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EFFECT OF ROASTING AND BLEACHING PROCESSES ON WHITE AND DARK BROWN SESAME SEED OILS

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ABSTRACT

Extracted oils from sesame (*Sesamum indicum* L.)seeds of two varieties (white and dark) before and after roasting process at 150 and 200 °C for 30 min were investigated. Roasted sesame oil was treated with 2 % acid – activated clay at 100 °C for 10 min. Physical and chemical properties of treated extracted oils (refractive index, color, free fatty acid %, peroxide value, iodine number, unsaponifiable matter content), oxidative stability by Rancimat method at 100 °C ± 2 °C, α-tocopherol content were determined. Sesamin, sesamol and sesamolin were measured in sesame oil samples by High Performance Liquid Chromatography (HPLC) and fatty acid composition was analyzed by Gas Liquid Chromatography (GLC).The results indicated that roasted sesame oil led to a significant increase in refractive index, color, free fatty acid % and peroxide value and a decrease in iodine number and oxidative stability. Treatment of roasted sesame oil with the acid – activated clay greatly improved the quality of roasted sesame oil.

Key words: *Sesame oil, roasting, roasted –treated, α- tocopherol, sesamol, sesamin, sesamolin.*

INTRODUCTION

Sesame seed (*Sesamum indicum* L.) has long been regarded in the as a health food, which increases energy and prevents aging (Namiki, 1995). World production of sesame seed was about 3 million metric tons in 2004. The major producers were Indian, china, and

Myanmar with 21, 20 and 17 %, respectively, of the total (FAO, 2004). Sesame plant grows in tropical and subtropical regions with a dry and a rainy season. It is grown in many parts of the world today for its important uses as edible oil, spices, insecticides, medicines, soap, green manure and ornaments (Obiajunwa *et al*., 2005). Sesame oil has a pleasant flavor and regarded as a superior vegetable oil. It ranks second with regard to nutritional value after olive oil (Alpaslan *et al*., 2001).

The chemical composition of sesame shows that the seed is an important source of oil (50 – 60 %), protein (18 – 25%), carbohydrate and ash (Kahyaoglu & Kaya 2006). The oil is highly resistant to oxidative deterioration (Abou-Gharbia *et al*., 2000), This could be attributed to endogenous antioxidants (sesamol, sesamolin, and sesamin) together with tocopherols (Ali *et al.,* 2007). It is not only a good source of edible oil, but is also widely used in baked goods and confectionery products (Suja *et al.,* 2005). It is also considered as a good beneficial to health in oriental countries. Many scientific works have been undertaken to investigate the health promoting effects of sesame (Shyu & Hwang 2002 & Ide *et al*.,2003). Sesame seeds typically give a greater yield of oil than many other oil seeds. Its oil has a mild taste and is high in unsaturated fatty acid (approximately 85%). The oil requires little or no winterization for use as a salad oil and is used as cooking oil, for shortening, margarine, soap, and pharmaceuticals, and a carrier for insecticides (Adeemi *et al*., 2008).

The antioxidant action of roasted seed oil is stronger than that of unroasted seed, and large amounts of sesamol were produced during the roasting process (Kumazawa et al., 2003 & Ismael *et al*., 2004), but the antioxidant activity of sesamol alone was not strong enough to explain the strong activity of roasted sesame seed oil.

Sesamol is formed from sesamolin during the bleaching process of unroasted sesame seed oil, and that the antioxidant activity of refined unroasted seed oil is mainly attributed to sesamolin (Uzun *et al*., 2008).

Roasted sesame oil contains higher concentration of free fatty acids, which are proximate (Bayrak., 2003), than soybean oil or corn oil because of the absence of a refining process (Chung & Choe 2001). The dark brown color of roasted sesame oil sometimes makes food color less desirable and decreases consumer preference. To expand the use of roasted sesame oil in cooking, it is necessary to improve color, decrease free fatty acid contents. Bleaching gives light color to oil and remove some free fatty acids present in oil.

Sesame seeds used in processing of confectionery products such as (Tahina and Halawa tahinia).During roasting processing on sesame seed before processed the roasted was changed of bioactive components and physco-chemical properties of oil especially color in final products.

The purpose of this search was to study the effect of roasting and bleaching processes on the oils extracted from both white and dark brown seeds. Regarding the physico-chemical properties and contents of (α-tocopherols, sesamol, sesamin and sesamolin) and fatty acid composition.

MATERIALS AND METHODS

Materials

Source of sesame seeds: White and Dark sesame seed samples were obtained from local market in Cairo, Egypt.

Solvents: All solvent in this study were of analytical grade (Merck).

Reagents and standards: sesamol, sesamin, sesamolin and α-tocopherol standards were purchased from Sigma Chemical Co.(St. Louis, Mo).

Methods:

Roasting process: A Sesame seeds were roasted at 150 and 200 ^{o}C for 30 min in electric oven.

Chemical analysis of sesame seeds: Moisture, oil, protein, carbohydrate (by difference), fiber and ash were determined according to the method described in A.O.A.C. (2005).

Oil extraction: Sesame seeds before and after roasting were crushed and pressed by a laboratory hydraulic press. The extracted oils were dried over anhydrous sodium sulfate, filtered through whatman filter paper No. 1 and kept in brown bottles at 5 ^{o}C until analysis.

Treating of roasted sesame oil: Roasted sesame oil was treated by mixing oil with acid clay at 2 %, heating at 100 ^{o}C for 10 min. and centrifugation (3000 rpm) for 10 min.

Physico-chemical properties of oil: Refractive index, color, free fatty acid %, peroxide value, iodine number were determined according to A.O.A.C. (2005). The unsaponifiable matter was extracted after saponification of oil at room temperature according to A.O.A.C. (2000).Total tocopherol was analyzed using to the colorimetric method of Wong *et al*., (1988).

Determination of induction period with a Rancimat: Rancimat 679 (Metrom Ltd., CH 9100 Herisau, Seitzerland) was used for the determination of oxidative stability of oils. The induction time was automatically determine, i. e., the time from the start of the experiment to the inter section point (Mendez *et al*., (1996).

HPLC analysis of sesamin, sesamol, and sesamolin: Sesamin, sesamol and sesamolin were analyzed with a Perkin Elimer LC-290 HPLC. The oil was dissolved in hexane/ chloroform (2:1 v/v) and 10 ul samples were used for injections. Reversed phase separations were performed with a C18 column packed with ODS. The chromatograph was operated with a mobile phase of 70 % methanol in water at a flow rate 0.4 ml/ min. The amount of each compound present was determined by the peak height at 300nm with a UV detector. Peak identification was carried out by comparison of relative retention times with those reported by Kamal-Eldin *et al*., (1994).

Fatty acid composition: The fatty acid compositions of oils were determined by gas liquid chromatography according to the method of Farag *et al*., (1985).

Statistical analysis: All experiments were performed in triplicate and the results were analyzed by one-way analysis of variation (ANOVA) (Steel *et al*., 1995). Multiple comparison tests were performed to determine any significant differences ($P \geq 0,05$ among treatments.

RESULTS AND DISCUSSION

-Chemical composition of sesame seeds:

Results in Table (1) demonstrate differences in the chemical composition between the fresh white and dark brown sesame seeds. The moisture contents of white and dark sesame seeds ware 4.12% and 4.60 %, respectively. Sesame seeds are a good source of oil and protein, the highest percent of crude oil (49.71 %) was found in white sesame seeds, dark sesame seeds contained (47.48%) as crude oil.

These percentages are very high compared to those of other oil seeds such as sunflower (36.00 %), and soybean (38.00 %) according to Kamal Eldin *et al*., (1994). The protein content of sesame seeds was found to be the second component in seeds. The percentages were 36.55 % and 38.54 % in white and dark sesame seeds. Ash content was 8.04 % and 8.50 % for white and dark sesame seeds respectively. Fiber content was 3.73 % and 3.56 % for white and dark sesame seeds respectively. Carbohydrates content, calculated by difference, was higher in white sesame seeds than in the dark sesame seed.

Table (1): Chemical composition of white and dark sesame seeds on dry basis.

Components (%)	White sesame	Dark sesame
Moisture	4.12	4.60
Oil	49.71	47.48
Protein	36.55	38.54
Ash	8.04	8.50
Fiber	3.73	3.56
Carbohydrates	1.97	1.92

-Quality of fresh white and dark sesame oil:

Table (2) shows some physico – chemical properties of fresh sesame oil (white and dark). In general, the values of the physical and chemical constants for sesame oil quality extracted from white and dark sesame oil (refractive index, color, free fatty acid, peroxide value, oxidative stability) were similar to those published in many places (Obiajunwa *et al*., 2005 & Uzun *et al.*, 2008).

- Quality of roasted sesame oil:

The changes in quality parameters of sesame oil extracted from white and dark sesame seeds by roasting at 150 and 200 ^{o}C for 30 min. are shown in table (2). It is worthnoting that sesame seeds were roasted at 150 and 200 ^{o}C for 30 min. and extracted oil from seeds were kept at 5 ^{o}C until analysis.

- Refractive index

Refractive index is a good diagnostic parameter for the degree of oil unsaturation and this value increased by increasing number conjugated double bonds in the oil. The data in Table (2) show that there was slight decrease in sesame oil refractive index during the increase roasting temperature.

- Oil color:

The color of roasted sesame oil samples was measured at fixed yellow glass slide and variable red glass slide. The color of sesame oil changed from clear and pale yellow to light then dark brown during the roasting process. Color darkening patterns were significantly different from each temperature heating. Color darkening is a complicated process involving interaction with fatty acids and other minor compounds present in the oil (Yoon *et al.*, (1987).

- **Free fatty acid % (F.F.A.):**

The free fatty acid %s of sesame oil samples extracted from roasted sesame seeds increased significantly and were strongly correlated with high temperature roasting (Table 2). The data of the present study show that the acidity of sesame oil (roasted) higher than fresh sesame oil. However, the free fatty acid % is still beyond the acceptable level.

- Peroxide value:

Hydroperoxides are the primary products of lipid oxidation. Therefore, The determination of peroxides can be used as an oxidation index for the primary stages of sesame oil oxidation. The data in Table (2) indicate that sesame oil peroxide value increased gradually with roasting temperature. It is worth noting that the peroxide values higher than the fresh sesame oil.

- Iodine value:

The iodine value reflects the degree of oil unsaturation. The data in Table (2) shows that the iodine values of fresh, roasted and treated roasted sesame seeds oil (white and dark) at 150˚C and 200˚C was 106.00, 107.00, 105.95, 105.87, 110.98, 110.93, 105.00, 105.20, 110.00 and 110.50 respectively. The iodine values of roasted sesame oil samples indicated a significant decrease during of the roasting process.

Table (2): Physical and chemical properties of the fresh, roasted and roasted-bleached Sesame oil.

Samples		Refractive index at 25 °C	Color unit at red yellow =35	F.F.A (% as oleic)	Peroxide value	Iodine number	Unsaponi-fiable matter (%)	Oxidative stability (hrs)
Fresh	White	1.4721	4.50	0.20	0.50	106.00	1.20	11.20
	Dark	1.4732	5.20	0.25	0.62	107.00	1.22	12.30
Roasted	White 150 °C	1.4719	7.50	0.60	2.50	105.95	1.28	8.00
	White 200 °C	1.4716	8.90	0.85	3.70	105.87	1.36	7.50
	Dark 150 °C	1.4729	8.50	0.68	3.00	110.98	1.31	9.00
	Dark 200 °C	1.4726	9.50	0.92	4.20	110.93	1.42	8.50
Roasted-bleached	White 150 °C	1.4720	4.80	0.45	0.65	105.00	1.27	10.50
	White 200 °C	1.4719	5.20	0.46	0.73	105.20	1.35	10.00
	Dark 150 °C	1.4730	5.50	0.47	0.71	110.00	1.32	11.00
	Dark 200 °C	1.4727	6.00	0.50	0.81	110.50	1.40	10.60
LSD*		0.001	0.50	0.10	0.20	0.30	0.01	1.00

*LSD value at $P \geq 0.05$ and demonstrated to least significant difference test.

-Unsaponifiable matter:

The unsaponifiable matter was important value in protection of oil. The data in Table (2) shows that the unsaponifiable matter values (%)of fresh, roasted and treated roasted sesame seeds oil (white and dark) at 150 ^{o}C and 200 ^{o}C was 1.20, 1.22, 1.28, 1.36, 1.31, 1.42, 1.27, 1.35, 1.32 and 1.40 respectively. The unsaponifiable matter values of roasted sesame oil samples were higher than fresh and treated roasted (white and dark) sesame seeds oil. The increase of unsaponifiable matter during roasted process may be due to conversion from bioactive components (sesamin, sesamol and sesamolin). This results was agreement with (Han *et al*., 1997).

- Sesame oil stability:

Rancimat apparatus was used in the present work to measure the induction periods of fresh, roasted and roasted-treated sesame oil samples. In fact, the low induction period of oil indicates the low oil stability towards oxidative rancidity. The induction period for fresh sesame oil was high and decreased by prolonging the roasting process (Table 2). This means the roasting process lowers the oil stability.

- Treated roasted sesame oil:

Effects of treated with acid clay at 2.00 % at 100 ^{o}C on the physical properties of roasted sesame oil are shown in Table (2). Treated with acid clay significant decreased the color red value of roasted sesame oil samples, suggesting the color of the roasted sesame oil became lighter. Pigments and brown gum materials in roasted sesame oil were removed by acid clay (Bayrak, 2003). Dark brown color of roasted sesame oil often deteriorates the original color of foods. The lightness of the oil increased because of the bleaching of coloring materials by heating.

Free fatty acid %s of roasted sesame oil treated with acid clay at 2.00 % at 100 ^{o}C are shown in Table (2). Treated significant decreased the free fatty acid % of roasted sesame oil ($P \geq 0.05$). Acid clay decreased the hydrolysis of triglycerides (Lee *et al*., 1994) and adsorbed free fatty acid (Chapman & Pfannkoch 1992). Roasted-treated sesame oil having low free fatty acid % might be more stable to the oxidation during storage or cooking and also of better for health.

Peroxide values of roasted sesame oil treated with acid clay at 2.00 % at 100 ^{o}C are shown in Table (2). Treated process significant decreased peroxide values of roasted sesame oil sample (white and dark). Also, these processes significant increase the oxidative stability of roasted sesame oil samples.

-Fatty acid composition of the extracted sesame oils:

It is well known that the knowledge of the fatty acids composition of oil can relate possible oxidation with specific unsaturated fatty acids, as well as can give an expecting for its possible uses for edible or industrial purposes. In addition, the fatty acids composition of the edible oils and fats is strongly correlated with the oxidative state and stability, and with the healthy safe quality of these lipids. Therefore, the fatty acids composition of sesame seed oils of two varieties (white and dark) after and before roasting process at 150 and 200 ^{o}C was carried out by gas chromatography analysis, compared to the roasted sesame oil treated with acid – activated clay at 2 % at 100 ^{o}C for 10 min. The obtained data are recorded in table (3).

The obtained results of table (3) show that the fatty acids in fresh sesame oil (white and dark) are mainly linoleic (C18:2) and oleic (C18:1) acid with small amounts of saturated fatty acids. Roasting process and treating with acid clay little difference in the fatty acid composition.

Table (3): Fatty acids composition of the fresh, roasted and roasted-bleached Sesame oil.

Samples		Fatty acids composition (%)				
		$C_{16:0}$	$C_{18:0}$	$C_{18:1}$	$C_{18:2}$	$C_{18:3}$
Fresh	White	10.42	6.49	44.09	37.54	0.28
	Dark	9.98	5.45	41.98	40.90	0.31
Roasted	White 150 °C	10.01	7.00	44.10	37.58	0.22
	White 200 °C	9.25	7.44	44.13	37.65	0.18
	Dark 150 °C	8.41	5.83	42.00	46.95	0.23
	Dark 200 °C	8.10	6.40	42.12	41.01	0.21
Roasted-bleached	White 150 °C	10.20	7.10	44.00	37.56	0.20
	White 200 °C	9.26	7.45	44.14	37.55	0.16
	Dark 150 °C	8.43	5.86	42.00	46.93	0.21
	Dark 200 °C	8.21	6.63	41.90	41.00	0.20
LSD*		0.10	0.15	0.2	0.10	0.005

*LSD value at $P \geq 0.05$ and demonstrated to least significant difference test.

- Effects of treated on α – tocopherols, sesamin, sesamol and sesamolin in roasted sesame oil:

Effects of treated of roasted sesame oil with acid clay at 2 % at 100 ^{o}C on α-tocopherols of fresh sesame oil (white and dark) (635.00 and 700 pm). Roasting process caused significant decrease α–tocopherols, possibly due to some degree of oxidation (Gutfinger. , 1981). Treated with acid clay did not have significant effects on the tocopherol contents in roasted sesame oil ($P\geq 0.05$).

Table (4) shows the effect of roasting at (150 and 200 ^{o}C) and treated with acid clay at 2 % at 100 ^{o}C on the sesamol, sesamin and sesamolin of sesame oils extracted. Higher values of sesamin and sesamolin were found in the oil samples from the fresh white and dark sesame seeds. Roasting process caused a decrease in both sesamin and sesamolin contents. The degradation of sesamolin was greater than sesamin because sesamolin decomposed to seamol. On the other hand, the sesamol content was detected as traces in the unroasted sesame oil samples, whereas appreciable increase in sesamol was observed after roasting due to conversion from sesamolin.

Effects of treated with acid clay on the contents of sesamol, sesamin and sesamolin in roasted sesame oil are shown in Table (4). Treated tended to decrease sesamolin contents and increase sesamol contents, which agrees with the reports by (Han *et al.*, 1997).

Table (4): α – tocopherols, sesamin, sesamol and sesamolin of the fresh, roasted and roasted-bleached Sesame oil.

Samples		Fatty acids composition (%)			
		α–tocopherols	sesamin	sesamol	sesamolin
Fresh	White	635.00	431.00	23.50	225.30
	Dark	700.00	456.12	34.00	238.00
Roasted	White 150 °C	550.00	448.00	22.70	224.90
	White 200 °C	500.00	475.00	22.10	224.59
	Dark 150 °C	635.00	469.00	33.87	237.80
	Dark 200 °C	591.00	491.00	33.30	237.41
Roasted-bleached	White 150 °C	548.00	429.00	23.90	200.00
	White 200 °C	501.00	425.00	24.00	191.00
	Dark 150 °C	630.00	454.00	34.50	203.00
	Dark 200 °C	592.00	451.00	35.00	195.00
LSD*		5.00	6.10	1.50	3.30

*LSD value at $P \geq 0.05$ and demonstrated to least significant difference test.

- Conclusions:

Treated with acid clay gave lighter color, decreased free fatty acid % and peroxide value of roasted sesame oil. Treated of roasted sesame oil could extend the usage of roasted sesame oil by increasing and improving oxidative property of the oil.

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تأثير عمليات التحميص و التبييض على زيوت كلا من بذور السمسم الأبيض و البنى الداكن

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تستخدم بذور السمسم في صناعة بعض المنتجات مثل الحلاوة الطحينية و الطحينة . و عند إجراء عملية التحميص على بذور السمسم قبل التصنيع قد تحدث بعض التغيرات في المركبات النشطة الحيوية و كذلك في خواص الزيت و التي من أهمها اللون مما يؤثر على لون المنتج النهائي . و بناء على ذلك تم دراسة تأثير كل من عملية التحميص و التبييضعلى خواص زيت بذور السمسم على درجات حرارة مختلفة.

لذا يهدف هدا البحث إلي دراسة تأثير عمليات التحميص و التبييض على جودة زيت السمسم المحمص. حيث تم استخلاص الزيت من صنفي السمسم (الأبيض والبنى الداكن) قبل و بعد عملية التحميص علي درجة حرارة 150 م5و 200م5 مدة 30دقيقة. كذالك تم معا ملة صنفي زيت السمسم المحمص بتراب التبييض النشط المحمض بنسبة 2٪ على 100 م5 لمدة10دقائق. ثم تم دراسة بعض الخواص الفيزيائية والكيميائية (معا مل الانكسار ـ اللون ـ رقم الحموضة ٪ كحا مض أوليك ـرقم البيروكسيد ـ الرقم اليودي ومحتوي المواد غير المتصبنة).

وأيضاً تم دراسة ثباتية الزيت باستخدام جهاز الرانسيمات علي درجة حرارة 100 م5 ±2 م5وتم دراسة محتوي الزيت من الالفا توكوفيرولات ومضادات الأكسدة (السيزامول - السيزامين ـ السيزامولين) وذلك باستخدام جهاز التحليل الكروماتوجرافي السائل (HPLC). كذالك تم دراسة محتوي الزيت من الأحماض الدهنية باستخدام جهاز الكروماتوجرافي الغازي (GLC).

وقد دلت النتائج علي أن هناك زيادة معنوية في معامل الانكسار و اللون و رقم الحموضة و رقم البيروكسيد. وحدث انخفاض في الرقم اليودي و فترة الثبات الأكسيدي.

أما بالنسبة لزيت السمسم المحمص المعا مل بتراب التبييض النشط المحمض فقد أدي إلي تحسين جيد في جودة زيت السمسم المحمص.