Journal of Applied Botany and Food Quality 84, 61 - 64 (2011)

[1] Erciyes University, Engineering Faculty, Department of Food Engineering, Kayseri-Turkey
[2] Ege University, Engineering Faculty, Department of Food Engineering, Izmir-Turkey

Evaluation of tocopherol homologues of Turkish sesame seed (*Sesamum indicum*) cultivars grown in different locations

Hasan Yalcin[1*], M. Kemal Unal[2]

(Received July 23, 2010)

Summary

The tocopherol homologues of four different cultivars of sesame seed (*Sesamum indicum*, L.) samples, Golmarmara, Muganli, Ozberk and Camdibi, were determined in the present study. The major tocopherol homologue in all sesame seed of adapted cultivars was γ-tocopherol (744-1333 mg/kg). α-Tocopherol is very minute component of tocopherol content in all cultivars (1.54-3.61 mg/kg). Similarly δ-tocopherol was determined in very small amount (0.50-0.59 mg/kg) and β-tocopherol was not detected in sesame seed of any cultivar. The highest content of γ-tocopherol was found in Golmarmara cultivar grown in Menemen. There are significant differences in γ-tocopherol content among cultivars and cultivated locations in all sesame seeds. Sesame seed cultivars grown in Menemen contained also the highest α-tocopherol content compared to the same sesame seed cultivars grown in any other location.

Introduction

There is a world-wide trend to avoid or minimize the use of synthetic food additives, hence the use of natural antioxidants in foods is recently receiving special attention. Currently, food industry shows great interest in replacing synthetic antioxidants with natural alternatives due to safety concerns (MOHAMED and AWATIF, 1998). In this respect, many naturally occurring phytochemicals as being safe antioxidants to be used in food formulations have attracted much attention. In addition, not only the scientists but also the consumers have become more interested in natural antioxidants due to their antitumor, antimutagenic and anticarcinogenic properties (SHAHIDI et al., 2006). Therefore, obtaining antioxidants from natural sources and developing novel food products with maximum retention of endogenous antioxidants are very important (BRYNGELSSON et al., 2002).

Lipid oxidation plays an important role in the deterioration of foods during processing and storage. It has been known that sesame oil compared to other edible oils is very resistant to oxidative deterioration. This strong antioxidant activity was attributed to the antioxidative lignan-type compounds such as sesamin and sesamolin as well as to the presence of tocopherols (MOHAMED and AWATIF, 1998). Sesame contains several tocopherol homologues including α-tocopherol, δ-tocopherol, and γ-tocopherol. The tocopherols are lipophilic, phenolic compounds of plant origin and are the major constituents of vitamin E (BRIGELIUS-FLOHE and TRABER, 1999). They are free radical scavengers that act as antioxidant by aiding in the protection of polyunsaturated fatty acids from lipid peroxidation (WILLIAMSON et al., 2007). Lipid oxidation is believed to be an important factor involved in the progression of atherosclerosis in human body (STEINBERG et al., 1989). Compounds that prevent the oxidation of plasma lipids may therefore be capable of reducing the risk of coronary heart disease (WAEG et al., 1994). Hence these compounds are currently intensively investigated as ingredients used for the development of food products that may be capable of reducing risk of major diseases, e.g. coronary heart diseases, by reducing their risk factors (DACHTLER et al., 2003).

Tocopherol in sesame seed exists mostly as the γ-isomer, and sesame seed shows a slight vitamin E activity. However, like vitamin E, γ-tocopherol prevents aging (NAMIKI, 2007). YOSHIDA and TAKAGI (1999) found that sesamol has a synergetic action with γ-tocopherol. Sesamol increase the bioavaibility of the γ-tocopherol in sesame seed and hence γ-tocopherol is more effective in sesame seed oil than the other oils (WU, 2007).

Since the use of sesame as a nutraceutical has been increasing, the determination of tocopherol variability among sesame genotypes becomes more important. Considering the fact that tocopherols (α, δ and γ-tocopherol) are responsible for different pharmacological activities ascribed to *S. indicum*, it would be beneficial to characterize the variability in content of tocopherols for the identification of superior sesame genotypes. The objective of the present study was to determine the contents of α, δ, and γ-tocopherols in diverse Turkish *Sesamum indicum* cultivars of different geographic origin. This is the first report concerning the levels of tocopherol homologues in 4 sesame genotypes developed in the West Mediterranean Agricultural Research Institute (WMARI) in Antalya, Aegean Agricultural Research Institute (AARI) in Menemen, and Aegean University Agriculture Faculty (AUAF) in Bornova in Turkey.

Materials and methods

Materials

Four different cultivars of sesame seed (*Sesamum indicum* L.) samples, Golmarmara, Muganli, Ozberk and Camdibi, were used in this research. Golmarmara cultivar was obtained from three different regions of Turkey; WMARI in Antalya, AARI in Menemen, and AUAF in Bornova. Muganli and Ozberk cultivars were obtained from WMARI and AARI. Camdibi cultivar was obtained only from WMARI.

Tocopherol standards were obtained from Sigma Chemical Company (St. Louis, MO, USA). All reagents used were HPLC-grade (Merck).

Methods

Oil Extraction

Sesame seed oil was extracted with hexane at 20°C for 72 hours; then filtered. This process was repeated three times using fresh solvent each time in order to extract most of the oil from sesame seeds. Miscella was collected, mixed and evaporated at 50°C under vacuum. Then the extracted oil was dried using anhydrous sodium sulphate.

Tocopherol Analysis

Tocopherol variants were analyzed according to the method suggested by CARPENTER (1979). μ-porasil column with 30×0.39 inside diameter installed on Hewlett Packard 1050 model HPLC with

* Corresponding author

absorbance dedector (295 nm) was used for tocopherol analysis. For isocratic separations, the mobile phase consisted of 99% n-hexane and 1% isopropyl alcohol with flow rate 1.4 mL/min.

Statistical Analysis

Two way analysis of variance (ANOVA) and Duncan's multiple range tests were applied to determine significance of differences among means by using a statistical package program (SPSS ver. 15.0) for $p<0.05$ significance level.

Results and discussion

Sesame seed plays an important role in human nutrition. Its seeds are used essentially for the production of oil. Normally, although vegetable oils are refined to improve color and to remove sediments and objectionable odors, virgin olive and sesame oils are exceptions, and both could be used directly. Sesame seed is used in the production of the paste and Halvah. It is also used as confectionary and medicinal ingredient. For this reason the amount of tocopherol is important in raw sesame seed.

The results showed that the major tocopherol homologue in all sesame seed oil of adapted samples was γ-tocopherol (Tab. 1). α-Tocopherol and δ-Tocopherol were found as small components of tocopherol content in all cultivars (Tab. 2, 3). β-tocopherol was not detected in sesame seed oil of any cultivar. The highest γ-tocopherol content was found in Golmarmara cultivar grown in Menemen whereas the same cultivar had the lowest γ-tocopherol content for the sample grown in Bornova. This cultivar was improved by the AARI which was established in Menemen. This research institute adapted this cultivar in Menemen condition. It indicates that the location of cultivation for the content of γ-tocopherol of sesame seed is as important as sesame seed cultivars for the content of γ-tocopherol. On the other hand all cultivars grown in Menemen generally have high γ-tocopherol content implying that cultivation area of the Menemen, Turkey is ideal for the production of sesame seed containing highest level of γ-tocopherol. Significant differences were found in γ-tocopherol content between cultivar and location for all sesame seed samples. Among the samples procured from Antalya region, Ozberk and Muganli cultivars had the highest and lowest γ-tocopherol content, respectively and Golmarmara cultivar had a value in between. Again, the results indicate the importance of adaptation of the cultivar for a specific location. This is the case for sesame seed cultivar of Ozberk which was adapted by WMARI for Antalya region. Sesame seed cultivars grown in Menemen had also the highest α-tocopherol contents compared with the same sesame seed cultivars grown in other locations. The lowest α-tocopherol content was observed in the sesame samples cultivated in Bornova. The lowest tocopherol levels of samples grown in Bornova showed that this region is not suitable for the production of sesame seeds having highest tocopherol homologues content. Although the range of γ-tocopherol levels of cultivars grown in Menemen was found higher compared to other studies, the levels of other tocopherol homologues were similar (YOSHIDA, 1994; NAMIKI, 2007; WILLIAMSON, 2007; CREWS, 2006; AUED-PIMENTEL, 2006). The positive effect of Menemen cultivation area was seen on α-tocopherol content of sesame seeds as it was seen on γ-tocopherol content. These results showed that cultivation area of the sesame seeds is very important in terms of tocopherol content. δ-Tocopherol contents of sesame seeds were observed in very small amounts which were not more than 1. The low level of δ-tocopherol contents of sesame seed samples generally agrees with other studies. However, only YOSHIDA et al. (1995) reported high level (20.5-13.6 mg/kg) of δ-tocopherol and α-tocopherol (3.8-5.2 mg/kg) in three cultivars of Japanese sesame seed. They also reported that the major tocopherol homologue in these seed was γ-tocopherol ranged from 468.5 to 517.9 mg/kg oil. YOSHIDA and TAKAGI (1997) investigated the effect of seed roasting on tocopherol content of sesame seed and they found 392-663 mg/kg γ-tocopherol in unroasted sesame seed and reported on the reduction of γ-tocopherol content by increasing the roasting temperature. In another study, YOSHIDA (1994) reported that γ-tocopherol was still retained over 900 mg/kg of the original level after roasting. The quantitative analysis of lignan and tocopherol profiles from 21 sesame seed samples were carried out by HEMALATHA and GHAFOORUNISSA (2004). γ-tocopherol was the only isomer detected in sesame seeds. Wide variations of γ-tocopherol levels (190-800 mg/kg) were observed in this study. RYAN et al. (2007) determined the levels of tocopherols in selected grains, seeds, and legumes grown in Ireland. While they found 100 mg/kg of γ-tocopherol in sesame seed which is quite very low for sesame, they did not determine other tocopherol homologues. CREWS et al. (2006) determined the tocopherol content

Tab. 1: γ-Tocopherol content of sesame seed (mg/kg)

Cultivar	Cultivated Area		
	Antalya	Menemen	Bornova
Golmarmara	982±11 B, b	1333±23 A, a	744±13 c
Muganlı	776±12 D, b	1064±22 B, a	-
Ozberk	1145±33 A, a	1012±10 C, b	-
Camdibi	872±12 C	-	-

Mean ± standard deviation
Different lowercase letters indicate the statistical difference in the same line ($p<0.05$)
Different uppercase letters indicate the statistical difference in the same column ($p<0.05$)

Tab. 2: α-Tocopherol content of sesame seed (mg/kg)

Cultivar	Cultivated Area		
	Antalya	Menemen	Bornova
Golmarmara	2.19 ± 0.11 B, b	3.61 ± 0.12 A, a	1.54 ± 0.06 c
Muganlı	2.31 ± 0.05 B, b	3.18 ± 0.11 B, a	-
Ozberk	2.71 ± 0.03 A, a	2.89 ± 0.19 C, a	-
Camdibi	1.96 ± 0.09 C, -	-	-

Mean ± standard deviation
Different lowercase letters indicate the statistical difference in the same line ($p<0.05$)
Different uppercase letters indicate the statistical difference in the same column ($p<0.05$)

Tab. 3: δ-Tocopherol content of sesame seed (mg/kg)

Cultivar	Cultivated Area		
	Antalya	Menemen	Bornova
Golmarmara	0.50±0.01 B, b	0.52±0.02 B, b	0.58±0.03 a
Muganlý	0.59±0.02 A, a	0.57±0.02 A, a	-
Ozberk	0.51±0.005 B, b	0.57±0.005 A, a	-
Camdibi	0.59±0.005 A, -	-	-

Mean ± standard deviation
Different lowercase letters indicate the statistical difference in the same line ($p<0.05$)
Different uppercase letters indicate the statistical difference in the same column ($p<0.05$)

of sesame seed oils obtained from seeds collected from five different countries. They reported that the only tocopherol detected in the sesame seed was γ-tocopherol ranged from 410 to 717 mg/kg. AUED-PIMENTEL et al. (2006) determined tocopherols to detect adulteration of sesame seed oils sold in Brazil. For this reason 5 samples were analysed for tocopherol and other compositional parameters by them. They found 160-570 mg/kg γ-tocopherol in commercial sesame seed oils. RANGKADILOK et al. (2010) reported tocopherol contents of sesame seed oil in the range of 304-647mg/kg in Thailand.

The existence of tocopherol in sesame seed is more important than for other oilseeds because sesaminol is able to effectively increase the availability of tocopherols in biological systems (OSAWA, 1999). γ-Tocopherol is a more potent antioxidant in oils, but it has a lower vitamin E value than α-tocopherol in biological systems (BURTON and TRABER, 1990). YOSHIDA and TAKAGI (1999) found that sesamol has a synergistic action with γ-tocopherol. To assess the effect of sesame seed oil on the induction period of sunflower oil oxidation, an extensive series of rancimat experiments have been conducted by DACHTLER et al. (2003). They reported that the increased oxidative stability of the sesame seed oil-enriched sunflower oil might be due to antioxidant activity of γ-tocopherol and sesaminol. SHIELA et al. (2004) increased the stability of groundnut oil by adding the sesame seed oil (863 mg/kg total tocopherol) (AUED-PIMENTEL et al., 2006). MOHAMED and AWATIF (1998) determined the effect of sesame seed oil which has 540 mg/kg tocopherol content, on the stability of sunflower oil. They observed that the antioxidative effect increased when the amount of sesame seed oil increased gradually. They point out that sesame seed oil possess antioxidant properties and could be used as alternative natural antioxidants with wide food application. CHU and KUNG (1998) reported that crude sesame seed oil blended with soybean oil improved the quality of the oil blend during storage at 60°C as compared with single soybean oil. This may be sourced by synergistic action of tocopherol and sesamol found in sesame seed oil (YOSHIDA, 1994). Oxidative stability of oils does not only depend on the tocopherol content but also degree of saturation. For example, flax oil has a significant amount of tocopherol, its high level of polyunsaturated fatty acid content reduces its stability. Although safflower oil has almost 2/3 times more tocopherol content than poppy oil; its oxidative stability value is half of poppy oil induction period (BOZAN and TEMELLI, 2008).

Effects of germination of sesame seeds on their composition were investigated by HAHM et al. (2009). They found that concentration of tocopherol increased as germination proceeded. Therefore it is quite likely that harvesting period of sesame seed has a significant influence on tocopherol content of sesame seeds.

To conclude we observed that cultivar and cultivation area have significant influence on the composition of tocopherol homologues of sesame seed and also some of new adapted sesame seed cultivars were found as suitable in terms of high tocopherol content.

Acknowledgements

The authors express thanks to WMARI, AARI and AUAF for supply of the materials and Scientific Research Fund of Aegean University for the financial support.

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Address of the authors:
[1*] Hasan Yalcin, Erciyes University, Engineering Faculty, Department of Food Engineering, 38039, Kayseri-Turkey, hsnyalcin@hotmail.com, Tel: (90 352) 4374901/32731, Fax: (90 352) 4375784
[2] M. Kemal Unal, Ege University, Engineering Faculty, Department of Food Engineering, 35100, Izmir-Turkey