EFFECT OF ARTIFICIAL DRYING AIR TEMPERATURE ON STABILITY OF THE MAJOR TURKISH HAZELNUT VARIETY, TOMBUL

MEKANİK KURUTMADA HAVA SICAKLIĞININ ÖNEMLİ TÜRK FINDIK ÇEŞİTLERİNDEN TOMBUL'UN KALİTESİNE ETKİSİ

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ABSTRACT: To investigate the effect of artificial drying on the stability of the major Turkish hazelnut variety, Tombul and to determine the optimum drying air temperature, hazelnuts were dried at 35°C, 40°C, 45°C and 50°C. Changes in fat content, fatty acid composition, free fatty acid content, iodine value, degree of unsanturation and rancimant value were investigated. Oil content, linoleic acid ($C_{18:2}$), Palmitic acid ($C_{16:0}$) and stearic acid ($C_{18:0}$) content were not significantly effected by the drying air temperatures. Oleic acid ($C_{18:1}$) content significantly differed between dried samples and undried samples, but not between dried samples. Relative proportion of the linoleic acid, palmitic acid and stearic acid decreased, but that of oleic acid increased as the drying air temperature increased. FFA content was not significantly affected at drying air temperatures of 35°C and 40°C. Rancimant value was highest in the undried samples, followed by the sample dried at 35°C. Rancimat value did not differ between 40°C and 45°C. The results pointed out that drying air temperature below 45°C is necessary not to disturb stability of the major Turkish hazelnut variety, Tombul.

ÖZET: Mekanik kurutmada hava sıcaklığının, önemli Türk fındık çeşitlerinden Tombul üzerindeki etkisinin araştırılması ve en uygun kurutma sıcaklığının belirlenmesi amacıyla, fındıklar 35°C, 40°C, 45°C ve 50°C'de kurutulmuşlardır. Toplam yağ, yağ kompozisyonu, serbest yağ asitliği, iyot sayısı, doymamışlık derecesi ve ransimat değerinde meydana gelen değişiklikler incelenmiştir. Kurutulmuş fındıklarda toplam yağ, linoleik asit ($C_{18:2}$), palmitik asit ($C_{16:0}$) ve stearik asit ($C_{18:0}$) miktarlarında istatiksel açıdan bir değişiklik gözlenmezken, oleik asit ($C_{18:1}$) miktarı, kurtulmamış fındıklara göre istatiksel olarak değişmiştir. Linoleik asit, palmitik asit ve stearik asitin oransal miktarları kurutma sıcaklığı arttıkça azalırken, oleik asitinki artmıştır. 35°C ve 40°C'deki kurutma sıcaklıklarının serbest yağ asitliği üzerindeki etkileri arasında istatiksel bir fark bulunamamıştır. 40°C ve 45°C'deki kurutma sıcaklıklarının ransimat değeri üzerindeki etkileri arasında da istatiksel bir fark bulunmazken, ransimat değeri kurutma sıcaklığı artıkça azalmışır. Bu sonuçlar, 45°C'nin altındaki kurutma sıcaklığının, önemli Türk fındık çeşitlerinden Tombul çeşidinin acılaşmaya olan dayanıklığınını etkilemediğini göstermektedir.

INTRODUCTION

Turkiye produces about 550, 000 t of hazelnuts annually which are about 80% of the world's hazelnut production, and exports 75% of its production with a value of one billion US dollars (AKDAĞ and ÖZTÜRK, 1993). Among cultivated Turkish hazelnut varieties, Tombul is the most widespread one (1/3 of the all production rate) (ANONYMOUS, 1995).

Drying in a reasonable time to safe moisture levels (<6%) is the one of critical points in the hazelnut processing besides harvest, storage, cracking, roasting, packaging and transportation (HEPERKAN, 1996; ÖZDEMİR *et.al.*, 1998). Traditionally, hazelnuts are harvested and susbsequently sun-dried on the ground in two stages. During the first stage, hazelnuts are dried from 40-30% moisture content to a moisture content of 20-15% in about 5 to 10 days depending on the weather conditions. Then, husk of the hazelnut shell is removed mechanically. During second stage of the sun-drying, hazelnuts are dried to 6% moisture content. Total drying period is about 15 to 30 days depending on weather conditions. Sun-drying on the ground enhances fungal load of the hazelnuts and the risk of mycotoxin formation due to mould growth (EKE and GÖKTAN, 1987). Microbial activity related quality losses were also reported for rice and peanut (PETIT et al.,

1971; SINGARAVADIVEL and ANTHONI, 1983; THAI *et al.*, 1990) Artificial drying of hazelnuts may prevent mould growth and related mycotoxin formation (ÖZDEMİR *et.al.*, 1998). However, adverse processing conditions was stated to accelerate rancidity development in nuts (BONVEHI and COLL, 1993; BEUCAHT and WORTHINGTON, 1978; FORBUS and SENTER, 1976; ST. ANGELO *et.al.*, 1979; PERREN and ESCHER, 1996a, b; PERREN *et al.*, 1996; ÖZDEMİR and ÖZİLGEN, 1997, ÖZDEMİR, 1998a, b). Like other nuts, hazelnuts contain high amount of oil (around 65% oil). Moreover, unsaturated fatty acids, namely oleic acid ($C_{18:1}$) and linoleic acid ($C_{18:2}$) constitute about 80% and 10% of the hazelnut oil, respectively (BONVEHI and COLL, 1993; GARCIA *et al.*, 1994; BAŞ *et al.*, 1996; ÖZDEMİR *et al.*, 1998b). Due to its high amount of unsaturated fatty acid content, hazelnut is susceptible to rancidity. Therefore, it is important to not to affect oil stability of the hazelnuts during artificial drying of hazelnut. Hence, the objective of the study was to investigate the effect of artificial drying air temperature of 35°C, 40°C, 45°C, and 50°C on the stability of the major Turkish hazelnut variety, Tombul and to determine optimum drying air temperature. This knowledge is important for the hazelnut producers and the industry not to bring about rancidity related problems during the artificial drying of hazelnuts.

MATERIALS AND METHODS

Materials

Samples of 2 kg of Tombul, the major Turkish hazelnut variety, was artifically dried for about 16 hr at constant temperatures of 35°C, 40°C, 45°C, 50°C and air flow rate of 0.8 m/s in a pilot scale cabinet dryer (Pasilac, APV, England). After cooling and moisture content analysis, the samples were preserved at - 30°C until other analyses.

Physico-chemical anlysis

Oil extraction: Oils were extracted from crushed hazelnuts as described in IUPAC (1979) using light petroleum ether (b.p. 40-60°C). The extracted oils were kept at -30°C until analysed.

Gas Choromotograhic analysis: The fatty acid methly esters of total lipids were obtained by direct trans methylation according to a standard method (AOCS, 1990).

Chromatograhic conditions: Gas liquid chromatography (GLC) of the methly esters was conducted on a GLC apparatus (Phlips Pye Unicam, Model SP 4500 Capillary, Germany) with a flame ionisation detector. The carrier gas was helium at a flow rate of 1-1.5 ml/min. A capillary column, Supelco SP2340 (60 m x 0.25 mm i.d.) was used for the fatty acid analyses. Injector and detector temperatures were 240°C and 250°C, respectively while column temperatures were increased from 170°C to 210°C with a rate of 8°C/min. Amount of injection was 0.3 µl. Fatty acids were identified by comparison with retention times of known standards.

Iodine Value (IV): Standard methods were used for the determination of iodine number (Wijs Method) (AOCS, 1990)

The degree of unsaturation (DU): The degree of unsaturation (DU) were calculated according to the following formula (PORZUCEK and RAZNIKIEWICZ, 1990) where ol, ln, lno stand for oleic, linoleic, and linolenic acids, respectively.

$$DU = (ol + ln \times 2 + lno \times 3) / 100 \qquad (E.1.)$$

Free fatty acid (FFA): Standard methods were used for the determination of FFA (AOCS, 1990).

Rancimat value (RV): Approximately 2.5 g of the extracted oil was heated for 10 min at 120°C in the Rancimat heating block (E617 Methrom Rancimat A.G. model, Switzerland) with air flow rate

of 10 ml/min. The dry air feed and the collection vessel were then connected. After that, the measurement of the conductivity curve continued until the breaking point which was equal to the induction time (hr) (HADORN and ZURCHER, 1974).

Statistical Analysis: Analysis of variance, multiple range least significant difference (LSD) test and correlation analysis were carrying out using a statistical package program (SPSS ver. 5.0) for $p<0.05$ significance level.

RESULTS and DICCUSSION

Results of fat content and fatty acid composition of the samples are shown in Table 1. Analysis of single factor ANOVA showed that there was a not significant difference between the treatments for fat content. The analysis also pointed out that there was a significant difference between the treatments for oleic acid content ($p= 0.033$). LSD test pointed out that oleic acid content did not significantly differ between dried samples but significantly differed dried samples and undried sample. Previously, oleic acid auto-oxidation was stated to be the biggest sources of the rancid substances in hazelnuts (BERGNER *et al.*, 1974; GROSCH *et al.*, 1983; KEME *et al.*, 1983a). Although there was no significant difference between treatments for linoleic acid, stearic acid and palmitic acid, relative proportion of the linoleic acid, palmitic acid and stearic acid decreased as the drying air temperature increased (Table 1). Changes in fatty acid composition was reported to be indirect measurement of lipid oxidation (MELTON, 1983; MASKAN ve KARATAŞ, 1998). Therefore, these changes can be related with the development of rancidity. Similar results were reported for storage of raw pistachio nuts (MASKAN and KARATAŞ, 1998).

FFA is measure of hydrolytic rancidity. FFA above 0.7% indicates onset of rancidity (RADTKE and HEISS, 1971; HADORN *et al.*, 1977; KEME *et al.*, 1983b). Although, ANOVA analysis showed a significant difference between the treatments for FFA ($p=0.0002$), FFA did not significantly differed between drying air temperature of 35°C and 40°C (Table 2). Drying air temperature of 45°C and 50°C resulted in FFA above 0.7%.

RV may be used as a measure of auto-oxidation. The ANOVA analysis pointed out that there was a significant difference between the treatments for RV ($p<0.0001$) (Table 2). RV was highest in undried sample (8.14), followed by the sample dried at 35°C (6.97). RV did not significantly differ

Table 1. The Mean (X) and Standard Deviation of Mean (SD) for Moisture Content, Fat Content, Fatty Acid Composition for Undried (control), and Dried Hazelnut Samples With Drying Air Temperatures of 35°C (T35), 40°C (T40), 45°C (T45) and 50°C (T50)[1].

					Fatty acid composition (% of oil)							
	Moisture (%)		Fat (%)		$C_{16:0}$		$C_{18:0}$		$C_{18:1}$		$C_{18:2}$	
Code	X	SD	X	SD	X	SD	X	SD	X	SD	X	SD
Control	13.5	0.20^{z}	64.1	0.40^{t}	7.86	1.03^{tv}	2.18	0.43^{t}	79.5	1.94^{t}	10.5	0.87^{v}
T35	4.99	0.04^{v}	65.6	1.09^{t}	6.82	0.07^{tv}	2.06	0.22^{t}	81.0	1.05^{t}	10.1	1.17^{v}
T40	3.63	0.01^{v}	65.3	2.89^{t}	7.38	0.36^{tv}	1.98	0.10^{t}	81.4	1.01^{vt}	9.22	0.57^{tv}
T45	2.57	0.55^{t}	65.7	0.66^{t}	6.61	0.73^{tv}	2.10	0.21^{t}	81.8	1.41^{vt}	9.47	0.48^{tv}
T50	3.52	0.11^{v}	66.7	0.88^{t}	5.98	1.55^{t}	1.91	0.38^{t}	83.5	0.89^{v}	8.58	0.35^{t}
P	<0.00001		N.S[2].		N.S.		N.S.		0.0044		N.S.	

[1] t, v, y, z homogeneous groups (rank test LSD).

[2] N.S. Not significant.

between 40°C and 45°C (Table 2). The results indicated that usage of higher drying air temperature brings about lower RV and subsequently lower stability to rancidity. It was also found that three was positive correlation between stearic acid and RV (r= 0.9403, p= 0.017), and negative correlation between oleic acid and RV (r= -0.9228, p = 0.025). The result showed that stearic acid contributes to the stability of hazelnuts but oleic acid decreases stability of the hazelnuts. Oleic acid was stated to oxidize 10 times faster than stearic acid (O'KEEFE *et al.*, 1993). The rates of oxidation of fatty acids for stearic acid ($C_{18:0}$), oleic acid ($C_{18:1}$), linoleic acid ($C_{18:2}$) and linolenic acid ($C_{18:3}$) was reported to be approximately 1:10:100:200, respectively (O'KEEFE *et al.*, 1993). DU and IV may be used shelf-life indicators, but there was no significant difference between the treatments for IV and DU (Table 2).

Table 2. The Mean (X) and Standard Deviation of Mean (SD) for Free Fatty Acid (FFA), Rancimat Value (RV), İodine Value (IV) and Degree of Unsaturation (DU) for Undried (Control), and Dried Hazelnut Samples With Drying Air Temperatures of 35°C (T35), 40°C (T40), 45°C (T45) and 50°C (T50)[1].

	FFA (%)		RV		IV		DU	
Code	X	SD	X	SD	X	SD	X	SD
Control	0.44	0.04^{t}	8.14	0.34^{t}	87.7	1.16^{t}	1.00	0.02^{t}
T35	0.45	0.32^{t}	6.97	0.46^{v}	88.3	1.53^{t}	0.97	0.05^{t}
T40	0.50	0.03^{t}	6.13	0.28^{y}	87.3	0.58^{t}	0.99	0.01^{t}
T45	0.98	0.28^{v}	6.05	0.23^{y}	87.5	0.50^{t}	1.00	0.01^{t}
T50	1.34	0.05^{y}	4.43	0.71^{z}	89.0	1.00^{t}	1.02	0.01^{t}
P	0.0003		<0.00001		N.S.[2]		N.S.	

[1] t, v, y, z homogeneous groups (rank test LSD).
[2] N.S. Not significant.

In summary, there was significant difference between dried samples and undried sample for oleic content. Relative proportion of the linoleic acid, palmitic acid and stearic acid decreased as the drying air temperature increased. Moreover, FFA content did not significantly differed at drying air temperature of 35°C and 40°C. RV was highest in the undried sample, followed by the sample dried at 35°C. It did not differ between 40°C and 45°C. Linoleic acid, palmitic acid, stearic acid content, degree of unsaturation and iodine value were not significantly affected by the drying air temperature. Therefore, drying air temperature below 45°C is necessary not to disturb stability, and not to decrease storage stability and shelf-life of Tombul variety. This results agrees with results of DUKE (1989) who suggested drying air temperature to be below 46°C for storing Turkish hazelnuts well and with CECIL and LITWILLER (1962) who suggested drying air temperature to be smaller than 50°C to prevent damage to nut meat.

CONCLUSION

Drying is one of the most critical steps during hazelnut processing. Improvement of the drying conditions of the hazelnuts would prevent quality losses, especially those related with microbial activity, and subsequently economic losses. Uses of artificial drying may achieve that goal. However, selection of drying temperature is of vital importance since high drying temperature would bring about rancidity. Our results indicate that a drying air temperature below 45°C is suitable to maintain stability of the major Turkish hazelnut variety, Tombul.

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