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Original Article

Nutritive Value of Persian Hazelnut (Corylus avellana L.) Orchards

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Abstract

Hazelnut (Corylus avellna L.) is one of the important nut crops in world. The harvesting of hazelnuts is done either by hand or by manual or mechanical raking of fallen nuts in Iran. Common hazel is widely cultivated for its nuts, including in commercial orchards in Europe, Turkey, and Iran. There are some genotypes of hazelnut in Iran that their growing areas are limited to Gillan, Aredbil, Mazandaran, Golestan, Zanjan and Qazvin Provinces. Varieties, location, composition of soils, usage of fertilizer and irrigation affect the fatty acid, mineral and vitamin composition of hazelnuts, and consequently influence the nutritional value and quality of the product. Therefore, the objective of this study was evaluation of protein, crude fiber, and fatty acids in samples in Tarem and Rudsar County farmlands as two economically important provinces. Samples were collected during the harvest season in 2015 from 10 different distinguished cultivars of trees grown in a replicated trial in an experimental orchard. The chemical and physical properties (crude protein, total fat, crude oil, crude fiber, ash, refractive index) were analyzed according to AOAC methods. In investigation on these two varieties, the highest fatty acid had oleic acid with 85.026% in Rudsar (Gillan) and 83.226% in Tarem samples. Evaluation of 420 hazelnut seedling samples reveals that Rudsar variety samples have more protein, ash and carbohydrate while crude fiber percentage in Tarem variety is more. The results of this research reveals that geographical conditions affect the nutritional value of hazelnut significantly ($p < 0.05$).

Keywords: Hazelnut kernel, Nutritive value, Protein, Crude fiber, Oil content.

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Introduction

Hazelnut is belonging to betulaceae family and corylus genera and everyone knows that it is one of the world major nut crops. This nut includes 25 species that 9 of them are more important due to commercial and breeding program uses. Hazelnut is one of the world major nut crops (Mehlenbacher, 1995). It is reported that in 2012, the world hazelnut production was around 0.9 million tons/year (Özdemir et al. 2014). Turkey contributing approximately 70% to the total global production is the largest producer in world as 17 varieties of hazelnuts are cultivated in Turkey (Oliveira et al. 2008; Alasalvar et al. 2009). Iran is the seventh hazelnut producer in the world with an annual production of 14,299 tons. Hazelnut is grown in a few areas of Iran with high rainfall and high relative humidity as high relative humidity is a major factor for successful hazelnut production (Salimi & Hoseinova, 2012). Several studies have indicated that nutritional value, mineral and fatty acid composition of hazelnut is affected by variety, ecological conditions, geographical origin, harvest year, climate, and composition of soil, irrigation, use of fertilizer, location, and method of cultivation (Oliveira et al. 2008; Alasalvar et al. 2009; Baltaa et al. 2006; Koksal et al. 2006).

Hazelnut oil is becoming increasingly popular in many countries and is widely used for cooking, deep frying, salad dressing, and flavoring ingredients (Alasalvar et al. 2009). Roasted hazelnuts are employed for obtaining butter paste or snacks, and also this seed is consumed either raw or roasted in snacks and it is used as an ingredient in a wide variety of processed foods (cakes, creams, chocolates and confectionary products (Costa et al. 2015; Jakopic et al. 2011). Hazelnut kernels are a good source of fat (50-73%) and contain unsaturated fatty acids, essential for human health (Koksal et al. 2006). A high MUFA diet tends to raise HDL cholesterol and lower LDL-cholesterol and TAG concentrations. Thus, hazelnut as an excellent source of MUFA may prove beneficial, preventing cholesterol-based atherosclerosis, cardiovascular disease. Thus, hazelnuts are not only a source of energy but they also provide certain compounds (MUFAs, PUFAs, vitamin E and natural sterols) that enhance the nutritional value of the human diet (3-10). Among tree nut oils, hazelnut oil has been reported to be a good source of fat-soluble bioactive (Alasalvar et al. 2009). Many quality traits such as kernel color, internal brown color and susceptibility to rancidity in hazelnut are influenced by kernel composition (Baltaa et al. 2006).

The lipid fraction forming the major part of hazelnuts (60%) is composed of non polar (98.8%) and polar (1.2%) constituents. Triacylglycerols are the major nonpolar lipid class, representing nearly 100% of the total nonpolar lipids in hazelnut oil (Ciemniewska-Zytkiewicz et al. 2011).

The resistance to oxidation of lipids is frequently associated with the shelf-life of foods, but there are many other factors that contribute to defining the quality of hazelnuts, such as appearance, texture, flavor, chemical composition, nutritional value, and of course, food safety. During storage, the lipid fraction can be subjected to hydrolysis and oxidation, resulting in undesirable odors and flavors, and in the reduction of the nutritional value of the kernels (Ghirardello et al. 2013). Unsaturated fatty acids, -tocopherol and mineral contents such as iron, manganese and copper are involved in rancidity (Ackurt et al. 1999). More detailed research on the lipid characteristics and essential mineral composition of hazelnut varieties will enhance knowledge and application of second grade quality of hazelnuts in a variety of food and specialty products.

The main goals of this investigation were to:

Determine the physical and chemical properties, protein, fatty acid, mineral contents of hazelnut kernel cultured in top hazelnut growing regions of Iran (Rudsar from province and Tarom from Zanjan province): Association with ecological conditions.

Materials and Methods

Sampling Methods:

Hazelnut (Corylus avellana L.) samples were collected during the 2015 harvest season (autumn season) from 10 different distinguished cultivars of trees grown in a replicated trial in an experimental orchard at Tarem (Zanjan province) and Rudsar (province) county farmlands.

Study Area:

Rudsar and Tarem are famous producers of hazelnut which are both located in North of Iran. Rudsar is the biggest producer of hazelnut and the most famous area for its export. This city is situated the East of and 70 kilometers from the center of the province (Rasht). Annual rainfall average of province is 1064.8 mm and in the autumn is the most. Also relatively humidity of air reaches up to 93%. According to statistics of Iranian agriculture ministry report, cultivation area of hazelnut in province place on the first step if ranking of the country. Hazelnut more spear on the rustic area in province. 66000 tons of hazelnut annually produced in and this figure is equal with 70% of total production in Iran (Husseinzadeh et al. 2011).

Tarem is also a big producer of hazelnut. Annual rainfall average of Zanjan province is 271.8 mm which the most happens in the winter. Both of above mentioned cities are the most appropriate areas for the development and nourishment of hazelnut in Iran. All trees under the study were of seedling origin and are growing naturally and treating traditionally. The measured nuts samples were collected manually. After harvesting of hazelnut, the shells are removed and the kernels dried at ambient temperature in air conditions and then are stored in refrigerating rooms at 4ºC. Some of the kernels are milled and then stored in the freezer at -18ºC until the time for research is reached.

Statistical Methods:

All the data were analyzed using the SPSS 20 statistical software for analysis of variance using ANOVA and Duncan's least significant difference (LSD at $p < 0.05$) for statistical significance. 3 duplicates with a replicate were considered in this research, and data was reported as the mean ± standard error of the mean.

Crude Fiber:

One gram of the ground hazelnut kernel was digested in 100 ml of 1.25% H_2SO_4. The solutions were boiled for 30 minutes and then were filtered and washed with hot distilled water. The filtrates were digested in 100 ml of 1.25% Sodium Hydroxide solutions. These solutions were heated for 30 minutes, filtered washed with hot deionized water and over dried. The final oven-dried residues were ignited in a furnace at 550°C. The weights of the left after ignition were measured as fiber contents by below formula and were expressed in term of the weights of the samples before ignition.

Crude Protein:

The protein nitrogen in one gram of the dried samples were converted to ammonium sulphate by digestion with concentrated H_2SO_4 (Merck 96.5%) and in the presence of $CuSO_4$ and K_2SO_4. The solutions were heated and the ammonia evolved were steam distilled into Boric acid 2%. The nitrogen from ammonia were deduced from the titrations of the trapped ammonia with 0.1M HCl with Tashirus indicator (methyl red: methylene blue

$$crude\ fiber\ percentage = \frac{crude\ fiber\ weight}{first\ sample\ weight} \times 100$$

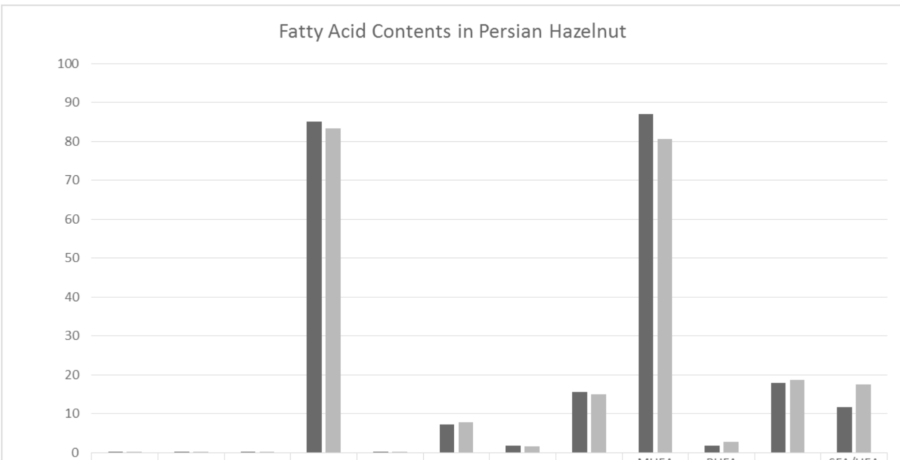
2:1) until a purplish pink color were obtained. Crude proteins were calculated by multiplying the valve of the deduced nitrogen by the factor 6.25 mg (Aryapak & Ziarati, 2014).

Ash Content:
One gram of the oven-dried samples in powder from was placed in acid washed crucible by known weight. They were ignited in a muffle furnace for 4-5 hours at 550 ºC. After cooling crucibles they were weighed and the ash contents were expressed in terms of the oven-dried weight of the sample.

Fatty Acid Determination:
Determination of Fatty acid composition for hazelnut samples were done by using a modified fatty acid methyl ester method as described by Hışıl (Hışıl, 1998; Abbasian et al. 2015). The oil was extracted three times for 2 g air-dried seed sample by homogenization with petroleum ether. The oil samples (50-100 mg) were converted to its fatty acid methyl esters (FAME). The methyl esters of the fatty acids (1 μl) were analyzed in a gas chromatography (Shimadzu GC-2011) equipped with a flame ionizing detector (FID), a fused silica capillary column (60 m x 0.25 mm i.e.; film thickness 0.20 micrometer).

Results

Crude fiber and ash content of hazelnut kernels in Tarem and Rudsar population are showed in figure 1. According to data which is shown in figure 1, the protein content percentage in Tarem kernel samples was 20.8 while it is 22.6 for Rudsar samples. The ash content in Tarem and Rudsar population were 2.8% and 3.0%, carbohydrate percentage were 13.3% and 14.2% and crude fiber were 7.87% and 7.81% respectively.
In investigation on these two varieties, the highest fatty acid had oleic acid with 85.026 % in Rudsar (Gilan) and 83.226% in Tarem samples. After oleic acid, stearic acid, linoleic acid, Butyric acid and palmitic acid contents were followed as 7.152%, 1.798 %, 0.133 and 0.055%, respectively in Rudsar variety. In this variety, total MUFA was found as 87.048 % although total SFA and total PUFA (Polyunsaturated Fatty Acid) were found as 15.599 % and 1.869 %, respectively (Table 2).



	Butyric acid (C4:0)	Myristic acid (C14:0)	Pentadecanoic acid (C15:0)	Oleic acid (C18:1,c)	Palmitic acid (C16:0)	Stearic acid (C18:0)	Linoelaidic acid (C18:2t)	SFA (Saturated fatty acid)	MUFA (Monounsaturated fatty acid)	PUFA (Polyunsaturated fatty acid)	SFA/MUFA (%)	SFA/UFA (Unsaturated fatty acid (%)
Rudsar	0.133	0.028	0.004	85.026	0.055	7.152	1.798	15.599	87.048	1.869	17.92	11.777
Tarem	0.201	0.039	0.004	83.226	0.048	7.83	1.546	15.056	80.598	2.846	18.68	17.554

■ Rudsar ■ Tarem

Fig. 2: The profile and rates of fatty acids of Persian Hazelnut (Corylus avellana L.) orchards kernel samples.

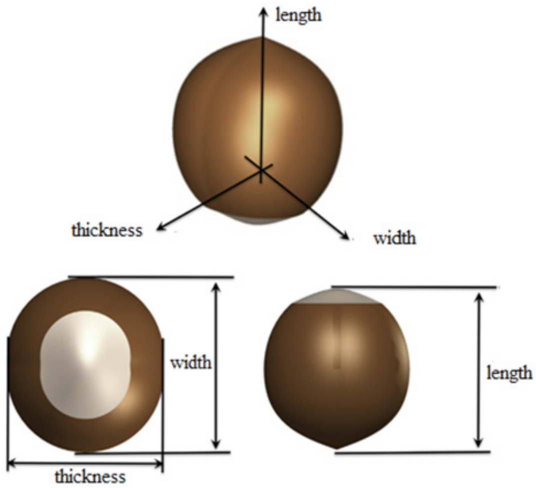


Fig. 3: Reference measuring system defined along hazelnut shell and kernel

Three kinds of specimens have been tested in the present research work.

Table 1: The diversity of nut size and weight and shell size of Persian hazelnut collected in 2015 in two mainhazelnut populations in the areas of Tarom and roodsar province regions (Iran)

Traits		Group	
		T*(n=30)	R*(n=30)
Nuts length (mm)	Mean	18.04	14.01
	Min	16.11	11.92
	Max	19.50	17.06
	SD	0.82	1.54
	CV (%)	4.54	10.99
Nuts diameter (mm)	Mean	16.22	15.29
	Min	13.40	12.00
	Max	18.80	18.10
	SD	1.33	1.33
	CV (%)	8.19	8.69
Nuts weight (g)	Mean	2.97	2.22
	Min	2.02	1.60
	Max	4.34	2.87
	SD	0.56	0.40
	CV (%)	18.85	18.01
Kernel weight (g)	Mean	1.46	1.08
	Min	0.92	0.74
	Max	1.77	1.29
	SD	0.21	0.21
	CV (%)	14.38	19.44
Shell diameter(mm)	Mean	1.68	1.43
	Min	1.25	1.13
	Max	2.36	1.60
	SD	0.27	0.14
	CV (%)	16.07	9.79

T=Tarom, R*=Roodsar*

In Tarem variety the order of fatty acids are the same while their levels showed significantly differences ($p < 0.05$). The total PUFA in Tarem samples was found 2.846%.
The oil contents of kernels changed among the location of farmlands to more than about 67% of each. However, because of economic value of the oil, these kernels could be used as potential sources of oils. Rudsar cultivars had more oil and according to variance analyses, differences between hazelnut cultivars to fatty acid contents were found statistically important at $p < 0.01$ level.
Some physical characteristics of hazelnut kernels, nuts and shells selected from Tarem and Rudsar samples indicated in Table 1, and model of measuring showed in Figure 3.

Discussion

According to research performance in Spain in 2014, means of crude fiber, protein, ash and lipid contents was determined that obtained 14.28, 13.43, 3.14 and 62.4 (g/100 g) respectively (Bernat et al. 2015).
Also, in study carried out on 20 genotypes of hazelnuts selected from native hazelnut population of Bitlis (eastern Anatolia, Turkey) in 2006, means of ash, protein and lipid contents was 2.11, 16.16 and 66.55(% dry weight) respectively. The hazelnut genotypes showed nut weight in a range from 1.85 to 3.63 g; kernel weight, 0.80–1.46 g; shell thickness, 1.20–2.04 mm; nut length, 16.1–23.4 mm; nut thickness, 12.9–18.5 mm (Baltaa et al. 2006).
A significant positive correlation (0.817) between nut weight and kernel weight was observed in this study which is as reported by other researchers, but no relationship between nut weight and kernel ratio ($P \leq 0.05$) was found. Shell thickness showed a negative correlation (-0.626); however, nut weight showed a positive correlation (+0.402) with shell thickness ($P \leq 0.01$). This means that heavier nuts have thicker and heavier shells.

The oil contents of hazelnuts were in the range of 51.4% to 75.1% of dried weight of the kernel. Combining the nut yield, percent kernel and oil content of the kernel. The hazelnut oils were unique in that only two fatty (oleic and linoleic) acids accounted for 90% of their fatty acid content. High oleic and linoleic acids contents and low linolenic acid content improved the oils thermo oxidative stability, while low levels of saturated (palmitic and stearic) acids enhanced their properties in cold environments. Significant amount of protein, healthy fat, mineral elements and dietary fiber in hazelnut promote healthiness.
In conclusion, evaluation of 420 hazelnut seedling samples reveals that Rudsar variety samples have more protein, ash and carbohydrate while crude fiber percentage in Tarem variety is more. The rainfall , treatment of crops such as Water and soil of the cultivation regions have an important role on quality and quantity of micronutrient compounds (such as minerals, protein, fatty acids and amino acids) in hazelnut. The results of this research reveals that geographical conditions affect the nutritional value of hazelnut significantly ($p < 0.05$).

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