Antioxidant Activity and Compounds of Indonesian Sesame (*Sesamum indicum* L.) Oil

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Sesame (Sesamum indicum L.*) is an important oilseed crop in the world, which can be well cultivated in Indonesia. Roasting is an important step for obtaining sesame oil from the seed. The aims of this study were to evaluate the effect of roasting, on (i) oil yield, and (ii) antioxidant activity and compounds in the oil. The roasting of the sesame seed were carried out at 180^{0}C) for 30 minutes). The roasted and unroasted seed were then pressed using hydraulic press at 140 kN for 5 minutes for obtaining the oil. The produced oil were evaluated for oil yields, the antioxidant activity, total phenolic compounds, α-tocopherol, sesamin, sesamolin, and sesamol contents of the oil. It was found that the oil yield, antioxidant activity and compound of the oil were significantly affected by roasting. The oil yields for unroasted and roasted sesame seed were 23.91 and 36.63 %, respectively. Roasting found not to affect the total phenolic compound, but increase the antioxidant activity of roasting oil almost as twice as in unroasting oil. Roasting may lowered the α-tocopherol and sesamolin contents in the oil, but increased the sesamol content. To some extent roasting of this seed also increase the degree of liking to the oil.*

***Keywords**: roasting, sesame oil, antioxidant activity, total phenolic compounds, lignans, α-tocopherol*

INTRODUCTION

Sesame (*Sesamum indicum* L.) seeds contain approximately 50% of oil and 25 % of protein, therefore it is reported as the most ancient oilseed known and used by human as a food source. It has been cultivated for centuries in Asia and Africa, for its high content of excellect quality of oil and protein. There are many kind of sesame seed in term of their colour, white, black, brown, and yellow seeds. Beside they are used as oilseeds, they also used as ingredient of some food. Ministry of Agriculture of the Republic of Indonesia, through *Balai Penelitian Tanaman Tembakau, Serat dan Kapas*, has released 4 varities of sesame plant, namely Sumberrejo1, Sumberrejo 2, Sumberrejo 3, and Sumberrejo 4.

As other oil seed, the most utilization of this seed is for vegetable oil source, and was reported as the sixth important oil seed in the world production (Lee, *et al*., 2010). Among the commonly used vegetable oils, sesame oil is known to be the most resistant to oxidative rancidity although it has high content of oleic and linoleic acid in the triglyceride. Its remarkable stability has reported due to the high content of sesamin, sesamolin, sesaminol, sesamol, and α-tocopherol (Fukuda, *et al*., 1986). Sesamin showed antioxidant activity (Yamashinta, *et al*., 2000 in Jeong, *et al*., 2004), anticarcinogenic (Hirose, *et al*., 1992 in Jeong, *et al*., 2004), blood pressure lowering (Matsumura, *et al*., 1998 in Jeong, *et al*., 2004), serum lipid lowering effects (Hirose *et al*., 1991 in Jeong, *et al*., 2004) in experimental animals and humans. Therefore, the occurence of this compound in sesame oil make sesame oil become more valueable. The process for sesame oil preparation involves cleaning, optionally dehulling, roasting, optionally grinding and pressing. Roasting is the key processing step that affect the color, composition, quality and stability of the oil produced (Yen and Shyu, 1989). Jeong *et al*. (2004) reported that roasting sesame seed at 200^{0}C for 60 minutes significantly increased the total phenolic content, radical scavenging activity,

reducing power and antioxidant activity in sesame meal extracts. Tashiro and co-workers reported that different strain and cultication area resulted in diferent oil content and minor components in the oil. Therefore, this paper reports the effect of roasting on the oil yield, antioxidant activity, total phenolic compounds, α-tocopherol, sesamin, sesamolin, and sesamol contents of the yielded oil.

MATERIALS AND METHODS

Materials

Sesame seeds (*Sesamum indicum* L.) were purchased from local farmer in Klaten, Central Java. Sesamol dan α-tokoferol standards, metanol, ethyl acetate, acetonitril, DPPH, and Folin-Ciocalteau were purchased from Sigma-Aldrich Co. (St. Louis, MO, USA). sesamin and sesamolin were isolated from sesame oil according to Reshma *et. al.,* (2009).

Roasting and oil extraction

Whole and cleaned sesame seed (500 g) were roasted in modified cofee roasting machine at 180^0C, for 30 minutes. After roasting, the seed were allowed to cool until 80^0C prior to be pressed using hydraulic press at 140kN for 5 minutes. Two other portions of whole, cleaned and unroasted sesame seed (500 g for each portion) were prepared for heated at 80^0C and unheated prior to be pressed using hydraulic press at 140kN for 5 minutes. The oils were allowed overnight at room to precipitate the impurities and the clear oil were decanted, stored at cool room until they were required for analysis.

Isolation and crystalization Sesamin dan Sesamolin

Isolation dan crystalization sesamin dan sesamolin was carried out according to reported by Reshma *et. al.,* (2009). Sesame oil (100 g) was dissolved in methanol (1:1 w/v) followed by heating at 70^oC for 10 minutes. This mixture was then, cooled to 50^oC, and allowed until 2 separate layer was formed in the separating funnel. The methanol layer was evaporated in rotary evaporator for removing the solvent. The concentrated methanol extract eas then partitioned into petroleum ether (1:2 w/v) and was keep at 4^oC for 48 hours until crystal of lignan was formed. The formed crystal was then dried in oven at 35^oC for 30 minutes fofr removing the solvent residue, followed by HPLC analysis.

Analysis of sesamol, sesamin, and sesamolin

Sesamol, sesamin and sesamolin and was analyzed by reverse phase HPLC using C18 column (150 x 4,6 mm) equiped with Rheodyne 7125 injector with 20 µl sampel loop and ultraviolet visible SPD-10A detector and was set at λ 290 nm. The mobile phase was methanol/water (70:30 v/v) at flow rate of 1 ml per minute. Sesamol, sesamin, and sesamolin in oil were quantified using calibration curve of standard sesamol and isolated sesamin and sesamolin, respectively.

Measurement of tocopherols content

Tocopherol analysis was carried out according to method repored by Aued-Pimental *et. al.,* (2006). The measurement of tocopherol was done using Shimadzu LC-10AD HPLC, equipped with a Shim-pack CLC-SIL 60 column (5µm, 150 x 4,6 mm id Shimadzu), Rheodyne injector having 20 µl sample loop, detector fluoresense (RF-10AXL) and was set at an exitation □of 300 nm and emissin □ of330 nm. The mobile phase was a mixture of hexane/ethanol (99,5 : 0,5 v/v) at a flow rate of 1.0 mL min^{-1}. Fifty mg of oil was dispersed in 5 mL of mobile phase for HPLC analysis. An aliquot sample solution was injected with fully 20 □ Ьloop. Quantification of tocopherols in oil is calculated using calibration curve of standard □ tocopherol

Measurement of total phenolic content

Measurement of total phenolic content was carried out according to Sahidi *et al*. (2004). Folin-Ciocalteau reagent (0.5 mL) was added into 0.5 mL of homogenized mixture of sesame oil and methanol (1:1 v/v), followed by addition of 1mL of saturated sodium carbonate solution. The volume of this solution was made up to 10 mL with distilled water and homogenized using a vortex mixer, and was incubated at room temperature for 45 minutes, prior to measurement of the absorbance at □ of 765 nm. The total phenolic compounds was expressed as miligram of gallic acid per gram sample using calibration curve of absorbance of methanolic gallic acid solution.

Measurement of antioxidant activity

The Antioxidant activity was expressed as free radical DPPH scavenging activity and was determined using a method reported by Suja *et. al.,* (2003). Methanolic solution of DPPH (3 mL of 0.025 g/L) was added into 1 mL of 5% methanolic sample solution and incubated at room temperature for 30 minutes, proir to be measurement of the absorbance at □ of 515nm.

Radical scavenging activity (%) = [1- {sample absorbance/control absorbance}] x 100.

RESULTS and DISCUSSION

Oil Yield

Table 1. Oil yield prepared by pressing of roasted and unroasted seed

Seed treatment	***Oil Yield* (% db)**
Roasting 180 ^{o}C 30 min	41.1^{c}
Without roasting	39.7^{b}
Without heat treatment	23.9^{a}

Each value is an average of three replicates determination.
Values with different following letters are significantly different (p<0,05)

Table 1 represent the oil yied prepared from roasted seed and unroasted seed, showing that heat treatment is needed for preparing seed for oil pressing. Roasting resulted in increasing the oil yield. Heat treatment is normally apply to oil seed prior to oil extraction, either by solvent extraction or pressing. Heating the oil seed may reduce oil viscosity, inactivate enzume, coagulate protein, rupture cell wall and membrane and make the seed soft and more pliable or plastic during pressing. However, excessive heating may has disadvantage such as produce excessive fine during pressing which affect some difficulty in the oil production. It was found in previous study that roasting 180^{0}C for 30 facilitate oil pressing. Since the oil content of the seed is 53.92%, that mean, after pressing some of the oil remains in the oil cake.

Antioxidant components

Antioxidant component analyzed in this experiment including total phenolic compounds, α-tocopherol, sesamol, sesamin dan sesamolin, Table 2.

Table 2. Antioxidant content in the pressed sesame oil prepared from roasted and unroasted seed in comparison with that in commercial sesame oil.

Seed treatment	Total Phenolic Content (milligrams gallic acid per gram oil) x 10^{-3}	Content (ppm)			
		Sesamin	Sesamolin	Sesamol	α-Tocopherol
Roasted 180 °C 30 min	2.4[a]	6855.05[b]	3996.34[b]	64.71[a]	11,836.13[b]
Unroasted	3.3[ab]	6942.01[a]	4306.47[a]	12.38[c]	16,562.95[a]
Commercial sesame oil	3.5[b]	6439.70[c]	3198.98[c]	36.12[b]	12,598.99[b]

Each value is an average of three replicates determination.
Values in the same column with different following letters are significantly different (p<0,05)

Total phenolic content.

Roasting sesame seed at 180 °C for 30 minutes found not to lower the total phenolic content in the pressed oil, Tabel 2. However, commercial oil has slightly higher total phenolic compared to the oil prepared from roasted and roasted in this study. This facts may due to the differences of the oil preparation or the variety of the oil seed.

Tocopherol content

Roasting at 180 °C for 30 minutes also found to lower the α-tocopherol content. After roasting process the tocopherol content retained about 75%. It may be due to oxidation process occurs during roasting, during which seed contact to the oxygen in the air, then oxidation potentially occurs, and the antioxidant was oxidized first. This finding is agree with previous study (Yoshida and Takagi, 1997; Lee et al., 2010), reported that □ and □ tocopherols were also derease with roasting temperature and time, but they did not find a-tocopherol. This differences may be attributed to differences of seed variety or geographical area.

Sesamol, sesamin and sesaminol content

Table 2 reveals that roasting at 180 °C for 30 minutes increase the sesamol content around five fold, concersely the sesamin and sesaminol contents slightly decrease with roasting. This finding also agree with previous study as reported by Yoshida and Takagi (1997 and Lee *et al*. (2010). Roasting may liberate sesamol from sesamolin, therefore still contribute to antioxidant activity.

Antioxidant activity

The antioxidant activity of the oil was expressed as radical scavenging capacity, as shown in Table 3, roasting at 180 °C for 30 minutes increase the antioxidant activity around 40%.

Table 3. Antioxidant activity in pressed sesame oil prepared from roasted and unroased seed in comparison with commercial sesame oil

Seed Treatment	Antioxidant activity (%)
Roasted 180 °C 30 min	42.74[b]
Unroasted	30.14[a]
Commersial sesame oil	57.66[c]
BHT	74.68[d]

Each value is an average of three replicates determination.

The increase of antioxidant activity may attributed for the increase of sesamol. Lee et al. (2010) reported that the increase of sesamol content play an important role for the increase of antioxidant activity. The other reseacher stated that there is a sinergy effect of sesamol and tocopherols that also contribute to antioxidant activity (Fukuda *et. al.*, (1986) in Yoshida and Takagi (1999). During roasting, non-enzymatic browning reaction Maillard-type also occurs, the Maillard reaction product also has antioxidant properties (Choe and Min, 2006), therefore may also contribute to the antioxidant activity.

CONCLUSION

Heat treatment , either roasting or only heat treatment up to 80ºC of sesame seed prior to oil pressing has an important role for increasing oil yield. Roasting using a modified coffee roaster at 180ºC for 30 minutes lowered the a tocopherol, sesamin and sesamolin, conversely increase the sesamol content in the pressed oil. As a result this roasting process increased the antioxidant activity. This roasting process is quick and simple technique for preparing sesame oil with good antioxidant activity.

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