FATTY ACID COMPOSITION AND PHYSICAL PROPERTIES OF TURKISH TREE HAZEL NUTS

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The fatty acid composition and some physical properties of nuts of Turkish tree hazels were investigated. Average nut weight, diameter, shell thickness, percent kernel, and moisture content were determined. Oil content ranged between 64.48% and 71.92%. Oleic and linoleic acids was the predominant fatty acids, together representing 91.7% of the total. The amount of palmitic and stearic acids was low while palmitoleic, margaric, margaroleic, linolenic, arachidic, and gadoleic acids were present in trace amounts. This is the first report on the fatty acid composition of Turkish tree hazel.

Key words: *Corylus colurna* L., Turkish tree hazel, oil, fatty acids, HPLC.

Hazelnut is a name given to the genus *Corylus* (Betulaceae) which includes about ten species. The hazelnut of commerce, one of the world's major tree nut crops, is the European hazelnut (*Corylus avellana* L.) [1]. The Turkish tree hazel (*Corylus colurna* L.) is one of the wild species within the genus *Corylus*. It grows in a tree form and can reach a height of 15–30 m with a trunk diameter up to 1 m [2–4]. It occurs naturally in mixed temperate forests of Romania, the Balkans, northern Turkey, Transcaucasia, and northern Iran [1].

Nuts of European hazelnut are consumed as a roasted snack or in pastries, baked goods, candy, or chocolate bars. The nuts are very nutritious and contain about 60% fat and 15% protein. A wide array of nut shapes is present in the species, but nuts of most commercial varieties are round. The shells are thin and the percent kernel ratio is high. The chemical composition and nutritional value of European hazelnuts, especially amino acids, carbohydrates, minerals, vitamins, oil, and fatty acids, and its effects on health benefits have been the subject of numerous investigations [5–14]. *Corylus colurna*, however, is not under cultivation as European hazelnut. But in Serbia and Turkey, nuts of this species are collected and sold, eaten as a snack, or used by the confectionary industry in candies, chocolates, and sweets due to their small size [3, 8].

Although Turkish tree hazel nuts are consumed and traded, there are limited reports about its nuts and their chemical composition, which are generally limited to protein and oil content. In this paper, we studied some physical properties and the fatty acid composition of nut samples of some Turkish tree hazel types.

Nut weight ranged from 1.33±0.24–2.91±0.24g and diameter ranged from 1.43±0.13–1.88±0.09 cm among the samples (Table 1). These results are within the ranges of 0.63–2.86 g for nut weight and 1.16–1.91 cm for diameter reported for Serbian *C. colurna* types [3]. The nuts of Giresun samples were the largest in terms of size and weight, while the nuts of Seben and C. Ahmetler samples were the smallest.

The thickness was not uniform along the shell, varying between 2.20±0.51 mm and 3.69±0.75 mm at the shoulder and between 0.67±0.13 mm and 1.05±0.25 mm at the base. Nuts in the Mudurnu-2 sample had the thickest shells and were difficult to crack and extract the kernels. The shape of the nuts was either round or compressed.

For percent kernel, the nuts of the Seben, Mudurnu-2, Gokcukur, and C. Ahmetler samples had values below 30% while the others were over 30% (Table 1). The percent kernel values of Serbian *C. colurna* types ranged from 25.9% to 40.1% [3, 4]. Nuts in the Mudurnu-1 sample had the highest percent kernel. However, the average of 31.3% is very low compared to that of commercially important Turkish hazelnut cultivars: 56.7% for Uzunmusa, 51.7% for Tombul, 49.8% for Palaz, and 48.7% for Fosa [8].

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TABLE 1. Physical Characteristics and Moisture Content of *C. colurna samples*[a]

Region (Province)	Sample	Shape	Diameter, cm[b]	Shell thickness, mm[c]	Weight, g	Kernel, %	Moisture, %
Western Black Sea (Bolu)	Seben	Round, slightly cylindrical	1.43±0.13	0.92±0.23 2.43±0.55	1.45±0.27	27.36±2.78	3.22±0.03
	Mudurnu-1	Round, top pointed	1.49±0.11	0.69±0.15 2.43±0.49	1.78±0.36	35.82±3.45	3.54±0.05
	Mudurnu-2	Round, top flattened	1.82±0.13	0.88±0.18 3.69±0.75	2.37±0.26	27.83±2.92	3.85±0.05
Eastern Black Sea (Giresun)	Center	Compressed, top pointed	1.88±0.09	0.67±0.13 2.44±0.53	2.91±0.24	34.03±3.03	3.27±0.04
Central Black Sea (Corum)	Alkaon	Compressed, top pointed	1.50±0.14	0.80±0.19 2.20±0.51	1.44±0.28	35.17±5.64	3.40±0.01
	Gokcukur	Compressed, top pointed	1.75±0.13	1.05±0.25 2.89±0.56	1.84±0.32	25.97±3.44	3.05±0.01
	C. Ahmetler	Compressed, top pointed	1.46±0.11	0.72±0.14 2.23±0.57	1.33±0.24	29.93±2.62	3.38±0.04
Average			1.62±0.12	0.82±0.18 2.62±0.57	1.87±0.28	30.87±3.41	3.39±0.03

[a]Values are the M±SD of triplicate of 25 nuts for each sample.
[b]Widest length.
[c]First number indicates the thinnest part (base) and the second number indicates the thickest part (shoulder) of the shell.

On the other hand, the Turkish cultivar Kargalak is only 35% kernel. In fact, this cultivar has large (2.82 g) nuts and the shell is not thick, but a low percent kernel because the kernel does not fill the space in the shell. However, the *C. colurna* kernels we examined were fully developed and completely filled the shells. Thus, the lower percent kernel is a result of having a thicker shell. Interestingly, the kernels of Giresun samples were heart-shaped due to pronounced lobes. Heat treatment is necessary for blanching kernels of European hazelnut cultivars. Likewise, kernels of all of the samples blanched easily after heat treatment. But nuts of the Seben sample lacked fiber and the pellicle (testa) of most of the kernels was easily removed just by rubbing by hand without heat treatment.

The kernel moisture content averaged 3.39±0.03% (Table 1). Higher values have been reported for European hazelnut cultivars: 5.1% in Spanish hazelnut cultivars [12] and 4.76% in Turkish cultivars [15].

The oil content was lowest in the Alkaon (64.48%) and highest in the Seben (71.92%) samples. The average oil content of our samples (68.11%) was higher than the 56.2–56.4% reported for Serbian *C. colurna* types [3, 4]. Compared to the oil content (54.8–71.0%) of European hazelnut cultivars [16], the oil content of our Turkish hazel tree samples is at the high end of the range (Table 2). The oil content of hazelnut kernels varies by cultivar [11, 16], year, location [12], and irrigation [17].

We were able to detect ten fatty acids in our samples (Table 2), while sixteen fatty acids were reported in the European hazelnut cultivar "Tombul" [6]. Palmitic acid was the main saturated fatty acid, followed by stearic acid. Other saturated fatty acids detected were margaric and arachidic acids, but only in very small quantities (< 0.1%). Saturated fatty acids comprised about 7.76% of the total in average. Monounsaturated fatty acids were predominant in the oil (79.87%) as in European hazelnuts [6], and were composed of oleic, palmitoleic, margaroleic, and gadoleic acids. Gadoleic acid was detected only in the Mudurnu and Alkaon samples. Polyunsaturated fatty acids were linoleic and linolenic acids (12.36%).

The fatty acid profiles of the samples from Bolu province and the sample from Corum province were similar, while those of the Giresun sample were quite different, especially for stearic, oleic, linoleic, and linolenic acids.

TABLE 2. Fat Content and Percentages of Fatty Acids of Lipid Fractions Extracted from *C. colurna* Samples

Fat/Fatty acids	Percentages of fat and fatty acids				Average
	Seben	Mudurnu-2	Giresun	Alkaon	
Total fat	71.92	66.98	69.21	64.48	68.11
Palmitic (16:0)	5.41	5.99	5.90	6.59	5.97
Palmitoleic (16:1)	0.26	0.30	0.36	0.30	0.31
Margaric (17:0)	0.03	0.03	0.01	0.02	0.02
Margaroleic (17:1)	0.06	0.07	0.06	0.06	0.06
Stearic (18:0)	1.84	1.88	1.27	1.90	1.72
Oleic (18:1)	77.94	78.31	86.32	75.25	79.46
Linoleic (18:2)	14.30	13.11	5.97	15.59	12.24
Linolenic (18:3)	0.11	0.15	0.07	0.15	0.12
Arachidic (20:0)	0.04	0.05	0.03	0.06	0.05
Gadoleic (20:1)	Tr.	0.10	Tr.	0.07	0.04
Σ_{sat}	7.32	7.95	7.21	8.57	7.76
Σ_{unsat}	92.67	92.04	92.78	91.42	92.23
$\Sigma_{Fatty\ acid}$	99.99	99.99	99.99	99.99	99.99

Tr.: trace < 0.01%.

The predominant fatty acids in the oil were oleic acid (79.46%) and linoleic acid (12.24%), which together represented about 92% of the total. The Giresun sample had the highest value for oleic acid (86.32%), even higher than the best quality European hazelnut cultivar “Tombul” of 82.6–82.7% [6, 8]. But the same sample had the lowest value for linoleic acid (5.97%). These data suggest that an increase in oleic acid is accompanied by a decrease in linoleic acid. Similar results were reported by Garcia et al. [16], suggesting a strong complementarity between oleic and linoleic acids in the oil seeds. Thus if a cultivar has a high oleic acid content, at the same time it will have a low linoleic acid content.

The data shows that the majority of the fatty acids in *C. colurna* kernels is unsaturated fatty acids (92.23%) on average, while saturated fatty acids comprised only 7.76% (Table 2). Unsaturated fatty acids play an important role in human nutrition and health. The fatty acid profile of nuts, high in unsaturated fatty acids such as oleic acid and low in saturated fatty acids, contributes to cholesterol lowering and hence coronary heart disease risk reduction by increasing the high density lipoprotein (HDL) in blood [7, 18, 19]. Turkish tree hazel kernels are rich in unsaturated fatty acids and their consumption would have health benefits similar to eating European hazelnut kernels.

EXPERIMENTAL

Plant Material. Nuts of seven different *C. colurna* types from different locations were used in the study. The origin of the samples was Bolu province in the Western Black Sea region, Corum province in the Central Black Sea region, and Giresun province in the Eastern Black Sea region in Turkey (Table 1). These locations are isolated from each other with a distance of 400 km or more. Nut samples were stored in the lab at room temperature until analyses. Physical analyses were done on all of the samples while four samples as representative of the regions were used in chemical analyses.

Physical Analysis. Nut weight, diameter, percent kernel, and shell thickness were determined either by weighing or by measuring with a digital caliper on randomly selected nuts for each sample.

Extraction and Preparation of Fatty Acids. Nuts were cracked by hand and the kernels were extracted. The kernels were ground to a powder in a coffee grinder. For determination of moisture content, 20 g powder was dried in an oven at 130°C for two hours, cooled in a desiccator, and weighed.

For total crude oil, 20 g of powder was placed in a cellulose thimble and extracted with hexane (40–60, Merck, Milan) for four hours using a Soxhlet apparatus [20]. For fatty acid analyses, the oil was extracted from 20 g of powder using 200 mL of hexane with constant stirring for 1.5 hours. The extraction was repeated two times using 100 mL of hexane each time. Hexane extracts were combined and filtered. The solvent was distilled using a rotary evaporator at 60°C under vacuum and the oil was collected. Fatty acid methyl esters were prepared according to the Ce2-66 method of AOCS [21].

Gas Chromatography. Esters were analyzed with a ThermoQuest Trace 2000 (Milano, Italy) Gas Chromatograph, equipped with a CGO-5512, BPX70 column (30 m long, 0.25 mm internal diameter, 0.25 mm film thickness, Phenomenex). The temperatures of the injector, column, and detector (FID) were 230°C, 190, and 240°C, respectively. Helium was used as the carrier gas at a constant flow rate of 0.5 mL/min.

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