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Determination of Oil Content and Fatty Acid Composition of Tea Plants at Plantations in the Black Sea Region

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Authors' contributions

This work was carried out in collaboration between both authors. Author FS designed the study, managed the literature searches and wrote the whole manuscript. Author MG collected the seed samples and carried out the oil content and fatty acid composition analysis. Both authors read and approved the final manuscript.

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ABSTRACT

Aims: The aim of this study was to determine the fatty acid composition and oil content of *C. sinensis* seeds collected from different locations at the Northern Black Sea region.
Study Design: The study based on the collection of tea seed samples from different locations at the the Northern Black Sea Region in Türkiye and comparing their fatty acid composition and oil content of analyzed samples.
Place and Duration of Study: Recep Tayyip Erdogan University, Faculty of Agronomy, Field Crops Department, Rize, Türkiye, between 2022 and July 2023.
Methodology: A total of 54 samples were taken within the scope of determining oil content and fatty acid composition of *Camellia sinensis* seeds collected from different locations. The location were choosen from different cities concerning altitude. The number of samples taken from the

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province of Rize is 37, the number of samples taken from the province of Trabzon is 7, the number of samples taken from the province of Giresun is 5, and the number of samples taken from the province of Artvin is 5. Fatty Acid composition was analyzed using GC-MS and oil content with an automated oil extraction device.

Results: Oil ratio and fatty acid composition were determined in these samples. As stated in the literature, oleic acid, which is the criterion of vegetable oil quality, was found to be high in all samples. With Principal Component Analysis, the oil content and fatty acid composition data of the samples were used to reveal the differences in the samples. The obtained data will shed light on future studies.

Conclusion: Knowing the fatty acid composition of tea oils will enable production of oils according to their intended use. For this purpose, it will be possible to produce oils suitable for the purpose by growing the desired types in suitable regions. We have to consider, that seeds were obtained after leaf harvest of tea plants. We can assume that the seed yield will increase if the tea plants are grown only for seed production. With governmental support tea seed oil production will be an potential additional income for local farmers.

Keywords: Camellia sinensis; oil content; fatty acid composition; Türkiye.

1. INTRODUCTION

Vegetable oils represent important raw materials used in the chemical industry. The rising prices of petroleum resources, combined with their finite and non-renewable nature, have renewed researcher interest in the development and use of alternative renewable feedstocks. Vegetable oils are an alternative energy source to petrochemicals because they are renewable, biodegradable, less toxic and environmentally friendly [1].

Tea (*Camellia sinensis* O. Kuntze) is a plant that was brought to Türkiye in the 1930s with the work of Ali Rıza Erten and Zihni Derin and quickly became an important and economically profitable plant. While we were a coffee-consuming society in the past, tea has become the most consumed beverage in Türkiye due to its suitability to our taste and the unique brewing method of Türkiye.

In Türkiye, tea is mostly known for its green leaves being collected in 2-3 harvest periods a year in order to produce green and black tea. The fact that tea seeds contain a significant amount of oil is not well known by our society.

The tea industry in Türkiye is an important sector for the regional and national economy. Although tea can grow in a limited area in the Eastern Black Sea region of our country, it is important as a beverage that we consume at every moment of our daily lives. In addition, the lack of opportunities for growing various agricultural products in the tea-growing region has increased the economic value of tea for the local people. In addition, the fact that tea cannot be grown in other regions due to the necessary climatic conditions has increased the importance of the tea region. In this context, tea is in a monopoly position due to the lack of an alternative in the region where it is grown and the lack of possibility to grow it in other regions [2].

Vegetable oil from oilseed plants has always been used for nutrition and is increasingly used as an industrial raw material today. Most oilseed plants characteristically accumulate oil in their seeds (rapeseed, sunflower) or fruits (palm, olive). Most of these oilseed crops grow in temperate climates, they only need adequate amounts of fertilizer and high yields can be achieved [3].

Tea seed oil is obtained from the seeds of various tea species belonging to the Theaceae family [4]. In terms of fatty acid composition, tea seed oil is similar to quality cooking oil and olive oil [5-6]. In addition to being quite expensive for general use, olive oil is not widely consumed because there are not enough resources to meet global demand.

According to recent research, tea seed oil is emerging as a new alternative to canola oil and olive oil due to its high oleic acid, medium linoleic acid and low linolenic acid content [6]. Rich in antioxidants, tea seed oil has been shown to lower blood pressure and cholesterol levels [7].

It has been reported that the oil content of tea seed is approximately 30-32% and has high organoleptic acceptability [6,8]. Tea seed oil is a high-quality cooking oil like olive oil and can be stored well at room temperature. It is known that tea seed oil reduces blood pressure and cholesterol levels, has high antioxidant content, is a rich source of emollients for skin care and minimizes the signs of aging [7].

The fatty acid composition of C. sinensis seed oil consists of 21.5% palmitic acid, 2.9% stearic acid [9], 56% oleic acid, 22% linoleic acid and 0.3% linolenic acid [6]. The main fatty acid in *C. sinensis* seed oil (50% of the total oil) is oleic acid [10]. Therefore, in terms of oleic acid, *C. sinensis* seed oil can be ranked between sunflower and olive oil [6].

The oil content and fatty acid composition of tea seeds collected from different villages in the Black Sea region were investigated regarding its oil content and fatty acid composition.

2. MATERIALS AND METHODS

2.1 Sample Collection

Tea seeds were collected from tea producing areas to examine the oil ratios and fatty acid composition. Seeds were collected at the appropriate time by planning according to the provinces where tea is grown and by going out to the field in sufficient numbers and from different areas in each province. In the collection of tea seeds, the most samples were collected from Rize province, which is the province where tea is grown most intensively.

Within the scope of the plan, tea seeds were collected from the field by determining the city, district, altitude, coordinates, garden owner and village or neighborhood name and accompanied by label information. was. The collected tea seeds were placed in cold storage at the end of each day to prevent possible changes in the oil content and fatty acid composition.

Information about the samples taken in the study is given in Table 1.

The total number of samples taken within the scope of the thesis is 54. The number of samples taken from Rize province is 37, the number of samples taken from Trabzon province is 7, the number of samples taken from Giresun province is 5 and the number of samples taken from Artvin province is 5. The lowest altitude sample was collected from Giresun province Eynesil İçesi Boztepe District (7 m) and the highest altitude sample was collected from Rize province İkizdere Ilıca Village (965 m).

2.2 Determination of Oil Content

After the sample collection was completed, the green outer shell parts of the tea seeds were separated and dried. It was dried at 40° C for 7 days, and the sample weights before and after drying were measured and recorded with a precision scale. Dried samples were ground with their inner shells in coffee grinder-like machines and brought to the appropriate particle size according to the extraction method for the detection of oil in tea seeds.

Fully automatic (Buchi) Soxhlet Extraction device was used to determine the tea seed oil content by extraction method. First of all, 5 g of the ground samples, which were kept in a ziplock bag with a label number, were weighed with a precision balance and placed into the cartridges to be used for extraction. On the ground sample in each cartridge; Overflow, spillage, flying etc. that may occur during the extraction process. A small amount of pure cotton was added to eliminate drawbacks such as.

Since the fully automatic extraction device processes 6 samples in one filling, 6 cartridges; They were placed into the glass tubes where the process will be carried out, respectively, by fixing them with the help of a lid. In order for the system to work, the beakers in which the liquid resulting from the extraction will be collected are placed in their places and made ready for operation.

100 ml of Diethyl Ether, which will be used in the extraction process, was measured with a graduated measuring tape and added to the samples placed in the device with the help of a funnel. After the ground samples were processed in the system for 120 minutes at 40°C, the solution accumulated in the previously weighed beakers was taken with the help of tongs and taken to the oven with the temperature set at 40°C. It was dried in the oven at 40° C for 24 hours to allow the diethyl ether in it to evaporate. The next day, the beakers were taken from the oven again with tongs and cooled in a desiccator. The cooled samples were weighed again on a precision scale and the amount of oil was determined according to the formula below.

Oil Content (%) = Last weight (gr) – First Weight (gr) / 5 x 100

Table 1. Location names of collected tea samples from different cities

City	District	Village	Coordinates	Altitude	Location name
Rize	Fındıklı	Sümer	41°17'05.64" 41°14'34.64"	90	Sümer Köyü Yazıcılar Mah. No.5
Rize	Fındıklı	Derbent	41°17'41.06" 41°15'49.69"	249	Armoin Mah.Selazer Güzergahı
Rize	Fındıklı	Derbent-Selazur Mevki	41°17'04.04" 41°15'54.91"	342	Selazur Mah.Hane No.85
Rize	Fındıklı	Beydere	41°14'41.00" 41°13'14.00"	343	Karşıyaka Mevkii
Rize	Fındıklı	Aslandere	41°14'35.19" 41°15'23.89"	420	Ziyuna Mevki
Trabzon	Sürmene	Gültepe	40°52'23.81" 40°03'53.00"	120	Küçükdere Yol Üzeri
Trabzon	Sürmene	Güney Köyü	40°46'07.58" 40°03'30.22"	422	Küçükdere Oylum yolu üzeri Güneyköy Oğuz Camii Yaolu Tabelası
Trabzon	Sürmene	Yeşilköy	40°47'28.41" 40°02'43.31"	790	Küçükdere Yeşilköy Yolu
Giresun	Eynesil	Altınlı	41°04'10.42" 39°09'06.30"	7	Boztepe Mahallesi Mezarlık Yanı Mustafa Yüksel Cad.
Giresun	Eynesil	Boztepe Mah.	41°03'52.90" 39°10'14.26"	225	Yukarı Boztepe Camii önü
Trabzon	Beşikdüzü	Şahmelik	41°00'12.19" 39°10'50.11"	585	Zalahna mevkii
Giresun	Tirebolu	Demircili Mah.	41°00'19.07" 38°51'27.93"	46	Güldal Mah.Yol üzer yokuş
Giresun	Tirebolu	Karaahmetli	40°56'39.57" 38°52'54.69"	285	Karaahmetli Yol kenarı
Giresun	Tirebolu	Kovapınar	40°55'41.00" 38°55'02.98"	424	Kovapınar köy içi yol çıkış
Artvin	Borçka	Muratlı	41°27'24.27" 41°42'45.62"	98	Muratlı Çay Fabrikası önü
Artvin	Borçka	Güreşen	41°27'10.82" 41°38'48.28"	235	Güreşen merkez camii mevkii
Rize	Hemşin	Ortaköy	41°02'15.58" 40°54'00.38"	347	Organik Çay fabrikası karşısı
Rize	Hemşin	Bilenköy	41°01'34.73" 40°54'15.88"	637	Bilenköy eski konak yanı
Rize	Hemşin	Nurluca	41°02'05.47" 40°54'02.85"	493	Serküme evleri
Rize	Pazar	Yemişli	41°09'07.00" 40°55'29.00"	49	Yemişli Mevki
Rize	Pazar	Orta Irmak Köyü	41°07'50.00" 40°56'40.00"	247	Yüksel Mevkii
Rize	Pazar	Akbucak Köyü	41°05'24.00" 40°57'38.00"	525	Yukarı Mahalle
Trabzon	Of	Cumapazarı	40°50'34.16" 40°14'55.08"	528	Konofol Mevkii
Trabzon	Of	Cumapazarı	40°50'07.16" 40°15'54.44"	265	Renk Mahallesi
Trabzon	Of	Ballıca	40°52'53.16" 40°16'59.81"	76	
Artvin	Hopa	Koyuncular	41°23'45.73" 41°30'38.52"	506	Çalin Mevki
Artvin	Hopa	Koyuncular	41°24'08.50" 41°30'10.08"	252	Zaluna Mevkii
Artvin	Hopa	Yoldere	41°23'28.25" 41°28'07.72"	69	Okul Mevkii
Rize	Ardeşen	Köprüköy	41°07'18.75" 41°03'06.79"	513	Kalaizeni Mevki
Rize	Ardeşen	Tunca Esentepe	41°07'42.87" 41°07'00.32"	622	Esentepe Mevkii

City	District	Village	Coordinates	Altitude	Location name
Rize	Ardeşen	Köprüköy	41°07'29.64" 41°02'34.76"	253	Taşköprü Mevkii
Rize	Merkez	Hayrat	41°01'22.27" 40°30'06.97"	64	Okul Civarı
Rize	Merkez	Ortapazar	40°59'01.53" 40°28'34.96"	310	Aşağı Mahalle
Rize	Merkez	Ortapazar	40°57'52.56" 40°28'37.26"	520	Hudut Kaya Mevkii
Rize	Kalkandere	Fındıklı	40°54'21.60" 40°28'12.1"	237	Fındıklı Köyü yolu Musluoğlu Mevki
Rize	İyidere	Köşklü	40°59'2.95" 40°21'32.91"	230	Köşklü-Kambiyoz Mevki
Rize	İyidere	Yapraklar	41° 0'5.18" 40°22'49.01"	185	Yapraklar Mahalle içi yol Arka Mevki
Rize	İkizdere	Ilıca	40°47'26.02" 40°35'32.89"	965	Ilıca Köyü Cami Mevkii
Rize	İkizdere	Gürdere	40°48'49.34" 40°33'14.88"	875	Sırtlar Mahalle Mevkii
Rize	İkizdere	Ihlamur	40°47'52.30" 40°32'7.38"	800	Ihlamur Köyü Orta Mahalle
Rize	Kalkandere	Aşağı Tatlısu	40°55'42.70" 40°25'15.88"	150	Güneysu Mevkii
Rize	Kalkandere	Yolbaşı	40°57'8.30" 40°28'5.70"	449	Yolbaşı Köyü Okul Mevkii
Rize	Kalkandere	Ormanlı	40°56'53.90" 40°24'60.00"	153	Ormanlı Köyü Karana Mevkii
Rize	Kalkandere	Çağlayan	40°55'27.30" 40°28'4.90"	305	Çağlayan Köyü Sağlamlar Mevkii
Rize	Güneysu	Ulucami	40°59'23.18" 40°36'24.34"	128	Ulucamii Dere Mevkii
Rize	Güneysu	Yüksekköy	40°56'38.86" 40°34'22.79"	791	Yüksekköy Üst Mahalle
Rize	Güneysu	Dumankaya	40°58'10.62" 40°35'52.73"	426	Dumankaya Köyü Köyiçi Mevkii
Rize	Çayeli	Derecik	41° 0'3.72" 40°40'58.16"	295	Derecik Köyü Cami Mevkii
Rize	Çayeli	Yaka	41° 4'50.32" 40°42'15.44"	19	Yaka Mahallesi Yalı Civarı
Rize	Çayeli	Yalıköy	41° 5'33.68" 40°44'7.43"	45	Yalıköy Dere Mevkii
Rize	Çayeli	Eskipazar	41° 4'59.71" 40°42'59.77"	63	Sofoğon Hozan
Rize	Derepazarı	Bahattinpaşa	41° 1'0.87" 40°26'44.90"	242	Aşağı Mahalle
Rize	Derepazarı	Kirazdağı	40°58'59.50" 40°24'27.60"	295	Baş Mahalle
Rize	Derepazarı	Bürücek	41° 1'37.11" 40°26'39.88"	138	Ortamahalle

After weighing, the remaining oils in the beaker were removed with the help of a pipette and transferred to Eppendorf tubes. The oils in closed Eppendorf tubes were covered with stretch film and stored in the refrigerator at +4° C.

2.3 Determination of Fatty Acid Composition

A 1 molar Potassium Hydroxide (KOH) solution was prepared to determine fatty acid composition. 0.1 g of the oils in the Eppendorf tubes were weighed and dissolved with 10 ml hexane in a 10 ml falcon tube. 0.5 ml (500 microliters) KOH was added to the dissolved oil and shaken. The mixture was left in a dark environment for 45 minutes. Then it was kept in the refrigerator at +4 degrees for 30 minutes. The solution taken from the upper phase accumulated on the surface with the help of an automatic pipette was transferred to 2 ml vials and fatty acid compositions were determined by Gas Chromatography (GCMS).

A SHİMADZU GC-2010 Plus device attached a TRCN-100 column (100m x 0.25 mm x 0.20 µm) was used for fatty acid analysis. The injection temperature was 250 ^{o}C with a pressure of 250 kPa. The column temperature was increased from 140^{o}C to 240^{0}C. FID temperature was 250^{o}C and injection volume was 1 µl. Split ratio was used as 1/100.

2.4 Data Analysis

Biplot Analysis were performed using the XLSTAT 2023 Statistical Program to visualize present variation in *S. tomentosa* plant parts investigated for chemical variability. Scatter plot diagrams were created using current data [11]. Based on oil content and fatty acid composition data Biplot diagram was created.

3. RESULTS AND DISCUSSION

3.1 Oil Content

Oil content values obtained from tea samples collected from Artvin, Giresun, Trabzon and Rize provinces/districts and villages are given in Table 1. Generally speaking, seed samples were collected from Altınlı village of Eynesil/Giresun, at an altitude of 7 m, and from İkizdere/Rize Gürdere village, at an altitude of 875 m. 37 samples representing all districts of Rize province and 17 samples from other provinces.

The oil content of the samples collected from Artvin province was between 15.2 - 22.6%, in Giresun province between 14.2-19.4%, in Rize province between 8.4-21.8% and in Trabzon province between 15.8 - 17.8%. Significant differences were detected between provinces and in terms of oil content.

In addition to the leaves of the tea (*Camellia sinensis* L.) plant (raw materials such as green tea, black tea, oolong tea, etc.), the seeds should also be considered as a product of the plant. Recently, with the widespread use of tea, the yield of tea seeds has also increased. For example, over one million tons of tea seeds are produced in China every year [12].

The huge increase in tea seed production increases the necessity to find suitable commercial practices. Like other Camellia species, tea seeds, which are from the Theaceae family, are rich in oil (30-32%) [13] and are considered a high-quality edible oil type because they contain high amounts of monounsaturated fatty [6]. Therefore, it is essential to use tea seeds as a source of edible oil, otherwise it will only be used in the establishment of new tea fields.

It is known that Camellia genus plant seeds have high oil content, on average around 30% oil per seed, but the oil content varies between 24% and 50% depending on the species, variety and environmental conditions. [4,6,13-16] High seed oil content is probably the result of a number of factors, but environmental variables such as soil, altitude, light, precipitation, humidity and temperature also play a key role, and these factors have been shown to influence the oil content in the seeds of many plants [17-20].

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 of commerce, oil is not usually obtained from this species. Commercial production of oil is derived from species like *C. sasanqua*, *C. japonica*, *C. tenuifolia* and *C. oleifera* [21]. *C. sinensis* seeds contains 20-30 % oil in its seeds [22].

The fat ratios obtained in this study were lower than the fat ratio values given for the Camellia sinensis species in the literature. One of the main reasons for this is the collection of tea seeds in Türkiye, especially after the 2nd or 3rd shoot. If certain tea farming areas are reserved for tea seed production and direct tea seed production is started without harvesting green leaves, it will be possible to increase both tea seed yield and oil rate in tea areas in Türkiye.

On the other hand, the way to be successful in growing oil Camellia species in different parts of the world is to select promising clones with high

Table 2. Oil content of collected tea samples

Sample codes	Province	District	Village	Oil Content
ÇT16	Artvin	Hopa	Yoldere	19.4
ÇT15	Artvin	Borçka	Muratlı	18.2
ÇT26	Artvin	Borçka	Güreşen	15.2
ÇT28	Artvin	Hopa	Koyuncular	22.6
ÇT27	Artvin	Hopa	Koyuncular	21.2
ÇT9	Giresun	Eynesil	Altınlı	16.4
ÇT12	Giresun	Tirebolu	Demircili Mah.	19.4
ÇT10	Giresun	Eynesil	Boztepe Mah.	14.2
ÇT13	Giresun	Tirebolu	Karaahmetli	19.0
ÇT14	Giresun	Tirebolu	Kovapınar	14.4
ÇT49	Rize	Çayeli	Yaka	18.8
ÇT50	Rize	Çayeli	Yalıköy	20.6
ÇT20	Rize	Pazar	Yemişli	15.2
ÇT51	Rize	Çayeli	Eskipazar	20.6
ÇT32	Rize	Merkez	Hayrat	18.0
ÇT1	Rize	Fındıklı	Sümer	15.6
ÇT45	Rize	Güneysu	Ulucami	21.2
ÇT54	Rize	Derepazarı	Bürücek	18.8
ÇT41	Rize	Kalkandere	Aşağı Tatlısu	8.4
ÇT43	Rize	Kalkandere	Ormanlı	12.6
ÇT37	Rize	İyidere	Yapraklar	21.8
ÇT36	Rize	İyidere	Köşklü	26.0
ÇT35	Rize	Kalkandere	Fındıklı	16.4
ÇT52	Rize	Derepazarı	Bahattinpaşa	17.2
ÇT21	Rize	Pazar	Orta Irmak Köyü	16.4
ÇT2	Rize	Fındıklı	Derbent	15.4
ÇT31	Rize	Ardeşen	Köprüköy	15.8
ÇT48	Rize	Çayeli	Derecik	20.0
ÇT53	Rize	Derepazarı	Kirazdağı	17.8
ÇT44	Rize	Kalkandere	Çağlayan	17.4
ÇT33	Rize	Merkez	Ortapazar	16.6
ÇT3	Rize	Fındıklı	Derbent-Selazur Mevki	17.6
ÇT4	Rize	Fındıklı	Beydere	15.6
ÇT17	Rize	Hemşin	Ortaköy	15.8
ÇT5	Rize	Fındıklı	Aslandere	16.2
ÇT47	Rize	Güneysu	Dumankaya	16.6
ÇT42	Rize	Kalkandere	Yolbaşı	18.6
ÇT19	Rize	Hemşin	Nurluca	16.6
ÇT29	Rize	Ardeşen	Köprüköy	19.2
ÇT34	Rize	Merkez	Ortapazar	15.4
ÇT22	Rize	Pazar	Akbucak Köyü	14.4
ÇT30	Rize	Ardeşen	Tunca Esentepe	20.4
ÇT18	Rize	Hemşin	Bilenköy	16.0
ÇT46	Rize	Güneysu	Yüksekköy	14.0
ÇT40	Rize	İkizdere	Ihlamur	15.4
ÇT39	Rize	İkizdere	Gürdere	19.0
ÇT38	Rize	İkizdere	Ilıca	17.6
ÇT25	Trabzon	Of	Ballıca	18.0
ÇT6	Trabzon	Sürmene	Gültepe	17.8

Sample codes	Province	District	Village	Oil Content
ÇT24	Trabzon	Of	Cumapazarı	17.8
ÇT7	Trabzon	Sürmene	Güney Köyü	17.2
ÇT23	Trabzon	Of	Cumapazarı	16.6
ÇT11	Trabzon	Beşikdüzü	Şahmelik	15.8
ÇT8	Trabzon	Sürmene	Yeşilköy	16.0

oil content and quality for the targeted regions [23].

Camellia plant, which is used to obtain ornamental plants and tea, is one of the four main tree-form plants (palm tree, coconut, olive oil and tea plant) containing oil [24]. Oil obtained from Camellia species has become important in China and to a lesser extent in Japan.

In China, tea seed oil was also traditionally used as a medication for burn injuries and stomachaches. Rats' serum levels of low density lipoprotein, triglycerides, and cholesterol may all be lowered by the saponin in tea seeds [25-26]. Tea seed oil is said to offer several health benefits, including lowering blood pressure and cholesterol, being rich in emollients for skin care, having a high antioxidant content (polyphenols, carotenoids, and vitamin E), and minimising indications of ageing [27-28].

In recent years, increasing attention has been drawn to the health benefits of olive oil, which has led to a dramatic increase in olive oil production outside non-traditional production regions outside the Mediterranean. Similarly, camellia oil now has a healthy image and it is possible to say that there will be a similar increase in its use.

3.2 Fatty Acid Composition

The fatty acid composition of tea seed samples collected from Artvin, Giresun, Trabzon and Rize provinces is given in the Table 3.

In tea seed samples, palmitic acid content varied between 10.31-20.74%, stearic acid content 1.18-3.52%, linoleic acid content 18.98-26.36% and linolenic acid content 0-1.23%.

As expected, oleic acid, an indicator of vegetable oil quality, was high in all samples. The oleic acid content in the samples collected from Artvin varied between 53.87-61.04%, 48.35-60.77% in Giresun, 34.09-62.41 in Rize and 49.94-61.28% in Trabzon.

Principal Component Analysis of tea seed oil samples is given in Fig. 1. 59.42% of the existing variation could be explained by the first two calculated principal components.

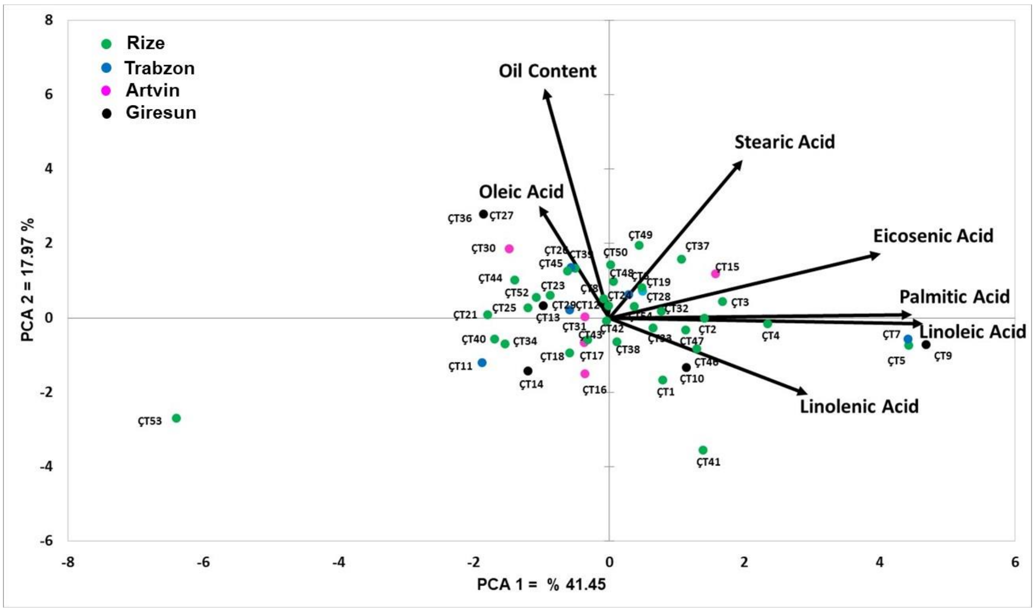

Fig. 1. Biplot of Tea samples based on oil content and fatty acid composition

Table 3. Fatty acid composition of collected tea samples

Sample	Province	District	Village	Palmitic Acid	Stearic Acid	Oleic Acid	Linoleic Acid	Linolenic Acid	Eicosenic Acid
ÇT28	Artvin	Hopa	Yoldere	17,2	2,43	56,96	22,25	0,34	0.72
ÇT15	Artvin	Borçka	Muratlı	17,84	3,2	53,87	23,68	0,3	0.79
ÇT16	Artvin	Borçka	Güreşen	17,32	1,18	57,97	22,63	0,28	0.56
ÇT27	Artvin	Hopa	Koyuncular	16,08	2,15	61,04	19,79	0,23	0.61
ÇT26	Artvin	Hopa	Koyuncular	16,83	2,2	59,05	20,84	0,28	0.68
ÇT9	Giresun	Eynesil	Altınlı	19,81	2,34	48,35	27,48	0,52	1.23
ÇT12	Giresun	Tirebolu	Demircili Mah.	17,17	1,93	57,02	22,84	0,23	0.67
ÇT10	Giresun	Eynesil	Boztepe Mah.	19,41	1,79	53,82	24,13	0,23	0.61
ÇT13	Giresun	Tirebolu	Karaahmetli	17,27	1,57	59,08	21,15	0,24	0.69
ÇT14	Giresun	Tirebolu	Kovapınar	16,88	1,45	60,77	20,07	0,32	0.43
ÇT49	Rize	Çayeli	Yaka	16,52	3,52	56,56	22,38	0,23	0.71
ÇT50	Rize	Çayeli	Yalıköy	17,27	2,44	57,7	21,51	0,25	0.74
ÇT20	Rize	Pazar	Yemişli	16,76	1,61	59,69	20,62	0,25	0.55
ÇT51	Rize	Çayeli	Eskipazar	16,75	1,27	58,38	22,67	0,31	0.62
ÇT32	Rize	Merkez	Hayrat	17,82	2,02	55,92	23,17	0,27	0.80
ÇT1	Rize	Fındıklı	Sümer	17,6	2,75	55,79	21,88	0,8	0.00
ÇT45	Rize	Güneysu	Ulucami	17,33	2,22	58,03	21,65	0,22	0.53
ÇT54	Rize	Derepazarı	Bürücek	17,27	2,03	56,44	23,07	0,29	0.71
ÇT41	Rize	Kalkandere	Aşağı Tatlısu	18,21	1,42	53,66	25,56	0,34	0.57
ÇT43	Rize	Kalkandere	Ormanlı	16,77	2,52	58,47	21,45	0,2	0.59
ÇT37	Rize	İyidere	Yapraklar	17,98	2,55	53,63	24,83	0,22	0.73
ÇT36	Rize	İyidere	Köşklü	16,18	2,14	61,3	19,58	0,2	0.55
ÇT35	Rize	Kalkandere	Fındıklı	16,57	1,57	61,94	18,98	0,21	0.50
ÇT52	Rize	Derepazarı	Bahattinpaşa	16,26	2,45	57,94	21,62	0,15	0,57
ÇT21	Rize	Pazar	Orta Irmak Köyü	15,72	1,94	61,54	19,77	0,18	0,53
ÇT2	Rize	Fındıklı	Derbent	17,19	2,43	55,16	23,81	0,27	0,98
ÇT31	Rize	Ardeşen	Köprüköy	17,35	2,32	57,74	21,72	0,25	0,61
ÇT48	Rize	Çayeli	Derecik	16,85	2,37	57,02	22,77	0,28	0,64
ÇT53	Rize	Derepazarı	Kirazdağı	10,31	1,3	34,09	12,84	0,11	0.00
ÇT44	Rize	Kalkandere	Çağlayan	15,75	2,31	60,25	20,76	0,23	0.60

Sample	Province	District	Village	Palmitic Acid	Stearic Acid	Oleic Acid	Linoleic Acid	Linolenic Acid	Eicosenic Acid
ÇT33	Rize	Merkez	Ortapazar	17,43	2,01	56,92	22,43	0,33	0.79
ÇT3	Rize	Fındıklı	Derbent-Selazur Mevki	18,37	2,29	54,99	22,84	0,3	1.04
ÇT4	Rize	Fındıklı	Beydere	18,65	2,67	50,72	23,59	0,33	1.00
ÇT17	Rize	Hemşin	Ortaköy	16,75	1,72	58,63	21,87	0,28	0.64
ÇT47	Rize	Güneysu	Dumankaya	17,84	2,18	54,48	24,45	0,3	0.70
ÇT42	Rize	Kalkandere	Yolbaşı	17,26	2,04	57,36	22,44	0,27	0.64
ÇT19	Rize	Hemşin	Nurluca	18,27	2,84	56,68	21,23	0,22	0.69
ÇT29	Rize	Ardeşen	Köprüköy	17,47	1,53	57,53	22,44	0,24	0.61
ÇT34	Rize	Merkez	Ortapazar	15,75	1,52	61,72	19,92	0,25	0.6
ÇT22	Rize	Pazar	Akbucak Köyü	16,16	2,38	59,81	20,47	0,37	0.68
ÇT30	Rize	Ardeşen	Tunca Esentepe	16,71	1,95	60,42	19,93	0,21	0.55
ÇT18	Rize	Hemşin	Bilenköy	17,34	1,31	58,87	21,44	0,25	0.63
ÇT5	Rize	Fındıklı	Aslandere	20,74	2,15	48,75	26,36	0,45	1.23
ÇT40	Rize	İkizdere	Ihlamur	15,79	1,67	62,41	19,1	0,27	0.56
ÇT46	Rize	Güneysu	Yüksekköy	17,68	2,3	54,46	24,46	0,29	0.74
ÇT39	Rize	İkizdere	Gürdere	15,33	2,85	60,49	20,13	0,36	0.70
ÇT38	Rize	İkizdere	Ilıca	16,36	1,61	58,65	22,24	0,45	0.69
ÇT25	Trabzon	Of	Ballıca	16,63	1,93	60,03	20,37	0,23	0.53
ÇT6	Trabzon	Sürmene	Gültepe	18,3	2,28	57,6	20,71	0,23	0.79
ÇT24	Trabzon	Of	Cumapazarı	16,61	2,28	58,17	21,7	0,29	0.71
ÇT7	Trabzon	Sürmene	Güney Köyü	20,00	2,26	49,94	25,79	0,58	1.23
ÇT23	Trabzon	Of	Cumapazarı	15,40	2,32	61,28	19,92	0,31	0.67
ÇT11	Trabzon	Beşikdüzü	Şahmelik	15,97	1,45	55,42	18,21	0,25	0.54
ÇT8	Trabzon	Sürmene	Yeşilköy	15,37	2,76	59,76	20,78	0,38	0.75

Climate factors affect fatty acid composition [29-30]. When the climate changes, the likelihood of changes in fatty acid composition increases, with temperature strongly affecting the biosynthesis of fatty acids, especially unsaturated fatty acids [31-32].

The climatic conditions of the cities and districts taken as a sample are different from each other. Since the tea plant is foreign pollinated, the differences obtained in this study are due to the heterogeneous structure of the tea plant and the effect of climatic factors.

We have to consider, that seeds were obtained after leaf harvest of tea plants. We can assume that the seed yield will increase if the tea plants are grown only for seed production. With governmental support tea seed oil production will be an potential additional income for local farmers.

PCA Analysis is helpful in genotype characterization and relative grouping calculated based on similarity [33-34]. PCA analysis can be used to differentiate plant materials, and the differences between various species can be visually revealed based on their chemical composition [35-36]. If these two methods are combined, characters that critically contribute to genetic variability in crops can be analyzed [37]. Biplot is another step in which one can group and identify the factors contributing to the variation obtained in PCA [38].

Tea seed samples collected using this method could be separated from each other in terms of oil content and fatty acid composition. The data obtained provided important data for future studies on tea seeds.

4. CONCLUSION

Vegetable oils obtained by processing oilseeds; It has a special importance in human nutrition as well as great importance for our health. The physical and chemical properties of oils are determined by the ratios and types of fatty acids they contain. The fatty acid composition of oil plants is not always constant; It is under the control of genetic, ecological, morphological, physiological and cultural practices. The distribution of fatty acids varies significantly in ecological regions at different latitudes. Among environmental factors, the effect of temperature on fatty acid synthesis is especially evident. Determining the effect of different latitudes and temperatures on the composition of fatty acids will enable regional production planning of oil crops and the production of vegetable oil for consumption purposes from different regions. Fatty acid composition is also affected by soil properties. Fatty acid compositions of oil crops are affected by genotype, as well as ecological and many other factors. In addition, fatty acids constantly change depending on the position of the seeds in the plant and during the period from the formation of the seed to its maturation. There may be differences in fatty acid composition between seeds harvested at different maturation periods; Therefore, when determining the fatty acid composition of seeds, their ripening periods should also be taken into account. As a result, fatty acid composition shows characteristic differences specific to plant species. In addition, the specific fatty acid composition of each oil plant is not constant and constantly changes depending on many factors.

Therefore, knowing under what conditions the fatty acid composition of oil plants will change is important in terms of oil quality. At the same time, the amount and type of fatty acids determine the usage method. Knowing the fatty acid composition of oils will enable production of oils according to their intended use. For this purpose, it will be possible to produce oils suitable for the purpose by growing the desired types in suitable regions.

Producing tea seeds and obtaining tea seed oil is a new topic for local tea farmers. Concerning the health issues of *C. sinensis* oil and its remarkable fatty acid composition suitable as edible oil, the support of tea seed oil production by the government will open a new additional income for loal tea farmers at the Black Sea Region.

The oil content and fatty acid composition of collected tea samples varied between locations, which reveals a huge potential for oil production for tea plantations in Türkiye if governmental support is present.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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