Innovative Food Additives: Oleaster Flour

[1]Dilek Dulger Altiner, [2]Emine Aydin, [3]Ayşe Inkaya Dundar, [4]Guler Celik, [5]Betul Kaplan, [6]Asuman Cansev, [*7]Yasemin Sahan and [7]Duygu Gocmen
[1]Istanbul Aydın University, Anadolu Bil Voc. High School, Department of Food Technology, Istanbul, Turkey
[2]Duzce University, Faculty of Agriculture and Natural Sciences, Department of Agricultural Biotechnology, Turkey
[3]Uludag University, Yenisehir Ibrahim Orhan Voc. High School, Department of Food Technology, Bursa, Turkey
[4]The Scientific and Technological Research Council of Turkey, Bursa Test and Analysis Laboratory, Bursa, Turkey
[5]Pamukkale University, Faculty of Engineering, Department of Food Engineering, Denizli, Turkey
[6]Uludag University, Faculty of Agriculture, Department of Horticulture, Bursa, Turkey
[7]Uludag University, Faculty of Agriculture, Department of Food Engineering, Bursa, Turkey

Abstract

Oleaster flours (OFs) were produced from two different genotypes. Fruit samples were dried at 50ºC for 20 hours in a hot air oven. Skin and seeds of dry fruits were removed, and then ground and sieved (mesh size 60). OFs contained high levels of dietary fibers and micro minerals. Palmitic acid was the major fatty acid which was followed by oleic acid. The level of citric acid in OFs was the highest and it was followed by malic, acetic and oxalic acids. It is possible to use the OFs as a good source of dietary fiber (DF), micro minerals, as well as organic and fatty acids (FA) in some processed foods such as bakery goods, dairy products, infant food, chocolate, beverages and confectionery. OFs could also be used in the preparation of low-fat, high-fiber dietetic products due to its functional properties.

Key words: Oleaster flour, dietary fibre, organic acid, fatty acid, functional

1. Introduction

Innovations understood as new products, processes or services are recognized as an important instrument for companies belonging to the food industry to stand out from competitors and to satisfy consumer expectations [1]

In particular during the last decade, consumer requirements in the field of food production have changed considerably: in fact, consumers increasingly believe that food contribute directly to their health [2,3]. Thus, foods are no more intended to only satisfy hunger and to provide the necessary nutrients, but also and especially to prevent nutrition-related diseases and to improve physical and mental well-being [4,5]. Owing to inovation, traditional foods which are known for centuries, is transformed into new products and thus the difference is creatred [6].

Innovations may occur throughout all parts of the food chain and a possible classification of the food innovations is the following: (1) new food ingredients and materials, (2) innovations in fresh foods, (3) new food process techniques, (4) innovations in food quality, (5) new packaging methods, and (6) new distribution or retailing methods [7].

Oleaster *(Elaeagnus angustifolia* L., Russian olive) belongs to *Elaeagnus* L. genus and *Elaeagnaceae* family. *Elaeagnus angustifolia* L. is a kind of shrub or tree with a height of up to 7 m and a capacity to grow under a wide range of environmental conditions [8]. This species shows a broad geographical range, existing widely in Asia and Europe, particularly in Turkey, Caucasia and Central Asia [9]. Oleaster's fruits are reddish-brown, elliptic, 9-12 mm long and 6-10 mm wide and they ripen in September [10,11]. Although this species grows naturally in most parts of Turkey, its fruits are of limited use in agricultural and food industry.

*Corresponding author: Address: Uludag University, Faculty of Agriculture, Department of Food Engineering, Bursa, Turkey E-mail address: yaseminsahan@gmail.com, Phone: +902242941502

In parallel with the increase in demand for healthy foods, functional products have been used increasingly as ingredients to improve functionality of foods by modifying their nutritive composition.

Oleaster fruits are also used as diuretic, tonic, antipyretic, antidiarrheal and as a medicine against kidney disorders in traditional Turkish medicine [10,11], against dysentery and diarrhea in The Kingdom of Jordan [12] and, owing to their anti-inflammatory, antinociceptive and analgesic effects, in Iranian folk medicine. Medicine obtained by decoction and infusion of its fruits is considered to be a good remedy against fever, jaundice, asthma, tetanus and rheumatoid arthritis [13].

Oleaster fruits are known for centuries. Therefore, the goal of our research was to examine flour from oleaster fruit and to investigate its composition of minerals, organic acids and FAs. Oleaster fruits can be consumed either fresh or in dried form [10,11]. However, there was no sufficient information regarding the composition of OF. Oleaster fruit can be used as an innovative food ingredient. OF may be obtained from dried fruits and its flour may be used as a functional ingredient in the production of bakery products, yoghurt, ice cream, infant food, chocolate, confectionery etc. thanks to its floury structure, specific taste and functional properties like DF, mineral content and phenolic compounds.

2. Material and methods

2.1. Materials

Two different genotypes were used as oleaster fruit samples. The fruits had approximately the same maturity with uniform shape, size and health conditions. Mature fruits were randomly collected. Fruit samples were dried at 50 ºC for 20 hours in a hot air oven dryer.

2.1.2. Preparation of OFs

OFs were produced by two different methods. The first preparation method: skin and seeds of dry fruit samples were removed using a plastic knife, and then the fruit pulp was ground in a coffee grinder and than sieved through 60 mm sieve to obtain Peeled Oleaster Flour (POF). In the second preparation method: only seeds of dry samples were removed using a plastic knife, and then the fruit pulp and skin were ground together in a coffee grinder and sieved through 60 mm sieve to obtain Unpeeled Oleaster Flour (UPOF). All flour samples were stored in glass jars and kept in at $+4^{o}$C prior to analyses. Due to using two different genotypes, samples are named as POF-1 (Genotype 1, Peeled Oleaster Flour), UPOF-1 (Genotype 1, Unpeeled Oleaster Flour), POF-2 (Genotype 2, Peeled Oleaster Flour) and UPOF-2 (Genotype 2, Unpeeled Oleaster Flour).

2.2. Methods

2.2.1. Chemical analysis

OFs were analyzed for moisture (Method No:925.40), ash (Method No:950.49), dietary fiber (DF) (Method No:985.29) [14]. Protein contents of samples were determined by the Kjeldahl method according to AACC Metod No: 46-10.01 using a Buchi apparatus (Models 430 and

320, Buchi Laboratoriums-Techinic AG, Flawil, Switzerland) [15]. Starch contents of OFs were determined with Starch (GO/P) Assay Kit (Sigma-Aldrich Corp.).

2.2.2. Determination of micro minerals

2.2.2.1. Sample preperation procedure

Sample digestion was carried out using the Millestone MLS 1200 (Italy) microwave digestion system, equipped with a rotor for 6 type sample vessels (polytetrafluorethylene (PTFE) tubes). Before use, quartz vessels were decontaminated in a bath of 10% HNO_3 (67%v/v), then rinsed with ultra pure water and dried in an oven at 40°C. The samples were homogenized and subsequently around 0.5 g was weighed directly on PTFE flasks after adding 6 mL of HNO_3 and subjected to a digestion program: 250W (2 min), 0W (2 min), 250W (6 min), 400W (5 min) and 600W (5 min). After cooling to room temperature, sample solutions were quantitatively transferred into 50 mL polyethylene flasks. 100 µL of internal standard solution (1 mg/L) was added and then the digested samples were diluted to 25 mL before analysis by using ICP-MS and ICP-OES equipments.

2.2.2.2. Instrumentation

ICP-MS measurements were performed using an Agillent 7500a Series Shield Torch System ICP-MS (USA).The sample solutions were pumped by a peristaltic pump from tubes arranged on a CETAC ASX 520 auto sampler (CETAC, Omaha, Nebraska, USA). The isotopes ^{53}Cr, ^{95}Mo, ^{82}Se and ^{59}Co were selected as analytical masses in ICP-MS standard mode. The analyses were performed at the following flow rates: (a) plasma gas of 15 L/min, (b) auxiliary gas of 0.9 L/min, and (c) sample of 0.8 mL/min. All chemical analyses were carried out in duplicate on each sample. Multi-element standard solutions were used for external calibration. Eight standards with standard linear regression and internal standardization were prepared at levels ranging from 0 to 200 µg/L. The calibration curve was drawn from six points including the calibration blank [16].

The Zn, Fe, Cu, Mn and B determination process was performed using an inductively coupled plasma optical emission spectrometer (ICP-OES) model Perkin Elmer 2100 with axial view (USA). The emission intensities were obtained for the most sensitive lines free of spectral interference. The analyses were performed at the following flow rates: (a) plasma gas of 15 L/min, (b) auxiliary gas of 1 L/min, and (c) sample of 0.8 mL/min. The mineral eluates were monitored at different wavelengths: 206.2 nm-Zn, 238.2 nm-Fe, 327.4 nm-Cu and 257.6 nm-Mn. All chemical analyses were carried out in duplicate on each sample.

2.2.3. Determination of fatty acid composition

The fatty acid (FA) compositions of OFs were separately extracted with diethyl ether for 6 hr by using Soxhlet Extraction Method.The extract was protected against light.The solvent was evaporated under reduced pressure and temperature and the oil was collected.The analytical methods for determination of FA compositions are described in regulation standard method [17]. Fatty acids were converted to fatty acid methyl esters before analysis by shaking a solution of 0.6 g of oil and 4 mL of isooctane with 0.2 mL of 2 N methanolic potassium hydroxide. The converted fatty acid methyl esters were analyzed using a Shimadzu (GC-17A)

chromatograph, equipped with a capillary column (DB wax; 30 m×0.25 mm; 0.25 μm), a split-splitless injector, and a flame ionization detector (FID). The carrier gas was nitrogen and used at a flow rate of 1 mL/min. The temperatures of the injector, detector, and oven were held at 250, 250, and 210 °C, respectively.

2.2.4. Determination of organic acids

Seven different organic acids (OAs) were analyzed by Dionex ICS 3000 ion chromatography device (CA, USA) which consists of a separation Acclaim 4x250 mm column, a gradient pump, and ICS-VWD UV detector set at 210 nm with a flow-rate of 0.6 mL/min maintaining the column temperature at 30^{o}C. In the mobile phase, 100 mM Na_2SO_4 (pH 2.65) was used. Organic acids quantification was achieved by the absorbance value recorded in the chromatograms based on the external standards in the standards solution and the peaks were integrated using a default baseline construction technique. Tested samples were prepared according to Qui and Jin [18].

2.2.6. Statistics

Data are presented as mean values +/- standard error of 3 replicates. Statistical analysis was performed by ANOVA on SPSS version 17.0 software for Windows (USA). When significant differences were found ($p \leq 0.05$), the least significant difference (LSD) test was used to determine the differences among mean values. Paired t-test was carried out to compare the properties of POF-1, UPOF-1, POF-2 and UPOF-2.

3. Result and discussion

3.1. Chemical Compositions

Chemical compositions of OFs are presented in Table 1. The moisture contents of OFs in the present study varied between 18.43-20.20%. The protein contents of OFs changes 3.74-4.65%. Protein contents of UPOF samples were higher than those of POF samples. The starch contents of OFs obtained in this study were found to be between 13.80-43.18%.The starch contents of POFs samples were significantly ($p \leq 0.05$) higher than those of UPOFs. It can be attributed to the presence of higher amount of starch in pulp than in peel.

The total dietary fiber (TDF) contents of OFs ranged from 20.67% to 30.65%. These results were lower than pumpkin flour samples (32.15- 36.73%) found by Aydin and Gocmen [19]. The higher TDF levels observed in UPOF samples may be possibly related to pericarp contents. OF is a good source in TDF, it might be important from the nutrition point of view.

Table 1. Chemical compositions of OFs [a]*

Samples	Moisture* (g/100g)	Protein* (g/100g, db)	Ash (mg/100g, db)	Starch (mg/100g, db)	Total Dietary Fiber (g/100g, db)
POF-1	18.99 ±1.05[a]	3.74±0.26[c]	2.46±0.22$_a$	43.18±2.26[b]	23.55±0.07[c]
UPOF-1	18.43±1.13[a]	4.49±0.17[b]	2.57±0.17$_a$	17.73±2.38[cd]	30.65±0.16[a]
POF-2	19.78±1.11[a]	4.51±0.24[b]	1.87±0.15$_b$	36.86±4.89[b]	20.67±0.21[d]
UPOF-2	20.20±0.96[a]	4.65±0.19[b]	1.87±0.21[b]	13.80±2.13[cd]	25.44±0.44[b]

[a] Means with different superscripts in columns indicate significant difference ($p \leq 0.05$).
* Data are expressed as means ± standard deviations.

3.2. Micro minerals

The micro minerals of flour samples obtained from *Elaeagnus angustifolia* L. are presented in Fig.1. According to average levels of micro minerals in all samples, Fe was found to be highest (10.72 mg/kg) and it was followed by B (7.79 mg/kg) and Zn (4.08 mg/kg).

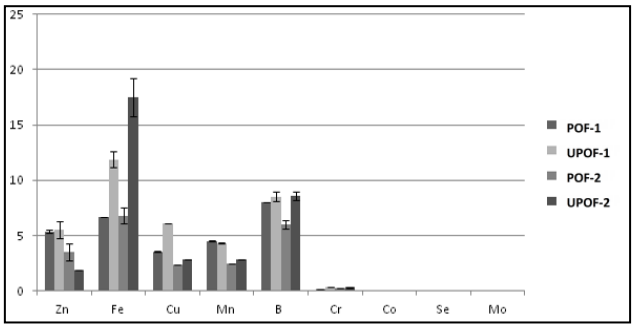

Fig. 1. The micro minerals of POF and UPOF from two genotypes.
Data show mean values of three replicates +/- standard error.

With regard to genotypes, generally Zn, Cu, Mn contents of genotype 1 (GO1) samples were higher than those of genotype 2 (GO2) samples ($p \leq 0.05$). These differences between genotypes may be due to growth conditions, genetic factors, soil properties and geographical variations. Our data showed that Fe, Cu, B, and Cr accumulations were higher in fruit skin than in pulp tissues. Conversely, no significant differences regarding Co, Se and Mo contents were determined in all samples ($p \leq 0.05$) (Fig.1).

The highest content of Zn was determined in UPOF-1 sample (5.50 mg/kg) while the lowest content of Zn was determined in UPOF-2 (1.90 mg/kg). Our results were compatible with those obtained by Dolezal et al. [20] and Akbolat et al.[21]. Fe content was the highest (17.53mg/kg) in UPOF-2. Our results revealed that the oleaster fruit is a good natural source of Fe. Dolezal et al.[17] reported lower (5.77mg/kg) Fe content in oleaster fruit suggesting that the oleaster fruits in Turkey contain greater amount of Fe. The levels of Cu in OFs were within the range of 2.37-6.11 mg/kg (Fig.1). Our results were higher than those reported by Dolezal et al.[17].

The B content varied between 5.99 mg/kg (POF-2) and 8.58 mg/kg (UPOF-2). Sungur and Okur [22] determined high concentrations of B were found in thyme (10.44 mg/kg), mint (6.96 mg/kg), red cabbage (6.45 mg/kg), broad-bean (6.28 mg/kg), quince (5.41 mg/kg), pomegranate (5.27 mg/kg) and orange (4.08 mg/kg) while low concentrations of B were found in pumpkin (0.76 mg/kg), white radish (0.97 mg/kg), plum (1.16 mg/kg) and cucumber

(1.17 mg/kg). Most foods had B concentrations in the range of 1.48-3.60 mg/kg. According to our results, oleaster fruits are good natural sources of B. Hence, our findings make a significant contribution to the limited information available in the literature.

Mn contents of all samples varied between 2.46-4.51 mg/kg. Mn concentrations in oleaster fruit were reported as 10.15 mg/kg by Dolezal et al. [17] and 47.10-49.76 mg/kg by Akbolat et al.[18]. We found lower Mn content compared with those reported in previous studies.

In the present study, Se contents of OFs ranged from 0.025-0.04 mg/kg. Se levels of all samples are relatively higher than those of different fruits investigated in another study by Ventura et al. [23]. Additionally, we provide information with regard to levels of essential nutrients Cr, Co and Mo in oleaster fruit for the first time in the literature.

The Cr values of oleaster ranged between 0.11-0.38 mg/kg. The Co content of oleaster fruits averaged 0.06 mg/kg; this value is smaller than the average Co content of the fruits, including apples (35.24-39.9 μg/g), plums (45.32 μg/g), cornelians (32.45-41.03 μg/g) [24], red guava (3.17 μg/g), yellow guava (0.31 μg/g), and guobiroba (0.62 μg/g) [25].The mean Mo levels of oleaster fruit varied between 0.03-0.05 mg/kg. No data have been reported on Mo content in dried fruits.

3.3. Fatty Acids

Nine different fatty acids (FAs) were detected in POF and UPOF samples of two genotypes and their percentages are presented in Fig. 2. The major FA in all samples according to average values was palmitic acid (C16:0) (34.31%), and it was followed by oleic acid (C18:1) (26.23%) and lignoceric acid (C24:0) (17.47%).

Linoleic acid characterized by high amounts of saturated FAs as compared to mono unsaturated FAs and polyunsaturated FAs. Goncharova et al. [26] reported an abundance of palmitoleic acid (16:1) in fruit skin and linoleic acid (18:0) and palmitic acid (16:0) in seeds. These differences might be explained by differences in genotypes, climatic condition and soil composition.

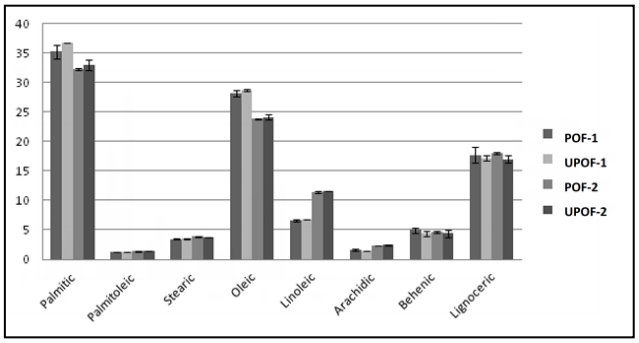

Fig.2. The fatty acids of POF and UPOF from two genotypes. Data show mean values of three replicates +/- standard error.

Significant differences were observed for each individual FA of POF and UPOF samples between genotypes. Palmitic and oleic acid concentrations were significantly higher in GO1 samples than in GO2 ($p \leq 0.05$). Conversely, palmitoleic, stearic, linoleic, arachidic acid levels

in GO2 samples were higher than those in GO1 ($p \leq 0.05$) (Fig.2). UPOF-1 had the highest palmitic (36.69%) and oleic acid (28.69%) contents in all FAs. The highest lignoceric acid level (18.02%) was detected in POF-2 samples compared to the other samples. UPOF-2 samples had the highest linoleic acid content (11.59%) among all samples. Oleic and linoleic acids were predominant unsaturated FAs in all samples.

3.4. Organic Acids

Organic acids may have a protective role against various diseases due to their antioxidant activity [27]. Seven different organic acids were detected in this study and their percentages were presented in Fig.3.

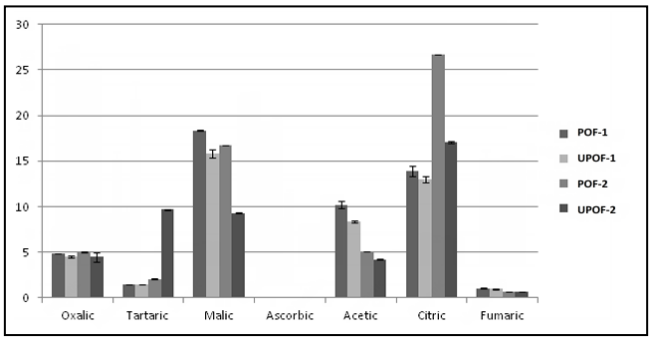

Fig. 3. The organic acids of POF and UPOF from two genotypes.
Data show mean values of three replicates +/- standard error.

According to the average values of POF and UPOF samples, the highest levels were obtained in citric acid (16.94mg/g) content which was followed by malic acid (15.07mg/g), acetic acid (6.97mg/g), oxalic acid (4.72mg/g), tartaric acid (3.67mg/g), fumaric acid (0.82mg/g), and trace amounts of ascorbic acid (0.035mg/g) (Fig.3). In this study, the levels of citric acid in OFs were within the range of 13.00-26.69mg/g (Fig.3).

Citric acid was the major organic acid in GO2 samples. Citric acid concentration of POF-2 sample (26.69mg/g) was 2 times higher than that of POF-1 sample (13.0mg/g). Additionally, its level in UPOF-2 was 1.3 times higher than that in UPOF-1 sample. Although citric acid contents were similar in GO1 samples, they were significantly different between GO2 samples ($p \leq 0.05$). Similar levels of citric acid have been reported in oleaster fruit by Dolezal et al. [20].

Malic acid was the predominant organic acid in GO1 samples. The highest malic acid concentration (18.36mg/g) was detected in POF-1 samples (Fig.3). Wang and Fordham [28] indicated that malic, quinic and citric acid were found in *Elaeagnus umbellata* Thunb. fruit and malic acid was the primary organic acid. Among all samples, POF-1 had the highest acetic acid content (10.21mg/g). The present study shows that oxalic acid contents range between 4.47-5.06mg/g (Fig.3). These results are much higher than in other fruits, such as fig (0.18mg/g), cranberry (0.17mg/g), and blueberry (0.25mg/g) [29].

The highest tartaric acid level (9.67mg/g) was detected in UPOF-2 samples while the lowest (1.46mg/g) tartaric acid concentration was found in UPOF-1 samples. Although citric acid

contents were similar in GO1 samples, they were significantly different in GO2 samples ($p \leq 0.05$). The levels of fumaric acid in OFs were within the range of 0.62-1.06mg/g (Fig.3).

Fumaric acid concentrations of GO1 samples were significantly higher than those of GO2 samples ($p \leq 0.05$). Acetic acid content of POF-1 was higher than that of UPOF-1($p \leq 0.05$). Usenik et al. [30] measured lower values for 13 sweet cherry cultivars (0.97-7.56mg/kg). In support of the findings from previous studies, our results suggest that OF contains moderate levels of fumaric acid. Ascorbic acid is the most widely distributed water soluble antioxidant in fruits and vegetables [31]. Although ascorbic acid was not detected in GO1 samples, extremely low levels of it were detected in GO2 samples (0.01mg/g, 0.06mg/g, respectively). Ascorbic acid levels in oleaster olives were slightly higher than those obtained in Czech Republic (132.5mg/kg) [20].

4. Conclusion

Although the oleaster grows spontaneously in many regions of Turkey, consumption of its fruit is limited and it is not yet used as an ingredient in food industry. The results of this study showed that OF has high nutritional contents. OFs showed high levels of TDFs and minerals. Many kinds of organic and fatty acids were determined in OFs. The OFs obtained in the present study seem to be suitable for food products such as bakery goods, dairy products (ice cream and yoghurt), beverages, confectionary, etc. It can also be used as an alternative innovative functional ingredient in food products which require relatively low fat and high dietary fiber content. Further studies are needed to produce bakery products supplemented with OF with improved nutritional and functional properties.

5. Acknowledgment

The authors would like to thank The Scientific and Technological Research Council of Turkey (TUBITAK) for their financial support to this research project (Project No: TOVAG 110 O 060).

References

[1] Menrad K. Market and marketing of functional food in Europe. Journal of Food Engineering, 2003;56:181-188.
[2] Mollet B, Rowland I. Functional foods: at the frontier between food and pharma. Current Opinion in Biotechnology, 2002;13:483-485.
[3] Young Y. Functional foods and the European consumer. In J Buttriss, M. Saltmarsh editors, Functional foods.II.Claims and evidence.London:The Royal Society of Chemistry. 2000.
[4] Menrad K. Market and marketing of functional food in Europe. Journal of Food Engineering, 2003;56:181-188.
[5] Robertfroid M. B. A European consensus of scientific concepts of functional foods. Nutrition, 2000;16:689-691.
[6] Anonymous 2015. Son yılların vazgeçilme trendi,
http://www.dunyagida.com.tr/haber.php?nid=1392 (Accsess date:23.02.215)

[7] Bigliardia B, Galati F. Innovation trends in the food industry: The case of functional foods and. Trends in Food Science & Tech 2013;31:118-129.
[8] Klich MG. Leaf variations in *Elaeagnus angustifolia* related to environmental heterogeneity. Environ Exp Bot 2000;44:171-83.
[9] Aksoy A, Sahin U. *Elaeagnus angustifolia* L. as a biomonitor of heavy metal pollution. Turk J Bot 1999;23:83-7.
[10] Ayaz FA, Bertoft E. Sugar and phenolic acid composition of stored commercial oleaster fruits. J Food Compos Anal 2001;14:505-11.
[11] Gurbuz I, Ustun O, Yesilada E, Sezik E, Kutsal O. Anti-ulcerogenic activity of some plants used as folk remedy in Turkey. J Ethnopharmacol 2003;88:93-7.
[12] Lev E, Amar Z. Etnopharmacological survey of traditional drugs sold in the Kingdom of Jordan. J Ethnopharmacol 2002;82:131-45.
[13] Ahmadiani A, Hosseiny J, Semnanian S, Javan M, Saeedi F, Kamalinejad M,et al. Antinociceptive and anti-inflammatory effects of *Elaeagnus angustifolia* fruit extract. J Ethnopharmacol 2000;72:287-92.
[14] AOAC Official methods of Analysis of Association of Official Analytical Chemists, Washington DC, USA;1990.
[15] AACC Official methods of American Association of Cereal Chemists, MN,USA; 2000.
[16] Sahan Y, Basoglu F, Gucer S. ICP-MS analysis of a series of metals (Namely: Mg, Cr, Co, Ni, Fe, Cu, Zn, Sn, Cd and Pb) in black and green olive samples from Bursa, Turkey. Food Chem. 2007;105:395-399.
[17] ISO 5509:2000. International standard of animal and vegetable oils and fats. Preparation of methyl esters of fatty acids. Iso:Geneva, Switzerland;2000.
[18] Qui J, Jin X. Development and optimization of organic acid analysis in tobacco with ion chromatography and suppressed conductivity dedection. J Chromatogr A 2002;950:81-8
[19] Aydın E, Gocmen D. The influences of drying method and metabisulfite pre-treatment on the color, functional properties and phenolic acids contents and bioaccessibility of pumpkin flour. LWT-Food Sci Tech 2015;60:385-92.
[20] Dolezal M, Velisek J, Famfulikova P. Chemical composition of less-known wild fruits. In: Pfannhauser W, Fenwick GR, Khokhar S, editors. Biologically active phytochemicals in food, Royal Society of Chemistry Special Publications. 2001,241-4.
[21] Akbolat D, Ertekin C, Menges HO, Guzel E, Ekinci K.Physical and nutritional properties of oleaster (*Elaeagnus angustifolia* L.) growing in Turkey. Asian J Chem 2008;20:2358-66.
[22] Sungur S, Okur R. Using azomethine-H method determination of boron contents of various foods consumed in Hatay Region in Turkey. Food Chem 2009;115:711-4.
[23] Ventura MG, Stibilj, V, Freitas, MC, Pacheco, AMG. Determination of ultratrace levels of selenium in fruit and vegetable samples grown and consumed in Portugal. Food Chem 2009;115:200-6.
[24] Hamurcu M, Ozcan MM, Dursun N, Gezgin S. Mineral and heavy metal levels of some fruits grown at the roadsides. Food Chem Toxicol 2010;48:1767-70.
[25] Pereira MC, Baschetti W, Rampazzo R, Celso PG, Hertz PF, Rios AO, et al. Mineral characterization of native fruits from the southern region of Brazil. Food Sci Technol Campinas 2014;34:258-66.
[26] Goncharova NP, Isamukhamedov ASH, Glushenkova AI. Glycolipids and phospholipids of the fruit of Elaeagnus angustifolia L. Chem. Nat. Compd. 1993;29:569-573.
[27] Silva BM, Andrade PB, Valentão P, Ferreres F, Seabra RM, Ferreira MA. Quince (Cydonia oblonga Miller) fruit (pulp, peel, and seed) and jam: antioxidant activity. J Agric Food Chem 2004;52:4705-12.

[28] Wang SY, Fordham I.M. Differences in chemical composition and antioxidant capacity among different genotypes of Autumn Olive (*Elaeagnus umbellate* Thunb.).Food Tech Biotech 2007;45:402-9.
[29] Pande G, Akoh, CC. Organic acids, antioxidant capacity, phenolic content and lipid characterisation of Georgia-grown underutilized fruit crops. Food Chem 2010;120:1067-75.
[30] Usenik V, Fabcic J, Stampar F. Sugars, organic acids, phenolic composition and antioxidant activity of sweet cherry (*Prunus avium* L.). Food Chem 2008;107:185-92.
[31] Seabra RM, Andrade PB, Valentão P, Fernandes E, Carvalho F, Bastos ML, Antioxidant compounds extracted from several plant materials. In: Fingerman M, Nagabhushanam R, editors. Biomaterials from aquatic and terrestrial organisms. New Hampshire: Science Publishers-Enfield (NH) Jersey Plymouth. 2006.