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Changes in sugar contents, amino acid, sterol and tocopherol compositions of prickly pear fruit and seed oils

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In the present study, moisture, sugar, protein, amino acid, sterol and tocopherols contents and composition of prickly pear fruits and seed oils grown in different locations (Fethiye, Hatay, Anamur, Adana and Alanya) in Turkey were determined. Prickly pear fruit samples contained 38.92 (Adana) - 44.71% (Antalya) glucose, 24.95 (Fethiye) - 29.17% (Alanya) fructose and 0.15 (hatay) and 0.36% (Antalya) and 6.17 (Muğla)-0.34% (Antalya) protein depending on locations. While alanine contents of prickly pear pulp change between 0.09% (Fethiye) and 0.13% (Alanya), valine contentsof fruit samples changed between 0.09% (Fethiye) and 0.13% (Alanya). Proline contents of prickly pear fruits varied between 0.84 (Alanya) to 1.07% (Fethiye). β-sitosterol contents of fruits ranged from 762.76 (Adana) to 974.86 mg/100 g (İskenderun-Hatay) whereas the total sterol amounts of prickly pear seed oils were identified between 1113.76 (Fethiye) and 1710.35 mg/100 g (Hatay). ɣ-tocopherol amounts of prickly pear seed oils varied between 17.4 Mersin (Anamur) and 25.5 mg/100 g Antalya (Alanya) and other tocopherols were found at very low levels depending on the location.The most abundant tocopherol was ɣ-tocopherol (17.4 mg/100 g (Anamur) and 25.5 mg/100 g (Alanya). Hence it may be inferred that habitat (locations) had significant effects on protein, sugar, amino acid, sterol and tocopherol contents of prickly pear samples. Results were found partly similar, and differences observed can be due to genetic factors of prickly pear seeds and climatic factors of habitats because habitat is an effective factor on phytochemical constituents of plants.

Keywords: Amino acids, Locations, Prickly pear, Seed, Sterol, Tocopherol

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There are several species belong to the genus *Opuntia*[1,2]. The prickly pear (*Opuntia ficus-indica* L.; "Cactaceae" family), which grows in most parts of the world with tropical and semitropic climates is an important food source. In Turkey, these plants is often known as prickly pear prickly pear, figs, prickly. Prickly pear fruit consists of 3 to 7% seeds, 36-48% Mesocarp and pericarp and 39-64% edible pulp[3-7]. Prickly pear grows wild in arid and semiarid regions in Mediterranean countries, Central America and South Africa[8]. Oil contents of different *Opuntia* seeds changed between 4.60 and 17.2%[2,5,9]. Recently, prickly pear fruits produced in Turkey are consumed using fresh fruit, juice, jam and marmalade production. Since the demand for its fruits for the production of fruit juices is increasing, the cultivation of prickly pear is increasing every year. In addition, seeds obtained as a by-product from processing into products such as fruit juice, jam and marmalade are considered to be potential edible oil and phytochemical sources. Production of prickly pear fruit in many countries such as Morocco, Tunisia, Ethiopia, Eritrea, Yemen and Turkey are common like other fruits such as oranges or bananas[10,11]. This fruit is rich in nutraceuticals and functional components, minerals, vitamin C and soluble fibres, amino acids and carbohydrates[12-15]. The peel and seeds of *Opuntia* fruits are discarded during cactus pear processing. The seeds, which are considered as waste during the processing of prikckly pear fruits, create important

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new resources as oil and food[8]. Cactus pear seed oil is important due to unsaturated fatty acid profile for human consumption[6,16]. Major lipid sterols of *O. ficus indica* seed are β-sitosterol and campesterol[13,17]. In the sterol fraction of prickly pear seed oil, the dominant sterols are-sitosterols, followed by campesterol and stigmasterol in decreasing order[17]. Tocopherol are considered effective antioxidants that prevent lipid oxidation. So, prickly pear seed oils should be quite stable[9]. Vegetable oilsare now being enriched with sterols as an example of functional food[18]. Several studies were carried out on the chemical composition of prickly pear seed oil of *Opuntia ficus indica*. However, limited studies were found on sterol and tocopherol contents of seed oils of *O. ficus indica*[13,17]. This work was undertaken to obtain information on composition of prickly pear seed oils harvested from 5 different locations. The goal of the current investigation was to explaine the effect of location on protein, sugar contents, amino acid compositions, sterol and tocopherol contents of prickly pear fruits and seed oils obtained from five different locations in Mediterranean region in South Turkey.

Materials and Methods

Material

Orange colored and ripe prickly pear fruits were provided from Fethiye (Muğla), Hatay, Anamur (Mersin) Adana and Alanya (Antalya) provinces in Mediterranean Region in Turkey. 200-500 mt altitude, 400-500 mm rainy regions, temperatures between 16°C - 35°C are their favorite climatic environments. They are affected by cold and frost. Approximately 45 kg prickly pear fruit collected from each location were brought to the laboratory in refrigerated bags. After the shells were removed, the seeds were separated from the pulps. Pulps were homogenized with a blender. After the seeds were washed thoroughly with tap water, they were dried at 60°C. After the dried samples were ground in a laboratory mill, they were stored at -20°C until analysis. The pulps were separated for lyophilization to use in analysing. After samples were dried, they were ground in a mortar mill. Ground samples were stored in sealed bottles at +4°C until analysis.

Methods

Determination of the moisture

The moisture and protein amounts of prickly pear fruits were analysed according to AACC approved methods[19,20]. The sugar analyses method of Kakehi and Honda[21] was used for sugar analyses by chromatographic methods.

Amino acid profile

The amino acids were determined according to AOAC Official Method[22]. Before amino acid analysis, acid hydrolysis, performic acid oxidation, and alkaline hydrolysis were performed in the samples, and then analyzed in each hydrolysate amino acid analyzer.

Oil extraction

Each of the ground prickly pear seed samples (about 10 g) was individually weighed and extracted 5 h using petroleum ether in the Soxhlet apparatus. The temperature applied in the extraction process was 50°C. At the end of the extraction period, petroleum ether was removed in the evaporator at 50°C. The oil content of the seeds was determined by analysing the data obtained[23].

Tocopherols

HPLC equipped a Merck-Hitachi low pressure gradient system equipped with an L-6000 pump, Merck-Hitachi F-1000 fluorescence spectrophotometer (detector wavelengths for excitation 295 nm, emission 330 nm) and a D. Samples of 20 µL were injected on a Diol phase HPLC column (25 cm x 4.6 mm ID (Merck, Darmstadt, Germany) used by a Merck 655-A40 autosampler at a flow rate of 1.3 mL / min. The mobile phase used, n-heptane. / tert-butyl methyl ether (99 + 1, v / v)[24].

Sterols

250 mg of oil prickly pear seed oil was boiled under reflux and saponified with ethanolic potassium hydroxide. Unsaponifiable material was isolated by solid phase extraction on an aluminum oxide column (Merck, Darmstadt, Germany). After separating the sterol fraction by thin layer chromatography, it was re-extracted from TLC material. The composition of the sterol fraction was then determined by GLC using betulin as the internal standard. Compounds were separated on SE 54 CB (Macherey-Nagel, Düren, Germany; 50 m length, 0.32 mm ID, 0.25 µm film thickness). Peaks were identified with standard compounds[25].

Statistical analysis

Analysis of variance (ANOVA) was performed by using JMP version 9.0. The results obtained are given as mean±standard deviation (MSTAT C) of independent prickly pear seed samples[26].

Results and Discussions

The amounts of moisture of prickly pear fruits was found between 19.79% (Adana) and 27.68% (Fethiye) (Table 1) ($p<0.05$). Also, protein amounts of prickly pear samples varied between 6.17% (Fethiye) and 9.34% (Alanya) (Table 1). The sugar compositions of dried prickly pear pulps are summarized in Table 1. Depending on locations, fructose contents of samples ranged from 24.95% (Fethiye) to 29.17% (Alanya) ($p<0.05$). Diaz Medina *et al*.[27] reported that riped *O. ficus indica* fresh fruit pulp contained 82.61% moisture and 0.94% protein. In other study, moisture and protein contents of fresh prickly pear fruits were found 87.07% and 1.03%, respectively[28]. It was not observed significantly differences among moisture contents. The moisture contents changed between 84 and 90%[29] and the highest value of 94.40% was obtained by Salim, *et al*.[30].

Glucose contents of fruits were found to be between 38.92% (Adana) and 44.71% (Alanya) (Table 2). The highest glucose content was found in prickly pear collected from Antalya (Alanya) location. In previous study, saccharose, glucose and fructose contents of dried *O. ficus indica* pulp were found 0.19%, 29% and 24%, respectively[30]. Chiteva and Wairagu[28] reported that prickly pear fruit contained 59.40% sugars and 92.57% carbohydrates. Results were found partly similar compared to literature values[28,30]. Dehbi *et al*.[31] determined 97.21-165.77 g/kg total sugar and 91.25-160.66 g/kg reducing sugar in juices extracted from nine Moroccan prickly pears. Results obtained exhibited fluctuations compared to results of previous studies. These fluctuations can be probably due to soil structure, climatic factors, location and harvest time.

The major amino acids of fruits were aspartic acid, serine, glutamic acid, proline, alanine, valine, leucine and histidine (Table 3). Aspartic acid contents of fruits changed between 0.20% (Fethiye) to 0.30% (Alanya). The aminoacid in highest amounts was proline, and ranged from 0.84% (Alanya) to 1.07% (Fethiye) ($p<0.05$). While alanine contents of prickly pear pulp change between 0.09% (Fethiye) and 0.13% (Alanya), valine contents changed between 0.09% (Fethiye) and 0.13% (Alanya). Nassar[32] reported that prickly pear seed flour contained 7.21 leucine, 4.50 isoleucine, 3.81 phenylalanine, 4.93 lysine, 2.24 tyrosine, 4.37 valine, 7.56 aspartic, 15.73 glutamic, 6.14 serine, 3.67 glycine, 3.45 alanine, 2.26 histidine and 4.81% arginine. Amino acid and protein contents were found partly different. These changes can be probably due to the parts of fruits, variety, ripening degree and locations.

Sterol contents of seed oils of prickly pear harvested from five different locations are given in Table 4. Differences in sterol contents of seed oils was observed depending on locations. β-sitosterol was the key sterol of all oil samples, followed by campesterol, sitostanol, stigmasterol, 5-avenasterol and 7-stigmasterol. β-sitosterol contents of prickly pear seed oils changed between 762.76 mg/100 g (Adana) and 974.86 mg/100 g (İskenderun-Hatay). In addition, campesterol contents ranged from 11.19 mg/100 g (Fethiye-Muğla) to 181.38 mg/100 g

Table 1 — Proximate analysis of prickly pear fruits collected from different locations (%)

Sample Location	Moisture	Protein*
Muğla (Fethiye)	27.68±3.81**a	6.17±0.38***b
Hatay (İskenderun)	26.65±4.29a	7.29±0.61b
Mersin (Anamur)	22.55±0.85b	7.97±0.99b
Adana	19.79±1.39b	6.61±0.34b
Antalya (Alanya)	22.19±0.68b	9.34±0.33a

*Nx6.25
**Mean ±Standard deviation.
***Mean values of the moisture, protein and the location with a different superscript nondiffer significantly ($p<0.05$)

Table 2 — Sugar composition of *Opuntia* fruits provided from different locations (%)

	Muğla	Hatay	Mersin	Adana	Antalya
Sugars					
Fructose	24.95±0.45*bc	26.50±2.08b	25.34±1.89b	26.53±1.64b	29.17±2.50a
Glucose	41.65±1.53a**	39.32±2.75b	39.69±5.88b	38.92±3.27bc	44.71±4.51a
Sucrose	0.16±0.03bc	0.15±0.01c	0.20±0.03b	0.18±0.02bc	0.36±0.14a
Raffinose	0.01±0.01c	0.01±0.0c	0.02±0.01b	0.02±0.01b	0.05±0.03a
Stachyose	-***	-	-	-	0.01±0.01a
Verbacose	-	-	-	-	0.01±0.01a

*Mean±Standard deviation.
**Mean values of the moisture, protein and the location with a different superscript nondiffer significantly ($p<0.05$)
***non identified.

(İskenderun-Hatay). Also, while sitostanol contents of oil samples changed between 49.66 mg/100 g (Fethiye-Muğla) and 69.02 mg/100 g (Anamur-Mersin), stigmasterol contents of seed oils were identified between 38.41 mg/100 g (Alanya-Antalya) and 81.54 mg/100 g (İskenderun-Hatay). The sterolin lowest amount was brassicasterol in all samples and its value was found between 1.23 mg/100 g (Alanya-

Table 3 — Amino acid profile of *Opuntia* fruits provided from different locations (%)

Amino acids	Muğla	Hatay	Mersin	Adana	Antalya
Hydroxyproline	0.01±0.01b**	0.02±0.01a	0.02±0.0a	0.01±0.01b	0.02±0.0a
Aspartic Acid	0.20±0.0b	0.25±0.0b	0.26±0.03b	0.20±0.01b	030±0.01a
Threonine	0.05±0.01c	0.06±0.0b	0.06±0.0b	0.06±0.0b	0.07±0.0a
Serine	0.11±0.01b	0.12±0.01a	0.12±0.01a	0.11±0.02b	0.12±0.01a
Glutamic Acid	0.18±0.01c	0.22±0.01b	0.25±0.02a	0.18±0.02c	0.27±0.02a
Proline	1.07±0.03a	0.96±0.09b	1.06±0.11a	0.98±0.05b	0.84±0.14b
Lanthionine	0.06±0.01c	0.06±0.0c	0.07±0.01b	0.07±0.01b	0.09±0.01a
Glycine	0.07±0.0b	0.07±0.01b	0.08±0.01a	0.08±0.0a	0.08±0.01a
Alanine	0.09±0.0c	0.11±0.01b	0.13±0.01a	0.13±0.01a	0.13±0.01a
Cysteine	0.03±0.0b	0.03±0.0b	0.03±0.01b	0.04±0.01a	0.04±0.0a
Valine	0.09±0.01b	0.10±0.0b	0.12±0.01a	0.11±0.01ab	0.13±0.0a
Methionine	0.09±0.01c	0.09±0.01c	0.12±0.01b	0.07±0.01d	0.13±0.0a
Isoleucine	0.09±0.01c	0.09±0.0c	0.11±0.0a	0.10±0.01b	0.11±0.0a
Leucine	0.11±0.01c	0.11±0.01c	0.12±0.01b	0.11±0.01c	0.13±0.1a
Tyrosine	0.07±0.0c	0.07±0.0c	0.09±0.01b	0.07±0.01c	0.12±0.01a
Phenylalanine	0.13±0.01c	0.14±0.01c	0.17±0.01b	0.15±0.01c	0.21±0.01a
Hydroxylysine	0.34±0.0b	0.35±0.03b	0.40±0.03a	0.30±0.06b	0.43±0.04a
Ornithine	0.01±0.0b	0.01±0.0b	0.01±0.0b	0.01±0.0b	0.02±0.0a
Lysine	0.07±0.01b	0.07±0.01b	0.09±0.01a	0.08±0.01b	0.09±0.01a
Histidine	0.09±0.01b	0.09±0.01b	0.11±0.02a	0.09±0.01b	0.11±0.02a
Arginine	0.06±0.0b	0.07±0.01b	0.09±0.02a	0.07±0.01b	0.09±0.01a
Tryptophan	< 0.04±0.0	< 0.04±0.0	< 0.04±0.0	< 0.04±0.0	< 0.04±0.0
Total	3.07	3.06	3.05	2.96	3.29

*Mean ±Standard deviation.
**Mean values of the moisture, protein and the location with a different superscript nondiffer significantly ($p<0.05$)

Table 4 — Sterol contents of prickly pear seed oils (mg/100 g)

Sterols	Locations				
	Adana	Fethiye-Muğla	Alanya-Antalya	Anamur-Mersin	İskenderun-Hatay
Cholesterol	15.73±1.34d	16.01±2.17c	14.62±1.58e	19.25±3.47b	20.28±4.89a
Brassicasterol	1.93±0.98b	1.97±1.04b	1.23±0.96d	1.77±1.43c	2.80±0.57a
24-methylencholesterol	0.0±0.0	11.19±1.67a	4.02±2.38d	8.12±0.87b	7.32±1.28c
Campesterol	150.55±12.3b	11.19±2.19d	131.70±15.29c	180.17±21.64a	181.38±32.47a
Campestanol	10.34±2.56c	10.01±1.98d	10.32±3.21c	13.34±4.26b	13.52±5.82a
Stigmasterol	52.27±5.67c	39.51±3.76d	38.41±4.19d	55.66±4.89b	81.54±6.18a
7-campesterol	4.48±1.29e	37.35±3.67c	36.52±4.29d	46.23±3.88b	58.93±6.57a
5,23-stigmastadienol	15.83±3.29d	16.15±4.76c	15.44±2.56d	18.66±4.79b	195.37±13.89a
β-sitosterol	762.76±13.27e	804.14±9.58d	816.38±11.47c	973.61±17.65b	9748.6±15.84a
Sitostanol	56.81±4.76d	49.66±5.61e	58.12±3.92c	69.02±7.53a	66.81±6.89b
5-Avenasterol	39.97±3.57b	39.02±5.61bc	38.36±3.85d	45.97±4.63a	39.22±3.92b
5,24-stigmastadienol	10.11±1.38b	7.48±1.72d	8.89±2.54c	10.93±2.33a	11.06±1.75a
7-stigmastenol	23.72±3.71d	42.20±5.84a	19.47±1.49e	28.68±2.81c	36.69±6.24b
7-Avenasterol	17.98±2.63d	27.88±3.75a	15.83±4.93e	21.63±6.29b	20.56±5.51c
Total	1162.47	1113.76	1209.31	1493.04	1710.35

*mean±standard deviation (n:3)
**Values within each column followed by different letters are significantly different ($p<0.05$)

Antalya) and 2.80 mg/100 g (İskenderun-Hatay). While 24-methylencholesterol content was not found in Adana sample, its value changed between 4.02 mg/100 g (Alanya-Antalya) and 11.19 mg/100 g (Fethiye-Muğla) in other samples. The highest amount of 5,23-stigmastadienol (195.37 mg/100 g) was found in İskenderun-Hatay sample. It is interesting that cholesterol is high in prickly pear seed oil. Cholesterol contents of prickly per seed oils varied between 14.62 mg/100 g (Alanya-Antalya) and 20.28 mg/100 g (İskenderun-Hatay). The total sterol contents of prickly pear seed oils changed between 1113.76 (Fethiye-Muğla) and 1710.35 mg/100 g (İskenderun-Hatay). Cactus seed oil contained 2.17 campesterol, 0.76 stigmasterol, 11.50 β-sitosterol, 0.57 sitostanol, 0.82 δ5-avenasterol, 0.23 g/kg δ7-avenasterol[33]. Ghazi *et al*.[17] reported that *Opuntia dillenii* (OD) and *Opuntia ficus indica* (OFI) oil contained 21.93 and 2.80% β-sitosterol, 3.75 and 0.51% campesterol, 1.64 and 0.0% stigmasterol and 0.0 and 0.27% fucosterol, respectively. Prickly pear seed oil contained 1.66 campesterol, 0.30 stigmasterol, 0.28 lanosterol, 6.75 β-sitosterol, 0.29 δ5-avenasterol and 0.05 g/kg δ7-avenasterol[13]. Partly similar values were reported by Ramadan and Mörsel[13], Elmannoubi *et al*.[33] and Ghazi *et al*.[17] for the sterol contents in prickly pear seed oils. However, some differences were observed among locations. These variations can be probably due to climatic factors[34] of habitats (locations) and prickly pear types.

Tocopherol contents of prickly pear seed oils are shown in Table 5. The highest tocopherol was ɣ-tocopherol and its value changed between 17.4 mg/100 g (Anamur-Mersin) and 25.5 mg/100 g (Alanya-Antalya). α-Tocopherol, β-tocopherol, β-tocotrienol, ɣ-tocotrienol and δ-tocopherol contents of oil samples were found very low in oil samples extracted from prickly pear seeds harvested from other locations. While α-tocopherol contents f oil samples range from 0.2 mg/100 g (Adana) to 0.7 mg/100 g (Alanya-Antalya), β-tocotrienol contents were found between 0.3 mg/100 g (Fethiye-Muğla and Anamur-Mersin) and 0.5 mg/100 g (Alanya-Antalya). β-Tocopherol was identified in only Fethiye-Muğla sample (0.1 mg/100 g). The total tocopherol amounts of prickly pear oils were established between 18.2 mg/100 g (Anamur-Mersin) and 27.1 mg/100 g (Alanya-Antalya). In all oil samples, ɣ-tocopherol was present in high quantities. High levels of tocopherols in the oils can contribute to strong stability toward oxidation. Cactus seed oil contained 10.98 mg/kg α-tocopherol, 421.08 mg/kg ɣ-tocopherol and 15.32 mg/kg δ-tocopherol[32]. *Opuntia dillenii* seed oil contained 0.29% ɣ-tocopherol[17]. Ramadan and Mörsel[13] reported that prickly pear seed oil contained 0.056 α-tocopherol, 0.012 β-tocopherol, 0.330 ɣ-tocopherol and 0.005 g/kg δ-tocopherol. Results were found partly similar and differences observed can be due to genetic factors of prickly pear seeds and climatic factors of habitats because habitat is an effective factor on phytochemical constituents of plants.

Prickly pear fruits are rich in fructose and glucose contents. Aspartic acid, serine, glutamic acid, proline, alanine, valine, leucine and histidine were found as major amino acids of prickly pear fruits. Amino acid and protein contents were found partly different. These changes can be probably due to the parts of fruits, variety, ripening degree and locations. Results were found partly similar, and differences observed can be due to genetic factors of prickly pear seeds and climatic factors of habitats because habitat is an effective factor on phytochemical constituents of plants. The sterol marker, β-sitosterol, accounted for 65.6%, 72.20%, 67.51%, 65.21% and 57.0% of the total sterol content in Adana, Fethiye-Muğla, Alanya-Antalya, Anamur-Mersin and İskenderun-Hatay and seed oil samples,

Table 5 — Tocopherol contents of prickly pear seed oils (mg/100 g)

Locations	Tocopherols						
	α- tocopherol	β- tocopherol	ɣ- tocopherol	β-tocotrienol	ɣ-tocotrienol	Δ-tocopherol	Total
Muğla (Fethiye)	0.5±0.01*b	0.1	22.2±0.19b	0.3±0.01c	0.2	0.1±0.01b	23.4
Adana	0.2±0.01c**	-***	20.6±0.17c	0.4±0.01b	0.2	0.2±0.01a	21.5
Antalya (Alanya)	0.7±0.02a	-	25.5±0.13a	0.5±0.02a	0.2	0.2±0.01a	27.1
Mersin (Anamur)	0.3±0.01c	-	17.4±0.11d	0.3±0.01c	0.2	0.1±0.01b	18.2
Hatay (İskenderun)	0.6±0.01a	-	21.6±0.11b	0.4±0.01b	0.2	0.2±0.01a	23.0

*mean±standard deviation (n:3)
**Values within each column followed by different letters are significantly different ($p<0.05$)
***nonidentified

respectively. The next main component was campesterol. Fethiye-Muğla seed oil contained a low quantityof sterols. On the contrary, İskenderun-Hatay contained a higher amount of sterols. In addition, habitat had no effect on ɣ-tocotrienol. Also, habitat (location) had partly affected δ-tocopherol.The fruits of the genus *Opuntiaficus indica* have been used for several purposes. Therefore, cactus-pear fruits are a promising plant with a big potential for food technologists. Depending on the location, the highest moisture content was detected in Muğla (27.68%) and Hatay (26.65%) samples. In addition, the highest protein content was determined in the Antalya (Alanya) sample. The protein content of other samples was found to be approximately close to each other. Both moisture and protein contents were affected by the locations. The highest fructose (29.17%) and glucose (44.71%) were detected in the sample obtained from Antalya location. Sugar contents of prickly pear fruits obtained from other locations were found to be relatively low. Probably, the reason for this may be that Antalya's annual average temperature is higher than other locations. Serine, proline, glutamic acid, phenylalanine, hydroxylysine were generally high in fruits obtained from all locations, but partial differences were detected depending on the location. The β-sitosterol and campesterol contents of the samples were found to be at the highest levels in the samples obtained from all locations. However, significant differences were observed in the amount of sterols of the samples depending on the location. In addition, the locations had some influence on the tocopherol contents of the samples.

Conclusion

The present investigation was to determine the change in biochemical properties of prickly pear fruits and seeds depending on location. The location had significant effects on the protein and amino acid content, sugar content, sterol and tocopherol profiles of prickly pear fruit and seed oils. The highest glucose was determined in prickly pear collected from Antalya (Alanya) location. Differences in sterol contents of seed oils were found to be partly dependent on locations. α-Tocopherol, β-tocopherol, β-tocotrienol, ɣ-tocotrienol and δ-tocopherol contents were found very low in oil samples extracted from prickly pear seeds harvested from other locations. Fluctuations in these properties of prickly pear pulp and seed oil may be probably due to changes in location, harvest time, climatic factors such as precipitation and, length of daylight.

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Conflict of Interest

The authors declare that they have no conflict of interest.

Authors' Contributions

MMÖ: Writing - review & editing; M S A: Software; BM: supervision; Ş Ş: formal analysis; AM S: Resources; K M A D H: methodology; IAMA: Investigation

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