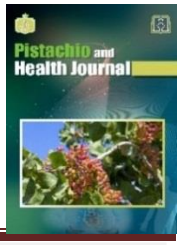

An Evaluation of Some Physicochemical Properties of Wild Pistachio Oil in Kerman Province

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Abstract

Introduction: Bene, i.e. wild pistachio (*pistacia atlantica*), is considered one of the natural resources in Iran. The production potential of this product is so high that upon identifying it, it will be possible to produce a large amount of edible oil annually. In addition, it is well comparable with other oilseeds in terms of the oil content, so it could have a high position among edible oils.

Materials and Methods: In this study, some physicochemical properties of oil from whole wild pistachios, including oil percentage, fatty acid profile, thermal stability (by the Rancimat method), and the refractive index were evaluated. The samples were prepared randomly from domestic supply centers of the counties of Baft, Jiroft, and Shahr-e Babak in September 2017, and oil from three kilograms of each sample was extracted using the cold press method.

Results: According to the results, the rate of oil extraction from whole wild pistachios varied from 27.5 to 28.5%, with unsaturated fatty acids having formed 83% of which. In addition, oleic acid was the predominant fatty acid with 52 to 54%, with the highest amount of which having been observed in the sample of the Baft County. The results of thermal stability and the refractive index were evaluated to be similar in the three oil samples. Based on the results, there was no statistically significant difference in thermal stability and the refractive index among the samples ($P \geq 0.05$).

Conclusion: The investigation of the fatty acid profile of wild pistachio oil showed that it is one of the most valuable oils in terms of the oleic acid content, being almost close to olive oil in this respect. Given the higher level of monounsaturated fatty acids (especially oleic acid) than its polyunsaturated counterparts, such as linoleic and linolenic acids, wild pistachio oil has suitable thermal stability.

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1. Introduction

Bene, P. mutica, or wild pistachio is a tree 2-7m high from the Anacardiaceae family with the scientific name of Pistacia Atalntica. Three varieties of wild pistachios have been identified, including Motica, kurdica, and Cabulica [1]. The species Motica constitutes 90% of different species of wild pistachios in Iran, being the most famous species. The area of wild pistachio forests is estimated at about 2.5 million hectares [2].

It seems that the kernel of wild pistachios has a higher amount of oil than other oilseeds, such as corn, cottonseed, peanuts, and sunflower seeds. Accordingly, an approximate amount of 58-55% of oil has been reported for the kernel of wild pistachios [2]. In addition, wild pistachios as oilseeds have been reported to have suitable thermal stability and antioxidant properties [3, 4].

The geographical presence of Bene, i.e. wild pistachios, starts from the Canary Islands and courtiers bordering the Mediterranean see, and extends to Asia Minor, Syria, the Caucasus, Iran, Afghanistan and Pakistan. Iran is the primary origin of this tree, which surrounds this country like a ring around the deserts inside Iran. Wild pistachios are seen profusely between Fars and Kurdistan provinces; however, in other parts of the country, including Kerman, Baluchistan, Yazd, Semnan, Lorestan, and Alamut heights, they are seen scantily along with wild almonds [5]. Studies conducted on nutrition in the past two decades indicate that the diet plays a crucial role in causing or preventing chronic diseases, such as cancer, cardiovascular disease, obesity, and diabetes [6]. Cardiovascular disease, In Iran, is the primary cause of death, which leads to 46% of all cases of death and 20-23% of the disease burden [7]. Given that fats account for 30% of the total energy intake, the role of fats in edible oils is very significant in this respect. Therefore, the present study helps meet some of the needs of the oil industry; in addition, it will help improve community health by improving the diet pattern and reducing the consumption of low-quality oils through controlling and preventing chronic diseases, especially cardiovascular disease.

Hamedanian et al. (2013) conducted a study on the structure of fatty acids in Pistacia Khinjuk oil and compared it with olive oil. Examination of the chemical composition of Pistacia Khinjuk kernel oil showed that its fat content was 30%. In addition, unsaturated fatty acids accounted for 83.06% of its fatty acid composition, with its predominant fatty acid having been oleic acid (57.3%). Accordingly, one could say that Pistacia khinjuk oil is relatively similar to olive oil in terms of chemical properties [8].

In another study conducted by Jahanbazi et al (2016), the sample of wild pistachio oil was evaluated in various diameter classes in Chaharmahal Bakhtiari province, which showed that the amount of oil extracted from wild pistachio seeds was different in different classes. In addition, the examination of the structure of fatty acids indicated the presence of a total of 11 types of fatty acids, seven unsaturated fatty acids (oleic, cis-iso-oleic, linoleic, linolenic, palmitoleic, gondoic, and behenic acids), and four saturated fatty acids (palmitic, stearic, myristic, and arachidic acids) in wild pistachio oil.

Nazifi et al (2011) reported the effect of wild pistachio oil on the serum level of the leptin hormone in rats with experimental hyperthyroidism. In this study, the use of wild pistachio oil in rats with hyperthyroidism caused a decrease in the incremental changes of thyroid hormones of T3 and T4 in rats fed with wild pistachio oil [10].

Daneshrad et al (1980) investigated physicochemical properties of two species of wild pistachios, including motica and kurdica. The kernel of the kurdica species accounted for 30% of its total weight, and the oil yield of kurdica kernel and hull was 53 and 63%, respectively. Besides, the kernel of the motica species accounted for 25.4% of its total weight, and the oil yield of motica kernel and hull was 57 and 31.5%, respectively. In addition, the fatty acid compositions of oil from the kernel and hull of kurdica and motica species were measured. The results showed that the fatty acid compositions of the outer hull of the two species of kurdica and motica were similar. Accordingly, the amount of the oleic fatty acid in the kernel of motica and kurdica species was 50.4 and 57%, respectively. Besides, the amount of linoleic fatty acid in the kernel of motica and kurdica species was 32.8 and 25.8%, respectively [11].

Safarzadeh et al (1999) identified the chemical composition of wild pistachios regardless of the species in full (kernel, hard skin, and hull). They calculated the amount of the total fat to be 26.8%. Besides, the amounts of fatty acids of palmitic, palmitoleic, stearic, oleic, linoleic, and linolenic were reported to be 17.29, 6.09, 2.35, 54.66, 18.5, and 0.59% respectively [12].

Benhassain et al (2007) examined chemical properties of wild pistachio seeds in Algeria. In the mentioned study, native samples from different climatic regions in northern Algeria were collected. Accordingly, chemical properties of wild pistachio seeds, such as protein, fiber, moisture, ash, as well as the structure of fatty acids and phytosterols were examined and compared with other species in Iran and the Middle East. The results showed that the species growing in northern Algeria was rich in proteins, unsaturated fatty acids, and fiber, with its main fatty acids being oleic acid (54.15%) and

linoleic acid (28.84%). In addition, the total content of monounsaturated fatty acids (MUFA) was 60.75 and 55.92% in Iranian and Algerian wild pistachios, respectively; besides, the total content of polyunsaturated fatty acids (PUFA) was 19.12 and 29.31% in Iranian and Algerian wild pistachios, respectively. In terms of the protein content, it amounted to 10.39 and 8.20%, in Algerian and Iranian wild pistachios, respectively; in addition, the amount of fat was reported to be 39.80 and 26.80% in Algerian and Iranian samples, respectively [13].

Givianrad et al (2013) compared fatty acid structures of wild pistachios and wild almonds. In their study, the amount of palmitic acid in wild pistachios and wild almonds was 13.12 and 9.94%, respectively; the amount of palmitoleic acid in wild pistachios and wild almonds was 2.04 and 0.3%, respectively; the amount of stearic acid in wild pistachios and wild almonds was 2.78 and 3.30%, respectively; the oleic acid content in wild pistachios and almonds was 50.65 and 67.18%, respectively; the linoleic acid content in wild pistachios and almonds was 29.76 and 22.13%, respectively; besides, the total content of saturated fatty acids (SFA) in wild pistachios and wild almonds was 16.5 and 10.24%, respectively; the total content of monounsaturated fatty acids (MUFA) in wild pistachios and wild almonds was 53.1 and 67.48%, respectively; finally, the total content of polyunsaturated acids (PUFA) in wild pistachios and wild almonds was 30.39 and 22.28%, respectively [14].

Soleiman-Beigi et al (2013) carried out a review study on chemical properties and nutritional indices of wild pistachio oil and compared them with those of olive, sunflower, and canola oils. In the mentioned study, it was found out that wild pistachio kernel oil had more oil than other oils; in addition, the approximate kernel oil contents in the species of motica and kurdica were reported to be 54 and 57%, respectively. Palmitic acid was the predominant saturated fatty acid in the oils compared, with the amount of which in species motica, species kurdica, wild pistachio shell, olive oil, canola oil, and sunflower oil having been reported to be 10.70, 4.68, 92.10, 12.22, 4.27, and 8.54%, respectively. Accordingly, there was good consistency between wild pistachio oil and olive oil in terms of the palmitic acid content. The content of oleic acid in motica oil, kurdica oil, and wild pistachio shell oil was 51.73, 50.42, and 51.6%, respectively. Besides, in motica oil and kurdica oil, linoleic acid had the highest percentage among unsaturated fatty acids with 31.34 and 32.39%, respectively; in addition, the content of linoleic acid was higher in both varieties of wild pistachios than that in olive oil and canola oil, having been 18.01 and 17.6, respectively [15].

This study aimed to evaluate the fatty acid profile and stability of wild pistachio

oil in different regions of Kerman province, including Baft, Jiroft, and Shahr-e Babak counties.

2. Materials and Methods

Sample collection

Wild pistachio samples were randomly selected from three climatic regions of Baft, Jiroft, and Shahr-e Babak counties in November 2017 and from each region; accordingly, three samples were prepared from domestic supply centers of each region, with three kilograms prepared from each sample.

Oil extraction

Oil extraction was conducted from whole seeds after doing the cleaning operation by the cold press method at a temperature of less than 45°C.

Measurement of physicochemical parameters

Fatty acid profile assessment

The fatty acid structures of oil samples were measured using gas chromatography equipment equipped with a flame ionization detector (FID) (Varian 3800 GC, Varian, USA) with a column 120m long, model BPX70. The temperature plan included the initial and final temperature of 198°C, the detector temperature of 250°C, the injection temperature of 250°C, and the inhibition time of 60 min.

Oil methylation

Fatty acid methylation and analysis of its methylated esters were conducted based on Iranian National Standard no. 4090. According to this method, the oil sample was methylated in the presence of heptane and 2M methanolic potassium at 50°C and injected from the supernatant into the gas chromatography equipment.

Thermal stability

Thermal stability was assessed using the Rancimat device (Rancimat, model 743, Metrohm, Switzerland) at 110°C with the air flow rate of 15 L/H, according to Iranian National Standard no. 3734.

Refractive index

Values of the refractive index of the oil samples were measured using a refractometer (Kruss, Model DR6200, Germany) at 40°C according to Iranian National Standard no. 5108.

Statistical Analysis

As many as nine treatments were tested, with the means compared using Minitab software at a significance level of 5% ($P< 0.05$). In addition, the means were compared by the Tukey's test. Besides, the calculation segment of Chemstation software of the gas chromatography device was used to measure the percentage of each fatty acid in the oil samples.

3. Results

Table 1 shows the composition and percentage of fatty acids in the wild pistachio samples. Based on Table 1, unsaturated fatty acids constitute 79-80% of the total fatty acids of the wild pistachio

oil. Among these fatty acids, oleic acid, being a monounsaturated fatty acid, had the largest share, which was reported to be higher than the other two samples in Baft County. In addition, the MUFA-to-PUFA ratio, being indicative of the level of oil resistance to oxidative reactions, was high in all three samples, with the highest value having been observed in the sample of Baft County.

Table 2 shows thermal resistance and the refractive indices of the three oil samples; however, the results of these two tests are the same in the three samples, with no significant differences existing among them.

Table 1- Profiles of fatty acids of wild pistachio oil in the counties of Baft, Shahr-e Babak, and Jiroft in Kerman province

County/ Content (Percentage)			
Type of fatty acid	**Baft**	**Shahr-e Babak**	**Jiroft**
Myristic acid	0.06a	0.06 a	0.06a
Palmitic acid	17.05a	15.33b	16.16a
Palmitoleic acid	10.70a	10.50a	9.56a
Stearic acid	2.40a	1.80b	2.2a
Oleic acid	54.06a	53.13b	52.03b
Linoleic acid	14.70b	19.30a	18.80a
Linolenic acid	0.40a	0.40a	0.46a
Arachidic acid	10.14a	10.13a	0.15a
SFA	19.55a	17.23b	18.46b
MUFA	64.76a	62.63b	61.60b
PUFA	15.10b	19.60a	19.33a
USFA	79.86ab	82.23a	80.93b
MUFA/PUFA	4.28a	3.19b	3.18b
PUFA/SFA	0.77b	1.13a	1.4a
USFA/SFA	4.06b	4.75a	4.35ab

Quantities of common letters in each row are not significantly different from each other ($P< 0.05$). **SFA:** Total saturated fatty acids; **MUFA:** Total unsaturated fatty acids with a double bond; **USFA:** Total unsaturated fatty acids, **PUFA:** Total polyunsaturated fatty acids

Table 2- Thermal stability and refractive indices of the oil from whole wild pistachio seeds in Baft, Shahr-e Babak, and Jiroft counties

County	Thermal stability (at 110°C/h)	Refractive index (at 40°C)
Baft	17.80a	1.4623a
Shahr-e Babak	1836a	1.4629a
Jiroft	1733a	1.4626a

Quantities of common letters in each row are not significantly different from each other (P< 0.05)

4. Discussion

The fatty acid profile of an oil could be one of the factors determining its oxidative stability and nutritional value. According to the results of this study, the predominant fatty acid in all three wild pistachio oil samples studied was oleic acid that is a valuable fatty acid and a member of omega-9 fatty acids. In fact, oleic acid reduces the risk of heart attack and any blockage in arteries and prevents cancer. It has been proven that the low prevalence of cardiovascular disease in Mediterranean countries is due to the consumption of olive oil that has a very high level of oleic acid (55-75%). Accordingly, wild pistachio oil could be considered as beneficial as olive oil in this respect [16, 17]. This result is consistent with the study of Farhoosh et al (2012) who studied the compositions of olive oil and wild pistachio oil [18]. Linoleic acid was the second predominant fatty acid, which is one of the essential omega-6 fatty acids and must be received through food. Palmitoleic acid is the third monounsaturated fatty acid, which its content being much more in whole wild pistachio oil than in edible oils. In a study conducted by Daneshrad et al on wild pistachio kernel oil and wild pistachio shell oil separately, they concluded that wild pistachio shell oil contained a high content of the palmitoleic fatty acid. However, its content in wild pistachio kernel oil is as much as that in other vegetable oils [11]. Saffarzadeh et al (1999) conducted a similar study on the properties of whole wild pistachio oil (with kernels and hull), in which the content of whole wild pistachio oil was reported to be 26.80%. Besides, the profile of fatty acids was not much different from the results of the present study [12].

In another study, Tavakoli et al conducted a research on the kernel oil from two common varieties of wild pistachios and compared the results with olive oil. Given that oil extraction was

done separately from the kernel and shell of wild pistachios, there were significant differences in some chemical attributes; accordingly, the percentage of palmitoleic acid and thermal resistance was lower in wild pistachio kernel [19].

Given the definitions of MUFA and PUFA, thermal stability of the Baft County sample was expected to be higher than that of the other two samples. However, considering the results obtained from the Rancimat test, thermal stability of the sample from the Baft County was not different from the other two samples. It could be concluded from this study and the previous one that the fatty acid profile is not the only effective factor in thermal stability. In fact, other factors, such as triacylglycerol distribution as well as the structure of low-quantity compounds, especially phenolic and tocopherol compounds, play an important role in thermal stability [20-22].

Comparison of thermal resistance of industrial edible oils having synthetic antioxidants with that of wild pistachio oil shows that the latter is rich in natural antioxidants [23-26]. In this regard, Tavakoli et al (2018) recommended the use of wild pistachio oil in order of increasing the stability of soybean oil [27].

Synthetic antioxidants allowed to be used in food products include TBHQ, propyl gallate (PG), butylated hydroxytoluene (BHT), and butylated hydroxy anisole (BHA). Research shows that some synthetic antioxidants exert negative physiological effects on the human body. Thus, the use of natural antioxidants has attracted much attention in order of reducing or preventing the use of synthetic antioxidants in foods and increasing food safety [28]. As already mentioned, wild pistachio oil has high thermal resistance that could be due to the presence of unique antioxidant compounds and the structure of its fatty acids. Thus, it is recommended that the whole wild pistachio seed oil, as a stable oil and a rich source of natural antioxidants, replace part of industrial antioxidants that have been proven to be unhealthy.

5. Conclusion

Given the fatty acid profile of wild pistachio oil, it could be considered a highly valuable oil among common vegetable oils. Results of the present study conducted on wild pistachios in Kerman province show that there is a difference in the fatty acid profiles in the three samples of the whole wild pistachio oils in the counties of Baft, Shahrbabak, and Jiroft. Besides, the high thermal resistance of wild pistachios could be due to the presence of unique antioxidant compounds and the structure of its fatty acids. There exist many forests of wild pistachios in Iran. Due to the abundant nutritional properties of wild pistachio oil for the presence of beneficial fatty acids and valuable nutrients as well as its high

oxidative stability, more attention should be paid to the industrial production and extraction of wild pistachio oil. Accordingly, this oil can be used directly or together with other vegetable oils in order of increasing their stability.

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Conflict of interest

The authors state that there is no conflict of interest regarding the publication of this study.

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