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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.

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