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Effect of Processing Techniques on the Quality Attributes of Oil Extracted from Sesame Seed (*SesamumIndicum*)

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Abstract: - *Sesamumindicum,* also known as sesame seed is widely naturalized in the tropical regions around the world and is cultivated for its edible seeds. This study therefore evaluated the quality attributes of oil extracted from sesame seed by different processing techniques. Oil was extracted from raw and roasted sesame seed by different processing methods and the following analyses were carried out: vitamins,physicochemical and quality properties. The results of vitamin analyses showed that oil form raw and roasted seed had 19.60 and 26.40µg/100g respectively of vitamin A; 0.17 and 0.26mg/100g respectively of vitamin B; 1268.50 and 1396.80µg/100g respectively of vitamin E were significantly different. The results also showed that there were significant increase in cholesterol (100 and 110mg/kg)for raw and roasted seeds respectively, whereas results from quality evaluation showed that oil from raw and roasted seed had acid value (2.52 and 1.64g KOH/g); peroxide value (0.80 and 3.00meq/kg); free fatty acid (0.71 and 0.35%); iodine value (170.05 and 154.82g/100g) and saponification value (178.00 and 184.00KOH/g) respectively. The study however showed that oil obtained from roasted seed is more prone to rancidity though it is significantly higher in vitamins.

Keywords: *Physicochemical, quality attributes,raw, roasted, sesame seed and vitamins.*

I. INTRODUCTION

Sesame (*Sesamumindicum, L.*) which is also known as beniseed is one of the oldest oil seed crops known to mankind and is the only cultivated sesamum species which belong to the family pedaliceae. (Salunkhe*et al.,* 1992). It is quite extensively cultivated in Northern Nigeria: Benue, Plateau, Kwara, Kogi and Niger State; yields in relatively poor climatic conditions and is widely used within Nigeria; more so it is an important component of Nigeria's agricultural exports (Ojiako et al., 2010). As in many common vegetable oils, the lipids of sesame seeds consist mainly of neutral triacyglycerols with small quantities of phospholipids. However, compared with other vegetables oils, sesame oil contains a relatively high percentage of unsaponifiable matter which includes sterols, sterol esters (mainly), tocopherol and unique compounds called sesame lignins(Chemonics, 2002). Sesame oil is classified as a poly unsaturated, semi – drying oil containing about 82% unsaturated fatty acids; oleic and linoleic acids are present in the oil (Yen and Shyu, 1989). It contains approximately 50% oil of very high quality (47% oleic acid and 39% linoleic acid) and 25% protein especially rich in methionine and tryptophan (Bedigian*et al.*,1985). Many nutraceuticals have been discovered from sesame, for instance, Cooney et al. (2001) reported that sesame oil contains pharmaceutical acid used as solvent for intra-muscular injections and has nutritive, demulcent, emollient and laxative properties.Sesame seed consists of a spermoderm, endosperm and cotyledon such that endosperm consists of two to five cell layers with thick rigid walls and is separated from the spermoderm by a membranewhich contains oil drops and small aleurone grains (Tunde – Akintunde and Akintunde, 2004).

Sesame oil has the highest concentration of Omega -6- fatty acids and two naturally occurring preservatives, sesamol and sesamin. They also contain vitamin B, (Thiamine) and vitamin E (tocopherol) (Sosanya, 2007),although oil extracted from sesame seeds is not as popular as other edible oils like groundnut, cotton seed rapeseed but it is also used as cooking oil to restrict its adulteration in some other products and in preparation of certain medicines (Oyetayo, 2009). The study however unraveled the quality properties of oil extracted from sesame seed by different traditional processing techniques.

II. MATERIALS AND METHODS

Extraction of Oil from Sesame Seed.

Sesame seeds obtained from Okene in Kogi State was washed in clean water to remove adhering latex and dehulled traditionally by soaking the seed in water for 2min, after which mortar and pestle were used to loosen the seeds from the seed coat, and poured into water, while hulls were made to float and removed. The seeds were oven dried at 65^0 C for 10h and winnowed. The dried seeds were divided into two portions, a

portion was roasted for 5min with the addition of salt using fry pan and later milled to powder, while another portion was milled into powder in its raw state. Oil was extracted by addition of hot water to the powder until a cake is formed, which was then transfer into a muslin cloth and pressed until the oil was fully extracted.

III. ANALYSES

Determination of vitamin A (retinol)

Vitamin A was determined by method described by Señoráns*et al*., (1999). Two grammes of each sample was weighed into a flat bottom reflux flask, 10ml of distilled water was added, shook carefully to form a paste. 25ml of alcohol KOH solution was added and the reflux condenser attached. The above mixture was heated in boiling water bath for 1h with frequent shaking. The mixture was cooled rapidly and 30ml of water added. The hydrolysate obtained was transferred into a separator funnel. The solution was extracted three times with 250ml quantities of chloroform. 2g anhydrous Na_2SO_4 was added to the extract to remove any traces of water. The mixture was then filtered into 100ml volumetric flask and made up to mark with chloroform. Standard solution of β-carotene vitamin A of range 0 – 50 µg/mg with chloroform by dissolving 0.003g of standard solutions prepared were determined with reference to their absorbances from which average gradient was taken to calculate vitamin A (β-Carotene in µg/100g). Absorbances of sample and standards were read on the spectrophotometer (Metrohmspectronic 210 model) at a wave length of 328nm.

Vitamin A µg / 100g was calculated using the formula:

$$Vitamin\ A\ (\mu g/100g) = \frac{\text{Absorbance of sample} \times \text{Dilution factor}}{\text{Weight of sample}}$$

Determination of vitamin B_1 (Thiamine)

Vitamin B1 was determined by method described by Hennessy (1941). One gramme of sample was weighed into 100ml volumetric flask, 25ml of $0.1MH_2SO_4$ was added and mixed carefully by swirling. Additional 25ml of $0.1MH_2SO_4$ was added to rinse any adhering sample particle off the flask. The flask was set in a boiling water bath to ensure a complete dissolution of the sample in the acid. The flask was shaken frequently in the first five minutes and subsequently every 5 minutes for 3 min 5ml of taka – diastase in 0.5M sodium acetate solution was added and flask set in cold water at for 2h and thereafter made up to 100 ml mark after mixing thoroughly. The mixture was filtered through a No 42 whatman filter paper; discarded the first 10ml and keeping the remaining. Standard Thiamine solution of range 100mg/ml to 50mg/ml were prepared from 100 mg/ml stock and treated same way prepared from sample above. The absorbances of the sample as well as that of standards were read on a fluorescent UV spectrometer (Cecil A 20 model) at a wavelength of 285 nm.

Vitamin B_1 mg / 100g was calculated using the formula:

$$Vitamin\ B1 = \frac{\text{Absorbance} \times \text{Average Gradient} \times \text{Dilution factor}}{\text{Weight of sample}}$$

Determination of vitamin E (Tocopherol)

Vitamin E was determined by method described by Señoráns*et al*., (1999). One gramme of samples was weighed into a 250ml conical flask filtered with a reflux condenser. 10ml of absolute alcohol and 20ml of 1m alcoholic sulphuric acid were added. The condenser and flask were wrapped in aluminum foil and refluxed for 45minand cooled for 15min. Distilled water (50 ml) was added to the mixture and transferred to a 250ml separating funnel covered with aluminum foil. The unsaponifiable matters in the mixture were extracted with 5x 30ml dimethyl ether. The combined extracts were washed free of acid and dry evaporated at a low temperature and the residues obtained were immediately dissolved in 10ml absolute alcohol. Aliquots of solutions of the sample and standards (0.3 – 3.0mg vitamin E) were transferred to a 20 ml volumetric flask, 5ml Absolute Alcohol added, followed by a careful addition of 1ml conc. HNO_3. The flasks were placed on a water bath at 90 ^{0} C for exactly 3min from the time the alcohol begins to boil and cooled rapidly under running water and adjust to volume with absolute alcohol. The Absorbance was measured at 470nm, against a blank containing 5ml absolute alcohol and 1 ml conc. $HNO_3$was treated in a similar manner.

Vitamin E (µg / 100g) was calculated using the formula:

$$Vitamin\ E = \frac{\text{Absorbance} \times \text{Average Gradient} \times \text{Dilution factor}}{\text{Weight of sample}}$$

Determination of cholesterol level

Cholesterol level was determined by method adopted by Okpuzor*et al.* (2009). Oil sample (1ml) was filled into the flask and 2ml of Liebermann – Burchard reagent was added, and 7ml of chloroform was added as well. The flask was covered with black carbon paper and stored in the dark for 15min the absorbance was read at 640nm after 15min.

Cholesterol (mg /kg)was calculated using the formula:

$$Cholesterol = \frac{\text{Concentration obtained in } \frac{\text{mg}}{\text{l}} \times \text{volume of sample}}{\text{Weight of sample}}$$

Determination of acid value

Acid value was determined by method adopted by Okpuzor*et al*. (2009). One gramme of sample was weighed into a conical flask and 50ml of ethanol was added. It was then warmed to dissolve uniformly, 2 drops of phenolphthalein indicator was added and titrated to a pink end point with 0.1N potassium hydroxide KOH solution.

Acid Value (mg KOH/ g) was calculated using the formular

$$Acid\ value = \frac{56.1 \times \mathrm{V} \times \mathrm{C}}{\mathrm{W}}$$

Where: 56.1 is equivalent weight of KOH; V is volume of KOH consumed;
C is concentration of the KOH; W is the weight of the sample in gram.

Peroxide value Determination

Peroxide value was determined by titration method of AOAC (2005). Five grammes of oil was weighed into a conical flask and 30ml of solvent mixture glacial acetic acid: chloroform in the ratio 3:2 respectively was added after which 0.5ml of saturated potassium iodine (KI) solution was added. It was allowed to settle for 1min and 30ml of distilled water was added and 1ml starch indicator. The moisture was then titrated immediately with 0.01N sodium. This sulphate solution until yellow colour is discharged and blank was also titrated.

Peroxide value (meq. peroxide/kg) was calculated using the formula:

$$Peroxide\ value = 10 \times \frac{(V1-V2)}{W}$$

Where: V1 = Volume of $Na_2S_2O_3$ consumed for sample; V2 = Volume of $Na_2S_2O_3$ for blank
W = Weight of the sample in gram

Total free fatty acid (FFA) determination

Free Fatty acid was determined by titration method described by AOAC (2005). One gramme of the test sample was weighed and filled into a conical flask and 50ml of the solvent mixture was added to the sample, 0.2ml of phenolphthalein indicator solution was added. It was then titrated while shaking with 0.1N KOH till pink colour appeared and persists for at 10sec. Blank titration was carried out as well.

% FFA (as Oleic Acid) was calculated using formula:

$$\%\ \text{FFA} = \frac{(V - B)\ \times N\ \times 28.21}{N}$$

Where: V = Volume of titrant (KOH) consumed for sample
B = Volume of titrant consumed for blank N = Normality of titrant (KOH)
28.21= Value from the molecular weight of Oleic acid (282.1g/mol) afterbeing multiplied by 100 followed by dividing with 1000 (converting weight to mg) in order to convert result to percentage.

Iodine value determination

Iodine value was determined by method of BPC (1988).A weighed sample of 0.1g was filled into an iodine flask, with the aid of a dispensing device, 10ml of chloroform was added and the sample was shook to dissolve the sample. A blank was also prepared with only 10ml chloroform both were placed (sample solutions and blank) in the dark for 60min, after 60min, 20ml of 10% KI solution (potassium iodine) was added. 100ml of distilled water was added and allowed to rinse down through the neck of the flask. It was then titrated immediately with 0.1N $Na_2S_2O_3$ until aqueous layer begin to lighten. Starch solution (3 ml) was added and titration process continued until the blue colour of the aqueous solution began to disappear. The iodine flask was stopped and shook vigorously to extract any iodine remaining in the chloroform layer. When the end point

(colourless) appeared to have reached, it was shook again and 2 drops of starch solution was added to verify that no more bluecolour was formed in the aqueous layer, the burette reading was then recorded.
Iodine value was calculated using formular:

$$\text{Iodine value} = \frac{\text{ml Na2S2O3 consumed for blank} - \text{ml Na2S2O3 consumed for sample x N x 12.69}}{weight\ of\ the\ sample\ in\ g}$$

where N = Normality of $Na_2S_2O_3$

Determination of Saponification value

Saponification value was determined by method of BPC (1988). One gram of sample was weighed in a tarred beaker and dissolved in about 3ml of the fat solvent (ethanol). The contents of the beaker was quantitatively transferred three times with a further 7ml of the solvent and 25ml of 0.5N alcoholic KOH was added and thoroughly mixed, it was then attached to a reflux condenser.Another reflux condenser was set up as the blank with all other reagents presents except fat (Ethanolic KOH, potassium hydroxide, Hydrochloric acid and phenolphthalein indicator). Both flasks were placed in a boiling water for 30min and then cooled at room temperature, phenolphthalein indicator was added to both flask and filtered with 0.5N HCl. The endpoint of the blank and the test were noted and the difference between the blank and the test reading gives the number of millilitres of 0.5N KOH required to saponify 1g of oil.
Saponification value of fat (mg of KOH consumed by 1g of fat) was calculated using formula:

$$Weigth\ of\ KOH = normality\ of\ KOH \times Equivalent\ weight \times Volume\ of\ KOH\ in\ litres$$

Volume of KOH consumed by 1g fat = (Blank test) ml.

Physicochemical analysis

Colour Intensity determination

Colour intensity was determined by method adopted by Olaniyan and Oje (2007). One gramme of flour was weighed into a beaker and 25ml of methanol was added and stirred for 30min for proper extraction of colour. It was then left for 10min before filtered using whatman filter and absorbance of the filtrate was determined at wavelengths of 420nm and 520nm.
Colour Intensity was calculated using formula = Absorbance at 420nm + absorbance at 520nm

$$\%\ \text{Yellow/Cream} = \frac{\text{Absorbance @ 420nm} \times 100}{colour\ intensity}$$

$$\%\ \text{Red/Brown} = \frac{\text{Absorbance @ 520nm} \times 100}{Colour\ intensity}$$

Density determiation

Densitywas determined by method adopted by Noureddini*et al.* (1992). The measuring cylinder was placed on a tarred balance and the weight was recorded as W_1. Some quantity of oil was introduced in the cylinder and tapped until a stable volume of the oil sample is obtained. The volume was recorded as V. the cylinder was then placed alongside with the content on the balance to obtain the weight of the sample, weight was recorded as W_2

$$\text{Bulk Density} = \frac{\text{W1 (g)} - W2\ (g)}{V\ (ml)}$$

Where: W_1 = Weight of empty cylinder W_2 = Weight of cylinder and sample
V = Volume of the sample
Viscosity was determined by method adopted by Noureddini*et al.* (1992), refractive index was determined using Pen Refractometer while Specific gravity obtained from each extraction temperature was determined using a specific gravity bottle. Melting point was determined by method described byOlatunji and Owoyale (2005).

Statistical Analysis

All determinations were made in triplicate and the results obtained from the various analysis were subjected to analysis of variance (ANOVA) using the statistical package for social sciences (SPSS) version 18.0. Means were separated using the Duncan multiple range test (DMRT) at 95% confidence level ($p<0.05$).

IV. RESULTS AND DISCUSSION

Effect of processing techniques on the vitamins of oil extracted from Sesame Seed.

The results of the effect of traditional processing techniques on vitamins of oil extracted from sesame seed are shown in Table 1. The vitamin A contents of oil from raw and roasted seeds were 19.60 and 26.40µg/100g respectively, results however showed that vitamin A significantly higher in roasted seed oil than raw seed oil. The vitamin B contents of oil from raw and roasted seeds which were 0.17 and 0.26mg/100g

respectively also showed significant difference, while the vitamin E content which ranges from 1268.50 to 1396.80 µg/100g of oil from raw and roasted seeds respectively showed significant difference.

Table 1:Effect of processing techniques on the vitamins of oil extracted from sesame seed.

Raw seed oil	Roasted seed oil
Vitamin A (µg/100g)	$19.60^{b} \pm 0.34$ $26.40^{a} \pm 0.26$
Vitamin B (mg/100g)	$0.17^{b} \pm 0.25$ $0.26^{a} \pm 0.12$
Vitamin E ((µg/100g)	$1268.50^{b} \pm 0.30$ $1396.80^{a} \pm 0.55$

Values are means of 3 replications

Values along the same column followed by different superscripts are significantly different ($p \leq 0.05$)
The significant difference observed in the vitamin content of oil from raw and roasted seeds could be due to biochemical compounds which inhibit the effective absorption and release of vitamin in its raw state, and as such heat generated during roasting is significant to availability of vitamins in sesame seed.

Effect of processing techniques on the quality properties of oil extracted from Sesame Seed.

The results of the effect of processing techniques on the quality of oil extracted from sesame seed are presented in Table 2. The peroxide values of oil from raw and roasted seeds were 0.80 and 3.00meq/kg respectively. Results showed that the peroxide value of oil from roasted seed is significantly higher than the raw seed, such that the initial evidence of rancidity in unsaturated fats and oils that measures the extent to which an oil sample has undergone primary oxidationis high in roasted seed. The results obtained are however in the range of value obtained by Okorieand Nwachukwu(2014) where soybean has 2.42meq/kg. The acid values of oil from raw and roasted seeds were 2.52 and 1.64 g KOH/g respectively, results however showed that acid value increased significantly in raw seeds.

Table 2:Effect of processing techniques on the quality properties of oil extracted from sesame seed.

Raw seed oil	Roasted seed oil
Peroxide Value (meq/kg)	$0.80^{b} \pm 0.15$ $3.00^{a} \pm 0.04$
Acid value (gKOH/g)	$2.52^{a} \pm 0.25$ $1.64^{b} \pm 0.12$
Free fatty Acid (%)	$0.71^{a} \pm 0.05$ $0.35^{b} \pm 0.30$
Iodine value (g/100g)	$170.05^{a} \pm 0.02$ $154.82^{b} \pm 0.13$
Saponification value (KOH/g)	$178.00^{b} \pm 0.18$ $184.00^{a} \pm 0.20$
Cholesterol (mg/L)	$100.00^{b} \pm 0.16$ $110.00^{a} \pm 0.24$

Values are means of 3 replications
Values along the same column followed by different superscripts are significantly different ($p \leq 0.05$).

The iodine values of oil from raw and roasted seeds were 170.05 and 154.82 g/100g; results showed significant difference which indicates that the amount of unsaturation (double bonds) in fatty acids is higher in raw seeds. The saponification values of oil from raw and roasted seeds were 178.00 and 184.00 KOH/g respectively. The results which represent the number of milligrams of potassium hydroxide required to saponify 1g of fat and measure the average molecular weight (or chain length) of all the fatty acids present, significantly higher in oil extracted from roasted seed. The cholesterol values of oil from raw and roasted seeds were 100.00 and 110.00 mg/L. The results showed there is significant difference; cholesterol which is a type of lipid that serves several necessary purposes in the body, such as making vitamin D in the skin, repairing cell membranes and producing hormones which can alsobe harmful to the health of the heart and brain, this is however significantly higher in roasted seed.

Effect of processing techniques on the physicochemical properties of oil extracted from Sesame Seed.

The results of the effect of processing techniques on the physicochemical properties of oil extracted from sesame seed are shown in Table 3. The colour intensity of oil extracted from raw and roasted seeds were 0.347 and 0.154% yellow/cream, results however show a significant increase in raw seed. The density of oil from raw and roasted seed ranged in the value of 0.034 and 0.036g/ml shows no significant difference.Since the specific gravity of crude oil is about 0.89 (International Oil Standards EPIC, 2004), the densities obtained showed that the values compared very well (P>0.05) with the above standard.The melting points of oil from raw and roasted seeds were -0.5 and -0.5^{0}C. The study shows a contrast results when compare with the findings ofOkorie and Nwachukwu (2014) where the melting point of soybean is 6.09 ^{0} C.

Table 3: **Effect of processing techniques on the physicochemical properties of oil extracted from Sesame Seed.**

	Raw seed oil	Roasted seed oil
Colour intensity (% yellow/ cream)	$0.347^a \pm 0.15$	$0.154^b \pm 0.04$
Density (g/ml)	$1.05^a \pm 0.25$	$0.95^b \pm 0.12$
Viscosity @ RT (Pa.s)	$0.034^a \pm 0.05$	$0.036^a \pm 0.30$
Melting point (C)-0.50	$-0.50^a \pm 0.13$	
Specific Gravity	$0.955^a \pm 0.18$	$0.864^b \pm 0.20$
Refractive index $1.51^b \pm 0.16$	$1.66^a \pm 0.24$	

Values are means of 3 replications

Values along the same column followed by different superscripts are significantly different ($p \leq 0.05$).

The refractive index (1.51 and 1.66) and Specific gravity (0.955 and 0.864) show a significant difference and as such agreed with International Oil Standard EPIC (2014). The viscosity of oil extracted from raw and roasted seeds however shows no significant difference.

V. CONCLUSION

The study unraveled the effect of processing techniques on the quality attributes of sesame seeds. Results obtained had shown that oil extracted from roasted sesame seed is significantly higher in vitamins than raw seed, whereas the peroxide value is significantly higher in roasted seeds which could make it prone to rancidity than raw seed. The study findings further revealed that oil extracted from roasted seeds is significantly higher in cholesterol than raw seed, while saponification value is significantly higher in roasted seed.

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