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Research Article

Effect of Different Roasting Methods on Some Properties of Walnut Kernels

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Abstract

In this study, the effects of oven roasting and microwave roasting on some properties of walnut kernels were determined. Roasting methods at different oven temperatures (70, 100 and 130 ºC for 1 h) and at different microwave powers (240, 535 and 830 W for 5 min) were applied to samples. Moisture ratio values, total phenolic compound, antioxidant activity, and oil yield of the roasted and unroasted products were discussed. The highest oil yield was determined in the high temperature oven roasting but the microwave roasting mostly increased the oil yield of the product. Microwave roasting was found to be more suitable for decreasing moisture content. The lowest antioxidant activity was detected with microwave roasting. It was determined that the effect on the amount of phenolic substance in the two methods was indifferent.

Keywords: Roasting, microwave, *Juglans regia* L., phenolic compound, oil

Farklı Kavurma Yöntemlerinin Ceviz İçlerinin Bazı Özelliklerine Etkisi

Öz

Bu çalışmada, fırında kavurma ve mikrodalga kavurmanın ceviz çekirdeklerinin bazı özellikleri üzerine etkileri belirlenmiştir. Numunelere farklı fırın sıcaklıklarında (1 saat süreyle 70, 100 ve 130 ºC) ve farklı mikrodalga güçlerinde (5 dakika süreyle 240, 535 ve 830 W) kavurma yöntemleri uygulanmıştır. Kavrulmuş ve kavrulmamış ürünlerin nem oranı değerleri, toplam fenolik madde miktarı, antioksidan aktivite değeri ve yağ verimi tartışılmıştır. En yüksek yağ verimi yüksek sıcaklıkta fırında kavurmada tespit edilmiş, ancak mikrodalga kavurma çoğu örneğin yağ verimini artırmıştır. Mikrodalga kavurma, nem içeriğini azaltmak için daha uygun bulunmuştur. En düşük antioksidan aktivite mikrodalga kavurma ile tespit edilmiştir. Her iki yöntemde de fenolik madde miktarı üzerindeki etkinin farksız olduğu belirlenmiştir.

Anahtar Kelimeler: Kavurma, mikrodalga, *Juglans regia* L., fenolik bileşik, yağ

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1 Introduction

Walnut (*Juglans regia* L.) is the most economically important oil and ecological tree species. It is known as one of the four main dried fruits, along with walnuts, almonds, cashews and hazelnuts, which are widely cultivated in the world [1]. Walnut, which is popular around the world, is valued for its nutritional, health and sensory properties. In addition, the pharmaceutical and cosmetic industries, its outer green bark, leaves, bark and berries are used as a rich source of natural polyphenols and other bioactive substances [2,3]. The edible part of the fruit is consumed fresh or roasted, alone or in combination with other edible products. With its rich nutritional content, walnut is a product of high economic value for the food industry. Worldwide production of walnuts in 2020 is over 3.3 million tons; China is the largest producer with 1.1 million tons and the other major producers are the USA, Iran and Turkey, respectively. In 2020, approximately 73% of the world's commercial walnuts were produced from these four countries [4]. Walnut kernels are a natural source of oil and contain 62-74% oil. The composition of walnut oil is mainly dominated by unsaturated fatty acids such as linoleic and to a lesser extent oleic and linolenic acids. Walnut, which is unique with its 4:1 balance between Omega-6 and Omega-3 polyunsaturated fatty acids, increases the amount of high-density lipoprotein, which lowers cholesterol and blood pressure, and can effectively reduce the risk of cardiovascular disease [5]. In addition to this, walnut attracts attention with its high polyphenol content reported up to 2500 mg/100g [6], have many health benefits, including reducing symptoms related to type II diabetes, cancer, intestinal dysbiosis, and neurological disorders [7,8].

Roasting is a widely used food processing method for nuts to obtain a pleasant taste and flavor [9]. During this process, raw foods are thermally treated above 125 °C to facilitate non-enzymatic reactions that contribute to the development of desirable flavors, textures and colors [10]. During roasting, various chemical reactions occur such as hydrolysis, oxidation, reduction, decarboxylation and polymerization. In addition, Maillard reaction products are formed during heat treatment. Maillard reaction products are involved in the formation of compounds with antioxidant, antiallergenic, antimicrobial or cytotoxic properties, as well as contributing to color, aroma and taste in foods [11]. During roasting, significant changes can occur in the antioxidant capacity of foodstuffs as a result of the breakdown of some heat-labile antioxidant components or the formation of new compounds with potential antioxidant activity by the Maillard reaction [12]. In a study, it was reported that the antioxidant activity of defatted sesame flour extract increased as the roasting temperature of sesame seeds increased and the maximum antioxidant activity was obtained when the seeds were roasted at 200°C for 60 minutes. In addition to the increase in antioxidant activity at this time and temperature, the total phenolic content, radical scavenging activity, and reducing powers increased significantly [13]. In another study with almond kernels, it was reported that phenolic components were largely lost in the initial stage of roasting and then gradually increased with roasting temperature and time. It was emphasized that similar results were observed for antioxidant activities. It has been stated that Maillard reaction products also increase with roasting temperature and time, and this may contribute to the increase in antioxidant activity [14]. The quality and process efficiency of roasted products depend on the composition and size of the product and the conditions of the applied process [15].

The increasing demand for roasted foods has led to the development of alternative methods to traditional roasting methods. Microwave roasting [11], forced convection continuous drum roasting [16], revtech roasting [17], superheated steam roasting [18], infrared hot air roasting [19] are some of them. Unlike traditional roasting, which requires a long roasting time, which negatively affects product quality, the microwave, which has gained popularity in home and large-scale food preparation systems, requires short processing times [11]

In this study, the effect of roasting at different time and temperature/power on the moisture content, oil content, antioxidant activity, total phenolic content of walnuts roasted in the oven and microwave was evaluated.

2 Material and Methods

2.1 Material

Walnut samples in shells were obtained from local producers in Amasya, Turkey, right after they were harvested. All chemicals used in the study are of analytical purity. The walnut kernels will be expressed as unroasted. Experiments were carried out in duplicate.

2.2 Oven roasting

Walnut kernels were roasted in the INOKSAN convection oven 1 hour at 70, 100, and 130 °C temperatures. Temperatures and time were determined by examining the studies carried out (Juhaimi et al., 2017). After the roasted samples were cooled, they were kept in the refrigerator at +4 °C until analysis. The walnut kernels will be expressed as oven-roasted.

2.3 Microwave roasting

Walnut kernels were roasted in VESTEL MW20-MW microwave oven for 5 min at 240, 535 ve 830 W microwave powers. Microwave powers and time were determined by examining the studies carried out (Juhaimi et al., 2017). After the roasted samples were cooled, they were kept in the refrigerator at +4 °C until analysis. The walnut kernels will be expressed as microwave-roasted.

2.4 Moisture content

The moisture contents of walnut kernels (unroasted, oven-roasted, and microwave-roasted) were measured at 100 ± 5 °C in an oven (MMM Ecocell) until a constant weight was obtained.

2.5 Total phenolic compound (TPC)

The method of Labuckas et al. [21] was modified and used to prepare the extracts. The mixtures were prepared at a ratio of 1/10 g/mL walnut:methanol (60% v/v), kept at room temperature for 24 h, and filtered at the end of the period, and extracts were obtained for total phenolic compound and antioxidant activity analyses.

Total phenolic compound (TPC) analysis was performed using the Folin-Ciocalteu reagent. 0.5 mL of Folin-Ciocalteu reagent (1/10 v/v) was mixed by adding 1 mL of extract, and 3 mL of sodium carbonate (Na_2CO_3, 75 g/L) was added after 5 minutes. The mixture was kept in the dark and at room temperature for 1 hour. Absorbances were measured at 765 nm by spectrophotometer (Shimadzu. UV-1800). Gallic acid (GA) was employed as a reference standard to prepare the calibration curve. The results were expressed as mg GA/100 g of dry matter [22].

2.6 Antioxidant activity (DPPH method)

The scavenging effects of the samples on the DPPH (1,1-diphenyl-2-picrylhydrazil) radical were measured by a modification of the method proposed by [23] 0.1 mL of extract was mixed with 3.9 mL of DPPH solution ($6x10^{-5}$ M) and left in the dark for 30 minutes. Absorbance was measured at 515 nm using a spectrophotometer. DPPH was expressed as mg Trolox Equivalent/g dry matter.

2.7 Oil yield

Oil from the walnuts was extracted using AOAC 920.39C method [24]. 10 g of unroasted and roasted samples were put into the Soxhlet extraction cartridge and inserted into the Soxhlet extractor. The extraction solvent was hexane. Samples were extracted continuously for 6 hours. After extraction, solvent was recovered by rotary evaporator. The obtained oil was dried in the oven for one hour at 65˚C. The samples were weighed after cooling. The oil yield (%) of the walnuts was determined using Eq. (1).

oil yield (%)=(weight of extracted oil)/(weight of walnut sample) ×100 (1)

2.8 Statistical analysis

The data were statistically evaluated by variance analysis (ANOVA) using MINITAB 16.0. The comparison of means was done by the least significant difference test at a significance level of 0.05.

3 Results and Discussion

3.1 Effect of roasting methods on moisture content

In its simplest definition, moisture content is a measure of water in food. Moisture content is a critical factor as it affects the flavor, texture, and shelf life of nuts [25]. The moisture contents of unroasted, oven-roasted, and microwave-roasted samples were given in Fig 1. The initial moisture content of the walnut kernel was calculated as 1.88%±0.01 (on a wet basis). In both roasting methods, it was determined that the moisture content decreased as the temperature or microwave power increased. It is seen that the lowest moisture content is obtained with oven roasting. The reason for this is thought to be due to the fact that oven roasting takes a much longer time than microwave roasting. Similar to our study, Bagheri et al. [25] reported that the moisture content decreased with increasing microwave power while roasting peanut kernel. A similar study was obtained by roasting pistachio kernels, where it was stated that the moisture content decreased as the temperature increased [26].

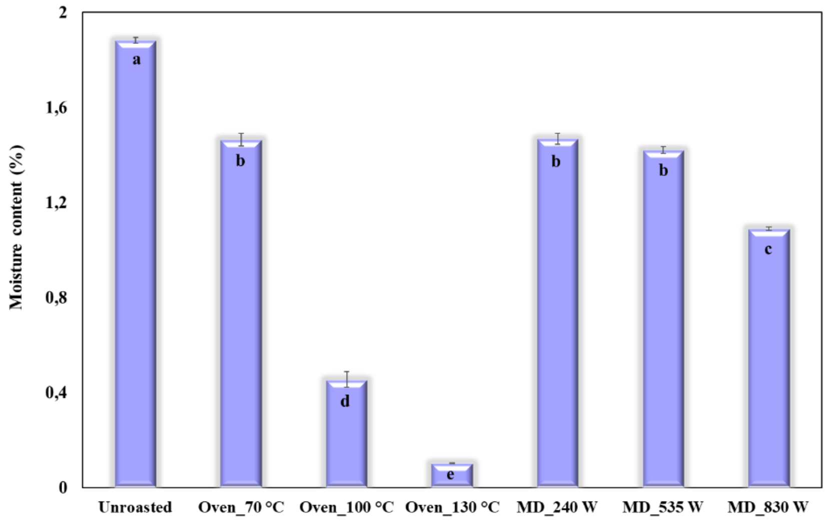

Figure 1. Variation of moisture contents under different roasting conditions

3.2 Effect of roasting methods on total phenolic compound

The TPC of unroasted, oven-roasted, and microwave-roasted samples were shown in Fig 2. As can be seen, the roasting method did not have a statistical effect on TPC. However, when the values were compared, a higher amount was obtained in the sample treated at 830 W microwave power, although there was no statistical difference. In a study on roasting Samh seeds [27] in the literature, it was observed that TPC increased with roasting compared to unroasted. It was stated that this situation was probably caused by the destruction of the cell by heat during roasting, and so the increase in the release of free phenolic compounds was observed. However, this finding has not been found to be coordinated with our study.

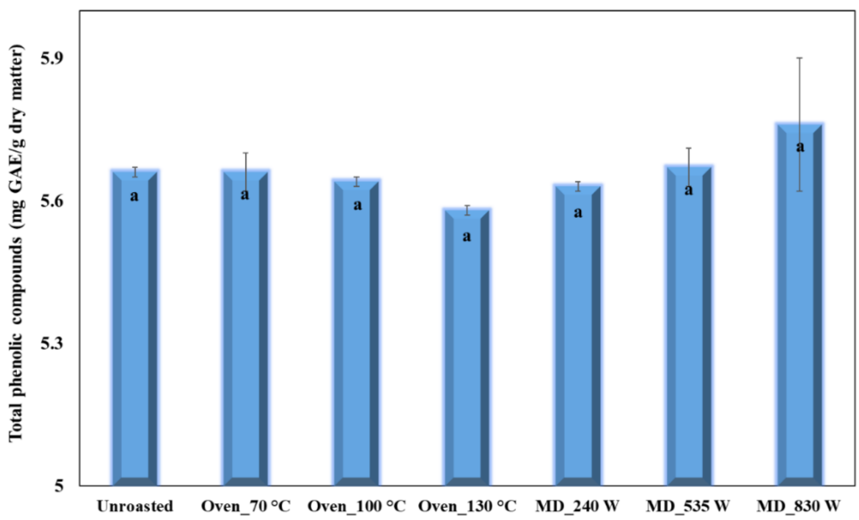

Figure 2. Variation of total phenolic compounds under different roasting conditions

3.3 Effect of roasting methods on antioxidant activity

The DPPH values of unroasted, oven-roasted, and microwave-roasted samples were shown in Fig 3. As with TPC, the effect of roasting on DPPH was also statistically insignificant. As a result, it was observed that the different temperatures, microwave powers, and times applied did not change the antioxidant activity of the walnut samples. When the literature was examined, it was stated that the increase in the antioxidant activity values with roasting was due to the antioxidant activity of the Maillard reaction products [28, 29]. However, this finding was not observed in our study.

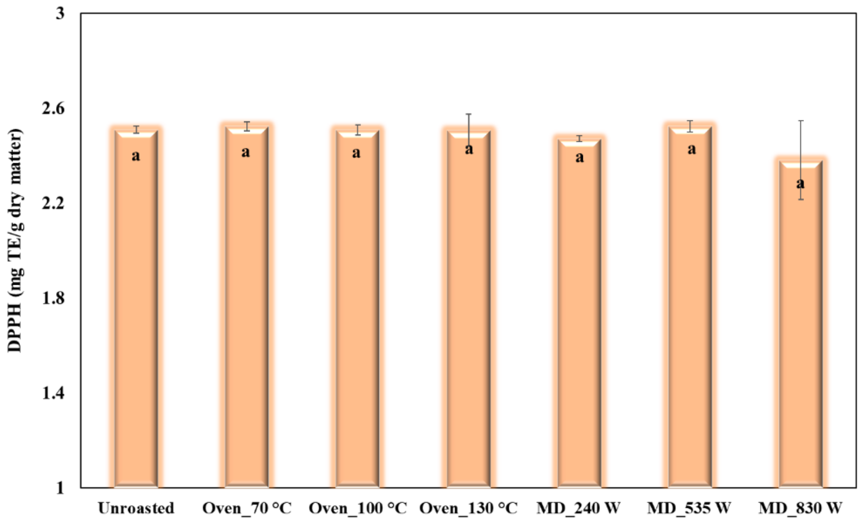

Figure 3. Variation of antioxidant activities under different roasting conditions

3.4 Effect of roasting methods on oil yield

The yield of the oil extracted from unroasted, oven roasted and microwave roasted walnuts are given in Figure 4. When walnut kernels were roasted in the oven at various temperatures, the oil yield ranged from 68.01 to 75.97%, The oil yield of unroasted walnut was determined as 69.66%, which is comparable to the oil yield previously reported [5, 30]. The oil yield with the highest of 75.97% was observed for walnut roasted at 130˚C. This was most likely caused by some protein denaturation, which enhanced the oil extraction ability of walnut [31]. However, it was shown that when walnuts were roasted at 70 and 100˚C (68.01% and 68.42%, respectively), the oil yield reduced.

The oil yields roasted in the microwave oven ranged between 70.54 and 73.60%. It was found that microwave-roasted walnut kernels produced more oil than raw walnut kernels (control). The microwave treatment could modify the cell wall and increase cell permeability. This makes it easier for oil to move through cell walls [32]. However, no significant difference was found between the oil yield of walnuts roasted at 240W and the control. The oil content of walnuts roasted at 535 W and 830 W was higher than the control group, and it was observed that the difference between them was insignificant.

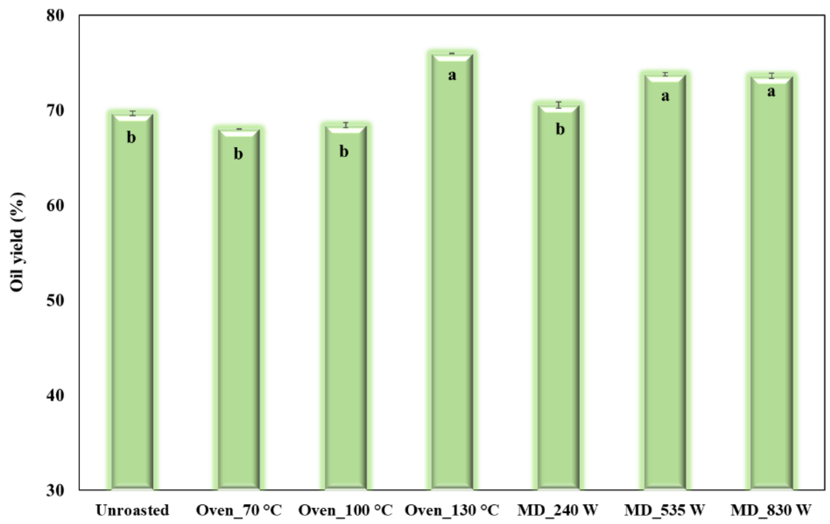

Figure 4. Variation of oil yields under different roasting conditions

4 Conclusion

In this study, it was determined that the moisture content decreased as the temperature or microwave power increased in oven and microwave roasting methods. The lowest moisture content was obtained with oven roasting. It is thought that this may be the reason why oven roasting takes much longer than microwave roasting. When the oil yield of walnut kernels roasted in the oven and microwave is examined; It was determined that the highest oil yield was at the highest temperature applied in the oven and at the two highest power of the microwave. Some protein denaturation, which increases the walnut's ability to extract oil, may be the cause. Different oven temperatures, microwave powers and application times did not statistically change the total phenolic content of walnut samples. However, when the values were compared, a higher amount was obtained in the sample treated at 830 W microwave power. This may be due to the low time used during microwave roasting. Similar to the total phenolic content results, it was observed that different temperatures, microwave powers and application times did not change the antioxidant activities of walnut samples. During roasting, significant changes in the antioxidant capacity of foodstuffs can occur as a result of the breakdown of some heat-stable antioxidant compounds or the formation of new compounds with potential antioxidant activity by the Maillard reaction. However, it can be said that low oven temperature, microwave power and times may have prevented these events. It has been concluded that the applied roasting processes can increase the water loss, while maintaining the antioxidant properties of the unroasted product.

Ethics in Publishing

There are no ethical issues regarding the publication of this study.

Author Contributions

All authors have participated in (a) conception and design, or analysis and interpretation of the data; (b) drafting the article or revising it critically for important intellectual content; and (c) approval of the final version.

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