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Evaluation of some Varieties of Okra (*Abelmoschusesculentus*) Seed Oil for Consumption and Industrial Uses

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Abstract

The demand for seeds oil is rapidly increasing due to the growth of the human population and the resulting increase in its consumption for both domestic and industrial uses. Hence, seed oils from three okra (*Abelmoschusesculentus*) varieties – Clemson spineless, ex-Samaru and NHAE-74 were extracted and their physicochemical properties were analysed and compared with some conventional seed oils. The percentage oil yield of the seeds determined for NHAE-74 (25.67±0.58 %) is significantly higher ($p < 0.05$) than Clemson spineless (24.33±0.29 %) and ex-Samaru (23.05±0.50 %). The acid value (3.65±0.02, 1.96±0.01 and 2.24±0.02 mgKOH/g), Iodine Value (114.59±0.01, 110.97±0.02 and 111.67±0.02 mg/100g) and Saponification value (122.02±0.19, 130.43±0.04 and 124.82±0.02 meqKOH/kg) of Clemson spineless, ex-Samaru and NHAE-74, respectively differ significantly ($p < 0.05$) among the three varieties, while the peroxide value (meqKOH/kg) of Clemson spineless (3.92±0.14) is significantly lower ($p < 0.05$) than the values of NHAE-74 (5.33±0.14) and ex-Samaru (5.00±0.25). The results further showed that the seed oil has a quality comparable to those of conventional oils and has great nutritional and industrial potentials.

Keywords: Okra, Seed Oil, Consumption, Industrial Uses

1. Introduction

The demand for seed oils is rapidly increasing due to the rapid growth of the human population and the expanding demand by the oil industries [1]. This has led to the exploration of some underutilized and newer sources of seed oil. Among the plants that have received particular attention as source of vegetable oil is okra (*Abelmoschusesculentus* L. Moench, or *Hibiscus esculentus* Malvaceae) [2]. This plant, traditionally grown in tropical regions, stands out because of its rapid growth cycle, high yield, ease of cultivation, high nutritional value and resistance to pests [3]. Okra seed appears to be a good source of oil (20-40%) and rich (60 to 70%) in unsaturated fatty acids [4], especially oleic (20.38%) and linoleic acids (44.48%) [2], as well as polyunsaturated fatty acids, which are essential for human nutrition [5]. Moreover, okra seed oil has a potential hypocholesterolemic effect [4]. Apart from their food and biochemical utilization, fats and oils are raw materials for coating, paint, pharmaceutical, soap, detergent and cosmetic industries [6].

2. Materials and Methods

2.1 Sample Collection and Treatment

Dry seeds of the three okra (*Abelmoschusesculentus*) varieties (Clemson spineless, NHAE-74 and Ex-samaru) were obtained from the Institute of Agricultural Research, Ahmadu Bello University, Zaria-Nigeria. The dry okra seeds were further sun-dried for one week and ground to powder using porcelain mortar [7]. The powder of each variety was packaged in a polyethylene bag and kept for oil extraction.

2.2 Oil extraction

From each 50 g of the sample, the oil was extracted using the soxhlet extraction method with petroleum ether (b.p 40-60 ºC) as described by Bouanga-Kalou et al.[8] in a 5.0 dm^3 Soxhlet extractor for 8 h (until ether becomes colourless). The oil was then recovered by evaporating off the solvent using a rotary evaporator.

2.3 Saponification Value (SV)

The oil sample (2.0 cm^3) was added to 20.0 cm^3 of ethanolic potassium hydroxide (0.50 $moldm^{-3}$ KOH-ethanol solution) in 200.0 cm^3 round bottom flask. The flask with its content was refluxed for 30 min. The hot solution was allowed to cool and later titrated against

0.50 moldm^{-3} hydrochloric acid using 1% phenolphthalein indicator to a colourless endpoint. A blank titration was carried out using the same procedure except that the sample was not added [9]. The SV was calculated using Equation 2.1.

$$Saponification\ Value = \frac{56.1 \times M(V_2 - V_1)}{W} \quad (2.1)$$

Where M = Molarity of hydrochloric acid, V_1 = volume of HCl used in the test, V_2 = volume of HCl used in the blank and W = weight of oil sample.

2.4 Acid Value

Five gram (5.0 g) of the oil sample was transferred into a 250.0 cm^3 conical flask and 50.0 cm^3 of hot neutralized alcohol was added. The content in the flask was boiled on a water bath and 5.0 drops of phenolphthalein indicator were added. The mixture was then titrated with 0.10 mol dm^{-3} sodium hydroxide until a pink colour was observed, indicating the endpoint [10]. The acid value was calculated on the basis of Equation 2.2.

$$Acid\ Value = \frac{M(T_B - T_s)}{W} \quad (2.2)$$

Where M = Molarity of NaOH, T_S = Titre value of the sample, T_B = Titre value of the blank and W = weight of oil sample.

2.5 Iodine Value

The oil sample (2.0 g) was transferred into a flask containing 10.0 cm^3 carbon tetrachloride, followed by the addition of 25.0 cm^3 of Wij's solution. The Wij's solution was prepared by dissolving 13.0 g resublimed iodine in 1 dm^{3}of 95% glacial acetic acid. The content was warmed on a water bath, then was cooled and divided into two parts (900.0 cm^3 and 100.0 cm^3). Pure dried chlorine was passed through the 900.0 cm^3 portion until the colour changed from deep brown to dark orange. The mixture of the Wij's solution and the sample was stored in a dark place for 30 min at 25 °C after which 15.0 cm^3 of 10% potassium iodide solution and 100 cm^3 of distilled water were added. The resulting mixture was titrated with 0.1 moldm^{-3} sodium thiosulphate solution, added gradually with constant and vigorous shaking until the yellow colour had almost appeared. Using 2.0 cm^3 of 1% starch indicator solution, the titration was continued until the blue-black colour disappeared, indicating the endpoint [9]. The iodine value was calculated using Equation 2.3.

$$Iodine\ Value = \frac{12692\ M(T_B - T_s)}{W} \quad (2.3)$$

Where M = Molarity of the solution, T_S = Titre value of the sample and T_B = Titre value of the blank.

2.6 Peroxide Value

One gram (1.0 g) of the oil was dissolved in 30.0 cm^3 of glacial acetic acid and chloroform (3:2, v/v) and 0.5 cm^3 of saturated KI was added. The solution was then titrated with a standardized 0.025 moldm^{-3} sodium thiosulphate solution using a starch indicator. The peroxide value (POV) was determined using Equation 2.4[11].

$$POV = \frac{1000 \times\ M(V_B - V_s)}{W}\ mg\ Equv.O_2 \quad (2.4)$$

Where V_S = amount of sodium thiosulfate solution consumed in the main test, V_B= amount of sodium thiosulfate solution consumed by the blank, M = molarity of sodium thiosulfate solution in moldm^{-3}.

3. Results and Discussion

Table 3.1 shows the physicochemical properties of three different varieties of okra seed oil. The percentage oil content of NHAE-74 (25.67 %) was significantly higher ($p < 0.05$) than Clemson spineless (24.33 %) and ex-samaru (23.50 %). The values of all the three varieties obtained fall within the range (20-40 %) [4,7,12] which are comparable to olive oil (25-30%) and linseed oil (33.5%) [13] but greater than cotton seed oil (15.05%) [14]. The yield of the oil qualifies the seeds to be classified as high oil yielding seeds [14,15].

The acid value is an index of free fatty acid content due to enzymatic activity in the seed [16]. There is significant difference ($p > 0.05$) among the three varieties of akra seeds analysed. The acid value found for NHAE-74 (2.24±0.02 mgKOH/g) is higher than ex-Samaru (1.96±0.01 mgKOH/g) but lower than Clemson spineless (3.65±0.02 mgKOH/g). The value of Clemson Spineless was close to the value (3.39 mgKOH) found by Ogungbenle and Omosola[10] for okra seed oil. The values also were found to be lower than those of calabash seed oil (5.92mg/KOH), lump-in-neck oil (4.59mgKOH/g), bottle gourd seed oil (5.21mgKOH/g) [17], neem seed oil (16.83 mgKOH/g) [18] and benniseed oil (4.76mgKOH/g) [19]. Considering the minimum acceptable value of 4.0 mgKOH/g recommended by the Codex Alimentarius Commission for oilseeds [16,20], the acid values obtained in the present studies indicate that the oils are suitable for human consumption.

The iodine value serves as a measure of the degree of unsaturation of oil. The results of iodine value differ significantly ($p < 0.05$) among the three varieties. The iodine value of the Clemson spineless (114.59±0.01 gI_2/100g) is the highest among the three varieties, indicating that it is the most unsaturated of the three oil samples studied, followed by NHAE-74 (111.67±0.02 gI_2/100 g) then ex-samaru (110.97±0.02 gI_2/100g). The value is similar to the findings (111.00 - 112.16 gI_2/100g) [10] for okra seed oil but higher than some vegetable oils; baobab oil (82.58 gI_2/100g), turkey vegetable oil (81.30 gI_2/100g), peanut oil (65.52 gI_2/100g) and palm oil (60.90 gI_2/100g) [21]. The iodine values of the seeds are lower than those of melon seed and (121.03 gI_2/100g) for

African pear, Caryodesedulis [22]. Because the iodine value was a little above 100 and so it could be classified as semi-drying oil [10,22]. Thus, the oil will attract high interest in the paint and coatings industry[20,23,24].

Table 1: Physicochemical properties of three varieties okra seed oil

Parameter	Clemson spineless	Ex- samaru	NHAE -74
Oil content (%)	24.33±0.29^{b}	23.50±0.50^{b}	25.67±0.58^{a}
Acid Value (mgKOH/g)	3.65±0.02^{a}	1.96±0.01^{c}	2.24±0.02^{b}
Iodine Value (mgI_2/100g)	114.59±0.01^{a}	110.97±0.02^{c}	111.67±0.02^{b}
Saponification Value (mgKOH/g)	122.02±0.19^{a}	130.43±0.04^{b}	124.82±0.02^{c}
Peroxide Value (meqKOH/kg)	3.92±0.14^{b}	5.00±0.25^{a}	5.33±0.14^{a}

The result is expressed as mean ± standard deviation of triplicate readings. Values in the same row with the same superscripts are not significantly different (p>0.05).

There is significant difference ($p < 0.05$) among the seeds in saponification value. The saponification value of NHAE-74 (124±0.02 mgKOH/g) was higher than the value obtained in Clemson spineless (122.02±0.19 mgKOH/g) but less than the value of ex-Samaru (130±0.04 mgKOH/g). The values were also lower than those of quinoa oil (192.0mgKOH/g) [9], shea-nut oil (195mgKOH/g), jatropha oil (193.55mgKOH/g)[25], coconut oil (253mgKOH/g) and palm kernel oil (247mgKOH/g) [25]. The saponification value of (200mgKOH/g) indicates a high proportion of low molecular weight fatty acid [25]. This shows that the oils have potentials for manufacture of soap and cosmetics; and for thermal stability of polyvinyl chloride (PVC)[10] and alkyd resins [16,26]. This property of the oil makes it a source of fatty acids required in the body make up.

The peroxide value (3.92 meqKOH/kg) of Clemson spineless is significantly lower ($p < 0.05$) than the peroxide value (5.00 meqKOH/kg) of ex-samaru and (5.33 meqKOH/kg) NHAE-74.The finding is similar to the finding of Ndangui et al. [7]who obtained 4.13± 0.28 mgEquiv.O_2/Kg and 3.12± 0.14 mgEquiv.O_2/Kgfor gumbo (*Abelmoschusesculentus* L.) seed oil using blye and dyer and Soxhlet extraction methods, respectively. Ogungbenle and Omosola [10] found greater values of 7.31 mgEquiv.O_2/Kg in dry Nigerian okra (*Abelmoschusesculentus*). The peroxide value is an index of rancidity and the higher the peroxide value of an oilthe more susceptible it is to rancidity during storage. The peroxide value of okra oil obtained in this research was below the maximum acceptable value of 10mgEquiv.O_2/Kg set by the Codex Alimentarius Commission for oil such as groundnut oil[20]. This low peroxide value shows the stability of the oil. It serves as an indicator of the oil to resist lypolytic hydrolysis and oxidative deterioration [27]. The rancidity of an oil depends on the extent of its exposure and its susceptibility to oxidation. It is, therefore, necessary to develop improved methods of storing these oils, such as the addition of anti-oxidant like butylhydroxy anisole [28] which reduces such susceptibility to rancidity.The significant variation in oil yield and its physicochemical properties is due to the differences in the variety of plants, cultivation climate, ripening, stage and the harvesting time[29].

4. Conclusion

The three varieties of okra seeds studied are generally good sources of oil. Their oils' good quantity and quality could be a substitute for conventional cooking oils. They also have good physicochemical properties which are comparable to conventional oils that can use for industrial manufacture of soap and cosmetics, and for thermal stability of polyvinyl chloride (PVC) and alkyd resins.

References

1. Hossain MA, Focken U, Becker K. Evaluation of an unconventional legume seed, Sesbania aculeata, as a dietary protein source for common carp, Cyprinus carpio L. Aquaculture [Internet]. 2001;198(1):129–40. Available from: http://www.sciencedirect.com/science/article/pii/S0044848600005743
2. de Sousa Ferreira Soares G, Gomes V de M, dos Reis Albuquerque A, Barbosa Dantas M, Rosenhain R, Souza AG de, et al. Spectroscopic and Thermooxidative Analysis of Organic Okra Oil and Seeds from *Abelmoschus esculentus*. Cuzzocrea S, editor. Sci World J [Internet]. 2012;2012:847471. Available from: https://doi.org/10.1100/2012/847471
3. Çalışır S, Özcan M, Hacıseferoğulları H, Yıldız MU. A study on some physico-chemical properties of Turkey okra (Hibiscus esculenta L.) seeds. J Food Eng [Internet]. 2005;68(1):73–8. Available from: http://www.sciencedirect.com/science/article/pii/S0260877404002596
4. Habtamu Fekadu Gemede, Negussie Ratta, Gulelat Desse Haki, Ashagrie Z. Woldegiorgis FB. Nutritional Quality and Health Benefits of Okra

(Abelmoschus esculentus): A Review. Food Sci Qual Manag. 2014;33:87–96.

5. Habtamu Fekadu Gemede, Negussie Ratta, Ashagrie Z. Woldegiorgis FB. Nutritional Quality and Health Benefits of "Okra" (Abelmoschus esculentus): A Review. Int J Nutr Food Sci. 2015;4(2):208–15.
6. Ayoade GW, AmooI. A, Akpambang VO. Physicochemical and Fatty Acid Composition of Crude and Refined Oils of African Canarium. Int J Sci Technol. 2015;4(5):230–4.
7. Ndangui CB, Kimbonguila A, Nzikou JM, Matos L, Pambou-tobi N, Abena AA, et al. Nutritive Composition and Properties Physico-chemical of Gumbo (Abelmoschus esculentus L.) Seed and Oil. Res J Environ Earth Sci. 2010;2(1):49–54.
8. Bouanga-Kalou, G. Kimbonguila, A. Nzikou, J M. Ganongo-Po, F. B. Moutoula, F E. Panyoo-Akdowa, E. Silou, Th. Desobry S. Extraction and characteristics of seed oil from Papaya (Carica papaya) in Congo-Brazzaville. Asian J Agric Sci. 2011;3(2):132–7.
9. Ogungbenle N. Nutritional evaluation and functional properties of quinoa (Chenopodium quinoa) flour. Int J Food Sci Nutr. 2003;54(2):153–8.
10. Ogungbenle H N and Omosola S M. The Comparative Assessment of Nutritive Values of Dry Nigerian Okra (Abelmoschus esculentus) Fruit and Oil. Int J Food Sci Nutr Eng. 2015;5(1):8–14.
11. Nkafamiya II, Maina HM, Osemeahon SA, Modibbo UU. Percentage oil yield and physiochemical properties of different groundnut species (Arachis hypogaea). African J Food Sci. 2010;4(7):418–21.
12. Benchasri S. Okra (Abelmoschus esculentus (L.) Moench) as a valuable vegetable of the world. Ratar Povrt. 2012;49:105–12.
13. Frank D. Gunstone. Vegetable Oils in Food Technology: Composition, Properties and Uses. 2nd Editio. Wiley-Blackwell; 2011. 16 p.
14. Adelola OB, Ndudi EA. Extraction and Characterization of Cottonseed (Gossypium) Oil. Int J Basic Appl Sci. 2012;1(2):398–402.
15. Singh P, Chauhan V, Tiwari BK, Chauhan SS, Simon S, Bilal S, et al. Research article biological sciences in iron deficient school age children. Int J Pharm Biol Sci. 2014;4(2):227:233.
16. Hassan L G, Umar K J, Adeyemi J O, Mohammed AS. Physicochemical Analysis of Albizia lebbeck L. Seed Oil. Bull Sci Assoc Niger. 2005;26:368–72.
17. Olaofe O, Ogungbenle HN, Akhadelor BE, Idris AO, Omojola OV, Omotehinse OT, Ogunbodede O. Physico Chemical and Fatty Acids Composition of Oils From. Int J Biol Pharm Allied Sci. 2012;1(3):355–63.
18. Anya A, Jack I, Osagie O. Synthesis and Characterization of Oil-Modified Alkyd Resin from Epoxidized Neem Oil. Am Chem Sci J. 2016;15(2):1–7.
19. Oshodi AA, Ogungbenle HN, Oladimeji MO. Chemical composition, nutritionally valuable minerals and functional properties of benniseed (Sesamum radiatum), pearl millet (Pennisetum typhoides) and quinoa (Chenopodium quinoa) flours. Int J Food Sci Nutr. 1999 Sep;50(5):325–31.
20. Abayeh O J, Aina E A, Okuonghae CO. Oil content and oil quality characteristics of some Nigerian oil seeds. J Pure Appl Sci. 1998;1(1):17–23.
21. Birnin-Yauri U, Garba S. Comparative Studies on Some Physicochemical Properties of Baobab, Vegetable, Peanut and Palm Oils. Niger J Basic Appl Sci. 2011;19(1):64–7.
22. Ajiwe V I E, Okeke C A, Nnabuike B, Ogunleye G A, Elebo E. Applications of oils extracted from African star apple (Chrysophyllum africanum), horse eye bean (Mucuna sloanei) and African pear (Dacryodes edulis) seeds. Bioresour Technol. 1997;59:259–61.
23. Mohammed M, Hamza Z. Physicochemical Properties of Oil Extracts from Sesamum Indicum L. Seeds Grown in Jigawa State – Nigeria. J Appl Sci Environ Manag. 2008;12(2):99–101.
24. Dangarembizi R, Chivandi E, Dawood S, Erlwanger KH, Gundidza M, Magwa ML, et al. Report-The fatty acid composition and physicochemical properties of the underutilised Cassia abbreviata seed oil. Pak J Pharm Sci. 2015 May;28(3):1005–8.
25. Akbar E, Yaakob Z, Kamarudin SK, Ismail M, Salimon J. Characteristic and composition of Jatropha curcas oil seed from Malaysia and its potential as biodiesel feedstock feedstock. Eur J Sci Res. 2009;29:396–403.
26. Eromosele CO, Paschal NH. Characterization and viscosity parameters of seed oils from wild plants. Bioresour Technol. 2003 Jan;86(2):203–5.
27. Akubugwo IE, Ugbogu AE. Physicochemical studies on oils from five selected Nigerian plant seeds. Pakistan J Nutr. 2007;6(1):75–8.
28. Moure A, Cruz JM, Franco D, Domínguez JM, Sineiro J, Domínguez H, et al. Natural antioxidants from residual sources. Food Chem [Internet]. 2001;72(2):145–71. Available from: http://www.sciencedirect.com/science/article/pii/S0308814600002235
29. Agbo E, Nemlin J, Anvoh BK, Gnakri D. Characterisation of lipids in okra mature seeds. Int J Biol Chem Sci. 2010;4(1):184–92.