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Tea (*Camellia sinensis*) Cultivation and Breeding in Turkey: Past and Present Status

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ABSTRACT

Tea was introduced into Turkey with the efforts of Zihni Derin and Ali Rıza Erten at the end of the 1930s. ÇAYKUR (Çay İşletmeleri Genel Müdürlüğü/ General Directorate of Tea Enterprises), a governmental company, is responsible for tea production and breeding in Turkey. The company developed tea clones and distributed to local farmers. But, after the 1950s multiplication of tea with seeds arised in Turkey. Assumedly, nearly the whole plantations in Turkey are multiplicated with seeds, which tradition is ongoing. ÇAYKUR selected nearly 40 clones which are preserved in the gene pool of ÇAYKUR. During the last 40 years, the establishment, pruning, harvest and transfer of harvested tea leaves etc. emerged to a insensible situation. These problems have to be solved for an better tea cultivation in Turkey. On the other hand, the understanding of the development of the genetic collection of a strategically important crop such as tea (*Camellia simensis* O. Kuntze) is very important for its breeding and improvement of advanced research facilities. This review summarises the available information on tea cultivation and tea breeding in Turkey. Tea cultivation in Turkey contributes significantly to the economic income of local farmers in the North-East Black Sea region. The major breeding achievement was the selection of clones, which were selected from present tea gardens. After adaptation of superior tea clones in classical and organic tea cultivation, tea cultivation and breeding will make an important progress in Turkey.

Keywords**:** Camellia sinensis, tea, tea production, tea breeding

Introduction

Tea production are practised in the Eastern Black Sea Region, in a zone beginning from the Georgian border up to the Fatsa district in Ordu. In this region, tea production is mainly located in Rize, Ordu, Giresun and Trabzon (Anonymous 2015). If we are considering the tea production areas in the world, these regions are located in the top zone. In Asian countries like China, India and Sri Lanka temperature does not falls up to minus degree in tea production areas and tea production is covering the whole year. But in our country, where we can feel four climates tea plantations are in fallow four six months. The fact that snow falls on Turkish tea plantations bring them an extra important characteristic. Because of this character, pesticides are not applicated in our tea production areas. That's why, Turkish tea has "the most natural tea" characteristic as compared to other teas in the world.

The biggest advantage of Turkish tea sector is that pesticides are not used for its cultivation. The winter conditions decease pests in natural means as it snow in Rize province, situated in the north east of Turkey. As a result of that, there is no need to use any pesticide. Actually, a very small populations of pests have been seen in Rize province, and they do not reach up to the economic threshold level require to use pesticides. Two important parameters prevent the production of organic tea in general. One of them is the pesticide and the other

one is chemical fertilizers. All of the tea, produced in Turkey, will be organic product if it is used organic fertilizers instead of chemical ones, as the Turkish tea industry has already not been used pesticides. This feature provides a great advantage to Turkish tea sector (Saklı 2011).

History of Tea in Turkey

In 1930s, the government decided to start a agricultural programme for poor farmers in the Northern Black Sea Region. After 1940s, tea cultivation started primarily in Turkey and the first aim was to meet the needs of the domestic demand. In beginning, it was very difficult to introduce the new crop, tea in the mentioned area. The general assumption of the people about the starting efforts of tea cultivation was negative at that time. But against this, the local tea industry and tea trade in Turkey established to a successful business. At the meantime, Turkey has established an important place in world tea production (Klasra et al., 2007).

We can see that tea cultivation was first started in Batum (Republic of Georgia). Russians imported seedlings from China and established plantations in the neighbouring of the Eastern Black Sea region of Turkey in the last quarter of 19th century. After a successful tea cultivation in Georgia, people stated that the same could be applied at the North East Part of Turkey.

After a succcessful introduction of tea by Russians in Batum imaginations arised that tea cultivation can be a option for local farmers in Turkey. First attempt was started to cultivate tea in Bursa and seedlings were imported in 1888 from China and Japan (Tekeli 1976). But because of unfavourable conditions for tea in Bursa, it was stated that tea plants needed a very specific environmental conditions to make an economic production.

Thereafter, Mr. Ali Riza Erten searched for the feasibility of some other suitable locations within the Turkey for tea cultivation and started extensive visits to Rize, Artvin, Ardahan (Turkey) and Batum (Georgia) in the Eastern Black Sea region (Kakuzu 1944; Kacar 1986a,b). He made a comprehensive analysis and stated that the ecology of Rize, Artvin and Ardahan was very similar to Batum. After his analysis, he give a report to the government that tea cultivation could be feasible at Rize and surroundings (Hatipoğlu 1934 a,b; Arar 1969).

In Turkey, tea cultivation first started by law in 1924 and the Tea Research Institute was established. In 1947, the first plant for processing green tea leaves was opened in Rize. Rize, Ordu, Giresun, Trabzon and Artvin are the provinces in which tea is produced.

In order to supply better service, parallel to the growth in this sector, an economic enterprise, ÇAYKUR (General Directorate of Tea Enterprises) was established in 1971 and was fully authorized as a state monopoly in the tea business. In 1984, with the abolishment of the monopoly in the tea sector, private enterprises were also given the rights of procurement, processing and marketing (Anonymous 2017).

Tea Production in Turkey

Although, the tea business in Turkey is a relatively new activity compared with the other producer countries, tea cultivation and the industry have shown very important improvement in a short time. While the production of dried tea was below 25, 000 tons in the 1950's, this figure reached significant quantities in recent years. Today, Turkey holds a significant place among the world's largest producer countries with a share of 3%. According to the Food and Agriculture Organization (FAO) statistics, Turkey ranks 8th place in the world production area of tea after China, India, Sri Lanka, Kenya, Indonesia, Vietnam and Myanmar.Regarding world tea production in the world Turkey ranks at the 5th place after China, India, Kenya, Sri Lanka and Vietnam (Table 2).

In Turkey, tea production is located in the North-East Black Sea Region. The tea plantations are distributed in the cities Artvin, Rize, Trabzon, Ordu and Giresun (Figure 1).

Table 3 shows the distribution of tea production areas according to related cities. The main tea production area is Rize with 65.96%. followed by Trabzon, Artvin, Giresun and Ordu. Parallelly, the number of tea farmers are following the same ranking.

Tea Plantation Areas in Turkey

Tea plantation areas are regulated in Turkey by law. In the Official Gazette of Turkey the judgment "Determination of tea plantation areas and authorization of tea producing farmers" was printed according to the No. 2. Article of the Tea Law and according to the writing of the Ministry of Food, Agriculture and Livestock. Based on this legal decision tea plantation areas are restricted with some cities and districts which are depicted in Table 4.

ÇAYKUR

ÇAYKUR was founded in 10.10.1983 as a government institution. Çaykur and its Atatürk Research Institute for Tea and Horticultural Cultures (Atatürk Çay ve Bahçe Kültürleri Araştırma Enstitüsü Müdürlüğü) are responsible for tea cultivation and breeding in Turkey.

Situation of Tea Research in Turkey

ÇAYKUR is a governmental institution which is responsible for tea research in Turkey. As mentioned before, different research schemes were conducted for farmers as their needs. In the last 5 years, two new tea research centers were founded. ÇAYMER and the Tea Research and Application Center of the Recep Tayyip Erdogan University.

Tea Research Institutions in Turkey

1. Rize Tea Research Institute

The business of the Rize Tea Research Institute is developing tea cultivation according to the agricultural policy of Turkey, creating investment, assisting funding, capital stock, achieving maximum benefit under free market conditions; and producing, import and export of all kinds of tea with supplement of necessary raw material, including all areas related to enhance the competitive capacity of the organization in inner and foreign markets.

2. ÇAYMER

In the context of the operational programme of regional competitiveness ÇAYMER (Rize Çay Araştırma ve Uygulama Merkezi/Rize Tea Reserach and Application Center) was signed an initiated in 14.01.2011 with support of Commodity of Exchange Market, Recep Tayyip Erdoğan University and Rize Office of Governor. This Project is financed by the EU and Turkish government. The general aims of this project are to improve the competitive capacity and production quality of the tea sector concentrated in Rize and surroundings, to strengthen the common Research and Development, innovation and infrastructure of business development from which the tea producer SMEs can get profit. The expectation is to provide high quality service to SMEs with improved infrastructure and to reach that 150 SMEs get service from this center. Further, this center aims to increase the added-value of tea quality with increasing tea product varieties and by-products, because, the present added-value of tea quality is low.

3. Tea Research and Application Center of Recep Tayyip Erdogan University

This center was initiated in 2017. The aims of this center are to conduct tea research at national and international level, to collaborate with international institutions, to appraise obtained results with farmers, and to participate in national and international congresses and cover all issues regarding tea production, education and further issues. Another aim is to support M.Sc and Ph.D. research work of students.

BREEDING EFFORTS ON TEA IN TURKEY

Firstly, the responsibility of breeding work on tea was assigned to Çaykur. But up to now, only clonal selection studies were carried out in Turkey, which are explained below in detail.

Clones Selection Work in Turkey

As we know, clones are genetically uniform copies of the donor plant and they display uniform yield and quality. After intensive mass clonal multiplication, the aims are to cultivate clones having high yield and resistance to pathogens etc.. However, the genetically diverse populations don't give homogeneous quality but these populations are less prone to environmental conditions (Bandyopadhyay and Das 2008). As mentioned before, ÇAYKUR developed tea clone since the 1940s and distributed them to farmers. But because of repudiation of the new crop a huge number of farmers removed the established plantations and proceeded with conventional plants.

After the recognition that tea has the potential as an economically important plant, tea establishment flourished again, but the farmers used seeds in the establishment of new plantations. Because of the cross-pollinating character of the tea plant, huge noticeable variation arised in Turkish tea plantations, which presents a good base for clonal selection. Wide genetic variability is necessary, because it is a resource for fighting against diseases, pests and the key factor to adapt changing environment (Barua 1963; Wachira et al., 1995).

Before the replacement of present tea plantations with new, high yielding genotypes it is necessary to preserve present, high diversity displaying populations as *in situ* conservation sites.

In Turkey, most of the tea plantations were established by using seeds; continuous seed propagation has produced populations with different yield and quality properties, reflecting wide genetic variation. Clonal selection studies were conducted in the Black Sea region and several promising tea clones such as 'Tuglali-10', 'Derepazari-7', and 'Pazar-20' have been identified (Öksüz 1987). Clones named Muradiye, Gündoğdu, Fener3, Enstitü1, Enstitü2, Hamzabey, Hayrat, Çayeli, Ardeşen, Fındıklı, Pazar and Iyidere followed later. Basically, clonal selection work was done by ÇAYKUR in this region. The full list of selected clones is given in Table 5.

TEA RESEARCH FACILITIES IN TURKEY

1. Improvement of Tea Quality

In 2016, the Research Project on "Improvement of Tea Quality" funded by DOKAP was initiated. The aim of this Project was firstly the establishment of a quality analysis laboratory for the Faculty of Agricultural Sciences in Rize, secondly the determination of biochemical, morphological and molecular variability in whole tea plantation areas and at least the creation of a mini tea factory for the mentioned Faculty of Recep Tayyip Erdoğan University.

2. Use of Organic Fertilizers in Tea Cultivation

2a. Research Project of the Faculty of Agriculture and Natural Sciences, Field Crops Department founded by the university was initiated. In present tea plantations, 21 different organic fertilizers were tested at 8 locations to observe their effects on yield.

2b. In 2018, the Project "Effect of Organic Fertilizers on Parameters with Medicinal value in Tea"

founded by DOKAP was initiated based upon the first mentioned Project. Additionally, one location on the organic tea production area in Hemşin was added to the mentioned locations.

3. Molecular marker work

Before starting a breeding programme, present genetic variation needs to be characterised. The molecular work was carried out by different researchers namely Kafkas et al., (2009) and Beriş et al., (2001, 2005, 2016) by using different marker systems to determine genetic variation in selected tea clones.

4. Plant Growth Promoting Bacteria as Organic Fertilizer

The research on utilization of plant growth promoting bacteria in organic tea production was conducted by Çakmakçı et al., (2012, 2013, 2016).

FUTURE TRENDS FOR TEA IMPROVEMENT IN TURKEY

As mentioned before tea plantations in Turkey are established using seeds. Therefore, huge heterogenity exists in Turkish tea plantations. Also as mentioned before, only clonal selection work was done beginning from the 1980s, but no adaptation and yield trials were conducted. Only the mentioned Project aimed to characterize present plantations on morphological, biochemical and molecular level.

Primarily, to improve tea production economic status in Turkey, there is need for further improvement in tea production practices. Besides, there is need for mass collection of germplasm in all tea producing areas in Turkey to establish a national tea germplasm collection, where the co-operation of ÇAYKUR and the local University and related agricultural faculty is required. The clonal selection work aims to generate selected clones using tissue culture were present in the past. Although, it is possible to characterize this selected material on the basis of morphological descriptors, but actually, the clearest and basic distinguishing tool are molecular markers.

Possible research studies for tea in Turkey:

1. Tea Seed Oil

All species of the *Camellia* genus produce an oleaginous seed. Crude edible oil was produced from tea seed in native mills in West Bengal, Himachal Pradesh and Assam and in the Northern region of Indo-china (Owuor et al., 1985). Tea seed oil has been produced on commercial scale in China where in 1958, 180,000 tons of the oil) was produced (Sengupta et al., 1986).

The oil extracted from the seeds of *Camellia* species both cultivated as well as other species is termed as tea seed oil. Though, *C. sinensis* is cultivated mostly for producing tea at commercial level, but oil is not usually obtained from this specie. Commercial production of oil is derived from species like *C. sasanqua*, *C. japonica*, *C. tenuifolia* and *C. oleifera*. Seeds of different *Camellia* species contain 20-70% oil which is comparable to olive (*Olea europaea*) oil in its quality. It could be, therefore, utilized as a potential substitute for olive oil as well as other edible oils.

The tea seed oil is yellow coloured, free flowing, has pleasant odour and can be stored for 3 months at room temperature without losing its quality (Roberts and De Silva 1972). Fatty acid composition of *C. sinensis* seed oil consisted of 21.5% palmitic acid, 2.9% stearic acid (Rajaei et al., 2008), 56% oleic acid, 22% linoleic acid and 0.3% linolenic acid (Sahari et al., 2004). The major fatty acid (50% of the total oil) in the *C. sinensis* seed oil was oleic acid (Rajaei et al., 2005). Therefore, with regard to oleic acid, *C. sinensis* seed oil can be ranked between sunflower and olive oil (Sahari et al., 2004).

2. Renewal of Tea Plantations

We know that present tea plantations were established using seeds. Because of the cross-pollination behaviour of this plant variation arised in local tea plantations. This leads to aberrance development and harvest of tea plants, which also leds to problems in processing because harvested tea leaves are not homogenous. Therefore, superior tea clones have to be selected and yield trials to be conducted in different environments and at different altitudes. After obtained results, the best performing clones should be multiplicated using cuttings or tissue culture technique. The renewal of present tea plantations will be an important next issue in the future.

3. Organic Tea Cultivation

In Turkey, tea cultivation begun first in 1938. After 1960s intensive chemical fertilizer use arised. Parallel to the developments in the world ÇAYKUR initiated in 2003 studies to increase organic tea farming in Turkey (Seyis et al., 2018). Within the context of organic tea farming Borçka/Artvin and Çamlıhemşin and Hemşin/Rize was chosen as organic tea production areas. In 2006, ÇAYKUR founded the "Organic Tea Farming Commission" to organize studies regarding organic tea farming and production and to determine a road map for organic tea.

Organic tea production increased from 378 da in 2007 up to 38,034 da in 2016. Also, a number of organic tea farmers increased from 135 in 2007 up to 11,786 in 2016 (Table 4). In Table 5, processed organic black and green tea amounts are given. The total quantity of purchased wet tea, processed black and green tea have been increased from 2009 up to 2016. There is a remarkable increase in organic tea production in Turkey during the last decade. Organic black tea production increased more as compared to organic tea production.

4. Development of a National Tea Germplasm Collection

Development and identification of germplasm accessions are important. They can be included in the breeding programmes, which is vital to broaden the gene pool of the cultivated tea plant. The relevant use of such collections depends on huge extent of the knowledge and understanding of the relevant characteristics and the genetic diversity of the collection. Therefore, the knowledge about different characteristics like morphological, agronomical and biochemical ones are important to use such material effectively and to use them in crop improvement programmes (Kottawa-Arachchi 2013).

In Turkey, nearly all tea plantations were multiplied with seed. Because of the cross-pollinating character of the tea plant huge variations have been arised in local tea plantations. The heterozygous character of present tea plantations leds to differentiation in harvest time and especially in the chemical content of harvested leaves.

Therefore, superior tea clones have to be selected from Turkish tea plantations to support tea breeding programmes. Such a Project will cover the coming 50 years of tea breeding.

Conclusion

Tea, a very important crop regarding the income of local farmers in the Northern Black Sea Region of Turkey, is multiplicated by farmers using seeds in the last 50 years. Because of this, huge variation was created in present tea plantations which offers a good base for the beginning of selection of superior clones, which of course should be characterised on molecular level using relevant markers and marker systems.

After the fulfilment of the selection process, the cultivation procedures should be reintegrated by farmers, because different and wrong practices were developed from farmers side. This could be achieved by educational seminars throughout the year. Of course, success could be achieved with the cooperation of farmers, the local university and local governmental and non-governmental institutions.

Table 1. Tea production areas in the world

Countries	Tea area (thousand ha)
China	1984
India	604
Sri Lanka	222
Kenya	203
Indonesia	119
Vietnam	115
Myanmar	83
Turkey	76
Other countries total	382

Source: FAO (2018)

Table 2. Tea production in the world

Countries	Yield (tonnes)
China	2.414
India	1.252
Kenia	473
Sri Lanka	349
Turkey	243
Vietnam	240
Endonesia	144
Japonya	80
Iran	75

Source: FAO (2018)

Table 3. Tea plantation area and number of farmers

City	Tea area (ha)	%	Number of farmers	%
Rize	555.146	66.49	132.264	61.75
Trabzon	162.469	24.09	51.595	24.09
Artvin	96.281	11.53	20.398	9.52
Giresun-Ordu	20.993	2.51	9.919	4.63
Total	834.889	100.00	214.160	100

Source: Anonymous (2017)

Table 4. Tea plantation areas in Turkey

Cities	Districts
Artvin	Arhavi, Borçka and Hopa
Giresun	Çanakçı, Espiye, Eynesil, Görele, Güce and Tirebolu
Rize	Center and all districts
Trabzon	Center, Araklı, Beşikdüzü, Çaykara, Dernekpazarı, Hayrat, Köprübaşı, Of, Sürmene and Vakfıkebir

Figure 1. Tea production areas at the Black Sea Region

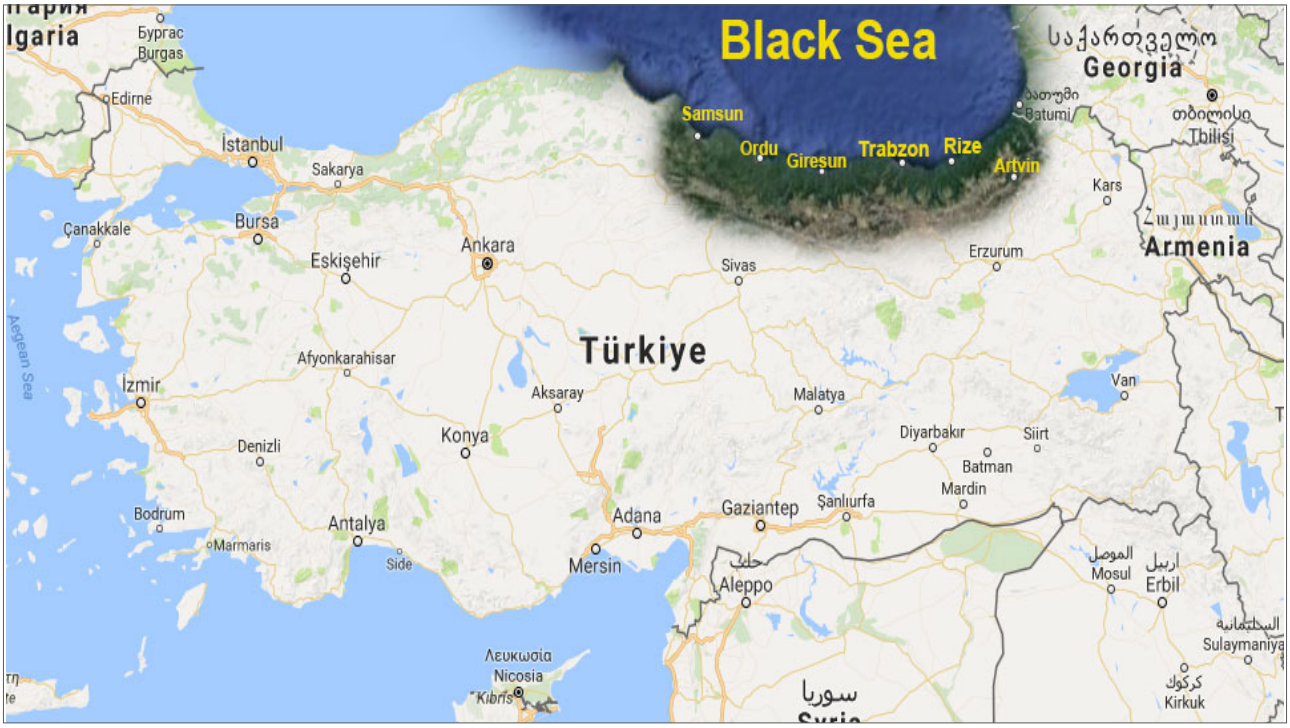

Table 5. Selected clones by the Tea Research Institute in Rize/Turkey

Name	Province of origin	Selected by
Ardeşen	Rize	Rize Tea Research Institute
Ali Rıza Erten	Rize	Rize Tea Research Institute
Çayeli-46	Rize	Rize Tea Research Institute
Çiftekavak	Trabzon	Rize Tea Research Institute
Derepazarı-7	Rize	Rize Tea Research Institute
Derepazarı-32	Rize	Rize Tea Research Institute
Enstitü-1	Rize	Rize Tea Research Institute
Çaykur-1	Rize	Rize Tea Research Institute
Çaykur-2	Rize	Rize Tea Research Institute
Çaykur-3	Rize	Rize Tea Research Institute
Çaykur-4	Rize	Rize Tea Research Institute
Enstitü-2	Rize	Rize Tea Research Institute
Enstitü-9	Rize	Rize Tea Research Institute
Enstitü-61	Rize	Rize Tea Research Institute
Fındıklı	Rize	Rize Tea Research Institute
Fener-3	Rize	Rize Tea Research Institute

Continuing table 5

Name	Province of origin	Selected by
Gündoğdu-3	Rize	Rize Tea Research Institute
Gündoğdu-19	Rize	Rize Tea Research Institute
Güneysu-26	Rize	Rize Tea Research Institute
Hamzabey	Rize	Rize Tea Research Institute
Hayrat	Trabzon	Rize Tea Research Institute
İyidere	Rize	Rize Tea Research Institute
Kalkandere-10	Rize	Rize Tea Research Institute
Kalkandere-12	Rize	Rize Tea Research Institute
Kömürcüler	Rize	Rize Tea Research Institute
Kolhida	Trabzon	Rize Tea Research Institute
Kömürcüler-1	Rize	Rize Tea Research Institute
Kömürcüler-4	Rize	Rize Tea Research Institute
Muradiye-10	Rize	Rize Tea Research Institute
Of-25	Trabzon	Rize Tea Research Institute
Of-37	Trabzon	Rize Tea Research Institute
Of-53	Trabzon	Rize Tea Research Institute
Of-66	Trabzon	Rize Tea Research Institute
Of-264	Trabzon	Rize Tea Research Institute
Pazar-14	Rize	Rize Tea Research Institute
Pazar-20	Rize	Rize Tea Research Institute
Pazar-42	Rize	Rize Tea Research Institute
Sürmene-1	Trabzon	Rize Tea Research Institute
Sürmen-6	Trabzon	Rize Tea Research Institute
Sürmene-24	Trabzon	Rize Tea Research Institute
Sürmene-29	Trabzon	Rize Tea Research Institute
Sürmene-39	Trabzon	Rize Tea Research Institute
Tuğlalı-10	Rize	Rize Tea Research Institute
Üniversite	Rize	Rize Tea Research Institute
Üniversite 2	Rize	Rize Tea Research Institute
Zihni Derin	Rize	Rize Tea Research Institute

Sources: Anonymous, (2017)

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