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Evaluation of some walnut varieties and their use in biscuit making

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Abstract
The study included physical, chemical, and manufacturing tests on walnuts and their powder from two types of walnuts: American and Belarusian walnuts. Physical tests revealed a higher average weight per nut of American walnuts (12.56 grams) than Belarusian walnuts. The shell width of Belarusian walnuts was also increased (2.6 cm²). Chemical tests (moisture, ash, and fat) revealed a higher percentage of Belarusian walnut powder (moisture 2.6%, ash 2.4%, and fat 64.63%). Manufacturing tests revealed that biscuits produced by adding walnut powder from which the fat had been removed were superior in texture and overall acceptability, and similar in color to biscuits produced by adding walnut powder with the fat present.

Keywords: Walnut varieties, physical and chemical properties, walnut powder, biscuit making American walnut, Belarusian walnut, nutritional composition, food product evaluation

Introduction
The walnut, whose scientific name is Juglans regia, is a plant in the Juglondaceae family [1] and is the most widely distributed fruit in the world.
The walnut tree is a new tree to the Old World [2], most likely first cultivated in Iran and then exported to other countries [3]. Walnuts are a fruit that grows in temperate tropical regions, and Iran is an important source of walnuts, with the Persian walnut being an important economic variety grown for its shell and pulp [4].
According to statistics compiled by the Food and Agriculture Organization of the United States (FAO) in 2007, Iran plays a significant global role in walnut production [5]. Persian walnuts grow on approximately 70,000 hectares of land, producing 170,000 tons of walnuts in their shells, making Iran the third-largest walnut-producing country in the world [3].
Walnuts in Iran have a distinct value in Iranian cuisine, such as fesenjan, a nut used in Iranian appetizers such as ghotab, baklava, and jerdavi (Iranian sweets), as well as rajinak.
Walnuts are grown in Iran in areas such as Tehran, Karaj, Samedan Khorasan, and Fars [6, 7], where favorable geographical conditions have led to the growth of approximately 8,000 walnut plant species [6].

Nutritional importance
Walnuts are essential for human health. They possess antioxidant and antibacterial properties, and are effective against cancer [2]. Furthermore, the seed of Juglans regia is considered a highly nutritious substance(8) .
In general, the walnut fruit contains 60% oil, but this percentage ranges between 52-70%, depending on the skill of the farmer, the location where it is grown, and the rate of irrigation [8, 9, 10].
The high protein and oil content of walnuts makes them an indispensable fruit in the human diet. Therefore, walnuts are classified as a strategic food item and are included in the list of essential plants in the United States Food and Agriculture Organization's list [11].
The main component of walnut oil is triglycerides, while fatty acids, disaccharides, monosaccharides, sterols, isosterols, and phosphates are all present as minor components in smaller proportions [9].
In fact, among fruit oils, walnut oils have the highest amount of polyunsaturated fatty acids (PUFA), reaching 78% of the total fatty acids [2].

The main fatty acids found in walnut oil are

- Oleic n-9 18:1
- Linoleic n-6 18:2
- Linolenic n-3 18:3

Therefore, walnuts are among the fruits with high amounts of omega-6 and omega-6 polyunsaturated fatty acids (PUFA), which are important dietary fatty acids [12]. The Food and Drug Administration (FDA) has provided health information indicating that diets containing walnuts reduce the risk of heart disease (8). The benefits of walnuts for the heart lie in their ability to lower cholesterol, reduce inflammation, and improve arterial function [1]. Although walnuts are rich in fat, a walnut-enriched diet has a beneficial effect on blood lipids, lowering cholesterol levels and reducing the ratio of low-density lipoprotein (LDL) to high-density lipoprotein (HDL) concentrations in blood serum by 12% [13].

Walnuts contain 16.60% protein, while albumin, globulin, prolamin, and gluten are respectively*:* (6.91%, 17.57%, 5.33%, and 70.11%) [14]. Walnuts are therefore an important source of amino acids for adults [8].

Walnuts are an important source of dietary minerals [15]: potassium, phosphorus, magnesium, iron, calcium, sodium, zinc, and copper, which are also present in moderate amounts [6, 15].

Iron (Fe) is a component of hemoglobin, myoglobin, and a large number of enzymes, making it an important mineral in the diet [6, 16] Calcium (Ca) constitutes approximately 100% of the human body's total body mass. It is the main component of bone and helps in the development of teeth [6, 13, 16] Potassium (K) is the third most abundant mineral in the human body and acts as an electrolyte. This mineral is important for maintaining the health of the heart, brain, kidneys, muscles, and other organs [6, 16]

Zinc (Zn): It is a component of enzymes involved in major metabolic processes and is an important element for plants, animals, and humans [17] Walnuts also contain the highest amount of polyphenolic antioxidants among all nuts [6,18]. It is also a good source of vitamins (E, A), fiber, and pectin [12]. It has been found that more than 990,000 hectares of land in Tehran are planted with walnut trees, making them an important economic resource [7].

The water and soil conditions for walnut cultivation play an important role in the quantity and quality of micronutrients in walnuts, such as minerals, vitamins, fatty acids, and amino acids.

Geographical conditions also affect the nutritional value of walnuts [6, 16].

Uses and Benefits of Walnuts

1. The leaves have an astringent, cleansing, and disinfecting effect, and the green rind has a natural laxative effect.
2. The leaves are used to treat skin diseases, such as viral infections called herpes.
3. The green rind and the subsequent woody rind have a diaphoretic effect.
4. The immature green rind kills worms, especially tapeworms.
5. It revitalizes the body and prevents sagging and weakness.
6. Walnuts prevent hair loss and turn white hair black when dyed.
7. Walnuts aid wound healing.
8. Like other nuts, they lower blood sugar levels.
9. They help remove calluses from the toes by massaging the calluses with the green peel.
10. Dried walnuts are boiled, dried, and sweetened with sugar. They are then served with other fruits as a nutritious, appetite stimulant, liver tonic, and sexual stimulant (small, soft, green walnuts are used).
11. Consuming a lot of walnuts is recommended for those suffering from multiple sclerosis.
12. The hard shell of walnuts, roasted and ground, is used to whiten teeth, strengthen gums, and eliminate bad breath (charcoal powder).

The aim of this research is to study some of the external characteristics and chemical components of walnuts, in addition to fortifying biscuits with walnut powder.

Materials and Methods

First: Materials

- Two types of walnuts were collected: American walnuts and Belarusian walnuts.
- A 95% hexane and alcohol solution was used, obtained from chemical laboratories.
- Sugar, flour, oil, sodium bicarbonate, and walnut powder were used to manufacture biscuits.
- All materials were collected from the local market.

Second: Methods of Work

1. Physical (External) Tests

Method of Work:

Two types of walnuts were taken, American and Belarusian, to study their physical (external) characteristics, including weight, volume, height, width, thickness, and percentage of purity. The weights were measured for each type of walnut, and the averages were taken. The width, height, thickness, and percentage of purity were added, and the differences between them were noted. The results shown in Table 1 were recorded.

2. Chemical Tests

The chemical tests include:

First: Measuring the moisture content

Second: Measuring the ash content

Third: Measuring the fat content

First: Measuring the moisture content

Apparatus, tools, and materials used

1. Moisture measuring plates
2. Sensitive balance
3. Temperature-controlled electric drying oven
4. Glass dryer
5. Metal holder

Methods of Work

1. Weighing the dry, clean moisture measuring plates and determining their weight.
2. Zero the scale.
3. Take weights of approximately 5 grams of the walnut varieties for which the moisture content was to be estimated.
4. Place the samples in dishes, weigh them, and record the weight of the sample and dish before drying.
5. Place the dishes and samples in an electric oven, set to

105 °C, for three hours.
6. Remove the dishes and samples from the oven and place them in a glass desiccator to cool.
7. Calculate the weights of the dishes and samples after drying.
8. The resulting weight loss is considered the moisture content.
9. Calculate the percentage using the following:

$$\text{Percentage of moisture (\%)} = \frac{\text{Weight of the sample before drying} - \text{Weight of the sample after drying}}{\text{Weight of the sample before drying}} \times 100$$

Second: Measuring the ash content
Apparatus, tools, and materials used:
1. Platinum combustion crucible
2. Sensitive balance
3. Drying oven
4. Incineration oven

Procedure
1. The combustion crucible was thoroughly washed and then dried in the drying oven until its weight was constant. The weight of the empty crucible was recorded.
2. Weights of approximately 5 grams were taken from the walnut samples to be estimated for ash content.
3. The samples were placed in combustion crucibles, and the weight of the crucibles and samples before incineration was recorded.
4. The crucibles containing the samples were placed in a drying oven at 105°C for 30 minutes to remove volatile substances and moisture until smoke from the samples ceased, allowing the sample to fully break down. This is known as "lignition."
5. The crucibles containing the samples were transferred to the incineration oven at 555°C for 2-3 hours. They turned white or gray, and the weight was recorded.
6. After the incineration oven cooled, the crucibles and samples were transferred to a glass desiccator with extreme caution to avoid ash evaporation. The samples were left to reach room temperature.
7. The crucibles and samples were weighed, and the weight after incineration was recorded.
8. The ash percentage was calculated according to the following formula:

$$\text{Total ash percentage (\%)} = \frac{\text{Weight of sample before incineration} - \text{Weight of sample after incineration}}{\text{Sample weight before incineration}} \times 100$$

Third: Measuring the fat content
Apparatus, tools, and materials used
1. Sensitive balance
2. Moisture measuring plates
3. Test tubes
4. Centrifuge
5. Drying oven

Materials used
1. Hexane
2. 95% alcohol
3. Walnut powder samples

Procedure
1. Four samples were taken from the walnut varieties whose fat content was to be estimated, each weighing approximately 2 grams.
2. The samples were placed in test tubes and 6 ml of 95% alcohol and hexane were added.
3. All test tubes containing the samples were placed in a centrifuge at 1000 rpm for 30 minutes to separate the fat.
4. After the fat separation process was complete, the separated fat and solvent were placed in moisture measuring plates, weighed, and the weight recorded before drying.
5. The plates containing the fat and solvent were placed in a drying oven at 50 °C until the solvent odor disappeared for disposal. From the solvent, then measure the weight.
6. Calculate the fat percentage according to the following formula:

Part
Fat percentage = × 100

Third: Biscuit manufacturing

Seq	the components	The amount	
		Weights	Measuring
1	Hydrogenated oil	64 g	→ ¼ cup (a quarter cup)
2	Sugar	130 g	½ cup (half a cup)
3	Salt	1 g	½ teaspoon (half a teaspoon)
4	Sodium bicarbonate	2,5 g	1 teaspoon (one teaspoon)
5	Dextrose solution (8.9 g dextrose, 50 ml water)	33 g	One teaspoon of sugar in half a cup of water
6	Water	16 g	
7	Flour	225 g	2 cups (two cups)

Note:
Nut powder was used as follows
Once, the flour was replaced with 3/4 cup nut powder, while the fat was present, and another time, the flour was replaced with 1/2 cup nut powder, with the fat removed from the mixture.

Methods

1. Beat the fat, sugar, salt, and soda for 3 minutes on slow speed with the mixer, adding all ingredients for one minute.
2. Add the dextrose solution and water and mix for 1 minute on slow speed, scrape, and mix for another minute on medium speed.
3. Add all the flour and mix for 2 minutes on slow speed, scraping the ingredients down each minute.
4. Roll out the dough to a thickness of 6 cm.
5. Cut into round pieces with a diameter of 6 cm.
6. Bake for 15 minutes at 205 °C.
7. Cool for 30 minutes after baking.

Results and Discussion

First: Some physical (external) characteristics of walnuts

It is noted from Table (1) that the American walnut differs in weight and width from the Belarusian walnut (weight 12.56 g, width 1.2 cm for the American walnut) (weight 11.97 g, width 3.6 cm for the Belarusian walnut). The difference was very small in the percentage of purity (47.20% for the American walnut, and 46.58%), while similarity was observed in the thickness characteristics of both (1.2 mm for thickness). Convergence was found in the thickness characteristics and height of both species (3.7 cm, 3.8 cm). The difference in these characteristics may be due to the differences in walnut tree varieties and the environmental factors related to their growth.

Table 1: Physical (external) characteristics of walnuts

Characteristics Type of Walnut	Weight	Height	Width	Yield Percentage	Thickness
American	12.56 g	3.8 cm	1.2 cm	47.20 %	1.2 mm
Belarusian	11.97 g	3.7 cm	2.6 cm	46.58 %	1.2 mm

Second: Some of the (internal) chemical components of the walnut. Table (2) reveals some of the chemical components of the walnuts used in this study, namely (moisture, ash, and fat). The differences between the studied species are noted in the moisture content of the American and Belarusian walnuts, which are (2.6%, 2.4%), (19, 20, 21, 22, 23%), respectively. It was also noted that the ash content of the American and Belarusian walnuts is (2% - 2.4%), respectively.

As for the percentage of fat extracted from the walnut powder, the percentage of fat varies according to the extraction method. The fat extracted from the American and Belarusian walnut powders treated with 95% alcohol was (3.41% - 2.96%), respectively. The percentage of fat extracted from the American and Belarusian walnut powders treated with hexane was (64.63% - 39.81%), respectively. The difference in chemical composition between the two studied walnut species may be due to genetic factors and the influence of environmental factors such as soil type, climate, and other factors.

Table 2: Chemical components of walnuts

Constituents Type of nut	Moisture	Ash	Fat	
			Hexane	Ethanol *% 95*
American	2.4 %	2 %	39.81 %	3.41 %
Belarusian	2.6 %	2.4 %	64.63 %	2.96 %

Biscuit production using walnut powder

The walnut species was selected for biscuit production, and Table (3) shows the sensory evaluation results of the produced biscuit.

Table 3: Sensory evaluation results of walnut-enriched biscuits

Type of biscuit	Texture	Flavor	Color	Overall acceptability
Standard sample	23.55	24.77	17.22	16.66
Sample using nut powder with fat	21.33	24.11	16.33	16.77
Sample using defatted nut powder	23.88	24.33	17.66	17.88

Table 3 shows the results of the sensory evaluation of the types of biscuits produced. It is noted that the biscuit produced using walnut powder from which the fat was removed outperformed the standard sample in general acceptance, as well as the sample using walnut powder with the presence of fat in color and texture, with a slight decrease in texture for the sample using walnut powder with the presence of fat.

Fourth: Biscuit Spread Factor

Table (4) shows a higher spread factor for biscuits produced by adding defatted walnut powder compared to those produced by adding walnut powder with fat and the standard sample.

This indicates that using defatted walnut powder is better for biscuit production than using walnut powder with fat and relying on walnut oil instead of hydrogenated oil.

Table 4: Spreading coefficient of biscuits produced from walnut powder

Spread ratio Type of biscuit	Spread ratio
Standard sample	28.19
Sample with nut powder (containing fat)	41.95
Sample with defatted nut powder	50.25

Conclusions

1. The chemical composition and external properties of the studied walnut species differed.
2. The process of separating fat from walnut powder using hexane was superior to the process of separating and extracting fat from walnut powder using alcohol.
3. The possibility of using walnut powder at a high level without affecting the quality of the biscuit.

4. The quality of biscuits produced using walnut powder with the fat removed was superior to biscuits produced using walnut powder with the fat present.

Recommendations

1. We recommend increasing walnut cultivation, providing large, suitable areas for its cultivation, and providing favorable environmental conditions for its growth.
2. We recommend in-depth study of its characteristics and efforts to increase productivity, as it is an economically and globally important fruit.
3. We recommend consuming it in sufficient, limited quantities and including it in the diet, as it provides the body with essential nutrients, especially essential amino acids, unsaturated fats, vitamins, and minerals.
4. We recommend consuming it because it reduces the risk of developing cholesterol diseases due to its high content of high-density lipoproteins, and reduces the risk of cardiovascular diseases due to its high content of unsaturated fats.
5. We recommend incorporating it into food products and providing products with high nutritional value.

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