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A research on evaluation of some fruit kernels and/or seeds as a raw material of vegetable oil industry

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RESEARCH ARTICLE

Abstract

The crude oils obtained from the kernels of apple (*Malus* spp.), plum (*Prunus domestica* L.), apricot (*Prunus armeniaca* L.), sweet cherry (*Prunus avium* L.), mandarin (*Citrus mitis*), peach (*Prunus persica* L.), sour cherry (*Prunus cerasus* L.) and grape (*Vitis vinifera* L.) fruits were examined for some of their physicochemical properties and fatty acid compositions. The total oil content of the kernels ranged between 18.5-39.5%. While grape (20.2%) and apple (18.5%) seeds show the lowest oil content, the highest oil content was found in peach (39.5%) and apricot (38.8%) kernels. The saponification number and unsaponifiable matter contents of the samples varied between 170-195 and 0.93-1.59, respectively. The refractive index values of plum (1.478 nD 20 °C) and apricot (1.475 nD 20 °C) kernel oils were higher than the values of other kernel oils. The specific gravity, iodine number, peroxide value, free fatty acid and total crude fat contents of the kernels varied between 0.901 and 0.960, 95 and 135, 1.87 and 3.00 meq O_2/kg oil, 0.92 and 3.5% and 18.49 and 39.5%, respectively. The kernel oils were found to be used as a source of edible oil with respect to their fatty acid composition and some physicochemical properties.

Keywords: fruit kernels, physico-chemical properties, oil, fatty acids

1. Introduction

The development of new crops for the production of industrial oils is an area of significant interest both scientifically and environmentally. While methods are being developed for modifying the fatty acid content and composition of oils produced by established crops such as oilseed rape and soya beans (Murphy, 1991), another approach is to investigate alternative sources of specialist oils (Msaada *et al.*, 2009). Seeds and kernels are the potential subjects of these investigations. Seeds and kernels are generally the deposits of the food processing plants (El-Adawy *et al.*, 1999; Gandhi *et al.*, 1997; Kamel *et al.*, 1982).

The fruit seeds and kernels are the main deposits for the fruit processing industries. And the oil content of these deposits are generally high. The seeds of wild apricot contain oil in 43.6-51.4% (Özcan, 2000). In recent years, the usage of the deposits of the industry is popular for researchers. Especially the usage of these deposits in food industry, agriculture and animal feed production is increasing. These studies also increase the effective use of the natural sources. The kernels of plum, peach, apricot, sweet and sour cherry are the best known deposits of the food industries. The oil content of the seeds are known to be high. Generally these oils find use in cosmetic industry. These oils approximately contain 51.6-81.0% oleic, 10.5-21.0% linoleic and 3-11% palmitic acid (Zlatanov and Janakieva, 1998). By the increase of the capacity of the industry, the deposits also become a dramatic problem for the nature. The importance of the cheap and valuable evaluation of these deposits increased (Lowe and Buckmaster, 1995). Alpaslan and Hayta (2006) reported that the oil content of apricot seed varied from 27.7 to 66.7% and that the main fatty acids are oleic (58.3-73.4%) and linoleic acid (18.8-31.7%). Lu and Foo (1998), reported the fatty acids of apple seed oil as linoleic, palmitic, linoleic, stearic and oleic, and the percentages in oil as 51.2, 10.5, 5.6, 43 and 4.1. Saidani *et al.* (2004) studied on the oils of five citrus varieties. They determined the fatty acids of the seed oils of *Citrus sinensis*, *Citrus limon* L., *Citrus bergamia* and *Citrus aurantium*. They reported that the main fatty acids of the citrus varieties was palmitic, oleic and linoleic

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acids. Several studies were carried out on the nutritional and chemical properties of some seed and the oils of the seed (Kamel and Kakuda,1992; Kamel *et al.*, 1982, 1985; Kodad *et al.*, 2004; Rahma and Abd el-Aal, 1988; Zlatanov and Janakieva, 1998). The aim of this study is to determine some physical and chemical properties of some seed and kernels oils, and to evaluate the potential usage of them as a vegetable oil source.

2. Materials and methods

Materials

Apple (*Malus* spp.), plum (*Prunus domestica* L.), apricot (*Prunus armeniaca* L.), sweet cherry (*Prunus avium* L.), mandarina (*Citrus mitis*), peach (*Prunus persica* L.), grape seeds (*Vitis vinifera* L.) and sour cherry (*Prunus cerasus* L.) were purchased from local markets in Konya and Mersin provinces. The seed and/or kernels of fruits were removed from pulp, and dried. Apple, grape seed and mandarin seeds were ground thoroughly. Ground samples were kept at the +4 °C up to analysis.

Methods

Physico-chemical analyses

Some physico-chemical properties (refractive index, nonsaponifiable matter, iodine value, density, acidity, peroxide value, and saponification value) of seed oils were analysed according to AOAC (1993). For oil analyses, each sample was homogenised and subjected to extraction for 6 h with petroleum ether (boiling range 40-60 °C) in a Soxhlet apparatus. The extracted oil was dried over anhydrous sodium sulphate and the solvent was removed under reduced pressure in a rotary film evaporator. Oil percentages were determined by weight difference (El-Adawy and Taha, 2001).

Determination of fatty acids

Fatty acid composition for kernel samples were determined using a modified fatty acid methyl ester method as described by Wang and Zhao (1997). The oil was extracted three times for 2 g air-dried seed sample by homogenisation with petroleum ether. The oil samples (50-100 mg) was converted to its fatty acid methyl esters. The methyl esters of the fatty acids (1 µl) were analysed in a gas chromatography (Shimadzu GC-2010; Shimadzu, Tokyo, Japan) equipped with a flame ionising detector, a fused silica capillary column (60 m × 0.25 mm i.d.; film thickness 0.20 micrometre). It was operated under the following conditions: oven temperature programme 90 °C for 7 min, raised to 240 °C at a rate 5 °C/min and than kept at 240 °C for 15 min; injector and detector temperatures 260 and 260 °C, respectively; carrier gas nitrogen at a flow rate of 1.51 ml/min; split ratio 1/50 µl/min.

A standard fatty acid methyl ester mixture (Sigma Chemical Co., St. Louis, MO, USA) was used to identify sample peaks. Commercial mixtures of fatty acid methyl esters were used as reference data for the relative retention times (AOCS, 1990). Quantitative analyses of the fatty acids were performed using the heptadecanoic acid methyl ester as internal standard.

Statistical

All determinations were conducted in triplicate. Data is expressed as mean ± standard deviation. The means were compared by using the one-way and multivariate analysis of variance (ANOVA) followed by Duncan's multiple range tests. The differences between individual means were deemed to be significant at $P<0.05$ (Püskülcü and İkiz, 1989).

3. Results and discussion

Physical and chemical properties

Some physicochemical properties of seed oils are presented Table 1. The saponifiable value and unsaponifiable matter of oil samples ranged between 170-195 and 0.93-1.59, respectively. Farrohi and Mehran (1975) examined sweet and sour cherry kernels from 8 Iranian cultivars and determined unsaponfiable matter from 0.77 to 1.19% and saponfiable value from 188.2 to 191.5. El-Adawy *et al.* (1999) reported 187.2 saponfiable value in tangerine oil. Alpaslan and Hayta (2006) expressed that the saponfiable value of seed oil of apricot from Turkey changed between 187.3 and 199.0 and, unsaponifiable matter of oil ranged from 0.10 to 1.58%. Kamel and Kakuda (1992) reported the unsaponifiable matter of apricot, cherry, peach and plum varied from 0.56 to 0.80%. Their findings are in accordance with our results.

According to our findings, the refractive index value of plum (1.478 nD 20 °C) and apricot (1.475 nD 20 °C) oil were found higher than the values obtained for the other kernels. The refractive index value of tangerine kernels was lowest. Farrohi and Mehran (1975) determined that the refractive index value of sweet and sour cherry oil were found between 1.4692 and 1.4721 nD 20 °C. El-Adawy *et* (1999) reported the refractive index value of tangerine as 1.4677 nD 20 °C. Alpaslan and Hayta (2006) studied on the kernel oils of apricot cultivated in Turkey, and refractive index values were determined between 1.464-1.480 nD 20 °C. Our results for the refractive index value of the kernel oil were similar to recent findings.

Table 1. Physico-chemical properties of some fruit kernel oils.

Properties	Apple	Plum	Apricot	Sweet cherry	Mandarin	Peach	Grape	Sour cherry
Refractive index (nD 20 °C)	1.4690 b	1.4780 a	1.4750 a	1.4705 b	1.4630 c	1.4680 b	1.4707 b	1.4702 b
Density (25 °C)	0.907 ef	0.905 fg	0.901 g	0.915 cd	0.960 a	0.912 de	0.925 b	0.920 bc
Saponification value	195	195	193	170	188	190	192	187
Iodine value	135 a	99 b	108 b	110 b	90 c	100 b	133 a	128 a
Peroxide value (meq O_2/kg)	1.87 b	2.95 a	2.82 a	2.91 a	2.0 b	3.0 a	1.90 b	2.8 a
Free fatty acid (oleic, %)	1.4 c	3.4 a	3.1 a	1.0 de	0.92 e	1.3 cd	1.3 cd	2.5 b
Unsaponifiable matter	1.0	1.4	1.0	1.45	0.95	1.1	1.59	0.93
Total oil content (%)	18.49 d	23.90 c	38.82 a	29.7 b	31.15 b	39.5 a	20.15 d	30.11 b

Mean values followed by different letters in the same row are significantly different (P<0.05).

The density of the kernel oils ranged between 0.901 (apricot) and 0.960 (mandarin seed oil). The density of the oils of apple, plum and apricot were found to be low in comparison to other kernel oils.

The iodine values of the kernel oils ranged from 95 to 135. The iodine values of the kernel oils of the apple, grape and sour cherry were found low. The lowest iodine value was detected in the tangerine kernel oil. Farrohi and Mehran (1975) reported the iodine value of the oils of sweet and sour cherry kernel samples grown in Iran varied between 123.1 to 127.8. El-Adawy *et al.* (1999) expressed that the iodine value of the tangerine kernel were determined as 91.54. Alpaslan and Hayta (2006) reported that the range of iodine value of the kernel oils of some apricots grown in Turkey was found as 90-114. Kamel and Kakuda (1992) stated that the iodine value of the kernels of apricot, cherry, peach and plum ranged from 105 to 113. Our findings were in the range of the recent studies.

The peroxide value of the kernel oils were found between 1.87-3.00 meq O_2/kg oil. The peroxide value of the kernel oils of apple, plum apricot, peach and sour cherry were found to be higher than the other samples. El-Adawy *et al.* (1999) stated that the peroxide value of the kernel oil of the tangerine was established as 5.90 meq O_2/Kg, and was found higher than our findings.

The percentage of the oil in kernel samples ranged from 18.55 5 to 39.5%. The percentages were found to be high for the kernel oils of peach (39.5%) and apricot (38.8%). Farrohi and Mehran (1975) reported that the oil contents of sweet and sour cherry were found between 20.5 to 37.9%. Our results for the cherry and the sour cherry were found in the range of their findings. El-Adawy *et al.* (1999) stated the oil content of tangerine kernels was found as 38.9%, and is higher than our findings as 31.2% for tangerine kernel oils. Alpaslan and Hayta (2006) reported that the range of oil percentage of some apricot kernel were found between 27.7 to 66.7%. Kamel *et al.* (1985) expressed that the oil content of grape seed was found as 14.1%, had higher than our results as 20.15%. The percentage of the oil in the kernels of apple and peach were found as 18.5 and 39.5%, respectively. Our results were lower in comparison with the findings of Rahma and Abd El-Aal (1988) and Kamel *et al.* (1982).

Fatty acid composition

The fatty acid composition of the kernel oils were represented in Table 2. The main fatty acid of the kernel oil of the apple was linoleic acid (53.37%). In decreasing order the fatty acids were oleic acid (35.75%), palmitic acid (6.81%), arachidic acid (1.18%) and linolenic acid (0.81%). Total saturated fatty acids were 7.99%, was lower in comparison to the findings of Kamel *et al.* (1982) as 12.4%. Lu and Foo (1998) reported 4.3% stearic acid in the seeds of apple. But stearic acid was not detected in the apple seeds. The fatty acids of plum kernel oil were oleic, linoleic, palmitic, linolenic and arachidic acids and, percentages were 74.19, 19.14, 6.03, 0.22 and 0.13%, respectively (Table 2). The fatty acids of apricot oil were oleic (69.36%), linoleic (24.0%), palmitic (5.56%) and palmitoleic (1.08%). In a previous study, oleic (58.3-73.4%) and linoleic acid (18.8-31.7%) were determined as the main fatty acids of apricot kernel oils (Alpaslan and Hayta, 2006). The fatty acids of the kernel oil of cherry was oleic, linoleic, linolenic, palmitic and arachidic acids and the percentages were 43.91, 39.90, 6.6, 8.38 and 1.21%, respectively.

The determined fatty acids in the kernel oil of sour cherry in decreasing order were 44.2% linoleic, 3.55% oleic, 6.08% palmitic, 5.7% linolenic acids. Our findings were in accordance with the results of Farrohi and Mehran (1975). The seed oil of tangerine was also evaluated for its fatty acids. Linoleic acid was the main fatty acid as 38.51%. Oleic 26.26%, palmitic 15.66%, myristic 10.65%, stearic 3.78%, linolenic 1.5% and arachidic acid 1.5% were the other determined fatty acids of the sample. Filsoof *et al.* (1976)

Table 2. Fatty acid composition of some fruit kernel oils.

Fatty acid (%)	Apple	Plum	Apricot	Sweet cherry	Mandarin	Peach	Grape	Sour cherry
Myristic (C14:0)	-[1]	-	-	-	10.65	-	-	-
Palmitic (C16:0)	6.81	6.03	5.56	8.38	15.66	5.93	9.30	6.08
Palmitoleic (C16:1)	-	-	1.08	-	-	-	-	-
Stearic (C18:0)	-	-	-	-	3.78	-	3.60	43.55
Oleic (C18:1)	35.75	74.19	69.36	43.91	26.26	57.46	20.1	44.20
Linoleic (C18:2)	53.37	19.14	24.00	39.90	38.51	25.44	62.75	5.70
Linolenic (C18:3)	0.81	0.22	-	6.60	1.50	-	0.65	-
Arachidic (C20:0)	1.18	0.13	-	1.21	1.50	6.18	0.30	-
Total unsaturated fatty acids	89.93	93.55	94.44	90.41	66.27	82.90	84.15	93.45
Total saturated fatty acids	7.99	6.16	5.56	9.59	31.59	12.11	13.20	6.08

[1] Not determined.

reported the fatty acids of seed oils of tangerine, grown in Iran, as 25.0% palmitic, 4.3% stearic, 0.6% palmitoleic, 27% oleic, 39.8% linoleic and 3.1% linolenic acid. Our results were similar with the findings of Filsoof and Mehran (1976). El-Adawy *et al.* (1999) also did not report any myristic acid in tangerine seed oils.

The fatty acid composition of grape seed oil was determined as 62.7% linoleic, 20.1% oleic, 9.3% palmitic, 3.6% palmitoleic, 0.65% linolenic and 0.30% arachidic acids. Kamel *et al.* (1985) expressed linoleic acid as the major fatty acid of grape seed oil. 57.45% oleic, 25.44% linoleic, 6.18% arachidic and 5.93% palmitic acids were determined in the kernel oil of peach. Rahma and Abd El-Aal (1988) reported the major fatty acids of the kernel oil of peach as 63.8% oleic and 15.4% linoleic acid and, 20.7% of the oil as saturated fatty acids.

4. Conclusions

As a result, eight of the kernel oils were found to be suitable as vegetable oil source. In general the kernel oils were found to be high in linoleic and oleic acids. Because of the high unsaturated fatty acids and especially oleic and linoneic acid content, the availability of the oils increases in margarine, cream filling, salad sauce production and cooking, Also the free fatty acid content and the peroxide values of the kernel oils were found to be low that increases the quality of the oil as a vegetable oil.

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References

Alpaslan, M. and Hayta, M., 2006. Apricot kernel: physical and chemical properties. Journal of American Oil Chemists' Society 82: 469-471.

American Oil Chemists Society (AOCS), 1990. Official methods and recommended practices, volume 1 (4th Ed.). AOCS, Champaign, II, USA.

Association of Official Analytical Chemists (AOAC), 1993. Official methods of analysis of the AOAC International. AOAC, Gaithersburg, MD, USA.

El-Adawy, T., Ramha, E.H., El-Badawy, A.A. and Gaffar, A.M., 1999. Properties of some citrus seeds. Part 3. Evaluation as a new source of protein and oil. Nahrung 43: 385-391.

El-Adawy, T. and Taha, K.M., 2001. Characteristics and composition of different seed oils and flours. Food Chemistry 74: 47-54.

Farrohi, F. and Mehran, M., 1975. Oil characteristics of sweet and sour cherry kernels. Journal of American Oil Chemists' Society 52: 520-521.

Filsoof, M., Mehran, M. and Farrohi, F., 1976. Determination and composition oil characteristics in Iranian almond, apricot and peach nuts. Fette, Seifen, Anstrichmittel 78: 150-117.

Gandhi, V.M., Mulky, M.J., Mukerji, B., Iyer, V.J. and Cherian, K.M., 1997. Safety evaluation of wild apricot oil. Food and Chemical Toxicology 35: 583-587.

Kamel, B.S., Dawson, H. and Kakuda, Y., 1985. Characteristics and composition of melon and grape seed oils and cakes. Journal of American Oil Chemists' Society 65: 881-883.

Kamel, B.S., Deman, J.M. and Blackman, B., 1982. Nutritional fatty acid and oil characteristics of different agricultural seeds. International Journal of Food Science and Technology 17: 263-269.

Kamel, B.S. and Kakuda, Y., 1992. Characterization of the seed oil and meal from apricot, cherry, nectarine, peach and plum. Journal of American Oil Chemists' Society 69: 492-494.

Kodad, O., Gracia Gomez, M.S. and Socias, R., 2004. Fatty acid composition as evaluation criterion for kernel quality in almond breeding. In: Laurens, F. and Evans, K. (eds.). ISHS Acta Horticulturae 663: XI Eucarpia Symposium on Fruit Breeding and Genetics. ISHS, Leuven, Belgium.

Lowe, E.D. and Buckmaster, D.R., 1995. Dewatering makes big difference in compost strategies. Biocycle 36: 78-82.

Lu, Y. and Foo, L.Y., 1998. Constitution of some chemical components of apple seed. Food Chemistry 61: 29-33.

Msaada, K., Hosni, K., Taarit, M.B., Hammami, M. and Marzouk, B., 2009. Effects of growing region and maturity stages on oil yield and fatty acid composition of coriander (*Coriandrum sativum* L.) fruit. Scientia Horticulturae 120: 525-531

Murphy, D.J. 1991. Designer oilseed crops. Genetic engineering of new oilseed crops for edible and non-edible applications. Agro-Industry Hi-Technology 2: 5-9.

Özcan, M., 2000. Composition of some apricot (*Prunus armeniaca*) kernels grown in Turkey. Acta Alimentaria 29: 289-293.

Püskülcü, H. and İkiz, F., 1989. Introduction to statistics [İstatistiğe giriş]. Bilgehan Press, Bornova-İzmir, Turkey.

Rahma, E.H. and Abd El-Aal, M.H., 1988. Chemical characterization of peach kernel oil and protein: functional properties, *in vitro* digestibility and amino acids profile of the flour. Food Chemistry 28: 31-43.

Saidani, M., Dhifi, W. and Marzouk, B., 2004. Lipid evaluation of same Tunisian citrus seeds. Journal of Food Lipids 11: 242-250.

Wang, H. and Zhao, X., 1997. Studies on some methods of fatty acid methyl esterification. China Trade Herbal Drugs 28: 72-73.

Zlatanov, M. and Janakieva, I., 1998. Phospholipid composition of some fruit-stone oils *Rosaceae* species. Lipid/Fett 100: 312-315.