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A research on the chemical, mineral and fatty acid compositions of two almond cultivars grown as organic and conventional in southeastern Turkey

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SUMMARY: Organic farming is a human and environment friendly production system that is based on soil fertility and food safety without using chemical fertilizers and pesticides in production, aiming to re-establish the deteriorated ecological balance as a result of harmful production practices. Organic products attract the interest of consumers as they are strongly perceived as healthier products compared to conventional food. This study aimed to determine the differences in chemical, mineral, and fatty acid characteristics between conventionally and organically cultivated Ferragnes and Ferraduel almond cultivars. When conventional and organic almonds were evaluated in terms of fatty acids, proximate compositions, and minerals, crude oil and Mg were statistically insignificant, while Cu was significant ($P < 0.05$) and all others were quite significant ($P < 0.001$). Total sugar was higher in organic samples compared to conventional samples in both cultivars. The crude oil and linoleic acid (12.93% for Ferragnes and 14.99% for Ferraduel) were higher in conventional samples but oleic acid (78.9% for Ferragnes and 81.08% for Ferraduel) was higher in organic samples. In addition, organic samples contained higher Mg and Fe but lower P, K, Ca, Na, Zn, Mn and Cu when compared with conventional samples. The results indicate that conventionally cultivated almonds present higher mineral content and lower fatty acid value compared to organically cultivated almonds.

KEYWORDS: *Conventional; Fatty acid; Minerals; Organic; Proximate; Prunus dulcis.*

RESUMEN*: Investigación sobre la composición química, minerales y ácidos grasos de dos cultivares de almendra cultivados como orgánico y convencional en el sudeste de Turquía*. La agricultura orgánica es un sistema de producción amigable con el ser humano y el medio ambiente, basado en la fertilidad del suelo y la seguridad alimentaria. Este sistema suele prescindir del uso de fertilizantes químicos y pesticidas en la producción, con el objetivo de prefijar el equilibrio ecológico previamente destruido como resultado natural de prácticas de producción incorrectas. Los productos orgánicos están atrayendo cada vez más el interés de los consumidores ya que se perciben como productos más saludables en comparación con los alimentos convencionales. Este estudio tenía como objetivo determinar las diferencias en las características químicas, minerales y ácidos grasos existentes entre los cultivares de almendra de Ferragnes y de Ferraduel, cultivados tanto convencionalmente como orgánicamente. Cuando se evaluaron las almendras convencionales y las orgánicas en términos de ácidos grasos, composiciones proximal y minerales, el aceite crudo y el Mg fueron estadísticamente insignificantes, mientras que los valores de Cu fue significativo ($P<0.05$) y todos los demás fueron bastante significativos ($P<0.001$). El azúcar total fue mayor en muestras orgánicas en comparación con muestras convencionales en ambos cultivares. El aceite crudo y el ácido linoleico (12.93% para Ferragnes y 14.99% para Ferraduel) fue mayor en muestras convencionales, pero el ácido oleico (78.9% para Ferragnes y 81.08% para Ferraduel) fue mayor en muestras orgánicas. Además, las muestras orgánicas contenían mayor Mg y Fe pero menor P, K, Ca, Na, Zn, Mn y Cu cuando se compararon con las muestras convencionales. Los resultados indican que las almendras convencionales presentan mayor contenido mineral y menor valor de ácidos grasos en comparación con las cultivadas orgánicamente.

PALABRAS CLAVE: *Ácido graso; Composición proximal; Convencional; Minerales; Orgánico; Prunus dulcis.*

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1. INTRODUCTION

The cultivated almond is classified into the subgenus Amygdalus from the genus Prunus of the family Rosaceae (Kester and Gradziel, 1998). The *Prunus amygdalus* L. (almond) is an important nut crop and cultivated and produced for various purposes compared to other commercial nuts in the world (Simsek *et al*., 2018). Turkey is one of the leading countries in almond production. The agricultural data shows that Turkey (150.000 tons) is the forth largest almond producer after USA (1.936.840 tons), Spain (340.420 tons) and Iran (177.015 tons) (FAO, 2020; Gülsoy and Şimşek, 2020).

The almond is one of the fruit species whose production and consumption is increasing around world because it contains valuable nutrients that have many benefits on human health (Gülsoy and Balta, 2014). The almond is a source of important compounds to maintain a healthy metabolic function because of its high levels of antioxidants, dietary fiber, vitamins (mainly E, A, B1, and B2) minerals, fat, protein, essential fatty acids, and polyphenols (Welna *et al*., 2008; Barreca *et al.*, 2020). Recent studies have documented a wide range of health benefits including possible protection from cancer (Davis and Iwahashi, 2001), obesity (Foster *et al*., 2012), diabetes (Lovejoy *et al*., 2002), high cholesterol (Fulgoni *et al*., 2002) and coronary heart disease (Jenkins *et al*., 2002). It is not only beneficial for muscle and joint pain, rheumatism, and skin diseases, but it also reduces headache, sore throat, urinary infections, and kidney disorders (Mushtaq *et al*., 2015).

As organic foods are perceived by consumers as healthier, more beneficial for a sustainable environment, more nutritious compared to conventionally produced foods and higher in quality, (Magnusson *et al*., 2001; Macllwain, 2004; Gomiero, 2018), the organic food industry is one of the fastest growing food and agriculture industries worldwide (Ballester-Costa *et al*., 2013). With the increasing number of consumers who care about healthy lifesyles and the environment, the tendency towards organically produced foods is increasing (Gülnur *et al*., 2016). However, whether there is a significant difference in terms of nutritional value between organic foods and foods grown according to conventional methods is a subject of ongoing discussion among consumers (Akan and Yılmaz, 2015). For this reason, in recent years, many studies have been conducted about the nutritional value of organically produced foods compared to those produced conventionally. These studies have revealed that organic foods have high dry matter content and amino acid quality (Zorb *et al*., 2006), high polyunsaturated fatty acids (Dangour *et al*., 2009), low nitrate and mycotoxin (Pussemier *et al*., 2006), high content in minerals (Lairon, 2010), a high amount of vitamin C, anthocyanin and antioxidant capacities (Woese *et al*., 1997), rich in carotenoids (Hoefkens *et al*., 2010) and phenolic compounds (Wang *et al*., 2008).

There are various studies in the literature comparing the quality characteristics of organic and conventional almonds. In these studies, Sánchez-Bel *et al*. (2008) compared the effect of organic and inorganic fertilizer applications on the chemical quality properties of the Guara almond cultivar. Venkatasubramanian (2011) compared some nutritional quality properties of organic and conventional market foods, including almonds. Vrastil (2018) compared some mineral contents of convetionally and organically grown almonds purchased from local markets. Karaat (2019) compared the pomological parameters, chemical properties and volatile aroma compounds of two organic and conventionally grown almond cultivars. However, there are limited number of studies, especially for detalied fatty acid compounds and macro-micro element contents in organic and conventionally grown almonds.

According to previous research, cultivation and retail market studies are two common methods used to examine the differences between organic and conventional products. In both methods, the advantages and disadvantages are highlighted. This research was performed on the food compositions of almonds picked directly from organic and conventional orchards and not by purchasing products from markets.

Environmental circumstances, harvest and post-harvest influences and accessible information on the products are some of the characteristics that distinguish farm and cultivation studies from retail market studies. For this reason, the notion that retail studies are representative of the expanding system on a large scale has been accepted (Magkos *et al.*, 2006). Considering all of these reasons, this research was carried out to assess and to compare some chemical properties, mineral contents, and fatty acid compositions of Ferragnes and Ferraduel almond cultivars grown by organic and conventional methods in the Dicle region (Diyarbakır) of Turkey.

2. MATERIALS AND METHODS

2.1. Plant materials and sampling

The study was conducted in the Dicle district of the Diyarbakir province of Southeast Turkey in 2020. The plant material of the study was composed of 6-7-year old Ferragnes and Ferraduel cultivars grafted on seedling rootstocks. The conventional almond orchard is situated between 38˚21’04”N and 40˚04’31”E coordinates, while the organic orchard is situated between 38˚20’51”N and 40˚03’55”E. The distance between both orchards is about 1000 meters. Ecological conditions and cultural practices such as drip irrigation, tillage, pruning and planting distance (5x6 meters) of the two almond orchards were similar.

In this study, 5 trees of each cultivar were selected and 3 repetitive readings on each tree were done. The study was designed according to the randomized complete block design. In the study, 5 trees for conventional growing, 5 trees for organic growing from each of the Ferragnes and Ferraduel cultivars were chosen to make a total of 20 trees.

2.2. Almond kernel analyses

2.2.1. Proximate analyses

Immediately after harvesting, the outer green sheels of the almonds were removed, and the almond fruits were dried for 20 days at room temperature. Then, fruit samples were ground, and their moisture content was determined. For moisture analysis, 3 g samples were weighed in nickel dry matter containers (tared), and oven dried at 105 ºC when their weight was constant. The results were calculated according to the methods given by the Turkish Standard Institute (AOAC, 1990; Simsek *et al*., 2018). Total ash content was determined by the combustion of 1 g of kernel almond into the muffle oven at 560 °C according to Gönül *et al*. (1988). For crude oil analysis, 5 g samples were homogenized and subjected to extraction for 6 h with 60-80 ml of hexane (boiling range 30-60 °C) in a Soxhlet apparatus. After 6 h of extraction, the samples were evaporated under vacuum, and then weighed and their oil yield was determined (James, 1995; Simsek *et al*., 2018). The crude protein ingredient was calculated by multiplying the percentage of nitrogen (N%) with a constant factor of 6.26 (AOAC, 1990; Simsek *et al*., 2018). Total sugar content was determined by the Anthrone method (Kaplankıran, 1984; Simsek *et al*., 2018).

2.2.2. Mineral composition

Analyses were performed by Atomic Absorption Spectrometry (Perkin-Elmer 703) for magnesium (Mg), calcium (Ca), iron (Fe), copper (Cu), zinc (Zn) and manganese (Mn), Flame Emission Spectrometry for potassium (K) and sodium (Na). Phosphorus (P) were determined by the colorimetric method (Saura Calixto and Canellās, 1982; Simsek *et al*., 2018; Simsek, 2021).

2.2.3. Fatty acid composition

For the the fatty acid methyl ester (FAME) extraction, 0.1 g of exemplary fat was melted in 2 ml of heptane, and 0.2 ml of a 2M methanolic KOH solution. The solution was shaken strongly for 30 seconds and was left to stand until the supernatant liquid became clear. Then, the heptane solution was injected into the gas chromatograph (GC). FAME analysis was performed on a 60 m capillary column (ID = 0.25 mm) covered with an Agilent 6890 series gas chromatography, adorned with a flame ionization detector, and 0.25 μm and 50% cyanopropyl methylpolysiloxane (J & W Scientific, Folsom, CA, the US) (Simsek, 2021). Helium gas was used as carrier gas at a flow rate of 30 ml/min and 1:50 ratio, and the temperature of the injector and the detector were set at 260 and 280 °C, respectively. The oven temperature was scheduled in accordance with a retention time of 1 minute at 120 °C, raised to 170 °C at 6.5 °C/min, and finally to 215 °C at 2.15 °C/min. Fatty acid methyl esters were defined by using standard FAMEs (Supelco – 47885 - U) and calculated in accordance with their percentage values (Dieffenbacher and Pocklington, 1992; Batun *et al*., 2017). In addition to individual fatty acid data, saturated fatty acids (SFA), unsaturated fatty acids (UFA) and UFA/SFA ratios were calculated.

2.3. Statistical analysis

All measurements were carried out in triplicate and analyses of variance (one-way Anova) of the results were performed using SPSS-22 software. The means obtained from each set were compared using the Duncan’s multiple range test at 0.05 confidence level.

3. RESULTS AND DISCUSSION

Significant differences (P < 0.001) for the evaluated proximate parameters were detected except for crude oil which was not significantly different between cultivars or growing systems (Table 1).

In the Ferraduel cultivar, there was a statistical difference in crude protein, moisture, and ash contents between conventional and organic growing, but no difference was found for crude oil or total sugar contents. However, while moisture, ash and total sugar were significantly different in Ferragnes, crude fat and protein were not.

The proximate chemical content results are presented in Table 1. The crude oil and crude protein contents of conventional Ferragnes samples were higher than the organic samples (48.32 and 48.01%, 24.34 and 23.97%, respectively). In the Ferraduel cultivar, crude oil was higher in the conventional samples than in the organic ones, (47.85 and 47.21% ,respecitvely) while crude protein was higher in the organic samples (24.08 and 26.44%, respectively). The highest moisture content was found in organic Ferragnes (2.90%), while the lowest was found in organic Ferraduel (2.57%). The lowest and highest ash values were found in Ferraduel. The highest total sugar content was found in the organic Ferragnes samples (5.20%) (Table 1).

There are very few studies investigating the chemical differences between organic and conventionally grown almonds. Among these studies, Venkatasubramanian (2011) compared the chemical properties of some organic and conventionally grown nuts and reported higher protein and carbohydrate, lower fat, moisture, and energy in organic production compared to conventional. These results were in parallel with the findings of the present study related to the protein in the Ferraduel cultivar, while incompatible results were obtained related to Ferragnes, and similar results were obtained with both cultivars for crude oil. Gulsoy and Balta (2014) investigated the total oil and protein compositions of conventionally grown Ferragnes and Texas cultivars in Aydın, Turkey and found 22.8% protein and 54.% crude oil for Ferragnes, and 33.1% protein, 49.8% crude oil for Texas. Rabadán *et al*. (2017) studied the crude oil contents of ten almond cultivars in Spain and reported crude oil contents as 54.14% for Ferragnes and 53.96% for Ferraduel. Karaat (2019) reported higher crude fat and lower crude protein, ash, and moisture in traditional compared to organic production of Ferragnes and Ferrudal cultivars grown in Adıyaman.

The differences in chemical composition may be caused by numerous factors such as cultivar, genetic factors, environmental conditions, irrigation, soil, tree age, growing technique, post-harvest processing, packaging, and storage conditions (Mele *et al*., 2018).

The statistical analysis results for the conventional versus organic almond mineral content comparisons are given in Table 2. Results from the data analyses indicate that there were statistically significant differences at P < 0.001 when comparing phosphorus, potassium, calcium, sodium, zinc, manganese iron and cupper between conventionally and organically grown almonds. However, magnesium was found to be insignificant. The micro and macro element contents in the almond kernels are presented in Table 2.

The highest amounts of macro and micro minerals were found in the Ferraduel cultivar except

TABLE 1. Sugar and proximate chemical composition of almond cultivars from conventional and organic orchards

	Ferragnes		Ferraduel		Level of significance p
	Conventional	Organic	Conventional	Organic	
Crude oil (%)	+48.32±1.42	48.01±2.40	47.85±1.78	47.21± 1.46	NS
Crude protein (%)	24.34±0.88 b	23.97±2.02 b	24.08±1.64 b	26.44±1.35 a*	0.000**
Moisture (%)	2.63±0.40 b	2.90±0.26 a	2.96± 0.39 a	2.57±0.34 b	0.000
Ash (%)	3.41± 0.26 a	3.25± 0.13 b	3.51±0.25 a	3.21±0.18 b	0.002
Total sugar (%)	3.22±0.21 c	5.20±0.34 a	3.78±0.97 b	3.84±0.43 b	0.000

* Means followed by the same letter in the each row are insignificant at the 95% probability level according to Duncan's multiple range test
NS,**: non-significant, significant at P ≤ 0.001, respectively. The results are expressed as mean value ± standard deviation
+: The study was carried out with three replicates and each replicate corresponded to five plants. Therefore, the values are based on fifteen plants.

TABLE 2. Macro and micro element contents in almond cultivars from conventional and organic orchards (mg/100 g).

	Ferragnes		Ferraduel		Level of significance p
	Conventional	**Organic**	**Conventional**	**Organic**	
P	544.28±73.36 b	538.31±73.51 b	687.35±77.68 a	503.35±67.27 b*	0.000***
K	752.12±70.16 b	794.67±149.22b	916.49±93.67 a	653.43±116.01 c	0.000
Ca	343.30±110.69 b	247.33±27.18 c	445.42±94.37 a	294.79±52.18 c	0.000
Mg	222.40±19.73	229.12±17.77	236.38±34.79	242.59±14.96	NS
Na	2.15±0.42 a	0.87±0.12 c	1.15±0.20 b	1.08±0.18 b	0.000
Zn	4.66±0.55 b	5.77±0.81 a	6.18±0.64 a	6.02±0.31 a	0.000
Mn	1.84±0.34 a	1.58±0.21b	1.91±0.35 a	1.84±0.15 a	0.000
Fe	5.89±0.50 c	6.73±0.73 b	7.00±0.79 b	8.01±0.31 a	0.000
Cu	1.72±0.51 b	1.96±0.20 a	1.99± 0.24 a	1.72± 0.19 b	0.010**

* Means followed by the same letter in the each row are insignificant at the 95% probability level according to Duncan's multiple range test
NS,**: non-significant, significant at P ≤ 0.001, respectively. The results are expressed as mean value ± standard deviation
+: The study was carried out with three replicates and each replicate corresponded to five plants. Therefore, the values are based on fifteen plants.

sodium (Na). The highest contents in phosphorus (P), potassium (K), calcium (Ca) and zinc (Zn), manganese (Mn) and copper (Cu) were found in the conventional samples of Ferraduel 687.35 mg/100g, 916.49 mg/100g, 445.42 mg/100g, 6.18 mg/100g,1.91 mg/100g and 1.99 mg/100g, respectively. The highest magnesium (Mg) and iron (Fe) contents were found in organically grown Ferraduel with 242.59 mg/100g and 8.01 mg/100g, respectively (Table 2). The results indicated higher mineral contents for the conventional samples of the Ferraduel cultivar compared to the organic samples. Phosphorus (P), calcium (Ca), sodium (Na) and manganese (Mn) contents were found to be higher in conventional Ferragnes cultivar than in the organic samples, while potassium (K), magnesium (Mg), zinc (Zn), iron (Fe) and copper (Cu) contents were higher in the organic samples.

Generally, the Mg and Fe contents in organic almonds were found to be higher than those of conventional almonds and P, K Ca, Na, Zn, Mn, Cu contents were observed to be lower than in conventional almonds.

In a comparative review conducted by Worthington (2001), higher levels of iron and magnesium in organic vegetables than in conventional ones were found consistent with the findings of the present. Fertilization significantly affects the mineral content of plants. Conventional potassium fertilizers dissolve more easily in soil water, while organically grown soils retain moderate amounts of potassium and magnesium in the root area of the plant. Therefore, organic products would be expected to contain more magnesium and phosphorus than conventional products (Crinnion, 2010).

Conventional almond samples contained more sodium compared to the organic ones. Since easily soluble fertilizers are used in conventional agriculture, soil solution ions are easily absorbed by the roots. Most mineral fertilizers contain highly soluble sodium and are quickly taken up by plants (Gastol and Domagala- Świątkiewicz, 2012).

Venkatasubramanian (2011) found that organic almonds have higher Fe, Ca, and K contents, and lower Na content compared to conventional almonds. The findings of the present study for Ferragnes were in line with Venkatasubramanian's (2011) findings for Fe, K, and Na, but not for Ca. The findings for Ferraduel were compatible with Fe and Na, but incompatible with Ca and K.

Vrastil (2018) compared some mineral (Ca, Fe, Mg, K, Zn) contents in traditionally and organically grown almonds purchased from local markets in three states of the USA and he found a small effect for Fe, a medium-size effect for Ca and K, and no effect for Mg or Zn between conventional and organic production statistically. Yada *et al*. (2011) stated that the nutrient composition of almonds may be changed depending on genotype and cultivar dependents, and may also be influenced by environmental factors, such as growing region, cultivation methods, and climatic conditions. On the other hand, differences in the mineral contents

Table 3. Fatty acid compositions (percent) of almonds from organic and conventional orchards

	Ferragnes		Ferraduel		Level of significance p
	Conventional	Organic	Conventional	Organic	
Palmitic Acid (C16:0)	6.02±0.26 d	6.69±0.18 b	6.26±0.31 c	7.61±0.09 a*	0.000**
Stearic Acid (C18:0)	2.04±0.06 d	2.26±0.06 c	2.39±0.18 b	2.77±0.06 a	0.000
Heptadecanoic Acid	0.09±0.01	0.09±0.00	0.09±0.01	0.14±0.18	NS
Arachidic Acid (C20:0)	0.09±0.01 b	0.09±0.01 b	0.10±0.01 a	0.08±0.01 b	0.000
Tricosanoic Acid (C23:0)	0.07±0.04a	0.04±0.02 b	0.05±0.03 b	0.07±0.03 a	0.004
Palmitoleic Acid (C16:1)	0.64±0.03 d	0.77±0.03 b	0.74±0.03 c	0.85±0.03 a	0.000
Oleic Acid (C18:1)	79.01±0.35 c	79.53±0.63 b	76.36± 0.70 d	81.08±0.49 a	0.000
Linoleic Acid (C18:2)	12.93±0.40 b	11.51±0.67 c	14.99±0.70 a	8.54±0.48 d	0.000
Linolenic acid (C18:3)	0.05±0.01	0.05±0.01	0.04±0.01	0.04±0.01	NS
SFA	8.06±0.26 d	8.96±0.21 b	8.65±0.39 c	10.38±0.12 a	0.000
UFA	89.62±0.26 a	91.04±0.21 c	91.35±0.39 b	89.62±0.12 d	0.000
UFA/SFA	11.42±0.38 a	10.17±0.26 c	10.58±0.53 b	8.64±0.11 d	0.000

* Means followed by the same letter in each row are insignificant at the 95% probability level according to Duncan's multiple range test
NS,**: non-significant, significant at $P \leq 0.001$, respectively. The results are expressed as mean value ± standard deviation
+: The study was carried out with three replicates and each replicate corresponded to five plants. Therefore, the values are based on fifteen plants.
SFA: saturated fatty acids, UFA: unsaturated fatty acids, UFA/SFA: saturated fatty acids/ unsaturated fatty acids

of almonds may be a result of specific practices, such as tillage or fertilization. Since mineral content depends on soil composition, differences may be less dependent on conventional or organic status, and more dependent on fertilization methods.

The analysis of variance for the fatty acids investigated in the present study and the multiple comparison test results are given in Table 3. There were significant differences ($P < 0.001$) for the evaluated fatty acids between cultivars and growing systems, except for heptadecanoic and linolenic acid. The fatty acid contents in the conventionally and organically grown almond samples are reported in Table 3. The prevalent fatty acids found in the almond cultivars were oleic acid, linoleic acid, palmitic acid, and stearic acid. Other fatty acids were found in trace amounts.

Oleic acid contents were found higher in organically grown Ferragnes and Ferraduel, while linoleic acid contents were lower in both cultivars. The highest oleic acid content was found in organic growing, which was 79.53% for Ferragnes and 81.08% for Ferraduel (Table 3). Conventional Ferraduel samples were found to possess the highest linoleic acid content (14.99%) followed by conventional Ferragnes samples (12.93%). On the other hand, palmitic, palmitoleic and stearic acid were determined at the highest level in organic production for both cultivars. Their values were higher in organic Ferraduel samples (7.61, 0.85, and 2.77% respectively). In addition, unsatured fatty acids (UFA) and unsatured fatty acid/satured fatty acid ratios (UFA/SFA) were found to be higher, and satured fatty acids (SFA) were found to be lower in both cultivars of organic almonds compared to conventional growing (Table 3). The results showed that organic almonds contain a higher amount of fatty acids compared to conventional ones.

In previous works, Samman *et al*. (2008), reported no consistent difference between the overall fatty acid composition of commercially available certified organic and conventionally produced edible oils. (coconut, canola, sesame and sunflower). Soares *et al*. (2013), reported that conventional and organic cultivation methods had little effect on the fatty acid composition of cashew nuts. Rabadan *et al.* (2017) reported that oleic, linoleic, and palmitic acid for Ferragnes and Ferraduel cultivars were 71.81, 17.62, 6.49 and 67.52, 21.47, and 6.64% respectively. Karaat (2019) compared the fatty acid composition of almond kernels grown organically and conventionally and reported that the most significant differences were observed in oleic and linoleic acid contents. The highest oleic acid content (82.4% in both cultivars) was recorded in organic fruits when compared to conventional samples (78.9% for Ferragnes and 75.8% for Ferraduel). Linoleic acid was found at the lowest ratio in organic samples for both cultivars. The results of this study were similar to Karaat's work (2019), although slightly higher. Simsek (2021) reported that oleic, linoleic, and palmitic acid contents ranged from 69.21 to 71.88%, from 18.76 to 22.02% and 5.62 to 7.35% in the almond genotypes from the Adiyaman province, respectively. In the present study, the oleic acid contents in conventional almond samples were somewhat different from those reported in previous works. (Rabadan *et al*., 2017; Simsek, 2021) but the linoleic acid content was lower. These differences and similarities in composition may be due to a diversified ecological condition of the soil, climate, location, genetics, and routine agronomic practices. Amaral *et al*. (2006) reported that genetic factors, as well as environmental factors, such as year of production and growing location, strongly influence the fatty acid composition. The difference between the fatty acid contents found in the present study compared to that found by other authors may be due to the methodologies used for extraction and quantification, growing conditions, and climate, time of harvest, variety, ripening, and processing methods.

4. CONCLUSIONS

In recent years, in parallel with the determination of the close relationship between nutrition and health and the increase in awareness in society, there has been a demand for healthier food among consumers. In order to meet this need, production systems that do not use chemical pesticides and fertilizers in both cultivation and processing stages, known as organic or ecological agriculture, have been developed in contrast to conventional production.

The purpose of this study was to explore the differences in biochemical contents between conventionally and organically produced almonds from two different cultivars. The results indicate that the growing system affects the biochemical contents of the Ferragnes and Ferraduel cultivars. Significant differences were found between the biochemical compositions of organically and conventionally grown samples of both cultivars. According to the results of the analysis, conventional almonds were found to be richer in terms of mineral content; whereas fatty acids were detected at higher levels in organic almonds.

Differences in the biochemical contents of the almond kernels may be due to various agricultural processes, such as location, soil composition, irrigation and fertilization, as well as many environmental factors. Although many studies have compared various organically and conventionally grown fruits and vegetables, the number of studies on almonds is limited.

Moreover, with the increasing demand for organic food products, including almonds, the acreage dedicated to organically grown almonds is likely to increase. In this context, it is thought that the findings from this study will make several contributions to the current literature.

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