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CHANGES IN FATTY ACID COMPOSITION OF HAZELNUT DURING FRUIT DEVELOPMENT

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Abstract

Hazelnut is rich in monounsaturated fatty acids, particularly oleic acid. The fatty acid composition of hazelnut has gained a great deal of attention due to its health benefits. The aim of this study was to evaluate the changes in the fatty acid composition of the Turkish hazelnut cultivars (Tombul, Palaz and Sivri) during fruit development. Four major fatty acids (oleic, linoleic, palmitic, and stearic acids) and three minor fatty acids (palmitoleic, linolenic, and arachidic acids) were detected in all hazelnut cultivars during all stages. The monounsaturated fatty acids content of the Turkish hazelnut cultivars increased during fruit development, whereas the polyunsaturated fatty acids content decreased. These results indicated that the oxidative stability of hazelnut oil may be enhanced during fruit development.

Keywords: ***Fatty acids, fruit development, hazelnut***

FINDIKTA MEYVE GELİŞME DÖNEMİNDE YAĞ ASİTLERİ KOMPOZİSYONUNDAKİ DEĞİŞİMLER

Özet

Fındık oleik asit gibi tekli doymamış yağ asitleri bakımından zengindir. Fındığın yağ asidi kompozisyonu sağlık yararları nedeniyle önem kazanmıştır. Bu çalışmanın amacı, meyve gelişimi sırasında Türk fındık çeşitlerinde yağ asidi kompozisyonundaki (Tombul, Palaz ve Sivri) değişimleri değerlendirmektir. Tüm fındık çeşitlerinde tüm gelişim dönemlerinde, dört makro yağ asidi (oleik, linoleik, palmitik ve stearik asit) ve üç minör yağ asidi (palmitoleik, linolenik ve araşidik asit) tespit edilmiştir. Meyve gelişimi sırasında Türk fındık çeşitlerinde tekli doymamış yağ asitleri içeriği artarken, çoklu doymamış yağ asidi içeriği azalmaktadır. Bu sonuçlar, meyve gelişimi sırasında fındık yağının oksidatif stabilitesinin artabileceğini göstermiştir.

Anahtar kelimeler: Yağ asitleri, meyve gelişimi, fındık

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INTRODUCTION

Hazelnut (*Corylus avellana* L.) is a nut tree, mainly grown in the Black Sea region of Turkey, and southern Europe. The world's largest producer is Turkey, followed by Italy and the USA (1). Seventeen cultivars are known to be grown in Turkey, of which Tombul, Sivri, and Palaz are major commercial cultivars. Only the Tombul cultivar is sorted as prime quality. Sivri and Palaz cultivars are classified as the second grade in quality (2).

Hazelnut includes macronutrients (proteins, carbohydrates, and lipids) and micronutrients (vitamins and minerals). It also comprises of bioactive compounds (tocopherols, phytosterols, squalene, and phenolic compounds). This composition makes hazelnut a valuable food. Bioactive components of hazelnut may help to reduce the risk of heart diseases and cancers (3-4).

Research on the lipid characteristics of nut oils has gained attention recently. Hazelnut is rich in monounsaturated fatty acids (mainly oleic acid). This fatty acid composition may contribute to the beneficial health effects of hazelnut. An increase in the intake of saturated fatty acids may raise risk of the heart diseases and cancers. Therefore, the replacement of saturated fatty acids with unsaturated fatty acids is suggested (5).

The fatty acid composition of the Turkish hazelnut cultivars at the harvest stage has been investigated. However, there are limited reports on the fatty acid composition of the hazelnut during fruit development (6). Therefore, the aim of this study was to evaluate the changes in the fatty acid composition of the primary Turkish hazelnut cultivars during fruit development.

MATERIAL AND METHODS

Samples

Samples belonging to the Turkish native cultivars Tombul, Palaz and Sivri were collected from same orchard in the Giresun Province of Turkey (July-August 2012). The same marked trees were used for subsequent sampling. Hazelnuts were harvested at three stages: early stage (ES), July 8-15; middle stage (MS), July 22-30; and harvest stage (HS); August 12-30. Hazelnut samples were stored at -18°C until analyzed.

The orchard was not irrigated. Total rainfall was 128.3 mm in June, 113.1 mm in July, and 61.1 mm in August, according to the data taken from the Turkish Meteorological Institute.

Fatty acid composition

Oil was extracted using the Soxhlet method (using petroleum ether as a solvent). The fatty acid composition was determined according to the analytical methods described in the AOAC methods. Fatty acid methyl ester was injected into a Shimadzu GC-2010 Plus gas chromatograph equipped with a flame ionization detector, a split/splitless injector, and a long capillary column (0.25 mm x 0.20 µm x 60 m, Teknokroma TR-CN100). The oven temperature program was as follows: the initial temperature of the column was 90°C, held for 5 minutes, then a 10°C/min ramp to 240°C, and held for 20 minutes. The carrier gas was nitrogen at a flow rate of 60 ml/min, the split ratio was 50:1, and the injection quantity was 1µl. The identification of FAMEs was performed by using a standard FAME reference mixture.

Statistical analysis

Significant differences in the fatty acid composition among the maturation stages were evaluated using one-way analysis of variance (ANOVA). LSD analysis was applied to determine the differences among the maturation stages. SPSS 17.0 software (IBM Corporation, New York, USA) was used for the statistical data processing.

RESULTS AND DISCUSSION

The fatty acid composition of the hazelnut cultivars is presented in Table 1. Oleic acid, linoleic acid, palmitic acid, and stearic acid were the major fatty acids detected in the hazelnut cultivars. Palmitoleic acid, linolenic acid, and arachidic acid were the minor fatty acids found in the hazelnut cultivars. The minor fatty acids contributed less than 1% to the total fatty acid content. The fatty acid composition of the hazelnut cultivars at the harvest stage was comparable to those reported in the literature (3, 7, 8).

Oleic acid, a monounsaturated fatty acid, was the most abundant fatty acid found in the hazelnut cultivars. The oleic acid content through the maturation stages ranged from 79.6 to 86.0% in the Tombul cultivar, from 81.4 to 87.1% in the Palaz cultivar, and from 80.8 to 86.8% in the Sivri

Table 1- Fatty acid composition (%) of hazelnut cultivars from early stage to harvest stage

Fatty acid	Tombul		
	ES	MS	HS
Palmitic acid	4.92±0.03[a]	4.69±0.12[a]	4.66±0.08[a]
Palmitoleic acid	0.12±0.02[a]	0.10±0.01[a]	0.12±0.01[a]
Stearic acid	2.13±0.01[a]	2.13±0.04[a]	1.99±0.04[b]
Oleic acid	79.57±0.23[b]	85.73±0.25[a]	86.04±0.37[a]
Linoleic acid	12.43±0.02[a]	7.07±0.02[b]	6.99±0.28[b]
Linolenic acid	0.32±0.01[a]	0.10±0.01[c]	0.13±0.01[b]
Arachidic acid	0.14±0.01[a]	0.11±0.01[b]	0.10±0.01[c]
SFA	7.19±0.04[a]	6.92±0.16[ab]	6.74±0.11[b]
MUFA	79.69±0.25[b]	85.83±0.25[a]	86.16±0.37[a]
PUFA	12.74±0.01[a]	7.16±0.01[b]	7.11±0.27[b]
Fatty acid	Palaz		
	ES	MS	HS
Palmitic acid	5.44±0.04[a]	5.25±0.07[b]	5.09±0.01[c]
Palmitoleic acid	0.13±0.01[a]	0.13±0.01[a]	0.14±0.01[a]
Stearic acid	2.37±0.01[b]	2.51±0.02[a]	2.30±0.01[c]
Oleic acid	81.37±1.63[b]	87.15±0.13[a]	87.09±0.06[a]
Linoleic acid	9.02±0.04[a]	4.63±0.04[c]	4.90±0.04[b]
Linolenic acid	0.31±0.01[a]	0.18±0.01[b]	0.19±0.02[b]
Arachidic acid	0.17±0.01[a]	0.13±0.01[b]	0.12±0.01[b]
SFA	7.98±0.03[b]	7.88±0.04[b]	7.50±0.01[c]
MUFA	81.50±1.63[b]	87.28±0.13[a]	87.23±0.24[a]
PUFA	9.24±0.08[a]	4.76±0.13[c]	5.08±0.06[b]
Fatty acid	Sivri		
	ES	MS	HS
Palmitic acid	5.25±0.06[a]	4.79±0.05[b]	4.46±0.02[c]
Palmitoleic acid	0.12±0.01[a]	0.12±0.01[a]	0.10±0.01[a]
Stearic acid	1.73±0.01[c]	1.88±0.01[b]	1.93±0.01[a]
Oleic acid	80.78±0.28[c]	84.98±0.01[b]	86.78±0.12[a]
Linoleic acid	11.48±0.04[a]	7.89±0.09[b]	6.36±0.13[c]
Linolenic acid	0.28±0.01[a]	0.20±0.01[c]	0.22±0.01[b]
Arachidic acid	0.15±0.01[a]	0.11±0.01[b]	0.09±0.01[c]
SFA	7.12±0.06[a]	6.78±0.04[b]	6.47±0.01[c]
MUFA	80.89±0.28[c]	85.10±0.01[b]	86.88±0.11[a]
PUFA	11.67±0.08[a]	8.04±0.02[b]	6.58±0.12[c]

Different letters in the rows represent significant differences (P<0.05)
ES; early stage, MS; middle stage, HS; harvest stage
SFA; saturated fatty acids, MUFA; monounsaturated fatty acids, polyunsaturated fatty acids

cultivar. Linoleic acid was the predominant polyunsaturated fatty acid in the hazelnut cultivars. The linoleic acid content through the maturation stages varied from 12.4 to 7.0% in the Tombul cultivar, from 9.0 to 4.9% in the Palaz cultivar, and from 11.5 to 6.4% in the Sivri cultivar. Palmitic acid was the most abundant saturated fatty acid detected in the hazelnut cultivars, followed by stearic acid. The palmitic acid content through the maturation stages ranged from 4.9 to 4.7% in the Tombul cultivar, from 5.4 to 5.1% in the Palaz cultivar, and from 5.3 to 4.5% in the Sivri cultivar.

The oleic acid ratio of the hazelnut cultivars increased during the fruit development, whereas the linoleic acid ratio decreased (P<0.05). The change in the palmitic acid content of the Tombul cultivar was not statistically significant during the fruit development (P>0.05). However, a significant decrease was observed for the Sivri and Palaz cultivars (P<0.05). The stearic acid ratio of the Tombul and Palaz cultivars appeared to decrease from the early stage to the harvest stage. However, the stearic acid ratio of the Sivri cultivar increased from the early stage to the harvest stage. The linolenic acid ratio decreased from the early stage to the middle stage, while it seemed to increase from the middle stage to the harvest stage. The arachidic acid ratio of the hazelnut cultivars showed a decreasing trend during the fruit development, whereas no significant change was observed for the palmitoleic acid content.

Available data on the fatty acid composition of the hazelnut cultivars during fruit development was limited. Our results were compatible with Seyhan et al. (6). They reported that the monounsaturated fatty acid content of the Tombul, Palaz and Badem cultivars increased during the fruit development, whereas the polyunsaturated fatty acid content decreased. In our study, the monounsaturated fatty acid content of the Tombul, Palaz and Sivri cultivars showed an increasing trend, while the polyunsaturated fatty acid content exhibited a decreasing trend. Several enzymes, such as thioesterases, elongases, and desaturases are regulated by the demand of fruit tissues and take part in fatty acid biosynthesis (9). An increase in the monounsaturated fatty acid content may be attributed to the biosynthesis of oleic acid due to Δ9-desaturase activity. Stearoyl-ACP Δ9-desaturase is responsible for the formation of oleic acid by desaturation of stearic acid (10). The decreasing trend of the polyunsaturated fatty acid content may be related to a dilution effect. The quantity of linoleic acid may be constant while the level of oleic acid increased with the biosynthesis of triglycerides (11-12). Furthermore, lipoxygenase activity may have resulted in a reduction in the linoleic acid content. The ratio of oleic acid to linoleic acid improved from the early stage to the harvest stage. A high oleic acid to linoleic acid ratio is known to improve oxidative stability (13).

In conclusion, the fatty acid composition of hazelnut oil was related to the fruit maturation. The ratio of monounsaturated fatty acid to polyunsaturated fatty acid increased with the fruit maturation, which may also improve the oxidative stability of hazelnut oil. The high level of oleic acid during all stages of maturation revealed the high nutritional value of hazelnut oil.

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