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Biodiversity for Food and Nutrition: Edible Wild Plant Species of Aegean Region of Turkey

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ABSTRACT: *In Turkey wild edible plants have been used in dietary as a source of food from prehistoric times onwards. The wild plants are common in Turkish cuisine and they are eaten raw, consumed after cooking, dried before use, consumed after processing. However they have different uses in different areas of the country. Wild edible plants have been widely consumed in Aegean region where the traditional foods are still cooked and even served at the local restaurants. The study was developed on the edible wild plants in Aegean Region of Turkey as a multi-disciplinary approach to gather data on the traditional uses of wild edibles; to improve the conservation and use of agricultural biodiversity for food and nutrition, as well as to build support for biodiversity conservation and enhanced well-being by providing evidence and raising awareness of the nutritional value of this diversity and its importance in food-based approaches to tackle unhealthy dietary. Eleven species of wild edible plants of Aegean Region have been prioritized in this study. Surveys were conducted in Izmir, Aydın, Muğla and Balıkesir to determine the baseline status of community biodiversity for food and nutrition, dietary diversity and traditional knowledge. The previous studies conducted on edible plants were the baseline of the survey. The ethno-botanic and socio-economic surveys were conducted at the selected ecological sites in the villages, local markets, local restaurants as well as supermarkets. The socio-economic studies were conducted for detail data with monographic technic. Surveys were carried out to generate the idea on marketing opportunity, to assist to obtain the information for the development of policy to upload the relevant information about the traditional knowledge. During surveys ethno-botanical information and the different type of dishes of wild edible plants were recorded. The data recorded from face to face questioners with 541 collector and 584 consumers for the conclusion of process from harvest to consumption. In the Aegean region, the majority of consumers stated that they consumed wild species 1-2 times a week. The collected amount varies according to the type of market. Some species are usually collected for commercial purposes. Samples were also collected for taxonomic identification and for further study on nutritional value priority species. Awareness activities have been conducted, leaflets, brochures were prepared and disseminated. Over 100 species of wild edible plants and over have been recorded from the study region.*

Keywords: *Wild edible plants, Aegean Region, socio-economic studies, traditional knowledge, ethno-botanical study.*

Beslenme ve Gıda için Biyoçeşitlilik: Ege Bölgesi'nin Yenilebilir Yabani Bitki Türleri

ÖZ: *Türkiye'de yenilebilir yabani bitkiler, tarih öncesi çağlardan beri besin kaynağı olarak diyette kullanılmıştır. Yenilebilir yabani bitkiler Türk mutfağında yaygındır ve bazıları pişmeden çiğ, tüketilirken, bazıları pişirilir, kurutulur ya da, işleme tabi tutulduktan sonra tüketilirler. Bununla birlikte, yenilebilen yabani türler ülkenin farklı bölgelerinde farklı kullanımlara sahipler. Ege Bölgesi'nde yabani yenilebilir bitkiler yaygın olarak tüketilmekte, geleneksel yiyecekleri hala pişirilmekte ve hatta yerel restoranlarda servis edilmektedir. Çalışma, Ege Bölgesi'ndeki yenilebilir yabani bitkilerin, geleneksel kullanımları hakkında veri toplamak için çok disiplinli bir yaklaşımla düzenlenmiştir. Çalışma, Gıda ve beslenme için tarımsal biyoçeşitliliğin korunması ve kullanımını iyileştirmenin yanı sıra, bu çeşitliliğin besin değeri ve gıda temelli yaklaşımlardaki*

önemi hakkında kanıt sağlayarak ve farkındalık yaratarak biyoçeşitliliğin korunması, sağlıksız diyetle mücadele ve refah düzeyinin arttırılması için destek oluşturmayı amaçlamaktadır. Bu çalışmada Ege Bölgesi yenilebilir yabani bitkilerin 11 türü öncelik verilmiştir. Gıda, beslenme, diyet çeşitliliği ve geleneksel bilgi için yerel biyolojik çeşitliliğinin temel durumunu belirlemek üzere İzmir, Aydın, Muğla ve Balıkesir'de anketler yapılmıştır. Yenilebilir bitkiler üzerinde yapılan ön çalışmalar anketin temelini oluşturmuştur. Etno-botanik ve sosyo-ekonomik anketler köylerde, yerel pazarlarda, lokantalarda ve süpermarketlerde seçilen ekolojik alanlarda gerçekleştirilmiştir. Sosyo-ekonomik çalışmalar, monografi tekniği ile ayrıntılı veriler için yürütülmüştür. Geleneksel bilgi ile ilgili bilgileri kaydetmek, politikanın geliştirilmesi için bilgi edinmeye yardımcı olmak amacıyla pazarlama fırsatı fikrini üretmek için anketler yapılmıştır. Anketler sırasında etno-botanik bilgi ve yenilebilir yabani türlerin farklı yemekleri kaydedilmiştir. Anketler, yüz yüze olarak hasattan tüketime geçiş sürecinde 541 koleksiyoncu ve 584 tüketiciyle yapılmıştır. Ege Bölgesi'ndeki tüketicilerin çoğunluğu haftada 1-2 kez yabani türleri tükettiklerini belirtmiş olup, Toplanan miktar piyasa türüne göre değişiklik göstermiştir. Bazı türlerin genelde ticari amaçlı olarak toplandığı belirlenmiştir. Öncelikli türler üzerinde taksonomik tanımlama ve beslenme değeri analizleri örnekler de toplanmıştır. Bilinçlendirme çalışmaları yapılmışı, broşürler hazırlanmış ve yayınlanmıştır. Çalışma bölgesinde 100'den fazla yabani yenilebilir bitki türü kaydedilmiştir.

***Anahtar Sözcükler**: Yabani yenilebilir bitkiler, Ege Bölgesi, sosyo-ekonomik çalışmalar, geleneksel bilgi, etno-botanik çalışma.*

INTRODUCTION

In Turkey wild edible plants (WEP) have been used as a source of food from ancient times onward. Although wild species are known to have played an important role in the regional economies and edible plant species may have different uses in different areas of the country (Tan and Taskın, 2009, 2011). The nutritional properties of edible wild plant and mushroom species are indicated in various studies (Etkin, 1996; Ayan *et al*., 2006; Aslantas *et al*., 2007; Ozbucak *et al*., 2007; Tan and Taskin, 2009; Ozen, 2010; Caglarirmak, 2011; Adanacioglu *et al.*, 2016). Local people as well as people in the cities nowadays utilize wild plants and mushrooms as food and for other use also (dye and for medical purposes) (Baytop, 1999). Local people given local names to the wild plants grow in surroundings villages (Cakilcioğlu and Turkoglu, 2010). There are various references to the various uses of plants in Anatolia in the old Hittite texts (Ertem, 1987). Recent studies have indicated that several basic food plants were first domesticated in Anatolia. However, the domestication of plants and cultivation of many species never decreased the demand of wild plant gathering. Gathering was one of the oldest traditions in Anatolia. Very earliest inhabitants used plants for food, fuel and medicine, formed traditional knowledge and passed on this heritage from one generation to the next and from one area to another. The wild edible plants and wild edible mushrooms are common in Turkish cuisine and they are used in pie (Borek in Turkish), either eaten raw, boiled, fried in oil or baked to be served as dishes such as stew, stuffed and rolled vegetables or as cold or hot drinks for certain occasions and seasons (Tan and Taskin, 2009, 2011; Adanacıoglu *et al.*, 2016).

The study on the edible wild plants WEP of Aegean Region (West of Turkey) was developed within the frame work of Biodiversity for Food and Nutrition Project as a multi-disciplinary research to gather data on the traditional uses of plants as well as to improve the conservation and use of agricultural biodiversity for food and nutrition by providing evidence and raising awareness of the nutritional value of this diversity and its importance in food-based approaches to tackle unhealthy dietary.

MATERIALS AND METHODS

The materials of this study were the edible wild species in western part of Turkey (Aegean Region of Turkey).

Surveys were conducted to determine the baseline status of community biodiversity for food and nutrition, dietary diversity and traditional knowledge. The previous studies conducted on edible wild plants (Tan and Taskin, 2009; Tan, 2010; Tan and Taskin, 2011) were the baseline of the survey. In according to information gathered from the

previous studies and also from the pre-survey about the wild edible plants and land races of local crops, the plants to be studied were selected (Table 1). From the pre-survey the sites where traditional uses of wild plants for food are very common were also selected. So, Izmir, Balikesir, Aydın and Mugla Provinces of west part of Anatolia were selected the study sites.

The pre-survey was carried to determine the edible wild plants used as food by village people in Western Anatolia. Study was mainly conducted in the villages, local markets as well as supermarkets to collect the information about the plant and their use. The local markets were visited and the wild edible plants sellers were interviewed. The famous local restaurants serve the foods cooked from the wild edible plants were visited to get the information about the use and local cooking. Information from super-markets was also collected for the packed and marketed wild vegetables. In the face-to-face interviews conducted with the local people, the wild plants they consumed as food were listed. The plant parts used by the locals and their methods of food preparation and usage were recorded.

The second step of survey was to identify the sites for the sampling of the selected species for the analysis of the nutritional values. The sampling was carried in according to the sampling protocol that describes the sampling process. Sampling Form was prepared and filled during collecting of samples which contains information about species names, sampling region, origin of sample, sampling date etc.

The taxonomic determination of the collected plants was carried out according to "Flora of Turkey and the East Aegean Islands" (Davis, 1965-1985; Guner *et al.,* 2000). The herbarium specimens were conserved at Aegean Agricultural Research Institute (AARI) Herbarium.

The ethno-botanic and socio-economic surveys were conducted at the selected ecological sites of Aegean Region, to get more information on the prioritized wild plant species. Socio-economic study was planned to investigate in detail the process from the collection to consumption for the aim of analysis and conclusion of process from collection/harvest to consumption; generate the idea on marketing opportunity; to upload the relevant information about the traditional knowledge on use of wild edible plants. Monographic research technique was used in the study. Information on this technique was obtained through questionnaires. At the same time, preliminary data collection work was carried out in selected areas in villages and markets.

Survey interviews techniques was preferred for questioning. The interview is data collection techniques via verbal communication.

The information was collected on the consumption of target Agricultural Biodiversity (AgBD) and local uses and traits of prioritized AgBD, as well as the data on associated traditional knowledge of targeted AgBD from local people in various ages who are collected the wild plants for family consumption or for selling the local markets. Information especially about the harvesting sites and villages for the plants and species were recorded.

The interview were started to determine the baseline status of local biodiversity for food and nutrition, dietary diversity and traditional knowledge.

The questionnaires were comprised:

1. Village information form
2. WEP species questionnaire collector survey
3. WEP consumer survey

Questionnaires were done on village base (Village Questionnaire), species base for collectors and for consumers. All gathered information was recorded into the project databases which were linked with the National Plant genetic Resources Data Bases. An inventory of wild edibles was also produced from that information.

RESULTS AND CONCLUSIONS

According to the results of that study WEPs have been widely consumed in Aegean region. Thus, ethno-botanical knowledge is still alive in the study. However, the use of wild edible plants is generally widespread among elderly people in the rural area. Some information gathered from survey for the studied species were given in Table 1. Over 100 species of wild edible plants and over have been recorded from the study region.

Seasonal vegetables derived from wild plants are sold in local markets in villages and markets or street vendors in the cities and towns. In villages local people collect wild plants for their home consumption and for selling in the markets (Tan and Taskin, 2009, 2011). Generally, collectors collect the wild plants for income since they are low-income families. The highest consumption is usually in the places of the villages where those plants are grown. Traditionally consumed known species are found in the local markets. Those species are usually send to the nearest town to sold in local markets or send directly to the consumers. A species consumed in a village or in a county may not be recognized and not consumed in the neighboring village or district.

According to the results of that study wild edible plants have been widely consumed in Aegean region. Thus, ethno-botanical knowledge is still alive in the study. However, the use of wild edible plants is generally widespread among elderly people in the rural area.

During the surveys over ninety species are determined which are gathered and consumed as vegetables in the study areas. The selected WEP species, their used part, the purpose of consumptions is given in Table 1. Within the edible plants, leaves, stems and flowers were the plant parts most widely used. The wild edible plants are consumed in many different ways and are prepared using diverse recipes according to local traditions. Some of them are eaten raw or as salad, and some others eaten cooked and thus require a more or less complex preparation process. Within the study areas in the most localities, most plants with edible leaves, roots, or fruits are eaten raw (e.g., *Rumex acetosella* leave). The majority of these plants are eaten fresh, directly after they are gathered. Many of them (e.g., *Foeniculum vulgare*, *Crithmum maritimum*, *Raphanus raphanistrum, Cichorium intybus*) are used in salads and dressed with olive oil and lemon or are eaten with yogurt. A number of plants are gathered and preserved to be stored and consumed on longer periods of the year (sometimes all year round, e.g., deepfreezed roots of *Scolymus hispanicus*, pickled *Crithmum maritimum*). Many of the wild edible plants have been eaten cooked. Some plants are consumed fried or roasted in olive oil (e.g., *Foeniculum vulgare, Opopanax hispidus, Rumex acetosella, Cichorium intybus*) and especially used in an omelette (e.g., *Cichorium intybus, Glebionis coronaria*) and a number of wild edible plants are used in traditional recipes. For example, the leaves of *Beta vulgaris* subsp. *maritima* (L.) Arcang*., Smyrnium olusatrum* and some others are used as filling for a traditional pie called in Turkish ‘börek’. The leaves of *Beta maritima*, are also used to make stufed (sarma), in which the boiled leaves are filled with rice and/or minced meat, and condiments and made into rolls before cooked and eaten with yogurt. Several parts of some wild edible plants like *Raphanus raphanistrum* are also used traditionally for soup called çorba in Turkish.

Some of the studied WEPs are also indicated to use for medicinal purposes by local people said to be a folk remedy (e.g., *Scolymus hispanicus* for renal diseases, like kidney stone; *Opopanax hispidus* for blood purifier; *Salicornia emericii* and *Crithmum maritimum* for goiter; an ointment is made from the *Cichorium intybus* leaves for wound healing; *Foeniculum vulgare* stomach disorders).

For the socioeconomic analysıs total 1125 consumers and collectors were surveyed. The details were given in Table 2. In the Aegean region, the majority of consumers stated that they consumed wild species 1-2 times a week. The collected amount varies according to the type of market. Some species are usually collected for commercial purposes.

Table 1. The wild edible plants studied in Aegean Region.
Çizelge 1. Ege Bölgesi'nde çalışılan yenilebilen yabani bitkiler.

Family Familya	Botanical name Botanik adı	English name İngilizce adı	Turkish name Türkçe adı	Local Names Yerel adları	Parts used Kullanılan kısmı	The way to consume Kullanımı
Amaranthaceae	*Beta vulgaris* subsp. *maritima* (L.) Arcang.	Sea beet	Kıyı pancarı	Deli pazı, yabani pancar, yaban pazısı, ova mancarı, pezik, deniz pancarı, dağ pancarı, kır pazısı, zık, yaban pancarı, kara mancar, deli ıspanak, yaban ıspanağı,	Rosette leave	Stuffed, pancake, pie, raw with salad, roasted. meal
Amaranthaceae	*Salicornia emericii* Duval-Jouve, Lectotype:*Salicornia europaea* L.	Glasswort or samphire	Deniz börülcesi	Kurşun otu, tuzlu ot, geren otu	Young plant	raw, stew, salad
Apiaceae	*Crithmum maritimum* L.	Rock samphire	Deniz teresi, Kaya koruğu	Deniz marulu, deniz otu, ada börülcesi, genevir, kereviz otu	Young plant and leave	stew, pickle, salad, omelet
Apiaceae	*Foeniculum vulgare* Mill.	Fennel	Arapsaçı	Rezene, çaşır, çaşıra, kokar ot, malatura, erezene, raziyane, sıra, marata	Whole plant	meal, roasted, pilaf, seasoning
Apiaceae	*Opopanax hispidus* (Friv.) Gris.		Kaymacık,	Sarı ot, sarı bacı, kaymaklık, kaymak otu, kırk sıralı, gaymecik, tülü ot	Young basal leave	meal, roasted, omelet
Apiaceae	*Smyrnium olusatrum* L.	Alexanders	Deli kereviz	Yabani kereviz, baldıran	Shoot and leave	stew, pie, salad, roasted, meal, fry
Asteraceae	*Glebionis coronaria* (L.) Spach Syn: *Chrysanthemum segetum* L.	Crown daisy	Ala gömeç	Ale gümeci, sarı papatya, öküz gözü, koyun gözü, yabani krizantem	Young sprouts	stew, salad, roasted, meal, omelet
Asteraceae	*Cichorium intybus* L.	Wild mustard	Hindiba	Hindibag, yabani hindiba, kara hindiba, tatlı hindiba, ak hindiba, günek, güneyik, yatlı günek, ak günek, radika, bahçe radikası, altlık, çatlangoz	Whole plant	meal, salad, omelet
Asteraceae	*Scolymus hispanicus* L.	Golden thistle	Şevketi bostan	Akkız, akçakızı, altın dikeni, ak dikeni, diken otu,çetmi dikeni, sarı diken, sütlü diken, süt dikeni, güzel hisar dikeni	Roots, young leaves	stew, salad, soup, omelet, meal
Brassicaceae	*Raphanus raphanistrum* L.	Wild radish	Eşek turpu	Turpotu, yaban turpu yabani turp, çalgıcı otu, yabani hardal	Shoot and leaf	roasted, salad, meal, omelet, stew, soup
Polygonaceae	*Rumex acetosella* L.	Sorrel	Kuzukulağı	Ekşi kuzukulağı, lutka, ekşi kulak, eğşimene, ekşice, ekşimik, ekşilik ekşimelek, ekşimek, ekşimen, turşu otu, ebem ekşisi, ebenekşisi, oğlak kulağı, küçük kuzukulağı	Leaf	roasted, stuffed, pie, soup, meal, salad

Wild edibles amount per household and annual consumption amounts per capita in Aegean Region for prioritized species in Aegean Region are shown in Table 3. The data we have presented here showed that gathering, processing and consuming wild edible plants are still important activities in west Anatolia. The consumption of wild edible plants is an addition or a complement to a diet of cultivated food plants, while the quantity and quality of traditional knowledge varies slightly among the studied region. With change in nutritional habits and the influence of contemporary western life style, interest of younger generation has seemed declined to the traditional knowledge necessary to identify, gather and process these species. However, in the cities the habit to consume the natural foods for health reason, in the markets the wild edible foods are sold and consumption of those getting increased. So even big firms are collected and packaged to sell in the supermarkets. In the region acquisition of economic benefits from species might promote local people's interest in conservation and maintenance of such locally important and threatened species. Sustaining wild edible plants is meaningful only if conservation efforts take into account the food plants inextricable connections with cultural heritage (Tan and Taskın, 2011).

Young people should be included when recruiting participants to ethnobotanical studies or to any type of consultation about WEP. The habit of using wild edible plants is still alive and is a traditional culinary practice that demonstrates rich traditional knowledge of local people. WEP were found to be important for livelihood as well as showing great potential for crop improvement. Priority species should be promoted for income generation activities through sustainable collection and trade. Communities should engage in minimizing the threats to these valuable resources.

Table 2. Number of survey carried out in Aegean Region.
Çizelge 2. Ege Bölgesinde yürütülen anket sayısı.

Number of Provinces Surveyed	4
Number of Counties Surveyed	19
Number of Site Surveyed	48
Number of Consumer Surveyed	584
Number of Collector Surveyed	541

Table 3. Wild edibles plants amount per household and annual consumption amounts per capita in Aegean Region.
Çizelge 3. Ege Bölgesi'nde yenilebilen yabani bitkilerin hane başı ve kişi başı yıllık tüketimi.

Wild edible plants Yenilebilir yabani türler	Engilish name İngilizce adı	Consumption per household (kg/year) Hane başı tüketim (kg/yıl)	Consumption per capita (kg/year) Kişi başı tüketim (kg/yıl)
Smyrnium olusatrum L. Baldıran/Deli kereviz	Alexanders	11.5	3.5
Salicornia emericii Duval-Jouve Deniz börülcesi	Glasswort or samphire	13.9	3.8
Raphanus raphanistrum L. Eşek turpu	Wild radish	15.0	4.0
Beta vulgaris subsp. *maritima* (L.) Arcang. Kıyı pancarı	Sea beet	11.1	3.0
Foeniculum vulgare Mill. Arapsaçı	Fennel	10.2	2.7
Crithmum maritimum L. Deniz teresi/kaya koruğu	Rock samphire	11.0	3.5
Cichorium intybus L. Hindiba	Chicory	9.4	2.6
Opopanax hispidus (Friv.) Gris. Kaymacık	Yellow herb	7.4	2.2
Rumex acetosella L. Kuzu kulağı	Sorrel	7.1	1.9
Glebionis coronaria (L.) Spach Alagömeç	Crown daisy	4.2	1.4

In addition to food value to the local people, the documented species are marketable and can provide the opportunity to supplement household income of rural people with limited economic opportunities. The survey of trade centers showed that many species possess potentialities for livelihood enhancement and socio-economic development by making widely popular value added products that could be easily sold.

Having surveyed WEP in a relatively large area, our study provides empirical evidence about diversity and status of WEP, as well as methodological insights about the proper knowledge holders to consult. Our results showed that WEP are not only sources of food and nutrients to the local communities, but could also be means of income generation, if managed sustainably. We also highlighted the potential species that could be used in genetic improvement of crop species. Several WEP can benefit local people not only as food, but also for their medicinal properties. These multi-valued resources are threatened by several anthropogenic and natural causes such as land-use change, habitat destruction, over-harvesting, over-grazing, and invasive species. Therefore, sustainable management of these resources for the wellbeing of the local communities as well as to conserve biodiversity is of the utmost importance and could also contribute to preserve cultural and genetic diversity. Inclusion of WEP in community forest management plans would be the most realistic conservation and livelihood approach for the study areas as most forests are managed by community forest user groups.

Our study also revealed an intriguing finding about WEP knowledge holders that will be very important to consider when designing samples to study WEP. Elders are often consulted and young people are generally ignored in ethnobotanical studies, but we demonstrated that young people who spend most of their time in the forests herding animals and foraging wild food hold WEP knowledge that older people do not hold. Therefore, ignoring young people during WEP surveys might result in the omission of valuable information.

REFERENCES

Aslantas, R., L. Pirlak, and M. Guleryuz. 2007. The Nutritional Value of Wild Fruits from the North Eastern Anatolia Region of Turkey. Asian Journal of Chemistry 19 (4): 3072-3078.

Adanacioglu, N., U. Yildiz, E. Ogur, L. Aykas, A. Tan ve T. Taylan. 2016. Türkiye Makromantar Genetik Kaynakları I. Ege Bölgesi. ANADOLU, J. of AARI 26 (1): 46-61.

Ayan, I., Z. Acar, H. Mut, U. Basaran, and O. Aşçı. 2006. Morphological, Chemical and Nutritional Properties of Forage Plants in a Natural Rangeland in Turkey. Bangladesh J. Bot. 35 (2): 133-142.

Baytop, T. 1999. Türkiyede Bitkiler ile Tedavi: Geçmişte ve Bugün (Therapy with medicinal plants in Turkey: *In* the past and present). 2nd ed., Nobel Tip Kitabevleri, Istanbul.

Caglarirmak, N. 2011. Edible Mushrooms: An Alternative Food Item. *In*: Proceedings of the 7th International Conference on Mushroom Biology and Mushroom Products (ICMBMP7).

Cakilcioglu, U., and I. Turkogu. 2010. An ethnobotanical survey of medicinal plants in Sivrice (Elazığ,Turkey). Journal of Ethnopharmacology 132 (1): 165-175

Davis, P. H. 1965-1985. Flora of Turkey and the East Aegean Islands Vol. 1-9. Edinburgh University Press, Edinburgh

Etkin, N. 1996. Medicinal cuisines: Diet and ethnopharmacology. International Journal of Pharmacology 34 (5): 313–326.

Ertem, H. 1987 Boğazköy Metinlerine Göre Hititler Devri Anadolusu'nun Florası, 2. baskı, Türk Tarih Kurumu Yayinlari Ankara.

Guner, A., N. Ozhatay, T. Ekim, and K. H. C. Baser. 2000. Flora of Turkey and Aegean Islands. Vol. 11 (Suplement 2). University Pres. Edinburg.

Ozbucak, T. B., O. Ergen, and A. S. Yalcin. 2007. Nutrition Contents of the Some Wild Edible Plants in Central Black Sea Region of Turkey. International Journal of Natural and Engineering Sciences 1: 11-13.

Ozen, T. 2010. Antioxidant activity of wild edible plants in the Black Sea Region of Turkey. Grasas y Aceites 61 (1): Enero-Marzo, 86-94. ISSN 0017-3495. DOI No: 10.3989/gya. 075509.

Tan, A. 2010. State of Plant Genetic Resources for Food and Agriculture. Second Report of Turkey on Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture), Meta Basım. Bornova (Turkish and English). ETAE Yayin No: 142. ISBN 978-975-407-292-1.

Tan, A., and T. Taskin. 2009. Ege Bölgesinde Sebze Olarak Kullanılan Yabani Bitki Türleri ve Kullanım Amaçları. (Edible Wild Species used as Vegetables in Aegean Region) Ege Tarımsal Araştırma Enstitüsü Müdürlüğü Yayın no: 136. 174 s. ISBN: 978-975-407-278-5.

Tan, A., and T. Taskin. 2011. Some edible wild plants of Turkey and their use. Transaction of the International Scientific Conference “Actual Problems in the Use of Useful Plants”. Proceeding. 26-28. October. 2011. Baku, Azerbaijan.

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Mediterranean Region Studies of Mainstreaming Biodiversity Conservation and Sustainable Use for Improved Human Nutrition and Wellbeing Project

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ABSTRACT: *"Mainstreaming biodiversity conservation and sustainable use for improved human nutrition and wellbeing" project is being carried out in three pilot sites in Turkey. Mediterranean pilot site contains high mountain steps of Taurus Mountains and Central Anatolian steps where transition zone between Irano-Turanian and Mediterranean biogeographic regions exists. This site has highest endemism rate in Turkey. Mediterranean pilot site includes 4 cities as Antalya, Konya, İçel and Karaman include 17 districts and 31 villages. In the Mediterranean Region 20 taxa; 16 of them using for nutrition, 3 of them using as folk medicine 1 is local race (cultivated). People in the rural area use many plant for nutritional and medical purpose. These species have been selected and collected from nature and local bazaars. Plant materials have been sent to the Bursa Food and Forage Control Central Research Institute for content analysis, Proximities, dietary fiber, vitamins and minerals were assayed using standard methods and reference materials. Plants are analyzed to the Western Mediterranean Agricultural Research Institute, Medicinal and Aromatic Plants Central Research Institute for antioxidant properties. Antioxidant activity analysis (two method using) was completed for all priority species of the project. The antioxidant activity analyses were done according to the DPPH and TEAC methods.*

Keywords: *Wild edible plants, Mediterranean Region, medicinal food, biodiversity, traditional knowledge, socio-economic surveys.*

İnsan Beslenmesi ve Refahının İyileştirilmesi için Biyoçeşitliliğin Korunması ve Sürdürülebilir Kullanımının Yaygınlaştırılması Projesi Akdeniz Bölgesi Çalışmaları

ÖZ: *"İnsan Beslenmesi ve Refahı İçin Biyolojik Çeşitliliğin Korunması ve Sürdürülebilir Kullanımı" projesi Türkiye'de üç pilot bölgede yürütülmektedir. Akdeniz pilot bölgesi, İran-Turan ve Akdeniz biyocoğrafik bölgeleri arasındaki geçiş bölgesinde bulunduğu Toros Dağlarının yüksek dağ steplerini ve Orta Anadolu steplerini içerir. Bu bölge endemik olarak en yüksek orana sahiptir. Akdeniz'de pilot bölgesinde 4 il; Antalya, Konya, İçel ve Karaman'da 17 ilçe ve 31 köy çalışılmıştır. Akdeniz Bölgesi'nde bulunan 20 takson; Bunlardan 16'sı beslenme için, 3'ü halk hekimliği ve 1'i yerel tür (yetiştirilen) olarak kullanılıyor. Kırsal alanda yaşayan insanlar, beslenme ve tıbbi amaçla birçok bitki kullanıyorlar. Bu türler doğadan ve yerel pazarlardan seçilmiş ve toplanmıştır. Bitki materyalleri içerik analizi için Bursa Yem ve Yem Kontrol Merkezi Araştırma Enstitüsüne gönderildi. Beslenme değerleri, diyet lifi, vitaminler ve mineraller standart yöntemler ve referans malzemeler kullanılarak analiz edilmiştir. Bitkilerin, Batı Akdeniz Tarımsal Araştırma Enstitüsü, Tıbbi ve Aromatik Bitkiler Merkezi Araştırma Enstitüsü'nde antioksidan aktivite analizleri yapılmıştır. Projenin tüm öncelikli türleri için antioksidan aktivite analizi (iki yöntem kullanılarak) tamamlanmıştır. Antioksidan aktivite analizleri için DPPH ve TEAC yöntemleri kullanılmıştır.*

Anahtar Sözcükler: *Yabani yenilebilir bitkiler, Akdeniz Bölgesi, tıbbi gıda, biyoçeşitlilik, geleneksel bilgi, sosyo-ekonomik anketler.*

INTRODUCTION

It has been estimated that there are some 8.7 million eukaryotic species on earth of which some 25% (2.2 million) are marine, and most of them have yet to be discovered (Mora *et al*. 2011). Wild biodiversity has an important role in contributing to food production and security in many agroecosystems worldwide (Scoones *et al*., 1992; Johns and Maundu, 2006; Turner *et al*., 2011; Dogan, 2012; Mavengahama *et al*., 2013; Vinceti *et al*., 2013; Powell *et al*., 2014; Achigan-Dako *et al*., 2014; Vira *et al*., 2015).

There is an increasing public awareness that nutrition and dietary components have a very relevant contribution to personal well-being and health (Biesalski *et al*., 2011). In the case of non-cultivated traditional vegetables, despite its intermingled nutritional and medicinal role has been widely documented (Etkin, 1996; Carvalho and Morales, 2010; Guarrera, 2003; Heinrich *et al*., 2005; Pardo-de-Santayana *et al*., 2005).

A recent survey summarizing information from 36 studies in 22 countries highlights that wild biodiversity still plays an important role in local contexts with around 90–100 wild species per location and community group. Based on some estimates, the use of wild food reached up to 300-800 species, although actual consumption and dietary intakes were not studied (Bharucha and Pretty, 2010).

The Project Objective is to strengthen the conservation and sustainable management of agricultural biodiversity through mainstreaming into national and global nutrition, food and livelihood security strategies and programs.

Mediterranean pilot site includes 4 cities as Antalya, Konya, İçel and Karaman (Figure 1). This site contains high mountain steps of Taurus Mountains and Central Anatolian steps where transition zone between Irano-Turanian and Mediterranean biogeographic regions exists. Due to these variations, we have also shown the vegetation and agriculture of these regions to be as variable as the factors creating the climate, as well as how the hydrologic cycle and energy balance play a role in the climate of these regions.

In biogeography, the Mediterranean Basin (also known as the Mediterranean Region) is the region of lands around the Mediterranean Sea that have a Mediterranean climate, with mild, rainy winters and hot, dry summers which supports characteristic Mediterranean forests, woodlands and scrub vegetation.

This area is highest endemism rate in Turkey. Antalyahas got 2126 taxa, 572 is endemic, Mersin has got 1724 taxa, 399 is endemic, Karaman has got 331 taxa, 150 is endemic and Konya has got 1396 taxa 428 is endemic.

Figure 1. The study area of Mediterranean Region.
Şekil 1. Akdeniz Bölgesi çalışma alanları.

Mediterreanean Region is rich in biodiversity over 20 important plant areas. This selected 20 taxa; 16 of them using for nutrition, 3 of them using as folk medicine 1 is local race (cultivated).

Examples of our most important target species studied in the Mediterranean Region about the importance of the purpose and usage are given. Some of these; *Colocasia esculenta* (Taro) is an ancient food crop that was domesticated at least 9000 years ago, largely for its underground corm. All plant parts can be utilized. Its corms are baked, roasted or boiled; the leaves are frequently eaten as a vegetable and represent an important source of vitamins. The blades and petioles of leaves can be preserved or dried, and thereby become an important food in times of scarcity. Various plant parts are used for medicinal purposes (Rao *et al.,* 2010; Iosefa *et al.,* 2013). *Nasturtium officinale* R. Br. (watercress) is used to cure abdominal pain in Turkish folk medicine and is eaten as a vegetable and in salads in Turkey (Tuzlaci and Erol, 1999). *Chondrilla juncea* is used raw in salads. *Cichorium intybus* as vegetable is used raw and cooked and also medicinal uses as digestive disorders such as laxative, diuretic and invigorative, hypoglycemic, depurative, disinfectant of urinary tract, hepatoprotective, and in skin diseases (Morales, *et al.,* 2014). White lupine (*Lupinus albus* L.) crops were important to many Mediterranean civilizations and was domesticated in the Old and New World (Putnam *et al.,* 1993). The fiber-rich flour made from white lupine seeds are used by humans. The flour is a good source of macro- and micro-nutrients, protein, fat, carbohydrates, minerals, and vitamins (Yanez, 1996). It is used to enrich pastas, cake mixes, cereals, and other baked goods (Birk, 1993). Sweet white lupine flour is also added to emulsify meat products to increase its nutritional value, aroma and to modify texture (Erbas *et al*., 2005). Among them *Tragopogon porrifolius* L. known as white salsify is used as a vegetable in Europe as well as in Turkey (Formisano *et al.,* 2010; Baytop, 1999).

Table 1. Study area in the provinces of Antalya, Konya, Icel and Karaman.
Çizelge 1. Antalya, Konya, İçel and Karaman illerindeki çalışma alanları.

City (İl)	Antalya	Konya	Icel	Karaman
District (İlçe)	Gündoğmuş Akseki Korkuteli Elmalı Gazipaşa	Taşkent Beyşehir Derebucak Ereğli Halkapınar	Aslanköy (Erdemli) Mut Gülnar Tarsus Çamlıyayla	Ermenek Ayrancı
Species (Tür)	1. *Juniperus drupacea* Labill. (Andız, Pekmez ardıcı) 2. *Pyrus serikensis* Güner & H. Duman (Serik Armudu) 3. *Dioscorea communis* (L.) Caddick & Wilkin (Kuşkonmaz) 4. *Chondrilla juncea* L. (Gara gavruk) 5. *Colocasia esculenta* (L.) Schott (Gölevez)	6. *Eremurus spectabilis* M.Bieb. (Çiriş) 7. *Nasturtium officinale* R.Br., Aiton (Su teresi) 8. *Lupinus albus* L. (Termiye, Tirmis) 9. *Acorus calamus* L. (Eğir) 10. *Capparis spinosa* L. (Kebere, Kapari) 11. *Eriolobus trilobatus* (Labill. ex Poir.) At Elması 12. *Ferulago trachycarpa* Boiss. (Çakşır, çaşır) 13. *Berberis crataegina* DC. (Karamuk)	14. *Gundelia tournefortii* L. (Kenger)	15. *Ferula elaeochytris* Korovin (Çakşır) 16. *Scorzonera cana* (C.A.Mey.) Griseb (Dedem sakalı) 17. *Gypsophila arrosti subsp nebulosa (*Boiss. & Heldr.) Greuter & Burdet (Çöğen) 18. *Rhus corioria* L. (Sumak) 19. *Tragopogon porrifolius* subsp. *longirostris* (Sch.Bip.) Greuter (Yemlik) 20. *Cichorium intybus* L. (Güneyik, Karahindiba)

The roots and young shoots are used as vegetables (Zidorn *et al.,* 2010). Aerial parts of the *T. porrifolius* and also some of other *Tragopogon* species are known as Yemlik and Teke Sakalı in Anatolia and they are eaten freshly or after cooked (Turan *et al.,* 2003; Ugur *et al.,* 2009).The genera were also used as herbal medicine. *T. porrifolius*is used, in European folk medicine, for its antibilious, diuretic, laxative effects and in Lebanese folk medicine for treatment of cancer (Formisano *et al.,* 2010; Turner *et al.,* 2011). *E. spectabilis*, locally known as "Çiriş otu" is widely used in Turkey as a wild edible vegetable and has been traditionally used in folk medicine. Its tender shoots, buds and leaves have traditionally been used as vegetable in cooking in a wide variety of recipes. It is an important wild species for rural peoples both diets and livelihood. "Foxtail lilly" was selected as target species for the Mediterranean Region (Tugrul Ay *et al.,* 2017).

MATERIALS AND METHODS

Target species have been selected in the Mediterranean Region. Surveys to determine the baseline status of community biodiversity for food and nutrition, dietary diversity and traditional knowledge were completed.

Table 2.Sustainability indices of the species studied in Mediterranean Region.
Çizelge 2. Akdeniz Bölgesinde çalışlan türlerinin sürdürülebilirlik indeksleri.

Species Tür	English Name İngilizce adı	Economic sustainability Sürdürülebilirlik indeksi	Food and nutritional sustainability index Gıda ve Beslenmede sürdürülebilirlik indeksi	Environmental sustainability Çevresel sürdürülebirlik indeksi	Total sustainability Index Toplam sürdürülebilirlik indeksi
Eremurus spectabilis	Foxtail lily	3.21156	0.59666	3.75000	7.55822
Lupinus albus	White lupin	2.29029	0.22516	4.75000	7.26545
Nasturtium officinale	Watercress	3.02472	1.61955	3.00000	7.64427
Chondrilla juncea	Rush skeleton weed	1.00752	0.79003	2.00000	3.79755
Tragopogon porrifolius subsp. *longirostris*	Purple salsify	2.89138	1.61329	3.00000	7.50468
Cichorium intybus	Common chicory	1.84513	0.58130	3.25000	5.67643
Dioscorea communis	Black bryony	2.03036	0.73952	1.75000	4.51988
Scorzonera cana	N/A	2.58520	0.34298	3.25000	6.17818
Ferulago trachycarpa	N/A	1.64958	0.48755	1.75000	3.88712
Colocasia esculenta	Taro, Elephant ear	2.12922	0.06351	2.75000	4.94273
Gundelia tournefortii	Gundelia or Galgal, Tumbleweed	1.81846	0.22460	2.50000	4.54306
Rhus coriaria	Elm-leaved sumach	4.07692	1.79172	3.25000	9.11864
Capparis spinosa	Caper bush	2.11664	0.26996	5.00000	7.38660
Ferula elaeochytris	N/A	3.01317	2.13341	2.50000	7.64658
Gypsophila arrostii subsp. *nebulosa*	N/A	3.01678	2.30713	2.00000	7.32391
Pyrus serikensis	N/A	2.14113	0.71530	2.25000	5.10643
Eriolobus trilobatus	Crab apple	0.86411	0.25056	3.25000	4.36467
Juniperus drupacea	Syrian juniper	4.32255	0.11723	4.00000	8.43978
Acorus calamus	Calamus or Sweet flag	2.04037	1.96942	1.75000	5.75978
Gundelia tournefortii	Berberis	3.42933	1.97736	3.75000	9.15669

Ecological and socio-economical surveys to document information on wild edibles plants and underutilized species/ land races in the Mediterranean Region have been done.

Socio-economic data and traditional knowledge collected during the surveys and 2.334 questionnaires administered across the regions. During the surveys the information has been gathered to allow analyzing and concluding the baseline status of community biodiversity for food and nutrition from foraging to consume.

Surveys to determine the baseline status of community biodiversity for food and nutrition, dietary diversity and traditional knowledge were completed. The survey results allow us to analyze and conclude the duration from foraging to consume.

At the same time the gathered information results to evaluate the marketing opportunities and also to develop new policies as well as documenting the traditional knowledge of the priority species and other utilized species for food and nutrition.

Food consumption and anti-oxidant analysis were completed for all species. To ensure sample quality and prevent deterioration, samples were promptly sent to "The Central Research institute of Food and Feed Control in Bursa" where composite samples were produced by combining primary samples.

Table 3. Antioxidant activity analysis results of the species studied in Mediterranean Region.
Çizelge 3. Akdeniz Bölgesi'nde çalışılan türlerin antioksidant aktivite analiz sonuçları.

Sample English name Örnek İngilizce adı	Scientific name Bilimsel adı	Turkish name Türkçe adı	1/IC50* (DPPH)	STD	µM trolox equivalent t/g sample (Örnek) (TEAC)	STD
Syrian juniper	*Juniperus drupacea*	Andız	122.4	4.9	208.8	0.1
N/A	*Ferulago trachycarpa*	Kuzukemirdi	245.4	3.7	315.8	19.7
N/A	*Ferula elaeochytris*	Çağ	5.5	0.5	38.9	1.8
Foxtail lily	*Eremurus spectabilis*	Çiriş	170.0	2.5	168.9	5.1
N/A	*Gypsophila arrostii* subsp. *nebulosa*	Çöğen	4.0	0.1	31.2	0.5
N/A	*Scorzonera cana*	Tekesakalı	275.6	7.4	522.6	18.0
Calamus or Sweet flag	*Acorus calamus*	Eğir	21.0	0.1	117.9	0.1
Rush skeletonweed	*Chondrilla juncea*	Garakavruk	434.2	6.6	690.0	2.2
Crab apple	*Eriolobus trilobatus*	At e lması	4.4	0	38.3	1.5
Taro, Elephant ear	*Colocasia esculenta*	Göleviz	12.9	0.2	29.8	1.5
Caper bush	*Capparis spinosa*	Kapari	85.6	3.9	465.8	10.6
Common chicory	*Cichorium intybus*	Hindiba (Med.)	274.2	11.4	539.0	6.4
Berberis	*Berberis crataegina*	Karamuk	1380.6	14.2	2362.1	2.7
Gundelia or Galgal, Tumbleweed	*Gundelia tournefortii*	Kenger	145.1	11.0	284.1	4.1
Black bryony	*Dioscorea communis*	Dolambaç	47.0	0.7	303.5	11.6
N/A	*Pyrus serikensis*	Zingit (serikarmutu)	93.4	6.7	244.4	13.1
Elm-leaved sumach	*Rhus coriaria*	Sumak	1825.3	76.1	3055.6	20.4
Watercress	*Nasturtium officinale*	Suteresi	420.0	16.1	903.0	17.7
White lupin	*Lupinus albus*	Termiye	undetected	undetected	undetected	undetected
Purple salsify	*Tragopogon porrifolius* subsp. *longirostris*	Helevan (Yemlik)	192.6	11.9	220.7	7.5
		BHT**	2101.2	277.1	16651.9	59.0

*The reverse of the fresh plant value in terms of mg which inhibits 50% of the 1g DPPH radical.
**Butyrate hydroxyl toluene.

RESULTS AND DISCUSSION

The food composition analyses (Proximate composition of the edible parts of the samples; Moisture, Fat, Protein, Total available Carydrate, Ash, Fibre, Energy, Mineral element, vitamin B_1, B_2 and vitamin content of edible parts of the samples of Ca, Fe, Mg, P, Zn, K, Na, C, Vit C, Vit B_1, Vit B_2) results of all species have been evaluating for the assessments of nutritional value.

For the detail information to implement to the project component the case studies and best practices in the regions were planned.

Antioxidant activity analysis (two method using) was done for all priority species of the project. The antioxidant activity analyses were done according to the DPPH (1, 1-diphenyl-2-picrylhydrazyl) radical scavenging method and TEAC (Trolox Equivalent Antioxidant Capacity/ABTS Method). These methods were made by the Thermo Scientific™ Multiskan™ GO microplate reader supplied from the BFN Project. IC50 values were calculated from the concentration-effect linear regression curve (Cemeroglu, 2010; Ayas *et al.,* 2014, 2017). The analyses results and Standard deviation values of the 20 plants and 1 control (BHT) are given in the table below.

The radical scavenging effect values of *Rhus coriaria* (1825.3) and *Berberis crataegina* (1380.6) are the closest of BHT value (2101.2) according to the DPPH method, this shows that these plant species radical scavenging effect are higher than the others and they have natural antioxidant characteristic. The antioxidant capacity values (µM trolox equivalent/g sample) of *Rhus coriaria* (3055.6) and *Berberis crataegina* (2362.1) are the closest of BHT antioxidant value (16651.9) according to the TEAC method.

It is known that red-purple colored plant species which are rich in anthocyanins show antioxidant activity sweeping the DPPH and ABTS radicals, this case were seen in the analyses results. In addition, the greater the diversity of species you eat, the more likely you are to cover all your nutritional bases including complementarity effects.

All data collected from surveys and laboratory analysis were recorded in the relevant data based to link national portals and databases. Tools and guidelines for dissemination were prepared. The target species were determined for the further studies such as creating markets and value chain to use. The related regulations, programs, master plans were reviewed for the development of policy guidelines.

CONCLUSION

The ethno-botanic and socio-economic surveys were conducted at the Mediterranean Region in the villages, local markets, local restaurants as well as supermarkets. In order to obtain detailed socio-economic and traditional information on edible wild species and local varieties, preliminary surveys were conducted primarily in the region. The socio-economic studies were conducted for detail data with monograph technic. During surveys ethno-botanical information and the different type of dishes of wild edible pants were recorded. The data recorded from face to face questioners with 149 collector and 632 consumers for the conclusion of process from harvest to consumption. In the Mediterranean Region, the majority of consumers stated that they consumed wild species 1-2 times a week. Some species are usually collected for commercial purposes, some are only gathering for domestic consumption and there are no sales of these species in the local market.

In addition, awareness activities have been conducted to disseminate the results and promote our project studies. These activities are leaflets, brochures, posters were prepared and also information about the BFN project on various televisions is provided. The Mediterranean Region and also the target species of the project; 43 species of botanical drawing were made.

Rural areas in the Mediterranean Region (Turkey) wild edible foods are collected and used for home consumption or sold in local markets and medical purposes thus complementing people's diets and representing an additional income for many households

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REFERENCES

Achigan-Dako, E. G., O. E. Sogbohossou, and P. Maundu. 2014. Current knowledge on *Amaranthus* spp.: research avenues for improved nutritional value and yield in leafy amaranths in sub-Saharan Africa. Euphytica 197 (3): 303-317.

Ayas, F., R. Toker, N. Cinar, and F. Uysal. 2014. Alıç (*Crataegus orientalis*) yaprağında farklı ekstraksiyon uygulamalarının antioksidan aktivite, toplam fenolik madde ve flavonoid miktarları üzerine etkileri. Bildiri kitabı ss. 666-671. II. Tıbbi ve Aromatik Bitkiler Sempozyumu-Yalova 23-25 Eylül 2014.

Ayas, F., K. Yuksel, O. Cinar, F. A. Vuran, and S. Tugrul Ay. 2017. The Antioxidant Capacities of Wild Species Collected from Turkey within the GEF-funded Biodiversity for Food and Nutrition (BFN) Project. Abstract book p. 36. International Symposium on Biodiversity and Edible Wild Species. 3-5 April 2017, Antalya, Turkey.

Baytop, T. 1999. Türkiye'de Bitkiler ile Tedavi Geçmişte ve Bugüne. Nobel Tıp Kitabevleri s. 236-237.

Birk, Y. 1993. Anti-nutritional factors (ANFs) in lupin and other legume seeds: Pros and cons. p. 424-429. *In*: Martins and da Costa (eds.), Advances in lupin research. Proc. 7th Int. Lupin Conf. held at Evora, Portugal, 18-23 April.

Biesalski, H. K., P. J. Aggett, R. Anton, P. S. Bernstein, J. Blumberg, and R. P. Heaney. 2011. Scientic substantiation of health claims: evidence-based nutrition. Nutrition 27: S1-S20.

Bharucha, Z., and J. Pretty. 2010. The roles and values of wild foods in agricultural systems. Phil. Trans. R. Soc. B. 365: 2913-2926

Carvalho, A. M., and R. Morales. 2010. Persistence of wild food and wild medicinal plant knowledge in a north-eastern region of Portugal. In M. Pardo-de-San-tayana, A. Pieroni and R. Puri (Eds.), Ethnobotany in the new Europe: People, health and wild plant resources (pp. 147-171). Oxford, UK: Berghahn Books.

Cemeroglu, B. 2010. Gıda analizleri. Nobel Yayın Dağıtım, Ankara, s. 682.

Dogan, Y. 2012. Traditionally used wild edible greens in the Aegean Region of Turkey. Acta Societatis Botanicorum Poloniae 81: 329-342.

Etkin, N. L. 1996. Medicinal cuisines: diet and ethnopharmacology. International Journal of Pharmacognosy 34: 313-326.

Erbas, M., M. Certel,, and M. K. Uslu. 2005. Some chemical properties of white lupin seeds (*Lupinus albus* L.) Food Chemistry 89: 341-345.

Formisano, C., D. Rigano, F. Senatore, M. Bruno, and S. Rosselli. 2010. Volatile constituents of the aerial parts of white salsify *(Tragopogon porrifolius* L., Asteraceae), Nat Prod Res 24: 663-668.

Guarrera, P. M. 2003. Food medicine and minor nourishment in the folk traditions of Central Italy (Marche, Abruzzo and Latium). Fitoterapia 74: 515-544.

Heinrich, M., M. Leonti, S. Nebel, and W. Peschel. 2005. "Local food-nutraceuticals": an example of a multidisciplinary research project on local knowledge. Journal of Physiology and Pharmacology 56: 5-22.

Iosefa, T., M. Taylor, D. Hunter, and V. S. Tuia. 2013. Community Biodiversity Management (ISBN13: 978-0-415-50220-7), 285 p.

Johns, T., and P. Maundu. 2006. Forest biodiversity, nutrition and population health in market-oriented food systems. Unasylva 57: 34-40.

Mavengahama, S., M. Mc Lachlan, and W. De Clercq. 2013. The role of wild vegetable species in household food security in maize based subsistence cropping systems. Food Security 5 (2): 227-233.

Mora, C., D. P. Tittensor, S. Adl, A. G. Simpson, and B. Worm. 2011. How many species are there on Earth and in the ocean?. PLoS biology. 9 (8): e1001127.

Morales, P., I. C.F.R. Ferreira, A. M. Carvalho, M. C. Sánchez-Mata, M. Cámara, V. Fernández-Ruiz, M. Pardo-de-Santayana, and J. Javier Tardío. 2014. Mediterranean non-cultivated vegetables as dietary sources of compounds with antioxidant and biological activity. LWT - Food Science and Technology 55: 389-396-DOI: 10.1016.

Pardo-de-Santayana, M., J. Tardío, and R. Morales. 2005. The gathering and consumption of wild edible plants in the Campoo (Cantabria, Spain). International Journal of Food Sciences and Nutrition 56: 529-542.

Powell, B., A. Ouarghidi, T. Johns, M. I. Tattou, and P. Eyzaguirre. 2014. Wild leafy vegetable use and knowledge across multiple sites in Morocco: a case study for transmission of local knowledge?. Journal of Ethnobiology and Ethnomedicine 10 (1): 34.

Putnam, D. H., S. R. Simmons, and L. L. Hardman.1993. Vernalization and seeding date effect on yield and yield components of white lupin. Crop Sci. 33: 1076-1083.

Rao, P. J. Matthews, P.B. Eyzaguirre, and D. Hunter (eds). 2010. *The Global Diversity of Taro: ethno- botany and conservation,* Bioversity International, Rome, Italy, pp 185-201.

Scoones, I., M. Melnyk, and J. N. Pretty. 1992. Hidden Harvest: Wild Foods in Agricultural Systems. A. Literature review and annotated bibliography. IIED, UK.

Turner, N. J., L. J. Luczaj, P. Migliorini, A. Pieroni, A. L. Dreon, L. E. Sacchetti, and C. A. Tenkerian. 2011. Anticancer and antioxidant Effects of *Tragopogon porrifolius* extract, Master Thesis, Lebanon.

Turan, M., S. Kordali, H. Zengin, A. Dursun, and Y. Sezen. 2003. Macro and micro mineral content of some edible leaves consumed in eastern Anatolia, Acta Agr. Scand B-S P 53: 129-137.

Tugrul Ay, S., A. Cinar, F. Ayas, S. Karakabak, N. Guzelsoy, and O. Ucurum. 2017. Foxtail lilly (*Eremurus spectabilis* M. Bieb) as Priority Species of Biodiversity for "Food and Nutrition Project" of Turk*ey.* Abstract book p. 36. International Symposium on Biodiversity and Edible Wild Species. 3-5 April 2017, Antalya, Turkey.

Tuzlaci, E., and M. K. Erol. 1999. Turkish folk medicinal plants. Part II: Eğirdir (Isparta) Fitoterapia 70 (6): 593-610.

Ugur, A., N. Sarac, O. Ceylan, M. Emin Duru, G. Omken, and O. Varol. 2009. Chemical Composition of Endemic *Tragopogon oligolepsis* and Studies on the Antimicrobial Activity Against Multi- antibiotic Resistant Bacteria, Nat. Prod. Res. 24: 861-872.

Vinceti, B., A. Ickowitz, B. Powell, K. Kehlenbeck, C. Termote, B. Cogill, and D. Hunter. 2013. The contribution of forest foods to sustainable diets. Unasylva 64: 54-64.

Vira, B., C. Wildburger, and S. Mansourian. 2015. Forests, Trees and Landscapes for Food Security and Nutrition; A Global Assessment Report. IUFPRO World Series Volume 33. Vienna. 172p.

Yanez, E. 1996. Sweet lupin as a source of macro and micro nutrients in human diets. Proc. 8th Int. Lupin Conf., Pacific Grove, California. 11–16 May, 1996. Univ. California, Davis.

Zidorn, C, B. O. Petersen, V. Sareedenchai, E. P. Ellmerer, and J. O. Duus. 2010. Tragoponol a Dimeric Dihydroisocoumarin from *Tragopogon porrifolius* L., Tetrahedron Lett. 51: 1390-1393.

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Biodiversity for Food and Nutrition Project: Black Sea Region Studies

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ABSTRACT: *Although wild species, landraces and species diversity play an important role in global food security and are necessary for food safety and nutrition, they are very rarely included in daily diets. The "Biodiversity for Food and Nutrition" project, which aims to ensure sustainable use of agricultural biodiversity, was carried out in three pilot sites in Turkey. As part of the project, Kastamonu, Samsun and Sinop provinces were chosen as the pilot sites in the Black Sea Region. At the beginning of the project, ten wild edible species and a landrace were identified by the pre-surveys performed at the Black Sea pilot site. The samples of the species were collected from at least ten locations and analyzed to determine their nutritional content. Most of the wild edible species found to be intensively consumed in the Black Sea pilot site are rich in minerals, vitamins and fiber. Preliminary surveys were conducted to obtain socio-economic information and traditional knowledge on wild edibles. The monograph technique was used and detailed data were collected using questionnaires. The surveys were conducted by collecting species and meeting face-to-face with collectors and consumers. Questionnaires were administered to a sample of 111 collectors and 295 consumers. The survey results showed that the most well-known and consumed wild edible species in Sinop and Kastamonu is Kaldirik. Most of the consumers stated that they consume wild species once or twice a week. Preparation of necessary policies and legislation will be addressed on the basis of knowledge that was obtained from this project. Awareness-raising activities will be held with the stakeholders to strengthen the sustainable use of these species.*

Keywords: *Wild edible, landrace, biodiversity, nutrition, traditional knowledge, einkorn, Black Sea Region.*

Gıda ve Beslenme için Biyoçeşitlilik Projesi: Karadeniz Bölgesi Çalışmaları

ÖZ: *Yabani yenilebilir türler, yerel çeşitler ve tür çeşitliliği küresel gıda güvenliği ve beslenme için hayati önem taşısa da günlük beslenmemizde oldukça az yer tutmaktadır. Tarımsal biyoçeşitliliğin sürdürülebilir kullanımının sağlanmasını amaçlayan "Gıda ve Beslenme için Biyoçeşitlilik projesi" Türkiye'de üç pilot alanda yürütülmektedir. Bu amaçla Karadeniz bölgesi çalışma alanı için Kastamonu, Samsun ve Sinop illeri seçilmiştir. Projenin başlangıcında, Karadeniz bölgesinde yapılan ön çalışmalarla on yenilebilir yabani tür ve bir adet yerel çeşit seçilmiştir. Bu türler besin içeriklerinin belirlenmesi için en az on noktadan toplanmıştır. Analiz sonuçlarında Karadeniz'de yaygın olarak tüketilen türlerin çoğunun mineral, vitamin ve lif açısından zengin olduğu görülmüştür. Hedef türlere ait sosyoekonomik ve geleneksel bilgilerin elde edilmesine yönelik ön*

araştırmalar yapılmıştır. Anketlerde monografi tekniği kullanılarak detaylı bilgi elde edilmiştir. Toplama ve anket çalışmalarında toplayıcı ve tüketicilerle yüz yüze görüşmeler yapılmıştır. Anket çalışmalarında toplam 111 toplayıcı ve 295 tüketici ile görüşülmüştür. Yapılan çalışmalar sonucunda Sinop ve Kastamonu'da en çok bilinen ve tüketilen yabani yenilebilir türün Kaldirik olduğu anlaşılmıştır. Çoğu tüketici yabani yenilebilir türler haftada bir iki kez tükettiklerini ifade etmişlerdir. Gerekli politika ve mevzuatın hazırlanması konusu bu projeden elde edilen bilgilere dayanarak ele alınacaktır. Bu türlerin sürdürülebilir kullanımını güçlendirmek için paydaşlarla birlikte bilinçlendirme faaliyetleri düzenlenmektedir.

Anahtar Sözcükler: *Yabani yenilebilir, yerel çeşit, biyoçeşitlilik, beslenme, geleneksel bilgi, siyez, Karadeniz Bölgesi.*

INTRODUCTION

The world's population has been growing for several decades. Biodiversity is very important for meeting the nutritional needs of such a growing population. The growth of population causes a decrease in the food supplies. Therefore, sustainable use of wild edibles as a source of alternative nutrition is very important. For this purpose, the BFN Project (Biodiversity for Food and Nutrition) was carried out in the Black Sea Region (Kastamonu, Samsun and Sinop provinces), the Aegean Region (Izmir, Balikesir, Muğla and Aydın provinces) and the Mediterranean Region (Antalya, Konya, Içel and Karaman Provinces) of Turkey. Within the scope of this project, some studies on wild edibles and Einkorn were conducted in the Black Sea pilot site. This study aims to increase welfare of target users and to contribute to the improvement of food security by ensuring conservation and sustainable use of biodiversity for food and nutrition. The objective of the project is to ensure conservation of agricultural biodiversity and to strengthen its sustainable management through national and global nutrition, food and livelihood security strategies and programs.

The project also aims to create an integrated knowledge base about agriculture, environment and public health and to make it available to the use of the relevant sectors for the purpose of contributing to the conservation of biodiversity and improvement of welfare in four partner countries. Besides, promoting conservation and sustainable use of biodiversity across all sectors by means of policies (policy and strategy development), raising awareness of the importance of biodiversity in food and nutrition and developing tools and equipment that will help disseminating best practices at the local and national level (awareness raising and dissemination) are also among the aims of the project. Within the scope of the project, some pilot sites were defined and the target species in these areas were selected.

There are various studies conducted on alternative nutrition trends and traditionally consumed species to prevent the fast food consumption, especially in the developed countries. Additional assessment of the use of these species, found to be mostly consumed by the preliminary studies in the Black Sea pilot site will be helpful for the sustainable management of agricultural biodiversity and the passing down of traditional knowledge. Studies on the use of wild edibles and landraces, especially in the countries like Turkey where traditional knowledge is widely used are very important for ensuring the sustainable use of biodiversity and meeting the food needs of the growing population.

MATERIALS AND METHODS

MATERIALS

The project site, i.e. the Black Sea pilot site, is located in the Euro-Siberian biogeographic region and through the Irano-Turanian biogeographic region. The region is very mountainous and heavily forested and exhibits a rich fauna and flora with a high level of endemism. The people living in the rural areas use various plants for nutritional purposes. Therefore, the Black Sea pilot site was included in this project.

To identify the prioritized species, selection criteria for the wild edibles and landraces were set in 2013 at the beginning of the Project as follows potential in nutrition, market opportunities, multi-user functionality and traditional and modern use of the edible wild species and landraces. The information about the species was revised based on

the information gathered from each region by pre-surveys and the most common edible plants in each pilot site were determined.

11 different species were identified (Table 1) and the current data on these species were obtained via surveys, questionnaires, field observations and the studies in the related literature.

METHODS

Collection

In 2014, data collection and standardization of sampling protocols were completed. Training of the enumerators for the assessment of local biodiversity for food and nutrition was done and the related traditional information was collected. The sampling form including a detailed description of the collected species (their scientific name, their local name, sampling region and harvesting time) was used to record information. In this study, all collection activities were done under the rules of the FAO Gene Bank Standards (Anonymous, 2014). To ensure the quality of samples and to prevent deterioration, the samples were promptly sent to the Central Research Institute of Food and Feed Control in Bursa, where composite samples were produced by combining the primary samples.

Socio economic studies

The monographic research technique was used to examine in detail the process from the collection/ production of species to their consumption. Data collection was performed using questionnaires. Besides, a pre-data collection was conducted in the residential areas and the farmers markets. The sample size was selected purposefully in a way to represent the population. Surveys were conducted in 2014 in 8 districts of the pilot provinces of Kastamonu and Sinop. Totally 339 consumer, 143 collector/producer were surveyed (Table 2).

Questionnaires targeting local markets, local food restaurants, supermarkets and a selected number of villages in the Black Sea pilot site were conducted to document information on the trade and consumption of wild edibles and Einkorn and preparation and cooking methods and to assess the socio-economic importance of target biodiversity. Some information was also obtained from the wild edible plant collectors about the collection sites, harvesting seasons and the availability of landraces and wild edibles.

In summary, the village information form included the following information: altitude, geographical location, population and household information, immigration status, market information, cooperatives status, amount of land in the lands deemed as village, animal assets, crops grown in the village and wild edibles collected in the village.

The data was analyzed using the basic statistical techniques such as weighted mean, frequency distribution and proportional distribution. The analysis also provided preliminary data for the value chain analysis.

Table 1. Target species of the Black Sea Region pilot site.
Çizelge 1. Karadeniz Bölgesi pilot alanı hedef türleri.

	Family Familya	Botanical name Botanik isim	Turkish name Türkçe isim	English name İngilizce isim
1	Amaranthaceae	*Chenopodium album* L.	Aksirken	Lamb's quarters, melde
2	Apiaceae	*Aegopodium podagraria* L.	keçiayağı	Ground elder
3	Apiaceae	*Oenanthe pimpinelloides* L.	Deli maydanoz	Corky-fruited water-dropwort
4	Asparagaceae	*Ornithogalum umbellatum* L.	Sunbala	Star of Bethlehem
5	Boraginaceae	*Trachystemon orientalis* (L.) G. Don	Kaldirik	Eastern borage (oriental borage)
6	Brassicaceae	*Capsella bursa-pastoris* (L.) Medik.	Çobançantası	Shepherd' purse
7	Caryophyllaceae	*Silene vulgaris* (Moench) Garcke	Ecibücü	Bladder campion
8	Polygonaceae	*Rumex crispus* L	Labada	Curly dock
9	Polygonaceae	*Polygonum cognatum* Meissn.	Madımak	Knotgrass (knotweed)
10	Smilacaceae	*Smilax excelsa* L.	Dikenucu	Prickly ivy
11	Poaceae	*Triticum monococcum* L.	Siyez	Einkorn wheat

Table 2. The Statistics of the Survey at the Black Sea Region Pilot Area.
Çizelge 2. Karadeniz Bölgesi pilot alanı survey istatistikleri.

Number of Provinces Surveyed Survey yapılan il sayısı	2
Number of Counties Surveyed Survey yapılan ilçe sayısı	8
Number of Sites Surveyed Survey yapılan mahalle sayısı	50
Number of Consumers Surveyed Survey yapılan tüketici sayısı	339
Number of Collectors/Producers Surveyed Survey yapılan toplayıcı/üretici sayısı	143

Food Analysis

Ten wild edible species and a landrace were collected from at least ten locations and analyzed to determine their nutritional content. Various wild edible species and one landrace were found to have some key nutrients for a healthy diet, macronutrients, minerals and vitamins. Samples were collected from Kastamonu and Sinop in the Black Sea pilot site during the optimum harvesting time between March and April in 2014. The plant samples were transported to the laboratory using cold packs at refrigerated temperatures on the same day of collection in order to preserve the nutrient composition of samples.

For sample preparation, the inedible parts of plants were removed and the edible parts were rinsed with tap water for 1-2 min and then with distilled water for 1 min. After cleaning, the plant samples were homogenized and subsamples were prepared for analysis. Accepted standardized techniques were used for nutrient analysis. The analysis was performed at the Central Research Institute of Food and Feed Control located in Bursa.

Policy Frame work

Within the framework of the Biodiversity for Food and Nutrition Project, activities were carried out to develop policies for the improvement of the relationship between biodiversity and nutrition. Moreover, some activities were done to strengthen cooperation between researchers, farmers and consumers for the purpose of promoting the use and consumption of biodiversity products. Meetings and workshops were held with the municipalities, civilian authorities and non-governmental organizations in the region, and presentations were made during different activities. The importance of nutritional value of local species in human health and nutrition was emphasized. This helped increasing the existing knowledge of people and reintroducing the forgotten local species to the society.

As part of the policy component of the project, the BFN activities are well integrated into the national policy, i.e. the Ministry of Food, Agriculture and Livestock's (MFAL) strategy on agriculture for the period of 2013-2017. One of the main research areas established by the strategy is biological diversity and genetic resources and GDAR Agricultural Research Master Plan 2016-2020 with various Research Opportunity Areas which is related to BFN. The Master Plan encourages research activities on agricultural biological diversity related to traditional knowledge which is valuable for nutrition, food security and safety as well as agricultural production. Besides, the 10th Development Plan of Turkey for 2014-2018, the Nutrition and Health Research of Turkey, the Healthy Nutrition and Active Life Program 2014-2017 and the Nutrition Friendly School Program are the related policies and strategies which makes the BFN linkage strong and support the sustainability of the BFN activities.

RESULTS AND DISCUSSION

Collection

In the Black Sea pilot site, the species were collected from the local markets and, where available, from the natural habitat. They were mostly collected directly from their natural habitats. Just few of them were bought from the local bazaars because of some unusual seasonal reasons and the very limited time for the sampling. Each sample was collected during their eating vegetation stage. The main principle was to ensure that the samples represent at least 10 different locations.

The information about the target species gathered from the surveys:

1. *Chenopodium album* L.: Lamb's quarters, melde is an ascending annual plant with 20-150 cm height and angular stem. It isfound in

all regions of Turkey. It is known by the local people by various Turkish names includingsirken, kelebek, iblice, yaban otu, unluca, ak kaz ayağı, ak pazı andyabani ıspanak. It is consumed by roasting, cooking with rice or bulgur and baking as fritter and pancake.

2. *Aegopodium podagraria* L.: Ground elder is a perennial plant with hallowed and grooved stem. It is found in Istranca andthe Eastern Black Sea region and the provinces of Istanbul, Artvin, Kırklareli, Rize. It is known by the local people by various Turkish names including keçi ayağı, mendek, kır marulu and gıvışkan. It is consumed raw or by roastingand cooking with rice or bulgur.

3. *Oenanthe pimpinelloides* L.: Corky-fruited water-dropwort is a perennial plant with 1m height. It is found in the Marmara, Black Sea andAegean Regions and the Adana province. It is known by the local people by various Turkish names includingdeli maydonoz, kazıyak and gazyak. It is consumed by roasting or cooking with yoghurt and bulgur.

4. *Ornithogalum umbellatum* L.: Star of Bethlehem is a perennial plant found in the Marmara, Black Sea andAgean Regions and the Hakkari province. It is known by the local people by various Turkish names includingsumbala, sakarca, sakarcık, akyıldız, çöplüce, karga soğanı and tükrük otu. It is consumed by roasting, frying or cooking.

5. *Trachystemon orientalis* (L.) G. Do: Eastern borage (oriental borage) is a perennial plant with hairy coarse-textured, heart-shaped leaves and stems. It is found in the Marmara and Black Sea Regions. It is known by the local people by various Turkish names including kaldirik, kaldırayak, kalduruk, galdirik, galdirek, ispıt, zılbıt, hodan, zıbıdık, deremancarı, burğı, deve mancarı and tamara. It is consumed in salads or byroasting or cooking with bulgur.

6. *Capsella bursa-pastoris* (L.) Medik.: Shepherd' pürse is an annual herbaceous plant with 55 cm height and a smoothed stem. It is found in all regions of Turkey. It is known by the local people by various Turkish names includingçoban çantası, medik and kuşekmeği. It is consumedraw or in salads, rice meals, andrice soups. It is also used in pastry or pancakes.

7. *Silene vulgaris* (Moench) Garcke: Bladder campion is a perennial plant with flowered 9-35 length stem. It is found in the Marmara, Black Sea and Central Anatolia regions. It is known by the local people by various Turkish names including ecibücü, mendek, gıvışkan, tavukayağı andkır marulu. It is consumed by roasting or it is cooked with rice or bulgur or used insoups.

8. *Rumex crispus* L.: Prickly ivy is a perennial flowering plant with stalks up to 100-150 cm height with shooting curled and wavy leaves from large basal rosettes. It is found in all regions. It is known by the local people by various Turkish names includinglabada, mancar, kıvırcık labada, labada otu, efelek, evelik, eveleyük and ekşi mancar. It is consumed by roasting or it is cooked with bulgur and soups.

9. *Polygonum cognatum* Meissn.; Knotgrass (knotweed) is a perennial plant with 15-30 cm height with ascending branched stems. It is found in all regions of Turkey. It is known by the local people by various Turkish names includingmadımak, ibi out and kuşekmeği. It is cooked plain or with bulgur or it is used in soups.

10. *Smilax excelsa* L.: Prickly ivy is a perennial plant with climbing and thorny stems and greenish flowers. It is found in the Marmara, Black Sea, Aegean and Mediterranean regions. It is known by the local people by various Turkish names includingkırçan, çoban ekmeği, dikenözü, müzmelek, müzmüldek, itmük, özdikeni, öz, kırçıyık, melevcan, melocan, melvocan, boylu gıcır, saparna, anadolu saparnası, iz dikeni, silcan, zimbilaçi, zimilaci and zimilas. Young shoots are consumed raw or are cooked or roasted. It is also used as an ingredient in pastries.

11. *Triticum monococcum* L.: Einkorn is annual plant with 100 cm height. It is found mostly in the northern part of Anatolia and the Central

Black Sea Region of Turkey. It is known by the local people by various Turkish names including zız, kaplıca and siyez. Einkorn wheat is used in traditional bread making or commonly processed into Bulgur in stone mills and used in dishes such as sour pilaf, dry pilaf or pilaf with tomato paste.

Socio economic studies

Extensive market surveys were carried out in 2014 to document information on the marketing of the target species in the pilot site. In the Black Sea Region pilot site, researchers collected information on the availability of wild edibles and Einkorn along with information on collecting sites and harvesting from 9 local markets in the towns and villages across three provinces (Samsun, Kastamonu and Sinop). Surveys were completed for this pilot site and the data were analyzed. Preliminary findings indicate good opportunities for the marketing of traditional wild edibles. The annual per capita consumption of wild edibles ranges from 1.1 kg to 6.2 kg. The most consumed wild edible species is Kaldirik. The annual per capita consumption of Siyez is 14.2 kg (Table 3).

Most of the consumers usually consume these species once or twice a week, except for madımak. Gıvışkan, sumbala, kaldirik and labada are the most consumed species (Table 4).

Some of the annually collected/produced wild species are reserved for household consumption, while some are distributed to neighbors/relatives and some are marketed. The most marketed species are those commonly known and consumed in the region. 85% of siyez, 63% of kaldirik and 52% of dikenucu are marketed (Table 5).

In the Black Sea Region, wild edibles, except for madımak and gıvışkan, are usually directly sold to consumers at the farmers market. They are not sold to wholesalers and middlemen. However, most of the manufacturers of local Siyez sell their products to middlemen/wholesalers at the farmers market. Collectors reach local markets making 8 to 35 km (Table 6). Sales are made at at least 2 local markets every week.

Table 3. The amount of wild edibles per household and annual consumption per capita in the Black Sea Region pilot site.
Çizelge 3. Karadeniz Bölgesi pilot alanında yenilebilir yabani türlerin hane başına ve yıllık tüketim miktarı.

Wild edibles Yenilebilir yabani türler	English name İnglizce isim	Consumption per household (kg/year) Hane başına tüketim (kg / yıl)	Consumption per capita (kg/year) Yıllık tüketim (kg / yıl)
Madımak	Knotgrass or knotweed	5.8	1.1
Ak sirken	Lamb's quarters ormelde	8.7	2.0
Gıvışkan	Bladder campion	5.3	1.1
Kaldirik	Eastern borage or oriental borage	25.9	6.2
Diken ucu	Prickly ivy	7.3	1.6
Çoban çantası	Shepherd' purse	7.5	1.9
Sunbala	Star of Bethlehem	5.4	1.3
Deli maydanoz	Corky-fruited water-dropwort	7.5	1.8
Labada	Curly dock	8.3	2.2
Keçi ayağı	Ground elder	7.6	2.0
Siyez Bulgur	Einkorn as bulgur	84.0	14.2

Table 4. Consumption of the wild species of the Black Sea Region pilot site (%).
Çizelge 4. Karadeniz Bölgesi pilot alanında yenilebilir yabani türlerin tüketim sıklığı (%).

Wild edibles Yenilebilir yabani türler	English name İnglizce isim	5-6 per week 5-6 kez/hafta	3-4 per week 3-4 kez/hafta	1-2 per week 1-2 kez/hafta	1 in 15 days 1 kez/15 gün	1 per month 1 kez/ay
Madımak	Knotgrass or knotweed	4.0	8.0	36.0	8.0	44.0
Ak sirken	Lamb's quarters ormelde	1.7	8.8	42.1	19.3	28.1
Gıvışkan	Bladder campion	4.6	22.7	45.5	13.6	13.6
Kaldirik	Eastern borage or oriental borage	3.6	10.7	58.3	13.1	14.3
Diken ucu	Prickly ivy	1.7	5.2	55.2	6.9	31.0
Çoban çantası	Shepherd' purse	4.5	9.1	50.0	18.2	18.2
Sunbala	Star of Bethlehem	3.5	14.3	42.9	10.7	28.6
Deli maydanoz	Corky-fruited water-dropwort	-	5.9	58.8	13.7	21.6
Labada	Curly dock	2.2	10.6	51.1	19.1	17.0
Keçi ayağı	Ground elder	3.1	6.2	50.0	12.5	28.2
Siyez Bulgur	Einkorn as bulgur	7.0	34.0	43.0	5.0	11.0

Table 5. Distribution of collected amounts of wild edibles in Black Sea Region pilot site by using pattern.
Çizelge 5. Karadeniz Bölgesi pilot alanında yenilebilir yabani türlerin kullanım miktarı ve amacına göre dağılımı.

Wild edibles Yenilebilir yabani türler	English name İnglizce isim	Household consumption (%) Hane halkı tüketimi (%)	Distributed to neighbors/ relatives (%) Komşulara ve akrabalara dağıtım (%)	Used as animal feed (%) Hayvan yemi (%)	Marketed (%) Satılan (%)	Amount collected (kg) Toplanan miktar (kg)
Madımak	Knotgrass or knotweed	95	5	-	-	146
Ak sirken	Lamb's quarters ormelde	69	4	1	26	496
Gıvışkan	Bladder campion	94	5	-	1	18
Kaldirik	Eastern borage or oriental borage	31	6	-	63	2.179
Diken ucu	Prickly ivy	46	2	-	52	407
Çoban çantası	Shepherd' purse	78	6	-	16	158
Sunbala	Star of Bethlehem	70	3	-	27	151
Deli maydanoz	Corky-fruited water-dropwort	67	6	-	27	399
Labada	Curly dock	56	6	-	38	400
Keçi ayağı	Ground elder	82	-	-	18	234
Siyez Bulgur	Einkorn as bulgur	11	4	-	85	25.505

Table 6**.** The Marketing Status of the Wild Edible Collectors in the Black Sea Pilot Site.
Çizelge 6. Karadeniz Bölgesi pilot alanında yenilebilir yabani tür toplayıcılarının pazarlama durumları.

Wild edibles Yenilebilir yabani türler	English name İnglizce isim	Average distance to market (km) Pazara ortalama uzaklık (km)	Proportion of sales to consumers at local market (%) Yerel pazarda tüketicilere satış oranı (%)	Proportion of sales to traders at local market (%) Yerel pazarda tüccara satış oranı (%)
Madımak	Knotgrass or knotweed		no sales at local market	
Ak sirken	Lamb's quarters ormelde	12	100	-
Gıvışkan	Bladder campion		no sales at local market	
Kaldirik	Eastern borage or oriental borage	14	100	-
Kaldirik	Eastern borage or oriental borage	14	100	-
Diken ucu	Prickly ivy	11	100	-
Çoban çantası	Shepherd' purse	25	100	-
Sunbala	Star of Bethlehem	7	100	-
Deli maydanoz	Corky-fruited water-dropwort	10	100	-
Labada	Curly dock	8	100	-
Keçi ayağı	Ground elder	35	100	-
Siyez Bulgur	Einkorn as bulgur	29	44	56

Nutrition Analysis

In this study, the analyzed wild species were found to have a wide range of nutrients. There are several factors known to affect the nutrient composition of foods: climate, geography, geochemistry, agricultural practices such as fertilizer use, stage of maturity, growth period. Dietary fiber was high in P. cognatum and S. excels, providing nearly one third of the Dietary Reference Intake. P. cognatum revealed the highest levels of Fe, Ca and Cu. The values for Vitamin C ranged between 2 and 83.1mg/100g. The highest Vitamin C value was found in O. umbellatum. Polygonum cognatum Meissn., Ornithogalum umbellatum L. and Smilax excelsa L. are some of the species which can be highlighted for their high contribution to dietary fiber, microelement and vitamin C intake. The food composition data of these wild species and the related traditional knowledge were incorporated to the BFN project database. Adding these findings to the food composition database would be helpful to promote the use of more biodiverse foods and healthy diets in Turkey (Guzelsoy *et al*., 2015).

CONCLUSIONS

The Black Sea region is especially rich in wild edibles and landraces. Due to the geographical features of the region, housing areas are scattered far from each other, which makes it difficult for people to reach the large cities. The people living in this mountainous region now prefer larger cities to live in. Villages had a large number of out-migrants who left the villages for education purposes or for the job opportunities in other sectors. Most of the villages visited for the study had a very small population size. The current population consists of either too old and lonely people or a few people who returned to village after being retired. This has a negative impact especially on the wild edible species because the traditional knowledge becomes extinct as it is used less and less over time. In the villages we visited, we had difficulty in finding people with knowledge about wild edible species. The reason is that there was usually only one or a maximum of two people with such knowledge in each village. These people were either above middle age or very old. Unfortunately, the traditional knowledge these people have will become extinct after they die. During the chats we had with them, we learned that young people do not like consuming these species and they prefer eating foods of the modern city life. Especially the adaptation of wild edibles and landraces to the urban style nutrition systems is very important for preventing children from consuming fast food.

Preparation of necessary policies and legislation will be addressed on the basis of knowledge that was obtained from this project. Awareness-raising activities will be held with the stakeholders to strengthen the sustainable use of these species. Therefore, the information gathered during this study is highly valuable. During the field studies, the local people were also provided with information about the wild edibles for awareness-raising purposes. Especially the importance of supporting sustainable consumption of these species and passing down this valuable information to the next generations was emphasized especially by pointing out the health benefits of these species and the tendency of people living in cities to consume them. During the field studies, it was pleasing to see that local people send by cargo some of the wild edibles to those who left the region. Even if they constitute a small population, these people have not forgotten the local tastes although they are used to the country life and they still consume these species, thus contributing, even if partially, to the conservation of the traditional knowledge about these species.

REFERENCES

Anonymous. 2014. FAO Gene Bank Standards. (http://www.fao.org/3/a-i3704e.pdf).

Guzelsoy, N. A., O. Ucurum, E. Tokat, A. Tan, S. Tugrul Ay, K. Ozbek, and I. Ozkan. 2015. Nutrient content of selected biodiverse food in Turkey. 11th International Food Data Conference (IFDC) 3-5 November, 2015 Hyderabad, India.

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Economic and Socio-Cultural Importance of Edible Wild Species

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ABSTRACT: *Every goods and service in the world has an economic importance and this importance is often measured by its value. Although this measure is often expressed in terms of money, it is difficult to express many services and resources with money. One of them is biodiversity and its services. There is a need to be aware of the economic value to ensure sustainable maximum benefit from all limited resources of biodiversity. Knowing the economic value of biodiversity is important in terms of sustainable development as well as ensuring sustainable use. Sustainable use is defined as "the use of biodiversity elements in a way of use that does not lead to a decline of biological diversity in the long term and thus biodiversity retains its potential to meet the needs and aspirations of present and future generations". In order to evaluate biodiversity economically, it is necessary to diversify the benefits, the goods and services offered to us, and to carry out an economic evaluation for each of them. Edible wild species are an important part of biological diversity. In addition to the services offered by other species, edible wild species also contribute to human nutrition. Especially in rural areas, edible wild species are among the easily accessible and low-cost foods. In the place where they found their consumption differs by the social and cultural structure of the society. Determining sustainable use and development strategies for a product whose supply and demand quantities and economic value are unknown may cause misapplication. Therefore; to enhance the economic and socio-cultural research and particularly to do the gender-sensitive value chain analysis are needed.*

Keywords: *Biological diversity, edible wild species, economic importance of biodiversity, socio-economy, sustainable use.*

Yenilebilir Yabani Türlerin Ekonomik ve Sosyo-Kültürel Önemi

ÖZ: *Dünyada her mal ve hizmetin ekonomik bir önemi vardır ve bu önem çoğu zaman ona biçilen değerle ölçülmektedir. Bu ölçü genellikle parasal olarak ifade edilmesine rağmen birçok hizmet ve kaynağın parayla ifade edilmesi oldukça zordur. Bunlardan biri de biyoçeşitlilik ve sunduğu hizmetlerdir. Biyoçeşitlilik gibi tüm sınırlı kaynaklardan sürdürülebilir maksimum faydanın sağlanması için ekonomik değerinin bilinmesine ihtiyaç bulunmaktadır. Biyolojik çeşitliliğin ekonomik değerinin bilinmesi, sürdürülebilir kullanımının sağlanmasının yanı sıra sürdürülebilir kalkınma açısından önem taşımaktadır. Sürdürülebilir kullanım, "biyolojik çeşitlilik unsurlarının, uzun dönemde biyolojik çeşitliliğin azalmasına yol açmayacak şekilde ve oranda kullanımı ve böylece biyolojik çeşitliliğin bugünkü ve gelecekteki nesillerin ihtiyaçlarını ve özlemlerini karşılama potansiyelini muhafaza etmesi anlamındadır", şeklinde tanımlanmaktadır. Biyoçeşitliliği ekonomik açıdan değerlendirebilmek için öncelikle sağladığı faydaları, bizlere sunduğu mal ve hizmetleri çeşitlendirmek ve her biri için ayrı ayrı ekonomik değerlendirme yapmak gereklidir. Yenilebilir yabani türler, biyolojik çeşitliliğin önemli bir parçasını oluşturmaktadır. Diğer türlerin sunduğu hizmetlerin yanı sıra insan beslenmesine de katkı sağlamaktadırlar. Özellikle kırsal alanda yaşayan halkın kolay ulaşılabilir, düşük maliyetli gıdaları arasında yer almaktadır. Tüketimleri yetiştikleri yöredeki toplumun sosyal ve kültürel yapısına göre şekillenmektedir. Arz ve talep miktarı ve ekonomik değeri bilinmeyen bir ürün için sürdürülebilir kullanım ve kalkınma stratejileri belirlemek yanlış uygulamalara sebep olabilecektir. Bu nedenle; ekonomik ve sosyo-kültürel araştırmaların arttırılmasına ve özellikle cinsiyete duyarlı değer zinciri analizlerin yapılmasına ihtiyaç bulunmaktadır.*

Anahtar Sözcükler: *Biyolojik çeşitlilik, yenilebilir yabani türler, biyoçeşitliliğin ekonomik önemi, sosyo-ekonomi, sürdürülebilir kullanım.*

INTRODUCTION

All goods and services in the world have an economic importance and this importance generally is expressed with money. The economic importance of biodiversity is measured by the monetary value attached to it, too. However, it is very difficult to measure many services or resources i.e. biodiversity with money. In order to demonstrate the economic importance of biodiversity and edible wild species that have an important place in biodiversity, it is first necessary to define biodiversity and the services that it offers and to show the importance of these goods and services.

Biodiversity is defined as the diversity of plants, animals or other living organism in a specific region or area. It is also described as all living organisms and the diversity of the habitats of these organisms and their relationships with each other and the environments they live in (Wilson, 1988; Primack, 1995; Mayer, 1995).

Biodiversity is divided into four categories as genetics, species, ecosystem, and functional diversity. (Cepel, 1997; Nunes *et al*., 2001a; Ulgen and Zeydanlı, 2008). Genetic diversity means diversity within species; species diversity means number of species; ecosystems diversity means the diversity of all living things and their habitats; and functional diversity means functional dimension of biodiversity (Mayer, 1996; Nunes *et al*., 2003). Functional diversity, biodiversity and genetic diversity have become a genetic resource for countries.

Having drawn attention since the 1980s, the concept of biodiversity, including the diversity of species, genes, ecosystem and ecosystem functions, has begun to develop in a certain social, economic and cultural context. The fact that biodiversity aims to provide more benefits to humans by using modern biotechnology gene resources has maximized the benefits of biodiversity and its components, and this has made it gain popularity (Demir, 2009). The concept of "Biodiversity Conservation", which has been widely used in recent years, should be regarded not only as a popular terminology but as an awareness trend.

When the problems arising from environmental change have been more explicit, we have become aware of how much we depend on the wildlife in a wide range. (Edwards and Abivardi, 1998). And this awareness has led us to conserve the wildlife; search for ways to use the sources sustainably and investigate what measures should be taken.

Although the issue of environmental protection has existed for many years, it has become more popular due to the increasing pressure on the environment. Priority should be given to the re-establishment of biodiversity and solutions to improve the function of ecosystem in seriously damaged areas. Environmental economy plays an important role in accomplishing this task (Edwards and Abivardi, 1998).

Being aware of the economic value of all limited resources such as biodiversity is great importance in terms of sustainable development. The concept of sustainable development has emerged as the expression of a balance intended to be established between society and environment from the 1970s onwards (Evin, 2005). Sustainable development is a model that addresses ecological balance and economic growth together, ensures the efficient use of natural resources gives importance to environmental quality and meets the needs of today's generations without jeopardizing the ability of future generations to meet their own needs. (Alagoz, 2007). Sustainable use comes into prominence in sustainable development. In the Convention on Biological Diversity, sustainable use is defined as follows: "The use of biodiversity components in a way and proportion that will not cause a reduction in the biological diversity in the long run and, thus, maintaining the potential of biodiversity to meet the needs and aspirations of present and future generations". Development efforts focusing on production and economic efficiency have been replaced with a more balanced development model with social objectives such as income distribution and poverty reduction. The environmental disasters that began to show their impact after the 1970s have brought to the world agenda the notion that protecting the environment is an important element of development (Gurluk, 2010).

For all these reasons, it is quite important to know the economic value of biodiversity. The total value of goods and services provided by biodiversity is called "Total Economic Value". There are different approaches and classifications about the goods and services that are the components of total economic value. The general view is that biodiversity needs to be analyzed with an integrated multidisciplinary approach that takes into account the differences between its components. The analysis of biodiversity concerns both environmental and social sciences. To build ecosystem dynamics of the model, human factor, economic activities and the relations between these must be examined.

Alternatives to the methods used in the researches have been offered. The most important reason behind this is the challenges faced in the monetary evaluation of many services and the search for solutions to these challenges. Although monetary value estimates explain the importance of biodiversity and have a social value in the positive direction, the current economic value estimates cannot be used to measure the passive or unknown values in general; therefore, they should be considered only as a perspective and the best lower limit values (Gowdy, 1998; Nunes *et al*., 2001b; Gowdy and Salman, 2010).

Species within biodiversity offer different services for human welfare. Edible wild species, which have an important place among these species, make more contributions to the human and animal nutrition, the income of the rural people and the socio-cultural structure in addition to the services provided by other species.

Today, edible wild species are increasingly becoming more valuable in terms of healthy nutrition. Increase in population, orientation in healthy and natural food, diversity in demand, problems caused by an unbalanced and inadequate nutrition and many health problems such as obesity, chronic common diseases and dieting have led people to feed on different foods. This situation increases the pressure on the species as well as the interest in edible wild species. Furthermore; excessive and unconscious collecting, urbanization, industrialization, chemical use and so on pose a great risk for edible wild species.

Turkey is very rich in terms of edible wild species and these species are extensively consumed in the rural areas of all regions. In this study, the reasons why edible wild species are important in Turkey in terms of economy, what services these species offer us and their relationship with socio-cultural structure have been examined. It is seen that there has been an increase in the researches on the economic importance and evaluation of biodiversity worldwide and Turkey in the recent years. These intensive discussions and researches on biodiversity economics have also entered the literature of environmental economics (Nijkamp *et al*., 2008). In this study, these researches have also been examined in detail and the economic importance of edible wild species has been presented in a holistic approach.

MATERIALS AND METHODS

The materials of this study consist of the observations obtained from scanning of the main sources and the field surveys conducted within the scope of "Biodiversity for Food and Nutrition Project". The sources on the economic assessment of biodiversity, concepts of sustainable development and ethno-botanical researches, socio-cultural structure and its relationship with edible wild plant species have been examined.

Within the framework of "Biodiversity for Food and Nutrition Project" that aims to conserve the appropriate biodiversity and ensure the sustainable use for food and nutrition, it is aimed to contribute to increasing the welfare of the users and improving their safety. Within the scope of the project, the process from the collection to the consumption of 40 edible wild species and 3 local varieties in the Aegean, Black Sea and Mediterranean Region which have been determined as the research area has been examined in detail. Researches have been carried out with the monograph method in order to provide preliminary data for value chain analysis studies. In this study, the data have been compiled by means of surveys.

In this study, some of the results obtained from the project researches have been briefly evaluated. During the observations made in the field and survey researches and the studies on the

sustainability of the species; the goods and services provided by edible wild plant species and the socio-cultural interactions and a set of challenges faced in the economic assessment of biodiversity have been emphasized. The marketing channels of edible wild species have also been determined by evaluating the data obtained from other researches.

RESULTS AND DISCUSSIONS

Goods and services provided by edible wild species

Edible wild species constitute a market value in terms of the goods and services they offer. This value has direct and indirect contributions to the economy. The sum of the values provided by the direct or indirect contributions of the edible wild species in terms of ecological, socio-cultural and economic also shows the total economic value. As many services and contributions cannot be evaluated monetarily, it is quite difficult to calculate the total economic value clearly. This value can offer us only an estimate. The direct or indirect contributions provided by the species are analyzed according to their qualities through different methods after being identified according to their service classes (Adamowicz, 1995; Goulder and Kennedy, 1997; Edwards and Abivardi, 1998; Nunes *et al*., 2001a; Farber *et al*., 2002; Limburg *et al*., 2002; Howarth and Farber, 2002; Wilson and Howarth, 2002; Hawkins, 2003; Pak *et al*., 2010; Mouysset, 2015).

Even though there are different classifications encountered in the researches, biodiversity services are categorized under four sub-headings as production function, habitat function, information function and regulatory service function under the main headings of in-use and out-of-use services (De Groot *et al*., 2002, De Groot, 2006).

According to the use of edible wild plant species, the goods and service value functions are classified as follows (De Groot *et al*., 2002).

Their values in terms of use

- **Direct Use** [Direct consumption (on the market)]
  - ***Production Function Value (Directly consumed)***
    - Commercial use
    - Food resources (for human and animal nutrition)
    - Raw material
    - Use in conventional medicine
    - Medical Resource
    - Use in biotechnology
    - Genetic resources
  - ***Information Function Value (without direct consumption)***
    - Cultural and historical
    - Aesthetic
    - Artistic and spiritual
    - Scientific and educational use
    - Recreation and tourism (eco-tourism and gastronomy tourism)
- **Indirect Use** (the service provided for the functioning, organization and protection of the ecosystem)
  - ***Habitat Value***
    - Shelter function
    - Biodiversity
    - Endemic diversity
    - Protection
  - ***Regulatory Service Value***
    - Contribution to the regulation of atmospheric gases
    - Contribution to the regulation of climate
    - Contribution to food chain
    - Contribution to water supply and resource conservation
    - Contribution to waste control and regulation
    - Contribution to soil formation
    - Contribution to prevention of erosion
    - Contribution to biological control
    - Contribution to pollination

Option value (the value that reflects the anxieties about which purposes these types may be used in the future). Option value is considered both in use and out-of-use value (Atasoy *et al*., 2014).

Out-of-use value (the iconic, cultural or spiritual values that people give themselves even though they are not protected for the use of the future generations and they have no benefits).

- Heritage value
- Existence or inner value

Some of these values are abstract and subjective. However, they are the values that guide people's willingness to protect. The general view is that modeling and multidisciplinary studies are needed since many services or goods cannot be expressed in monetary terms (Turker *et al*., 2001; Demirayak, 2002; Toksoy *et al*., 2003; Erdem, 2004; Erten, 2004; Polasky *et al*., 2005; Nijkampa, 2008; Demir, 2009; Faydaoglu and Surucuoglu, 2011; Mouysset, 2015;).

Why is it important to be aware of the economic value of edible wild species?

In addition to the use of edible wild plant species in human nutrition; the most prominent features that show its importance for the economy are being tradable and a source of income for rural people, its contribution to tourism and socio-cultural structure and being used as low-cost animal feed.

Increasing demand for edible wild species and their increasing value thanks to their commercial place put a great pressure on the species. Also, destruction of the nature by extreme and unconscious collecting, habitat degradation, climate change, invasion of alien species, pollution and so on affect wild species significantly (Hood, 2010; Karagoz *et al*., 2010; Anonymous, 2016; Karagoz *et al*., 2016). A part of edible wild species is close to settlements and easily accessible. For this reason, human factor is the most important risk for edible wild species. Some measures must be taken in order to protect these species, meet the increasing demands and make them sustainable. Becoming aware of the economic value and importance of edible wild species will ensure:

- ✓ protecting them more efficiently in nature
- ✓ the sustainability and development of the businesses that collect, process or trade these species,
- ✓ the determination of more effective policies and strategies,
- ✓ raising consciousness and awareness in the society,
- ✓ the use and sustainability of these limited resources so as to provide the highest benefit

As edible wild species are provided from nature by collecting, it is not known how much it is collected, how much of it is marketed or consumed. Not knowing the amount which is subject to supply, demand and commerce on product basis is the most important problem in the management of their sustainable use as well as the determination of their economic contributions. There are no official statistics on these species in Turkey. There are only statistical data on some tradable species consumed for medical purposes.

Importance of Edible Wild Species for Human Nutrition

Edible wild species constitute a general source of a large part of the species produced today. Wild forms also have an important place in direct consumption. They are important in terms of being low cost food that is easily accessible, having high nutritional value, diversity in diet and nutrition and so on.

They are among low cost and easily accessible foods especially for the people living in rural areas. However; increase in population, diversity in demand such as feeding on healthy and natural food, unbalanced and inadequate nutrition, health problems such as obesity, common chronic diseases and dieting have directed people to the search for different nutrition resources. With this trend and the effect of migration from the rural areas, consumption has now shifted to urban areas, too. We can observe this in the number of edible wild species sold in district markets and the increase in their quantity.

The locals collect the plants primarily from their own gardens or nearby places and consume them as main course or salads at main meals. Among the species that are extensively consumed in every region of Turkey, especially in the Aegean and Black Sea, the traditional species peculiar to that region are consumed more commonly. Frequency, quantity and type of consumption vary according to the social and cultural structure of the society and the habits of the people in the region. They are mostly consumed as cooked, though it varies according to the species. They are also consumed

as raw, dried, salted or pickled (Aktan and Bilgir 1978; Duran, 1998; Simsek *et al*., 2002; Simsek *et al*., 2004; Akan *et al*., 2005; Cakilcioglu and Turkoglu, 2009; Yapici *et al*., 2009; Altay and Celik, 2011; Faydaoglu and Surucuoglu, 2011; Ozturk and Olcucu, 2011; Yaylagul, 2011; Ozgen *et al*., 2012; Akan *et al*., 2015). Commonly consumed species are frozen as raw or boiled, and kept for consumption in the winter months.

Edible wild plant species are rich in fiber, protein, vitamins and minerals as well as being alternative to the species in the cultivated production. (Bilgir and Aktan, 1978; Cook *et al.,* 1998; Yıldırım *et al*., 2001; Alarcón *et al*., 2006; Yang *et al*., 2009; Kim *et al*., 2013). Due to its importance in terms of health, its high nutrient content and its contribution to the Mediterranean diet, the interest in edible wild species in the world is increasing day by day. (Garcia-Herrera *et al*., 2014).

Their importance in terms of the Contribution to Household Income

Edible wild species directly or indirectly contribute to the income of the rural people. They contribute directly to those who collect and sell the species and indirectly to the household income derived from their contribution to eco-tourism or gastronomy tourism. Products with high commercial value are the main source of income for many households and people continue to do this job as a profession. They are one of the major sources of income for subsistence family businesses engaged in farming. They are especially important for women living in the rural area. It is the women who collect, process or market many species. In the pilot areas researched, it has been determined that collectors, mostly women, contribute to the family income by selling the species they collect from the gardens, fields, forests, lake sides, sea sides and even rocky areas within or outside the village in local markets. In the early hours of the morning, they go to the nearby collection areas on foot and to the remote areas by riding animals or motor vehicles. After collecting the species required to be freshly consumed according to the needs of the market and their home in the amount they can carry; they clean, sort, bond and strip them according to their characteristics and then sell in the local market. They sell their products not only in a single market, but also in other markets established in the nearby areas. They go to the markets about 4-5 couples a week.

The situation is slightly different for processed products. After the phases of collection, sorting and processing, they are sold directly or through wholesalers. Furthermore, it has been seen that the collectors or wholesalers send them to the district markets in the cities by bus or cargo in order to meet the demands of the consumers who have migrated to that city or other cities. Due to the gathering of crowded migrant groups in many neighborhoods in the cities, they try to keep the traditions of these people alive in these areas. People can find the products peculiar to their regions in these markets established 1-2 times a week. These products bring revenue to all actors taking place in the chain during the phases of collection, marketing and consumption.

Raising awareness of the people who earn income from these species for the protection and management of biodiversity will increase their income; and taking measures to ensure sustainability is important for rural development. Rural people are the principal key element in protecting these species in the nature. There is a need for precautionary measures to increase their awareness on the benefits of biodiversity, the protection of these species on-site and growing the species that can be cultivated in small areas and, briefly to ensure the sustainable use.

Being tradable

Most edible wild species are sold as unprocessed mostly in local markets and, in small quantities, in district markets. Some of them are traded as processed or unprocessed products in national and international markets. In the local and district markets, many wild species are sold for medical and gastronomic purposes or as tea and spices (Polat *et al*., 2012a, b). International markets mostly consist of species consumed for medical purposes.

The higher the income obtained from the tradable species is, the more the pressure on the species increases. Therefore, some species are at the danger of extinction. For example, the market sale price of "golden thistle" (*Scolymus hispanicus L.*) in the Aegean region, one of the research areas, is higher than other species. Collectors of blessed thistle desire to sell more in order to earn more. It has been observed that the density of the species has decreased in the areas nearby the village; people go to the remote collecting locations by vehicles and collect a higher amount of species. The same applies to the species "eastern borage" [*Trachystemon orientalis* (L.) G. Don] in the Black Sea Region. Therefore, it is necessary to concentrate on the study of cultivation of edible wild species and take measures in order to protect these species in the wild.

Although there are some exceptions, some collectors tend to regard the areas where the species grow as their own as their income from them increases and they try to protect that region.

Some of the wild species are consumed as processed. It has been observed that this sector has also improved today. They are sold as pickled, canned, frozen or raw material. Furthermore, the increase in demand has also improved the e-commerce of these species in the electronic environment. Platforms where collectors, processors, sellers and consumers gather together have been formed. There is a marketing phase for 2-3 months as of the time the species first appear. The consumer can request the product directly from the collector at the desired amount.

Local people constitute the collectors. Some of the sellers in the district markets collect some species by themselves. The mediators / wholesalers are those who sell products to the district markets from the villages; the processors are the people who collect the species or the processing industry for the other people in the village or the species that can be used as food raw material. Although the marketing channels of edible wild species differ according to the regions and species, the majority of them directly reach to the consumers from the collectors. While collectors sell some products in local markets, some of them are sent to the district markets through the mediators/wholesalers (Figure 1). In some areas collectors sell their products on mobile stalls in the street alleys.

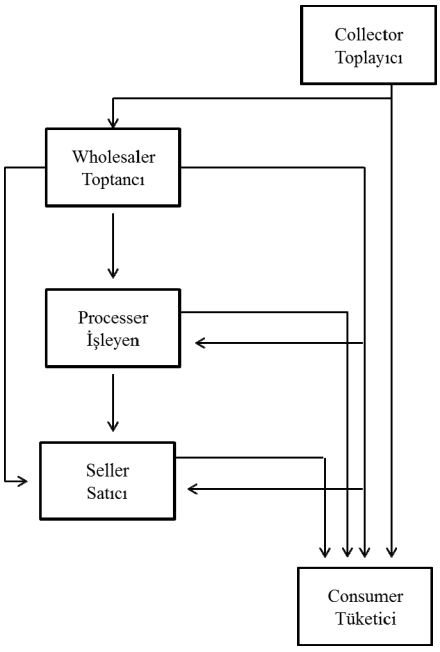

Figure 1. Marketing channels of edible wild species.
Şekil 1. Yenilebilir yabani türlerin pazarlama kanalları.

It has been determined in market surveys that large grocery stores place on their countertops particularly the species with a tendency in a sustainable production or branding, while they prefer to provide the species that can be cultivated through contracted production.

Sale prices of the species vary depending on supply, demand and recognition. Prices are high the first and last time when these species are available in the markets and low during the interim period. Prices in local markets are based on the prices of the previous year, the prices cultivated forms that can be an alternative and consumer demand.

Their importance in Animal Feeding

The collectors of edible wild species in the rural area have a low-income level; the majority of them

do this job as a subsistence family business. They feed a small number of cattle or sheep/goats for domestic needs. These collectors feed the animals with the remaining waste after cleaning and removing the herbs they collect and make use of the waste as a low-cost feed source. Furthermore, most of the edible wild species are used directly in feeding animals. The animals are put out to the grass in the wild or fed with the species collected.

Their importance in terms of contribution to the tourism

Tourism is as a strong sector that can eliminate the regional income imbalances and this sector's share on the economy continues to increase. In the age of information technology, people's passion for travel leads to having more conscious tourists. Food culture that varies form one region to another draws the attention of the visitors and thus gastronomic tourism, which has been formed in this direction, takes its place as an element of touristic attraction among the types of tourism. For the tourism of a country, the cuisine of that country is one of the important criteria in the tourists' selection of place. The wild herbs growing according to the geographical characteristics of the region and the meals made from these wild herbs also have an important place in the culinary culture of a country or a region (Comert and Ozkaya, 2014).

Wild species are one of the focal points of tourism both in terms of visuality, commerce and nutrition. In addition to being a part of the cultural and traditional structure of the regions for centuries, they are also an important part of the regional tourism. For example; Aegean herbs and Alacati Herbs Festival, Black Sea dishes, Mediterranean cuisine offer quite attractive alternatives for tourists. They have also been subject to movies, documentaries, photographs, paintings and folk songs.

Some markets separate from the others in terms of their historical background, spatial size and variety of exhibited products, and become a product of tourism (Ataberk, 2010). Local products are offered to the public in these markets where local producers and local consumers gather together. Alacati, where Aegean herbs which have become a tourism product are exhibited, is the best example for this. The participation in the Alacati Herbs Festival continues to increase every year; local and foreign tourists show a great interest to this festival. It has become a residential area that improves itself in many ways, boost the income of local people and create new jobs. Edible wild herbs are also included in the menus of the restaurants and touristic hotels in this place. They have also started to take part in the menus of touristic hotels in the Mediterranean region.

The participation of individuals in tourism varies according to their income, education level, age, gender, nutrition and health status. Considering that most of the long-time tourists, in particular, eat their meals at these accommodation places or restaurants, it is important to include the meals made from the edible wild herbs in the menus of these places (Kozak, 2014, Karaca *et al*., 2015).

Medical Use

Wild species were used in the treatment of many diseases by many local people for centuries and they are still in use. In addition to being used as a raw material for medicines, it is also densely used in simple treatments in the field of conventional medicine.

However, as a result of the population decrease in the villages due to migration, the information on their use in the field of conventional medicine is facing extinction together with the small number of the elderly population remaining in the village. Furthermore, the young population has no interest in these species. It is very important to record the details of their use in the folk traditions so that this information is not lost (Akan and Bakir Sade, 2015).

Importance of Socio-cultural Structure of Biodiversity

Socio-culture can be expressed as the beliefs, customs, traditions, habits and rules formed by the interaction of people in a community and the

relationships emerging from the effect of this structure on the lives of people. Social and cultural approaches, beliefs, traditions in a society constitute the socio-cultural environment. In short, it is the society and institutions where the individuals interact with the culture they live in.

People in Turkey have been acquainted with many cultures since ancient times, become neighbors and lived with the people from these cultures. Along with these cultural exchanges; factors such as the abundance of food varieties, customs and traditions have helped to create a rich cuisine. Human nutrition patterns are shaped by the cultural, geographical, ecological and economic structure and the historical process. This culture, defined as nutrition culture, includes the subjects of how people choose what to eat, when the selected food is consumed, how the food is prepared and cooked and varies depending on the eating habits of the community in which the individual lives (Kose *et al*., 2010).

The process of the edible wild species from collection to consumption is mostly shaped by the socio-cultural structure. The consumed species and their ways of collection, cooking, and how they are consumed vary among different cultures.

In the Black Sea Region, the majority of those who collect and sell the wild species are women. In the Aegean Region, although female labor force is a little more, the work is carried out in cooperation with men. Species are generally known by the rural people in the area where they grow. A large part of those who consume or collect these species is of middle age. This is a feature of the socio-cultural structure.

When we examine the differences in the consumption patterns, we can see that consumption is more favorable as salad with olive oil or as raw food in the Aegean and Mediterranean regions and as main dish with eggs or plain roasted in the Black Sea region. Although consumption patterns are different according to the species, they vary mostly according to the traditional habits of the people in the region where the species grow.

Interaction between humans also ensures the intercultural interaction. While people migrating to different cities continue their culture, they also introduce their own cultures and learn the culture of the community they are in. This interaction is particularly important in the recognition and ensuring the prevalence of edible wild species. Sale in the Mediterranean region of a species that grows in the Black Sea Region and is a traditional gift of that community is a result of socio-cultural interaction.

Socio-culture also has adverse effects on edible wild species. It is possible to see these effects more clearly in the rural area. Young people who come from other cultures for marriage or different reasons do not know these herbs or consume them because they are not used to, and therefore the nutrition culture in rural areas is gradually changing.

The effect of edible wild species on the socio-cultural structure and the effect of the socio-cultural structure on these species and the value of the benefits derived from this interaction cannot be financially expressed in a clear way. This situation should not be understood as they have no economic value. Knowing the socio-cultural structure helps us evaluate the edible wild species from a socio-economic perspective, determine and implement the right strategies by examining the elements that affect them.

The diversity resulting from the socio-cultural structure and the information obtained from this diversity is a cultural heritage for every country. One of the valuable pieces of this heritage, called traditional knowledge, is the use of traditional wild species. It is of great importance to hand the traditional use down from generation to generation and records it in order to ensure a sustainable consumption.

CONCLUSION AND RECOMMENDATIONS

Biodiversity is a powerful factor and a driving force in sustainable development for countries. Edible wild species have a significant share in the human nutrition within biodiversity, increasing the

welfare of the rural people, ensuring a balanced and healthy nutrition and development of tourism.

The anxieties arising from the increase in population and severe destruction in the nature have brought about the question of how we can benefit from the nature in a more sustainable way. This question has increased the interest in edible wild species, consumption of which is limited in the regions as part of the traditional structure. However; it is necessary to develop policies that will ensure that these species are conserved and harvested, consumed and used in a sustainable manner before bringing them into the use of other people. It is thought that social and economic benefits can be increased in this way (Gul, 2014).

The study shows that environmental, social and economic elements are intertwined in edible wild species, the focal point is the economy and there is a close connection and a great interaction between them. The evaluation to be made regarding the sustainability based on this interaction through socio-economic point of view has two benefits. Firstly, it will reveal the effect of socio-economic factors on the loss and diversity of species. And secondly, it will show the socio-economic contribution provided by the species.

There is a different service and contribution of each species in the nature. A wild species we consume can play an important role in maintaining the existence of another species. A disturbance in the chain can cause the rings of the whole chain to break over time. Regarding the economic value of a species, we can say we may face results that can never be changed. It has been found that the rings of this chain weaken and decrease in the nature as the market value of the tradable species increases. The risk for species, roots or onions of which are consumed, is much greater. While some of them are severely decreasing, some are facing the danger of extinction. Society's awareness and knowledge level must be raised in order to reduce the risk and ensure a sustainable use.

Identification and economic expression of the edible wild species' elements that contribute to human welfare is an important trigger in the development of conservation consciousness. Another important trigger is the emotional (instinctual) factors. The role of emotional factors is much greater than ecological, economic and social factors at the core of conservation, (Martín-López *et al*., 2007). As there is not a monetary criterion, it is very difficult to evaluate these species. However, emotional factors have a significant influence on taking protection measures. Therefore, it will be useful to take into account the other non-monetary criteria derived from social-psychology and human ecology disciplines.

Furthermore, socio-cultural structure is an important issue that needs to be considered in the identification and implementation of sustainable development strategies, even though it cannot be monetarily expressed. Especially when considering the importance of edible wild species in terms of health, it is important to evaluate the nutritional factors in detail in addition to environmental, socio-economic and socio-cultural factors for a sustainable diet.

To summarize the importance of contribution to be made by the evaluation of biodiversity on a micro and macro level; at the micro level, it contributes to revealing the complex role it plays in the process of increasing human welfare while providing information on structure and operation. At the macro level, it enables us to create indicators related to human welfare and sustainability by allowing us to monitor how the change resulting from the human activity is affecting the integrity of human beings and natural environment (Freeman *et al*., 2003; Ozhanci *et al*., 2011).

When the goods and services offered by edible wild species have been examined, it has been determined that a significant portion of the services cannot be expressed in monetary terms and a service or goods emerging from a result of a link and interaction between the services comes into existence with the effect of another service. Therefore, a multidisciplinary approach should be developed to form a common mindset for modeling and evaluation.

The studies on putting forth the economic feasibility of edible wild species are limited even though they are densely used in Turkey. There is a need for multidisciplinary value chain analyses that can increase the economic and socio-cultural researches and analyze the process from environmental value to consumption value well. Regarding the species-based studies of regional and edible wild species, it is useful to conduct gender sensitive value chain analyses by taking into account the socio-cultural structure.

REFERENCES

Adamowicz, V. 1995. Alternative Valuation Techniques: A comparsion and movement to a snythesis. (Editors) K. G. Willis and J. T. Corkindale. 1995. Enviromental Valuation: New Perspectives, Cab International.

Akan, H., and Y. Bakir Sade. 2015. Kâhta (Adıyaman) merkezi ve narince köyü'nün etnobotanik açıdan araştırılması. Beü Fen Bilimleri Dergisi 4 (2): 219-248.

Akan, H., M. Aslan, M. M., Balos. 2005. Şanlıurfa kent merkezindeki semt pazarlarında satılan bazı bitkiler ve kullanım amaçları. Ot Sistematik Botanik Dergisi 12 (2): 43-58.

Aktan, N. ve B. Bilgir. 1978. Ege Bölgesinde insan beslenmesinde kullanılan bazı yabani otlar (Tilkicen, Sirken, Labada, Sinir Otu) üzerinde araştırmalar, Ege Üniversitesi Ziraat Fakültesi Dergisi 15: 167-182.

Alagoz, M. 2007. Sürdürülebilir kalkınmada çevre faktörü: teorik bir bakış. Akademik Bakış Uluslararası Hakemli Sosyal Bilimler E-Dergisi 11: 1-12.

Alarcón, R., L. T. Ortiz, and P. Garcia. 2006. Nutrient and fatty acid composition of wild edible bladder campion populations [*Silene Vulgaris* (Moench.) Garcke]. International Journal of Food Science and Technology 41:1239-1242.

Altay, V. ve O. Celik. 2011. Antakya semt pazarlarındaki bazı doğal bitkilerin etnobotanik yönden araştırılması. Biyoloji Bilimleri Araştırma Dergisi. 4 (2): 137-139.

Anonymous. 2016. Answers to the exploration questions: local threats to biodiversity. https://www.khanacademy.org/partner-content/cas-biodiversity/why-is-biodiversity-threatened/local-threats-to-biodiversity/a/answers-to-the-exploration-questions-local-threats-to-biodiversity. Web Erisim 22.03.2017.

Ataberk, E. 2010. Yerel pazarlar-turizm ilişkisi ve Tire. I. Ulusal Tire Sempozyumu 18-20 Ekim 2010, http://www.academia.edu/20274579/Yerel_Pazarlar-Turizm_İlişkisi_ve_Tire.

Atasoy, Y., I. Ç. Selcukcan Ero, Z. Ayvaz Reis ve S. Gulsecen. 2014. bilgi ekonomisi açısından biyoçeşitliliğin ekonomik değeri. Akademik Bilişim'14 - XVI. Akademik Bilişim Konferansı Bildirileri. 5-7 Şubat 2014 Mersin Üniversitesi. Mersin.

Bilgir, B. O. ve N. Aktan. 1978. Ege bölgesinde insan beslenmesinde kullanılan bazı yabani otlar (Tilkicen, Sirken, Labada, Kuş Otu, Sinir Otu) Üzerinde Araştırmalar. E.Ü.Z.F. Dergisi 15 (3): 167-182.

Cook, J. A., D. J. Vanderjagt, A. Dasgupta, G. Mounkaila, R. S. Glew, W. Blackwell, and R. H. Glew. 1998. Use of the trolox assay to estimate the antioxidant content of seventeen edible wild plants of Niger. Life Sciences, 63 (2): 105-110. DOI: 10.1016/S0024-3205(98)00245-8.

Comert, M., and F. D. Ozkaya. 2014. Gastronomi turizminde türk mutfağının önemi. Journal of Tourism and Gastronomy Studies 2 (2): 62-66.

Cakılcıoglu, U. ve I. Turkoglu. 2009. Çitli ovası (elazığ) ve çevresinin etnobotanik özellikleri. E-Journal Of New World Sciences Academy - Ecological Life Sciences 4 (2): 81-85.

Cepel, N. 1997. Toprak kirliliği erozyon ve çevreye verdiği zararlar. Tema Vakfı Yayını. NO: 14, İstanbul.

De Groot, R. 2006. Function-Analysis and valuation as a tool to assess land use conflicts in planning for sustainable, multi-functional landscapes. Landscape And Urban Planning 75: 175-186.

De Groot, R., A. M. Wilson, and J. M. R. Boumans. 2002. A typology for the classification and valuation of ecosystem functions, goods and services. Ecological Economics 41: 393-408.

Demir, A. 2009. "Kardelende ekonomik değer analizi", ankara üniversitesi biyoteknoloji enstitüsü, sosyo-ekonomik gelişme ve biyoteknoloji Doktora Tezi.

Demirayak, F. 2002. Biyolojik çeşitlilik-doğa koruma ve sürdürülebilir kalkınma TÜBITAK VIZYON 2023 projesi çevre ve sürdürülebilir kalkınma paneli, Aralık 2002.

Duran, A. 1998. Akseki (Antalya) İlçesindeki bazı bitkilerin yerel adları ve etnobotanik özellikleri. Ot Sistematik Botanik Dergisi 5 (1): 77-92.

Edwards, P. J., and C. Abivardi. 1998. The value of biodiversity: where ecology and economy Blend Biological Conservation Volume 83 (3): 239-246.

Erdem, E. H. 2004. Biyolojik çeşitliliğin ekonomik değerinin belirlenmesi; yabani orkide örneği, Ege Üniversitesi Fen Bilimleri Enstitüsü Yüksek Lisans Tezi, İzmir.

Erten, S. 2004. Uluslararası düzeyde yükselen bir değer olarak biyolojik çeşitlilik. H. Ü. Eğitim Fakültesi Dergisi Sayı 27. Beytepe/Ankara.

Evin, H. 2005. "Trakya Bölgesi deri ve bitkisel yağ sanayi'nde çevre duyarlılığı", Trakya Üniversitesi Fen Bilimleri Enstitüsü Yayınlanmamış Doktora Tezi.

Farber, S., R. Costanza, and M. Wilson. 2002. Economic and ecological concepts for valuing ecosystem services. Ecological Economics 41: 375-392.

Faydaoglu, E. ve M. S. Surucuoglu. 2011, "Geçmişten günümüze tıbbi ve aromatik bitkilerin kullanılması ve ekonomik önemi", Kastamonu Üniversitesi Orman Fakültesi Dergisi 11: 52-67.

Freeman, A. M. III., J. A. Herriges, and C. L. Kling. 2003. The measurement of environmental and resource values; theroy and methods. Resources Fort He Future, Washington D.C.

Garcia-Herrera, P., M. C. Sanchez-Mata, M. Camara, V. Fernandez-Ruiz, C. Diez-Marques, M. Molina, and J. Tardio. 2014. Nutrient composition of six wild edible mediterranean Asteraceae Plants of dietary interest. Journal Of Food Composition And Analysis 34: 163-170.

Gowdy, J. (Ed.). 1998. Limited Wants, Unlimited Means: A reader on hunter-gatherer economics and the enviroment. Washington, D.C. Island Press.

Gowdy, J., and Salman A. 2010. "Institutions and ecosystem functions: the case of Keti Bunder, Pakistan." In valuation of regulating services of ecosystems. Pushpam Kumar and Mike Wood (eds.) Routledge, London. pp. 201-221.

Goulder, L. H. and D. Kennedy. 1997. Valuing ecosystem services: philosophical bases and empirical methods. in nature's services: societal dependence on natural ecosystems. G.C. Daily, Ed. Island Press, Washington, D.C. pp. 23-47.

Gul, V. 2014. Rize yöresine ait tıbbi ve aromatik bitkilere genel bir bakış Iğdır Üni. Fen Bilimleri Enst. Der. Iğdır Univ. J. Inst. Sci. and Tech. 4 (4): 97-107.

Gurluk, S. 2010. Sürdürülebilir kalkınma gelişmekte olan ülkelerde uygulanabilir mi?. Eskişehir Osmangazi Üniversitesi İİBF Dergisi 5 (2): 85-99.

Hawkins, K. 2003. Economic valuation of ecosystem services. University of Minnesota.

Hood, L. 2010. Biodiversity: Facts And Figures. http://www.Scidev.Net/Global/Biodiversity/Feature/ Biodiversity-Facts-And-Figures-1.html.

Howarth, R., and S. Farber. 2002. Accounting for the value of ecosystem services. Ecological Economics 41: 421-429.

Karaca, O. B., O. Yildirim, C. Cakici. 2015. Gastronomi turizminde otlar, ot yemekleri ve sağlıkla ilişkisi üzerine bir değerlendirme, Journal of Tourism And Gastronomy Studies 3 (3): 27-42.

Karagoz A., N. Zencirci, A. Tan, T. Taskin, H. Koksel, M. Surek, C. Toker ve K. Ozbek. 2010. Bitki genetik kaynaklarının korunması ve kullanımı. Türkiye Ziraat Mühendisliği VII. Teknik Kongresi. Bildiriler (I): 155-177. 11-15 Ocak, Ankara.

Karagoz, A., K. Ozbek, N. Sari. 2016. Türkiye'nin bitkisel biyolojik çeşitliliğinin korunması ve sürdürülebilir kullanımına ilişkin sorunlar ve çözüm önerileri, Tarla Bitkileri Merkez Araştırma Enstitüsü Dergisi 25 (1): 88-99.

Kim, S. J., S. C. Min, H. J. Shin, Y. J. Lee, A. Reumcho, S. Y. Kim, and J. Han. 2013. Evaluation of the antioxidant activities and nutritional properties of ten edible plant extracts and their application to fresh ground beef. Meat Science 93: 715-722. (DOI: 10. 1016/j.meatsci.2012.11.029).

Kozak, N. 2014. Turizm Pazarlaması. Ankara: Detay Yayıncılık.

Kose, Ş., E. Ocak, and M. Z. Bahadir. 2010. Ramazan Bayramı Tatlısı: Kömbe. pp. 881-882. The 1st International Symposium on "Traditional Foods From Adriatic To Caucasus", 15- 17 April 2010, Tekırdag/Turkey.

Limburg, K. E., R. V. O'neil, R. Costanza, and S. Farber. 2002. Complex Systems and Valuation. Ecological Economics. 41: 409-420.

Martín-López, B., C. Montes, and J. Benayas. 2007. The non-economic motives behind the willingness to pay for biodiversity conservation. Biological Conservation 139 (1-2): 67-82.

Mayer, J. 1995. Nachhaltige Entwicklung – Ein Leitbild Zur Neuorientierung Der Umwelterziehung Dgu-Nachrichten 12: 43-56.

Mayer, J. 1996. Biodiversitätsforschung Als Zukunftsdisziplin. *In:* Vogt. H & M. Sieger (Hrsg.) Berichte Des Inst›Tutes Für Didaktik Der Biologie, Idb 5. Universität Münster.

Mouysset, L. 2015. Repenser le défi de la biodiversité. L'économie écologique**,** Paris, Éditions Rue d'Ulm, coll. Sciences durables 88 p., Préface de Pierre-Henri Gouyon, ISBN : 978-2-7288-0532-7.

Nijkamp, P., G. Vindigni, and P. A. L. D. Nunes. 2008. Economic valuation of biodiversity: A comparative study. Ecological Economics 67: 217-231. Doi: 10.1016/J.Ecolecon.2008.03.003.

Nunes, P. A. L. D., and J. C. J. M. van den Bergh. 2001a. Economic valuation of biodiversity: Sense or nonsense. Ecological Economics 39: 203-222.

Nunes, P. A. L. D., J. C. J. M. van den Bergh, and P. Nijkamp. 2001b. Ecological-economic analysis and valuation of biodiversity. Department of Spatial Economics Free University De Boelelaan 1105 1081 HV Amsterdam Netherlands.

Nunes, P. A. L. D., J. C. J. M. van den Bergh, and P. Nijkamp. 2003. The Ecological Economics of Biodiversity; Methods and Policy Application. Edward Elgar Publishing (EE), 23-14-16-55, U.K.

Ozhanci, E., Irmak, M.A., Yilmaz, H., 2011. Ekolojik koridorlar kapsamında erzurum-uzundere güzergahı vadi peyzajı tiplerinin ortaya konması i. ulusal akdeniz çevre ve orman sempozyumu, 26-28 Ekim 2011, Kahramanmaraş KSÜ Doğa Bilimleri Dergisi. Özel Sayı, 2012 Kahramanmaraş.

Ozgen, U., Y. Kaya, and P. Houghton. 2012. Folk medicines in the villages of ilıca district (Erzurum), Turkey. Turkish Journal of Biology 36: 93-106.

Ozturk, F. ve C. Olcucu. 2011. Ethnobotanical features of some plants in the district of Şemdinli (Hakkari-Turkey). International Journal of Academic Research 3: 120-125.

Pak, M., F. M. Türker, and A. Öztürk. 2010. Total economic value of forest resources in Turkey. African Journal of Agricultural Research 5 (15): 1908-1916.

Polasky, S., C. Costello, and A. Solow. 2005. The economics of biodiversity handbook of environmental economics. Volume 3. *In*: K. G. Mäler and J.R. Vincent (Eds.). Doi: 10.1016/ S1574-0099(05)03029-9.

Polat, R., S. Selvi, U. Çakılcıoglu ve M. Acar. 2012a, Bingöl semt pazarlarında satılan yabani bitkilerin etnobotanik açıdan incelenmesi, Biological Diversity and Conservation (ISSN 1308-8084) 5 (3): 155-161.

Polat, R., U. Cakilcioglu, F. Ertug, and F. Satil. 2012b. An evaluation of ethnobotanical studies in Eastern Anatolia. Biological Diversity and Conservation (ISSN 1308-8084) 5 (2): 23-40.

Primack, R. B. 1995. Naturschutzbiologie. – Heidelberg, Berlin, Oxford (Spektrum Akad. Verl.) p. 713.

Simsek, I., F. Aytekin, E. Yesilada ve S. Yildirimli. 2002. Anadolu'da halk arasında bitkilerin kullanılış amaçları üzerinde etnobotanik bir çalışma. pp. 434-457. 14. Bitkisel İlaç Hammaddeleri Toplantısı, Bildiriler, , 29-31 Mayıs 2002, Eskişehir.

Simsek, I., F. Aytekin, E. Yesilada ve S. Yildirimli. 2004. An Ethnobotanical Survey of the Beypazari, Ayaş, and Güdül District Towns of Ankara Province (Turkey) Economic Botany 58 (4): 705-720.

Toksoy, D., C. Gumus ve H. Ayyildiz. 2003. türkiye'de orman kaynaklarının durumu ve tıbbi bitkilerin ticareti üzerine bir değerlendirme. Orman ve Ekonomi Dergisi 8: 7- 14.

Turker, M. F., M. Pak ve A. Ozturk. 2001. "Toplam ekonomik değer yaklaşımı ve orman kaynaklarının sunduğu ürün ve hizmetlerin bu kapsamda irdelenmesi", I. Ulusal Ormancılık Kongresi, 20-23 Mart 2001, s. 171-182. Ankara/Türkiye.

Ulgen, H. ve U. Zeydanli. 2008. Ed., Orman ve biyolojik çeşitlilik. Doğa Koruma Merkezi. Ankara. http://www.dkm.org.tr/Dosyalar/YayinDosya_eav1erm2.pdf.

Wilson, E. O. 1988. The current state of biological diversity. pp. 3-18 *In*: Biodiversity, Nacional Academy Press. Washington, D.C. Web Erisim: 22.03.2017.

Wilson, M. A., and R. Howarth. 2002. Discourse-based valuation of ecosystem services: establishing fair outcomes through group deliberation. Ecological Economics 41: 431-443.

Yang, S., X. Liu, H. Wu, H. Wang, and C. Qing. 2009. Steroidal saponins and cytoxicity of the wild edible vegetable *Smilacina atropurpurea*. Steroids 74: 7-12.

Yapici, I. U., H. Hosgoren ve O. Saya. 2009. Kurtalan (Siirt) ilçesinin etnobotanik özellikleri. Dicle Üniversitesi Ziya Gökalp Eğitim Fakültesi Dergisi 12: 191-196.

Yaylagul, O. 2011. Samsun Pazarlarında Satılan Şifalı Bitkiler. Samsun Sempozyumu. 13-16 Ekim, Samsun.

Yildirim, E., A. Dursun, and M. Turan. 2001. Determination of the nutrition contents of the wild plants used as vegetables in upper Çoruh valley. Turk J. Bot. 25: 367-371.

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Nutritional Properties of some Wild Edible Plant Species in Turkey

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ABSTRACT: *Wild edible plants play an important role in daily diet of Turkish people. They have been used for food and also for medicinal purposes. Turkey is one of the important countries with its rich biodiversity in wild edibles and consists of more than 11.000 plant species. Most of the wild edible species can potentially make a considerable contribution to dietary requirements, so nutrient properties of these species should be determined to demonstrate the nutritional value of agricultural biodiversity. In this study some wild edible species from three different biogeographic regions of the Aegean, Black Sea and Mediterranean were collected and analyzed to demonstrate the nutritional value of some wild edibles in Turkey. Proximates, dietary fiber (DF), minerals and vitamin C were assayed using standard methods and reference materials. The findings of this study show that most of the wild edible species can considerably contribute to requirements of dietary fiber, vitamin C and some minerals such as iron, potassium and phosphorus. These species could be a good alternative to other commonly consumed plants due to their high nutrient content. However, preparation methods and consumption ways are also important in the evaluation of their contribution to dietary requirements.*

Keywords: *Biodiversity, wild edibles, nutrient composition.*

Bazı Yabani Yenilebilir Bitki Türlerinin Besin Özellikleri

ÖZ: *Yenilebilir yabani bitkiler, Türk halkının günlük beslenmesinde önemli bir rol oynamaktadır. Gıda olarak ve tıbbi amaçlar için kullanılmaktadır. Türkiye yenilebilir yabani türler açısından zengin bir biyoçeşitliliğe sahiptir ve 11.000'den fazla bitki türü barındırmaktadır. Yenilebilir yabani bitkiler günlük beslenme gereksinimlerinin karşılanmasında önemli bir yere sahiptir ve tarımsal biyoçeşitliliğin besin değerinin ortaya konulabilmesi için bu türlerin besin ögesi kompozisyonlarının belirlenmesi önem arz etmektedir. Çalışmada Ege, Karadeniz ve Akdeniz olmak üzere üç farklı biyocoğrafik bölgeden 12 farklı yenilebilir yabani bitki türü toplanarak besin ögesi kompozisyonunu belirlemek amacıyla analizler yapılmıştır. Standart yöntemler ve referans materyaller kullanılarak makro besin öğesi, mineral ve C vitamini analizleri gerçekleştirilmiştir. Çalışmanın bulguları, yenilebilir yabani bitkilerin çoğunun diyet lifi, C vitamini, demir, potasyum ve fosfor gibi bazı besin ögeleri açısından beslenmemize önemli ölçüde katkıda bulunduğunu göstermektedir. Bu bitkiler, yüksek besin içeriğinden dolayı yaygın olarak tüketilen diğer bitkilere alternatif olarak tüketilebilirler. Bununla birlikte, hazırlama yöntemleri ve tüketim şekli de beslenme gereksinimlerine olan katkının değerlendirilmesinde göz önünde bulundurulmalıdır.*

Anahtar Sözcükler: *Biyolojik çeşitlilik, yenilebilir yabani bitkiler, besin kompozisyonu.*

INTRODUCTION

Turkey contains a unique biological diversity with over 11.707 plant species recorded, of which 3.649 are endemic, including many nutritionally-important species (Guner *et al*., 2012). There are three different biogeographic regions in Turkey; Euro-Siberian, Irano-Turanian and the Mediterranean region each with its own endemic species and natural ecosystems.

Wild species are very important for global nutrition and food security (Hunter *et al.,* 2016; Toledo and Burlingame, 2006). Nutrient data for wild foods and cultivars should be systematically generated to help improve dietary diversity and to overcome hunger (Anonymous, 2008; Stadlmayr *et al*., 2011). However, to date there has been few studies on the food composition data of wild edible species in Turkey and also in other countries. This may be due to the low interest of researchers on the food composition data of wild species yet the nutritional value of wild species is very important for food security and nutrition to evaluate their contribution to nutrition and health (Burlingame *et al*., 2009).

Wild edible plants have an important role in Turkish cultural life. For many generations, they have been used as food, medicines, dyes and ornamentals and are also important source of income for local people in different regions. There are various ethnobotanical references from Turkey which emphasizes that wild plants have different uses in various parts of the country (Ozbucak *et al.* 2006; Altundag and Ozhatay, 2009; Ozhatay *et al*., 2009; Yucel *et al.,* 2010; Dogan *et al*., 2013; Polat *et al*., 2013;) They can be eaten raw or cooked and they constitute ingredients for many food dishes. They are mostly used by mixing with cultivated vegetables in the preparation of dishes. These wild plant species have great potential for contributing to improved incomes of local people. Most of these plants are collected for family consumption and for selling in local markets (Yildirim *et al.,* 2001; Sekeroglu *et al.,* 2006; Tan *et al*., 2011).

Although wild vegetables and fruits constitute an important part of the local population's diet, biodiversity in the three biogeographic regions is under threat from land and ecosystem degradation from urbanization, industrialization, fires, seasonal settlements and tourism among other threats (Karagoz *et al.,* 2016; Sekercioglu, *et al*., 2011). Additionally there is a lack of information about the nutritional characteristics of many wild edible species which contributes to poor awareness and understanding of the value of this local biodiversity. There have been some studies on the nutrient composition of wild edible plant species but none of these studies are comprehensive including proximate, mineral and vitamin content of these wild species (Ozbucak *et al*., 2007; Civelek *et al*., 2013).

The main aim of this study was to determine the nutrient content of some wild edible plants collected from the Black Sea, Aegean and Mediterranean Region of Turkey. This data will be helpful in promoting local species and varieties for dietary diversity and income generation, and also value and maintain the ecosystems that nurture them.

MATERIALS AND METHODS

Collection and preparation of samples

Ornithogalum umbellatum L.*, Capsella bursa-pastoris* (L.) Medik.*, Polygonum cognatum* Meissn., *Smilax excelsa* L.*, Beta maritima* L., *Glebionis coronaria* (L.) Spach, Syn: *Chrysanthemum segetum* L., *Smyrnium olusatrum* L., *Cichorium intybus* L., *Dioscorea communis* (L.) Caddick&Wilkin, *Tragopogon porrifolius* subsp. *Longirostris* (Sch. Bip.) Greuter, *Eremurus spectabilis* M.Bieb., *Chondrilla juncea* L. species were prioritized for nutrition composition analysis. Samples were collected at the optimum time for harvesting during 2014 from Black Sea, Aegean and Mediterranean Regions. Taxonomic identification of the species were made according to "Flora of Turkey' (Davis, 1965-1985; Davis *et al.*, 1988).

Three batches of each species (about 200 g) were collected from three different sites to obtain

representative data. One composite sample was prepared from three batches for each site. The weights of the each composite sample were approximately 600 g. The plant samples were transported at refrigerated temperature using cold packs to the laboratory on the same day of collection in order to protect nutrient composition of samples.

For sample preparation, the inedible parts of plants were removed and the edible parts were rinsed with tap water for 1-2 min and then with distilled water for 1 min. After cleaning, the plant samples were homogenized and subsamples were prepared for analysis. The subsamples were frozen at -20 ^{o}C until analysis.

Chemical Analysis

The proximate analyses were performed according to the following AOAC methods (Anonymous, 2014).The moisture content was determined according to AOAC 930.04 (Anonymous, 2014) by drying in an air oven maintained at 105±2 ˚C and dried at least for 2 hours until samples reached constant weight. Total fat content was determined gravimetrically by modifying AOAC 920.39 (Anonymous, 2014) after a continuous extraction process with petroleum ether using ANKOMXT20 Fat Analyzer (ANKOM Technology Corp.). Protein content was calculated over total nitrogen determined by a combustion–detection technique, AOAC 992.15 (Anonymous, 2014) by LECO FP-528 Nitrogen/Protein determinator using a conversion factor of 6.25. Dietary fiber content was determined using the Official Method 991.43 enzymatic-gravimetric method (Anonymous, 2014). Total ash (inorganic matter) content was determined using the AOAC 942.05 (Anonymous, 2014). The organic matter of the samples were removed by heating at 600 °C for 48 h. Available carbohydrate content was calculated by difference [100-(water + protein + fat + ash + alcohol + dietary fiber)] (Greenfield & Southgate, 2003).

Calcium, sodium, potassium, magnesium, phosphorus, copper, iron and zinc content of samples were determined according to Nordic Committee on Food Analysis (NMKL) Method, 186. A high-pressure microwave system (Berghof SW-4, Eningen, Germany) was used for digestion of samples. About 0.5 g sample was weighted into Teflon PFA vessels and 4 ml of the concentrated HNO3 65% (Suprapur, Merck, Darmstadt, Germany) and 2 ml of H2O2 30% (Suprapur, Merck, Darmstadt, Germany) were added for digestion. A five step programme was used for digestion using 30 Bar of pressure with a rising temperature from 130°C to 200°C gradually. The samples were cooled, filtered and each solution was diluted to 50 mL with deionized water. Ca, Na, K, Mg, P, Cu, Fe and Zn were measured by inductively coupled plasma mass spectrometer (Agilent 7500cx, Agilent Technologies, Santa Clara, CA). The ICP-MS instrument was equipped with micromist nebulizer, nickel sample and skimmer cones. Plasma power was 1550 W and argon flow rates of 15, 0.9, 0.16 L/min for the plasma, carrier and plasma gases, respectively.

Vitamin C analysis was performed according to procedure described by Gökmen *et al.* (2000), with little modification. Ten grams of each sample were weighed and extracted with 6% metaphosphoric acid in an ultrasonic bath for 20 min and then filtered before HPLC analysis. Vitamin C was analyzed by reverse-phase HPLC (Agilent 1100, Agilent Technologies, Santa Clara, CA) with UV-DAD detector at 244 nm. HPLC was performed using a C18 reversed-phase column (Hichrom C18; 150 mm x 4.6 mm, 5 µm particle size), a mobile phase of methanol and water containing tetrabutyl ammonium hydrogensulfate.

RESULTS AND DISCUSSION

Proximate composition

Proximate analyses of the wild edible plant species are summarized in Table 1. Moisture is the predominant component in plants. The high moisture supports chemical reactions,

microbiological growth and it is directly reactant in hydrolytic processes, but provides positive properties such as taste and texture. The moisture contents of plants were determined between 77.9-92.0 g/100 g.

The highest ash (3.05 g/100 g) and carbohydrate (8.93 g/100 g) were obtained in *Polygonum cognatum* and *Ornithogalum umbellatum*, respectively. Fat contents were low and varied from 0.12 to 0.83 g/100 g in wild edible species. The protein contents ranged between 0.12-3.93 g/100 g and all of the species provide less than 10% of the Dietary Reference Intake (DRI) for protein (Anonymous, 2000). *Smilax excelsa* had the highest protein value (3.93 g/100 g). Compared with the protein contents reported by Ozbucak *et al.* (2007) for *S. excelsa* (7.28%), protein value was lower in the samples analyzed in this study. This may be due to populations, environment, genotype and environment interactions.

Smilax excelsa and *Polygonum cognatum* were notable for their high fiber contents (8.17 and 9.52 g/100 g respectively) providing a third of the DRI. The dietary fiber cotents for *Polygonum cognatum* and *Smilax excelsa* were notably higher than the dietary fiber results reported by Koca *et al.* (2015). Supplementing the diet with these species containing high fiber could be recommended due to its beneficial effects on health.

Minerals and Vitamin C

The detection and quantification limits of minerals determined are shown in Table 2. In this study, twelve wild plant species were analyzed for eight minerals. The concentrations of the minerals and vitamin C in plants are given in Table 3.

In the comparison of the concentration of minerals among wild edible plants, differences were observed. These variations could be from species, distribution of elements in the soil, environmental and weather conditions. K was the most abundant among the minerals quantified. Its concentration was between 256-709 mg/100 g in the plants analyzed. *Capsella bursa-pastoris*, *Smyrnium olusatrum* and *Glebionis coronaria* had the highest K content (709, 593 and 555 mg/100 g respectively. Al-Snafi (2015) reported an average value of K was 224.4 mg/kg for edible parts of *Capsella bursa-pastoris* which was lower than the results found in this study.

The concentration of Ca ranges from 46 to 275 mg/100 g. Ca is an essential nutrient because it is involved in the structure of the muscular system. Additionally, it controls essential processes like muscle contraction, cell growth, activity of brain cells and blood clotting (Belitz *et al.,* 2004). Similar result was found for *Capsella bursa-pastoris* (239.6 mg/100 g) by Al-Snafi (2015). Phosphorus content of samples studied ranged from 27.6 mg/100 g (*Beta maritima* L.) to 80.3 mg/100 g (*Capsella bursa-pastoris*).

Magnesium concentration varied from 15.2 to 77.8 mg/100 g in all samples. Some authors reported that the Mg contents of wild species were 0.20 g/100 g (*Smilax excelsa*), 0.23 g/100 g (*Polygonum cognatum*) Civelek and Balkaya (2013) and 38.17 mg/100 g for *Polygonum cognatum* (Turan *et al.,* 2003). These differences may be due to ecological factors and collection time.

Most of the wild plant species were excellent sources of several minerals, particularly iron. Fe was more than 10% of the DRI per 100 g of most of the species. *Polygonum cognatum* had highest iron content (37.4 mg/100 g) providing nearly 200% per cent DRI for male. Similar results were found for *Chenopodium album* (Yildirim *et al.,* 2001; Daur, 2015) and *Capsella bursa-pastoris* (Al-Snafi, 2015). However iron bioavailability should be considered while evaluating the iron content of foods. Iron deficiency may arise from low iron intake or by consuming foods from which iron is not well absorbed. Therefore bioavailability studies should be performed in order to provide consumers with reliable information on good food sources of iron.

Table 1. Proximate composition of the edible parts of wild edible plant samples (per 100g).
Çizelge 1. Yenilebilir yabani bitki türlerine ait örneklerin besin değerleri (100 g örnekte).

Species Tür	Moisture Nem (g)	Fat Yağ (g)	Protein Protein (g)	Carbohydrate Karbonhidrat (g)	Ash Kül (g)	Dietary fibre Diyet lif (g)	Energy Enerji (kcal/100g)
Ornithogalum umbellatum L.	87.0±0.3	0.27±0.04	0.53±0.01	8.93±0.22	0.84±0.04	2.45±0.03	45.1±1.0
Capsella bursa-pastoris (L.) Medik.	91.0±0.1	0.18±0.03	2.66±0.20	2.40±0.20	1.64±0.10	1.36±0.03	24.6±1.4
Polygonum cognatum Meissn.	77.9±0.2	0.65±0.05	2.06±0.04	6.77±0.23	3.05±0.01	9.52±0.12	60.3±0.6
Smilax excelsa L.	82.6±0.2	0.41±0.02	3.93±0.01	3.88±0.12	0.97±0.04	8.17±0.06	51.3±0.7
Beta maritima L.	89.2±0.9	0.18±0.02	2.42±0.08	1.26±0.05	1.64±0.06	5.27±0.48	26.8±1.2
Glebionis coronaria L. Spach	90.3±0.1	0.31±0.03	1.58±0.10	0.84±0.02	1.30±0.05	5.71±0.30	23.9±0.7
Smyrnium olusatrum L.	89.2±0.5	0.12±0.02	0.66±0.04	3.37±0.22	1.52±0.01	5.17±0.16	27.6±1.1
Cichorium intybus L.	91.1±1.1	0.28±0.03	0.53±0.08	2.12±0.17	1.54±0.07	4.45±0.55	22.0±0.9
Dioscorea communis (L.) Caddick&Wilkin	89.4±0.2	0.43±0.05	1.38±0.19	1.32±0.16	0.94±0.03	6.50±0.65	27.7±0.6
Tragopogon porrifolius subsp. Longirostris (Sch. Bip.)	87.5±0.2	0.83±0.05	0.15±0.01	5.41±0.39	1.52±0.04	4.70±0.38	38.5±0.6
Eremurus spectabilis M.Bieb.	92.0±0.5	0.46±0.03	0.12±0.01	4.06±0.19	0.73±0.01	2.75±0.31	25.9±1.1
Chondrilla juncea L.	89.8±0.3	0.70±0.03	3.22±0.04	3.61±0.34	1.32±0.04	1.37±0.05	36.4±1.6

Values are given as average and standard deviation of three independent composites (Ortalama ve Standart sapma değerleri 3 örnek ortalama değeridir).

Table 2. Mineral and Vitamin C content of edible parts of wild edible plant samples (mg/100g).
Çizelge 2. Yenilebilir yabani bitki türlerine ait örneklerdeki mineral ve C vitamini değerleri (mg/100g).

Species Tür	Minerals (Mineraller)								Vitamin C
	K	Ca	Na	P	Mg	Fe	Zn	Cu	
Ornithogalum umbellatum L.	256±30	128±1	5.5±0.5	36.8±1.9	19.5±.4.0	3.6±0.1	0.26±0.01	0.08±0.01	83.1±5.4
Capsella bursa-pastoris (L.) Medik.	709±67	249±42	3.7±0.5	80.3±6.1	47.5±6.7	7.9±1.1	1.30±0.18	0.17±0.04	62.7±2.1
Polygonum cognatum Meissn.	449±8	275±5	2.2±0.1	43.2±0.9	77.8±1.7	37.4±0.8	0.71±0.03	0.52±0.02	23.5±4.0
Smilax excelsa L.	436±17	69±3	1.6±0.1	60.6±2.5	22.7±0.9	1.5±0.1	0.77±0.03	0.40±0.02	2.0±0.6
Beta maritima L.	506±29	95±9	292±80	27.6±1.7	75.3±9.1	5.0±0.8	0.30±0.12	0.14±0.06	18.3±0.5
Glebionis coronaria L. Spach	555±11	239±31	198±48	46.5±9.4	53.4±11.7	8.7±1.9	1.97±0.18	1.77±0.37	10.2 ±2.9
Smyrnium olusatrum L.	593±39	180±9	2.9±0.1	46.1±4.7	37.5±1.3	3.7±0.1	0.25±0.04	0.22±0.04	75.3±10.3
Cichorium intybus L.	461±79	138±15	47.3±7.7	31.3±1.6	32.8±3.6	10.5±4.1	0.39±0.10	0.21±0.04	4.7±0.6
Dioscorea communis (L.) Caddick&Wilkin	444±9	46±1	1.4±0.1	72.3±1.5	27.0±0.5	1.2±0.1	0.59±0.01	0.17±0.01	36.5±3.4
Tragopogon porrifolius subsp. Longirostris (Sch.Bip.)	318±34	192±10	4.9±0.5	45.7±5.1	63.7±6.7	15.2±3.0	0.53±0.06	0.18±0.05	32.4±6.8
Eremurus spectabilis M.Bieb.	263±19	76±3	1.5±0.3	42.8±2.1	15.2±0.5	2.4±0.9	0.36±0.01	0.08±0.01	129.4±22.9
Chondrilla juncea L.	333±18	194±2	4.9±0.2	47.3±0.4	50.5±1.2	8.1±1.3	0.37±0.01	0.23±0.04	32.2±3.4

Values are given as average and standard deviation of three independent composites (Ortalama ve Standart sapma değerleri 3 örnek ortalama değeridir).

Table 3. Calibration information of elements.
Çizelge 3. Elementlere ait kalibrasyon bilgileri.

Elements Elementler	Mass Kütle	LOD Tespit limiti (µg/kg)	LOQ Tayin limiti (µg/kg)	R2	Concentration range Kalibrasyon aralığı (µg/l)
K	39	80	260.00	0.9999	1000-50 000
Ca	43	50	0.17	0.9998	1000-50 000
Na	23	50	0.15	0.9998	1000-50 000
P	31	40	0.12	0.0097	1000-50 000
Mg	24	90	0.32	0.9997	1000-50 000
Fe	56	21	68.70	0.9975	10-50
Cu	63	22	72.70	0.0095	10-50
Zn	66	16	52.20	0.9993	75-375

Glebionis coronaria and *Polygonum cognatum* provide high copper intakes and copper is involved in oxidation–reduction reactions which are important for life. Cu content varied from 0.08 to 1.77 mg/100 g. The highest contents of Zn (1.30 mg/100 g) were observed in *Capsella bursa-pastoris.* This value, as well as those found for *Capsella bursa-pastoris* were higher than the values reported by Al-Snafi (2015). A partially different Zn content from our result was reported by Phillips *et al.* (2014) and Daur (2015) for *Chenopodium album*; Civelek and Balkaya (2013) for *Smilax excelsa* and *Polygonum cognatum*.

Results showed that there were wide ranges of variations among the species regarding to mineral concentrations of the wild species studied. The highest mineral concentrations of edible wild plant species studied were determined in *Polygonum cognatum*, whereas the lowest concentration was *Ornithogalum umbellatum*.

Vitamin C content of the samples are highly variable ranging from 2.0 to 124.4 mg/100 g. Vitamin C was high in *Eremurus spectabilis* and *Ornithogalum umbellatum* relative to the other species and provides nearly 100% of the DRI per 100g. (75 mg/day for women and 90 mg/day for men), according to the Food and Nutrition Board (2000). Vitamin C is an essential water soluble protein and antioxidant either in the food or the human body, by the destruction of oxygen free radicals. Compared with the results reported by Sekereoglu *et al*. (2006), the vitamin C content was higher in *Ornithogalum umbellatum* samples analyzed in this study.

CONCLUSION

In this study a wide variability on nutrient content was obtained among the analyzed wild plant species. There are several factors known to affect the nutrient composition of foods; genetic factors, climate, geography, geochemistry, agricultural practices such as fertilizer use, stage of maturity, and the growth period. *Polygonum cognatum*, *Smilax excelsa* and *Eremurus spectabilis* are some of the species which can be highlighted for their high contribution to dietary fiber, microelement and vitamin C intake. The food composition data of wild plant species will be very helpful in promoting the use of more biodiverse foods for healthy diets in Turkey. The studied plant species could be a good alternative to other commonly consumed vegetables due to their high nutrient content. However, preparation methods and consumption ways are also important in the evaluation of their contribution to dietary requirements. Further studies should be performed on these species to demonstrate the effect of processing on nutrient composition.

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REFERENCES

Altundag, E., and N. Ozhatay. 2009. Local Names of Some Useful Plants From Igdir Province (East Anatolia). Istanbul J. Pharm. 40: 101-115.

Al-Snafi, A. E. 2015. The Chemical Constituents and Pharmacological Effects of *Capsella bursa-pastoris.* A Review. Int. J. Pharm. 5 (2): 76-81.

Anonymous. 2000. Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids. Institute of Medicine, Food and Nutrition Board. National Academy Press, Washington, D.C., USA.

Anonymous. 2008. Expert Consultation on Nutrition Indicators for Biodiversity: Food composition. Food and Agriculture Organization of the United Nations (FAO).

Anonymous. 2014. AOAC. Official Methods of Analysis of the Association of Official Analytical Chemists. Association of Official Analytical Chemists, Washington, D.C., USA. Retrieved December 12, 2015 from: http://www.eoma.aoac.org/.

Belitz, H. D., W. Grosch and P. Schieberle. 2004. Food Chemistry (3rd ed). Springer-Verlag Berlin. 1070 p.

Burlingame, B., R. Charrondiere, and B. Mouille. 2009. Food composition is fundamental to the cross-cutting initiative on biodiversity for food and nutrition. J. Food Compos. Anal. 22: 361-365.

Civelek, C., and A. Balkaya. 2013. The Nutrient Content of Some Wild Plant Species Used as Vegetables in Bafra Plain Located in the Black Sea Region of Turkey. Eur. J. Plant Sci. Biotechnol. 7: 62-65.

Daur, I. 2015. Chemical composition of selected Saudi Medicinal Plants. Arab. J. Chem. 8: 329-332.

Davis, P. H. (1965-1985). Flora of Turkey and the East Aegean Islands. Edinburgh University Press, Edinburgh, Volume: 1-9.

Davis, P. H., R. R. Mill, K. Tan. 1988. Flora of Turkey and the East Aegean Islands. Edinburgh University Press, Edinburgh, Volume 10.

Dogan, Y., R. Ugulu, and N. Durkan. 2013. Wild Edible Plants Sold in The Local Markets of Izmir, Turkey. Pakistan J. Bot. 45: 177-184.

Greenfield, H., and D. A. T. Southgate. 2003. Food Composition Data: Production, Management and Use, 2nd ed. Food and Agriculture Organization of the United Nations, Rome.

Gokmen, V., N. Kahraman, N. Demir and J. Acar. 2000. Enzymatically validated liquid chromatographic method for the determination of ascorbic and dehydroascorbic acids in fruit and vegetables. J. Chromatogr. A 881: 309-316.

Guner, A., S. Aslan, T. Ekim, M. Vural, and M. T. Babac. 2012. A Checklist of the Flora of Turkey (Vascular Plants). 1st ed. İstanbul, Nezahat Gökyiğit Botanic Garden.

Hunter, D., I. Ozkan, M. O. D. Beltrame, W. L. G. Samarasinghe, Vv. W. Wasike, U. R. Charrondière, T. Borelli, and J. Sokolow. 2016. Enabled or disabled: is the environment right for using biodiversity to improve nutrition? Front. Nutr. 3: 14.

Karagoz, A., K. Ozbek, and N. Sari. 2016. Problems Regarding Conservation and Sustainable Use of Turkey's Plant Biodiversity and Proposed Solutions. Journal of Field Crops Central Research Institute 25 (1): 78-87.

Koca, I., I. Hasbay, S. Bostanci, V. A. Yilmaz, and A. F. Koca. 2015. Some Wild Edible Plants and Their Dietary Fiber Contents. Pak. J. Nutr. 14 (4): 188-194.

Ozbucak, T. B., H. Kutbay, and O. E. Akcin. 2006. The contribution of wild edible plants to human in the Black Sea region of Turkey. Ethnobotanical Leaflets 10: 98-103.

Ozbucak, T. B., A. O. Ergen, and S. Yalcin. 2007. Nutrition Contents of the Some Wild Edible Plants in Central Black Sea Region of Turkey. International Journal of Natural and Engineering Sciences 1: 11-13.

Ozhatay, N,, E. Akalin, E. Ozhatay, and S. Unlu. 2009. Rare and endemic taxa of Apiaceae in Turkey and their conservation significance. Istanbul J. Pharm. 40: 1-9.

Phillips, K. M., P. R. Pehrsson, W. W. Agnew, A. J. Scheett, J. R. Follett, H. C. Lukaski, and K. Y. Patterson. 2014. Nutrient composition of selected traditional United States Northern Plains Native American plant foods. J. Food Compos. Anal. 34: 136-152.

Polat, R., U. Cakilcioglu, and F. Satil. 2013. Traditional uses of medicinal plants in Solhan (Bingöl-Turkey). J. Ethnopharmacol. 148: 951-963.

Sekercioglu, C. H., S. Anderson, E. Akçay, R. Bilgin, O. Can, G. Semiz, C. Tavsanoglu, M. B. Yokes, A. Soyumert, K. Ipekdal, I. Saglam, M. Yucel, and N. Dalfes. 2011. Turkey's globally important biodiversity in crisis. Biol. Conserv. 144: 2752-2769.

Sekeroglu, N., F. Ozkutlu, M. Deveci, O. Dede, N. Yilmaz. 2006. Evaluation of some wild plants in terms of their nutritional values used as vegetable in Eastern Black Sea Region of Turkey. Asian J. Plant Sci. 5: 185–189.

Stadlmayr, B., E. Nilsso, B. Mouille, E. Medhammar, B. Burlingame, and R. Charrondiere. 2011. Nutrition indicator for biodiversity on food composition. A report on the progress of data availability. J. Food Compos. Anal. 24: 692-698.

Tan, A., and T. Taskin. 2011. Some edible wild plants of Turkey and their use. Transaction of the International Scientific Conference "Actual Problems In the Use of Useful Plants", Bakü, Azerbaijan. 26-28 October, 2011.

Toledo, A., and B. Burlingame. 2006. Biodiversity and nutrition: a common path toward global food security and sustainable development. J. Food Compos. Anal. 19: 477-483.

Turan, M., S. Kordali, H. Zengin, A. Dursun, and Y. Sezen. 2003. Macro and Micro Mineral Content of Some Wild Edible Leaves Consumed in Eastern Anatolia, Acta Agriculturae Scandinavica, Section B- Soil & Plant Science 53 (3): 129-137.

Yildirim, E., A. Dursun, and M. Turan. 2001. Determination of the nutrition contents of tıe wild plants used as vegetables in upper Coruh Valley. Turkish Journal of Botany 25: 367-371.

Yücel, E., F. Guney and I. Y. Sengun. 2010. The wild plants consumed as a food in Mihalıccık district (Eskişehir/Turkey) and consumption forms of these plants. Biological Diversity and Conservation. 3 (3): 158-175.

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The Antioxidant Capacities and Consumption Per Capita of Edible Wild Species and Local Varieties Collected from Turkey within the GEF-Funded Biodiversity for Food and Nutrition (BFN) Project

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ABSTRACT: *Biodiversity for Food and Nutrition (BFN) Project enhancing global knowledge of biodiversity for food and nutrition by providing nutrition information about wild species that are currently underutilized or are disappearing from local diets. Wild edible plants are eaten raw, cooked, dried and processed depending on the region where they grow. Wild edible foods are collected from particularly in rural areas and many households village and used for home consumption or sold in local markets. The antioxidant capacity analyses of wild species collected from Turkey within the BFN Project were done by two different methods, DPPH (2,2-diphenyl-1-picrylhydrazyl radical scavenging effect) and TEAC (Trolox Equivalent Antioxidant Capacity/ABTS Method). The antioxidant capacity results of the 42 plant species collected from Turkey were compared to the results of the Butylated hydroxyl toluene (BHT) which is a reference synthetic antioxidant compound.*

The radical scavenging effect values of ***Rhus coriaria*** *(1825.3) and* ***Berberis crataegina*** *(1380.6) are the closest of BHT value according to the DPPH method. The antioxidant capacity values (µM trolox equivalent / g sample) of* ***Rhus coriaria*** *(3055.6) and* ***Berberis crataegina*** *(2362.1) are the closest of BHT antioxidant value (16651.9) according to the TEAC method. When the results of the two methods are compared, the antioxidant capacity results have paralells in most of the species. The annual intake of mM trolox equivalent antioxidant capacity was calculated by multiplying the consumption per capita of TEAC results. This process has led to a different ranking than above.*

Keywords: *Wild edibles, BFN, antioxidant capacity, DPPH, TEAC.*

Beslenme ve Gıda için Biyoçeşitlilik (BGB) Projesi Kapsamında Türkiye'den Toplanan Yenilebilir Yabani Tür ve Yerel Çeşitlerin Antioksidan Kapasiteleri ve Kişi Başı Tüketimleri

ÖZ: *Gıda ve Beslenme için Biyolojik Çeşitlilik (BFN) Projesi ile şu anda yeterince kullanılmayan ya da yerel diyetlerden kaybolan vahşi türler hakkında beslenme bilgisi sağlayarak küresel gıda ve beslenme biyolojik çeşitliliğin önemini arttırmak amaçlanmıştır. Yabani yenilebilir bitkiler, yetiştiği bölgeye bağlı olarak çiğ, pişirilmiş, kurutulmuş ve işlenmiş olarak tüketilirler. Yabani yenilebilir gıdalar, özellikle kırsal alanlardan ve birçok evin bahçesinden toplanır ve ev tüketiminde kullanılır*

veya yerel pazarlarda satılırlar. BFN Projesi kapsamında Türkiye'den toplanan yabani türlerin antioksidan aktivite analizleri, DPPH (2,2-difenil-1-pikrilhidrazil radikal temizleme etkisi) ve TEAC (Trolox Eşdeğeri Antioksidan Kapasitesi / ABTS Yöntemi) olmak üzere 2 farklı yöntemle gerçekleştirildi. Türkiye'den toplanan 42 bitki türünün antioksidan aktivite sonuçları, bir referans sentetik antioksidan bileşik olan Bütilledirilmiş Hidroksi Toluen'in (BHT) sonuçları ile karşılaştırılmıştır.

DPPH yöntemine göre, ***Rhus coriaria*** *(1825.3) ve* ***Berberis crataegina*** *'un (1380.6) radikal temizleme etkisi değerleri BHT'nin sonucuna en yakın değerlerdir. TEAC yöntemine göre,* ***Rhus coriaria*** *(3055.6) ve* ***Berberis crataegina*** *(2362.1) antioksidan kapasite değerleri (μM trolox eşdeğeri / g örneği) BHT değerine (16651.9) en yakın değerlere sahiptirler. İki yöntemin sonuçları karşılaştırıldığında, antioksidan aktivite sonuçları türlerin büyük çoğunluğunda benzer değerlere sahip bulunmuştur. mM trolox eşdeğer antioksidan kapasitesinin yıllık alımı, türlerin kişi başına düşen yıllık tüketimin TEAC sonuçları ile çarpımı sonucu hesaplanmıştır. Bu işlem yukarıda belirtilenlerden farklı bir sıralamaya neden olmuştur.*

Anahtar Sözcükler: *Yenilebilir yabani bitkiler, BFN, antioksidan kapasite, DPPH, TEAC.*

INTRODUCTION

In 2012, the Global Environment Facility (GEF) fund a new project called "Mainstreaming Biodiversity Conservation and Sustainable Use for Improved Human Nutrition and Well-being (BFN project)" which operates in Kenya, Sri Lanka, Turkey, and Brazil. Coordinated by Bioversity International and co-implemented by FAO and the United Nations Environment Program (UNEP).

In Turkey, Biodiversity for Food and Nutrition (BFN) project tries to mainstream biodiversity conservation and sustainable use for improved nutrition into national food and livelihood security strategies formed or strengthened. The BFN project is enhancing global knowledge of biodiversity for food and nutrition by providing nutrition information about wild species that are currently underutilized or are disappearing from local diets. Wild edible foods are collected from particularly in rural areas and many households village and used for home consumption or sold in local markets. Wild edible plants are eaten raw, cooked, dried and processed depending on the region where they grow.

According to the World Health Organization (WHO) (Anonymous, 1991), using edible and/or medicinal plants about three-quarters of the world population rely upon traditional remedies for their health care. In fact, herbs/plants are the oldest friends of mankind. They not only provided food but also served the humanity to cure common ailments. Edible plants have provided the modern medicine with numerous plant derived therapeutic agents (Hudaib *et al*., 2008; Arasimowicz *et al*., 2009; Caylak, 2011). Some phytochemicals (phenolics, flavanoids, vitamin E, vitamin C, lycopene, beta-carotene etc.) which are herbal and identified as beneficial chemicals are evidence of the antioxidant activity of the plant. The antioxidant activity values changes according to the amounts of this beneficial phytochemicals containing in inspected species (Bahorun *et al*., 2006; Isbilir, 2008; Arasimowicz *et al*., 2009). It is known that red-purple colored plant species which are rich as anthocyanin show antioxidant activity sweeping the DPPH and ABTS radicals.

The food we eat, the drugs and medicines we take, the air we breathe, and the water we drink include fried foods, alcohol, tobacco smoke, pesticides, air pollutants, and many more which are cause free radicals (Burt, 2004). Free radicals are atoms or molecules that are highly reactive with other cellular structures because they contain unpaired electrons. Free radicals are natural by-products of ongoing biochemical reactions in the body, including ordinary metabolic processes and immune system responses. Antioxidants, as "free radical scavengers", are compounds that either reduce the formation of free radicals or react with and neutralize them. Antioxidants often work by donating an electron to the free radical before it

can oxidize other cell components. Once the electrons of the free radical are paired, the free radical is stabilized and becomes non-toxic to cells (Burt, 2004; Caylak *et al*., 2007; Bahorun *et al*., 2006; Isbilir, 2008). They are used for the stabilization of polymeric products, of petrochemicals, foodstuffs, cosmetics and pharmaceuticals (Isbilir, 2008).

MATERIALS AND METHODS

The antioxidant capacity and radical scavenging effect results of the 42 plant species collected from the Black Sea, Mediterranean and Aegean Region pilot sites in Turkey were compared to the results of the Butylhydroxyltoluene (BHT) which is a reference synthetic antioxidant compound and available commercially.

Extraction

Antioxidant compounds of the sample are extracted firstly if the sample is in the completely texture (fruit, vegetable, herb) form. For the edible plants which are in the fresh herb form: 9.5 mL methanol with 80% purity is added to the 0.5 g sample and extraction is made in the orbital shaker during 1 hour. The tube is centrifuged in 5204 g during 10 minutes. Later, the liquid phase in the tube is collected. 9.5 mL methanol with 80% purity added to the residual part in the tube and the same procedures are repeated 3 times. After this procedure, the extracts are taken to the 50 mL volumetric flask and it is diluted to the volume of the volumetric flask (Cemeroglu, 2010; Ayas *et al*., 2014, 2017).

Radical Scavenging Effect with Using DPPH (2,2-diphenyl-1-picrilhydrazil)

After extraction, analysis may be done directly or diluting with methanol. Preparation of the DPPH* radical solution (1mM): It should be prepared depending to the number of samples. 600 µl DPPH is taken to the each of the test tubes. Different volumes (20-40-60-80-100 µl, these values may be changed according to the sample) of the sample extracts are added to the test tubes. The total volume of the each tube is completed to the 6 mL with methanol. The tubes are vortexed; the incubation procedure is made during 15 minutes in a dark place in the room temperature. 5400 µl MeOH is added to the 600 µl DPPH for using as a replicate sample. The incubation of the replicate sample is made during 15 minutes. The absorbance values of the samples are read in the spectrophotometer with 517 nm at the end of the incubation procedure.

Calculation: the percentage inhibition values corresponding to each volume of the sample are calculated according to the equation below.

% Inhibition=[(ADPPH–Aextract)/ADPPH] x 100

The determined inhibition values are graphed with the volume values of the samples, linear regression analysis is made, the curve related to the sample and linear equation of the curve are determined. EC50 value is calculated with using this equation. Conclusion of DPPH value (1/IC50) was showed the reverse of the fresh plant value in terms of mg which inhibits 50% of the 1g DPPH radical (Cemeroglu, 2010; Ayas *et al*., 2014, 2017).

Trolox equivalent antioxidant capacity (TEAC) method/ABTS radical cation decolorization assay

7 mM ABTS solution containing 2,45 mM potassium persulfate is waited during 12-16 hours at room temperature and dark place for ensuring ABTS radical solution, phosphate buffer saline (pH:7.4). The radical solution is diluted to the 0.700±0.02 absorbance value at 734 nm wavelength in the spectrophotometer (Obón *et al*., 2005; Papandreou *et al*., 2006; Apak *et al*., 2007; El Rayess *et al*., 2014). 0.2 mL is taken from the ABTS radical solution diluted in microcuvette and the starting absorbance is recorded. The different volumes (as 1, 2, 3, 4, 5 µl) of extract are added to the radical solution in the microcuvette and then the absorbance values are read during 6 minutes in every 1 minute by Thermo Scientific™ Multiskan™ GO microplate reader, the values are

recorded. The inhibition values determined in the end of the 6 minutes are plotted in a graph against to the sample amounts and linear regression analysis is made (Cemeroglu, 2010; Ayas *et al*., 2014; 2017). The slope of the extract curve is rated to the slope of the trolox curve and TEAC value is calculated and expressed as Trolox equivalents in μM (Table 1) or mM (Table 2).

Consumption Per Capita

In order to determine the consumption per capita (kg/year) of plant species, research has been done with monograph technique. The data were compiled by survey using question-answer method.

RESULTS AND DISCUSSION

The antioxidant capacity analyses of wild species collected from Turkey within the BFN Project were done by two different methods, DPPH (2,2-diphenyl-1-picrylhydrazyl radical scavenging effect) and TEAC (Trolox Equivalent Antioxidant Capacity/ABTS radical cation decolorization assay Method). The antioxidant capacity results (Table 1) of the 42 plant species collected from Turkey were compared to the results of the Butylated hydroxyl toluene (BHT) which is a reference synthetic antioxidant compound and available commercially.

The radical scavenging effect values of *Rhus coriaria* (1825.3) and *Berberis crataegina* (1380.6) are the closest of BHT value (2101.2) according to the DPPH method, this shows that these plant species radical scavenging effect are higher than the others and they have natural antioxidant characteristic. Koşar *et al*., (2004) and Charehsaz *et al*., (2015) found similar results. They found that radical scavenging effect values of different extracts from *Rhus coriaria* and *Berberis crataegina* are closest of BHT value according to the DPPH method.

The antioxidant capacity values (μM trolox equivalent/g sample) of *Rhus coriaria* (3055.6) and *Berberis crataegina* (2362.1) are the closest of BHT antioxidant value (16651.9) according to the TEAC method. Charehsaz et al. (2015) were found similarly, antioxidant capacity values of *Berberis crataegina* (2152) are closest of this study value according to the TEAC method. If the results of the two methods are compared, the antioxidant capacity results have paralells in most of the species. This validates the reliability of the study. It is known that red-purple colored plant species which are rich as anthocyanin show antioxidant activity sweeping the DPPH and ABTS radicals, this case were seen in the analyses results.

The consumption per capita (kg/year) results of the 42 plant species collected from Turkey were showed in Table (2). These results showed that *Triticum monococcum* (14.2 kg/year), *Colocasia esculenta* (9.2 kg/year), *Vignaun guiculata* (6,3 kg/year) and *Trachystemon orientalis* (L.) G. Don (6.2 kg/year) are the best consumption per capita in plant species collected from Turkey.

The annual intake of mM trolox equivalent antioxidant capacity (Table 2) was calculated by multiplying the consumption per capita (kg/year) of TEAC (μM trolox equivalent/g sample) results. This process has led to a different ranking than Table 1.

Table 1. The antioxidant capacity values of samples according to the DPPH and TEAC method.
Çizelge 1. DPPH ve TEAC metoduna göre örneklerin antioksidan kapasite değerleri.

Sample Number Örnek No	English name İngilizce ismi	Scientific name Latince ismi	Turkish name Türkçe ismi	1/IC50* (DPPH)	STD	µM trolox equivalent/g sample (TEAC) µM troloks eşdeğeri/g örnek	STD
1	Elm-leaved sumach	*Rhus coriaria*	Sumak	1825.3	76.1	3055.6	20.4
2	Berberis	*Berberis crataegina*	Karamuk	1380.6	14.2	2362.1	2.7
3	Curly dock	*Rumex crispus* L.	Labada	593.1	10.8	921.3	11.2
4	Watercress	*Nasturtium officinale*	Suteresi	420.0	16.1	903.0	17.7
5	Prickly ivy	*Smilax excelsa L.*	*Kırçan*	453.7	19.7	808.8	15.0
6	Rush skeletonweed	*Chondrilla juncea*	Karakavuk	434.2	6.6	690.0	2.2
7	Ground elder	Aegopodium podagraria L.	Keçi ayağı	356.8	27.8	652.6	9.8
8	Knotgrass or knotweed	*Polygonumcognatum*	Madımak	346.7	19.4	611.3	6.6
9	Eastern borage or oriental borage	*Trachystemon orientalis* (L.) G. Don	Kaldirik	347.8	15.6	572.8	13.7
10	Common chicory	*Cichorium intybus*	Hindiba (Akdeniz)	274.2	11.4	539.0	6.4
11	Salsify	*Scorzonera cana*	Tekesakalı	275.6	7.4	522.6	18.0
12	Alexanders	*Smyrnium olusatrum*	Deli kereviz	201.4	1.9	492.5	32.8
13	Caper bush	*Capparis spinosa*	Kapari	85.6	3.9	465.8	10.6
14	N/A	*Ferulago trachycarpa*	Kuzukemirdi	245.4	3.7	315.8	19.7
15	Black bryony	*Dioscorea communis*	Dolanbaç	47.0	0.7	303.5	11.6
16	Gundelia or Galgal	*Gundelia tournefortii*	Kenger	145.1	11.0	284.1	4.1
17	Rock samphire	*Crithmum maritimum*	Denizteresi	173.5	0.9	280.4	13.0
18	Serik crab	*Pyrus serikensis*	Zingit	93.4	6.7	244.4	13.1
19	Sea beet	*Beta maritima*	Kıyı pancarı	50.3	0.2	241.4	7.1
20	Purple salsify	*Tragopogon porrifolius* subsp. *longirostris*	Helevan (Yemlik)	192.6	11.9	220.7	7.5
21	Glasswort or Samphire	*Salicornia emericii Duval-Jouve*	Deniz börülcesi	47.8	0.9	210.7	27.1
22	Syrian juniper	*Juniperus drupacea*	Andız (Enek)	122.4	4.9	208.8	0.1
23	Yellow Herb	*Opopanax hispudus*	Kaymacık	44.1	2.6	208.0	4.4
24	Lamb's quarters	*Chenopodium album* L.	Ak sirken, Sirken	39.8	1.4	206.6	1.8
25	Crown Daisy	*Glebionis coronaria* (L.) Spach	Alagömeç	161.0	7.8	188.9	3.3
26	Wild Radish	*Raphanus raphanistrum*	Eşekturpu	23.5	3.6	180.5	7.6
27	Foxtail lily	*Eremurus spectabilis*	Çiriş	170.0	2.5	168.9	5.1
28	Sorrel	*Rumex acetosella*	Kuzukulağı	26.9	0.5	167.2	13.5
29	Shepherd's-purse	*Capsella bursa-pastoris* (L.) Medik	Çoban çantası	34.8	0.1	158.3	0.8
30	Cowpea	*Vignaun guiculata*	Börülce	17.9	1.7	142.7	5.3
31	Common chicory	*Cichorium intybus*	Hindiba (Ege)	28.3	0.6	139.0	1.6
32	Fennel	*Foeniculum vulgare*	Arapsaçı-rezene	31.7	2.2	122.6	5.3
33	Calamus or Sweet flag	*Acorus calamus*	Eğir	21.0	0.1	117.9	0.1
34	Bladder Campion	*Silene vulgaris* (Moench) Garcke	Ecibücü (Gıvışkan)	81.0	2.5	114.3	8.0
35	Golden thistle	*Scolymus hispanicus*	Şevketi bostan	18.3	1.1	95.4	0.6
36	Star of Bethlehem	*Ornithogalum umbellatum* L	Sunbala, Sakarcık	7.1	0.2	60.5	2.2
37	Ferula or giant fennel	*Ferula elaeochytris*	Çağ (Çakşır kök)	5.5	0.5	38.9	1.8
38	Crab apple	*Eriolobus trilobatus*	Atelması	4.4	0.0	38.3	1.5
39	Arrost's baby's-breath	*Gypsophila arrostii* subsp. *nebulosa*	Çöğen	4.0	0.1	31.2	0.5
40	Taro, Elephant ear	*Colocasia esculenta*	Göleviz	12.9	0.2	29.8	1.5
41	Einkorn wheat	*Triticum monococcum*	Siyez	1.6	0.0	9.3	0.4
42	White lupin	*Lupinus albus*	Termiye	undetected		undetected	
			BHT**	2101.2	277	16651.9	59

*the reverse of the fresh plant value in terms of mg which inhibits 50% of the 1g DPPH radical.
**Butylated hydroxyl toluene.

Table 2. The consumption per capita (kg/year) and the annual intake of mM trolox equivalent of the 42 plant species.
Çizelge 2. Çalışmada kullanılan 42 bitki türüne ait yıllık tüketim miktarları ve bu türlerle yıllık olarak alınan antioksidan kapasitesinin mM troloks eşdeğeri.

Sample Number Örnek No	English name İngilizce ismi	Scientific name Latince ismi	Turkish name Türkçe ismi	Consumption Per Household (kg/year) Ev Başına Yıllık Tüketim (kg/yıl)	Consumption Per Capita (kg/year) Kişi Başına Yıllık Tüketim (kg/yıl)	mM trolox equivalent/year (TEAC) mM troloks eşdeğeri/yıl
9	Eastern borage or oriental borage	*Trachystemon orientalis* (L.) G. Don	Kaldirik	25.9	6.2	3551.4
2	Berberis	*Berberis crataegina*	Karamuk	3.5	1.2	2834.5
3	Curly dock	*Rumex crispus* L	Labada	8.3	2.2	2026.9
12	Alexanders	*Smyrnium olusatrum*	Deli kereviz	11.5	3.5	1723.8
7	Ground elder	Aegopodium podagraria	Keçi ayağı	7.6	2.0	1305.2
5	Prickly ivy	*Smilax excelsa L.*	Kırçan	7.3	1.6	1294.1
4	Watercress	*Nasturtium officinale*	Suteresi	5.0	1.4	1264.2
17	Rock samphire	*Crithmum maritimum*	Denizteresi	11.0	3.5	981.4
18	Serik crab	*Pyrus serikensis*	Zingit	13.5	3.9	953.2
1	Elm-leaved sumach	*Rhus coriaria*	Sumak	1.2	0.3	916.7
30	Cowpea	*Vignaun guiculata*	Börülce	21.9	6.3	899.0
10	Common chicory	*Cichorium intybus*	Hindiba (Akdeniz)	4.6	1.6	862.4
21	Glasswort or Samphire	*Salicornia emericii Duval-Jouve*	Deniz börülcesi	13.9	3.8	800.7
19	Sea beet	*Beta maritima*	Kıyı pancarı	11.1	3.0	724.2
26	Wild Radish	*Raphanus raphanistrum*	Eşekturpu	15.0	4.0	722.0
6	Rush skeletonweed	*Chondrilla juncea*	Karakavuk	2.2	1.0	690.0
11	Salsify	*Scorzonera cana*	Tekesakalı	4.0	1.3	679.4
8	Knotgrass or knotweed	*Polygonumcognatum*	Madımak	5.8	1.1	672.4
23	Yellow Herb	*Opopanax hispudus*	Kaymacık	7.4	2.2	457.6
24	Lamb's quarters	*Chenopodium album* L.	Ak sirken,	8.7	2.0	413.2
15	Black bryony	*Dioscorea communis*	Dolanbaç	4.0	1.3	394.6
22	Syrian juniper	*Juniperus drupacea*	Andız (Enek)	5.8	1.8	375.8
31	Common chicory	*Cichorium intybus*	Hindiba (Ege)	9.4	2.6	361.4
20	Purple salsify	*Tragopogon porrifolius* subsp. *longirostris*	Helevan (Yemlik)	5.1	1.6	353.1
32	Fennel	*Foeniculum vulgare*	Arapsaçı-rezene	10.2	2.7	331.0
28	Sorrel	*Rumex acetosella*	Kuzukulağı	7.1	1.9	317.7
29	Shepherd's-purse	*Capsella bursa-pastoris* (L.) Medik	Çoban çantası	7.5	1.9	300.8
40	Taro, Elephant ear	*Colocasia esculenta*	Göleviz	29.3	9.2	274.2
25	Crown Daisy	*Glebionis coronaria* (L.) Spach	Alagömeç	4.2	1.4	264.5
35	Golden thistle	*Scolymus hispanicus*	Şevketi bostan	10.0	2.7	257.6
27	Foxtail lily	*Eremurus spectabilis*	Çiriş	4.5	1.5	253.4
16	Gundelia or Galgal	*Gundelia tournefortii*	Kenger	2.7	0.8	227.3
41	Einkorn wheat	*Triticum monococcum*	Siyez	84.0	14.2	132.1
14	N/A	*Ferulago trachycarpa*	Kuzukemirdi	1.5	0.4	126.3
34	Bladder Campion	*Silene vulgaris* (Moench) Garcke	Ecibücü (Gıvışkan)	5.3	1.1	125.7
36	Star of Bethlehem	*Ornithogalum umbellatum*	Sunbala, Sakarcık	5.4	1.3	78.7
13	Caper bush	*Capparis spinosa*	Kapari	0.3	0.1	46.6
33	Calamus or Sweet flag	*Acorus calamus*	Eğir	0.4	0.2	23.6
38	Crab apple	*Eriolobus trilobatus*	Atelması	2.2	0.6	23.0
39	Arrost's baby's-breath	*Gypsophila arrostii* subsp. *nebulosa*	Çöğen	2.1	0.7	21.8
37	Ferula or giant fennel	*Ferula elaeochytris*	Çağ (Çakşırkök)	1.4	0.4	15.6
42	White lupin	*Lupinus albus*	Termiye	4.2	1.4	-

The results of multiplying above 1000 mM trolox equivalent / year are respectively: *Trachystemon orientalis* (L.) G. Don (3551.4), *Berberis crataegina* (2834.5), *Rumex crispus* (2026.9), *Smyrnium olusatrum* (1723.8), *Aegopodium podagraria* (1305.2), *Smilax excelsa* (1294.1) and *Nasturtium officinale* (1264.2).

CONCLUSION

It is known that red-purple colored plant species which are rich in anthocyanins show antioxidant activity sweeping the DPPH and ABTS radicals, this case were seen in the analyses results. Nevertheless, the annual consumption of the plant should also be evaluated. In addition, the greater the diversity of species you eat, the more likely you are to cover all your nutritional bases including complementarity effects. Antioxidant capacity and consumption per capita of plants data generated by the BFN Project in Turkey have been scattered across databases in various government agencies and sources for being evaluated. BFN Turkey which was formed three geographically distinct locations in Turkey: the Black Sea, Mediterranean and Aegean Region pilot sites has excelled in raising awareness of the conservation and sustainable use of wild edibles.

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REFERENCE

Anonymous. 1991. Report on the intercountry expert meeting of traditional medicine and primary health care. WHO-EMTRM/1-E/L/12.92/168, 30 November - 3 December 1991, Cairo, Egypt.

Apak, R., K. Guclu, B. Demirata, M. Ozyurek, S. E. Celik, B. Bektasoglu, and D. Ozyurt. 2007. Comparative evaluation of various total antioxidant capacity assays applied to phenolic compounds with the CUPRAC assay. Molecules 12 (7): 1496-1547.

Arasimowicz, M., J. Floryszak-Wieczorek, G. Milczarek, and T. Jelonek. 2009. Nitric oxide, induced by wounding, mediates redox regulation in pelargonium leaves. Plant Biology 11: 650–663.

Ayas, F., K. Yuksel, O. Cinar, F. A. Vuran, and S. Tugrul Ay. 2017. The Antioxidant Capacities of Wild Species Collected from Turkey within the GEF-funded Biodiversity for Food and Nutrition (BFN) Project. Abstract book p36. International Symposium on Biodiversity and Edible Wild Species. 3-5 April 2017, Antalya, Turkey.

Ayas, F., R. Toker, N. Cinar, and F. Uysal. 2014. Alıç (*Crataegus orientalis*) Yaprağında Farklı Ekstraksiyon Uygulamalarının Antioksidan Aktivite, Toplam Fenolik Madde ve Flavonoid Miktarları Üzerine Etkileri. Bildiri kitabı s. 666-671. II. Tıbbi Ve Aromatik Bitkiler Sempozyumu-Yalova 23-25 Eylül.

Bahorun, T., M. A. Soobrattee, V. Luximon-Ramma, and O. I. Aruoma. 2006. Free Radicals and Antioxidants in Cardiovascular Health and Disease Internet Journal of Medical Update 1 (2): 25-41.

Burt, S. 2004. Essential oil: their antibacterial properties and poential aplications in foods- a review. International Journal of Food Microbiology 94: 223-253.

Cemeroglu, B. 2010. Gıda analizleri. Nobel Yayın Dağıtım, Ankara, 682 ss.

Charehsaz M., H. Sipahi, E. Celep, A. Ustundag, O. Cemiloglu Ulker, Y. Duydu, A. Aydın, and E. Yesilada. 2015. The fruit extract of *Berberis crataegina* DC: exerts potent antioxidant activity and protects DNA integrity. DARU Journal of Pharmaceutical Sciences 23: 24.

Caylak, E. 2011. Hayvan ve bitkilerde oksidatif stres ile antioksidanlar. Tıp Araştırmaları Dergisi 9 (1): 73-83.

Caylak, E., I. Halifeoglu, S. Aydin, S. Telo, O. Bulmus, and H. Celik. 2007. The Effects of Sulfur-Containing Compounds on Total Antioxidant Capacity Levels of Liver, Kidney and Brain in Lead-Exposed Rats. Turkiye Klinikleri J. Med. Sci. 27: 823-828.

El Rayess, Y., R. Barbar, E. A. Wilson, and J. Bouajila. 2014. Analytical methods for wine polyphenols analysis and or their antioxidant activity evaluation, Wine: Phenolic Composition, Classification and Health Benefits, Editor: El Rayess, Y., Nova Publishers.

Hudaib, M., M. Mohammada, Y. Bustanji, R. Tayyema, M. Yousef, M. Abuirjeied, and T. Aburjai. 2008. Ethnopharmacological survey of medicinal plants in Jordan, Mujib Nature Reserve and surrounding area. J. Ethnopharmacology 120: 63-71.

Isbilir, S. S. 2008. Yapraklari Salata-Baharat Olarak Tüketilen Bazi Bitkilerin Antioksidan Aktivitelerinin İncelenmesi. Doktora Tezi. Trakya Üniversitesi Fen Bilimleri Enstitüsü Kimya Ana Bilim Dalı Edirne.

Kosar, M., B. Bozan, F. Temelli, K. H. C. Baser. 2004. Sumak (Rhus Coriaria)'ın Fenolik Bileşikleri ve Antioksidan Etkileri. 14. Bitkisel İlaç Hammaddeleri Toplantısı, Bildiriler, 29-31 Mayıs 2002, Eskişehir, Eds. K.H.C.Başer ve N.Kırımer, Web'de yayın tarihi: Haziran 2004.

Obón, J., M., M. R. Castellar, J. A. Cascales and J. A. Fernández-López. 2005. Assessment of the TEAC method for determining the antioxidant capacity of synthetic red food colorants. Food Res. Int. 38 (8): 843-845.

Papandreou, M., A., C. D. Kanakis, M. G. Polissiou, S. Efthimiopoulos, P. Cordopatis, M. Margarity and F. N. Lamari. 2006. Inhibitory activity on amyloid-β aggregation and antioxidant properties of Crocus sativus stigmas extract and its crocin constituents, J. Agric. Food Chem. 54 (23): 8762-8768.

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Sea Beets [Beta vulgaris subsp. maritima (L.) Arcang.] Wild Edible Beets and Home Garden Beets of Turkey

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ABSTRACT: *Beta (beet) species is included in* ***Betoideae*** *subfamily in the* ***Amaranthaceae*** *family. This genus has several wild species and cultivar groups, the sugar beet, the root vegetable known as the beetroot or garden beet, the leafy vegetables chard and spinach beet and mangel, which is a fodder crop.* ***Beta (Beet)*** *species are the important genitors for cultivated beets. Turkey is being one of the centre of origin for beet, has important genetic base of beets belong to section Beta and Section* ***Corollinae****. So the most of the species of section Beta and all species of Section* ***Corollinae*** *distributed in Turkey. Most of the wild species are edible and used in local food by local people in the distribution areas. Sea beet,* ***Beta vulgaris*** *subsp.* ***maritima****, is most common edible among wild beet species and is the wild ancestor of all cultivated beets, such as Sugar-beet, Swiss chard and Beetroot. Sea Beet grows in coastal places at tidelines, on shingle beaches, cliffs and sea-walls, and in saltmarshes. Leaf beet and beet root landraces are also grown by farmers and in vegetable gardens. The diverse forms and landraces of vegetable, table and fodder beets have been grown and used locally for generations in Turkey. Different landraces for different uses are found. To assess the diversity of* ***Beta*** *species survey, collection,* ***ex-situ*** *conservation at the National Seed Gene Bank of the Aegean Agricultural Research Institute (AARI) and also morphological evaluation studies were carried out. Result of morphological characterization of* ***Beta*** *species in Turkey showed continuous variation in most of the characteristics resulting from the gene flows between wild and cultivated forms. Among section Beta, variation was observed in pigmentation, hairiness, plant habit, flowering, flower and seed clusters, pollen fertility and leaf types, whereas the section* ***Corollinae*** *samples exhibited broad variation in flower and leaf characteristics. As priority species of Biodiversity for Food and Nutrition Project of Turkey detailed survey and socioeconomic surveys were conducted on sea beet. The socio-economic studies were conducted for detail data with monography technic. The data recorded from face to face questioners and analyzed. During surveys ethno-botanical information and traditional farming systems were recorded. The food composition of sea beets collected from Aegean Region was also determined to evaluate nutritional value of sea beet.*

Keywords: *Beet,* ***Beta****, sea beets,* ***Beta vulgaris*** *ssp.* ***maritima****, morphological characters, diversity, variability, socio-economic study, traditional knowledge, food composition.*

Türkiye'nin Kıyı Pancarları [Beta vulgaris subsp. maritima (L.) Arcang.] Yabani Yenilebilir Pancarları ve Bahçe Pancarları

ÖZ: Beta *(pancar) türleri* ***Amaranthaceae*** *familyasındaki* ***Betoideae*** *alt familyasına dahildir. Bu cins yabani tür ve şeker pancarı, pancar veya bahçe pancarı olarak bilinen kök sebze, yapraklı sebze pazı ve ıspanak pancarı ve mangel gibi kültür*

*formlarını içerir. **Beta** (Beet) türleri, kültür pancarı için önemli genitördürler. Türkiye'nin pancarın olası orijin merkezlerinden biri olarak, **Beta** ve **Corollinae** seksiyonlarına ait türler içerdikleri genetik varyasyon ve pek çok genle kültür pancarları için önemli bir genetik potansiyele sahiptirler. Beta seksiyonundaki türlerin çoğu ve seksiyon **Corollinae**'nin tüm türleri Türkiye'de yayılış göstermektedir. Yabani türlerin çoğu yenilebilmekte ve dağıtım bölgelerindeki yerel halk tarafından yerel gıda maddelerinde kullanılmaktadır. Kıyı pancarı, **Beta vulgaris** subsp. **maritima**, yabani pancar türleri arasında en yaygın yenilebilir tür olup şeker pancarı ve diğer kültür pancarlarının yabani atasıdır. Kıyı pancarı, kıyı bölgelerinde deniz kenarlarında, kumsallarda, deniz kayalıkları ve deniz kıyıları, ve tuz bataklıklarında yetişir. Yaprak pancarı ve kök pancarları çiftçiler tarafından sebze bahçelerinde yetiştirilmektedir. Sebze, sofra ve yemlik pancar yerel çeşitleri Türkiye'de nesiller boyu yetiştirilmekte ve kullanılmaktadır. Farklı yerel çeşitler yöresel olarak farklı şekillerde kullanıma sahiptir. **Beta** türlerinin çeşitliliğini değerlendirmek için, toplama, Ege Tarımsal Araştırma Enstitüsünün (ETAE) Ulusal Tohum Gen Bankası'ndaki **ex situ** koruma ve morfolojik değerlendirme çalışmaları yapılmaktadır. Türkiye'de Beta türlerinin morfolojik karakterizasyonu sonucu, yabani ve kültür formları arasındaki gen akışından kaynaklanan sürekli bir varyasyon saptanmıştır. Beta seksiyonunda pigmentasyon, tüylülük, bitki tipi, çiçeklenme, çiçek tohum kümeleri, polen fertilitesi ve yaprak tiplerinde varyasyon gözlemlenirken, **Corollinae** seksiyonunda çiçek ve yaprak özelliklerinde geniş varyasyon görülmüştür. Türkiye'nin Gıda ve Beslenme Biyoçeşitlilik Projesi için öncelikli türlerinden biri olarak kıyı pancarı üzerinde ayrıntılı etüdler ve sosyo-ekonomik araştırmalar yapılmıştır. Sosyo-ekonomik çalışmalar, monografi tekniği ile ayrıntılı veriler için yürütülmüştür. Veriler, yüz yüze yapılan anketlere kaydedilmiş ve analiz edilmiştir. Anketler sırasında etno-botanik bilgi ve geleneksel tarım sistemleri kaydedilmiştir. Ege Bölgesi'nden toplanan pancarların gıda bileşimi de deniz pancarının besin değerini değerlendirmek için belirlenmiştir.*

Anahtar Sözcükler: *Pancar, **Beta**, kıyı pancarı, **Beta vulgaris** ssp. **maritima**, morfolojik karakterler, çeşitlilik, değişkenlik, sosyo-ekonomik çalışma, geleneksel bilgi, gıda bileşimi*

INTRODUCTION

Beta (beet) species is included in Betoideae subfamily in the Amaranthaceae family. This genus has several wild species and cultivar groups, the sugar beet, the root vegetable known as the beetroot or garden beet, the leafy vegetables chard and spinach beet and mangel, which is a fodder crop.

Zohary and Hopf (2000) noted that beet is linguistically well identified and the earliest known written mention of the beet comes from eighth century BC Near East. In the 1st century BC, domestic beet was represented in the Mediterranean basin primarily by leafy forms (chard and spinach beet) and later very probably also by beetroot cultivars. Early uses of beet as a wild vegetable, herb or medical plant were followed by cultivation, which most likely began in Asia Minor, one of the natural habitats of the species (Biancardi *et al*., 2012). So, sea beet the ancestor of modern cultivated beets, prospered along the coast of the Mediterranean and Aegean Sea, is known from prehistory for food and above all for medicinal uses. After domestication, beet became more important, especially after its most recent use as a sugar crop. But also the cultivation for leaves (chard and spinach beet) and root (beetroot) to be used as vegetables and cattle feed (mangel) retains its economic value. *Beta vulgaris* ssp. *maritima* has become crucial as source of useful characters. Beets are also used as medicinal plant, ornamental plant, dye and as renewable resource.

Sea beets are very tolerant and have a large environmental adaptability to conditions such as high salinity and poor soil, which is related to its extreme genotypic and phenotypic variation. *Beta vulgaris* ssp. *maritima* crosses efficiently with sugar beet and produces viable seeds.

Turkey is being one of the center of origin for beet, has important genetic base of beets belong to section *Beta* and Section *Corollinae*. So the most of the species of section *Beta* and all species of Section *Corollinae* distributed in Turkey (Box 1). Most of the wild species are edible and used in local food by local people in the distribution areas since centuries. The primitive cultivars and land races of garden beets are still grown by farmers and at home gardens. The beetroots and chards are most common as home garden plants. Gardens

have been made in Turkey since ancient times. Traditional Turkish houses always had a garden, no matter what the size of the house was itself. Bahce/Bostan refers to the traditional land use system around a homestead, where several species of plants (mostly vegetables and fruit species) are grown and maintained by household members. They are important sources of food, fodder, fuel, medicines, spices, ornamentals, construction materials and income. Home gardens are also important contributors to the food security and livelihoods of farming communities. Their products are primarily intended for the family consumption, for family incomes are sold in the local markets. Mangel landraces are also grown by farmers as fodder plant (Tan, 1992, 1993, 1994; Tan *et al.*, 2000; Tan *et al.*, 2003a; 2003b; Tan and Inal, 2004).

MATERIALS AND METHODS

MATERIALS

Beet species collection at National Gene Bank of Turkey was the material of the research. For the detailed study on sea beet as priority species of Biodiversity for Food and Nutrition Project of Turkey sea beets from Aegean Region of Turkey are also the material of the study.

METHODS

Surveys

For the distribution patterns of beets were conducted. This study was essential first step in the development of a comprehensive strategy for the conservation and use of beet plant genetic resources of Turkey.

Before conservation and use of beet species, surveys were conducted for a basic understanding of the taxonomy, genetic diversity, geographic distribution, ecological adaptation and ethnobotany of a plant group as well as of the geography, ecology, climate and human communities of the target region and the beets growing areas. So, eco-geographical surveys, ethnobotanical surveys and socioeconomic-surveys (for sea beets only) were studied and data were recorded. Socio-economic study was planned to investigate in detail the process from the collection to consumption for the aim of analysis and conclusion of process from collection/harvest to consumption; generate the idea on marketing opportunity; to upload the relevant information about the traditional knowledge on use of sea beet. Monographic research technique was used in the study. Information on this technique was obtained through questionnaires. At the same time, preliminary data collection work was carried out in selected areas in villages and markets.

Box 1. *Beta* Species Found in Turkey (Türkiye'deki *Beta* türleri).

Beta* Section *Beta
Wild Species
Beta vulgaris ssp. *adanensis* (A. Pamuk. ex Aellen) Ford-Lloyd & J.T. Williams
Beta vulgaris ssp. *maritima* (L.) Arcang. – sea beet (incl. *Beta vulgaris var. trojana* (Pamukç.) Ford-Lloyd & J.T. Williams)
Cultivated species
Beta vulgaris ssp. *provulgaris* (ancestral form)
Beta vulgaris ssp. *vulgaris* – common beet (incl. beetroot, sugar beet and mangel)
Beta vulgaris ssp. *cicla* (L.) W.D.J. Koch – chard (incl. spinach beet)

Beta* Section *Corollinae
B. lomatogona Fisch. et Mey.
B. macrorhiza Stev.
B. foliosa (sensu Haussk.)?
B. corolliflora Zoss.
B. trigyna Wald. Et Kit.
B. intermedia Bunge.

Collection and Conservation

Seed collection was made in according to the standards for acquisition of germplasm and Genebank standards for orthodox seeds (Anonymous, 2014a). All seed samples were accompanied by associated data as detailed in the FAO/Bioversity Multi-Crop Passport Descriptors (Guarino *et al*., 1995).

Morphometric Analysis

For the existing variation of sections *Beta* and *Corollinae* of genus *Beta* samples collected and conserved at National Gene Bank of Turkey, morphometric analysis was carried out. The experiment was under uniform conditions, and morphological characters of Descriptors for Beta (Anonymous, 1995) were observed, recorded and analysed by means of Principles Component Analysis (PCA).

Food Composition Analysis

In this study some sea beet samples from Aegean region were collected and analyzed to demonstrate the nutritional value of some wild edibles in Turkey. Proximities, dietary fiber (DF), vitamins and minerals were assayed using standard methods and reference materials. Moisture was determined according to AOAC 964.22, fat content was determined gravimetrically by AOAC 920.39. Total protein was determined from the nitrogen content by the Kjeldahl method using conversion factors. Total dietary fiber was determined according to the AOAC enzymatic method 991.43. Ash was determined by incinerating at 500°C in a muffle furnace for 6h by the AOAC 942.05 (Anonymous, 2014b). Minerals were determined using ICP-MS (Agilent 7500cx) according to NMKL 186 method. Vitamin C analysis was performed according to procedure described by Gokmen *et al*., 2000.

RESULT AND DISCUSSION

Surveys

Field survey studies were planned from the southern regions and sea level to the northern regions and higher altitudes depending on the flowering period of Beta species. The distribution and habitats of Beta species found in Turkey were also re-determined (Box 2). The herbarium species are also collected during survey to maintain the specimens at AARI herbarium as the reference of the beet collection and for further identification. Seed collection periods were estimated based on flowering periods.

During surveys the information on home garden beets were recorded. The home gardens are the microenvironments within the surrounding ecosystem and there is relation with a household or a social group. They are multifunctional and diverse plant composition. The home garden beets are the local cultivars of *Beta vulgaris* (including, different forms of leaf beets and beetroots which are vary on the color range includes golden, orange, yellow, pink, red, white and roots with pink and white rings when sliced. Mostly The yellow and white forms of beetroot also provide particularly good foliage for food and vary in shape (the globe forms mostly).

Through questionnaires data analysis annual consumption of sea beets per household determined as 11.1 kg/year and consumption of sea beets per capita was 3 kg/year. Consumption frequency was given in Figure 1.

Young leaves of sea beets are collected and sell at local markets to use for medicinal purposes and as food raw or cooked. An annual collected amount of sea beet is 911 kg/year. The distribution use pattern of collected amounts of sea beet is given in Figure 2. Marketing status of sea beet were also determined and given in Table 1.

Collection and Conservation

The missions are programmed to collect the existing *Beta* genetic resources within the frame work of Industrial Crops Genetic Resources Group and the *Beta* landraces, wild relatives and weedy forms were collected and conserved *ex situ* at the national genebank at AARI in applying the genebank standards.

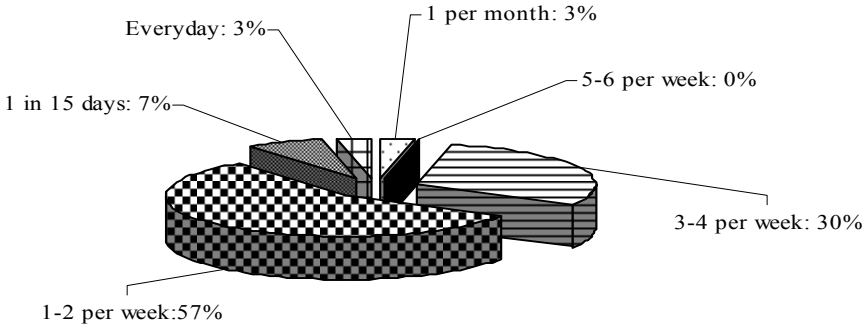

Figure 1. Sea beets consumption frequency.
Şekil 1. Kıyı pancarı tüketim aralıkları.

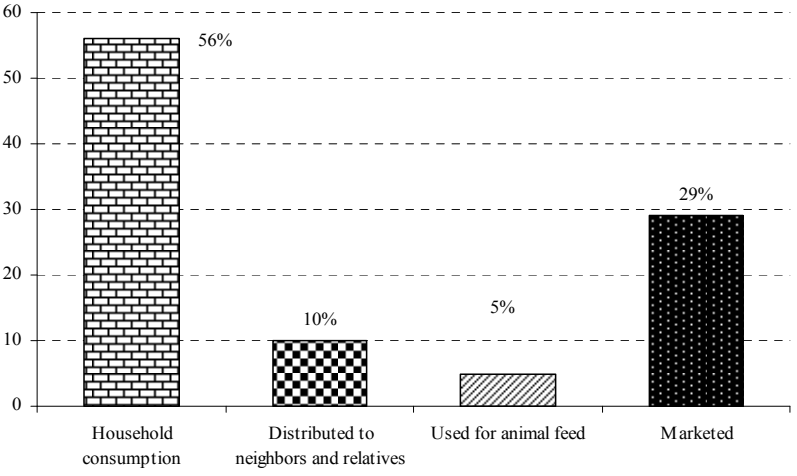

Figure 2. Distribution use pattern of collected amounts of sea beet.
Şekil 2. Kıyı pancarlarının toplanan miktarlarının kullanımı.

Table 1. Marketing status of sea beet.
Çizelge 1. Kıyı pancarının pazarlama durumu.

Average distance to market (km) Markete ortalama uzaklık (km)	Proportion of selling to consumers at local market (%) Yerel pazarda tüketicilere satış oranı (%)	Proportion of selling to trader at local market (%) Yerel pazarda tüccarlara satış oranı (%)
33	78	22

Box 2. Habitats of *Beta* Species in Turkey (Türkiye'deki *Beta* türlerinin yaşam alanları).

***Beta* Section *Beta* Species**
Sea level to 700 m.
Mainly in coastal areas but found at inland habitats influenced from littoral regions.
Weeds in cultivated fields
Field borders
Road sides

Beta* Section *Corollinae
550 to 2300 m.
Inland mountainous areas
Field borders
Weeds in cultivated fields
Road sides
In vegetation of woody perennials mainly in (Quercus woodlands)
In vegetation of herbaceous and woody perennials

Morphometric Analysis

Beta sect. *Beta* accessions generally have green hypocotyl colour, while some are red. Some of the accessions flowered in first year and some in second year. Plant types are variable within and among population: erect, erect-procumbent, procumbent, erect-prostrate and prostrate plant types were observed. Tepals are convex in general and periant segment was keeled. Anthers are longer then stigma, yellow, mostly fertile. Few samples are fertile and sterile pollens are found. Leafs are mostly glabrous or sparsely hairy. Leaf size has high variation. No swelling in the roots in wild forms was observed. Seed clusters mostly are 2-4. Main branching is mostly one. Interspesific and intraspesific variation were observed. *Beta* sect. *Corollinae* accessions had green, pink and red hypocotyl colour. All perennial and most of them flowered in second year, third and fourth year flowering were also observed. Flowering asynchrony was found within and between populations. Plant type generally erect procumbent. Tepal shape is convex or straight, flower clusters 1, 2, 3 and keel absent or available. Fasciation was observed in some samples.

According to Principles Component Analysis (PCA) among the section *Beta*, continuous variation were observed on pigmentation, hairiness, plant habit, flowering, flower clusters and leaf types; whereas *Corollinae* section individuals exhibited large variation related to their flower characteristics and leaf types. From the result of two distinct groups were obtained for wild and primitive root types of section *Beta* among the first two principal components. In the group of wild forms, the samples of *B. maritima, B. adanensis* and *B. trojona* originated from the form of *B. maritima* sensu lato were formed subgroups that were lacking in pattern. The leaf beets and *B. maritima* complex were far from clear-cut. However the leaf beet forms were distinctly separated from root types. The individuals of ancestral form of *B. vulgaris* (*B. provulgaris*) were distributed outside of these two main groups. It is assumed that the subgroups of *B. maritima* sensu lato complex resulted from the gene exchange occurred readily in their natural habitat. The results of cytological study also support this consideration. In section *Corollinae*, the picture was obtained from Principal Component Analysis. Two distinct groups were consisted of the individuals of *B. corolliflora* and *B. lomatogona* complex scattered within the first two exigent vectors. *B. lomatogona* sensu lato group was represented with *B. lomatogona, B. intermedia*, and *B. trigyna, B. corolliflora* sensu lato group was included within the general variation exhibited by *B. corolliflora*. It is considered that the infraspecific variation found in this section results from the existing facultative apomixes in some forms. In determined meiotic behaviours were observed in the intermediate forms of some *B. intermedia* individuals. With regard to the evaluation of results of this research,

the artificial classification has been avoided and the forms of genus Beta sections Beta and *Corollinae* were classified as their species complex. The scatter diagrams were shown in Figure 3 and Figure 4 for section *Beta* and Section *Corollinae* species.

Food Composition Analysis

Sea beet dietary fibre content is 5, 27g/100g and it can be considered as source of fibre according to Regulation (EC) No. 1924/2006. Proximate composition of sea beet per 100g is given in Table 2. Sea beet can also be highlighted for its high contribution to microelements nutritional intakes since a 100 g portion of their leaves would provide over 50 % of the RDA (for men) for iron. Mineral composition of sea beet mg/100g is given in Table 3.

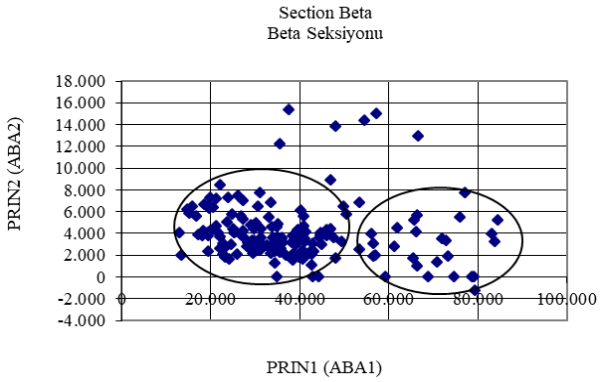

Figure 3. The distribution of the *Beta* sect. *Beta* samples.
Şekil 3. *Beta* seksiyon *Beta* örneklerinin dağılımı.

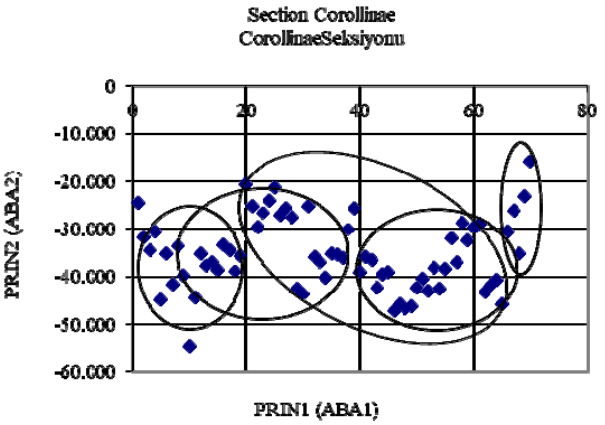

Figure 4. The distribution of the *Beta* sect. *Corollinae* samples.
Şekil 4. *Beta* seksiyon *Corollinae* örneklerinin dağılımı.

Most of the wild edible species can considerably contribute to requirements of dietary fiber, vitamin C and iron. So, these species could be a good alternative to other commonly consumed plants such as spinach, parsley, lettuce due to their high nutrient content. However, it should be noted that ways of consumption and preparation methods may affect nutrient content and bioavailability of foods so these factors should be evaluated while assuming their contribution to dietary requirements.

Table 2. Proximate composition of sea beet (per 100g).
Çizelge 2. Kıyı pancarının macro besin öğeleri (her 100 g).

Moisture (g) Nem (g)	Fat (g) Yağ (g)	Protein (g) Protein (g)	Carbohydrate (g) Karbonhidrat (g)	Ash (g) Kül (g)	Dietary Fibre (g) Hazmolabilir lif (g)
89.2±0.9	0.18±0.02	2.42±0.08	1.26±0.05	1.64±0.06	5.27±0.48

Table 3. Minerals and Vitamin C content of sea beet (mg/100g).
Çizelge 3. Kıyı pancarının mineral ve C vitamini içerikleri (mg/100g).

Ca	Na	Mg	P	Zn	Fe	Cu	Vitamin C
95.4±8.5	292.4±80.1	75.3±9.07	27.6±1.7	0.30±0.12	5.0±0.8	0.14±0.06	18.3±0.5

REFERENCES

Anonymous. 1995. Descriptors for Beta (*Beta* ssp.). CPRO-DLO-CGN/ IPGRI. Rome, Italy.

Anonymous. 2014a. Genebank Standards for Plant Genetic Resources for Food and Agriculture. Rev. ed. Rome.

Anonymous. 2014b. AOAC. Official Methods of Analysis of the Association of Official Analytical Chemists. Association of Official Analytical Chemists, Washington, DC, USA. Retrieved December 12, 2014 from: http://www. eoma.aoac.org/.

Biancardi E, L.W. Panella, R.T. Lewellen. 2012. *Beta maritima*: the origin of beets. Springer, New York, pp 293.

Gokmen V, N. Kahraman, N. Demir, and J. Acar. 2000. Enzymatically validated liquid chromatographic method for the determination of ascorbic and dehydroascorbic acids in fruit and vegetables. J Chromatogr A 881: 309-316.

Guarino, L., R. V. Rao, and R. Reid (eds.). 1995. Collecting plant genetic diversity. Technical guidelines, Wallingford, UK, CAB International.

Tan, A. 1992. Türkiye' de yayılış gösteren *Beta* L. (Chenopodiceae) türlerinin sınıflandırılması üzerine araştırmalar. Doktora Tezi. Ege Üni. İzmir.

Tan, A. 1993. A numerical taxonomic study on wild beets (*Beta vulgaris* L. s. lat.) in the Mediterranean. Anadolu, J. of AARI 3 (1): 1-12.

Tan, A. 1994. Beta genetik kaynaklarının doğal varyasyonu ve ıslah yönünden potansiyeli (natural variation within Beta genetic resources and their potential to beeriding). Anadolu, J. of AARI 4 (2): 37-54.

Tan, A. L. Aykas, and A. Inal. 2000. Status report of *Beta* genetic resources in Turkey. *In*: Maggioni, L., L. Frese, C. Germeier and E. Lipman, Comps. Reports of a Working Group on Beta. First Meeting, 9-10 September 1999. Broom's Barn, Bury St. Edmunds, UK. IPGRI.

Tan, A., L. G. Aykas, A. Inal. 2003a. Türkiye'de yayılış gösteren pancar (*Beta* L.) türlerinin değerlendirilmesi: *Beta* Seksiyon *Beta*. (Evaluation of beet (*Beta*) L. Species distrubuted in Turkey: *Beta* Section *Beta*). Anadolu, J. of AARI 13 (1): 1-16.

Tan, A., L. G. Aykas, A. Inal. 2003b. Türkiye'de yayılış gösteren pancar (*Beta* L.) türlerinin değerlendirilmesi: Beta Seksiyon Corollinae. (Evaluation of beet (*Beta*) L. Species distrubuted in Turkey: *Beta* Section *Corollinae*). Anadolu, J.of AARI. 13 (2): 1-16.

Tan, A., and A. Inal. 2004. *Beta* genetic resources actıvities in Turkey. *In*. Freese, L., C. Germeier, E. Lipman, and L. Maggioni (Comp.). Report of a Working Group on Beta and World Beta Network. Second Joint Meeting, 23-26 October 2002, Bologna Italy. International Plant Genetic Resources Institute, Rome, Italy. Pp. 66-70.

Zohary, D., and M. Hopf. 2000. Domestication of Plants in the Old World. Oxford: University Press. ISBN 0198503571.

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A Traditional Underutilized Crop of Turkey: Cowpea [Vigna Unguiculata (L.) Walp.] Landraces

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ABSTRACT: *Many diverse cowpea [**Vigna unguiculata** (L.) Walp.] landraces are still maintained on-farm in Turkey. Two of the ssp. grown in Turkey: **Vigna unguiculata** subsp. **sesquipedalis** (L.) Verdcourt and **Vigna unguiculata** subsp. **unguiculata**. Cowpea is a popular and important leguminous crop especially in Aegean, Mediterrenean and South Marmara Regions which is known as "börülce" and has different local names like "acebek", "loğlaz", "lolaz", "lübye", "kocafasulye", "karnıkara", "sarı gelin" in Turkey. These landraces are maintained on-farm for various reasons, including better quality than commercial varieties, better performance in terms of yieldor persistence under harsh agro-environmental conditions, traditional uses such as particular traits appreciated by the farm family. They are not necessarily maintained under 'traditional farming systems', but are 'maintained because of tradition', especially related to food. It is already marketed as niche. However, most of them, especially garden and neglected crops, are highly threatened because they are cultivated primarily by aging farmers. It is better adapted to drought, high temperatures and biotic stresses than other legume species. Green pods, fresh seeds and dry grains are consumed as different dishes and it plays an important role in the nutrition of the local people in Turkey.To assess the diversity of cowpea landraces in Turkey, cowpea populations were surveyed, collected, conserved ex-situ at the National Seed Gene Bank of the Aegean Agricultural Research Institute and also evaluated agro-morphologically. A total of 253 landrace accessions mainly from the Aegean, Mediterranean, and South Marmara Regions of Turkey were used to evaluate 41 qualitative and quantitative agro-morphological characteristics of the landrace samples. All landraces showed high variation of observed characters. As priority underutilized species of Biodiversity for Food and Nutrition Project of Turkey various studies were conducted on cowpea landraces. During surveys ethno-botanical information and traditional farming systems were recorded. The socio-economic studies were conducted for detail data with monography technic. The data recorded from face to face questioners with 23 producers/farmers and 67 consumers. Surveys for the conclusion of process from harvest to consumption were conducted to generate the idea on marketing opportunity, to assist to obtain the information for the development of policy to upload the relevant information about the traditional knowledge. During surveys ethno-botanical information, the different type of dishes of fresh pods and cowpea dry grains and traditional farming systems applied to cowpea production were recorded. Generally, the average age of responders is 53 and 76% have primary school degrees. The vast majority of consumers use the cowpeas 1-2 times a week in their diet. Cowpea consumption per household is 21.9 kg. year^{-1}and consumption per capita is 6.3 kg. year^{-1}. Consumption percentage has found as 76.1% and 61.7% of harvested amount are marketed. The food composition of dry grain and fresh pods collected from Aegean Region was also determined to evaluate nutritional value of cowpea landraces. The proximate composition and mineral content of cowpea samples were analyzed using standard methods and reference materials. The study shows that dry grains contain a rich source of protein, dietary fiber, zinc, potassium and iron. Dry grains of cowpea can be a good solution to digestion problems by regulating intestinal function with high dietary fiber content. Fresh pods also have high dietary fiber, potassium and zinc content. Cowpea meals are good sources of nutrients and can be used as ingredients in healthy diets.*

Keywords: *Cowpea, **Vigna unguiculata** (L.) Walp., landraces, genetic diversity, agricultural biodiversity, socio-economic study, traditional knowledge, food composition.*

Türkiye'de Yeterince Tüketilmeyen Geleneksel Ürün: Börülce [Vigna Unguiculata (L.) Walp.] Yerel Çeşitleri

ÖZ: *Birçok farklı börülce [**Vigna unguiculata** (L.) Walp.] yerel çeşitleri halen Türkiye'de tarlalarda yetiştirilerek üretici şartlarında muhafaza edilmektedir. Börülcenin iki ssp.'i Türkiye'de yetiştirilmektedir. Bunlar: **Vigna unguiculata** subsp. **sesquipedalis** (L.) Verdcourt ve **Vigna unguiculata** subsp. **unguiculata**. Börülce, "börülce" olarak bilinen ve "acebek", "loğlaz", "lolaz", "lübye", "koca fasulye", "karnıkara", "sarı gelin" gibi farklı yerel isimlere sahip olup, Ege, Akdeniz ve Güney Marmara Bölgelerinde popüler ve önemli bir baklagil türüdür. Bu arazi koşulları, ticari çeşitlere kıyasla daha kaliteli, kötü tarımsal-çevre koşullarında verim veya dayanıklılığın daha iyi olması, çiftlik ailesi tarafından takdir edilen belirli özellikler gibi geleneksel kullanımlar da dahil olmak üzere çeşitli nedenlerle küçük aile çiftliklerinde yetiştirilmektedir. Yerel çeşitler gıda ile ilgili olduğundan, 'geleneksel tarım sistemleri' altında muhafaza edilmekle kalmaz, özellikle 'gelenek nedeniyle' muhafaza edilir. Börülce de dahil olmak üzere yerel çeşitler ülkemizde halen "niş pazar"larda (dar bir tüketici grubunun istek ve gereksinmelerini karşılayan pazarlar) pazarlanmaktadır. Bununla birlikte, çoğu bahçe bitkileri ve ihmal edilmiş bitkiler, esas olarak yetiştiren çiftçilerin yaşlanmakta olması nedeni ile büyük tehdit altındadır. Börülce diğer baklagillere göre kuraklık, yüksek sıcaklıklar ve biyotik streslere daha iyi adaptasyon göstermektedir. Börülce, taze taneleri ve baklası yanında kuru taneleri ile de farklı yemekler olarak tüketilmekte ve Türkiye'de yöre halkının beslenmesinde önemli bir rol oynamaktadır. Türkiye'deki börülce yerel çeşitlerine ait populasyonlar Ege Tarımsal Araştırma Enstitüsünün Ulusal Tohum Gen Bankası'nda survey, toplama, ex-situ olarak korumaya tabi tutulmuş ve agro-morfolojik olarak da değerlendirilmiştir. Başta Ege, Akdeniz ve Güney Marmara Bölgelerinden olmak üzere toplam 253 yerel çeşit örneklerinin 41 kalitatif ve kantitatif özellikleri agro-morfolojik olarak belirlenmiştir. Tüm yerel çeşitler, gözlemlenen karakterler açısından yüksek oranda farklılık göstermiştir.Gıda ve Beslenme Projesi için Biyoçeşitlilik projesi önceliği Türkiye'nin yeterince kullanılmamış türler arasında olan börülce yerel çeşitleri üzerinde çeşitli çalışmalar yürütmek olmuştur. Survey sırasında etno-botanik ve geleneksel tarım sistemlerine aitbilgiler kaydedilmiştir. Sosyo-ekonomik çalışmalar, monografi tekniği ile ayrıntılı veriler edinmek için yürütülmüştür. Veriler, yüz yüze görüşmelerle 23 üretici / çiftçi ve 67 tüketiciyle yapılarak kaydedilmiştir. Hasattan tüketime sürecin tamamlanması için yapılan araştırmalar, geleneksel bilgi ile ilgili bilgileri yüklemek, politikanın geliştirilmesi ve bilgi edinmeye yardımcı olmak için pazarlama fırsatı fikrini oluşturmak üzere yürütülmüştür. Anketler süresince etno-botanik bilgi, taze ve kuru börülce yemekleri ile börülce üretiminde uygulanan geleneksel çiftçilik yöntemleri kaydedilmiştir.Anketin uygulandığı kitlenin yaş ortalaması genel olarak 53'tür ve % 76'sı ilkokul diplomasına sahiptir.Tüketicilerin büyük çoğunluğu börülceyi haftada 1-2 kez diyetlerinde kullanmaktadırlar.Hanehalkı börülce tüketimi yıllık 21,9 kg ve kişi başına düşen tüketim yıllık 6,3 kg'dır. Tüketim % 76,1 oranında olup, hasat edilen tutarın % 61,7'si pazarlanmaktadır. Ege Bölgesi'nden toplanan taze ve kuru börülce yerel çeşitleri baklasına ait gıda bileşimleri, besin değerlerini değerlendirmek için de belirlenmiştir. Börülce örneklerinin bazı besin ve mineral içerikleri standart yöntemler ve referans değerler kullanılarak analiz edilmiştir.Çalışma; kuru börülce tanelerin protein, diyet lifi, çinko, potasyum ve demir içerdiğini ve zengin bir kaynağı olduğunu göstermektedir. Kuru börülce tanesi, yüksek diyet lifi içeriğiyle bağırsak fonksiyonunu düzenleyerek sindirim problemlerine iyi bir çözüm olabilir. Taze taneler de yüksek diyet lifi, potasyum ve çinko içermektedir. Börülce yemekleri iyi besin kaynaklarıdır ve sağlıklı diyet için katkı sağlar.*

Anahtar Sözcükler: *Börülce, **Vigna unguiculata** (L.) Walp., Agro-morfolojik karakterler, yerel çeşit, genetik çeşitlilik, varyasyon, tarımsal biyoçeşitlilik, sosyo-ekonomik çalışma, geleneksel bilgi, gıda bileşimi.*

INTRODUCTION

Turkey is the one of the most significant countries for plant genetic resources and plant diversity in the world. Many agricultural crop species are part of the native Anatolian flora and domesticated 3000-7000 years ago, or they have gradually been introduced through cultural exchanges held with other civilizations in ancient times (Tan, 2010).

Cowpea, *Vigna unguiculata* (L.) Walp. (2n=22), is one of the most ancient human food sources. Although native country of cowpea is uncertain and it has believed to be originated in Africa (Anonymous, 2017), it is one of the most important indigenous legumes of the tropics and sub tropics (Joel, 2010). After it was introduced into Anatolia, its cultivation spread throughout most of the country. With its widespread distribution, natural and artificial selection by farmers has resulted in a great diversity of landraces. In many regions of Turkey, diverse cowpea landraces have gradually been developed over time (Tan, 2010).

Given the diversity of cowpea landraces in Turkey, populations of cowpea were collected, regenerated, conserved in cold storage conditions according to *ex-situ* conservation methods at the National Gene Bank (NGB) of the Aegean Agricultural Research Institute (AARI) and were also evaluated agro-

morphologically. A total of 253 landrace accessions mainly from the Aegean and Mediterranean regions of Turkey were used to evaluate 41 qualitative and quantitative agro-morphological characteristics in the landrace samples (Kir *et al.*, 2015).

The purpose of this study was to evaluate socioeconomic and nutritional value of cowpea landraces as priority underutilized species of Biodiversity for Food and Nutrition Project of Turkey.

MATERIALS AND METHODS

Survey and collection of landraces of cowpea were carried out from different parts of Turkey, especially Aegean, Mediterranean, South Marmara and South East Regions. Agro-Morphologically Characterization of plant genetic resources (PGR) has been performed. Morphological observations were performed according to characters of descriptors chosen among the International Board for Plant Genetic Resources Institute (IBPGRI) and International Union for the Protection of New Varieties of Plants (UPOV) of plant feature criteria. Multivariate relationships among accessions were revealed through the Principal Component Analysis (PCA) (Clifford and Stephenson, 1975).

Questionnaire survey study was conducted in Aydın provinces of Aegean Region. Questionnaire surveys were carried out for collecting ethnobotanic and socio-economic data by using face-to-face interviews with cowpea landraces producers and consumers. Monographic research technique was used in the study. Total of 23 cowpea farmers and 67 consumers were interviewed in 2014. In the study the number of interviewed farmers and consumers that represent population were determined by judgment sampling.

Dry grain and fresh pods of cowpea landraces samples were taken from local markets of Aydın and Muğla for food composition analysis. Proximate composition (protein, dietary fibre and carbohydrate) of samples were analyzed according to reference AOAC procedures. Minerals were determined by ICP MS after microwave digestion using NMKL 186 method. The procedure described by Gokmen *et al.*, 2000 was used for vitamin C analysis. Thiamin and riboflavin were analyzed by HPLC (Agilent 1260, Agilent Technologies, Santa Clara, CA) with fluorescence detection and Lahely *et al.* (1999) procedure was modified for the determination of niacin.

RESULT AND DISCUSSION

Observation data of samples were included in the research and assessed with the Principle Component Analysis (ABA). At the end of the analysis, Eigen values of 3 main components were found between 8.326 and 3.761. These components accounted for 36.2% of the total variance.

Group A and two sub-groups were formed in the second main components, which were evaluated as 17.71% of the total variance and 10.48% of the total variance. In the formation of the first major component, the number of first flowering days is 0.241, days to first mature pods are 0.232, the terminal leaflet shape is 0.231, the mature pod curvate is 0.221, the mature pod length is 0.260, the number of flowering days is 0.239, the number of days of holding 50% pods was mainly affected by the values of 0.241 and fresh pod length of 0.271. This main group formed of accessions which have short pod length and thin pod. In the first of the two subgroups, earliness of populations related to days to first flowering and days to first mature poding were affected by consisted group. But, high length plants and landraces which have medium-earliness (days to flowering and days to mature podding) consisted second sub-group.

Agro-Morphologically Characterization results of this study showed in agreement with the agronomic and morphological results of many studies of cowpea local varieties. In our country, studies of cowpea were carried out in the departments of Horticulture and Field Crops of Agriculture Faculties of various universities and a very wide variation of cowpea local populations, (Unlu *et al.*, 2006; Peksen *et al.*, 2005) yield

performance of cowpeas, (Peksen *et al.*, 2002; Unlu, 2004; Peksen, 2007; Geren *et al.*, 2007) and the salinity tolerance of a cowpea local variety (Dasgan *et al*., 2006) have been reported.

Cowpea (*V. unguiculata* L.) landrace accessions were surveyed and collected, regenerated, morphologically characterized and conserved by means of the several project studies (Kir *et al.*, 2010; Kir and Tan, 2012; Kir *et al.*, 2015). At the end of the activities;

- Within local varieties representing Turkish geographical area, material with high and low relative resistance to arid conditions has been identified.
- These local varieties have been the source material for new projects.
- The material under custody of cowpea genetic resources has been expanded.
- Genetic resources of cowpea have been transferred to the National Genetic Bank in sufficient quantities and agro-morphological definitions.
- This material has been presented for the information and use of the identified material, the country and the world scientists / breeders.
- The size of the current genetic variation has been determined.
- The passport information of the material will be transferred to the data base program in AARI National Gene Bank in electronic environment and the information of our cowpea collection has been opened to the use of breeders.

During surveys for the conclusion of process from harvest to consumption were conducted to generate the idea on marketing opportunity, to assist to obtain the information for the development of policy to upload the relevant information about the traditional knowledge.

It was observed that cowpea is a popular and important leguminous crop especially in Aegean, Mediterranean and South Marmara Regions. It is widely known as “börülce” but it has different local names like “acebek”, “loğlaz”, “lolaz”, “lübye”, “kocafasulye”, “karnıkara”, “sarı gelin” throughout of Turkey. These landraces are maintained on-farm for various reasons, including better quality than commercial varieties, better performance in terms of yield or reistance under harsh agro-environmental conditions, traditional uses such as particular traits appreciated by the farm family. They are not necessarily maintained under ‘traditional farming systems’, but are ‘maintained because of tradition’, especially related to food. It is already marketed as niche. However, most of them, especially garden and neglected crops, are highly threatened because they are cultivated primarily by aging farmers.

Generally, the average age of responders determined as 53 and 76% of them having primary school degrees. The vast majority of consumers use the cowpeas 1-2 times a week in their diet. Cowpea consumption per household is 21.9 kg. year^{-1} and consumption per capita is 6.3 kg. year^{-1} (Table 1). The vast majority of consumers (76.1 %) use the cowpeas 1-2 times a week in their diet (Table 2).

Total production of local cowpea is determined as about 8 tons. 61.7% of harvested amount are marketed and 18% of them used as household consumption (Table 3).

While all cowpea producers sell dried cowpea grains directly to consumers at local market, 68 % of them sell fresh pods to consumers and 33% of them sell fresh pods to trader at local market. 41% of producers sells fresh pods to traders at markets (Table 4).

During surveys different type of dishes prepared by using cowpea green pods and dried grains were recorded. Green pods, fresh and dried grains of cowpea are used in salads and meals which are prepared with olive oil. Dried grains also are used in ‘Tarhana’ soup especially in Mugla Province of Aegean Region in Turkey.

The food composition of dried grain and fresh pods collected from Aegean Region was also determined to evaluate nutritional value of cowpea landraces. The data presented in Table 5 showed

proximate composition of dried grain and green pods of cowpea samples. Mineral composition and vitamin content of cowpea mg/100g is given in Table 6 and 7 respectively.

Table 1. Cowpea amount per household and annual consumption amounts per capita in Aegean Region.
Çizelge 1. Ege Bölgesinde hanehalkı ve kişi başına düşen yıllık börülce tüketim miktarı.

Species Tür	Consumption Per Household (Kg / year) Hanehalkı Başına Tüketim (kg/yıl)	Consumption Per Capita (Kg / year) Kişi Başına Tüketim (kg/yıl)
Cowpea Börülce	21.9	6.3

Table 2. Consumption frequency of cowpea of Aegean Region (%).
Çizelge 2. Ege Bölgesinde börülcenin tüketim sıklığı (%).

Species Tür	Everyday Hergün	3-4 times per week Haftada 3-4 kez	1-2 times per week Haftada 1-2 kez	1 in 15 days 15 15 Günde 1 kez	1 per month Ayda 1 kez
Cowpea Börülce	3.0	11.9	76.1	4.5	4.5

Table 3. Distribution of harvested amounts of Aegean cowpea by using pattern.
Çizelge 3. Ege Bölgesi hasat edilen börülcenin tasarruf şekline göre dağılımı.

Species Tür	Household consumption (%) Ev tüketimi (%)	Distributed to neighbours/ relatives (%) Komşu-akrabaya dağıtılan (%)	Used for animal feeding (%) Hayvan beslemede kullanılan (%)	Marketed (%) Pazarlanan (%)	Amount harvested (Kg) Hasat miktarı (kg)
Cowpea Börülce	18.3	4.7	15.3	61.7	7996

Table 4. The cowpea marketing status of producers in Aegean Region.
Çizelge 4. Ege Bölgesindeki üreticilerin börülce pazarlama şekilleri.

Species Tür	Average distance to market (km) Pazara ortalama uzaklık (km)	Proportion of Selling to Consumers at Local Market (%) Yerel pazarda tüketiciye satış yapanların oranı (%)	Proportion of Selling to Trader at Local Market (%) Yerel pazarda tüccara satış yapanların oranı (%)	Proportion of Selling to Trader at Village (%) Köyde tüccara satış yapanların oranı (%)
Cowpea (dry) Kuru Börülce	14	100.0	-	-
Cowpea (fresh) Taze Börülce	14	66.7	33.3	-

Table 5. Proximate composition of cowpea.
Çizelge 5. Börülcenin yaklaşık besin bileşimi.

Species Türler	Moisture Nem (g/100g)	Fat Yağ (g/100g)	Protein Protein (g/100g)	Carbohydrate Karbonhidrat (g/100g)	Ash Kül (g/100g)	Dietary fiber Diyet lifi (g/100g)	Energy Enerji (kcal/100g)
Dried Cowpea Kuru Börülce	9.3±0.2	1,36±0.04	21.68±0.18	30.75±0.22	3.44±0.05	33.50±0.03	288.9±1.0
Fresh Cowpea Taze Börülce	88.6±0.3	0.47±0.02	3.23±0.11	3.69±0.40	0.66±0.02	3.31±0.01	38.8±1.0

Table 6. Mineral contents of cowpea (mg/100g)
Çizelge 6. Börülcenin mineral içeriği (mg/100g)

Species Türler	Ca	Fe	Mg	P	Zn	K	Na	Cu
Dried Cowpea Kuru Börülce	107.5±2.7	5.6±0.1	166.7±2.6	283.8±3.8	3.34±0.01	1148±13	8.4±0.1	1.06±0.1
Fresh Cowpea Taze Börülce	64.6±0.5	1.05±0.02	61±1.9	67.5±1.1	0.68±0.02	299±4	2.6±0.1	0.25±0.01

Table 7. Vitamin content of cowpea.
Çizelge 7. Börülcenin vitamin içeriği.

Species Türler	Vit C (mg/100g)	Thiamin (mg/100g)	Riboflavin (mg/100g)	Niacin (mg/100g)	Beta-Carotene (µg/100g)	Alpha-tocopherol (mg/100g)
Dried Cowpea Kuru Börülce	nd	0.53±0.01	0.086±0.003	1.83±0.34	nd	0.20±0.01
Fresh Cowpea Taze Börülce	9.9±1.2	0.23±0.04	0.079±0.004	1.30±0.10	429±56	4.64±0.47

nd: not detected.

Protein and fat content was 21.68 and 1.36 mg/100g, respectively in dried grain samples and these values are very close to data obtained by Antova *et al.*, 2014. The result of this study showed that dried grain of cowpea contains a rich source of protein, dietary fiber, zinc, potassium and iron. Dried grain of cowpea can be a good solution to digestion problems by regulating intestinal function with high dietary fiber content. Fresh pods also have high dietary fiber, potassium and zinc content. Cowpea meals are good sources of nutrients and can be used as ingredients in healthy diets.

CONCLUSION

Although Anatolia is not centre of origin for *Vigna* spp. studies apparently showed that Turkey is centre of diversity of cowpea cultivars. So, multivariate relationships among accessions were highly variable and qualitative and quantitative characteristics of cowpea local varieties have shown a wide variation.

Although cowpea landraces are maintained on-farm by aging farmers, the consumption amount and frequency is high in Aegean Region. Nutritional and mineral composition results of this study support its consumption as a nutritive legume crop for local people. In addition, when we consider cowpea is better adapted to drought, high temperatures and biotic stresses than other legume species, there are needed to encourage young farmers for its production.

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REFERENCES

Anonymous. 2017. *Vigna unguiculata* (L.) Walp. http://www.fao.org/ag/agp/agpc/doc/gbase/data/pf000090.htm.

Antova, G., T. D. Stoilova, and M. Ivanova. 2014. Proximate and lipid composition of cowpea (*Vigna unguiculata* L.) cultivated in Bulgaria. Journal of Food Composition and Analysis 33: 146-152.

Clifford, H. T., and W. Stephenson. 1975. An introduction to numerical classification, Academic Press.

Daşgan, Y., S. Koc, B. Ekici, H. Aktas, K. Abak. 2006. Bazı fasulye ve börülce genotiplerinin tuz stresine tepkileri, Alatarım 5 (1): 23–31.

Geren, H., R. Avcıoglu, H. Soya ve B. Kir. 2007. İkinci Ürün Koşullarında Mısır (*Zea mays* L.)'ın Börülce (*Vigna unguiculata* L.) ve Fasulye (*Phaseolus vulgaris* L.) ile Birlikte Ekiminin Tane Verimi ve Bazı Verim Özelliklerine Etkisi, Ege Üniversitesi Ziraat Fakültesi Dergisi 44(3): 27-41.

Gokmen V, N., Kahraman, N., Demir, and J. Acar. 2000. Enzymatically validated liquid chromatographic method for the determination of ascorbic and dehydroascorbic acids in fruit and vegetables. J. Chromatogr A 881: 309-316.

Joel, M. 2010. Estimation of Consumer Preferences For Cowpea Varieties in Kumi and Soroti Districts, Uganda, Msc Thesis, Agricultural and Applied Economics of Makerere University, 102 pp.

Kir, A., and A. Tan. 2012. Collection, regeneration, morphological characterization and conservation of cowpea (*Vigna unguiculata* L.) landraces in Turkey, *In*: V. Negri, R. Torricelli, and N. Maxted (Eds.), Landraces Issue 1, p.20, October, 2012.

Kir, A., A. Tan, N. Atikyilmaz, and T. Taskin. 2010. Agro-Morphological Characterization of the Cowpea (*Vigna unguiculata* L.) Landraces in Turkey, Legumes for Global Health 5th International Food Legumes Research Antalya.

Kir, A., A. Tan, N. Ay, N. Korkmaz, and M. Gunduz. 2015. Agro-Morphological Characterization of Cowpea [*Vigna unguiculata* (L.) Walp.] Landraces of Ege and Marmara Regions of Turkey, Anadolu, J. of AARI 25 (2): 1-23.

Lahely S, M, Bergaentzle, C., Hasselmann. 1999. Fluorimetric determination of niacin in foods by high-performance liquid chromatography with post-column derivatization. Food Chem. 65: 129-133

Pekşen, E. 2007. Yield performance of cowpea cultivars under rainfed and irrigated conditions, International Journal of Agricultural Research 2 (4): 391-396.

Peksen, A., E. Peksen, H. Bozoglu. 2002. Effect of sowing dates on yield and quality of cowpea (*Vigna unguiculata* Walp.) genotypes grown in greenhouse. Acta Horticulturae 579: 351-354.

Peksen, E., C. Artık, and B. Palabıyık. 2005. Determination of genotypical differences for leaf characteristics in cowpea (*Vigna unguiculata* L. Walp.) genotypes. Asian Journal of Plant Sciences 4 (2): 95-97.

Tan. A. 2010. State of Plant Genetic Resources for Food and Agriculture. Second Report of Turkey on Conservation and Sustainable Utilization of Plant Genetic Resources For Food and Agriculture., Meta Basım. Bornova (Turkish and English).

Unlu, H. O., H. Unlu, and H. Padem. 2006. Isparta ve yöresinde yetiştirilen börülcelerin (*Vigna unguiculata* L. Walp.) tohum ve bitkisel özelliklerinin saptanması, VI. Sebze Tarımı Sempozyumu, Kahramanmaraş, Eylül, 2006.

Unlu, H. 2004. Börülce (*Vigna unguiculata* L. Walp) çeşitlerinde farklı ekim zamanlarının sulu ve kurak koşullarda verim ve kalite özelliklerine etkisi, Süleyman Demirel Üniversitesi Ziraat Fakültesi Bahçe Bitkileri Bölümü, Yüksek Lisans Tezi, Isparta.

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Foxtail lilly (Eremurus spectabilis M. Bieb.) as Priority Species of Biodiversity for Food and Nutrition Project of Turkey

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ABSTRACT:*"Mainstreaming biodiversity conservation and sustainable use for improved human nutrition and wellbeing" project is being carried out in three pilot site in Turkey. Mediterranean pilot site includes 4 cities as Antalya, Konya, İçel and Karaman. In the Mediterranean Region 20 species were found to be widely used both for human consumption and for medicinal purposes. Foxtail lilly of in the Mediterranean Region of 20 species were selected as target species. The* ***Eremurus*** *genus is one of the important genera of the family* ***Liliaceae****, including over 40 species. Natural populations of this genus are widely distributed on dry and stony grazed hillsides.* ***E. spectabilis****, locally known as çiriş otu, çireş, dağ pırasası, yabani pırasa, güllük, kiriş, sarı çiriş, sarı zambak is widely used in Turkey as a wild edible vegetable and has been traditionally used in folk medicine. Rural people in the Mediterranean Region are extremely experienced with inadequate yields due to climatic and inappropriate topographic conditions. People often use wild plants supplement their usual diets in the region. In this study,* ***E. spectabilis*** *have been analyzed for its nutrition value, antioxidant properties and socio-economic surveys.*

Keywords: *Wild edible plant,* ***Eremurus spectabilis****, foxtail lily, antioxidant activity, chemical content,socio-economic surveys.*

Beslenme ve Gıda için Biyoçeşitlilik Projesi Hedef Türü Çiriş Otu (Eremurus spectabilis M. Bieb.)

ÖZ:*"İnsan Beslenmesi ve Refahı İçin Biyolojik Çeşitliliğin Korunması ve Sürdürülebilir Kullanımı" projesi, Türkiye'de üç pilot bölgede yürütülmektedir. Akdeniz pilot bölgesi Antalya, Konya, İçel ve Karaman olmak üzere 4 şehri içermektedir. Akdeniz Bölgesi'nde beslenme ve tıbbi amaçlarla kullanılan 20 doğal tür hedef olarak seçilmiştir.* ***Eremurus*** *cinsi, 40'dan fazla türün dahil olduğu* ***Liliaceae*** *familyasının en geniş cinslerinden biridir. Bu cinsin doğal populasyonları, kuru ve taşlı yamaçlara yayılmıştır. Çiriş otu, çireş, dağ pırasası, yabani pırasa, güllük, kiriş, sarı çiriş, sarı zambak gibi yerel adlarla bilinen* ***E. spectabilis****, Türkiye'de yabani yenilebilir bir sebze olarak yaygın şekilde kullanılmaktadır ve geleneksel olarak halk tıbbında da kullanılmıştır. Akdeniz Bölgesi'nde kırsal kesimdeki insanlar, iklim ve uygun olmayan topografik şartlar nedeniyle beslenme diyetlerini tamamlamak için genellikle yabani bitkiler kullanmaktadır. Bu çalışmada* ***E. spectabilis****'in besin değeri, antioksidan özellikleri ve sosyo-ekonomik anket sonuçları incelenmiştir.*

Anahtar Sözcükler:*Yenilebilir yabani bitkiler,* ***Eremurus spectabili*** *, çiriş, antioksidan aktivite, kimyasal içerik, sosyo-ekonomik.*

INTRODUCTION

"Mainstreaming Biodiversity Conservation and Sustainable use for Improved Human Nutrition and Wellbeing" project is being carried out in four countries as Turkey, Brasil, Sri Lanka and Kenya. The main point of this project was to strengthen the conservation and sustainable management of agricultural biodiversity through mainstreaming into national and global nutrition, food and livelihood security strategies and programmes. In Turkey project has three pilot site including Mediterranean, Aegean and Blacksea regions. Mediterranean pilot site represented by 4 cities as Antalya, Konya, Içel and Karaman. In the Mediterranean Region 20 species were found to be widely used both for human consumption and for medicinal purposes and from among these species "Foxtail lilly"was selected as target species for the Mediterranean Region.

The Eremurus genus is one of the important genera of the family Liliaceae, including over 40 species. Natural populations of this genus are widely distributed on dry and stony grazed hillsides. *E. spectabilis*, locally known as 'Çiriş otu, çireş, dağ pırasası, yabani pırasa, güllük, kiriş, sarı çiriş, sarı zambak' is widely used in Turkey as a wild edible vegetable and has been traditionally used in folk medicine.

Eremurus spectabilis Bieb. geographically distributed in the region of South Asia and Central Asia, including Turkey, Iran, West Pakistan, Afghanistan, Iraq, Palestine, Lebanon, Syria and Caucasus. Foxtail lily, belongs to the family of Liliaceae, is a perennial herbaceous plant with 1 m plant height. It grows at 1000-2750 in stepe, open scrub, limestone rocks and screes. Its tender shoots, buds and leaves have traditionally been used as vegetable in cooking in a wide variety of recipes. It is an important wild species for rural peoples both diets and livelihood.

In this article nutrition value, antioxidant properties and socio - economic surveys of *E. spectabilis* has presented. The findings of our studies show that with great importance to nutrition for local people, *E. spectabilis* is thought to be important as an alternative vegetable in the future.

MATERIALS AND METODS

The study was conducted in Antalya, Mersin, Konya and Karaman provinces of Mediterranean Region, situated in the southern part of Turkey. Mediterranean climate is seen in Antalya and Mersin, Konya and Karaman has continental climate.

Questionnaire surveys were carried out for collecting ethnobotanic and socio-economic data by using face-to-face interviews with foxtail lily collectors and consumers. Monographic research technique was used in the study. In this technique, data were collected through questionnaire survey, using face-to-face interviews with foxtail lily collectors and consumers.

Foxtail lily samples were taken from local markets for food composition analysis. Identification of the specimen was performed according to literature (Davis *et al.*, 1988). Macronutrients, vitamin C and minerals were assayed. Standard and/or published methods were used in the analysis. Protein, dietary fibre, fat and ash of samples were analyzed according to reference AOAC procedures (Anonymous, 2014). Quantitation of each element was performed by ICP MS after microwave digestion. The procedure described by Gokmen *et al.* (2000) was used for vitamin C analysis.

The antioxidant capacity studies were performed by DPPH (1, 1diphenyl-2-picryl hydrazyl) radical scavenging method and TEAC (Trolox Equivalent Antioxidant Capacity/ABTS Method) were expressed as Trolox equivalents with spectroscopic measurements. These methods were made by the Thermo Scientific™ Multiskan™ GO microplate reader supplied from the BFN Project. IC50 values were calculated from the concentration-effect linear regression curve (Cemeroglu, 2010).

RESULTS AND DISCUSSION

13 collector and 46 consumer questionnaires were finalized during this study. According to our results *E. spectabilis* is important for three main reasons for the local people of region: as a low priced, easily accessible food source and as a source of income.The results of the obtained data have been evaluated in terms of nutritional value and socio-economic importance of the foxtail lily plant.

Nutrition Value of *Eremurus spectabilis*

Edible parts of E. spectabilis analysed for nutrient composition. The macro-nutrient composition is given in Table 1 where values of nutrients are reported on a fresh weight basis. The energy and fat content was low. In previous study by Tosun *et al.* (2012), protein and ash content of *E. spectabilis* sample have been reported as 1.20 % and 0.87 %, respectively. These findings were higher than our results. The dietary fibre content (2.75 mg/100 g) was similar to the corresponding contemporary food such as leeks (3.01 g/100g) given in Turkish Food Composition Database, TURKOMP (Anonim, 2014).

Edible plants can contain macro- and microelements, which have beneficial health effects. The results of the elements of *E. spectabilis* in raw material were shown in Table 2. Potassium was considerably higher than sodium as is common in plant foods making these vegetables a good choice for diets poor in Na.

The iron content was found as 2.42 mg/100 g and this value is lower than the value (7.1 mg/100 g) reported by Tosun *et al.* (2012).

This can be attributed to the fact that mineral content may be influenced by environmental conditions such as soil composition, among other factors.

The particular nutritional importance of foxtail lily as a vegetable is high value of vitamin C (129.4 mg/ 100g fresh weight) but it should be noted that there will be reduction in Vitamin C content after preparation and cooking of foxtail lily.

Socio-economic Surveys of *Eremurus spectabilis* in Turkey

The ethno-botanic and socio-economic surveys were conducted at the Mediterranean Region in the villages, local markets, local restaurants as well as supermarkets. In order to obtain detailed socio-economic and traditional information on edible wild species and local varieties, preliminary surveys were conducted primarily in the region.

The socio-economic studies were conducted for detailed data with monography technic.

In the Mediterranean Region, the foxtail lily species do not have a lot of consumption. It is consumed approximately 1.5 kg per person and 4.5 kg per household per a year (Table 3).

According to consumption frequency; 53% of consumers consume 1-2 times a week, 31% once a month, 9% once every 15 days and 5% once 3-4 times a week (Figure 1).

According to the collector and consumer survey results; 70% of the collected amount is on the market. Its amount of the assigned to the home consumption is at about 4% level. 25% of the collected amount is used in animal feeding (Figure 2).

All of the collectors participating in the survey make the product direct sale to the consumer in the local markets which is located on average 55 km. There is no sale of vehicles/wholesalers since they are collected in low quantities (Table 4).

Table 1. Nutrient content per 100g edible portion of *E. spectabilis.*
Tablo 1. Her 100g yenilebilir *E. spectabilis* için besin içeriği.

Sample Örnek	Moisture (g) Nem (g)	Fat (g) Yağ (g)	Protein (g) Protein (g)	Carbohydrate (g) Karbonhidrat (g)	Ash (g) Kül (g)	Dietary fibre (g) Diyet lifi (g)	Energy (kcal) Enerji (kcal)
E. spectabilis Çiriş	92.0	0.46	0.12	4.06	0.73	2.75	25.9

Table 2. Vitamin C and mineral contents of *E. spectabilis* (mg/100g fresh weight).
Tablo 2. *E. spectabilis* için vitamin C ve mineral içeriği (mg/100g taze ağırlık).

Sample Örnek	Ca	Fe	Mg	P	Zn	K	Na	Cu	Vit C (mg/100g)
E. spectabilis Çiriş	76.0	2.42	15.23	42.8	0.36	263	1.48	0.08	129.4

Table 3.The annual consumption of target species foxtail lily (kg/year).
Tablo 3. Hedeflenen çiriş türünün yıllık tüketimi (kg/yıl).

Consumption per household (kg/year) Hanehalkı başına tüketim (kg/yıl)	Consumption per capita (kg/year) Kişi başına tüketim (kg/yıl)
4.5	1.5

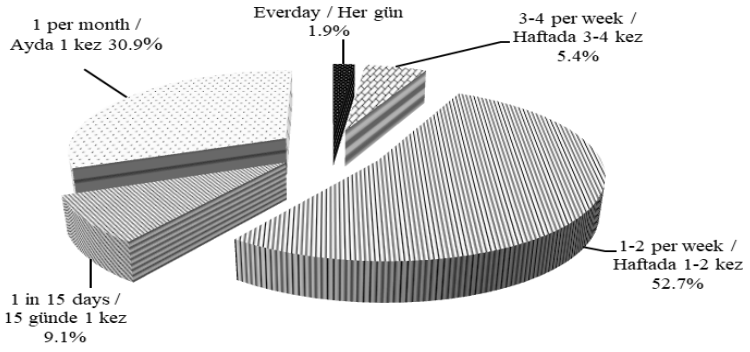

Figure 1. Consumption frequency of foxtail lily (%).
Şekil 1. Çiriş için tüketim sıklığı (%).

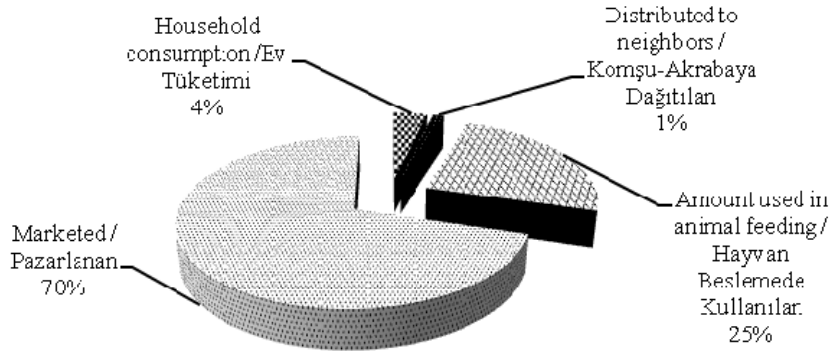

Figure 2. Use Type of foxtail lily.
Şekil 2. Çiriş kullanım tipleri.

Table 4. The foxtail lilly marketing status of collectors.
Tablo 4. Çiriş toplayıcılarının pazarlama durumu.

Average distance to market Pazara ortalama uzaklık (km)	Proportion of selling to consumers at local market Yerel pazardaki tüketicilere satış oranı (%)	Proportion of selling to trader at local market Yerel pazarda tüccara satış oranı (%)	Proportion of selling to trader at village Köyde tüccara satış oranı (%)
55	100	-	-

During surveys ethno-botanical information and the different type of dishes of wild edible plants were recorded from face to face questioners.

The aerial part of plants (Foxtail lilly) were collected from nature and used in salads. The plants are used for folk medicine to treat some ailments such as hemorrhoids and diabetics and also used as anti-dysuria and anti-hypertensive in our region of Turkey.

CONCLUSION

The findings of our studies shows that with great importance to nutrition for local people, *E. spectabilis*is thought to be important as an alternative vegetable in the future. In recent years, domestic market sales of foxtail lily plant, which has been collected from nature and consumed mostly by local people, has also increased.

This situation makes the foxtail lily plant an important source of livelihood for local people. In order to be delivered the foxtail lily plant to the more consumer are carried out post-harvest studies within the scope of the project. At the same time, on behalf of protecting our plant genetic resources, studies on the cultural production possibilities of the foxtail lily plant will be started as soon as possible.

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REFERENCES

Anonim. 2014. Turkomp. Turkish Food Composition Database, version 1.0 Food Institute, TÜBİTAK Marmara Research Center, Gebze / Kocaeli. http:// www.turkomp.gov.tr. Accessed 11.06.16.

Anonymous. 2014. AOAC. Official Methods of Analysis of the Association of Official Analytical Chemists. Association of Official Analytical Chemists, Washington, DC, USA. Retrieved December 12, 2015 from: http://www.eoma.aoac.org/.

Cemeroglu, B. 2010. Gıda Analizleri, Gıda Teknolojisi Derneği Yayınları No: 34, 480 s. Ankara.

Davis, P. H., R. R. Mill, and K. Tan. 1988. Flora of Turkey and the East Aegean Islands (Suppl. I) 10: 206-207. Edinburgh Univ. Press, Edinburgh.

Gokmen, V., N. Kahraman, N. Demir, and J. Acar. 2000. Enzymatically validated liquid chromatographic method for the determination of ascorbic and dehydroascorbic acids in fruit and vegetables. J. Chromatogr. A 881: 309-316.

Tosun, M., S. Ercisli, H. Ozer, M. Turan, T. Polat, E. Ozturk, H. Padem, H. Kilicgun. 2012.Chemical Composition and Antioxidant Activity of Foxtail Lily (*Eremurus spectabilis*) Acta Sci. Pol., Hortorum Cultus 11 (3): 145-153.

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ITS Phylogeny and Molecular Dating of some Gundelia (Asteraceae) of Anatolia

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ABSTRACT: Gundelia *L. is known to be a monotypic genus according to the flora books.* ***Gundelia tournefortii*** *L. was the only species of the genus* ***Gundelia*** *L. In our research we used the recently introduced species:* ***Gundelia aragatsi*** *Vitek, Fayvush, Tamanyan & Gemeinholzer,* ***Gundelia dersim*** *Vitek, Yüce & Ergin,* ***Gundelia munzuriensis*** *Vitek, Yüce & Ergin,* ***Gundelia vitekii*** *Armağan,* ***Gundelia komagenensis*** *Fırat,* ***Gundelia colemerikensis*** *Fırat,* ***Gundelia cilicica*** *Fırat and* ***Gundelia anatolica*** Firat*, in order to reconstruct a phylogeny inference and molecular dating by using ITS region. The mentioned species were collected from Turkey and beside our collections, the ITS sequences belonging to* ***G. tournefortii*** *accessions of former studies were used in our research. According to the phylogeny inference,* ***G. anatolica*** *was different from all* ***Gundelia*** *accessions. Some* ***G. tournefortii*** *accessions belonging to former studies grouped with* ***G. cilicica****,* ***G. dersim*** *and* ***G. colemerikensis****,* ***G. munzurensis*** *clustered with* ***G. vitekii****.* ***Gundelia komagenensis*** *and* ***G. aragatsi*** *accessions were grouped as close relatives. According to the molecular dating the distinction of the genus* ***Gundelia*** *from the relative genera was around 14.1 million years ago (mya).*

Keywords*:* ***Asteraceae****,* ***Gundelia****, ITS, molecular dating, phylogeny.*

Anadolu'da Yetişen Gundelia (Asteraceae) Taksonlarının ITS Filogenisi ve Moleküler Tarihlendirilmesi

ÖZ*: Flora kitaplarına göre* ***Gundelia*** *L. monofiletik bir cins olarak bilinmektedir.* ***Gundelia tournefortii*** *L. cinsin tek türü olarak bilinmektedir. Çalışmamızda ITS bölgesine dayalı filogenetik analiz ve moleküler tarihleme yapmak için yeni tanımlanan türleri de kullandık. Bunlar:* ***Gundelia aragatsi*** *Vitek, Fayvush, Tamanyan & Gemeinholzer,* ***Gundelia dersim*** *Vitek, Yüce & Ergin,* ***Gundelia munzuriensis*** *Vitek, Yüce & Ergin,* ***Gundelia vitekii*** *Armağan,* ***Gundelia komagenensis*** *Fırat,* ***Gundelia colemerikensis*** *Fırat,* ***Gundelia cilicica*** *Fırat ve* ***Gundelia anatolica*** *Fırat. Adı geçen yeni türler Yürkiye'den arazi çalışmaları yaparak toplanmış ve bizim toplamalarımızın yanısıra* ***G. tournefortii*** *türüne ait daha önceki çalışmalarda ortaya çıkmış ITS dizileri de kullanılmıştır. Filogenetik ağaca göre,* ***G. anatolica*** *tüm* ***Gundelia*** *örneklerinden farklıdır. Daha önceki çalışmalarda toplanmış bazı* ***G. tournefortii*** *örnekleri* ***G. cilicica****,* ***G. dersim*** *ve* ***G. colemerikensis*** *ile birlikte kümelenmiştir.* ***G. munzurensis G. vitekii*** *ile grup oluşturmuştur.* ***Gundelia komagenensis*** *ve* ***G. aragatsi*** *örnekleri birbirine en yakın gruplanmışlardır. Moleküler tarihlendirmeye göre* ***Gundelia*** *cinsinin ayrılma zamanı 14.1 milyon yıl öncesine tarihlenmektedir.*

Anahtar Sözcükler: Asteraceae*,* ***Gundelia****, ITS, moleküler tarihleme, filogeni.*

INTRODUCTION

Gundelia L. belongs to the tribe Lactuceae according to the chloroplast *ndhF* gene (Karis *et al.,* 2001). In the flora books (Nikitin, 1960; Vasilchenko, 1961; Sofieva, 1961; Kupicha, 1975; Feinbrun-Dothan, 1978; Rechinger, 1989; Avetisian, 1995) *Gundelia tournefortii* L. is the only species of the genus *Gundelia,* and all other names were recorded as synonyms. Recently, several new species have been described, i.e. *G. aragatsi* Vitek, Fayvush, Tamanyan& Gemeinholzer, *G. armeniaca* Nersesian from Armenia, and *G. dersim* Vitek, Yüce&Ergin, *G. munzuriensis* Vitek, Yüce&Ergin, *G. vitekii* Armağan, *G. komagenensis* Fırat, *G. colemerikensis* Fırat, *G. cilicica* Fırat, *G. anatolica* and *G. mesopotamica* Fırat from Turkey and *G. tehranica* Vitek & Noroozi from Iran (Firat, 2016; Firat 2017a; Firat, 2017b).

For the taxonomic evaluation, molecular systematic approach was implemented to the genus *Gundelia* by Vitek *et al.* (2010). The researchers used ITS marker to investigate the infraspecific relations of the genus. In the phylogram they have constructed, *Gundelia* was clearly monomorphic and the infraspecific relations were supported with low posterior probability values. However, it was still probable to distinguish the new proposed taxa as different from others, with the help of the phylogeny tree. In our study we have used the ITS sequence data to reveal the phylogeny and molecular dating of the known *Gundelia* taxa.

MATERIALS AND METHODS

Plant material

A total of 10 herbarium specimens for each species were collected from the field and deposited in the herbaria ANK, E and VANF [acronyms according to Thiers (2016)], and in the personal herbarium of the author (Herb. Fırat). The ITS sequences were gathered from NCBI GeneBank are as follows: *Scorzonera purpurea* AJ633477, *Tragopogon albinervis* KF050360, *Warionia saharae* AY190608, *Scolymus maculatus* AJ633469, *Catananche caerulea* AJ633465 were used as outgroups and *Gundelia aragatsi* ssp. *steineri*_1 FN582290, *G. aragatsi* ssp. *steineri*_2 FN582289, *G. aragatsi* FN582288, *G. aragatsi* FN582283, *Gundelia sp*. FN582287, *G. tournefortii* FN582281, *G. tournefortii* FN582284, *G. tournefortii* FN582277, *G. tournefortii* FN582285, *G. tournefortii* FN582278, *G. tournefortii* AY504691, *G. tournefortii* FN582282, *G. tournefortii* FN582279, *G. tournefortii* FN582280, *G. tournefortii* FN582286 were used with our own collections to construct the phylogeny tree.

DNA extraction, amplification, and sequencing

Total DNA was isolated with the DNAeasy Plant Mini Kit following the manufacturer's protocols (Qiagen, Germany). The amplification of ITS region, including 5.8S ribosomal RNA gene, was performed using primers ITS1 and ITS4 (White *et al.,* 1990). The PCR amplification of ITS followed Warwick *et al.* (2004). Purification and sequencing were performed by Bioeksen (İstanbul).

Data Analysis

Sequences were aligned manually by using BioEdit (Hall, 1999). The aligned ITS sequences were analyzed using Bayesian approaches following BEAST1.8.0 (Drummond *et al.,* 2012). For the Bayesian analyses, GTR + Gamma model was chosen as best model according to Akaike Information Criterion (AIC). Two independent Marcov Chain Monte Carlo (MCMC) runs were conducted with 10 million generations and sampled every 1,000 generations. Each run was checked in Tracer v1.5 (Rambaut and Drummond, 2007). Among the trees obtained 25% (5,000) were discarded as burn-in. Treeannotater v.1.7.5 programme was used to obtain the maximum clade credibility tree.

We used an external calibration point introduced by Tremetsberger *et al.* (2013). The age of

Scolymus hispanicus L. and *Catananche caerulea* L. was set to 13.6 Ma (million years ago) with ±0.42 Ma standard deviation. Divergence time estimation was performed under the lognormal clock model. GTR with four gamma categories were used as a substitution model and Yule process of speciation was used as a tree prior. MCMC runs was conducted with 100 million generations and sampled every 10,000 generations. Each run was checked using Tracer v1.5 (Rambaut and Drummond, 2007) and then combined in Logcombiner v1.7.5. Treeannotater v.1.7.5 program was used to obtain a single posterior probability and maximum clade credibility tree was visualized using Figtree v1.3.1 (Anonymous, 2016).

RESULTS AND DISCUSSION

According to the phylogeny reconstruction, *G. anatolica* derived from all other *Gundelia*s (Fig. 1). The rest of the species grouped under two major clades. First group consisted *G. colemerikensis, G. dersim, G. munzuriensis, G. tournefortii, G. vitekii, G. komagenensis* and *G. aragatsi*. *Gundelia colemerekensis* clearly derived from *G. dersim* (posterior probability 1.0) in the first subclade. The species with ca.3 flowered cephaloid compound (*G. munzuriensis*, *G. vitekii*, G. *aragatsi*) grouped together in the second subclade. All other investigated taxa have ca. 6-flowered cephaloid compound. Second group comprised *G. tournefortii* accessions of Vitek *et al.* (2010) and *G. cilicica*. As described in the introduction part of this paper, formerly *Gundelia* was considered as a monotypic genus. The squences gathered from the genebank were identified according to the flora books, therefore all *Gundelia* accessions were named as *G. tournefortii*. These *G. tournefortii* samples

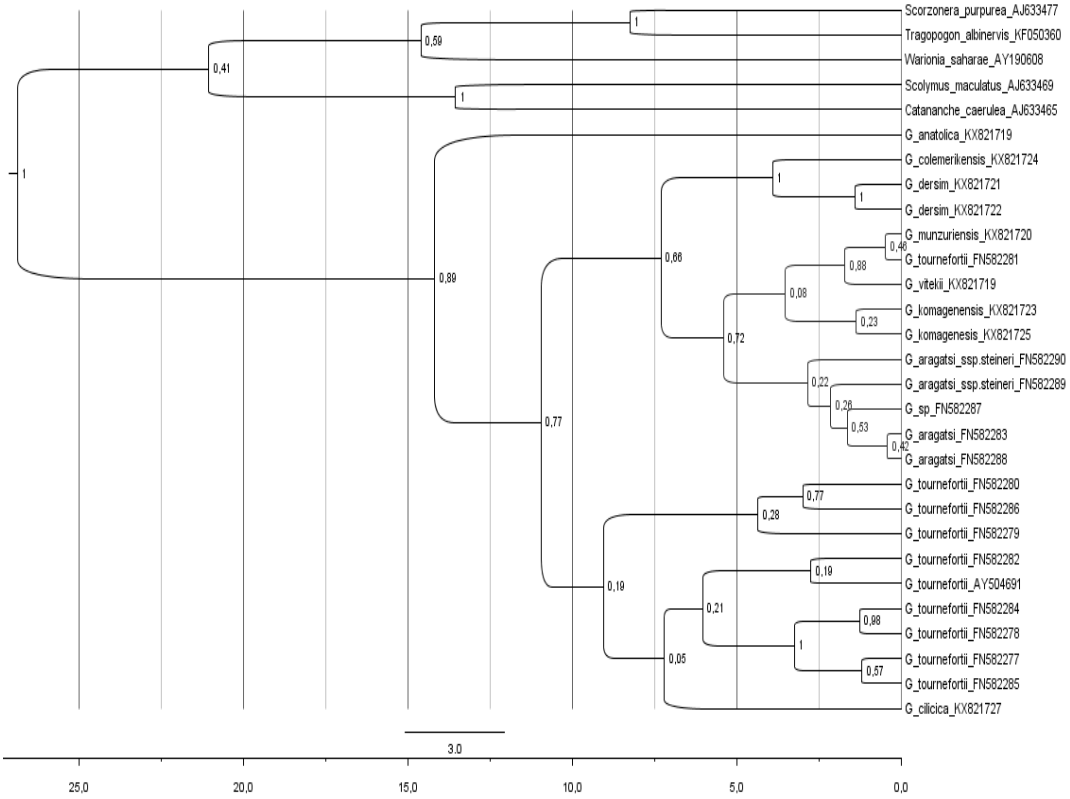

Figure 1. The phylogeny tree of the *Gundelia* species; numbers on branches indicate clade credibility, x bar shows the time scale (mya).
Şekil 1. *Gundelia* türlerinin filogenetik ağacı; dalların üzerindeki sayılar clade credibility değerleridir, x ekseni zaman aralığını göstermektedir (milyon yıl önce).

could be identified with comparing the newly described species and our phylogeny tree could give an idea for naming the species. For example, FN582284, FN582277, FN582285, FN582278, AY504691, FN582282, FN582279, FN582280, FN582286 could be *G. cilicica* or could be some other species close to *G. cilicica*. FN582287 could be *G. aragatsi*. FN582281 could be either *G. munzurensis* or *G. vitekii*. According to the molecular dating, the distinction of the genus *Gundelia* from the relative genera was around 14.1 mya mid-Miocene. The distinction of the ca.3 flowered cephaloid compound species group from the ca. 6-flowered cephaloid compound species group was around 7.3 mya late Miocene of the Cenozoic.

REFERENCES

Anonymous. 2016. Molecular evolution, phylogenetics and epidemiology. http://tree.bio.ed.ac.uk/software/figtree.

Avetisian, V. E. 1995. Gundelieae. In: A. L. Takhtajan (Ed.). Flora Armenii 9. Koeltz Scientific Books, Havlíčkův Brod. pp. 212-216.

Drummond, A. J., M. A. Suchard, D. Xie, & A. Rambaut. 2012. Bayesian Phylogenetics with BEAUti and the BEAST 1.7. MolecularBiology and Evolution 29: 1969-1973.

Feinbrun-Dothan, N. 1978. Flora Palaestina, 3. The Israel Academy of Sciences and Humanities, Jerusalem, 481 pp.

Firat, M. 2016. Four new species of *Gundelia* L. (Asteraceae) from Anatolia: *G. komagenensis, G. colemerikensis, G. cilicica* and *G. anatolica.* Vameda Ofset Press, Van, 32 pp.

Firat, M. 2017a. *Gundelia rosea* (Asteraceae), a new record for the Flora of Turkey with contributions to its systematics. Acta Biologica Turcica 30 (2): 31–35.

Firat, M. 2017b. *Gundelia mesopotamica* (Asteraceae), a new lactiferous species from Mardin (Turkey). Acta Biologica Turcica 30 (3): 64-69.

Hall T. A. 1999. BioEdit: a user-friendly biological sequence alignment editor and analysis program for Windows 95/98/NT. Nucleic Acids Symp., Ser. 41: 95- 98.

Karis P. O., P. Eldenäs, and M. Källersjö. 2001. New evidence for systematic position of *Gundelia* L. With notes on delimitation of Arctoteae (Asteraceae). Taxon, 50: 105-114.

Kupicha, F. K. 1875. *Gundelia*. *In*: P. H. Davis (Ed.). Flora of Turkey 5. University Press, Edinburgh, pp. 325-326.

Nikitin, V. V. 1960. *Gundelia* L. In: B. K. Schischkin (Ed.). Flora Turkmenii 7. Akademiia nauk Turkmenskoĭ SSR, Institut Botaniki, Ashkhabad, p. 141.

Rambaut, A., and A. J. Drummond. 2007. Tracer, version 1.4. Available from http:// beast.bio.ed.ac.uk/Tracer.

Rechinger, K. H. 1989. *Gundelia*. In: K. H. Rechinger (Ed.). Flora Iranica 164. Akademische Druck- und Verlagsanstalt, Graz, pp. 107-109.

Sofieva, R. M. 1961. *Gundelia* L. *In*: I. I. Karjagin (Ed.). Flora Azerbajdžana 8. Azerbaijan National Academy of Sciences Press, Baku, pp. 347-348.

Thiers, B. 2016. Index Herbariorum: A Global Directory of Public Herbaria and Associated Staff. New York Botanical Garden's Virtual Herbarium. http://sweetgum.nybg.org/science/ih/

Tremetsberger, K., Gemeinholzer, B., Zetzsche, H., Blackmore, S., Kilian, N., & Talavera, S. (2013). Divergence time estimation in Cichorieae (Asteraceae) using a fossil-calibrated relaxed molecular clock. Organisms Diversity and Evolution, 13 (1): 1-13.

Vasilchenko, I. T. 1961. *Gundelia* L. In: V. L. Komarov (Ed.). Flora SSSR, 26. Nauka Publishers, Moscow & Leningrad, p. 862.

Vitek, E., G. Fayvush, K. Tamanyan, and B. Gemeinholzer. 2010. New taxa of *Gundelia* (Compositae) in Armenia. Annalen des Naturhistorischen Museums Wien, Serie B 111: 85-99.

Warwick, S. I., Al-Shehbaz, I. A., Sauder, C. A., Murray, D. F., Mummenhoff, K. 2004. Phylogeny of *Smelowskia* and related genera (Brassicaceae) based on nuclear ITS DNA and chloroplast trnL intron DNA sequences. Annals of the Missouri Botanical Garden 91: 99–123.

White, T. J. T, Bruns, S. L., Taylor, J. W. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In: Innis, M. A., Gelfand, D. H., Sninsky, J. J. and White, T. J. (Ed.). PCR Protocols: A Guide to Methods and Applications, Academic Press, Inc., New York. pp. 315–322.

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Halophytes as a Potential Food Source

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ABSTRACT: *Increase in soil salinity and water deficiency is important problems of the world especially in agricultural areas. Beside of spending effort and capital for remediation of such areas, using salt tolerant crops can be a good alternative. For saline areas halophytes are the best candidates as a crop. They can survive in saline areas with salinity over 0.5%. Halophytes have some traditional usages as food, medicine, industrial products, forage and fuel. In Turkey, especially in coastal areas some of them are consumed as a vegetable. Turkey has large saline areas, which are accepted as wastelands, can be used for production of halophytes without great effort. Production of halophytes as food or any kind of industrial product also values these areas. In this study, halophytic plants with known usage for food and have potential for agricultural production in Turkey are provided.*

Keywords: *halophytes, crop, vegetable, saline areas.*

Potansiyel Gıda Kaynağı Olarak Halofitler

ÖZ: *Toprak tuzluluğundaki artış ve kuraklık dünya genelinde özellikle tarımsal üretim için en önemli sorunlardır. Bu gibi alanların remediasyonu için harcanan çaba ve bütçeyle karşılaştırıldığında tuza toleranslı türler olan halofitler ürün olarak iyi bir alternative sağlamaktadır. %0,5'den yüksek tuzluluk şartlarında bile varlığını sürdüren halofit bitkilerin gıda, ilaç, endüstriyel hammadde, yem ve yakıt bitkisi olarak geleneksel kullanımları bulunmaktadır. Türkiye'de ise özellikle kıyı bölgelerinde sebze olarak tüketilmektedirler. Ülkemizde gerek doğal gerekse insan etkisi ile oluşmuş olan tuzlu alanlar oldukça geniş bir alanı kaplamakta ve genel olarak işe yaramaz çorak alanlar olarak Kabul edilmektedir. Ancak bu alanlar büyük bir çaba gerektirmeksizin halofit tarımında kullanım potansiyeline sahiptirler. Halofit bitkilerin gıda veya herhangi bir endüstriyel ürün olarak üretilmesi bu alanları da değerlendirecektir. Bu çalışmada gıda olarak dünya genelinde kullanılan taksonlardan ülkemizde de doğal olarak yetişenler ve ayrıca kullanımı olup ülkemizde akrabaları bulunan taksonlar ve potansiyel kullanımları verilmiştir.*

Anahtar Sözcükler: *halofit, ekin, sebze, tuzcul alanlar.*

INTRODUCTION

Drought and salinity stress are the main problems of whole world that cause decrease in agricultural production (Boyer, 1982; Gallagher, 1985). Especially the contribution of soil salinity to soil loss increases, almost 7% of the terrestrial areas are salt affected and the Na affected areas are even larger (Flowers *et al.,* 1997; Panta *et al.,* 2014). Soil salinity is an important problem especially at arid and semi-arid regions where irrigation takes place. Nowadays 20% of 230 million ha irrigated area is seriously affected from salinization (Gallagher, 1985). Globally, although irrigated areas cover 15% of total agricultural areas, provide 1/3 of world's food demand (Ghassemi *et al.,* 1995; Pessarakli and Szabolics, 1999), and 11% of world's irrigated areas are even influenced from salinization in some level (Anonymous, 2012).

Salinity is the increase in total concentrations of dissolved salt in soil or water through natural processes (primary salinization) or anthropogenic activities (secondary salinization) (Ghassemi *et al.,* 1995). The secondary salinization is the increased accumulation of dissolved salts in irrigation water, and each year it is the major component of the loss of ≥10 million ha irrigated area (Owens, 2001). It is expected that this situation is going to get worse with especially changing climate. Natural saline areas cover 6% of world's terrestrial areas and because of high salinity these areas cannot be cultivated (Gallagher, 1985).

Agricultural plants are mostly glycophytes, and the increase in soil salinity results in increase in researches to get soil resistant varieties (Malcolm, 1996; Mudie, 1974; Epstein *et al.,* 1980; O'Leary, 1984; Flowers *et al.,* 2010). Although the results are hopeful, it is easy to grow halophytes as crops rather than making the glycophytes resistant (Ventura and Sagi, 2013; Flowers, 2004; Gallagher, 1995). In Turkey, salinity problem is observed in Harran, Amik, Konya and Lower Seyhan Plains.

There are many definitions for halophytes but the most accepted or general one is the plants that are able to survive and complete their life cycle in the presence of soil salinity at least equivalent to 200 mM NaCl (Flowers *et al.,* 1986; Flowers and Colmer, 2008), in fact many of them can grow over this level (Gallagher, 1985). 0.25% of Angiosperms are halophyte (Flowers *et al.,* 2010) and almost 350 taxa spreading in different families and genera.

Some of the halophytes traditionally gathered from nature for different purposes, like food, animal feed, drug production, cosmetics and industrial crude material. These halophytes and their relatives can be evaluated as agricultural crops.

MATERIALS AND METHODS

Literature on edible halophytes were surveyed, the ones already used for human consumption and their relatives that have potential were determined. Literature mentioned in reference part was examined in detail and the information from them were evaluated and added to the text. Also, the personal observations of the authors, during their field excursions and visits to local markets, were added.

RESULTS

Most of the taxa accepted as halophyte cannot be able to grow well at 200 mM NaCl. And the changes in halophyte definition cause some of the taxa that have low resistance to salinity are accepted as halophyte. Plants are consumed as cooked, raw, pickled, vegetable oil, ground to powder, and salt and salt substitutes. Different parts are consumed like leaves, young shoots, seeds, seed pots, flower buds, roots and fruits. The most commonly consumed halophyte genera are *Atriplex, Bassia, Chenepodium, Plantago, Portulaca, Salicornia, Salsola,* and *Suaeda.* The most widely gathered and used cultivated halophytic taxa were determined and listed in below.

***Arthrocnemum macrostachyum*:** Seeds are source of vegetable oil (Weber *et al.,* 2007).

***Atriplex* spp.:** Leaves can be consumed as cooked or raw like spinach but seeds can only be consumed after cooking. Also tips of leaves and stems are source of manna (Gallagher *et al.,* 1985; Wilson *et al.,* 2000).

***Bassia* spp.**: Leaves are cooked and seeds are ground into powder and mixed with flour.

***Beta maritima*:** Young shoots can be consumed like spinach (Ventura *et al.,* 2015).

***Cakile* spp.:** Stem, flower buds and immature seed pots are consumed as raw or cooked. The roots are ground into powder (O'Leary *et al.,* 1985).

***Chenopodium* spp.:** Leaves, young shoots and seeds of *Chenopodium* species are consumed after different preparation methods. Seeds are not only consumed as cooked they are also source of vegetable oil. Especially *C. quinoa* is an important

commercial product nowadays. Leaves and young shoots mostly cooked but can also consumed as raw (Panta *et al.,* 2014; Dagar, 2005; Rameshkumar and Eswaran, 2013; Yajun *et al.,* 2003; Ventura *et al.,* 2015).

***Crambe maritima*:** Leaves, young shoots, flower buds and roots are consumed as raw or cooked (Ventura *et al.*,2015).

***Cressa cretica*:** Seeds are source of edible oil (Weber *et al.,* 2007).

***Crithmum maritimum*:** Leaves are consumed as vegetable after cooking or as raw. Seeds pots are used for making pickles (Zarrouk *et al.,* 2003; Franke, 1982; Davy *et al.,* 2001; Simopoulos, 2004; Tardio *et al.,* 2006).

***Descaurinia sophia*:** Leaves are consumed as cooked or raw. Seeds are either cooked or ground into powder (Yajun *et al.,* 2003).

***Diplotaxis* spp.:** Leaves are consumed as raw or plant is ground into powder to prepare bread and biscuits.

***Inula chritmoides*:** Young leaves are consumed as either cooked, raw or pickled (Gallagher *et al.,* 1985; Zurayk and Baalbaki, 1996).

***Nitraria* spp.:** Fruits of *N. schoberi* are consumed as raw or cooked. And the seeds of *N. sibirica* are used as vegetable oil (Yajun *et al.,* 2003).

***Plantago* spp.:** Mostly leaves are consumed as cooked or raw. Seeds of *P. lanceolata* are ground into a powder and mixed with regular flours (Gallagher *et al.,* 1985).

***Portulaca* spp.:** Leaves, stems and seeds are consumed cooked or raw. Also, the whole plant is burned and used as salt substitute (Franke, 1982; Davy *et al.,* 2001; Simopoulos, 2004; Tardio *et al.,* 2006).

***Salicornia* spp.:** Mostly young shoots and seeds are consumed. Young shoots are not only consumed as cooked or raw also pickled. Seeds are source of vegetable oil (Panta *et al.,* 2014; Ventura *et al.,* 2015; Glenn *et al.,* 1991; Franke, 1982; Davy *et al.,* 2001; Simopoulos, 2004; Tardio *et al.,* 2006).

***Salsola* spp.:** Mainly young shoots are consumed, either cooked, raw or salt and salt substitutes.

***Suaeda* spp.:** Leaves and seeds are consumed. Seeds are used for oil production. Leaves are cooked or uncooked (Weber *et al.,* 2007; Wang *et al.,* 2012; Yajun *et al.,* 2003).

***Tripolium pannonicum*:** Leaves are cooked or pickled (Davy *et al.,* 2001; Simopoulos, 2004; Tardio *et al.,* 2006; Ventura *et al.,* 2015).

***Zygophyllum* spp.:** Flower buds of *Z. fabago* are pickled and vegetable oil is produced from seeds of *Z. album* (Zarrouk *et al.,* 2003).

DISCUSSION

Scientific and technological improvements can support the food production, which is severely needed, by using primary or secondary salinized areas for agriculture. The usage of low quality waters, brackish or salty water for irrigation of halophytic crops, high quality fresh water can be used for drinking water or other purposes. Halophyte crops can be used for treatments (restoration-remediation) of secondary saline areas. After the restoration, these areas can be used for general production again.

Usages of halophytes changes for countries and cultures. Although they are not widely used in Turkey, they have potential for human consumption. Some of the widely consumed halophytes naturally grow in Turkey but their consumption is not common. Relatives of some widely consumed halophytes grow in Turkey and their potentials can be investigated. Also, the ones with high economical value can be evaluated as potential crop even though they are not native.

REFERENCES

Anonymous. 2012. FAO Statistical Year Book 2012. World Food and Agriculture Organization of the United Nation, Rome, p. 366.

Boyer, J. S. 1982. Plant productivity and environment. Science 218: 443-448.

Dagar, J. C. 2005. Ecology, Management and Utilization of Halophytes. Bull. Nat. Inst. Ecol. 15: 81-97.

Davy, A. J., G. F. Bishop, and C. S. B. Costa. 2001. *Salicornia* L. (*Salicornia pusilla* J. Woods, *S. ramosissima* J. Woods, *S. europaea* L., *S. obscura* P.W. Ball & Tutin, S. nitens P.W. Ball & Tutin, S. fragilis P.W. Ball & Tutin and S. dolichostachya Moss). J. Ecol. 89: 681-707.

Epstein, E., J. D., Norlyn, D. W. Rush, R. Kingsbury, and D. B. Kelley. 1980. Saline culture of crops: a genetic approach. Science 210: 399-404.

Flowers, T. J. 2004. Improving crop salt tolerance. J. Exp. Bot. 55: 307-319.

Flowers, T. J., and T. D. Colmer. 2008. Salinity tolerance in halophytes. New Phytol. 179: 945-963.

Flowers, T. J., M. A., Hajibagheri, and N. J. W. Clipson. 1986. Halophytes. Q Rev. Biol. 61: 313-337.

Flowers, T. J., P. F. Troke, and A. R. Yeo. 1997. The mechanism of salt tolerance in halophytes. Ann. Rev. Plant Physio. 28: 89-121.

Flowers, T. J., H. K. Galal, and L. Bromham. 2010. Evolution of halophytes: multiple origins of salt tolerance in land plants. Funct. Plant Biol. 37: 604-612.

Franke, W. 1982. Vitamin C in sea fennel (*Crithmum maritimum*), an edible wild plant. Econ. Bot. 36: 163-165.

Gallagher, J. L. 1985. Halophytic crops for cultivation at seawater salinity. Plant Soil 89: 323-336.

Ghassemi, F., Jakeman, A. J., and H. A., Nix. 1995. Salinization of land and water resources, human causes, extent, management and case studies Sydney, University of New South Wales.

Glenn, E. P., J. W. O'Leary, M. C. Watson, L. T. Thompson, and R. O. Kuelh. 1991. *Salicornia bigelovii* Torr.: an oilseed halophyte for seawater irrigation. Sciene 251: 1065-1067.

Malcolm, C. V. 1996. Economic and environmental aspects of the sustainable use of halophytic forages. p. 363-376. *In*: R., Choukr-Allah, C., Malcolm and A., Hamdy (Eds.) Halophytes and Biosaline Agriculture. Marcel Dekner, New York.

Mudie, P. J. 1974. The potential economic uses of halophytes. pp. 565-597. *In*: R. J., Reimold and W.H., Queen (Eds.) Ecology of halophytes. New York Academic Press.

O'Leary, J. W. 1984. The role of halophytes in irrigated agriculture. pp. 285-300. *In*: R. C., Staples, G.H., Toenniessen (Eds.) Salinity tolerance in plants. New York John Wiley & Sons.

O'Leary, J. W., E. P. Glenn, and M. C., Watson. 1985. Agricultural production of halophytes irrigated with seawater. Plant Soil 89: 311-321.

Owens, S. 2001. Salt of the earth. Genetic engineering may help to reclaim agricultural land lost due to salinization. EMBO Report 2: 877-879.

Panta, S., T. J. Flowers, P. Lane, R. Doyle, G. Haros, and S. Shabala. 2014. Halophyte agriculture: success stories. Environ. Exp. Bot. 107: 71-83.

Pessarakli, M., and I., Szabolcs. 1999. Soil salinity and sodicity as particular plant/crop stress factor. p: 1-16. *In*: M., Pessarakli (Ed.) Handbook of Plant and Crop Stress Marcel Dekker, New York.

Rameshkumar, S. and K., Eswaran. 2013. Ecology, utilization and coastal management of salt tolerant plants (halophytes and mangroves) of Mypad coastal regions, Andhra Pradesh India. Int. J. Environ. Biol. 3: 1-8.

Simopoulos, A. P. 2004. Omega-3 fatty acids and antioxidants in edible wild plants. Biol. Res. 37: 263-277.

Tardio, J., M., Pardo de Santayana, and R. Morales. 2006. Ethnobotanical review of wild edible plants in Spain. Bot. J. Linn. Soc. 152: 27-71.

Ventura, Y., and M., Sagi. 2013. Halophyte crop cultivation: the case for Salicornia and Sarcocornia. Environ. Exp. Bot. 92: 144-153.

Ventura, Y., A., Eshel, D., Pasternak and M., Sagi. 2015. The development of halophyte-based agriculture: past and present. Ann. Bot. 115: 529-540.

Wang, L., Z. Y., Zhao, K., Zhang, and C. Y. Tian. 2012. Oil content and fatty acid composition of dimorphic seeds of desert halophyte *Suaeda aralocaspica*. Afr. J. Agr. Res. 7: 1910-1914.

Weber, D. J., R., Ansari, B., Gul and M. A., Khan. 2007. Potential of halophytes as source of edible oil. J. Arid. Environ. 68: 315-321.

Wilson, C., S. M., Lesch, and C. M., Grieve, 2000. Growth stage modulates salinity tolerance of New Zealand Spinach (*Teteragonia tetragonoides* Pall) and Red Orach (*Atriplex hortensis* L.). Ann. Bot. 85: 501-509.

Yajun, B., L., Xiaojing., and L., Weiqiang. 2003. Primary analysis of four salt tolerant plants growing in Hai-He plain China. p. 135-138. *In*: H., Leith, M., Mochtchenko (Eds.) Cash Crop Halophytes: Recent Studies, Kluwar Academic Publishers, London, Great Britain.

Zarrouk, M., H. El Almi, N. B. Youssef, N. Sleimi, A. Smaoui, D. B. Miled, and C. Abdelly. 2003. Lipid composition of seeds of local halophytes: *Cakile maritima*, *Zygophyllum album*, *Crithmum maritimum*. *In*: Lieth, H., Mochtchenko, M. (eds.) Cash crop halophytes: recent studies, Dordrecht, Kluwer Academic Publisher. pp: 121-124.

Zurayk, R., and R. Baalbaki. 1996. Inula crithmoides: a candidate plant for saline agriculture. Arid Soil Res. Rehab. 10: 213-223.

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Strategy of Conservation and Protection of Wild Edible Plants Diversity in Burkina Faso

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ABSTRACT: *Plant species are divided in cultivated or crops and non-cultivated or spontaneous or wild. Cultivated species are few in Burkina Faso and are mostly recent introduction. Wild species play an important socio-economic role. This paper aims to show the importance of wild edible plants by their used parts, mode of harvest and uses. So, we did this study on the basis of our previous Ethnobotanical surveys in Burkina Faso. Surveys have been made with a list of 135 species met in our previous inventories. The results revealed that spontaneous edible plants can be grouped in shrubs and herbaceous. The over exploitation of the wild edible plants make their protection and preservation necessary in order to achieve greater food security. Management of wild trees involves the identification of constraints and the solutions researching. Popular species such as* ***Adansonia digitata****,* ***Bombax costatum****,* ***Parkia biglobosa****,* ***Tamarindus indica*** *and* ***Vitellaria paradoxa*** *are subject to mutilation due to bad harvesting, which compromises their renewal. Thus measures must be taken to preserve them and to improve their contribution to food by implementing substantial resources. In these measures, all the actors and structures have to be involved for a good management of wild edible biodiversity.*

Keywords*: Edible wild plants, plants harvesting, mutilation of species, preservation, Burkina Faso.*

INTRODUCTION

Nowadays, with the technical revolution, economic expansion, poverty, conflict and population pressure, the scientific community agree to say that the salvation of mankind goes through conservation and rational use of natural resources. Everything seems to indicate that the current structure of exploitation and consumption of resources are not sustainable and approach natural limits in some areas. In fact, spontaneous flora plays a very important role in the socio-economic balance of population in development. This flora serves food according to Belem *et al.* (2010) and Yameogo *et al.* (2010).

Walter (2001) in FAO report about NWFP shows that Africa, which has only 16.8% of forest cover worldwide, has been responsible for 56% of the reduction of forest cover between 1990 and 2000. In Africa countries, the edible species are straightly harvested from natural resources (Malaisse, 1997; Belem, 2008). In Burkina Faso, as in other parts of the world, forest resources are purveyors of goods

and services. Populations are deriving their livelihoods, their medication, their energy, their equipment and work income (Belem, 2008). In Burkina Faso, forest resources play a major role in food security, especially in times of welding for poor households (Lamien *et al.*, 1996).

In addition to the food security aspect, the use of forests products covers a large number of areas and they are the subject of commercial transactions at local, national and even international markets level (Zida, 1990; Belem *et al.,* 1997). These products are obtained by collecting or gathering by women in general. For some species as shown by Sina and Belem (2002) the roles are separated and the woman is relegated to the role of transformative.

Face to this situation of human growing pressure on natural resources, the country reacted in creating national parks and forests in the years 1935, whose the classified forest of Toessin and forest of Mare aux Hippopotames. The Mare aux Hippopotames forest became Biosphere reserve in 1986 (Belem 2008).

Our study, according to Taita (2003) and Belem (2008) proposes some objectives to analyze the conservation strategy for non-wood forest products (NWFP).

Specifically, we propose to identify non timber forests products (NTFPS), to assess the consumed parts and analyze their forms of use by the communities, the mode of consumption and the availability of the products. The method used is a compilation of results from many surveys done about spontaneous species in general, and edible species in particular in the riverine villages of Toessin classified forest and Mare aux Hippopotames, biosphere reserve.

The results have shown that the edible species resources are subject to big destruction. This situation and in addition, the intensification of agriculture, then the non-timber forests products harvesting pose a threat for the biodiversity (Belem, 2008). So, developers have to react. Thus, « elaborate a national strategy and an action plan for national actors' capacities building » is necessary. These capacities building aim to attend biodiversity conservation and sustainable utilization for spontaneous species in general and for edible species in particular (Sina and Belem, 2002). This fact is necessary for today agriculture and the future one.

MATERIALS AND METHODS

MATERIALS

Study site

Our investigations took place mainly in the riverine villages of Toessin classified forest and Mare aux Hippopotames, biosphere reserve. Mare aux Hippopotames, biosphere reserve is located between 11°30' and 11°45' N then between 04°05' and 04°12' West longitude at Western South of Burkina Faso. Toessin classified forest is located between 12°45' and 12°47' latitude North then between 2°25' and 2°22' West longitude at Western North of Burkina Faso.

Study villages

The choice of the number of selected villages took account of the total number of riverside villages in each forest (Anonymous, 2003). 4 out of 10 riverside villages were chosen in the mare to hippopotames biosphere reserve (Bala, Bossora, Tierako and Sokourani) and 4 villages (Itian, Mesga, Minissia and Toessin), at the classified forest of Toessin according to their accessibility.

METHODS

Data collection

The method is a compilation of results from many surveys done about spontaneous species in general and edible species in particular (Belem, 1993; Belem *et al.,* 1996a; Belem *et al.*, 1996b; Belem *et al.,* 1997; Belem, 2008; Belem *et al,*, 2010).

Those surveys have been done by participatory rural appraisal method (PRA). This method Permitted to list all the useful spontaneous plants met in the riverine villages of Mare aux

Hippopotames Biosphere Reserve and Plateau Central area where Toessin forest is located. With this first list of 175 useful wild species, we did deep enquiries to show the edible one. For that, focus groups, resource persons have been interviewed to identify edible plants characteristics and to identify the actions made or to make for edible species conservation and protection.

Data analysis

All collected data by interview have been analyzed in Excel 2010. Enquiries data analysis allow to state, the Statute of edible species, the wild edible plants organs, the consumption modes, the availability of organs during the year (dry season or wet season), the Statute of Biodiversity conservation and species evolution, the actual Actions for conservation and protection and the proposed Strategy and action.

RESULTS AND DISCUSSION

Edible species statute

Zongo, (2006) in his investigations about food plants in three ecological regions of Burkina Faso, found 3 statutes for edible plants. He has noted about sixty edible Crops species, Protoculture species stayed in parklands or in homes garden and Spontaneous species that grow spontaneously in nature. This last category of plants is the most met, about one hundred and are harvested for their products (Figure 1).

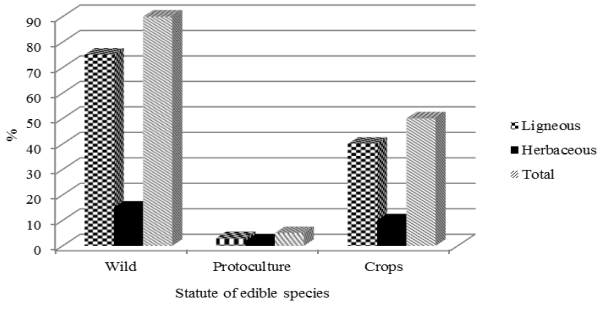

Figure 1. Part of trees and herbs in the edible plants of Burkina Faso.

List of edible species cited

Our previous surveys have noted a total of 175 multipurpose species whose 130 species met in the Biosphere reserve of Mare aux Hippopotames (Belem, 2008), and 45 in the Toessin classified forest (Belem *et al.,* 1997). Among them, 80 species or 46 % are edible plants. Our results are less important than those of Taita (2003) in the central area of the reserve, which has noted 57 food plants representing 78 % of the total of identified plants. Spontaneous edible plants contain Herbs and Trees. Our study noted 56 Ligneous (65 %) as shown in the Table 1 and 24 Herbs (35 %) as shown in the Table 2. This is similar to Zongo (2006) who found 75% of edible wild trees and 25 % of herbs in 3 ecological areas of Burkina Faso.

Spontaneous edible species organs

We noted, like Helmfried (1997) that leaves, roots, stems, flowers, fruits, bulbs, tubers and ash are consumed by populations, either directly or after processing. The 80 identified edible plants are used either raw or in the preparation of sauces, couscous, cakes, like juice drink or like Marmalade.

We noted also that the harvest period varies according to the plants and for the same plant the sought-after parties. For ligneous plants, 59 % are available in dry season, 34 % in wet season and 7 % in all seasons. 92 % of Herbaceous are available in wet season while 8 % are in the dry season. The edible ligneous and herbaceous plants count vegetative and reproductive organs. Vegetative organs of plants are used as food. They are roots, rhizomes, stems and leaves. The reproductive organs are bulbs, tubers, flowers, fruits, grains, almonds and nuts. Reproductive organs intervene more than the vegetative one in food with respectively 75 % and 25 %. This fact shows that edible species are endangers because of problems of renewal (Belem, 2008). Some species have their renewal or reproductive organs which are edible. So a certain competition sets up between species renewal and species consumption. Some protective actions have to be made to avoid the disappearing of species, according to Sina and Belem, (2002).

Table 1. Ligneous food plants.

Species	Family	Eaten parts ¤			Mode of Food	Availability Period
		Le	Fr	Fl		
Acacia macrostachya	Mimosaceae		x		Sauce; Couscous	DS
Adansonia digitata	Bombacaceae	x	x		Sauce, Juice, Boiled	AS
Afzelia africana	Caesalpiniaceae	x			Sauce; Couscous	WS
Annona senegalensis	Annonaceae		x	x	Raw; Sauce	WS
Azadiractha indica	Meliaceae		x		Raw	DS
Balanites aegyptiaca	Balanitaceae	x	x	x	Raw; Sauce Couscous	DS
Bombax costatum	Bombacaceae	x		x	Sauce	DS
Borassus aethiopum	Arecaceae		x		Oil, Sauce	DS
Boscia angustifolia	Capparaceae	x	x		Cake;Couscous	DS
Boscia salicifolia	Capparaceae	x	x		Cake; Couscous	DS
Bosia senegalensis	Capparaceae	x	x		Cake; Couscous	DS
Cadabba farinosa	Capparaceae	x	x		Cake; Couscous	DS
Capparis corymbosa	Capparaceae	x	x		Cake ; Couscous	DS
Celtis integrifolia	Ulmaceae	x			Sauce	DS
Ceiba pentandra	Bombacaceae	x	x		Sauce	DS
Combretum micranthum	Combretaceae	x			Boiled	DS
Crateva religiosa	Capparaceae	x			Sauce	DS
Detarium microcapum	Caesalpiniaceae		x		Raw	DS
Diospyros mespiliformis	Ebenaceae		x		Raw	DS
Elaeis guineensis	Arecaceae		x		Oil, Sauce	WS
Ficus capensis	Moraceae		x		Sauce	DS
Ficus ingens	Moraceae		x		Sauce	DS
Ficus sycomorus	Moraceae		x		Raw	DS
Gardenia erubescens	Rubiaceae		x		Raw	DS
Gardenia sokotensis	Rubiaceae		x		Raw	DS
Gardenia ternifolia	Rubiaceae		x		Raw	DS
Grewia bicolor	Tiliaceae		x	x	Raw	DS
Grewia cissoides	Tiliaceae		x		Raw	DS
Lannea acida	Anacardiaceae		x		Raw	WS
Lannea kerstingii	Anacardiaceae		x		Raw	WS
Lannea microcapa	Anacardiaceae		x		Raw	WS
Lannea velutina	Anacardiaceae		x		Raw	WS
Leptadenia hastata	Asclepiadaceae	x			Sauce, Couscous	WS
Maerua angolensis	Capparaceae	x			Couscous	DS
Maerua angolensis	Capparaceae	x			Couscous	DS
Maerua crassifolia	Capparaceae	x			Couscous	DS
Moringa oleifera	Moringaceae	x	x		Sauce, Couscous	AS
Parinari curatelifolia	Chrysobalanaceae	X	x		Sauce	DS
Parkia biglobosa	Mimosaceae		x		Cake, Boiled	WS
Piliostigma reticulatum	Caesalpiniaceae	x			Juice	WS
Piliostigma thonningii	Caesalpiniaceae	x			Juice	WS
Pterocarpus lucens	Fabaceae	x			Sauce	WS
Pterocarpus santalinoides	Fabaceae	x			Sauce	WS
Saba florida	Apocynaceae		x		Juice, Sucettes	WS
Saba senegalensis	Apocynaceae		x		Juice, Sucettes	WS
Sclerocarya birrea	Anacardiaceae		x		Juice; Raw	DS
Spondias mombin	Anacardiaceae	x			Raw	WS
Strychnos innocua	Loganiaceae	x			Couscous	WS
Strychnos spinosa	Loganiaceae	x			Couscous	WS
Tamarindus indica	Caesalpiniaceae	x	x		Juice, boiled	DS
Vernonia amygdalina	Asteraceae	x			Couscous	AS
Vitellaria paradoxa	Sapotaceae		x		Raw; Butter	WS
Vitex chrysocarpa	Verbenaceae		x		Raw	DS
Vitex diversifolia	Verbenaceae	x	x		Sauce; Raw	DS
Vitex doniana	Verbenaceae	x	x		Sauce; Raw	DS
Ximenia americana	Olacaceae		x		Sucettes	DS
Ziziphus mauritiana	Rhamnaceae		x		Sucettes, Cake	DS

¤ Eaten parts: Le = Leaves; Fr = Fruits; Fl = Flowers; B = Bulb; Availability: WS = Wet season; DS = Dry season; AS = All season.

Table 2. Herbaceous edible plants.

Species	Family	Eaten parts ¤			Mode of Food	Availability Period
		Le	Fr	Fl		
Aeschynomene indica	Fabaceae	x			Sauce	WS
Amaranthus spinosus	Amaranthaceae	x			Sauce	WS
Amaranthus hybridus	Amaranthaceae	x			Sauce	DS
Brachystelma bengeri	Asclepiadaceae			B	Raw	WS
Cassia tora	Caesalpiniaceae	x			Sauce, Couscous	WS
Celosia trigyna	Amaranthaceae	x			Sauce	WS
Ceratoteca sesamoides	Pedaliaceae	x			Sauce	WS
Chrysanthelleum americanum	Asteraceae	x			Boiled	WS
Cleome ciliata	Pedaliaceae	x			Sauce	WS
Cleome viscosa	Pedaliaceae	x			Sauce	WS
Commelina diffusa	Commelinaceae	x			Sauce	WS
Corchorus olitorius	Tiliaceae	x			Sauce	WS
Evolvulus alsinoides	Convolvulaceae	x			Sauce	WS
Glossonema boveanum	Asclepidaceae	x			Sauce	WS
Hibiscus asper	Malvaceae	x			Sauce	WS
Hibiscus cannabinus	Malvaceae	x			Sauce	WS
Ipomoea aquatica	Convolvulaceae	x			Sauce	WS
Ipomoea eriocarpa	Convolvulaceae	x			Sauce	WS
Lippia chevalieri	Verbenaceae	x			Boiled	DS
Lippia multiflora	Verbenaceae	x			Boiled	DS
Nymphea lotus	Nympheaceae		x		Raw	WS
Oryza barthii	Poaceae		x		Raw	WS
Tacca leonpetalus	Taccaceae			B	Couscous	WS
Urginea altissima	Liliaceae			B	Raw	WS

¤ Eaten parts: Le = Leaves; Fr = Fruits; Fl = Flowers; B = Bulb; Availability: WS = Wet season; DS = Dry season; AS = All season.

Harvest impact on ligneous species biodiversity

Species are rather used commonly by the majority of the population of the region for food or for commercial interest and because source of income (Zida, 1990; Belem *et al.*, 1996b; Lamien and Bayala, 1996) *Adansonia digitata* (leaves and fruits), *Detarium microcarpum* (fruits), *Lannea microcarpa* (fruits), *Parkia biglobosa* (grains, fruits), *Saba senegalensis* (fruits), *Sclerocarya birrea* (almund), *Tamarindus indica* (feuilles, fruits), *Vitellaria paradoxa* (fruits, butter). Due to their resemblance certain species are used to prepare the same kind of sauce. (Helmfrid, 1997). It is the case of *Corchorus* and *Hibiscus* species. Certain species are just used during hunger period: They are *Dioscorea dumetorum* and *Ipomoea eriocarpa* and certain fruits no consumed ordinary like fruits of *Lannea velutina*, *Cola cordifolia* and *Ficus* spp.

Most of the fruity species are relegate to wild category and are brought to home for children. They are *Gardenia erubescens*, *Diospyros mespiliformis*, *Annona senegalensis*, *Adansonia digitata* and *Ziziphus mauritiana*. *Ziziphus mauritiana* has been improved by greffage, allowing it to give bigger fruits with more pulp and more interesting nutritional characters. Through these observations, we think that many wild species can be improve and domesticated. It is the case of species producing pulp that can be used to make cake, juice and syrup.

According to Belem *et al.* (1996b) one of the ways to combat food insecurity could be the use of the forest food plants that may contribute to food self-sufficiency. The intensive activity period is, in one way, during May and June, at the end of dry season and the beginning of the wet season. At this period, most of the trees are flowering or budding and wear young leaves and stems, and in the second way in September and November, where herbaceous species are in maturity. Wild edible species harvesting have negative impacts. Impacts give a certain status to trees. Three Status have been described by Guigma (2012), Sina and Belem (2002), Belem *et al*. (1997), Lamien and Bayala (1996).

Figure 2. Example of edible fruits.

Figure 3. Example of edible flowers and grains.

There are the surexploited species, the endangerous species and the vulnerable species.

In our plant list we met these three categories of plants as following:

The Surexploited species*:* In this category, plants are intensively harvested by their grains, flowers, roots or fruits for food and also for medicine. We noted: *Parkia biglobosa*, *Annona senegalensis, Sarcocephallus latifolia, Vitex doniana.*

Figure 4. Example of edible leaves.

The Endangerous species*:* In this category, plants are intensively harvested for their food, but also for craft, fodder and medicine. So species become more and more scarter. We can note: *Afzelia africana, Boscia senegalensis, Pterocarpus lucens*.

The Vulnerable species: *Adansonia digitata, Bombax costatum, Vittelaria paradoxa, Detarium microcarpum, Lannea microcarpa, Sclerocarya birrea, Spondias mombin, Saba senegalensis, Tamarindus indica.* All these species have big importance in food and are sources of income, even at national and international levels. This fact makes them vulnerable.

Strategy for protection and conservation of edible biodiversity the statute of biodiversity conservation and evolution

The overexploitation of the vegetative organs (roots, leaves, bark, wood) cause physiological disorders and lower productivity. We agree with Taita, (2003) to recognize that the use of seeds and

flowers is a threat for species whose regeneration is done by seeds. As a result, all species to various uses and high indices of use deserve particular looks in spontaneous species management strategies (Belem, 2008). The actual actions for conservation and protection of wild edible species are defined in the Table 3. The ministries structures as research centers and institutes and NGOs involved in the biodiversity protection are noted.

Table 3. The actual national actions for biodiversity conservation and protection (Zongo, 2006).

Ministries	Structures
Ministry of Scientific Research	CNRST/ INERA/DPF
	CNRST/ INERA/DPV
	CNRST/ DTA
	UO/SH
	UO/SVT
Ministry of Environment and Forestry	DRECV
	CNSF
	ENEF
Ministry of Health	Direction of Nutrition
NGOS, National and international level	Tree aid
	CEAS-BF
	Naturama
	Ga Mo Wigna
	AFRS
	ABF
	Catholic Women Association of Banfora
	FONGDJA

The proposed strategy and actions

For the wild edible species management strategies, according to Belem (2008), governments have to identify first the constraints, the applied strategy with its objectives, the approach to be used and the actions to be taken.

The constraints: The three constraints identified are: the big interest for crops species, the lack of money and the climate.

The strategy: The global goal is to insure the conservation and sustainable utilization of edible wild species for human food. Specific objectives are:

i) identify and know edible wild species for human food,

ii) insure the protection and the conservation of edible wild species important for human food,

iii) insure sustainable utilization of edible wild species for human food.

The approach: It comprises 3 steps as protection of patrimony, knowledge of the resource and the sustainable utilization of biologic resources.

The actions: The different actions to improve and to have a sustainable management of wild edible species are described in the Table 4. After our surveys, we propose two important actions according to the food species sustainable management and their exploitation.

Table 4. Summary of actions for improvement and sustainable management of wild edible species (Zongo, 2006).

Actions topics	Actions
Affirmation of plant protection interest	Organization Financial and technical Means setting
Actions for the knowledge of plant genetic resources	Surveys Prospection, vouchers collection Genetic studies ; Plants Domestication Seeds Bank (cryoconservation and in vitro trials) Biochemical studies Agronomic studies Physiologic and ecology studies
Actions for the plant resources protection and conservation	Fight against desertification Protection against anarchic harvest Protection against genetic erosion Enhancing the protection Sensibilization of populations Priorisation Arboretum and botanic gardens
Actions for a sustainable utilization	Transformation and storage Commercialization Domestication Genetic improvement

Management of wild edible species

Due to the diversity of wild edible species, an important effort has to be done for their valorization and rational management to reach a food security. Management supposes the identification

of constraints and solutions searching. The much appreciated species as *Adansonia digitata*, *Bombax costatum*, *Parkia biglobosa*, *Tamarindus indica* and *Vitellaria paradoxa* are subject to mutilations, compromising their renewal. Parasitic attacks and bush fires also compromise the production cycle and the regeneration of some species. In general, it is to take care of the mode of spontaneous plants harvesting because it can be a cause of depletion of natural flora.

Improving the exploitation of wild edible species

It is desirable to use better methods of plants harvesting. A regular and rational utilization of wild edible species have an opportunity to reduce our dependence to crops plants. This has the other opportunity to fight the low agricultural yields, being then a form of an adaptation to climate change.

RECOMMANDATIONS

- Give more attention and interest to food species to enable them to play their role as a dietary supplement and as a source of income.
- A special place must be reserved to the structures and peasants associations, associations of women and other rural organizations in any national strategy of development of food species.
- A special attention must be given to the actions needed to ensure the production, processing, packaging, conservation, marketing and distribution of food species.
- A call must be made to all the skills available on the territory: private structures of the State, farming structures, NGOs, laboratories, offices, etc.
- Establish priorities at all levels, based on the national interest after the identification a comprehensive food species.

CONCLUSION

Through this study, we found that the use of forest plants contributes:

i) to the satisfaction of food needs
ii) to the variation of the meals and
iii) to supplement the food ration in times of famine.

Indeed the 80 food species identified show how plants contribute to diversification and to the improvement of the daily rations in rural areas. The study found that plants from picking provide non-wood products that are consumed by people or marketed in the transformed status or not. Usually gathered non timber forest products are eaten on-site (fruits), after firing (flowers, leaves, tubers) or after a long series of transformations. They are exploited by the women and especially children. The role played by women in the development of these products is essential in the process of exploitation of plant resources. Plants bring life substances (carbohydrates, proteins, lipids, vitamins etc.). This qualitative contribution helps to ensure nutritional balance of the man. Due to the diversity of food plants, an effort must be made in the direction of their development and their rational management in order to achieve greater food security. Management requires the identification of constraints and the search for solutions: such popular species *Adansonia digitata, Bombax costatum, Parkia biglobosa, Tamarindus indica* and *Vitellaria paradoxa* are often the subject of mutilation during the harvest of bark, leaves, fruit or flowers, which compromise their regeneration. Parasitic attacks and bush fires also compromise the production cycle and the regeneration of some species. In general, it is to take care of the mode of collection of spontaneous plant because picking can be a cause of depletion of natural flora. Improving the exploitation of these species is therefore desirable.

REFERENCES

Anonymous. 2003. l'Institut National de la Statistique et de la Démographie (INSD). http://www.insd.bf/n/.

Belem, O. M . 1993. Contribution à l'étude de la flore et de la Végétation de la forêt classée de Toessin, Province du Passoré. Thèse de Doctorat de 3è cycle, en Ecologie Tropicale option Botanique, Université de Ouagadougou, B. F.

Belem O. M., O. Bognounou, M. C. Sorgho. 1996a. La jachère et son utilité dans le Bazèga : cas de Tanghin et de Bazoulé Burkina Faso. *In:* Proceedings of La Jachère, Lieu de Production ".

Belem, O. M., O. Bougnounou, S. J. Ouédraogo, and A. A. et Maiga. 1996b. Les ligneux à usages multiples dans les jachères et les champs du Plateau Central du Burkina Faso. In Biodiversité, Friches et jachères. Journal d'Agric. Trad. et de Bota. Appl. 38 (1): 251-272.

Belem, O. M., L. Aké Assi, and S. Guinko S. 1997. Exploitation et utilisation des végétaux de la forêt classée de Toessin, province Passoré, Burkina Faso, Science et Technique, Sciences naturelles vol 23: 80-92.

Belem, O. M. 2008. Les galeries forestières de la Réserve de la Biosphère de la Mare aux Hippopotames du Burkina Faso : caractéristiques, dynamique et ethnobotanique, Thèse de doctorat d'Etat es Sciences Nat, soutenue le 10 Juin 2008, Ouagadougou, Burkina Faso. 282p.

Belem, O. M., J. Yameogo, and S. Guinko. 2010. Les ligneux alimentaires des galeries forestières de la réserve de Biosphère de la Mare aux Hippopotames, Burkina Faso, Fruit, Vegetable and cereal Scienceand biotechnoloy 4 (special issue 1): 10-17, © Global Science Book.

Guigma, Y. 2012. Utilisation des espèces spontanées dans trois villages contigus du Sud du Burkina Faso. Tropicultura 30 (4): 230-235.

Helmfrid, S. 1997. La cueillette féminine dans l'économie familiale. Exemple d'un village cotonnier burkinabé, Rapport de recherche dans le cadre du projet Recherche sur l'amélioration et la gestion de la jachère en Afrique de l'Ouest, ORSTOM Bobo-Dioulasso, 47p.

Lamien, N., and J. Bayala. 1996. Rôle social et économique de l'arbre dans le milieu rural: aspect utilisation et commercialisation de quelques produits forestiers non ligneux dans l'ouest du Burkina. Ouagadougou. Rapport de recherche, INERA, Burkina Faso. 28 pages.

Lamien, N., A. Sidibe, and J. Bayala. 1996. Use and commercialization of non-timber forest products in Western Burkina Faso. Communication for International Conference on Domestication and commercialization of non-products in the agroforestry systems. February 19-23 1996, Kenya. INERA/RSP West Zone Bobo-Dioulasso. Burkina Faso.

Malaisse, F. 1997. Se nourrir en forêt claire africaine: approche écologique et nutritionnelle. Les presses Agronomiques de Gembloux. CTA. 384 pages.

Sina, S., and B. Belem. 2002. Les produits forestiers non ligneux au Burkina, Les produits forestiers non ligneux au Burkina Faso: Utilisation et commercialisation-Centre National de Semences Forestières. 21 p.

Taita, P. 2003. Use of woody plants by locals in Mare aux Hippopotames Biosphere Reserve in western Burkina Faso. Biodiversity and Conservation 12: 1205-1217.

Walter, S. 2001. Les produits forestiers non ligneux en Afrique: un aperçu régional et national, *PROJECT GCP/RAF/354/EC* "Sustainable Forest Management Programme in African ACP Countries" FORESTRY DEPARTMEN/FAO, 315 p.

Yameogo, J., S. J. Ouedraogo, J. Bayala, and O. M. Belem. 2010. Potentialités Médicinales et Alimentaires de dix sept espèces ligneuses préférées dans les parcs agroforestiers au sud-Ouest du Burkina Faso, Fruit, Vegetable and cereal Scienceand biotechnoloy 4 (special issue 1), 55-61, © Global Science Book, Indexé.

Zida, D. 1990. Utilisation et Commercialisation des ligneux et des essences forestières locales dans le département de Yako, Province du Passoré. Mémoire ISN/IDR. Université de Ouagadougou. 120 p.

Zongo, J. D. 2006. Stratégie nationale et un plan d'action en matière de renforcement des capacités nationales pour la conservation et l'utilisation durable de la diversité biologique végétale, importante pour l'agriculture d'aujourd'hui et du futur.rapport de consultation CONEDD, 65 p.

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Economically Important Wild Mushroom Saffron Milk Cap [Lactarius deliciosus (L.) Gray] of Aegean Region, Turkey

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ABSTRACT: *The edible wild mushrooms have an economic value throughout the world. The world market for wild mushrooms was valued at US$ 3-5 billion. In Turkey, about 40 wild mushroom species are used for home consumption and 25 of them are used for sale. Saffron milk cap (**Lactarius deliciosus** (L.) Gray) is among one of the well-known wild mushroom specie due to its intensive consumption and trade especially Aegean Region of Turkey. The aim of this study was to evaluate ethnobotany, socio-economic and nutritional value of **Lactarius deliciosus** (L.) Gray. According to our results, **L. deliciosus** is valuable for folk of Aegean Region as a low priced and easily accessible food source and as a source of income. Food composition results showed that **L. deliciosus** is rich in Vitamin B, minerals and dietary fibre. The antioxidant activity values of saffron milk caps were determined as 9.9 1/IC50 according to the DPPH (1,1-diphenyl-2-picrylhydrazyl radical scavenging effect) method and 46.4 µM trolox equivalent /g sample according to the TEAC (Trolox Equivalent Antioxidant Capacity/ABTS) method.*

Keywords: Lactarius deliciosus*, saffron milk cap, etnobotany, socioeconomy, nutritional value, antioxidants.*

Türkiye - Ege Bölgesi'nde Ekonomik Öneme Sahip Yabani Çıntar Mantarı [Lactarius deliciosus (L.) Gray]

ÖZ: *Yenilebilir doğa mantarları dünya genelinde ekonomik değere sahiptir. Dünya pazarında doğa mantarlarının değeri 3-5 milyar ABD dolarıdır. Türkiye'de 40 kadar doğa mantarı ev tüketiminde ve bunların 25'i satış için kullanılmaktadır. Çıntar mantarı (**Lactarius deliciosus** (L.) Gray) yoğun tüketimi ve ticarete konu olması nedenleriyle Türkiye'de özellikle Ege Bölgesinde en bilinen doğa mantarları arasında yer almaktadır. Bu çalışmanın amacı **Lactarius deliciosus** (L.) Gray 'in etnobotanik, sosyo-ekonomik, besin ve antioksidan değerlerinin değerlendirilmesidir. Çalışmamızın sonuçlarına göre; Ege Bölgesindeki yerel halk için çıntar mantarı düşük ve kolay ulaşılabilir bir gıda kaynağı ile gelir kaynağı olmasıyla önemlidir. Gıda kompozisyon analiz sonuçlarına gore **L. deliciosus** Vitamin B, mineral ve lif içeriği açısından zengindir. Çıntar mantarının antioksidant değerleri DPPH (1,1-difenil-2-pikrilhidrazil radikal süpürme etkisi) yöntemine gore 9.9 1/IC50 ve TEAC (Trolox Eşdeğeri Antioksidan Kapasitesi/ABTS) yöntemine gore 46.4 µM trolox eşdeğeri /g örnek olarak belirlenmiştir.*

Anahtar Sözcükler*: **Lactarius deliciosus**, çıntar, etnobotani, sosyo-ekonomi, besin değeri, antioksidan.*

INTRODUCTION

There are about 14,000-22,000 mushroom species known worldwide. Of these, about 7000 species are considered to possess varying degrees of edibility, and more than 3000 species are regarded as prime edible mushrooms (Chang and Miles, 2004). At present, worldwide usage and consumption of wild edible mushrooms are considerable high. 200-300 mushroom species are gathered from wild or cultivated for their aroma and nutritional and healing properties in the Far East countries such as China, Japan and Korea. The world market for wild mushrooms was valued at US$ 3-5 billion (Jong, 2005; Anonymous, 2009).

2400 mushroom species were recorded (Solak *et al*., 2015) and nearly 300 wild mushroom species are known to be edible in Turkey. Wild edible mushrooms have been part of the human diet in Turkey (Pekşen and Akdeniz, 2012). 40 mushroom species are collected from wild for consumption and nearly 25 of them sold at local or foreign markets. In the past decade, export revenues of wild mushrooms were estimated at US$ 187, 554 million (Adanacioglu *et al*., 2016; Anonymous, 2016). Saffron milk cap mushrooms (*Lactarius* spp.) are very popular with their aroma, taste and nice appearance among commercialized wild mushroom species in Turkey. *Lactarius deliciosus* (L.) Gray is one of the well-known mushroom within *Lactarius* species, due to its intensive collection, consumption and trade from autumn to winter, in the Aegean region of Turkey.

Lactarius deliciosus (L.) Gray is locally known as çıntar, kanlıca, elicek, ebişek, melki, merki, sütlü mantar, çam melkisi, çam mantarı, espir, espit, tirmit and glifoz in Turkey. *Lactarius deliciosus* is member of genus *Lactarius* in the order *Russulales* containing several edible species. *L. deliciosus is an* ectomycorrhizal fungal specie grows in coniferous woodland, particularly under pines. It is easily recognized by the saffron-colored sap it bleeds when damaged, the concentric rings of carrot-coloured blotches on the surface of the cap, and its tendency to turn green with age or after being handled (Anonymous, 2012).

The purpose of this study was to assess ethnobotany, socio-economic, nutritional and antioxidant values of saffron milk cap [*Lactarius deliciosus* (L.) Gray].

MATERIALS AND METHODS

The study was conducted in Izmir, Aydin and Balıkesir provinces of Aegean Region. Aegean Region is situated in the western part of Turkey and Mediterranean Climate is seen.

Questionnaire surveys were carried out for collecting ethnobotanic and socio-economic data by using face-to-face interviews with saffron milk cap mushroom collectors and consumers. Monographic research technique was used in the study. In this technique, data were collected through questionnaire survey, using face-to-face interviews with saffron milk cap mushroom collectors and consumers.

Mushroom samples were taken from local markets for food composition analysis. Identification of the specimen was performed according to literature (Lincoff, 2009). Proximate composition (protein, dietary fibre and carbohydrate) of samples were analyzed according to reference AOAC procedures (Latimer, 2012). Minerals were determined by ICP MS after microwave digestion using NMKL 186 method. The procedure described by Gökmen *et al*. (2000) was used for vitamin C analysis. Thiamin and riboflavin were analyzed by HPLC (Agilent 1260, Agilent Technologies, Santa Clara, CA) with fluorescence detection and Lahely *et al*. (1999) procedure was modified for the determination of niacin.

The antioxidant capacity studies were performed by DPPH (1, 1diphenyl-2-picryl hydrazyl) radical scavenging method and TEAC (Trolox Equivalent Antioxidant Capacity/ABTS Method) were expressed as Trolox equivalents with spectroscopic measurements. These methods were made by the Thermo Scientific™ Multiskan™ GO microplate

reader supplied from the BFN Project. IC50 values were calculated from the concentration-effect linear regression curve (Cemeroğlu, 2010; Öztürk *et al*., 2011).

RESULTS AND DISCUSSION

In this presented study, 41 collector and 77 consumer questionnaires were finalized. According to our results *L. deliciosus is* important for two main reasons for the local people of region: as a low priced and easily accessible food source and as a source of income.

As given in Table 1, in the region, while most of the collected *L. deliciosus* is marketed (80 %), the rest is used for household consumption (10.4 %) and distributed to neighbor-relatives (9.3 %). Only very few amount of collected mushrooms are used for animal feed (1 %).

According to De Frutos *et al*. (2008), the most popular distribution channels for wild edible mushrooms are, direct sales, intermediaries, or sales to mushroom industries. Our results indicated that direct marketing channels are mainly preferred by saffron milk cap collectors. 59 % of collectors preferred to sell their gathered saffron milk caps directly to consumers at local markets and 41% of them sell their saffron milk caps to trader at local market (Table 2). The local market price for saffron milk cap was determined as 5-10 TL/kg and their retail price was recorded as 1.25-1.50 TL/kg in 2014.

Saffron milk cap consumption frequency is high in the Aegean Region. According to saffron milk cap vegetation periods, 39 % of consumers are consumed saffron milk cap mushroom 1-2 times per week and, 37 % of them are consumed 3-4 times per week (Fig.1). It is determined that saffron milk cap consumption amount per households is 17.8 kg and consumption amount per capita is 5.7 kg/year.

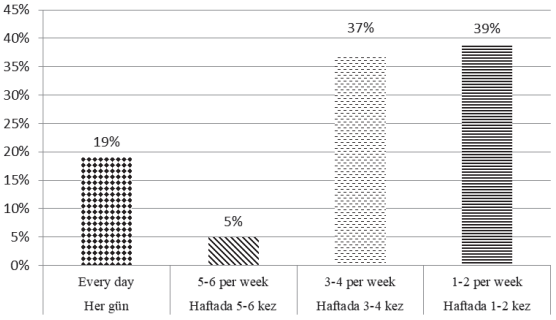

Figure 1. Consumption frequency of saffron milk cap of Aegean Region (%).

Şekil 1. Ege Bölgesi'nde çıntar mantarının tüketim sıklığı (%).

Table 1. Using pattern of saffron milk cap collected from Aegean Region.
Çizelge 1. Ege Bölgesi'nden toplanan çıntar mantarının tasarruf şekillerine göre dağılımı.

Mushroom name Mantar adı	Household consumption (%) Ev tüketimi (%)	Distributed to neighbors/ relatives (%) Komşu-akrabaya dağıtılan (%)	Used for animal feed (%) Hayvan beslemede kullanılan (%)	Marketed (%) Pazarlanan (%)	Amount collected (kg) Toplanan miktar (kg)
Saffron milk cap Çıntar	10.4	9.3	0.1	80.2	7024

Table 2. The saffron milk cap marketing status of collectors in Aegean Region.
Çizelge 2. Ege Bölgesi'nde toplayıcıların çıntar mantarını pazarlama şekilleri.

Mushroom name Mantar adı	Average distance to market (km) Pazara ortalama uzaklık (km)	Proportion of selling to Consumers at local market (%) Yerel pazarda tüketiciye satış yapanların oranı (%)	Proportion of selling to Trader at local market (%) Yerel pazarda tüccara satış yapanların oranı (%)	Proportion of selling to trader at village (%) Köyde tüccara satış yapanların oranı (%)
Saffron milk cap Çıntar	27	59.0	41.0	0

Saffron milk cap is frequently used in various dishes in the studied areas mainly in the autumn and winter, freshly after collection. Pickling, canning, and drying techniques used by local people make this mushroom consumed the whole year. Saffron milk cap is eaten as fried, roasted, meatballs, scrambled eggs and pies. It is used in rice pilaf and soups.

L. deliciosus is often used as food in the Aegean Region therefore proximate composition and mineral contents of saffron milk cap were determined and given in Table 3 and Table 4, respectively.

It is reported that chemical composition of mushrooms depends on composition of substratum, size of pileus, harvest time, and species of mushroom (Bernas *et al*., 2006; Pushpa and Purusphothama, 2010; Onbasili *et al*., 2015). Protein content of mushrooms varies between 0.8 g/100 g-1 fresh matter, ie. 7.6 g/ 100 g-1 dry matter (Bernas *et al*., 2006). It is known that the fat content of mushrooms is low and consumed for low calorie diet (Onbasili *et al*., 2015). In the previous reports, it is possible to see various fat content from 0.8 % to 27.5 % in dry mushrooms (Colak *et al*., 2009).

In general, herein the gross composition of *L. deliciosus* was found as water (91.9 %), protein (0.17 %), fat (0.32 %), carbohydrates (2.86 %), fiber (4.05 %) and ash (0.66 %). Similar results reported for the Portuguese *L. deliciosus* in which moisture content 90.05 ± 0.53, total fat 0.22 ± 0.00, crude protein 2.96 ± 0.04, ash 0.51 ± 0.02 and carbohydrates 6.26 ± 0.15 (g/100 g of fresh weight) were determined (Barros *et al*., 2007). *L. deliciosus* from Kastamonu province of Turkey also studied and moisture, fat, protein, ash and dry matter levels of the mushroom were found as 8.75±0.72, 2.64±0.16, 75.25±0.15, 4.61±0.03, 89.96±0.24% mg/100g (% dry weight) respectively (Onbasili *et al*., 2015).

L. deliciosus was found as a good source of dietary fiber which has important physiological effects on glucose, lipid metabolism and good for intestinal health.

Reis *et al*. (2012) reported that the main constituents in the ash are potassium and, depending on the mushroom, phosphorus (Mattila *et al*., 2001) or magnesium (Manzi *et al*., 1999), in addition to calcium, copper, iron and zinc (Guillamón *et al*., 2010). High potassium content is characteristic of mushrooms (Kalac, 2013). According to our results, K was the most abundant element (215±4 mg/100g fresh weight) in the samples of *L. deliciosus*, it was followed by P (36.6±1.2 mg/100g fresh weight). *L. deliciosus* was also found rich in Mg, Ca and Fe, 10.6±0.1; 3.4±0,3; 2.5±0.6; mg/100g fresh weight, respectively.

Mushrooms are important source of vitamins; especially Vitamin group B is abundant (Breene, 1990; Wani *et al*., 2010). Similar results were obtained from this study. Our findings showed that saffron milk cap is also rich in Vitamin group B (Table 5).

Ozturk *et al*. (2014) determined that the DPPH activity of *L. deliciosus* was 6.43 mg/ml and Onbaşili *et al*. (2015) showed that DPPH scavenging activity of *L. deliciosus* methanolic extract was found to be IC50: ›17. Herein the antioxidant activity values of *L. deliciosus* was determined as 9.9 1/IC50 according to the DPPH (1,1-diphenyl-2-picrylhydrazyl radical scavenging effect) method and 46.4 µM trolox equivalent /g sample according to the TEAC (Trolox Equivalent Antioxidant Capacity/ABTS) method. The results of *L. deliciosus* were compared to the results of the Butylated hydroxyl toluene (BHT) which is a reference synthetic antioxidant compound and available commercially (Table 6).

If the results of the two methods are compared, the antioxidant activity results have parallels. These results show that saffron milk cap has quite low antioxidant activity with regards to methods which used in this study.

Table 3. Proximate chemical composition of saffron milk cap (*L. deliciosus*).
Çizelge 3. Çıntar mantarının (*L. deliciosus*) yaklaşık besin bileşimi.

Species name Tür adı	Moisture Nem (g/100g)	Fat Yağ (g/100g)	Protein Protein (g/100g)	Carbohydrate Karbonhidrat (g/100g)	Ash Kül (g/100g)	Dietary fiber Diyet lifi (g/100g)	Energy Enerji (kcal/100g)
L. deliciosus	91.9±0.4	0.32±0.04	0.17±0.01	2.86±0.47	0.66±0.01	4.05±0.09	23.1±2.0

Table 4. Mineral contents of saffron milk cap (*L. deliciosus*) (mg/100g fresh weight).
Çizelge 4. Çıntar mantarı (*L. deliciosus*)'un mineral içeriği (mg/100g taze ağırlık).

Species name Tür adı	Ca	Fe	Mg	P	Zn	K	Na	Cu
L. deliciosus	3.4±0,3	2.5±0.6	10.6±0.1	36.6±1.2	0.57±0.03	215±4	3.9±0.1	0.06±0.01

Table 5. Vitamin content of saffron milk cap (*L. deliciosus).*
Çizelge 5. Çıntar mantarı (*L. deliciosus*)'un vitamin içeriği.

Species name Tür Adı	Vit C (mg/100g)	Thiamin (mg/100g)	Riboflavin (mg/100g)	Niacin (mg/100g)	Alpha-tocopherol (mg/100g)
L. deliciosus	nd	0.22±0.01	0.33±0.04	1.23±0.11	5.38±0.29

nd: Not detected.

Table 6. The antioxidant activity values of saffron milk cap (*L. deliciosus).*
Çizelge 6. Çıntar mantarı (*L. deliciosus*)'un antioksidan aktivite değerleri.

Species name Tür adı	1/IC50* (DPPH)	STD	µM trolox equivalent / g sample (TEAC) µM trolox eşdeğeri / g örnek (TEAC)	STD
L. deliciosus	9.9	0.4	46.4	0.4
BHT**	2101.2	277.1	16651.9	59.0

*the reverse of the dry plant value in terms of mg which inhibits 50% of the 1g DPPH radical.
**Butylated hydroxyl toluene.

CONCLUSION

The majority of collected saffron milk cap is sold at local markets by family members who gathered it in the region. Thus, the income from saffron milk cap is an important source to Aegean Region people.

Based on our findings, saffron milk cap has quite low antioxidant activity but it is rich in vitamin B, minerals and dietary fiber. When we consider the consumption frequency of saffron milk cap is high, this mushroom can serve as a valuable food source for folk of Aegean Region.

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REFERENCES

Adanacioglu N., U. Yildiz, E. Ogur, L. Aykas, A. Tan, and T. Taylan. 2016. Türkiye Makromantar Genetik Kaynakları I. Ege Bölgesi. Anadolu, J. of AARI 26 (1): 46-61.

Anonymous. 2009. Mushrooms. Calu crop production guides. http://www.calu.bangor.ac.uk/.

Anonymous. 2012. Saffron milk cap (*Lactarius deliciosus*). http://www.trufflesandmushrooms.co.nz/ Lactariu s%20 deliciosus %20web.pdf.

Anonymous. 2016. Türkiye İstatistik Kurumu. www.tuik.gov.tr/.

Barros L, P. Baptista, D. M. Correia, S. Casal, B. Oliveira, I. C.F.R. Ferreira. 2007. Fatty acid and sugar compositions, and nutritional value of five wild edible mushrooms from Northeast Portugal. Food Chemistry 105: 140-145.

Bernas E., G. Jaworska, Z. Lisiewska. 2006. Edible Mushrooms as a source of Valuable Nutritive Constituents. Acta Sci. Pol. Tech. Aliment 5 (1): 5-20.

Breene W. M. 1990. Nutritional and medicinal value of specialty mushrooms. J. Food Prod. 53 (10): 883–894.

Cemeroğlu, B. 2010. Gıda analizleri (Food Analysis). Nobel Yayın Dağıtım, Ankara, 682 p.

Chang S. T., and P. G. Miles. 2004. Mushrooms Cultivation, Nutritional Value, Medicinal Effect, and Environmental Impact. 2nd edition. 477 pp. CRC press US.

Colak, A., Faiz, Ö., Sesli, E., 2009. Nutritional Composition of some wild edible mushrooms. Türk Biyokimya Dergisi-Turkish J. of Biochemistry 34 (1): 25-31.

De Frutos, P., Martínez Pena, F., Esteban Laleona, S., 2008. Propuesta de ordenación comercial de los aprovechamientos micológicos a través de lonjas agrarias: análisis económico y financiero para la provincia de Soria. Revista Espanola de Estudios Agrosociales y Pesqueros 217: 73–103.

Gökmen V, N., Kahraman, N., Demir, J. Acar. 2000. Enzymatically validated liquid chromatographic method for the determination of ascorbic and dehydroascorbic acids in fruit and vegetables. J Chromatogr A 881: 309-316.

Guillamón, E., A. García-Lafuente, M. Lozano, M., D´Arrigo, M.A. Rostagno, A. Villares, J.A. Martínez. 2010. Edible mushrooms: Role in the prevention of cardiovascular diseases. Fitoterapia 81: 715-723.

Jong, S. C. 2005. The Market Potential for Medicinal Mushrooms. www.mushworld. com.

Kalac, P. 2013. A review of chemical composition and nutritional value of wild-growing and cultivated mushrooms. J. Sci. Food Agric. 93 (2): 209-218. Doi: 10.1002/jsfa.5960. Epub 2012 Nov 21.

Lahely S, M, Bergaentzle, C., and Hasselmann. 1999. Fluorimetric determination of niacin in foods by high-performance liquid chromatography with post-column derivatization. Food Chem. 65: 129-133.

Latimer G.W. 2012. Official Methods of Analysis of AOAC International. AOAC International.

Lincoff, G.H. 2009. Field guide to mushrooms. Knopf, Boroi Books, Chanticleer Press, Inc., New York. 926 p.

Manzi, P., L. Gambelli, S. Marconi, V. Vivanti, L. Pizzoferrato. 1999. Nutrients in edible mushrooms: An interspecies comparative study. Food Chem. 65: 477-482.

Mattila, P., K. Könkö, M. Eurola, J.-M. Pihlava, J. Astola, L.Vahteristo, V. Hietaniemi, J. Kumpulainen, M. Valtonen, V. Piironen. 2001. Contents of vitamins, mineral elements, and some phenolic compounds in cultivated mushrooms. J. Agric. Food Chem. 49: 2343-2348.

Onbasili, D., G. Yuvali Çelik, H. Katircioğlu , İ. Narin. 2015. Antimicrobial, Antioxidant Activities and Chemical Composition of *Lactarius deliciosus* (L.) Collected from Kastamonu Province of Turkey. Kastamonu Üni., Orman Fakültesi Dergisi 15 (1): 98-103.

Ozturk M., M. E. Duru, Ş. Kivrak, N. Mercan-Doğan, A. Türkoğlu and M.A. Özler. 2011. *In vitro* antioxidant, anticholinesterase and antimicrobial activity studies on three *Agaricus* species with fatty acid compositions and iron contents: A comparative study on the three most edible mushrooms, Food Chem Toxicol. 49: 1353-1360.

Ozturk, M., G., Tel, F. A., Öztürk, M. E., Duru. 2014. The cooking effect on two edible mushrooms in Anatolia: Fatty acid composition, total bioactive compounds, antioxidant and anticholinesterase activities. Rec. Nat. Prod. 8 (2): 189-194.

Pekşen, A., and H. Akdeniz. 2012. Organik Ürün Olarak Doğa Mantarları. Ormancılık dergisi. 8: 34-40. http://www. of.duzce.edu.tr.

Pushpa, H. and K. B. Purushothoma. 2010. Nutritional Analysis of Wild and Cultivated Edible Medicinal Mushrooms. World Journal of Diary and Food Sciences 5: 140-144.

Reis, FS, L., Barros, A., Martins , IC, Ferreira.2012. Chemical composition and nutritional value of the most widely appreciated cultivated mushrooms: an inter-species comparative study. Food Chem Toxicol. 50 (2): 191-7.

Solak, M. H., M. Işıloğlu, E. Kalmış, H. Allı. 2015. Macrofungi of Turkey, Checklist Volume II, Üniversiteliler Ofset, Bornova, İzmir.

Wani, B. A., R. H. Bodha and A. H. Wani. 2010. Nutritional and medicinal importance of mushrooms. Journal of Medicinal Plants Research Vol. 4 (24): 2598 - 2604.

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Characterization, Nutritional Value and Consumption Habit of Wild Mushroom in Tigray, Northern Ethiopia

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ABSTRACT: *Wild mushroom has been abundant and the consumption habit of mushrooms by local people has long history in northern Ethiopia though decreased with the prevailing degradation. The paper assessed the phenotypic species diversity, nutritional value and farmer's perception on consumption habit of wild mushrooms. Fifteen 1000 m^2 plots were established to analyze the phenotypic species diversity and nutritional value from four different micro habitats. Managed grassland encompassed greater mushroom species diversity. A total of 1.189 individual mushrooms belonging to two genera and eleven species were identified. Most mushroom species preferred open to slightly open canopy cover. The moisture, protein, carbohydrate, fat, ash, fiber and phosphorus content of mushrooms ranged from 81.8-87.9%, 23.4-37.2%, 32.4-43.9%, 1.9-4.4%, 14.9-19.6%, 12.3-18.1%, 0.6-0.9% respectively. There were significant difference in moisture, protein and carbohydrate contents between mushroom species ($P<0.05$). About 96% of the respondents had awareness about mushroom consumption. 95.3% of the respondents have attested that the current status of edible wild mushroom population decrease in distribution. 40% of the respondents whom were previously consuming mushroom have currently stopped to use it. There is sharp decline in distribution and consumption of mushroom. In order to protect the decreasing status of mushroom, grassland management and mushroom conservation should be promoted and encouraged.*

Keywords: *Wild mushroom, phenotypic species diversity, nutritional value, farmer's perception, Tigray, Ethiopia.*

INTRODUCTION

Mushrooms are the fruiting bodies of macro fungi (Abate, 2008). They include both edible/medicinal and poisonous species; however, originally, the word "mushroom" was used for the edible members of macro fungi and "toadstools" for poisonous ones of the "gill" macro fungi (Moore, 2005). Scientifically the term "toadstool" has no meaning at all and it has been proposed that the term is dropped altogether in order to avoid confusion and the terms edible, medicinal and poisonous mushrooms are used Ogbe and Obeka (2013). Edible mushrooms once called the "food of the Gods" and still treated as a garnish or delicacy can be taken regularly as part of the human diet or be treated as healthy food or as functional food (Cheung, 1996). The extractable products from medicinal mushrooms, designed to supplement the human diet not as regular food, but as the enhancement of health and fitness, can be

classified into the category of dietary supplements/ mushroom nutriceuticals (Chang and Miles, 2004).

It has been estimated that over 70,000 species of fungi are found and of which about 2000 species that belong to 31 genera are regarded as prime edible mushrooms (Moore, 2005). Wild edible fungi are collected for food and to earn money in more than 80 countries (Boa, 2004). The number of poisonous mushrooms is relatively small whereby only about 10% that belong to 30 species are lethal (Moore, 2005). There is undoubtedly high diversity of wild mushroom in Africa (Abate, 1998). However, information about wild edible mushroom is scarce in many countries of the continent.

Fresh mushrooms are frequently collected by local people mainly for own consumption while dried mushrooms are sold at market places and along roadsides (Yokabi *et al*., 2004). Domestic use and better marketing of wild mushrooms could contribute to improve the livelihoods and to reduce the poverty of the local communities (Bloesch and Mbago, 2006). Mushrooms can be used as a meat substitutes when meat becomes very scarce or expensive (Osagualekhor and Okhuoya, 2005). The consumption of mushroom can make a valuable addition to the often unbalanced diets of people in developing countries and they are considered to provide a fair substitute for meat with at least a comparable nutritional value to many vegetables (Marshall and Nair, 2009). Edible mushrooms provide high quality protein that can be produced with greater biological efficiency than animal protein, rich in fiber, minerals and vitamins and have low fat content, with high proportion of polyunsaturated fatty acids relative to total content of fatty acids (Marshall and Nair, 2009). Indigenous people in different countries have different eating habits and mushroom dish preparation (Wambua, 2004).

Diversity and distribution of mushroom depends on variety of substrates/hosts, rainfall, temperature. The existing variation in vegetation type and geography makes mushroom diversity to be high in Ethiopia (Abate, 2008). Farmers in Ethiopia have long experience on consumption habit and are able to distinguish between edible and non-edible wild mushrooms (Delelegn *et al*., 2013). Mushroom cultivation is a very recent activity in Ethiopia. Small scale mushroom production presents an opportunity for farmers as an additional work, and is specially an option for farmers with no adequate farm lands (Beetz and Kustudia, 2004).

Mushroom cultivation is seasonal, characterized by the alternation of rainy season, from May/June to September /October part of the year. It mostly grows in the Ethiopian plateau particularly in the southwestern part of the country (Tuno, 2001). In Tigray region particularly in the study area different types of wild mushroom are grown that are not scientifically characterized but known locally as edible and non-edible mushroom with nutritional and medicinal importance (Anonymous, 2013). The study area is characterized by dry climatic conditions and unreliable rainfall. It suffers from chronic food shortages as it lies in a major drought prone area, whose food self-sufficiency prospects are further thwarted by very infertile soils. The study area is one of the 12 chronic food insecure districts of the region. This problem is largely common in low-and middle-income countries which mainly have poor food production system and hence, suffer from serious malnutrition (Olumide, 2007). Such countries must find ways of improving food production so as to feed the ever increasing human population. East African mushrooms are highly treasured by the rural communities as mushrooms start growing soon after the first rains and become very handy and tasty vegetable long before the agricultural crops are ready for harvest (Olila *et al*., 2007). Mushrooms have not given due attention as an important crop that can fetch substantial income to farmers to alleviate poverty (Olumide, 2007). There is lack of mushroom documentation even though the farmers have experiences on picking and consuming of wild mushroom. Therefore, identifying and quantifying of wild mushroom in the study area was important. The objective of this

paper was to study the phenotypic species diversity, nutritional value and farmer's perception on consumption habit of wild mushroom.

MATERIALS AND METHODS

Description of the study area

The study was conducted in Enderta district, south eastern Zone of Tigray, Northern Ethiopia located at 13° 09' and, 14° 34' North and 39° 12' and, 40° 28' East (Fig. 1).

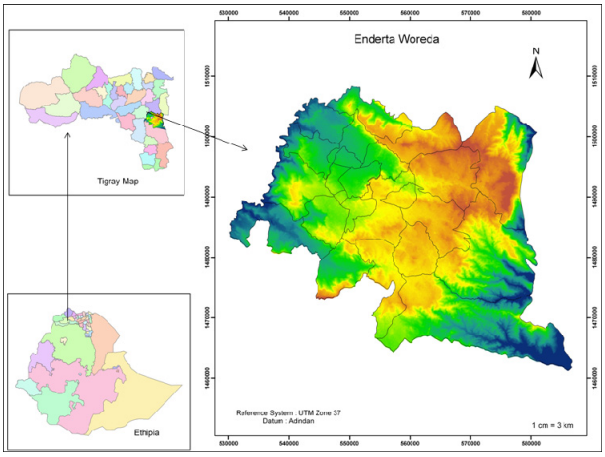

Figure 1. Location maps of the study area.

The area is characterized by erratic rainfall and frequent droughts. The main rainy season lasts from mid-June to first week of September preceded by a less predictable smaller rainy season between March and May (Fig. 2). The minimum and maximum mean annual temperature ranges from 12-15°C to 22-37°C and the average annual rainfall ranges between 390 and 1108.6 mm (Alula-Abanega airport 1959-2012). The subsistence agricultural production is almost entirely dependent on the main rain season (Esteri, 2008). The study area is contained in two major agro climatic zones; where the greater portion (94%) lies in the 'Weyna Dega'(moderate) climatic zone with an elevation range between 1800 m and 2678 m, while a smaller portion (6%) lies in the 'Kolla' (hot) having altitudinal climatic zone ranging between 1500m-1700m (Anonymous, 2010).

The topography comprises several forms from high slope to flat, ragged and deep gorges and gullies. The area was distinguished by cleared forest and now considered as the most degraded and eroded area in the region. The forest cover of the study area accounts for only 1.05% of the regional cover (Anonymous, 2014). The most common soils of the study area are: *Arenosols, Calcisols, Cambisols, Kastanozems, Leptosols, Luvisols, Phaozems, Regosols, Vertisols* and Fluvisols. The Fluvisols are mainly confined to the alluvial deposits along the river valley (Gebrekidan, 2004; Esteri, 2008).

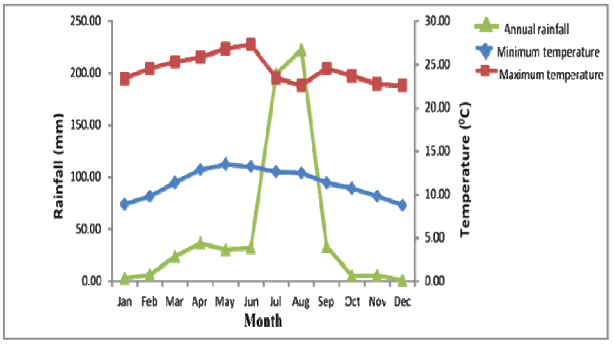

Figure 2. Climatic diagram for the study area.

The type of land use varies with the topography or landform. Most of the hill tops are occupied by the churches and villages while the flat level areas are used for agriculture and urbanization (Esteri, 2008). Agriculture and livestock are the backbone of the economy in the area. The farming system of the study area is mixed crop with livestock farming system. Agriculture is source of subsistence for the majority of the population.

Sampling techniques and experimental design

The sampling unit of the study was plot and household. Three villages namely *May-Alem*, *Mesob*o and *Meseret* were randomly selected from the total villages in the district. Using a proportional simple random sampling technique, 150 households were randomly selected from the three villages for interview to conduct the community perception survey. The sampling was done using a list of all households in the villages that was obtained from the village administrations and development agents to systematically identify respondent households. In addition, 11 key informants composed of elders of male and female, mushroom consumers and extension agents were

involved in Focus Group Discussions (FGD) to collect and triangulate the information on edible and non-edible mushrooms.

Reconnaissance survey was undertaken throughout the district in all villages to identify the best possible site where mushroom can grow. Accordingly, 68 mushroom growing areas that comprise four micro habitats namely; cultivated, woody, managed grazing land (with seasonal control) and unmanaged grazing land were identified. Then five sites from each micro habitat were randomly taken by drawing a lottery and replicated three times to minimize possible errors. Therefore, a total of 60 (4x5x3) sample plots were determined from all micro habitats to acquire data for species diversity, characterization and nutritional analysis of the wild mushrooms. From each of the four micro habitat 15 replication in 5 sites were used as a block to minimize possible error. Sample size was determined to be 1000m^2 (100m*10m) plots with 50m spacing. Because large sample area and strip plot sizes are needed in order to facilitate the search of wild mushrooms.

Data collection

Collection of primary data involved identification of mushroom growing areas and understanding farmers' perception on consumption habit of wild mushrooms. Semi structured questionnaire for individual interview to collect information about; where mushroom grows, factors that influence the growth of mushrooms, current state of mushroom, place of collection, time of growth, consumption pattern, domestication and cultivation of wild mushrooms were involved. Interviews were conducted with the selected farmers under each selected village. The questionnaire was open and closed ended which provide both qualitative and quantitative data. Focus group discussions were conducted to collect data on; the state of wild mushrooms, consumption habit of farmers, the role and variability of edible and inedible wild mushrooms, effect of eating wild mushroom and mitigation measures up on eating poisonous wild mushrooms. Secondary data were collected from district office of Agriculture and Rural Development, to assess the major interventions to promote and conserve wild mushroom.

Canopy cover, fruiting body feature (color, shape, test and size of mushroom) and substrates that potentially host mushrooms were observed and recorded and mushroom species collected from each sample plot. The wild mushrooms found were counted, characterized and collected for nutrient value analysis and species diversity. Slope, coordinate points (using GPS) and soil texture recorded to characterize the habitat where the mushroom grows. The distance where each mushroom grow from the nearby tree recorded to estimate the amount of cover suited for mush room growth. The canopy cover in the plot was estimated as described by Kent and Coker (1996) and categorized as open (0-25%), slightly open (26-50%), slightly closed (51-75%) and closed (76-100%). Mushroom stalk (stem) length, diameter of the cap (pileus) were measured using a graduated ruler and taken for characterization and species diversity. A digital camera was used to capture photograph for each of the identified species. Mushroom specimens and the photographs used to characterize and identify the wild mushroom to a species level using morphological features. Vernacular names of wild mushroom fruit bodies were identified by the local people at the field. Sample species specimens were carefully collected from mushroom growing areas from different locations every morning during the months of July to September. Samples were uprooted by lifting them up holding the stripe gently and firmly very close to the rhizomorph having some soils along with it. This was done to avoid possible damage of tissues. Each specimen was carefully collected and labeled before transporting to town for nutrition analysis and characterization. The specimens were dried in air for 3-14 days. Specimens were stored in transparent polythene bags that were loosely tighten to allow proper aeration. Each of the specimens were properly labeled and sent to Jije Analytical testing service laboratory in Addis Ababa, Ethiopia for nutritional analysis.

Identification of Specimen

The specimens were identified in Mekelle University at the collage of dry land agriculture using the books of fungus (Peter and Shelly, 2011), internet and mushrooms pictures. Farmer's indigenous knowledge was used to complement the identification process.

Chemical analysis

Mushrooms from the different micro habitat were first washed thoroughly to free from mud, ferns and other extraneous material, dried on blotting paper, cut into pieces and dried at 80°C for 48 hours. The whole mushrooms (Pileus + stipe) were dried, grounded to a fine powder and stored under vacuum for further analysis. The moisture content, crude fiber, nitrogen and protein, fat and phosphors contents of the mushroom was determined using the Anonymous (1990) procedure. All nutritional analysis was done in triplicates.

Data Analysis

Phenotypic diversity of wild mushroom was analyzed using conventional method which were matching photograph picture during field observation with world fungus book, diagnostic structures such as visual characteristics, habitat and smell and test of wild mushrooms that were recorded at field, and internet.

Species diversity were analyzed using the fisher's alpha, Simpson's and Shannon's (H,) diversity indices and Evenness or Equitability (E) to determine mushroom species and diversity in the different micro habitat. Total species richness was also estimated using Chao1 estimate. These calculations were done using PASTsoftware. Nutritional value were analyzed using one-way analysis of variance (ANOVA) followed by Tukey's HSD Test with $\alpha = 0.05$. This analysis was carried out using Minitab 16 statistical software. The survey data were analyzed through descriptive statistics and probit model. The probit model was selected for identifying the determinant factors that influence the consumption habit of mushroom. The dependent variable of the study was a binary. One was assigned for those households who consumed mushroom otherwise given zero. Accordingly, the model is given by following formula:

$$E(Y_i = 1/X_i) = \beta_0 + \sum_{i=1}^{n} \beta_i X_i = \int_{-\infty}^{X_i} \Phi(X)dX = \frac{1}{\sqrt{2\Pi}} \int_{-\infty}^{\infty} e^{-\frac{1}{2}X^2} dX$$

Where, $\Phi(.)$ is the cumulative distribution function of the standard normal distribution. The coefficient of the above model uses to interpret only the direction. For instance, the probability of the farmer to consum mushroom increases with β_i exceeding zero. The coefficient of the probit model doesn't use for analysis and interpretation purposes. The study used the marginal probit model to capture the magnitude of the coefficient, which shows by how many units the response variable increases or decreases with a unit change, from the baseline, in one explanatory variable, keeping other independent variables constant using:

$$\frac{\partial P(Y_i = 1/X_i)}{\partial X_i} = \frac{\partial (Y_i / X_i \beta_i)}{\partial X_i} = \frac{\partial (\beta_0 + \sum_{i=1}^{n} \beta_i X_i)}{\partial X_i}$$

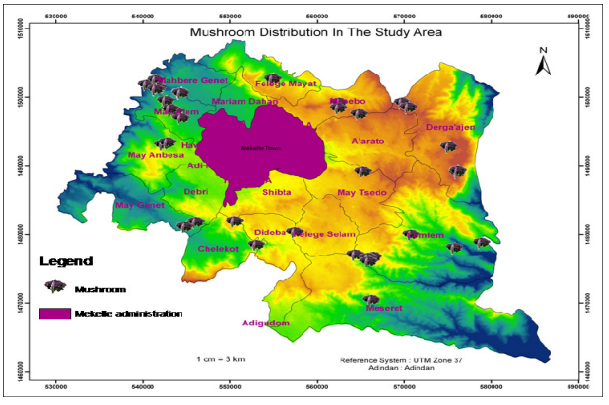

Figure 3: Map of distribution of wild mushroom throughout the study area.

RESULT AND DISCUSSION

Ecology of wild mushroom

Majority of the species identified were distributed in all the study area (Fig. 3). The common species

were *Termitomyces rubustus, Clitocybe gibba, Panaeolus papilionaces* and *Leucoagaricus rubrotinctus. Termitomyces clypealus* was exceptionally found in two study sites namely May-alem and Mahberegenet sites.

Eleven different wild mushroom species were found in the four micro habitat sites. Two species were restricted to one micro habitat site and six species appeared in two micro habitats (Table 1). The highest number of species was found on managed grass land and wood land (Table 1). These land uses were moderately disturbed and provided better growing conditions for the mushrooms. Similar observations were made in Uganda by Engola *et al*., (2007) that they found higher species diversity in managed grass land. Unlike to this finding, other studies in Uganda Opige *et al*., 2006 found more species grown on cultivated land and over grazing land. The rainy season appear to provide more and adequate condition for the fruiting bodies more than the drier parts of the year. This could be due to the fact that mushrooms growth depends on the appropriate rainfall conditions.

Studied mushroms

1. *Termitomyces robustus*

Local name (Tigrigna Language): "*Agule*"

Species name: *Termitomyces robustus*

Family: Lyophyllaceae

Order: Agarics

The species has a remarkable association with certain species of termite. The termite activates the fungi inside their mounds using the mycelium to help breakdown and release nutrients from indigestible woody material. In return, the fungus provided with food resource, is protected from competitors, and actively spread from mound to mound. This species fruit bodies appear in the rainy season commonly from August to September and widely collected by local people for food and mostly abundant on cultivated land and managed grass land.

Basic characteristics and features of the species; Cap: form convex at first, flattening when expanded and when becoming old the cap upward from stem. The surface of cap often irregularly ridged or channeled frequently splitting as it expands and old. The color of the surface of the cap /brown yellow/ocher-brown to dark brown and when it dry changes completely brown dark to dark. Gills: are white to pinkish cream and stems have the color of gills. Mycelium: has 25-30 cm long and a blackish root like base. Cap diameter is 12-32 cm, stem height is 10-24c.m. Edible pleasant taste and small, Stem have not ring, easily perishable and easily spoil after collection.

Table 1. Wild mushroom frequency (number) and occurrence (%) in different micro habitat sites.

Type of species	Frequency (number) and percentage							
	Grazing land		Cultivated land		Wood land		Man aged grazing land	
	No	%	No	%	No	%	No	%
Clitocybe gibba	13	37.1	0	0	8	22.8	14	40.0
Termitomyces robust	1	9.1	6	54.5	0	0	4	36.4
Termitomyces clypealus	0	0	9	81.8	0	0	2	18.2
Panaeolus papilionaces	6	46.2	0	0	4	30.8	3	23.0
Chlorophylluh molybdites	4	30.7	0	0	4	30.7	5	38.6
Phyllotopsis nidulans	0	0	0	0	0	0	1	100.0
Termitomyces microcarpus	0	0	0	0	0	0	1	100.0
Rhizopogon luteolus	2	66.7	0	0	1	33.3	0	0
Russula nigricarns	0	0	0	0	4	80.0	1	20.0
Panaeolina foenisecii	0	0	0	0	4	66.7	2	33.3
Leucoagaricus rubrotinctus	0	0	0	0	5	71.4	2	28.6

2. *Termitomyces clypealus*

Local name (Tigirgna Language): "Mulkulkay"

Species name: *Termitomyces clypealus*

Family: Lyophyllaceae

Order: Agarics

It is not widespread and is generally uncommon and somewhat less distribution that found in two sites in the study area. The mushroom name implies and derived from the behavior of the mushroom during cooking, which is during making food it is difficult to handle for eating they call it "*Mulkulkay*" or not hold easily. The species are more grow in sandy soil texture and in cultivated and wood land. Normally as compare to other mushroom it has strong and longest mycelium.

Basic characteristics and feature of the species; Cap: form convex at first, flattening when expanded. The color of the surface of the cap /whitish and it has dark color at center of the cap. The caps are cracking from the margin to center of cap and when it dry does not change the color. Gills: are white to pinkish cream and stems are having the color of gills. Mycelium: has 25-45 cm long and do not have a blackish root like base. Cap diameter is 8-12, stem height is 10-13cm. Edible pleasant taste and small. Stem have not ring.

3. *Clitocybe gibba*

Locally name (Tigirgna language): "Kintishara"

Species name: *Clitocybe gibba,*

Family name: Tricholomataae

Order: Agaricals

It is found widespread in the study area which does not depend on soil fertility and micro habitat. *Clitocybe gibba* is normally similar when young with non-edible poisonous mushroom. It has brittle gill that makes people difficult to eat. The whole body is whitish with shallow mycelium and is the most common species.

Basic characteristics and features of the species; The caps are hemispherical when young and becoming flattens and then depressed to funnel-shaped. The surface is smooth white. The gills are whitish and narrow spaced. Stems are white and short that grow usually as cluster. Cap diameter is 8-12 cm and stem is height 5-8 cm. Edible pleasant test and small. Stem have not ring.

4. *Termitomyces microcarpus*

Local name (Tigrigna Language): "Nieshtey Kintishara"

Species name: *Termitomyces microcarpus*

Family: Lyophyllaceae.

Order: Agarics

Cap conical or bell-shaped when young, with an incurved margin, becoming flattened or concave with the margin split in several places and turned upwards and having a prominent, humped, pointed centre; pure white, or leaden-grey when moist, later becoming dirty white or pale brownish, especially on the hump. Young specimens are slightly silky or striate, older ones are distinctly striate and splitting easily. Gills white, free from the stem or just touching it, Flesh rather thick, waxy white throughout. This mushroom grows in very dense clusters and usually on bare patches of earth thrown up by termites. It develops best in the rainy season. These pellets are composed of fungus threads (hyphae) from which the mushrooms arise, and at first are whitish, later turning yellowish. The mushrooms are edible and of good flavor but so small that a great number are required to provide a meal. The *Termitomyces microcarpus* is small, but makes up for its size by fruiting in vast numbers, typically on or around old stumps grow with termite, individual fruit bodies are not only small, but are also fragile crumbling easily if picked. The respondent of study area were not collected and also do not distinguish whether it is edible or not they said because it is small to collect they do not consider as edible but not also distinguish as non-edible. In other country collected for food by indigenous people in Ghana and other part of Africa (Peter and Shelly, 2011).

Basic characteristics and features of the species; the shape of the cap is convex, very thin-fleshed and fragile, smooth pale whitish color becoming pale gray. The gills are whitish at first, becoming

black. The stem is whitish to pale cap-colored and smooth. The cap diameter is 1.5-2.5 cm and stem height is 4-5 cm. Edible pleasant small and stems have not ring.

5. *Phyllotopsis nidulans*

Local name (Tigrigna language): "*Kebero Zbei*"
Species name: *Phyllotopsis nidulans*
Family name: Trichoomataceae
Order: Agarics

The Fruit bodies grow as cluster and are laterally attached to wood. It seems to be much less common.

Basic characteristics and features of the species; Fruit bodies are wide, shell shaped, and soft. The caps are weakly convex to flat, orange-buff, becoming pale ocher-yellow, with densely hairy surface. The gills are cap colored and the stem is absent. Habitat: managed grass land and not edible. Cap diameter is 8-10 cm.

6. *Panaeolus papilionaces*

Local name (Tigirgna Language): "Nieashten Aynihimi"
Species name: *Panaeolus papilionaces*
Family name: Psathyrellaceae
Order: Agarics

This species are charming, but like most panaeolus species it is dung-lover, occurring directly on old herbivore dung or manure ground. It is also small and thin. Habitat grows in elsewhere which were higher abundance.

Basic characteristics and features of the species; The shape of the cap is hemispherical which were smooth and vary in color from ivory or creamy white to cream, buff grayish or radish brown and the gills are mottled black. The stem is smooth color, but often covered in fine whitish particles when fresh. The cap diameter is 1-2 cm and stem height is 4-5 cm. Not edible.

7. *Russula nigricans*

Local name: "Tslal zbei"
Species name: *Russula nigricans*
Family name: Russulaceae
Order: Agarics

This species is occasionally solid that gradually gets black with age. The old black fruit bodies can persist for weeks. The species sometime considered as edible, but has been implicated in cases of gastroenteritis poisoning.

Basic characteristics and features of the species; the caps are convex, later on becoming flatter and depressed with age. The cap surface is smooth, sordid whitish to cream with smoky, grey-brown patches eventually becoming black. The gills are widely spaced, sordid white, becoming gray brown then black. The stem is cap color and cap diameter is 8-10 cm, stem height is 7-9 cm. Not edible with unpleasant odor. Stem have not ring.

8. *Chlorophyllum molybdites*

Local name (Tigrigan language): "Abiyi Aynihimi"
Species name: *Chlorophyllum molybdites*
Family name: Agaricaceae
Order: Agarics

Chlorophyllum molybdites is number one species responsible for cases of fungal poisoning. It is primarily a tropical sub-tropical agaric particularly common in grass land where it can form impressive rings.

Basic characteristics and features of the species; Caps have form spherical when young, becoming flat to shallowly umbonate, with brown or pinkish brown central patch that is surrounded by small scales of similar color on whitish background. The gills are white, becoming greenish. The stem is smooth, whitish, sometimes browning toward the base, with large, often loose, scaly ring. The cut flesh in the stem base may turn reddish. The cap diameter is 15-24 cm and stem height is 5-7 cm. Not edible. Stem have ring.

9. *Leucoagaricus rubrotinctus*

Local name (Tigrigna language): "Tslal Aynihimi"
Species name: *Leucoagaricus rubrotinctus*
Family name: Agaricaceae

Order: Agarics

Leucoagaricus rubrotinctus is related to Lepiota species, but tend to be larger and more slender with a distinct (not partial) ring on the stem. It is also known as the red eyed parasol, is one of the most widespread and easily recognized species, thanks to attractive color, however this species cannot found in huge quantity.

Basic characteristics and features of the species; has convex cap that becoming flat or weakly umbonate when expanded. The cap center is pinkish red to orange, typically splitting or cracking to ward margin and breaking up in to scale on whitish back ground. The gills are white and the stems are white with white membranous ring. The cap diameter is 8-10 cm and stem height is 9-13 cm. Not edible. Stem have ring.

10. *Panaeolina foenisecii*

Local name (Tigirgna language): "keyhi Nieshtey Aynihimi"

Species name: *Panaeolina foenisecii*

Family name: Psathyrellaceae

Order: Agarics

Panaeolina Foenisecii are common little agaric to occur in garden lawns. The caps are changing color as they dry out and also small size.

Basic characteristics and features of the species; Caps are convex and smooth, dull yellow-brown. The gills are dark brown and mottled with whitish edge. The stems are fragile whitish color when young then becoming to dark brown. The cap diameter is 2-3 cm stem height is 3-5 cm. Not edible.

11. *Rhizopogon luteolus*

Local name (Tigirgan language): "Fossikaria"

Species name: *Rhizopogon luteolus*

Family name: rhizopogonaceae

Order: Puffballs

The fruit bodies can be surprisingly conspicuous, partly because of their color and size, because they normally grow half-embedded in the ground and half exposed, rather than hiding deep in litter. In some areas it has deliberately been introduced as beneficial ectomycorrhizal associate, helping the trees establish themselves on poor soils or in reclaimed land such as old spoil heaps.

Basic characteristics and features of the species; The *Panaeolina foenisecii* produces solid, potato-like Fruit bodies that are sordid yellow ocher and may have some darker, finally threadlike mycelia cords attached. The interior is spongy whitish yellow at first, becoming dingy olive-brown on maturity.

Wild mushroom growth substrate

Different mushroom species require certain growing media in the wild (Table 2). Different substrates enabled different species to grow in different proportions. Soil, termite mound, animal dung and log grew seven species (69.8%), three species (21.6%), two species (13.3%) and one species (0.9%) respectively. Mushroom species adapt to a specific substrate to grow and develop (Engola *et al*., 2007). Most mushroom species grew in soil substrate.

Most mushroom species preferred open canopy followed by slightly open canopy cover but none in the closed canopy cover (Table 3). The difference could have been brought about by the fact that under open canopy the moisture from the rain would easily reach the mushroom and aid their growth than in closed canopy, the dense cover expected to trap moisture is less preferred and they may not grow at all. Mushrooms preferred open canopy (Opige *et al*., 2006).

Figure 4. *Termitomyces Robustus.*

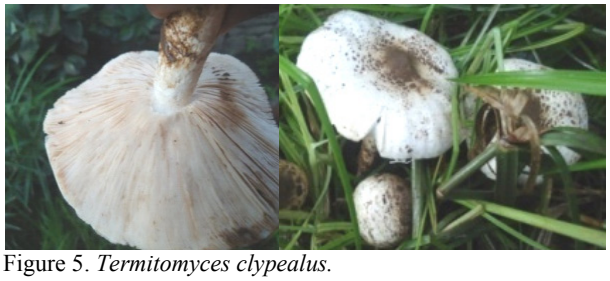

Figure 5. *Termitomyces clypealus.*

Figure 6. *Clitocybe gibba.*

Figure 7. *Termitomyces microcarpus* at field level.

Figure 8. *Phyllotopsis nidulans.*

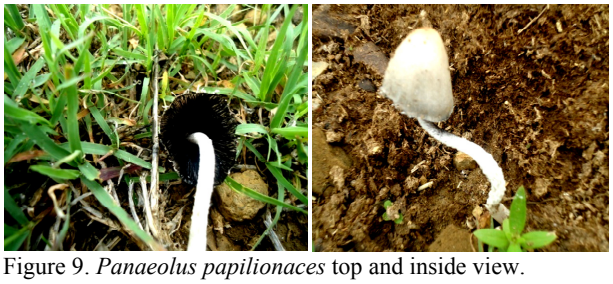

Figure 9. *Panaeolus papilionaces* top and inside view.

Figure 10. *Russula nigricans* top &inside cap view.

Figure 11: *Chlorophyllum molybdites* at different growth stage on the field.

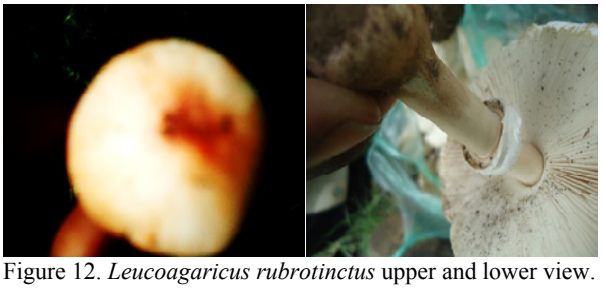

Figure 12. *Leucoagaricus rubrotinctus* upper and lower view.

Figure 13. *Panaeolina foenisecii* upper view.

Figure 14. *Rhizopogon luteolus.*

Species diversity

According to Abate, (2008a) mushrooms can be classified based on order as gill, bracket (pore), and puffballs, morels and truffles fungus. In this study 11 species were morphologically characterized (appendix 1) and identified (Table 4). *Termitomyces robust*, *Clitocybe gibba*, *Termitomyces clypealus* and *Termitomyces microcarpus* known as edible mushrooms. *Phyllotopsis nidulans*, *Panaeolus papilionaces*; *Russula nigricarns*, *Chlorophyllum molybdites*, *Leucoagaricus rubrotinctus*, *Panaeolina foenisecii* and *Rhizopogon luteolus* are known as non-edible wild mushrooms. A total of 1189 individual mushrooms were characterized and recorded comprising 11 species of which four of them were edible and seven were non edible categorized in two genera (Table 4). The abundant species in the study area was *Clitocybe gibba* and the least abundant species was *Termitomyces microcarpus* and orange nock oyster (Table 5). The highest richness, Shannon's, equitability-J, and Simpsons diversity indices of mushroom occurred in grass land. The woodland had the highest Fishers alpha and the cultivated land had the lowest values for all the species diversity and richness (Table 6). In agreement with this study, Engola *et al*. (2007) found the highest species diversity in grass land with quite high species abundance of about 4650 individuals of which 15 of them were edible species. The difference in the abundance of the species could be related to the high level of disturbance and difference in mushroom growing conditions such as amount of rain fall and soil fertility.

Table 2. Mushroom occurrence in different natural substrate.

Type of species	Type of substrate			
	Soil	Decayed log	Manure	Termite mounds
Clitocybe gibba	35	0	0	0
Termitomyces robust	0	0	0	1
Termitomyces clypealus	0	0	0	1
Panaeolus papilionaces	5	0	8	0
Chlorophylluh molybdites	13	0	0	0
Phyllotopsis nidulans	0	1	0	0
Termitomyces microcarpus	0	0	0	1
Rhizopogon luteolus	3	0	0	0
Russula nigricarns	5	0	0	0
Panaeolina foenisecii	6	0	0	0
Leucoagaricus rubrotinctus	7	0	0	0
Total	74	1	8	3

Table 3. Mushroom occurrence under different canopy cover.

Type of species	Canopy cover (%)		
	Occurrence	0-25	26-50
Clitocybe gibba	16	43.2	56.8
Termitomyces robust	6	0	100.0
Termitomyces clypealus	9	81.8	18.2
Panaeolus papilionaces	8	61.5	38.5
Chlorophylluh molybdites	6	46.0	54.0
Phyllotopsis nidulans	1	100.0	0
Termitomyces microcarpus	0	0	100
Rhizopogon luteolus	1	33.3	66.7
Russula nigricarns	3	60.0	40.0
Panaeolina foenisecii	2	33.3	66.7
Leucoagaricus rubrotinctus	4	57.0	53.0

Table 4. Identified species and local name of wild mushrooms.

SN	Species	Common name	Local name	Order	Edibility
1	*Termitomyces robust*	Robust Termite	Aigulle	Agarics	Edible
2	*Termitomyces clypealus*		Mulkulkay	Agarics	Edible
3	*Clitocybe gibba*		Kintishara	Agarics	Edible
4	*Termitomyces microcarpus*		Nieashten Kintishara	Agarics	Edible
5	*Phyllotopsis nidulans*	Orange nock oyster	Kebero Zbei	Agarics	Not Edible
6	*Panaeolus papilionaces*	Petticoat Mottle gill	Nieashten Aynihimi	Agarics	Not Edible
7	*Russula nigricarns*	Blacking brittle gill	Mrkus zibiea	Agarics	Not Edible
8	*Chlorophylluh molybdites*	False parasol	Abiyi Ayni himi	Agarics	Not Edible
9	*Leucoagaricus rubrotinctus*	Ruby dapperling	Tslal Aynihimi	Agarics	Not Edible
10	*Panaeolina foenisecii*	Brown Mottlegill	Betsa Nieashten Aynihimi	Agarics	Not Edible
11	*Rhizopogon luteolus*	Yellow False Truffle	Fossikaria	Agarics	Not Edible

Table 5. Presence and absence of wild mushrooms in different micro habitats.

Species	Grazing land	Cultivated land	Wood land	Managed grazing land
Clitocybe gibba	√	×	√	√
Termitomyces robust	×	√	×	√
Termitomyces clypealus	×	√	×	√
Panaeolus papilionaces	√	×	√	√
Chlorophylluh molybdites	√	×	√	√
Phyllotopsis nidulans	×	×	×	√
Termitomyces microcarpus	×	×	×	√
Rhizopogon luteolus	√	×	√	×
Russula nigricarns	×	×	√	√
Panaeolina foenisecii	×	×	√	√
Leucoagaricus rubrotinctus	×	×	√	√

(√ indicate presence) and (× indicate that absent) of different types of mushroom species.

Table 6. Wild mushroom diversity indices on four micro habitats.

Land use	Diversity indices						
	S	No/plot	D	1-D	H	F_A	C-1
Grazing land	5.00	194.00	0.75	0.25	0.38	0.56	1.73
Cultivated land	2.00	352.00	0.97	0.03	0.05	0.23	1.07
Wood land	7.00	162.00	0.67	0.33	0.52	0.75	2.00
Managed grazing land	10.00	516.00	0.61	0.39	0.61	0.59	2.27

Where: S=Taxa (s), no/plot=individuals, D=dominance (D), 1-D=Simpson 1-D, H=Shannon-H), F-A=Fisher alpha and C-1=Chao-1.

Nutritional values of wild Mushroom

Moisture content: All the specimens had high moisture content (Table 7). Mushrooms generally have high moisture content which enables them to have shorter shelf life, which makes most mushrooms to be highly perishable and deteriorate easily after harvest if preservative measures are not employed (Kadiri and Fasidi, 1990). The moisture content of the collected mushroom samples ranged from 81.83% to 87.96% (Table 7). The highest moisture was recorded from *Termitomyces robust* (87.9%) and the lowest moisture content was obtained from *Clitocybe gibba* (81.83%). Significant difference was observed between species in moisture content of *Termitomyces Robust* (Table 7) from *Chlorophyllum Molybdites* and *Clitocybe Gibba* mushroom. The variation might be due to species and natural substrate. This is similar to the result obtained in Nigeria by Gyar and Owaku, (2011) recorded a moisture content ranged 80.53-89.94% of dry weight and lower with the results from India by Manjunathan and Kaviyarasan, (2011) observed that the moisture content of the collected mushroom samples ranged from 87.13% to 95.17% of dry weight.

Crude Protein: Mushroom is considered to be a good source of digestible protein content above most vegetables and somewhat less than most meats and milk reported by Krishnendu *et al*., (2013). In the present study the protein content of

the collected mushroom samples ranged from 23.46% to 37.21%. The highest protein was obtained from *Chlorophyllum molybdites* (37.21%) and the lowest protein content was from *Clitocybe gibba* (23.46%). Significant difference was observed protein content between species of *Chlorophyllum molybdites* (Table 7), *Termitomyces robust, Termitomyces clypealus* and *Clitocybe gibba* mushrooms. The variation might be due to the species and the natural substrate where the species grow. According to Kaviyarasan *et al*. (2011) protein contents of mushrooms were reported to vary according to the genetic structure of species. This is similar to the result obtained in Brazil by Chang (2007), the protein content ranged from 10-40% on a dry weight basis, in India by Krishnendu *et al*. (2013) protein content 16.7 - 24.7 %, in India by Kaviyarasan *et al*. (2011) protein content 30.27-39.11% and by Aglarirmak *et al*. (2002) protein content ranged 26-31% and higher with results found in Iran by Ogbe and Obeka (2013) observed that the protein content 16.79%, and in India by Longvah and Deosthale (1998) with a protein content 15.9-22.8 % of the collected mushroom samples on dry weight basis.

Total Carbohydrate: Edible mushrooms are highly valued for the carbohydrate constitutes. A considerable portion of the carbohydrate compounds occurs in the form of polysaccharides of different sizes. Fungal polysaccharides are represented by glycogen and some indigestible form as dietary fiber of cellulose, chitin, mannose and glucans (Krishnendu *et al*., 2013). In the present study the highest carbohydrates content ranged from 32.41% to 43.93%. The highest carbohydrate was obtained from *Clitocybe gibba* (43.93%) and the lowest carbohydrate content was obtained from *Termitomyces robust* (32.41%). Significant difference was observed in carbohydrate content between *Clitocybe gibba*, *Termitomyces robust* and *Chlorophyllum* species (Table 7). The variation might be due to species and the natural substrate.This is similar to the result obtained in India by Kaviyarasan *et al*. (2011) carbohydrate content 33.23% to 47.83% and was lower than that reported by Ogbe and Obeka (2013) and in Europe by Pavel (2012) carbohydrate content 63.27% and 50-60% respectively.

Total Fat: The highest fat content ranged from 1.99 to 4.47%. The highest fat was obtained on *Termitomyces robust* 4.4667% and the lowest fat content was obtained on *Chlorophyllum molybdites* 1.99 %. Significant difference was observed between species in fat content of *Termitomyces robust* (Table 7) from *Chlorophyllum molybdites* mushroom. The variation might be due to species and natural substrate. This is similar to the result obtained in Turkey by Aglarirmak *et al*. (2002) fat content ranging from 1.1 - 8.3%, fat content range from 1.8-17% of dry weight.

Total Ash: The ash content of wild mushroom was high (Table 7) which means higher composition of minerals that are indispensible to human health and a reflection of the high content of organic matter present in the sample (Gyar, 2011). In the present study the highest ash content ranges from 14.92% to 19.60%. The highest ash was obtained on *Termitomyces clypealus* 19.60%, and the lowest ash content was obtained on *Termitomyces robust* 14.92%. Significant difference was not observed between the species. This is similar to the result obtained in India by Kaviyarasan *et al*. (2011), ash content ranging from 5.1-16.8%, reported in Turkey by Aglarirmak *et al*. (2002) ash content of ranging from 8.1-17.7%, and obtained by Ogbe and Obeka (2013) the ash content were 8.42% of dry weight.

Crude Fiber: This species of mushroom is a very rich source of plant fiber (Table 7). According to Gordon (2002) there is a “dietary fibre hypothesis” which suggests that the main role of the insoluble fibre found in fresh mushrooms is to ensure the peristaltic regularity and good bowel health. It also helps slow digestion and adds satiety or staying power to foods. In the present study the highest fiber content ranges from 12.32% to 18.07%. The highest fiber was obtained on *Termitomyces Robust* 18.07% and the lowest fiber content was obtained on *Clitocybe gibba* 12.32%. Significant

difference was not observed between the species. This similar reported in Nigeria by Etang *et al*., (2006) fiber content 11.2-18.4%. And higher than the result reported by Krishnendu *et al* (2013) the fiber content were 8.71-12.5% in dry weight base.

Phosphors: Phosphors are one of the prevailing mineral in wild mushroom with substantial amount (Table 7). In the present study the highest phosphors content ranges from 0.55% to 0.91%. The highest phosphors was obtained on *Termitomyces clypealus* 0.91% and the lowest phosphors content was obtained on *Clitocybe gibba* 0.55%. Significant difference was not observed between the species. This is similar to the result obtained by Pavel (2012), phosphors content of ranging from 0.5-1.0 and higher than the result reported by Longvah and Deosthale (1998) Phosphorus content 0.40 - 0.49% in dry weight base.

Generally the above result shows that considerable amount of nutrient content of wild mushroom were observed and essentially may be taken regularly as part of the human diet or be treated as healthy food or as functional food to study area and other area community. But the nutritional content among edible and non-edible mushrooms was almost comparable except on protein content. The behaviour of edible and inedible which was poisons of wild mushroom may be contributing other mineral which cannot cover this study. And also comparing along with edible mushrooms there were differ in their nutritional content due to the fact that different genetically structure of the species and natural substrate of the wild mushrooms grown.

Farmers perception habit on wild mushroom

The descriptive result of the study shows that about 79% of the respondents were male. The average age was about 47 years. About 38% of the respondents were literate in different levels, ranged from religious to college level.

The study used the regional livelihood threshold (18000 Birr per household per year) as a benchmark to investigate the percentage of food secure and food insecure households in the study areas. Accordingly, about 63% of the respondents were food secure, which meant that they on average earned more than 18000 ETB (Table 8).

Table 7. Nutrient content of three edible and one inedible wild mushroom in (DW %).

Composition	*Termitomyces robust*		*Chlorophylluh molybdites*		*Clitocybe gibba*		*Termitomyces clypealus*	
Moisture content	87.96±2.200	a	82.82±2.171	b	81.83±1.210	b	83.34±1.525	ab
Protein	30.14±3.520	b	37.21±3.586	a	23.46±0.762	b	26.48±0.936	b
Fat	4.47±0.518	a	1.99±0.421	b	3.59±1.510	ab	2.61±0.045	ab
Carbohydrate	32.41±4.278	b	32.94±3.169	b	43.93±6.134	a	35.81±1.759	ab
Ash	14.92±3.104	a	15.44±3.554	a	16.69±4.377	a	19.60±0.272	a
Fibre	18.07±2.139	a	12.42±1.973	a	12.32±6.378	a	15.50±1.127	a
Phosphorus	0.91±0.223	a	0.82±0.162	a	0.55±0.079	a	0.91±0.107	a

Data are mean values ± standard deviation (SD) of Triplicate results and Means that do not share a letter are significantly different.

Table 8. Socio-demographic characteristics of the study population**.**

Variable	Observation	Mean value
Male headed households (%)	150	80
Average age of the head (year)	150	47
Married proportion (%)	150	78
Literate household heads	150	37
Primary occupation proportion agriculture (%)	150	94
Average livestock resources (TLU)	150	9
Average annual income (Birr)	150	25843
Proportion of food secure people (%)	150	63
Average land size of head (hectare)	150	0.9
Mushroom consumed (%)	150	90
Mushroom not consumed (%)	150	10

The respondents recognized that mushroom grows in their local areas, mainly managed grassland, cultivated land, unmanaged grass land and wood land. Mushroom grows mainly in rainy season especially from the first week of June to late September though some mushroom like *Termitomyces robust* and *Termitomyces clypealus* grows starting mid of July to the last week of September. The participants in the household survey and focus group discussion explained the factors that influence the growing condition of wild mushroom are heavy storm, lighting, thunder and organic matter. Similar reports and folklore were reported in others. For example, the issues of lighting, thunder and storm were common in Japan. Anonymous (2008) studied the determinant factors of mushroom using static electricity and found that it depends on the species of the mushroom. For example, artificial lightening can therefore be very beneficial for the mushroom business in Japan (Adey, 1993). Islam and Ohga (2012) explained why lightning trigger mushroom growth was that heavy rain and lightning trigger the germination of dormant spores in the soil. Furthermore, lightning causes the precipitation of atmospheric nitrogen to nitrate which enhances mushroom growth and fruiting body formation.

Though mushroom in the study area has a long history, it has gradually declined. About 95% of the respondents realized not only the reduction but also disappearing of mushroom from some land uses mainly due to anthropogenic effects such as deforestation, expansion of cultivated areas, increasing settlement and other factors. Similarly, alarming decline in wild edible mushroom populations has been reported from central part of Burkina Faso which was closely linked to disappearing forest habitats (Guissou *et al*., 2008). In Wacha kebele, south Ethiopia there is a sharp decline in wild mushroom population (Delelegn *et al*., 2013). In contrary, in countries like Japan, the Republic of Korea, China, and the Russian Federation, the tradition of eating wild edible mushroom is much stronger and appears to have withstood the changes experienced elsewhere as stated by Boa (2004). Hence, the population of wild edible mushroom is increasing in some of the developed countries probably due to better management of natural forests in contrast to the trend seen in developing countries.

Several studies conducted on the abundance, edibility and endanger species of mushroom (Guissou *et al*., 2008). The respondents easily identified endangered and non-endangered species of wild mushroom. They also easily distinguished the edible and inedible species of the mushrooms. In this study the respondent identified the highest abundant species as *Clitocybe gibba* and the endangered species was *Termitomyces robust.* The reason for this condition could be the difference in resistance of species to anthropogenic factors.

Another important issue about mushroom is that who consume the mushroom and whether the local communities are aware of the consumption habit of the wild mushroom. Because of the knowledge transfer from local elders, about 96% of the respondents had information and knowledge on consumption habit of mushroom. The respondents consumed wild mushroom regardless of economic status because of its good taste, sometime solving food shortage, and substituting meat. In other words, some of the respondents (57%) ate wild mushroom simply by chance when they found wild mushroom, and some (33%) consumed it during shortage of food at home while others (10%) consumed at any time due to good aroma of the wild mushroom. According to the participants in the household survey and focus group discussion, the farmers ate the wild mushroom in fresh (raw), by cooked or roasted depending upon the preference of the farmers. *Termitomyces robust and Termitomyces clypealus* were consumed as raw while *Clitocybe gibba* required caution as it was similar with other poisonous mushroom like *Leucoagaricus rubrotinctus and Chlorophyllum molybdites* species during young stage. The appetite to eat different mushroom species was

determined by its taste. *Termitomyces robust* was preferred all consumers, the second choice was *Termitomyces clypealus*, preferred by 80 % of the consumers and the third choice of consumers' was *Clitocybe gibba*. The result of consumers preference indicates that mushroom flavors has no relationship with its nutrient content, this was in conformity with Chang, (2007) who, reported that the desirability of a food product does not necessarily bear any relationship to its nutritional value. Instead, its appearance, taste and aroma sometimes can stimulate one's appetite.

Pertaining to the taste quality from accessible edible wild mushroom in the area of the total respondent responded that *Termitomyces robust* the first 81.3%, *Termitomyces clypealus* 9.3% and *Clitocybe gibba* 8.7%. Besides annual consumption per household in kilogram of edible wild mushroom of the respondent was those consume from 0.25-5kg respond 76%, 5-10kg consume respond 12% ,10-20 kg consume respond 6.7% and those consumed 20-30 kg respond 2%. The annual mean consumption per household of the respondents was 3.5 kg/HH. In agreement with other study in Czech Republic obtained by Gyar (2011) consumed wild mushroom about 70% of the population with a statistical mean of 5.6 kg of fresh mushrooms per household yearly. Nevertheless, some individuals consume over 10 kg yearly. UK household consumption of mushrooms was 36 g/week mushroom Pavel (2012).

As regards the current status of edible wild mushroom consuming at study area, most of 95.3% of the respondents indicated that there were a sharp decrease in mushroom consumption. As compared to previous consumers currently they reduce consumption of respondents by 40% were responded. The most important reasons for decreasing mushroom consumption in the current study were attributed reduce growing of mushroom 53.3%, followed farmers understand mushroom as poor food 30%, farmers got other better options 12.7% and the rest 4% they said there were no reduction as responded by the respondent.

The other wonderful point about the 94% respondents of study area were they clearly able to distinguish between edible and non-edible wild mushrooms and they have different ability to distinguish among edible and non-edible wild mushroom by which using color, size, smell, and ring of mushrooms. They gave different reasons that were not consume inedible mushrooms such as could be not eat by people, it is poisonous, bad smell, and attack by insects as 61.3%, 24.7%, 9.3% and 2% respectively.

Besides part of the respondent have did different treatment for those who encounter chance to eat non-edible mushrooms which got illness in a way that treated by drinking milk products such as fresh milk, sour milk and lentil. This is very interesting that coupling such traditional knowledge with scientific description and identification of the edible fungi could have paramount advantage in sustainable utilization of the resource for various obvious purposes in the area as well as elsewhere in the region. Furthermore, such local knowledge could be even more important for people who are not familiar to the area as one should eat mushrooms only if one knows their names and their properties with considerable precision.

Finally, domestication of mushroom was not practiced as indicated by the participants in the questionnaire survey and focus group discussion because the local farmers didn't know whether or not the mushroom has seed or spore for reproduction. However few of respondent have experience in the form of client on their farm or communal land locally they called it "*fekur*" (mean an area that used for collection of mushroom at private level year to year regularly). Market condtion of wild mushrooms in the study area were respond 100% has did not practiced due to the fact that farmers did not consider and lack knowledge as cash crop wild mushrooms. In addition 100% have not cultivated mushroom due to lack of awareness and knowledge. But 84% portion of the respondent has interest to cultivate if they got, counseling, support on training and spawn.

Factors influence consumption of wild mushroom

The study used probit model to identify the major factors that influence consumption habit of wild mushroom in the study area. The overall fitness of the model was statistically (Pseudo R^2 = 0.5610). Of the stated independent variables of the model, age of the households had a positive and statistically significant influence on the consumption habit of the households for wild mushroom.

Age variables appeared to influence the level of consumption of mushroom of the households studied and their signs are complete agreement with a priori expectations because as age increase the consumption of mushroom by farmers increases due to the fact that elders have experience and knowledge about wild mushroom consumption. However the other important independent variables such as educational level, income and farm size have not influence and statically not significantly difference the consumption of mushrooms. The above result was also similar with results found practically during different field survey techniques conducted in this research. The magnitude effect of the independent variables, age of the household heads was the only statistically significant variable that explains the consumption habit of mushrooms. The result (Table 9) explained that as the age of the respondent increased by one year, the probability of consuming mushroom increased by about less than 1 percent.

CONCLUSION

Four wild edible and seven non-edible wild mushrooms categorized in to two genera were identified. The species composition of the identified wild mush rooms were few compared to other similar areas. Species diversity was high in managed grassland. Type of substrate, level of canopy cover and heavy rain fall were some of the determinant environmental factors that affect the distribution of mushroom. Wild mushrooms were rich in carbohydrate and protein content and were low in fat content. According to the respondents there were a decline in abundance and distribution wild edible mushroom species; particularly *Termitomyces robust* was endangered. The traditional culture of hunting and consuming wild mushrooms is declining in the study area.

Table 9. Probit regression estimation of mushroom consumption.

Attributes	Coef.	dF/dx	Std. err	Z	P>|z|	95% Conf.
Family number	0.09	0.00	0.18	0.49	0.62	0.27
Age	0.17	0.00	0.05	3.54	0.001	0.07
Farm Size	1.14	0.002	0.86	1.33	0.18	0.54
Female	0.95	0.001	0.77	1.23	0.22	0.56
Illiterate	0.70	-0.001	0.89	0.79	0.43	2.44
Read & writing	0.70	0.001	1.39	0.50	0.62	2.03
One-six grade	1.40	-0.015	1.04	1.35	0.18	3.44
Married	1.38	0.015	1.31	1.05	0.29	1.19
Separated	0.09	0.000	1.32	0.07	0.94	2.50
Food secure	0.10	0.000202	0.60	0.16	0.87	1.07
LR $Chi^2(10)$ = 54.47				Pseudo R^2 = 0.561		

REFERENCES

Abate, D. 1998. Mushroom Cultivation: A Practical Approach. Berhanena Selam Printing Press. Addis Ababa, Ethiopia.

Abate, D. 2008a. Wild Mushrooms in Ethiopia and Our Eating Habit. National Mushroom Conference, Faculty of Science, May 14-15, Addis Ababa. Ethiopia.

Adey, W. 1993. "Biological Effects of Electromagnetic Fields," in Journal of Cellular Biochemistry, Japan. Pp 410-416.

Aglarirmak, K., C. Necla, F. Kemal, and S. Unal. 2002. Nutritional Value of Edible Wild Mushrooms Collected from the Black Sea Region of turkey, Colegiode Post graduates México. (Available *In:* http://www.redalyc.org/articulo.oa). Date accessed: May 13, 2013.

Anonymous. 1990. AOAC. Official Methods of Analysis; 14th Ed. Association of Official Analytical Chemists, Washington DC, USA.

Anonymous. 2008. Lightning help mushroom to germinate after a thunder storm. (Available http://www. answerbag.com/q_view/804298#ixzz2pnPkhbDJ. Date accessed: June 23, 2013.

Anonymous. 2010. Office of Agriculture and Rural Development, Annual Report of Enderta district. Mekelle, Ethiopia.

Anonymous. 2013. Office of Agriculture and Rural Development, Annual Report of Enderta district. Mekelle, Ethiopia.

Anonymous. 2014. Office of Agriculture and Rural Development, Annual Report of Enderta district. Mekelle, Ethiopia.

Beetz, A., and M. Kustudia. 2004. Mushroom Cultivation and Marketing: Horticulture Production Guide. National Center for Appropriate Technology, California, USA. Pp 12-25.

Bloesch, B., and D. Mbago. 2006. Vegetation Study of the Selous-Niassa Wild life Corridor Biodiversity. Conservation Values and Management Strategies. (Available). Date accessed: April 13, 2013.

Boa, E. 2004. Wild Edible fungi a global overview of their use and importance to People. FAO, Rome, Italy. (Availablehttp://www.fao.org/docrep/007/y5489e/y5489e05.htm#top). Date accessed: May 13, 2013.

Chang, S. 2007. Mushroom Cultivation Using the "ZERI" Principle: Potential for Application in Brazil, Pp 33-34.

Chang, S., and P. Miles. 2004. Culture Preservation in Mushrooms Cultivation, Nutritional Value, Medicinal Effect and Environmental Impact. CRC press. Boca Raton, Florida. Pp 189–201.

Cheung, P. 1996. Dietary fiber content and composition of some edible fungi determined by two methods of analysis. J. Sci. Food Agric, UK. Pp 255–260.

Delelegn, W., M. Diriba, and Y. Teferi. 2013. Mushroom consumption habits of Wacha Kebele residents, south-western Ethiopia. Global Research Journal. Jimma University, Kaffa Zone, Ethiopia. Pp 6-16.

Engola, A., G. Eilu, and J. Kabasa. 2007. Ecology of Edible Indigenous mushroom of the Lake Victoria Basin (Uganda). Research Journal of Biological Sciences. Makerere University, Kampala-Uganda. Pp 62-68.

Esteri, A. 2008. Geometrics and Natural Resources Evaluation. Land Evaluation in Enderta District; Tigray, Ethiopia. Florence, tict Mc press INC. Pp 142-176

Etang, H., D. Olila, and I. Kisovi. 2006. Nutritional and Biological Qualities of Mushrooms from Niger Delta Region Rainforest of Nigeria. Nigerian Journal of Microbiology pp 20-23

Gebrekidan, T. 2004. Impact of Free Grazing and Open Access to Communal Lands on Natural Resource: The Case of Tigray Regional state in Ethiopia. Ethiopia Journal of Natural Resources. ISBN 1563-3705 Volume 6(1): 55-69 Addis Abeba, Ethiopia.

Guissou, K., A. Lykke, P. Sankara, and S. Guinko. 2008. Declining Wild Mushroom Recognition and Usage in Burkina Faso. Econ. Bot. Pp 530-539.

Gyar, S. and G. Owaku. 2011. Estimation of Some Metal Elements and Proximate Properties of Boletus Edulis (Fr), Journal ofSciences, Nasarawa State University, Keffi, Nigeria.(.Available online at: http://www.uni-sz.bg) Data accessed: December 25, 2014.

Islam, F., and S. Ohga. 2012. The response of fruit body formation on Tricholoma matsutake insitu condition by applying electric pulse stimulator, Japan. (Available at http://www.answerbag.com/q) .Data accessed: December 25, 2014.

Kadiri, M., and I. Fasidi. 1990. Changes in Nutritional Content of Two Nigerian Mushrooms T.robustus and L. Subnudus) during sporophore development. Die Nahrung PP 415-420.

Kaviyarasan, V., S. Johnsy, S. Davidson, and V. Dinesh. 2011. Nutritive Value Of Edible Wild Mushrooms Collected from the Western Ghats of Kanyakumari District. Center for Advanced Studies in Botany, University of Madras, India. Pp 69-74.

Kent. M, and P. Coker. 1996. Vegetation Description and Analysis a Practical Approach: John Wiley and Sons, New York.

Krishnendu, A., G. Subrata, C. Subhash. 2013. Proximate analysis of three wild edible mushrooms of West Bengal, India. International Journal. Pp. 365-369

Longvah, T., and Y. Deosthale. 1998. Compositional and nutritional studies on edible wild mushroom from northeast India. Food Chemistry, Pp. 331-334

Manjunathan, J., and V. Kaviyarasan. 2011. Nutrient composition in wild and cultivated edible mushroom, International Food Research Journal Tamil Nadu., India. Pp 809-811.

Marshall, E., and N. Nair. 2009. Make Money by Growing Mushrooms: Food and Agriculture Organization of the United Nations, Rome. (Available at http://ftp.fao. org/docrep/fao). Date accessed: September 13, 2014.

Moore, D. 2005. Principles of Mushroom Developmental Biology. Inter. J. Med. Mushrooms. Ganoderma lucidum: Implication on Utilization in Poultry Production. Iran. Pp79-101.

Ogbe, A., and A. Obeka., 2013. Proximate, mineral and anti - nutrient composition of wild *Ganoderma lucidum*: Implication on its utilization in poultry production. Faculty of Agriculture, Nasarawa State University, Keffi, Nigeria. Available on: www. ijas.ir. Date accessed: May 25, 2013.

Olila, D., G. Kyeyune, J. Kabasa, and L. Kisovi. 2007. Assessment of Potential for Domestication of Termitomyces Microcarpus: An indigenous edible and medicinal mushroom from the Lake Victoria basin. Agriculture Journal, Kanpala Uganda. Pp27-63.

Olumide, O. 2007. Economic analysis of mushroom marketing as a copping strategy for poverty reduction in Ondo State, Nigeria. Afr. Crop Sci. Conf. Proc. pp. 1255-1260.

Opige, M., E. Keteyo, J. Kabasa, and D. Olila. 2006. Biodiversity and Ecology of Indigenous Edibleand Medicinal. Agricultural Journal. Mekerere University eastern, Uganda: 284-290.

Osagualehor, K., and J. A. Okhuoya. 2005. Sociocultural and Ethnomycological Uses of Mushrooms among the Esan People of Nigeria. Int. J. Med. Mushroom. pp 442-443.

Pavel, K. 2012. Chemical Composition and Nutritional Value of European Species of Wild Growing Mushrooms Department of Applied Chemistry, Faculty of Agriculture, University of South Bohemia, CZ-370 05 České Budějovice, Czech Republic.

Peter, R., and E. Shelly. 2011. The Book of Fungi: A life. The university of Chicago press. Chicago, USA.

Tuno, N. 2001. Mushroom utilization by the Majangir, an Ethiopian tribe. The Mycologist. Pp78- 79

Yokabi, K., M. Agho, and D. Martinez-Carrera. 2004. Ethnomycological studies on wild edible mushrooms in Cameroon, Central Africa. Micologia Appllcada International. Pp 34-36.

Wambua, J. 2004. Mushroom Cultivation in Kenya. Mushroom Growers Handbook, (Available at http://ftp.fao.org/docrep/fao/011/i0522e/i0522e00.pdf) Date accessed: May 13, 2013.

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Wild Edible Fruits: A Rich Source of Biodiversity

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ABSTRACT: *Wild edible fruits are highly valued fruit crops for their unique flavors, textures, and colors. In recent years, wild edible fruits have been shown to provide significant health benefits because of their high antioxidant content, vitamins and minerals, fiber, folic acid, etc. In addition to fresh consumption, wild edible fruits are widely used in beverages, ice cream, yogurt, jams, jellies and many other food products. A number of wild edible fruits are used by rural and tribal populations and significantly contribute to their livelihood. The use of non-cultivated foods, of which wild fruits form a part, as a diet supplement, or as a coping mechanism in times of food shortage, provides an important safety net for the rural poor especially in underdeveloped countries. There is now a greater awareness that products from the wild may support household subsistence and also that income may be created from their sale, either in raw or processed forms. This awareness has prompted a research on the diversity of species that are used and their relation to the socio-economic status of those who use them. Wild edible fruits are important constituents of biodiversity. The aim of this study is to compare the morphological, biochemical and molecular diversity among wild edible fruits and cultivated ones.*

Keywords*: Wild fruits, content, biodiversity, rural life.*

Yabani Yenilebilir Meyveler: Zengin Biyolojik Çeşitlilik Kaynağı

ÖZ*: Yabani yenilebilir meyveler, benzersiz lezzetleri, dokuları ve renkleri ile son derece değerli meyve grubunu oluştururlar. Son yıllarda yapılan çalışmalarla, yabani yenilebilir meyvelerin, yüksek antioksidan içeriği, vitaminler, mineraller, lif, folik asit, vb. zengin olması nedeniyle sağlık bakımından önemli yararlar sağladığı ortaya konulmuştur. Yabani yenilebilir meyveler, taze tüketime ek olarak, içecek, dondurma, yoğurt, reçel, jöle ve diğer pek çok gıda ürünlerinde yaygın olarak kullanılmaktadır. Bir takım yabani yenilebilir meyveler kırsal ve yerli nüfusları tarafından kullanılmakta ve onların geçim kaynaklarına önemli ölçüde katkıda bulunmaktadırlar. Yabani meyveleri içine alan kültüre alınmamış bitkilerin, diyet takviyesi olarak veya gıda yetersizliğinde kullanılması, özellikle az gelişmiş ülkelerde kırsalda yaşayanlar için önemli bir gıda güvenlik ağı sağlar. Günümüzde, doğadan gelen ürünlerin hane halkının geçimini destekleyebileceği ve ayrıca ham ya da işlenmiş halde satışlarından elde edilecek gelirin daha fazla farkındalık oluşturacağına inanılmaktadır. Bu farkındalık, kullanılan türlerin çeşitliliği ve bunları kullananların sosyo-ekonomik durumu ile olan ilişkileri üzerine araştırma yapmayı teşvik etmektedir. Yabani yenilebilir meyveler biyolojik çeşitliliğinde önemli bir bileşenini oluşturmaktadır. Bu çalışmanın amacı yabani yenilebilir meyveler ile kültür meyveleri arasındaki morfolojik, biyokimyasal ve moleküler çeşitliliği karşılaştırmaktır.*

Anahtar Sözcükler*: Yabani meyveler, içerik, biyolojik çeşitlilik, kırsal yaşam.*

INTRODUCTION

The earth is filled with an overwhelming plant biodiversity and a number of efforts have been made to categorize them based on their size, forms, habitat, structure, anatomy, and biochemical and molecular features with the aim of interpreting the relationships among the plants. (Mishra *et al*., 2015; Tsou *et al*. 2016).

Horticultural plants including cultivated and wild edible forms play a highly important role on human diet as vitamins, minerals and dietary fiber sources and they have also become a significant part of human life due to their medicinal and environmental uses as well as aesthetics and economic values. The stem, leaf, flowers, roots and the fruits of fruit crops have the highest potential of export (Kaczmarska *et al*., 2015; Ipek *et al*., 2016).

More recently, food and nutritional security have been regarded as one of the key concerns around the world. In addition, low food intake and poor access to food in underdeveloped countries remain unresolved issues (Andersen *et al*., 2003; Adebooye and Phillips, 2006). Around one billion people rely on wild harvested products for nutrition and income and the "invisible" trade in wild resources is estimated to reach $90 billion/annum (Pimentel *et al*., 1997). In India alone the livelihoods of around 6 million people are maintained by the harvest of forest products (Tuxill, 1999) and a great number of studies highlight just how important wild harvested plants, particularly obtained from forests, are to the economy of the rural poverty in the world (Pimentel *et al*., 1997). In many rural locations, particularly the areas that lack basic infrastructure and market access, the collection of wild resources provides a considerable support for subsistence in local livelihoods (Delang, 2006). In addition, the harvest and sale of wild products often provide one of the only means of access to cash economy (Redzic, 2007).

Wild edible fruits have played a significantly vital part in supplementing the diet of people since ancient times. Many people in tribal areas still use them as a supplement of their basic needs of food even the dependence on these fruits has gradually decline as more exotic fruits have been introduced. These fruits from forests are rich in terms of protein and energy and highly useful in treating protein energy deficiencies. The production and consumption of these fruits in arid zones provide dietary supplement in addition to commercial opportunity. Growing trees for fruit production promotes the prevention of more or less permanent stands in barren land. Such trees often represent features of desert landscapes and form the basis of traditional agro forestry land use system. They are immune to many diseases and often used in different formulation of 'Ayurveda' in Indian Folk-medicine. They provide fibers which prevent constipation (Kumbhojkar and Vartak, 1988; Natrajan and Paulsen, 2000).

A number of recent studies have indicated that the dietary use of wild fruits appears in numerous records especially in underdeveloped countries and some botanical studies and publications have emphasized on the diversity and food value of wild edible fruit plants (Reddy *et al*., 2006, Mishra *et al*., 2007; Deshmukh and Shinde, 2010).

Efforts have been made to assess crop genetic diversity using morphological, biochemical and molecular marker technologies over the last three decades. These assessments have created considerable amount of knowledge about the extent and nature of genetic diversity present in conserved and/or actively utilized germplasm of various crops (Rauf *et al*., 2010). These assessments not only facilitate our efforts in germplasm conservation, but also provide guidance for better germplasm utilization for genetic improvement (Kacar *et al*., 2014). Morphological and biochemical characters are likely to be influenced by environmental conditions whereas genetic characters are not influenced. Using all of them for germplasm characterization can offer more information about germplasm. Molecular markers provide discriminatory information, and they are commonly used for germplasm characterization for fruit species in addition to pomological traits (Ercisli, 2004).

There is a concensus that modern plant breeding reduces crop genetic diversity and intensive selection in modern plant breeding programs within a narrow range of plant germplasm with limited allele introgressions over time would have reduced genetic diversity. It is also evident that newly released crop varieties are phenotypically more uniform than before, implying a genetic diversity reduction (Duvick, 1984; Bowman *et al*., 2003).

Comparison of wild and cultivated plants in terms of plant culture, plant breeding and propagation, fruit quality and characteristics, harvesting, processing and transport, obtain by consumers and plant viability and sustainability are shown in Table 1, 2, 3, 4, 5 and 6. It is clear that there were huge differences on these characteristics between wild and cultivated plants. Because they grow in less than ideal conditions, wild edible fruits are often smaller than cultivated ones. They also produce less fruit in general, and the fruits are not as plump, making them seedier. Cultivated fruits are often juicier and sweeter. Wild edible fruits are very important in the diet and in the social life of the village people and they are always collected when in season, and brought by the villagers into the urban markets. The people themselves had a host of uses for many wild edible fruit species throughout world. Wild fruit bushes are hardier than cultivated bushes and do not transplant well.

Table 1. Comparison of wild and cultivated plants in terms of plant culture.
Çizelge 1. Yabani ve kültür formlarının bitki kültürü açısından karşılaştırılması.

Wild (Yabani)	Cultivated (Kültür formu)
No monoculture	Monoculture (establish nursery)
Irrigation with seasonal rainfall	Regularly Irrigated
Natural adaptation	Greenhouse cultivation/adaptation in special climate chambers
Full size growth	Production of dwarf types
Pollination by natural means (insects, wind)	Artificial pollination
Flowering and fruit set due to natural conditions/periodicity	Flowering and fruit set reduced and reproduced/enforcement for periodicity
No chemical fertilizers	The use of chemical fertilizers
No toxic applications (Pesticide, fungucide and so on)	There are toxic applications (Pesticide, fungucide and so on)

Table 2. Comparison of wild and cultivated plants in terms of plant breeding and propagation.
Çizelge 2. Yabani ve kültür formlarının bitki ıslahı ve çoğaltma açısından karşılaştırılması.

Wild (Yabani)	Cultivated (Kültür formu)
Natural selection	Selection by people
Irrigation with seasonal rainfall	Regularly Irrigated
No crossing (but, favorable circumstances)	Artificial hybridization common (Genetic engineering)
Seed propagation / vegetative propagation with the natural way	Vegetative propagation (mostly grafting)
Growth on their roots	Proper grafting of rootstocks

Table 3. Comparison of wild and cultivated plants in terms of fruit quality and characteristics.
Çizelge 3. Yabani ve kültür formlarının meyve kalitesi ve özellikleri açısından karşılaştırılması.

Wild (Yabani)	Cultivated (Kültür formu)
Small, fibrous, sour, bitter, sweet rarely (low sugar level)	Large, low-fiber, usually very sweet (high sugar level)
Small fruit, large seed	Large fruit, small seed

Table 4. Comparison of wild and cultivated plants in terms of harvesting, processing and transport.
Çizelge 4. Yabani ve kültür formlarının hasat, işleme ve taşıma açısından karşılaştırılması.

Wild (Yabani)	Cultivated (Kültür formu)
Multi-maturing fruits fall to the ground or is collected by hand	Generally, unmaturation harvest/pre-harvest chemical use in case of mechanical
No fumigation	Fumigation (hot water or cold applications)
No cooling/No transport	Cooling (for months)/transport (distances
No use of protective	There are protective film, wax, packaging operations

Table 5. Comparison of wild and cultivated plants in terms of obtain by consumers.
Çizelge 5. Yabani ve kültür formlarının tüketicilerin eldesi açısından karşılaştırılması.

Wild (Yabani)	Cultivated (Kültür formu)
Plant searched/harvested/existing of thornly, poisonous fruit, harmful animal attack etc. circumstances	Presented for easy and ready case in supermarkets

Table 6. Comparison of wild and cultivated plants in terms of plant viability and sustainability.
Çizelge 6. Yabani ve kültür formlarının bitki canlılığı ve sürdürülebilirliği açısından karşılaştırılması.

Wild (Yabani)	Cultivated (Kültür formu)
Remains viable and grows in nature	Protected by people, living in natüre can not continue

Diversity of wild fruit collection

In India, fifty-six fruiting plant species belonging to 40 genera and 26 families have been harvested from natural stands and their habit, local names, parts used and mode of consumption are determined (Mahapatra and Panda, 2012).

More generally, local climatic and edaphic conditions contributed to variation in inter-site fruiting season in a number of species. Consequently, it was considerable overlap in ripening among different species, both within and among localities, resulting in year-round availability of wild fruits in India (Figure 1).

Diversity on biochemical characteristics among wild and cultivated fruits

Yildiz *et al.* (2010) reported diversity among wild and cultivated blackberries on total phenolic content, total anthocyanin content and antioxidant activity determined by different methods. The result showed that (Table 7), lower values for most biochemical parameters were observed in cultivar Chester than all wild genotypes. They also reported high antioxidant activity in wild blackberries. Reyes-Carmona *et al*. (2005) also reported high bioactive content in wild blackberries compared to cultivated ones. This phenomenon could be due to an induction in the synthesis of antioxidant enzymes and an increase in polyphenolic concentration brought about due to the greater exposure of the unsheltered wild plants to extreme temperatures, and insult by pests and pathogenic organisms, because phenolic compound biosynthesis is typically a stress-defense mechanism (Antonnen and Karjalainen, 2005).

Species (Tür)	Jan.	Feb.	March	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Aegle marmelos					■	■						
Artocarpus lacucha					■	■	■	■	■	■		
Bauhinia purpurea	■	■	■									
Buchanania lanzan				■	■							
Dillennia pentagyna					■	■						
Diospyros malabarica			■	■								
Diospyros melanoxylon			■	■								
Ficus hispida	■	■	■	■	■	■	■				■	■
Flacourtia indica			■	■	■							
Gardenia gummifera						■	■	■				
Limonia acidissima											■	■
Mangifera indica				■	■							
Phoenix acaulis					■	■						
Phyllanthus emblica	■										■	■
Schleichera oleosa						■	■	■				
Semecarpus anacardium				■	■							
Spondias pinnata	■											
Syzigium cumini							■	■				
Xylia xylocarpa									■	■		
Ziziphus oenoplia	■										■	■

Figure 1. Fruiting calendar of 20 common wild fruit species (Shaded segments show period of fruiting) in India.
Şekil 1. Hindistan'da 20 yaygın yabani meyve türünün fenolojik takvimi (gölgeli kesimler meyve verme dönemini gösterir).

Table 7. Total anthocyanin (TA), total phenolic content (TPC), antioxidant activity (β-carotene and FRAP) and free radical scavenging capacity (DPPH) of samples.
Çizelge 7.Toplam antosiyanin (TA), toplam fenolik içerik (TPC), antioksidant aktivite (β-carotene and FRAP) ve serbest radikal giderme gücü (DPPH).

Genotypes Genotip	TA (mg cyaniding-3-glucoside eq./100 g FW)		TPC (mg GAE/100 g FW)		DPPH (µmol/g FW)		FRAP (µmol/TE g FW)		B-carotene bleaching assay (%)	
ART1	149	b	390	ab	35.0	ab	48.75	de	84.66	bc
ART2	138	c	424	a	37.4	a	54.35	b	87.45	ab
ART3	155	ab	406	ab	34.4	ab	53.40	bc	85.34	bc
ART4	168	a	379	b	36.1	ab	51.10	cd	83.10	cd
ART5	134	b	404	ab	35.4	ab	45.60	ef	84.88	bc
ART6	147	b	349	bc	34.8	ab	49.80	d	83.70	c
ART7	160	ab	352	bc	33.6	ab	52.15	c	83.01	cd
ART8	160	ab	397	ab	36.7	ab	54.10	bc	86.67	b
ART9	157	ab	346	bc	33.6	ab	47.90	e	82.34	d
ART10	138	c	358	bc	33.8	ab	56.30	a	83.07	cd
Chester	147	b	310	c	33.1	b	45.00	f	82.40	d
BHT									89.67	a

Different latter indicate the statistical difference within same column among genotypes at 5% level.

Biodiversity loss in cultivated (grafted) plants
A sample Carob (*Ceratonia siliqua* L.)

In a study that conducted in the main carob growing areas in Turkey (Mediterranean and Aegean regions) on wild populations and grafted genotypes (unnamed types grafted on seedlings) (Tetik *et al*., 2011) . A total of 70 carob trees from various areas (38 wild trees and 32 grafted accessions) were analyzed in this research during 2009-2010 (Fig. 2). The average values for pod dimensions (width, length and thickness), pod mass, seed mass, seed number, pulp mass, seed and pulp ratio, acidity, SSC and pH were determined.

A considerable number of variations in most of the traits were found between and within wild and grafted genotypes of carob. The genotypes were plotted on three dimensions based on their PCA results (Fig. 2). The grafted and the wild genotypes of carob were grouped together. The grafted genotypes were easily separated from the wild genotypes. Another interesting finding was that grafted genotypes showed lower diversity than wild genotypes (Figure 2).

S allele diversity in wild accessions

Halasz *et al*. (2013) carried out a study to determine of the *S*-genotypes of 63 wild-growing Turkish apricots (*Prunus armeniaca* L.) grown in Erzincan, Turkey by PCR amplification of the *S-RNase* intron regions and *SFB* gene in order to characterise their sexual (in)compatibility phenotype (Fig. 3).

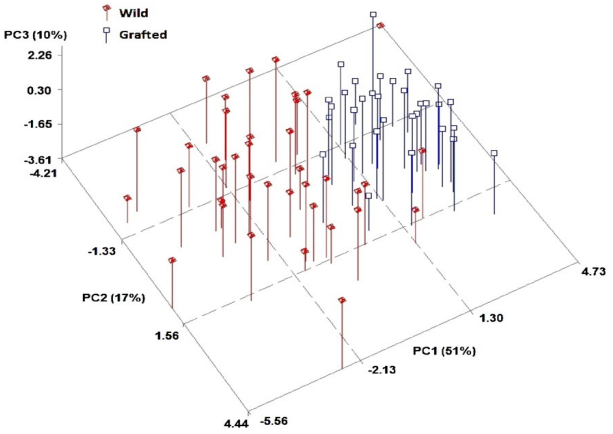

Figure 2. PCA plot of the first three PCs depicting relationships among *C. siliqua* genotypes.
Şekil 2. *C. siliqua* genotipleri arasındaki ilişkileri gösteren ilk üç PC'nin PCA gösterimi.

They identified ten previously described and two new *S*-alleles (provisionally labelled S_X and S_Y) were identified in the genotypes. They also determined a total of 36 different *S*-genotypes were assigned to the tested accessions. The S_C-allele responsible for self-compatibility in apricot was not present, indicating that all accessions are self-incompatible. The analysis of *S*-allele frequencies

allowed to conclude the allele richness in wild apricot populations. The *S*-RNase alleles detected in commercial Turkish cultivars as described by Halász *et al*. (2010) (A) and wild-grown accessions (B) in the Erzincan region.

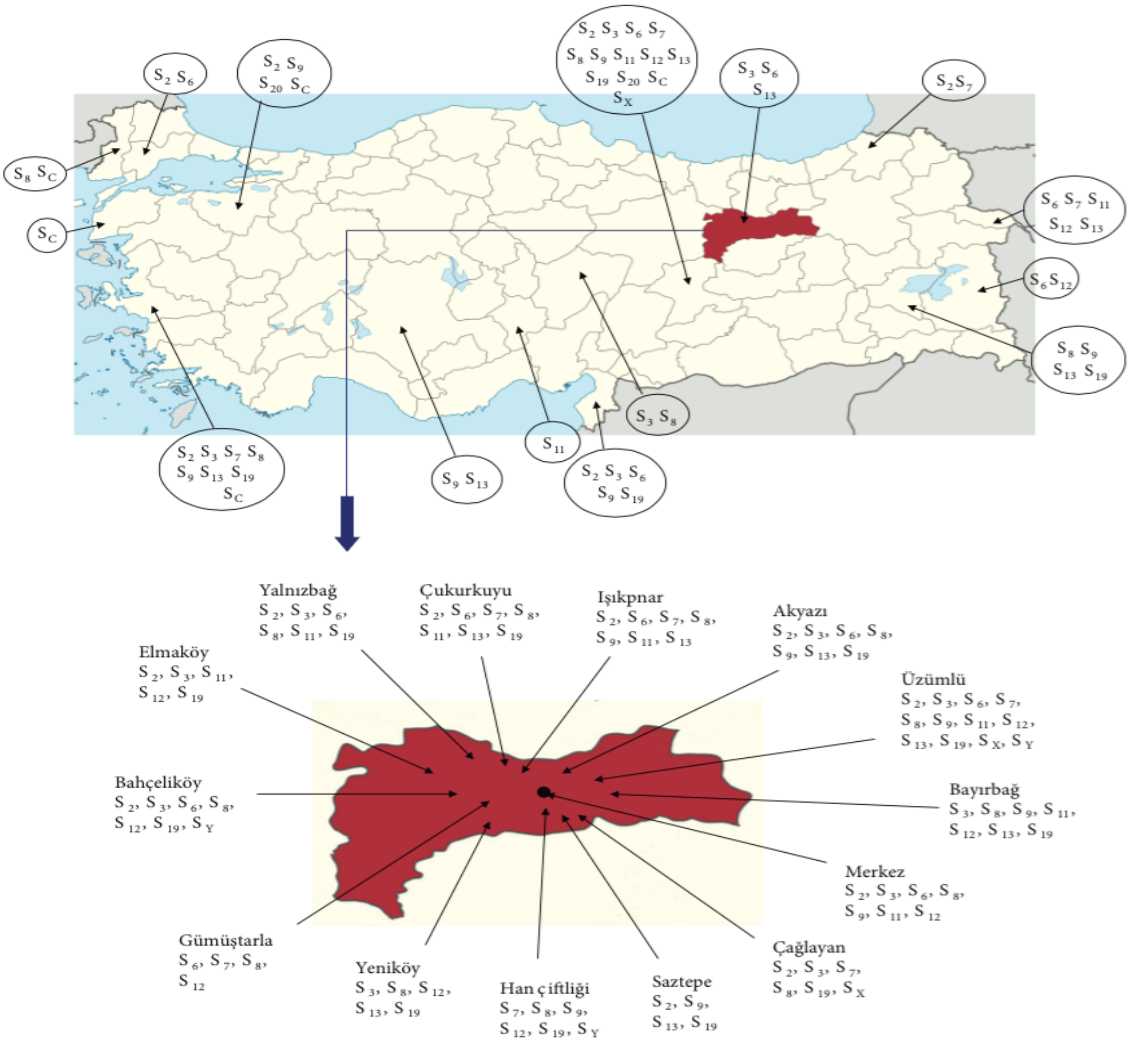

Figure 3. The spread of apricot self-incompatibility ribonuclease alleles in Turkey.
Şekil 3. Türkiye' de kayısı' da kendine uyuşmaz ribonükleaz allelerinin dağılımı.

REFERENCES

Adebooye, O. C., and O. T. Phillips. 2006. Studies of seed characteristics and chemical composition of three morphotypes of *Mucuna urens* (L.) Medikus-Fabaceae. Food Chem. 95: 658-663.

Andersen, L. T., S. H. Thilsted., B. B. Nielsen., and S. Rangasamy. 2003. Food and nutrient intakes among pregnant women in rural Tamil Nadu, South India. Public Health Nutr. 6: 131-137.

Anttonen, M. J., and R. O. Karjalainen. 2005. Environmental and genetic variation of phenolic compounds in red raspberry. Food Comp Anal. 18: 759-769.

Bowman, D. T., O. L. May., and J. B. Creech. 2003. Genetic uniformity of the U.S. upland cotton crop since the introduction of transgenic cottons. Crop Sci. 43: 515-518.

Delang, C. O. 2006. The role of wild plants in poverty alleviation and biodiversity conservation in tropical countries. Prog Dev Stud. 4: 275-286.

Deshmukh, B. S., and V. Shinde. 2010. Fruits in the Wilderness: A Potential of local food resource: Int J Pharm Bio Sci. 2 (1): 1-11.

Duvick D. N. 1984. Genetic diversity in major farm crops on the farm and in reserve. Econ Bot. 38: 161-178.

Ercisli, S. 2004. A short review of the fruit germplasm resources of Turkey. Genet. Res. Crop. Evol. 51: 419-435.

Halász, J., A. Pedryc., S. Ercisli., K. U. Yilmaz., and A. Hegedűs. 2010. *S*-genotyping supports the genetic relationships between Turkish and Hungarian apricot germplasm. J. Amer. Soc. Hort. Sci. 135: 410-417.

Halasz, J., A. Hegedus., B. Szikriszt., S. Ercisli, E. Orhan., and H. M. Unlu. 2013. The *S*-genotyping of wild-grown apricots reveals only self-incompatible accessions in the Erzincan region of Turkey. Turk. J. Biol. 37: 733-740

Ipek, A., K. Yilmaz., P. Sıkıcı., N. A. Tangu., A. T. Oz., M. Bayraktar., M. Ipek., and H. Gulen. 2016. SNP discovery by GBS in olive and the construction of a high-density genetic linkage map. Biochem Genet. 54: 313-325.

Kaczmarska, E., J. Gawronski., M. Dyduch-Sieminska., A. Najda., W. Marecki., and J. Zebrowska. 2015. Genetic diversity and chemical characterization of selected Polish and Russian cultivars and clones of blue honeysuckle (*Lonicera caerulea*).Turk. J. Agric. For. 39: 394-402.

Kacar, Y., O. Simsek., D. Donmez., M. Boncuk., T. Yesiloglu., and P. Ollitrault. 2014. Genetic relationships of some citrus genotypes based on the candidate iron chlorosis genes. Turk J Agric For. 38: 340-347.

Kumbhojkar, M. S., and V. D. Vartak. 1988. Ethno botanical studies on wild edible grapes from sacred groves in Western Maharashtra. J. Econ. Tax. Bot. 12 (2): 257-263.

Mahapatra, A. K., P. C. Panda. 2012. Wild edible fruit diversity and its significance in the livelihood of indigenous tribals: Evidence from eastern India. Food Sec. 4: 219-234.

Mishra, S. N., P. C. Tomar., and N. Lakra. 2007. Medicinal food value of *Capparis* sp. Indian J. Tradit Know. 6 (1): 232-237.

Mishra, P. K., R. B. Ram., and N. Kumar. 2015. Genetic variability, heritability, and genetic advance in strawberry (*Fragaria* × *ananassa* Duch.). Tur. J. Agric. For. 39: 451-458.

Natarajan, B., and B.S. Paulsen. 2000. An ethnopharmacological study from Thane district, Maharashtra, India: Traditional knowledge compared with modern Biological Science. Pharm Biol. 38: 139-151.

Pimentel, D., M. Mcnair., L. Buck., M. Pimentel., and J. Kamil. 1997. The value of forests to world food security. Hum. Ecol. 25: 91-120.

Rauf, S., J. T. da Silva., A. A. Khan., and A. Naveed. 2010. Consequences of plant breeding on genetic diversity. Int. J. Plant Breed. 41: 1-21.

Reddy, K. N., C. Pattanaik., C. S. Reddy., and V. S. Raju. 2006. Traditional knowledge on wild food plants in Andhra Pradesh. Indian J. Tradit Know. 6 (1): 223-229.

Redzic, S. J. 2007. Wild edible plants and their traditional use in the human nutrition in Bosnia-Herzegovina. Ecol Food Nutr. 45 (3): 189-232.

Reyes-Carmona, J., G. G. Yousef., R. A. Martinez-Peniche., and M. A. Lila. 2005. Antioxidant capacity of fruit extracts of blackberry (*Rubus* sp.) produced in different climatic regions. J. Food Sci. 70: 497-503.

Tetik, N., I. Turhan., H. R. Oziyci., H. Gubbuk., M. Karhan., and S. Ercisli. 2011. Physical and chemical characterization of *Ceratonia siliqua* L. germplasm in Turkey. Sci. Hort. 129: 583-589.

Tsou, C., L. Li., and K. Vijayan. 2016. The intra-familial relationships of Pentaphylacaceae as revealed by DNA sequence analysis. Biochem Genet. 54: 270-282.

Tuxill, J. 1999. Appreciating the Benefits of Plant Biodiversity. *In*: Brown, L.R., Flavin, C., French, H. and Starke, L., State of the World 1999: a Worldwatch Institute Report on Progress Toward a Sustainable Society, W.W. Norton, New York. pp. 96-114.

Yildiz, H., M. Sengul M., F. Celik., A. Hegedus., S. Ercisli., and M. Tosun. 2010. Some phytochemical and antioxidant characteristics of wild and cultivated blackberry (*Rubus caucasicus*) fruits. J. Food Agric Environ. 8 (3-4): 156-159.

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Molecular Characterization of Materials Selected from Some Camelina [Camelina sativa (L.) Crantz] Populations

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ABSTRACT: Camelina sativa *(L.) Crantz. is an oilseed crop which is native to Mediterranean and Central Asia. In the recent years, the* ***Camelina*** *oil became popular worldwide for human consumption, Omega-3 fatty acid content and possibility of the use as biodiesel fuel. The fact that it grows naturally in flora of Turkey, its competition power with the other plants in the growing field and the possibility of its cultivation without high amounts of nutrients make it as an alternative oil plant. Molecular characterizations of single plant, which was selected from thirty four* ***Camelina*** *accessions obtained from the US Gene Bank and from the Central Research Institute of Field Crops in Turkey, were used in this study. These seedlings were tested with seventy-three universal ISSR markers. Then eleven markers, which were highly polymorphic, were selected for characterization. According to characterization results, statistical analyses were performed in NTSYS-PC. Hence, genetic relationship between genotypes was shown on dendrogram which will be used in breeding purpose.*

Keywords: Camelina sativa*, false flax, molecular characterization, ISSR.*

Bazı Ketencik [Camelina Sativa (L.) Crantz] Populasyonlarından Seçilen Materyallerin Moleküler Karakterizasyonu

ÖZ: *Ketencik [****Camelina sativa*** *(L.) Crantz], Akdeniz ve Orta Asya'ya özgü yağlı tohumlu bir bitkidir. Son yıllarda,* ***Camelina*** *yağı yüksek Omega-3 yağ asidi içeriği ve biyodizel yakıt olarak kullanılma olanağı nedeniyle dünya çapında popüler hale gelmiştir. Türkiye'nin bitki örtüsünde doğal olarak yetişmesi, yetiştiği alanlarda diğer bitkilerle olan rekabet gücünün fazla olması ve yüksek miktarda besin elementlerine ihtiyaç duymaması nedeniyle alternatif bir biyodizel bitkisi haline gelmiştir. Bu çalışmada, ABD Gen Bankası'ndan ve Türkiye Tarla Bitkileri Merkez Araştırma Enstitüsü'nden elde edilen otuz dört* ***Camelina*** *aksesyonundan seçilen tek bitkilerin moleküler karakterizasyonu yapılmıştır. Bu genotipler yetmiş üç universal ISSR markörü ile test edilmiştir. Daha sonra, genetik karakterizasyon çalışmaları için polimorfik olan onbir primer seçilmiştir. Elde edilen sonuçların istatistiksel analizi NTSYS-PC programında yapılmıştır. Elde edilen dendogram ile genotipler arasındaki genetik ilişki belirlenmiş olup, bu bilgi gelecekteki ıslah programlarına yön verebilecektir.*

Anahtar Sözcükler: Camelina sativa*, ketencik, moleküler karakterizasyon, ISSR.*

INTRODUCTION

Camelina sativa (L.) is named as German sesame and Siberian oil. The natural distribution area is Mediterranean and Central Asia (Putnam, *et al.,*1993; McVay, 2008). The oil is used as food, as lamp oil and for cosmetics since ancient times (Knorzer, 1978). Cultivation of the *Camelina sativa* began in the Neolithic period and was used as an oil plant throughout the Iron Age (Knorzer, 1978).

There are seven commonly known species of *Camelina* Crantz., namely *Camelina sativa* (L.) Crantz., *C. laxa* C. A. Mey, *C. rumelica, C. microcarpa* Andrz. ex DC., *C. hispida* Boiss., *C. anomala* Boiss. & Hausskn. and *C. alpkoyensis* Stars. (Mutlu, 2012). Among these species, *Camelina sativa* is the only species with economic importance (Kurt and Seyis, 2008).

Camelina sativa contains many natural antioxidants, such as tocopherols, which are used as oil stabilizing and edible oil. The most important feature of *Camelina sativa* is the high linolenic acid content (38%). Hence, *Camelina sativa* meets requirement of cooking oil because of rich OMEGA-3 fatty acid content (Crowley and Fröhlich, 1998). Furthermore, the plant is an important source for biodiesel and used in the machine lubricant industry. The high iodine value of the methyl ester *of Camelina sativa* oil allows the machine to be used in oil for longer time without deterioration (Frohlic and Rice, 2005). Because of that, several molecular studies about *C. sativa* genotypes were published in literature (Vollmann *et al*., 2005; Gehringer *et al.,* 2006; Ghamkhar *et al.,* 2010).

The purpose of our research is to provide information for breeding of *Camelina sativa*. Our research is the first research in Turkey which provides information on molecular basis for breeding purposes.

MATERIALS AND METHODS

Thirty four *Camelina sativa* (L.) Crantz genotypes were used in this study, which were gathered from the Seed Bank of the Agricultural Research Service of the United States Department of Agriculture (Table 1).

The seeds were planted in pots and kept in 25 ^{o}C temperature and 45-52% humidity in the climate cabinet. After 21 days, the DNA was isolated from fresh leaves by DNeasy Plant Mini Kit from Qiagen (Hilden, Germany). DNA quality and quantity were controlled in 1% agarose gel. PCR amplification was performed according to modified Qiagen protocol; in a total volume of 25 µl master mix (2x PCR Master Mix Fermentas); containing 20–50 ng of genomic DNA, 1µl l M primer and 1 unit of Taq DNA polymerase. PCR reactions were started with an initial denaturation of 2 min at 94 ^{o}C; followed by 30 cycles of 1 min at 94 ^{o}C, 2 min at 52 ^{o}C (annealing) and 40 s at 72 ^{o}C (extension), with a final extension step at 72 ^{o}C for 5 min. Amplified products were separated by 2 % agarose gel electrophoresis with 1x TBE buffer and stained with ethidium bromide. DNA bands were visualized by KODAK GL 200 Imaging Cabinet (Eastman Kodak Company, Rochester, USA).

Eleven primers formed polymorphic bands out of 73 oligonucleotide primers (Table 2). The GC percentages of selected primers were between of 47.1% and 66.7%. Amplified bands were coded as diallelic characters (present=1, absent= 0). Fragment sizes were determined manually by 100 bp DNA Ladder Plus (Fermentas, Carlsbad, CA, USA). The IBM PC version of NTSYS (Rohlf, 2000) was used for clustering analysis (CA). A Mantel test (Mantel, 1967) was applied to Jaccard's, Simple matching and Dice similarity coefficients. The maximum value (r=0.83819) was obtained with Jaccard's. Thus, we combined the Jaccard's similarity coefficient with the Unweighted Pair Group with Arithmetic Mean (UPGMA) clustering algorithm for CA. The complete data matrix is available on request in NTS format.

RESULTS AND CONCLUSION

After the screening of 34 genotypes with 11 ISSR primers (UBC primers No. 841, 842, 826, 820,

811, 810, 889, 887, 878, 851 and 14), 51 polymorphic bands were obtained. The size of bands ranged from 100 bp to 1000 bp.

When the dendrogram drawn according to the Jaccard's index was examined, it was seen that the dendogram was divided into two branches (Figure 1). The cluster in the second branch was mostly from the European - Siberian floristic region. The geographical locations of our country and other countries were concordant with the clusters in the dendrogram.

The two most closely clustered accessions in the dendrogram were 14 and 16, Denmark and Germany respectively. They were similar to each other with 0.89. According to the obtained dendrogram, accessions 44 and 30, which were from Poland and Germany were the least similar to the rest of the *Camelina* accessions and formed another cluster. The similarity index score of these two accessions was 0.48. Apart from this cluster, the other cluster had another two groups. One group consisted accessions 37 and 6, and the other group consisted the rest. The similarity level of these two groups was 0.58.

To conclude, it is clear that *Camelina* has a high potential to be an alternative source for oil industry. Results of the study provide priceless value to literature of *Camelina* plant. We hope that our results will contribute the future breeding programs and to develop new varieties.

Table 1. *Camelina sativa* accessions used in our study.
Çizelge 1. Çalışmada kullanılan *Camelina sativa* aksesyonları.

No	Code	Origin	No	Code	Origin
2	Ames 31220	Georgia	30	PI 650152	Germany
5	Ames 31232	Georgia	31	PI 650153	The Former Soviet Union
6	PI 258366	The Former Soviet Union	32	PI 650154	The Former Soviet Union
7	PI 258367	The Former Soviet Union	33	PI 650155	Poland
10	PI 304270	Swiss	36	PI 650158	Poland
11	PI 304271	Swiss	37	PI 650159	Poland
13	PI 311736	Poland	38	PI 650160	The Former Soviet Union
14	PI 597833	Denmark	39	PI 650161	The Former Soviet Union
15	PI 633192	Germany	40	PI 650162	Poland
16	PI 633193	Germany	41	PI 650164	Austria
17	PI 633194	Germany	42	PI 650165	The Former Soviet Union
20	PI 650142	Denmark	44	PI 650167	Poland
23	PI 650145	Germany	46	PI 652885	Slovenia
25	PI 650147	Swiss	47	PI 652886	Slovenia
27	PI 650149	Germany	48	Einfact (Leindotter)	Germany
28	PI 650150	Denmark	49	K-49	Germany
29/2	PI 650151	Swiss	52	K-52	Ukraine

Table 2. Sequences of the primers used in our study.
Çizelge 2. Çalışmada kullanılan primer dizileri.

Primers	Sequence 5′ → 3′
UBC841	GAGAGAGAGAGAGAGAYC
UBC842	GAGAGAGAGAGAGAGAYG
UBC826	ACACACACACACACACC
UBC820	GTGTGTGTGTGTGTGTC
UBC811	GAGAGAGAGAGAGAGAC
UBC810	GAGAGAGAGAGAGAGAT
UBC889	DBDACACACACACACAC
UBC887	DVDTCTCTCTCTCTCTC
UBC878	GGATGGATGGATGGAT
UBC851	GTGTGTGTGTGTGTGTYG
UBC814	CTCTCTCTCTCTCTCTA

B = (C, G, T); D = (A, G, T); V = (A, C, G); Y = (C, T).

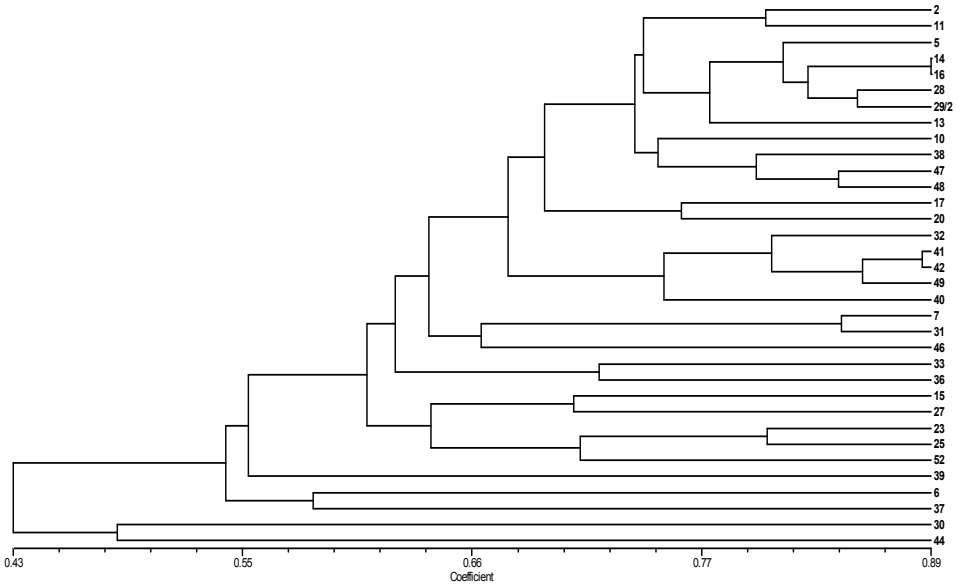

Figure 1. CA dendrogram of *Camelina sativa* accessions created with UPGMA.
Şekil 1. *Camelina sativa* aksesyonları için UPGMA ile oluşturulan kümeleme analiz dendogramı.

REFERENCES

Crowley, J. G. and A. Fröhlich. 1998. Factors Affecting the Composition and Use of *Camelina*. Crops Research Centre, Oak Park, Carlow.

Frohlic, A. and B. Rice. 2005. Evaluation of *Camelina sativa* oil as feedstock for biodiesel production. Industrial Crops and Products 21 (1): 25-31.

Gehringer, A., W. Friedt, W. Lühs, and R. J. Snowdon. 2006. Genetic mapping of agronomic traits in false flax (*Camelina sativa* subsp. *sativa*) *Genome*, 2006, 49 (12): 1555-1563.

Ghamkhar, K., J. Croser, N. Aryamanesh, M. Campbell, N. Kon'kova, and C. Francis. 2010. *Camelina* [*Camelina sativa* (L.) Crantz] as an alternative oilseed: molecular and ecogeographic analyses. Genome 53 (7): 558-567.

Knorzer, K. H. 1978. Evolution and spread of gold of pleasure (*Camelina sativa* S. L.). Ber. Dtsch. Bot. Ges. 91: 187-195.

Kurt, O., and F., Seyis, 2008. Alternatif Yağ Bitkisi: Ketencik [*Camelina sativa* (L.) Crantz]. OMU. Zir. Fak. Dergisi 23 (2): 116-120.

Mantel, N. A. 1967. The detection of disease clustering and a generalized regression approach. Cancer Res. 27: 209-220.

Mcvay, K. A. 2008. *Camelina* Production in Montana: A self-learning resource from MSU Extension (MT200701AG). Available at: http://www.msuextension.org.

Mutlu, B. 2012. *Camelina*. *In*: A.Güner, S.Aslan, T.Ekim, M.Vural, M.T.Babaç (Eds). Türkiye Bitkileri Listesi (Damarlı Bitkiler), İstanbul, Nezahat Gökyiğit Botanik Bahçesi ve Flora Araştırmaları Derneği Yayını, 2012.

Putnam, D. H., J. T. Budin, L. A. Field, and W. M. Breene. 1993. *Camelina*: a promising low-input oilseed. *In*: Janick J, Simon J. E. (Eds.) New crops. Wiley, New York, pp. 314-322.

Rohlf, F. J. 2000. NTSYS-pc: Numerical taxonomy and multivariate analysis system, version 2.01. Applied Biostatistics. Setauket, New York.

Vollmann, J., H. Grausgruber, G. Stift, V. Dryzhyruk, and T. Lelley. 2005. Genetic diversity in *Camelina* germplasm as revealed by seed quality characteristics and RAPD polymorphism. Plant Breeding 124: 446-453.

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In Vitro Plant Regeneration of Libyan Wild Plants: Edible Species (Arbutus pavarii) and Endanger Species [Haplophyllum tuberculatum (Forsk.) Juss]

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ABSTRACT: *Protocol of micropropagation of* ***Arbutus pavarii*** *and* ***Haplophyllum tuberculatum*** *was successfully achieved.* ***In vitro*** *plant regeneration of* ***Arbutus pavarii*** *was attempted using single nodal on MS medium supplemented with different concentration of three various growth regulators indole-3-butyric acid (IBA), Kinetin (K) and N-Isopentenylaminopurine (2ip). Multiple shoots from single node were obtained on MS medium with the 0.5 mg/l 2ip. While, faster improving of shoots elongation was on MS contained 0.5 mg/l K. Explants obtained in micropropagation step were used for rooting step under several treatments. The best results were obtained when explants were sup-cultured on MS medium with 1 mg/l IBA. New plants were vigorous, of good quality and presented phenotypic characters similar to mother plants. Micropropagation of* ***Haplophyllum tuberculatum*** *was achieved from sterilized single nodal segments on MS medium supplemented with for different concentrations of 2,4-D for callus induction and other different hormones K and BA for multiplication of auxiliary branches and rooting . The highest results of the weight of callus were growing in MS medium containing 1 or 2 mg/l 2.4-D hormone with maltose. Whereas, the axillary soothing was significantly proliferated on MS medium supplemented 2 mg/ l^{-1} K. Acclimation of plantlet was in greenhouse.*

Keywords: Micropropagation, growth regulators, ***Arbutus pavarii****,* ***Haplophyllum tuberculatum****,* ***in vitro*** *culture.*

INTRODUCTION

Plant biodiversity is reported that one of important genetic resources of many species growing spontaneously around the Mediterranean basin (Louhaichi *et al*, 2011). Libya is one of Mediterranean basin country and a native of many plant species that model of biodiversity (El-Darier and El-Mogaspi, 2009). Plants that have economic importance such as *Haplophyllum tuberculatum* (Forsk.) Juss and strawberry trees (*Arbutus pavarii)* which are located in different environments (coastal, mountainous and desert) in Libya (El-Darier and El-Mogaspi, 2009). There are a number of factors for the difficulty of germination and growth of these plants naturally in the wild land. Drop in rate of rainfall annually it is the most important environmental factor which has made the wild lands drier and decreased significantly seeds germination (Elmaghrabi *et al.,* 2017). In addition, overgrazing and the use of lumber as firewood and also expansion of new farms, which contributed of deterioration sharply of edible and medical wild plant resources which led these species to endanger (Elmaghrabi *et al* 2017).The genus *Arbutus* belongs to the *Vaccinioideae* subfamily which includes evergreen shrub-like woody taxa with laurel-like and sclerophyllous leaves of the *Ericaceae* family (Torres *et al*., 2002). There were about six species

of *Arbutus* grows spontaneously around the Mediterranean basin. The species is drought tolerant and able to regenerate following forestry fires making it quite interesting for forestation programs in Mediterranean regions. Fruits are used to make jellies and a spirit which represents the main income for owners (Torres *et al*., 2002). *Arbutus pavarii* species it is only located in the coast of Libya especially at El-Jabal El-Akhdar Region in the Mediterranean Regions (El-Darier and El-Mogaspi, 2009). *Haplophyllum tuberculatum* (Forsk) juss that belongs to the Rutaceae familly (El-Naggar *et al*., 2014). *Haplophyllum tuberculatum* is a herbal plant is, simple leaves, reciprocal, heterogeneous white, small yellow flowers (Puricelli *et al*., 2002). The whole plant is being used in pharmaceutical product with the exception of the roots. The essential oil of *Haplophyllum tuberculatum,* which prepared by hydrodistillation of the fresh flowering aerial parts of the plant collected from wild types (Al-Rehaily *et al*., 2014). The oil was subsequently analyzed by GC and GC-MS. Thirty seven compounds, accounting for 96.4 % of the oil composition were identified in this study (Al-Rehaily *et al.*, 2014). The antimicrobial and activity of the essential oil was also evaluated against various human pathogens, where a relatively low inhibitory range was observed. Because these species (*Haplophyllum tuberculatum* and *Arbutus pavarii*) which have good economic value and, the scarcity of plant biomass available in the natural habitat, we set up non-conventional methods for plant propagation from nodal stem segments and, at the same time, we established cell cultures of the plant (Elmaghrabi *et al.*, 2017). Native plants, calli and suspension cultures were found to produce several plant regeneration which was true-to-typeness (Elmaghrabi and Ochatt, 2006). Micropropogation of endanger and medical plants which difficult to propagate under normal condition for biodiversity and environmental balances that will lead to improve agriculture facility in Libya. The purpose of this study was to develop an efficient protocol for *in vitro* propagation of endanger edible strawberry tree (*Arbutus pavarii*) and medical plant *Haplophyllum tuberculatum*.

MATERIALS AND METHODS

In order to investigate the effects of different concentrations of growth regulator into MS medium (Murashige and Skoog, 1962) for *in vitro* culture initiation and callus formation. Single nodal segments were used as explants, obtained from young growth of an adult plant growing in the wild near Tripoli for *Haplophyllum tuberculatum* and El-Jabal El-Akhdar Region for *Arbutus pavarii*. Following excision, all explants were well washed under running tap water. Explants were surface-sterilized with immersed in ethyl alcohol concentration of 70% for two minutes and with 20% (v/v) commercial sodium hypochlorite (NaOCl) with 0.1% Tween 20, for 15 min, followed by four 3-min rinses with sterile distilled water. Explants of *Arbutus pavarii* placed (25×100 mm, one explant per tube) with 10 ml medium. The test tubes were covered with transparent plastic film. The culture medium consisted of MS medium (Murashige and Skoog, 1962) with 3% (w/v) sucrose and 0.8% (w/v) agar. The effect of three growth hormones at 0.5 or 1.0 mg/l each was compared: benzyladenine (BA), kinetin (K) *N*-isopentenyl adenine (2iP) or indole-3-butyric acid (IBA). While the four explants of *Haplophyllum tuberculatum* were placed in Petri dish with 20 mL MS medium with 3% (w/v) maltose supplemented various concentration (0.5, 1.0, 2.0 or 4.0 mg/l) of 2,4-Dichlorophenoxyacetic acid (2,4-D) for callus induction. Then the callus were sub-cultured on MS medium with different concentration (0.1, 0.5, 1.0 or 2.0 mg/l) of K or BA. Forty-eight explants for both species (*Arbutus pavarii* and *Haplophyllum tuberculatum*) per treatment were used. After 45 days in culture, data were recorded evaluating shoots length and number of: branches, leaves and roots and a subculture were carried out using the media of the initial culture of each three weeks. Cultures were incubated at 25°C, 16 h photoperiod under 37.5

μmol m^{-2} s^{-1} fluorescent light. The pH of the media was adjusted at 5.6-5.7 before autoclaving at 121°C for 20 min. For ex vitro acclimatization well rooted micro shoots were transferred to 300 ml jars, containing 1 part of perlite and 1 part of compost (v/v). The plants, for both species initially covered with transparent film, and placed under, 16-h photoperiod (natural day light extended with incandescent light). The completely randomized design was used. The significance of the results was tested by ANOVA with Minitab software (version 17) and the means were compared by Student's t at P=0.05.

The percentage of responding explant did not exceed 79% for *Arbutus pavarii*. However, cultures were successfully established at intervals of 45 days (Table 1, Fig 1). The best results of root number (24.2 per explant) were obtained when explants sup-cultured on MS medium supplemented with 1 mg/l IBA (Table 1). The shoot elongation (2.96 cm) and the number of roots (10.8) were the high medium on supplemented with 0.5 mg/l K, comparison to media with BA or 2iP (Table 1).While, on medium with 0.5 mg/l 2ip produced the highest number of leaves (12.7) and number of branches (2.0) (Table 1).0.5 mg/l of K or 2ip was much more effective for shoot length, root induction and number of: branches and leaves than BA or IBA or even 1 mg/l K or 2ip which were produced the lowest number of roots 2.9 and 2.8, respectively (Table 1). Therefore, K or 2ip at 0.5 mg/L proved the most effective cytokinin for culture initiation, multiplication and acclimatization *in vivo* culture stages of *Arbutus pavarii* (Fig 1).

Similar results concerning the effectiveness of various cytokinins on shoot production have been reported for *A. andrachne* (Bertsouklis and Papafotiou, 2009). It is reported that in plants of the family *Ericaceae*, the natural compounds zeatin and 2iP are more effective than other cytokinins for shoot proliferation (George *et al*., 2008). Rooting is essential to the success of micropropagation. Without an effective root system plant acclimatization will be difficult and the rate of plant propagation may be severely affected (Gonçalves *et al*., 1998). Seventy-five of the micro shoots were rooted *in vitro* on MS with 0.5 mg/l K and 70% of the micro plants established successfully acclimatization *in vivo* culture (Fig 1).

In terms of *Haplophyllum tuberculatum,* during assessment stage of callus induction on MS medium supplemented with four various concentration of 2,4-D hormone, 2 or 4 mg/l 2,4-D was produced significantly the highest weight of callus induction, in comparison of 0.0, 0.5 or 1.0 mg/l 2,4-D (Fig. 2). Amongst two cytokinins tested, K proved to be more effective than BA for initiating shoots and a higher yield of shoot per explant (Table 2). Kinetin at 1mg/l seemed to be the best concentration, since it facilitated a high rate of proliferation, shoot induction, number of leaves and shoot elongation (Table 2). Although at a higher concentration, K (2 mg/l) stimulates a biggest of number of brunches, but significantly reduced their shoot length, number of roots and also associated with shoot induction (Table 2). Conversely BA (1-2 mg/l) induced limited average of shoot induction, but stimulated number of branches. While, medium with 2 mg/l produced significantly the best number of roots (Table 2). The shoot induction and root development was significantly decreased when callus sub-cultured on MS medium supplemented with 0.1 mg/l for both cytokinins K and BA. Whereas, 0.5 mg/l BA produced high of shoot length and number of branches, but 0.5 mg/l K it is only stimulated shoot elongation (Table 2). Therefore, micropropagation of *Haplophyllum tuberculatum* was achieved and all stages *in vitro* culture exhibited in this study started from callus induction on MS medium with 2 mg/l 2,4-D until plantlet acclimatization *in vivo* culture (Fig 3). According to earlier articles the aptitude for proliferations of this medical plant species was limited. In comparison although similar results were reported on B5 medium supplemented with 1.3 mg/l 2,4-D and 0.25 mg/l K (Puricelli *et al*, 2002). Protocol described in this study with 1mg/l K involved five sub-cultured resulting in higher yield of axillary shoots. Moreover, the rooting and shooting rates reported here is higher than one previously obtained by Gholami *et al*. (2009) on MS medium supplemented with 1 mg/l IBA. *In vitro* rooting

and ex vitro establishment were similar to that reported for *A. andrachne* (Bertsouklis and Papafotiou, 2009). Similarly, *Capparis spinosa L.* plantlets obtained *in vitro* were easily acclimatized (Elmaghrabi *et al.*, 2017).

CONCLUSION

These results indicate the enormous potential of these methods for the biomass propagation of both species *Arbutus pavarii* and *Haplophyllum tuberculatum*.

The protocols developed in this study will be useful for micropropagation of endanger and medical plants which difficult to propagate under normal condition for biodiversity and environmental balances that will lead to improve agriculture facility in Libya.

Table 1. The effects of growth hormones on the percentage of explants responding, the number of: branches, leaves, roots and shoot length, per explants of *Arbutus pavarii* after 45 days of culture initiation of single nodal sections on MS medium.

Treatment (mg L^{-1})	Shoot length (cm)	Number of branches	Number of leaves	Number of roots	Explants responding (%)
Control (0)	1.48	0.93	4.1	0.1	18.2
0.5 BA	1.52	1.50 *	9.6 *	4.8 *	32.7 *
1.0 BA	1.92	1.60 *	9.9 *	3.7 *	58.2 **
0.5 2ip	2.07 *	2.00 *	12.7 *	7.7 **	68.8 ***
1.0 2ip	2.01 *	1.60 *	9.9 *	2.8 *	64.7 **
0.5 K	2.96 **	1.70 *	11.9 *	16.8 ***	75.8 ***
1.0 K	1.99	1.80 *	12.2 *	2.9 *	77.5 ***
1.0 IBA	2.36 *	1.10	7.8	24.2 ***	72.8 ***

Means of the same column which are followed stars are statistically different at $p \leq 0.05$.

Table 2. The effects of cytokinin on the average of shoot induction, the number of: branches, leaves, roots and shoot length, per explants of after 45 days of culture initiation of *Haplophyllum tuberculatum* Forsk. Juss callus of single nodal sections on MS medium.

Treatment (mg L^{-1})	Shoot length (cm)	Number of branches	Number of leaves	Number of roots	Average of shoot indication
Control (0)	1.0	3.0	1.1	0	17.1
0.1 BA	1.3	4.0	1.2	0	50.2 **
0.5 BA	1.8 *	14.0 *	4.5 **	2.9 **	62.0 ***
1.0 BA	1.7 *	15.1 **	4.4 **	3.2 **	13.3
2.0 BA	1.4	13.0 *	4.2 **	5.3 ***	17.1
0.1 K	1.2	9.0	1.0	0.1 *	13.0
0.5 K	1.9 *	12.1 *	2.6 *	0.9 *	25.2 *
1.0 K	2.0 *	16.2 **	4.1 **	4.5 ***	73.0 ***
2.0 K	1.4	14.1 *	5.3 **	1.7 *	54.4 **

Means of the same column which are followed by stars are statistically different at $p \leq 0.05$.

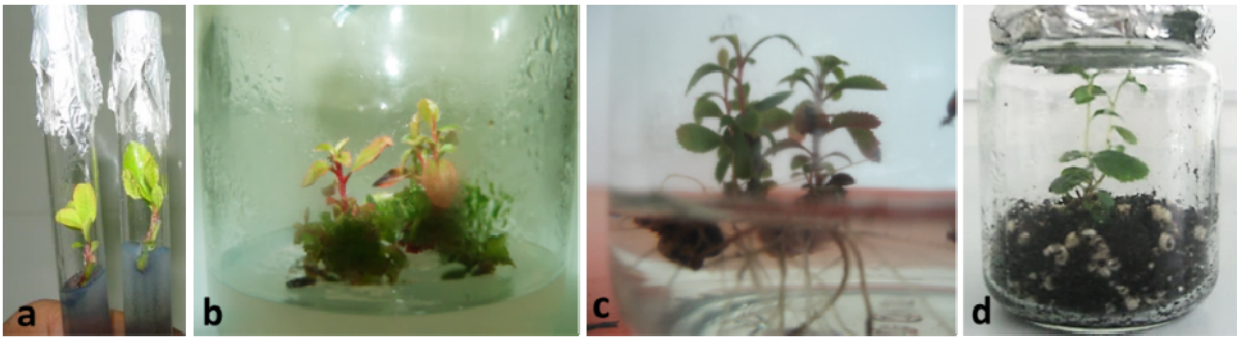

Figure 1. Stages of micropropagation of *Arbutus pavarii*; a, Shoot induced from nodal segments on modified MS medium supplemented with 0.5 mg/l K; b, Multiplication of shoots; c, Four week old rooted shoots on same medium (0.5 mg/l K); b, *Ex vitro* acclimatization well rooted micro shoots were transferred to 300 ml jars, containing 1 part of perlite and 1 part of compost (v/v) for full plant.

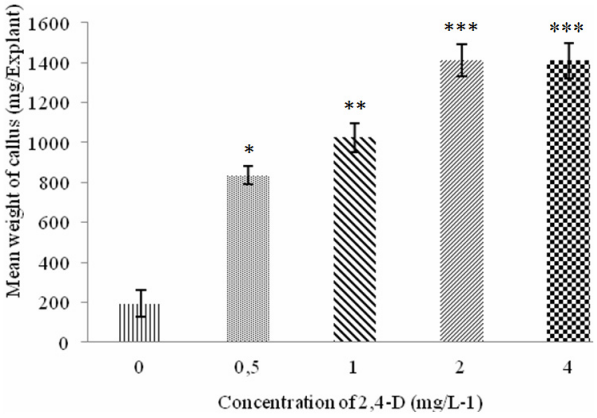

Figure 2. Composite mean (± S.E.) callus growth of *Haplophyllum tuberculatum* Forsk. Juss after a four-week on MS medium supplemented with four various concentrations (0.5, 0.1, 2.0 or 4.0 mg/l) of 2,4-D. Callus FW was recorded after four weeks. ($P \leq 0.05$) (n= 12 replicates).

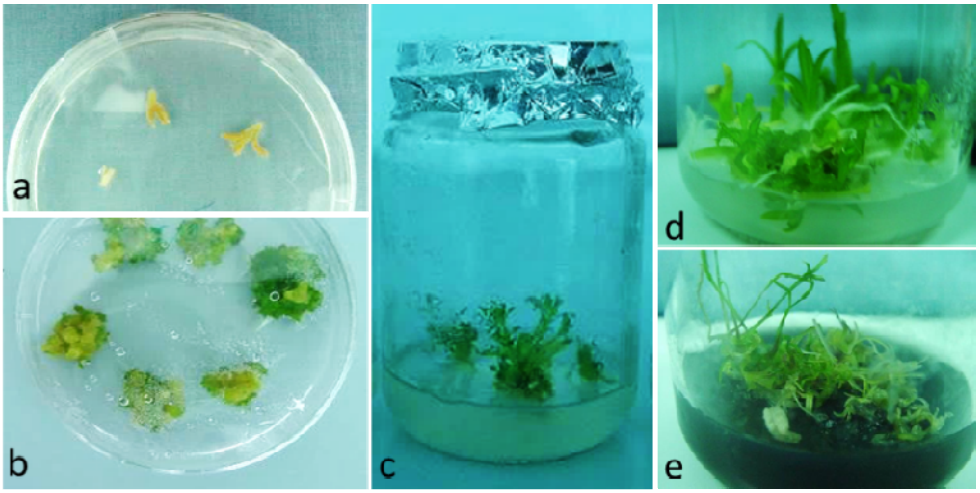

Figure 3. Stages of micropropagation of *Haplophyllum tuberculatum* Forsk. Juss; a, Single nodal segments; b, Callus induction and development on modified MS medium supplemented with 2 mg/l 2.4-D; c, Multiplication of shoots on MS medium contained 1.0 mg/l K; d, Six week old rooted shoots on same medium (1.0 mg/l K); e, Ex vitro acclimatization well rooted micro shoots were transferred to 300 ml jars, containing 1 part of perlite and 1 part of compost (v/v) for full plant.

REFERENCES

Al-Rehaily, A. J., S. I. Alqasoumi, H. S. Yusufoglu, M. A. Al-Yahya, B. Demirci, N. Tabanca, D. E. Wedge, F. Demirci, U. R. Bernier, J. Becnel, H. E. Temel, and K. H. Baser. 2014. Chemical composition and biological activity of *Haplophyllum tuberculatum* Juss. essential oil. Journal of Essential Oil Bearing Plants 17 (3): 452-459.

Bertsouklis, K. F., and M. Papafotiou. 2009. *In vitro* propagation of *Arbutus andrachne* L. Acta Hort. 813: 477-479.

El-Darier, S. M., and F. M. El-Mogaspi. 2009. Ethnobotany and relative importance of some endemic plant species at El-Jabal El-Akhdar Region (Libya). World Journal of Agricultural Sciences 5 (3): 353-360.

Elmaghrabi, A. M., and S. J. Ochatt. 2006. Isoenzymes and flow cytometry for the assessment of true-to-typeness of calluses and cell suspension of barrel medic prior to regeneration. Plant Cell Tissue Org. Cult. 85: 31-43.

Elmaghrabi, A. M., E. Abughnia, and S. Hamoud. 2017. *In vitro* propagation of the wild medicinal plant, caper (*Capparis spinosa* L.). African Journal of Biotechnology. ISSN: 1684-5315. http://www.academicjournals.org/AJB. (under press).

El-Naggar, E. B., S. M. El-Darier, A. A. El-Mekanen, E. Švajdlenka, and M. Zemlièka,. 2014. Chemical Composition of Essential Oil of *Haplophyllum tuberculatum* (*Rutaceae*) Grow Wild in Different Habitats of Egypt. Global Journal of Pharmacology 8 (3): 385-393.

George, E. F., M. A. Hall, and G. J. De Klerk. 2008. Plant Propagation by Tissue Culture, 3rd Edition. Springer.

Gonçalves, J. C., G. Diogo, and S. Amâncio. 1998. *In vitro* propagation of chestnut (*Castanea sativa* × *C. crenata*): Effects of rooting treatments on plant survival, peroxidase activity and anatomical changes during adventitious root formation. Sci. Hort. 72 (3): 265-275.

Gholami, M., K. Javidnia, R. Miri, and M. Soltani. 2009. Micropropagated *Haplophyllum patavinum* Hand-Mazz. (Rutaceae) Oil as rich source of α-Palmitolactone. Iranian Congress of Physiology and Pharmacology (19). http://en.seminars.sid.ir/ViewPaper.aspx?ID=1607.

Louhaichi, M., A. K. Salkini, H. E. Estita, and S. Belkhir. 2011. Initial Assessment of Medicinal Plants Across the Libyan Mediterranean Coast. Advances in Environmental Biology 5 (2): 359-370.

Murashige, T., and F. Skoog. 1962. A revised medium for rapid growth and bioassays with tobacco tissue cultures. Physiol. Plant. 15: 473-497.

Puricelli, L., G. Innocenti, G. Dellemonache, R. Caniato, R. Filippini, and E. M. Cappelletti. 2002. *In vivo* and in vitro production of alkaloids by *Haplophyllum patavinum.* Natural Product Letters 16 (2): 95-100.

Torres, J. A., F. Valle, C. Pinto, A. Gar cia-Fuentes, C. Salazar. And E. Cano. 2002. *Arbutus unedo* L. communities in southern Iberian Peninsula mountains. Plant Ecol. 160: 207-223.

ANADOLU (ISSN 1300 – 0225) DERGİSİ
YAYIN İLKELERİ

1. ANADOLU dergisinde tarım bilimleri alanında hazırlanan ve daha önce yayımlanmamış orijinal araştırma, derleme ve bitki tescil makaleleri yayımlanır.
2. ANADOLU, hakemli bir dergi olup, yılda 2 sayı yayımlanır.
3. Makale Türkçe ve İngilizce dillerinden birisi ile, 25 sayfayı geçmeyecek şekilde, çift aralıklı olarak yazılmalı, başlangıç sayfası dahil tüm sayfalar numaralandırılmalıdır.
4. Makale, Microsoft Word yazılım programıyla bir basılı kopya ve CD ile ve birlikte yayın komisyonuna posta ile gönderilir. Ayrıca, elektronik ortamda e-posta ile "etae@tarim.gov.tr" adresine gönderilmesi de önemle önerilir.
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7. **Makalenin ana bölümleri aşağıdaki sıraya uygun olmalıdır**

   Makale; Başlık, Özet, Türkçe Anahtar Sözcükler, Abstract, Keywords, Giriş, Materyal ve Metot, Bulgular ve Tartışma, Sonuç ve Öneriler (isteğe bağlı), Teşekkür (isteğe bağlı) ve Literatür Listesi ana başlıkları altında hazırlanmalıdır. Tüm başlıklar büyük harflerle koyu punto olmalıdır.

   BAŞLIK: Metne uygun, kısa ve açık olmalı; yazar ad (adlarını) ve adresini kapsamalıdır.

   ÖZ (ABSTRACT): 200 kelimeyi geçmemeli, literatür bildirişi ve şekil içermemeli, Türkçe ve İngilizce olarak yazılmalı, makalenin içeriğini yansıtan anahtar sözcükleri kapsamalıdır. İngilizce Abstract'ın başına, eserin İngilizce başlığı yazılmalıdır. Özet ve Abstract'tan sonra 3-10 anahtar sözcük ve keywords yer almalıdır.

   GİRİŞ

   MATERYAL VE METOT

   BULGULAR VE TARTIŞMA

   SONUÇ VE ÖNERİLER (isteğe bağlı)

   TEŞEKKÜR (isteğe bağlı)

   LİTERATÜR LİSTESİ

8. Makalenin yazı tipi Times New Roman olmalıdır. Özet, Abstract ve metin içindeki diğer başlıklar paragraf başlangıcında olmalıdır. Makale başlığı koyu, 14 punto, bölüm başlıkları koyu, 11 punto olmalıdır. Giriş, materyal ve metot, araştırma bulguları, tartışma ve sonuç bölümleri 11; özet, anahtar sözcükler, abstract, keywords, çizelgeler, grafikler, resimler ile bunların başlıkları, şekiller ve alt yazıları, dipnot ile literatür listesi 9 punto yazılmalıdır.
9. Yazar isimleri, makale başlığının altında bir satır boşluktan sonra unvan belirtilmeden, koyu ve 11 punto ile verilmelidir. Yazarın ön ismi açık olarak ve küçük harfle, soyadı ise büyük harfle yazılmalıdır. Birden fazla yazar varsa onlar da aynı şekilde araya virgül vb. işaret konulmadan verilmelidir.
10. Yazarlarla ilgili açıklayıcı bilgiler ve diğer dipnotlar rakamla belirtilmeli, yazarlarla ilgili dipnotta, adres öncesi unvan verilmelidir. Ayrıca dipnotla sorumlu yazarın e-posta adresi de eklenmelidir.
11. Makale A4 kağıdına yazılmalı, marjin olarak; üst: 4,0 cm, alt: 3,35 cm, sağ: 2,25 cm, sol: 2,25 cm, üst bilgi: 2,55 cm, alt bilgi: 2,35 cm boşluk bırakılmalıdır. Paragraflar satır başından başlamalı ve her iki yana dayalı olmalıdır.
12. Makalede yer alan cins ve türlerin bilimsel isimleri ile Latince kelimeler italik olmalıdır.
13. Literatür listesi makalenin en sonunda yer alır. Listedeki literatürler alfabetik sırada "yazar-tarih" sistemine göre verilmelidir. Numaralama kullanılmamalıdır. Aynı yazarla başlayan tek yazarlı makale çok yazarlı makaleden önce yer almalıdır. Aynı yazarların yer aldığı makaleler metinde ve literatür listesinde tarih sırasına göre, aynı yazarların aynı yılda yaptığı birden fazla makale için ise yılın yanına "a", "b" gibi harf konur. Makale metninde ikiden fazla yazarlı literatürlerde sadece ilk yazar ismi belirtilir ve bunu "ve ark." ile "tarihi" takip etmelidir. Bilimsel kitap adının tüm kelimelerinin baş harfleri, kitap bölümünün adı veya literatür bir makaleden alıntı ise; sadece ilk kelimesi büyük harf olmalıdır. Bir kuruluşun yayını, yayın numarasıyla yazılmalı, diğer kitaplar için basıldığı matbaa adı ve şehri belirtilmelidir. Literatür listesinde her literatürün ilk satırını izleyen satırlar 1 cm içeri çekilmelidir. Makale içindeki atıflarda da "yazar-tarih" sistemi kullanılmalıdır. Birden çok kaynağa aynı anda atıf yapılacaksa yayınlar noktalı virgül ile ayrılmalı ve kronolojik sıra ile verilmelidir. Dergi adları ve kısaltmalar Science & Engineering Journal Abbreviations (http://scieng.library.ubc.ca/)'a göre yapılmalıdır. Yazarlar referansların ya da literatürlerin doğruluğundan sorumludur.

    Makalede yer alan literatür bildirişleri aşağıdaki örneklere uygun olmalıdır:

Kongre, sempozyum veya seminer

Yang, S. M. 1988. Report of the ad hoc committee on sunflower rust. p. 250-255. *In* Proc. 12th Int. Sunflower Conf., Vol. II. Novi Sad, Yugoslavia. 25-29 July. Int. Sunflower Assoc. Paris, France.

Arslanoğlu, F. ve İ. Atakişi. 1997. Bazı patates çeşitlerinde farklı yumru iriliklerinin ve dikim şekillerinin yumru verimi ve verim kriterleri üzerine etkisi. Türkiye II. Tarla Bitkileri Kongresi. 22-25 Eylül 1997. Samsun. s. 648-651.

Kitap

Demir, İ. 1975. Genel bitki ıslahı. Ege Üniv. Zir. Fak. Yay. No: 212. Bornova, İzmir.

Hallauer, A. R., and J. B. Miranda. 1981. Ouantitative genetics in maize breeding lowa State Univ. Press Ames. IA, USA.

Kitaptan bir bölüm

Miller, J. F., and G. N. Fick. 1977. The genetics of sunflower. pp. 441-495. *In*: A. A. Schneiter (Ed.). Sunflower Technology and Production. Argon. Monogr. 35. ASA, CSSA, and SSSA, Madison, Wl, USA.

Tosun, M. 2005. Kalıtım derecesi. s. 10-32. A. Ş. Tan (Ed.). Bitki Islahında İstatistik ve Genetik Metotlar. Ege Tarımsal Araştırma Enst. No: 121. Menemen, İzmir.

Bilimsel dergiden makale

Tan, A. S., C. C. Jan., and T. J. Gulya. 1993. Inheritance of resistance to race 4 of sunflower downy mildew in wild sunflower accessions. Crop Sci. 32: 949-952.

Kıtıkı, A., T. Kesercioğlu, A. Tan, M. Nakiboğlu, H. Otan, A. O. Sarı ve B. Oğuz. 1997. Ege ve Batı Akdeniz Bölgelerinde yayılış gösteren bazı *Origanum* L. türlerinde biyosistematik araştırmalar. Anadolu 7 (2): 26-40.

Doktora ve yüksek lisans tezi

Tan, A. Ş. 1993. Ayçiçeğinde (*Heliauthus aıvuus* L.) melez varyete (F1) ıslahında kendilenmiş hatların çoklu dizi (Line x Tester) analiz yöntemine göre kombinasyon yeteneklerinin saptanması üzerine araştırmalar. Doktora tezi. E. Ü. Zir. Fak. Fen Bil. Ens. Tarla Bitkileri Ana Bilim Dalı Bornova - İzmir.

Whited, D. A. 1967. Biochemical and histochemical properties associated with genetic male sterility at the Ms locus ın barley (*Hordeum vulgare* L.). Ph.D. thesis North Dakota State University. Fargo ND, USA.

İnternet sitesinden alıntı

Plakhine, D., and D. M. Joel. 2010. Ecophysiological consideration of *Orobanche cumana* germination. Helia 33 (52):13-18. From http://www. doiserbia. nb.rs/ Article.aspx?id=1018-18061052013P.

Crop Science Society of America, Terminology Committee. 1992. Glossary of crop science terms. Available at: www.crops.org/cropgloss/. CSSA, Madison, WI, USA.

USDA-ARS National Genetic Resources Program. 2005. Germplasm Resources Information Network (GRIN) database. Available at http://www.ars-grin.gov/ npgs/acc/ acc_queries. html. National Germplasm Resources Laboratory, Beltsville, MD, USA.

Anonim yayın

Resmi yayınlara ve yazarı olmayan kaynaklara "Anonim" veya "Anonymous" olarak atıfta bulunulmalıdır.

Anonim. 1996. İmla kılavuzu. Türk Dil Kurumu yayınları. No: 525. Ankara.

Anonymous. 1970. *Septoria helianthi.* CMI distribution maps of plan diseases. No: 468. Commonwealth Mycol. Inst., Kew, England.

14. Grafik, harita, fotoğraf, resim ve benzeri sunuşlar "Şekil", sayısal değerler ise "Çizelge" olarak isimlendirilmelidir.

15. Çizelge ve grafikler MS Word ve MS Excel ile yapılmalıdır. Çizelge ve grafik rengi siyah-beyaz ve çizgi kalınlığı ¼ pt. olmalıdır. Çizelgelerde her rakam veya öge ayrı bir hücrede yer almalıdır. Kısaltmalar ya başlıkta veya dipnotta açıklanmalıdır.

16. Çizelgeler, grafikler ve bunların başlıkları metinden ayrı sayfalarda, ayrıca grafikler elektronik ortamda "Excel" formunda teslim edilmelidir. Eğer gerekliyse, makalede yer alması planlanan resimler yüksek çözünürlükte, JPEG, GIF veya TIFF dosyası olarak teslim edilmelidir.

17. Çizelge ve grafiklerin Türkçe isimlerinin altına İngilizceleri ve ayrıca çizelgelerde tanımlayıcı nitelikteki ilk satır ve ilk sütundaki ifadeler ile grafiklerin apsis (x) ve ordinat (y) eksenindeki ifadelerin yanına veya altına İngilizceleri de yazılmalıdır.

18. Ondalık sayılar virgül ile ayrılmalıdır. İstatistik önemlilik; 0,05, 0,01 ve 0,001 olasılık düzeyinde sırasıyla tek, iki ve üç yıldız ile (*, ** ve ***) gösterilmelidir. Bu nedenle de bu simgeler diğer notlar için kullanılamaz. Eğer farklı seviyede bir önemlilik derecesi mevcutsa bu da ilave bir açıklama ile bildirilebilir. Önemlilik olmaması durumu ÖD (NS) ile belirtilmelidir. Tablo dipnotları için ise ‡, §, #, ∫ gibi semboller kullanılır.

19. Metin içinde yer alan kısaltmalar ilk yazıldığında tam açılımının yanında parantez içinde gösterilmelidir. DNA vb. standart kısaltmalar için böyle bir tanımlamaya gerek yoktur. Kısaltmalar için Türk Dil Kurumu (TDK) yazım kuralları dikkate alınmalıdır.

20. Yayının benimsenen bilimsel standartlara uymadığı veya anlaşılması zor ve gereksiz tekrarlamalarla dolu olduğu durumlarda, Anadolu Yayın Kurulu, yayımlanmak üzere sunulan yayınlarda değişiklik yapma hakkına sahiptir. Büyük ölçüde düzenlenme gerektiren yazılar düzeltme ve yeniden yazım için yazarına geri gönderilir. Bu gibi makalelerin, düzeltilerek iki ay içinde Anadolu Yayın Kurulu'na tekrar gönderilmesi gerekir.

21. Dergiye gönderilen yazıların Anadolu'da yayımlanıp, yayımlanamayacağı dört ay içerisinde yazara bildirilir.

22. Bir makalenin Anadolu'da yer alması, içeriğinin benimsendiği anlamını taşımaz ve bu konuda dergiye herhangi bir sorumluluk yüklemez. Makalelerin bilimsel sorumlulukları yazarlarına aittir.

23. Yazarlara telif hakkı olarak herhangi bir maddi ödeme yapılmaz. Makale yazarına bir adet ayrı basım gönderilir. Daha fazla ayrı basım ücrete tabidir.

24. Anadolu yazım kuralları Ege Tarımsal Araştırma Enstitü Müdürlüğü'nden veya web sitesinden temin edilebilir. (http://arastirma.tarim.gov.tr/etae/Menu/48/Anadolu-Dergisi).

INSTRUCTIONS TO AUTHORS OF MANUSCRIPTS FOR ANADOLU (ISSN 1300-0225)

1. Journal of ANADOLU aims to provide a medium of communication among scientists in the fields of agricultural science, by publishing original research articles, reviews, and crop registration papers.
2. ANADOLU, The Turkish Journal of Agriculture is biannually issued and published by the Aegean Agricultural Research Institute (AARI).
3. Manuscripts should not exceed 25 pages, must be typed double-spaced, all pages numbered starting from the title page and written in Turkish or English.
4. ANADOLU encourages authors to submit their articles prepared according to publication policy of ANADOLU. Three clearly legible copies of the manuscript prepared by using MS Word copied in a CD must be submitted to the directorate of AARI. Submission of manuscripts as e-mail attachment to the AARI directorate at "etae@tarim.gov.tr" is strongly encouraged.
5. A manuscript number will be mailed to the corresponding author within three days.
6. Authors should mention that the report is of original research and no similar paper has been published or submitted for publication elsewhere. The cover letter should include the corresponding author's full address, telephone/fax numbers and an e-mail address. The manuscripts are not sent back to the author if it is not published.
7. **Manuscripts should be arranged as follows**

   The manuscript should consist of the parts of Title, Abstract, Keywords, Introduction, Material and Methods, Results and Discussion, Conclusion (if necessary), Acknowledgement (if necessary) and References. All these headings should be written as bold capital letters.

   TITLE: Should be clear, concise but informative containing key words that reflect all important aspects of the article. The title should be followed by the author (s) name (s), and address (es).

   ABSTRACT: Should be complete in itself and informative without reference to text or figures, including keywords, and not exceeding 200 words. Following the abstract, about 3 to 10 keywords should be listed.

   INTRODUCTION

   MATERIALS AND METHODS

   RESULTS AND DISCUSSION

   CONCLUSIONS (If necessary)

   ACKNOWLEDGEMENT (If necessary)

   REFERENCES
8. The manuscript should be written in Times New Roman font. All headings should be written with indent and bold capital letter. Size of headings and their styles should be written as follows: Title of manuscript should be bold and 14 size; Introduction, Material and Methods, Results and Discussion, Conclusion (if necessary), Acknowledgement (if necessary) and their headings 11 size; Abstract, Keywords, Tables, Graphics, Figures, Legends and References 9 size.
9. The Title Page should include the authors' full names. Following the title and 1 space line, authors' names should be written with 11 sizes and bold. First name of the authors are written miniscule and the last name capital letters.
10. The name of the corresponding author along with phone, fax and e-mail information and present addresses should be written as a footnote.
11. The page size and margins of manuscript are as follows: A4; top: 4,0 cm, bottom: 3,35 cm, right: 2,25 cm, left: 2,25 cm, header: 2,55 cm, footer: 2,35 cm. Each paragraph should start with indentation, and be aligned to both side.
12. Species, genus, and latin names should be written in italic.
13. References in the References should be arranged alphabetically at the end of the paper by author. The author-year notation system is required; do not use numbered notation. All single-author entries precede multiple-author entries for the same first author. Use chronological order only within entries with identical authorship (alphabetizing by title for same-author, same-year entries). Add a lowercase letter a, b, c, etc. to the year to identify same-year entries for text citation. Do this also for any multiple-author entries. When there are more than two authors, only the first author's name should be mentioned, followed by "*et al*" and "year". In the References each book should be listed by their publisher name, publication number (if available). All words of the book title and only the first word of the book parts and manuscript title should start with a capital letter. Each reference should be written with 1 cm indent except for the first line. Journal names are abbreviated according to Science & Engineering Journal Abbreviations (http://scieng.l ibrary.ubc.ca/). Authors are fully responsible for the accuracy of the references. The author-year notation system is also required in the manuscript. More than one citation are placed chronologically in order and separated by semicolon ";".

Reference examples

Paper from a Symposium, Conference or Seminar:

Yang, S. M. 1988. Report of the ad hoc committee on sunflower rust. p. 250-255. *In*: Proc. 12th Int. Sunflower Conf., Vol. II. Novi Sad, Yugoslavia. 25-29 July. Int. Sunflower Assoc. Paris, France.

Arslanoğlu, F. ve İ. Atakişi. 1997. Bazı patates çeşitlerinde farklı yumru iriliklerinin ve dikim şekillerinin yumru verimi ve verim kriterleri üzerine etkisi. Türkiye II. Tarla Bitkileri Kongresi. 22-25 Eylül 1997. Samsun. s. 648-651.

Book

Demir, İ. 1975. Genel bitki ıslahı. Ege Üniv. Zir. Fak. Yay. No: 212. Bornova, İzmir.

Hallauer, A. R., and J. B. Miranda. 1981. Quantitative genetics in maize breeding. Iowa State Univ. Press. Ames, IA.

Part of the book

Miller, J. F., and G. N. Fick. 1977. The genetics of sunflower. pp. 441-495. *In*: A. A. Schneiter (Ed.) Sunflower Technology and Production. Argon. Monogr. 35. ASA, CSSA, and SSSA, Madison, WI, USA.

Tosun, M. 2005. Kalıtım derecesi. s. 10-32. A. Ş. Tan (Ed.). Bitki Islahında İstatistik ve Genetik Metotlar. Ege Tarımsal Araştırma Ens. No: 121. Menemen, İzmir.

Paper from a scientific journal

Tan, A. S., C. C. Jan., and T. J. Gulya. 1993. Inheritance of resistance to race 4 of sunflovver downy mildew in wild sunflower accessions. Crop Sci. 32: 949-952.

Kıtıkı, A ., T. Kesercioğlu, A. Tan, M. Nakiboğlu, H. Otan, A. O. Sarı ve B. Oğuz. 1997. Ege ve Batı Akdeniz Bölgeleri'nde yayılış gösteren bazı *Origanum* L. türlerinde biyosistematik araştırmalar. Anadolu 7 (2): 26-40.

Ph.D or Master thesis

Tan, A. Ş. 1993. Ayçiçeğinde (*Heliaıthus aıvıuus* L.) melez varyete (F1) ıslahında kendilenmiş hatların çoklu dizi (Line x Tester) analiz yöntemine göre kombinasyon yeteneklerinin saptanması üzerine araştırmalar. Doktora tezi. E. Ü. Zir. Fak. Fen Bil. Ens. Tarla Bitkileri Ana Bilim Dalı Bornova - İzmir.

Whited, D. A. 1967. Biochemical and histochemical properties associated with genetic male sterility at the Ms locus in barley (*Hordeum vulgare* L.). Ph.D. thesis North Dakota State University. Fargo ND, USA.

Reference from internet site

Plakhine, D., and D. M. Joel. 2010. Ecophysiological consideration of *Orobanche cumana* germination. Helia 33 (52): 13-18. From http://www. doiserbia.nb.rs/Article.aspx?id=1018-18061052013P.

Crop Science Society of America, Terminology Committee. 1992. Glossary of crop science terms. Available at: www.crops.org/cropgloss/. CSSA, Madison, WI, USA.

USDA-ARS National Genetic Resources Program. 2005. Germplasm Resources Information Network (GRIN) database. Available at http://www.ars-grin.gov/npgs/acc/acc_queries. html. National Germplasm Resources Laboratory, Beltsville, MD, USA.

Anonymous

Official and collective documents without an author should be cited as "Anonymous" and "Anonim"

Anonim. 1996. İmla kılavuzu. Türk Dil Kurumu yayınları. No: 525. Ankara.

Anonymous. 1970. *Septoria helianthi*. CMI distribution maps of plan diseases. No: 468. Commonwealth Mycol. Inst., Kew, England.

14. The graphics, pictures, maps etc. are named as "Figure" and the numerical values are presented as "Tables".
15. Tables and graphs should be created by using MS Word and MS Excel, respectively. In tables, each item should be placed into a separate cell. Tables and graphs color must be black and white, and thickness of the borders should be ¼ pt. Abbreviations or symbols must be explained either in the title or as footnote.
16. Tables and graphics and their legends should be submitted in separate pages. The graphics are prepared by using MS Excel and submitted as electronic forms as well. Pictures (if necessary) should be submitted GIF, TIFF or JPEG files in high resolution.
17. In the tables, graphics and figures; the legends, first column and line of the tables and apsis (x) and ordinate (y) of the graphics should be written in English as well and placed under the legends, headings of the column and line of the tables and x and y coordinate of the graphics written in Turkish.
18. Numbers written in decimal notation separated with comma ",". In order to show statistical significance at the 0.05, 0.01, and 0.001 probability levels, the *, **, and *** are always used in this order, respectively, and these cannot be used for other notes. Significance at other level is designated by a supplemental note. Lack of significance is usually indicated by NS. For table footnotes, use the following symbols: ‡, §, #, ∫.
19. Abbreviations should be spelled out and introduced in parentheses when used at first time in the text. Standard abbreviations (such as DNA, etc.) need not be defined. Abbreviations should be written according to Turkish Language Association (http://www.tdk.gov.tr).
20. The Editorial Board reserves to make alterations in manuscripts submitted for publications. Such alterations will be made if manuscripts do not conform to accepted scientific standards or if they contain matters which in the opinion of the Editorial Board are unnecessarily verbose or repetitive. Where papers need extensive alteration, they will be returned to the senior author for checking, corrections and re-typing. Such papers must be returned to the Editorial Board within two months.
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