COMPARATIVE STUDIES ON THE EXTRACTION, CHARACTERIZATION AND COMPARATIVE STUDIES OF SOME NIGERIAN SEED OILS

Supported by tetfund TERTIARY EDUCATION TRUST FUND

J. E. Asuquo[1], I. S. Udegbunam[2] and E. E. Etim[2]*

[1]Department of Chemistry, University of Uyo, Akwa–Ibom State, Nigeria

[2]Department of Chemical Sciences, Federal University Wukari, PMB 1020, Taraba State, Nigeria

*Corresponding author: emmaetim@gmail.com

Received: December 05, 2016 **Accepted:** February 24, 2017

Abstract: Physico-chemical properties of four Nigerian seeds namely: *Poga oleosa, Ricinus communis* L. (Castor seed oil), Butyrospernum parkii (shea butter), and Hevea brasilensis (rubber) seeds were extracted for its oils with six solvents: chloroform, ethanol, hexane, carbon tetrachloride, pet-ether and water were investigated using standard techniques. The oils were characterized for the following parameters: saponification value, unsaponifiable matter, iodine value, acid value, peroxide value, ester value, viscosity, refractive index, specific gravity, pH and moisture content. The results obtained for the tested parameters suggest that the oils investigated in this study have potential industrial applications such as in the manufacture of paints, soaps and hair products.

Keywords: Castor, physico-chemical, *Poga oleosa*, shea butter, rubber seed

Introduction

The world demand of vegetable oil is constantly increasing due to increase in world population. The production of vegetable oils and fat which is around 30 metric tonnes, is not enough to meet the needs of people, since fats and oils are required industrially for the manufacture of soap and other industrial purposes (Kovo and Bawa, 2007). Fats and oil whether the source is animal, vegetable or marine in origin represent the highest source of energy per unit weight that man can consume, being an important food source for man, they are also extensively used for nutritional, cosmetic industrial purpose, drying dispersant and in the therapeutics (Rauken and Kill, 1993). Vegetable oils account for 80% of the world's natural oils and fats supply (FAO, 2000), with increasing awareness of the importance of vegetable oils in the food, pharmaceuticals and cosmetics industries, there is need to search for indigenous plants species that can provide such oils and characterize them (Andrew *et al.*, 2012).

Castor oils derived from castor plant (*Ricinus communis* L.), represents a potential by-product and it is used in many technical, medical and different industrial application like biodiesel productions (Asuquo *et al.*, 2013a,b; Amara and Salem, 2009). Castor oil has over 1000 industrial uses and because of this, its demand increases. A scientific investigation of the crop to improve its oil content will go a long way to meet up with the demand (Sepidar *et al.*, 2009).

Shea butter oil botanically called *Butyrospernum parkii* is a soft paste of the melted fat with milky colour in solid form and brownish when melted. It has a characteristic odour, it contain fatty acid triglycerides and a high amount of unsaponifiable matter, which ranges from 2.5% to 15% (Asuquo *et al.*, 2010; Eka, 1997). The composition of the product depends on several criteria particularly the geographical occurrence, its botanical origin, handling of the seeds and processing (Astintoke, 1987). According to Tella (1979), Shea butter oil contains cinnamic acid, a substance that helps protect the skin from harmful ultra-violet rays. Crude shea butter has natural anti-oxidant properties due to its tocopherol content (Astintoke, 1987).

The rubber tree (*Hevea brasilensis*) (Asuquo *et al.*, 2012a), is exploited in Nigeria mainly for latex in view of its economic importance, the auxiliary products namely wood and seeds are mostly neglected (Hosen *et al.*, 1981). The seeds have been found to be rich in oil. Its contents in the dried kernel varies from 35 to 45%, it is semi-drying oil and consist of 17.22% saturated fatty acids and 17-82% unsaturated fatty acids and is comparable to drying oils commonly used in surface coating (Aigbodion and Pillai, 2000). Rubber Seed Oil (RSO) has been found to have potential applications in many areas amongst which are in the production of biodiesel as fuel for compression engines (Radmadhas *et al.*, 2005, Ikwuagu *et al.*, 2000).

African Brazil Nut (*Poga oleosa* pierre, *Rhizophoroceae*) is a medium sized tree up to 30 m high (Burkill, 1997). It is widely distributed from Nigeria to Congo region in the dense equatorial forest often along river banks and coastland. The tree produces edible nut used as condiments and cooking oil (Burkill, 1997). In human medicine, the oil is employed as a laxative in the treatment of gonorrhea and a massage oil.With the increasing global demands for shea butter, castor seed, rubber seed and *Poga oleosa* oils, a comparative study on the physico-chemical parameters arising from the characterization of the oils from Nigerian origin is essential. According to Sonau *et al.* (2006), the differences in the variation of the physico-chemical composition of vegetable oils have been often attributed to environmental factors such as rainfall, soil fertility, maturation period, agronomic practices and genetic substitution.

This study therefore, investigates the comparative analysis of the physico-chemical composition arising from their characterization.

Materials and Methods

Castor, Shea butter, Rubber seeds and *Poga oleosa* seeds were purchased from the South-eastern Nigeria. The seeds were dehulled, cleaned and dried under the sun for a day and later dried in the oven for three hours at 50^{o}C to ensure that water and moisture were removed. The seeds were immediately ground using mortar and pestle into a paste in order to weaken and rupture the cell. The paste was stored in a labeled airtight container for oil extraction. All chemicals and reagents used were analytical grade. In all cases, distilled water was used, (Asuquo *et al*., 2010, 2012a,b,c,d,e,f,g,h,i; 2013a,b).

Oil extraction

The Oils from the different pastes obtained was extracted with chloroform, ethanol, n-hexane, petroleum ether and water solvents for five hours using soxhlet apparatus, (Asuquo *et al*., 2010, 2012a, 2012b, 2013a).

Degumming and purification

The oils were heated to 60^{o}C and activated carbon added; this decolourized the oil. The bleached oils were mixed with water thoroughly and heated again to 60^{o}C, stirred vigorously for 15 min, filtered, cooled and the sludge on the filter paper was discarded. The extracted oils (purified) were transferred into glass bottles and stored in a refrigerator until all analyses were completed (Asuquo *et al*., 2010, 2012a,b,c,d,e,f,g,h,i; 2013a,b).

Physico-chemical characterization

Standard procedures of American oil Chemists Society were used for indices values (AOAC, 1997) procedures were applied for acid value (standard 969.17, 1997), iodine value (standard 965.33, 1997), saponification value (standard 920.16, 1997). Refractive index, colour, viscosity, melting point and specific gravity were determined using recommended methods (AOAC, 1997). Viscometer, refractometer and tintometer were used to determine viscosity, refractive index and colour, respectively. The unsaponifiable matter in the oil was determined using standard methods (AOAC, 1997) while the ester value was obtained by subtracting the acid value from the saponification value. The percentage of moisture content in the seeds was determined following the method recommended by AOAC (1997).

Results and Discussion

The results of the physicochemical properties of the four Nigerian seed oils considered in this study are summarized in Table 1. The saponification values for *Poga oleosa* oil, castor seed, shea butter and rubber seed oils were obtained as 214.58, 176.09, 185.20 and 193.61 respectively. The saponification value obtained for *Poga oleosa* oil (214.58) is higher than those of rubber seed oil (193.61), shea butter oil (185.20) and Castor seed oil (176.09). The saponification value helps to determine the quantity of alkali (in mg) needed to neutralize the acids and saponify the esters contained in 1 g of lipid (Roger *et al.,* 2010). The higher the saponification value of oil, the higher the lauric acid content of that oil, therefore *Poga oleosa* oil will be most suitable in production of soap. The saponification value obtained for *Poga oleosa* oil is slightly higher than those of the common oils such as soyabean (189-195), pea nut oil (187-196) and cotton seed oil (189-198) (Codex, 1993).

The values unsaponifiable matter for *Poga oleosa*, castor seed, shea butter seed and rubber seed oils were presented in Table 1 and were given as 8%, 0.5%, 5.68% and 0.7%. The value obtained for *Poga oleosa* oil (8%) was higher than those of other oils analysed (0.5%, 5.68%, and 7% respectively for castor seed, shea buter and rubber seed oils). The value obtained for shea butter oil (5.68%) was close to that reported by (Dhellot *et al.,* 2006) which was 5.1%. the values for the unsaponifiable matter obtained in the study for the various oils is however lower than those of other oils such as avacador pear (2.8%), dacryodes edulis (2.3%), red egusi seed oil(1.6%), *Cannarium schweinfuhil Engl.* (1.3%), sesame (1.2%), white melon (1.1%), palm kernel oil (0.22%) (Asuquo, 2008) except for *Poga oleosa* oil whose value is 8%.

Iodine value measures the degree of unsaturation in fat or vegetable oil (i.e. the number of double bonds) (Danith 2008). It determines the stability of oils to oxidation as well as allows the overall unsaturation of the fat to be determined quantitatively. Iodine values obtained for *Poga oleosa*, castor seed, shea butter and rubber seed oils were obtained as 57.87, 83.73, 63.45 and 134.51 respectively. The iodine values obtained for *Poga oleosa*, castor seed and shea butter oils classify them as non-drying oils. Non- drying oils have iodine values than 100 (Asuquo, 2008) these iodine values are lower than those of sunflower (110-143), soya bean (120-143), Coula-edulis (90-95) and rubber seed oil (134.51) (Abayeh *et al*., 1999). The low iodine values for *Poga oleosa*, castor seed and shea butter oils indicate the oils are rich in saturated fatty acids, which ensures stability against oxidation and rancidification of goods prepared with the oil (Goh, 1994).

Table 1: Physicochemical properties of *Poga oleosa*, castor seed, rubber seed and shea butter oils

Parameters	Oils			
	***Poga oleosa* oil**	**Castor seed oil**	**Shea butter oil**	**Rubber seed oil**
Saponification value	214.58	176.09	185.20	193.61
Unsaponifiable matter	8%	0.5%	5.68%	0.7%
Iodine value	57.87	83.75	63.45	134.51
Acid value	101.54	2.69	1.79	1.68
Peroxide value	26.67	14.40	14.20	14.40
Ester value	113.04	174.09	183.4	191.93
Viscosity	37.71	13.02 (poise)	17.78 (poise)	10.32 (poise)
Refractive index	1.39	1.47	1.60	1.46
Specific gravity	0.91	0.96	0.92	0.92
pH	4.78	5	NA	6
Colour	100% haze unit	Yellow	Milky cream	Dark brown
Moisture content	0.313%	8%	10%	8.6%
Taste	Tasteless	Nauseaating	Tasteless	NA
Opacity	clear	Clear	Fat (solid)	Clear
Melting point	NA	35-37^oC	51-56^oC	45-48^oC

The peroxide value obtained for *Poga oleosa*, castor seed, shea butter and rubber seed oils are 26.67, 14.4, 14.2 and 14.4, these values are higher than 10 which characterizes a number of conventional oils e.g. Amaranthus hybridis (Codex, 1993). Castor seed oil has a peroxide value of 14.4 lower than 64±2.20 reported by Abitogun *et al*. (2009) but lower than 14.2 reported for shea butter oil (Asuquo, 2008). *Poga oleosa* oil has higher peroxide value (26.67) than castor seed oil (14.4), shea butter (14.2) and rubber seed oil. Oils with higher peroxide value are more unsaturated than with lower peroxide values. More unsaturated oil is known to absorb more oxygen and develop higher peroxide values and oils with high peroxide values are prone to rancidity (Asuquo, 2008). The WHO/FAO stipulated a permitted maximum peroxide level of not more than 10 equivalents of peroxide oxygen/kg of the oils; therefore, since the oil in this study has a peroxide value above 10, it may not be suitable for consumption.

The ester value represents the number of milligrams of potassium hydroxide required to saponify the esters present in 1 kg of the oil. It is obtained as the difference between the saponification value and the acid value. The ester value obtained for *Poga oleosa*, castor seed, shea butter and rubber seed oils are 113.04, 174.09, 183.4 and 191.93 respectively. The ester value obtained for *Poga oleosa* oil (113.04) is lower than those of castor seed oil (174.09), shea butter oil (183.40) and rubber seed oil (191.93)

Acid value is used as an indicator for edibility of an oil and suitability for use in paint and soap making industries (Aremu *et al.,* 2006; Akubugwo *et al.,* 2008). The values for *Poga oleosa*, castor seed, shea butter, and rubber seed oils were obtained as 101.54, 2.69, 1.79 and 1.68 respectively. *Poga oleosa* oil has a high acid value (101.54) when compared to those other oils. The high acid value for *Poga oleosa* showed that the oil may not be suitable for use as edible oil, but may be useful for the production of paints, soaps and shampoos (Aremu *et al.,* 2006, Akintayo, 1997). The acid values obtained for shea butter (1.79) and rubber seed oils (1.68) are within the standard acid value for organic oil which is 2 (Nwankwo *et al.,* 1985). The acid value obtained for castor seed oil is slightly above 2.

The viscosity value obtained for *Poga oleosa*, castor seed, shea butter and rubber seed oils are 37.71, 13.02, 17.78 and 10.32 poise, respectively. The viscosity value for *Poga oleosa* oil (37.71) does not compare favourably with other seed oils in study, but compares favourably with those obtained for peanut (37.0), palm oil (39.6), rape seed oil (31.3), coconut oil (34.9) and corn oil (33.5) (Asuquo *et al*., 2010, 2012a, 2012b, 2013).

The refractive index values obtained for *Poga oleosa*, castor seed, shea butter and rubber seed oil were 1.39. 1.47, 1.60, and 1.46, respectively. These values are within the standard value for refractive index of organic oil which is between 1.3-1.6 (Kovo and Bawa 2007). Refractive index is an indication of the level of saturation of the oil.

The pH values of the four seed oils analysed were presented in Table 1. The values for *Poga oleosa*, castor seed, shea butter and rubber seed oils were obtained as 4.78, 5 and 6, respectively. The pH value of 6 obtained for rubber seed oil is slightly higher than castor seed and *Poga oleosa* oils (4.78). This value is an indication of the presence of reasonable amounts of free fatty acids and thus the advantageous utilization of the oil in soap making.

The specific gravity of *Poga oleosa*, castor seed, shea butter and rubber seed oils indices were also presented in table 1. The specific gravity of castor seed is higher than those of *Poga oleosa* oil (0.91), shea butter oil (0.92) and is in line with 0.9587 reported by Abitogun *et al.* (2009). The high specific gravity value of castor oil is attributed to the presence of hydroxyl groups in the oil. The specific gravity of shea butter oil (0.92) obtained is in agreement with that reported in literature (Lewkowitsch, 1969). The specific gravity of rubber seed oil was found to be similar to shea butter oil (0.92). Asuquo (2008) reported a specific gravity of 0.916 for RSO obtained from the Rubber Research Institute of Nigeria. The values of specific gravity obtained for these oils indicate that the oils are less dense than water.

The percentage moisture content of *Poga oleosa*, castor seed, shea butter and rubber seed oils were obtained as 0.313%, 8%, 10% and 8.6% respectively. The percentage moisture content obtained for rubber seed oil (8.6%) is in between those of shea butter oil (10%) and castor seed oil (8%) (Asuquo *et al.,* 2010). Low moisture content is an indication of good shelf life for the oil. Low moisture content of oil might be effectiveness of the distillation apparatus used for recovering the oil. (Asuquo *et al.,* 2010)

Conclusion

The four Nigerian oils: *Poga oleosa* oil, Castor seed oil, shea butter oil and rubber seed oils were analysed for physico-chemical parameters and the characteristics exhibited by these oils are of good quality and could be recommended for industrial use.

References

Abayeh OJ, Abdulrazak AK & Olagun R 1999. Quality characteristics of *Canarium schweiturthin*. *Engl*. *Oil Plant Goods for Human Nutr.,* 54(1): 43-48.

Abitogun AS, Alademeyin OJ & Oloye DA 2009. Extraction and characterization of castor seed oil. *The Internet J. Nutri. & Wellness*, 72(8): 100-105.

Aigbodion AI & Pillai CST 2000. Preparation analysis and applications of rubber seed oil and its derivatives in surface coating. *Prog. Org. Coat.,* 3: 187-192.

Akintayo ET 1997. Chemical composition, physicochemical properties of flutted pumpkin seed and seedoils.*Rivista Italiana Sotanze Grasse,* 74: 13-16.

Akubugwo IE, Chinyere GC & Ugbogu AE 2008. Comparative studies on oils from some common plant seeds in Nigeria. *Pak. J. Nutr.,* 7(4): 570-573.

Amara AA & Salem SR 2009. Degradation of castor oil and lipase production by *Pseudomonas aeruginosa. America-Eurasian J. Agric and Environ. Sci*., 5(4): 556-563.

Andrew C, Buba AA, Itodo AU & Etim EE 2012. Thermoxidative degradation of commonly used vegetable oils: A comparative study. *J. Emerging Trends in Engr. & Appl. Sci. (JETEAS)*, 3(6): 924-928.

AOAC 1997. *Official Methods of Analysis*, 17th Ed. Washington, DC,

Aremu MO, Olaofe O & Akintayo ET2006. Chemical composition and physicochemical characteristics of two varieties of Bambara groundnut (*Vigna subterrenea*) flours. *J. Appl. Sci.,* 6: 1900-1903.

Asintoke E 1987. Saponification studies of shea butter oil. An unpublished B.Sc. Project. University of Port Harcourt, 1-40.

Asuquo JE 2008. Studies on the adsorption of some selected metallic soaps onto hematite. Phd Dissertation, University of Port Harcourt, Nigeria.

Asuquo JE, Anusiem ACI & Etim EE 2010. Extraction and characterization of shea butter oil. *Wojast*, 2(2):282-288.

Asuquo JE, Anusiem ACI & Etim EE 2012a. Extraction and characterization of rubber seed oil. *Int. J. Modern Chem.*, 1(3): 109-115.

Asuquo JE, Etim EE, Ukpong IU & Etuk SE 2012b. Extraction, characterization and fatty acid profile of *Poga oleosa* oil. *Int. J. Modern Anal. & Separ. Sci.*, 1(1):23-30.

Asuquo JE, Anusiem ACI & Etim EE 2012c. Effect of temperature on the adsorption of metallic soaps of shea butter oil onto hematite.*Int. J. Modern Chem.*, 1(2): 83-92.

Asuquo JE, Anusiem ACI & Etim EE 2012d. pH effect on the adsorption of metallic soaps of shea butter oil onto hematite in aqueous media. *Int. J. Modern Chem.*, 2(2): 74-83.

Asuquo JE, Anusiem ACI, Etim EE & Umoh UE 2012e. Effect of temperature on the adsorption of metallic soaps of rubber seed oil onto hematite. *Int. J. Modern Chem.*, 1(3):135-143.

Asuquo JE, Anusiem ACI & Etim EE 2012f. Effect of pHon the adsorption of the metallic soaps of rubber seed oil onto hematite in aqueous medium. *Int. J. Modern Anal. & Separ. Sci.*, 1(1): 31-39.

Asuquo JE, Anusiem ACI & Etim EE 2012g. Studies on the effects of pHand temperature on the adsorption of metallic

soaps of castor seed oil. *Int. J. Chem. Sci.*, 5(2): 248-252.
Asuquo JE, Anusiem ACI & Etim EE 2012h. Studies on the effect of pH on the adsorption of the metallic soaps of shear butter, castor and rubber seed oils. *Int. J. Modern Engr. Sci.*, 1(3): 105-117.
Asuquo JE, Anusiem ACI & Etim EE 2012i. Comparative study of the effect of temperature on the adsorption of metallic soaps of shea butter, castor and rubber seed oils onto hematite. *Int. J. Modern Chem.*, 3 (1):39-50.
Asuquo JE, Anusiem ACI & Etim EE 2013a. Extraction and Characterization of Castor seed oil from the South-Eastern Nigeria. *Int. J. Res. & Advan. Physical Sci.*, 3(1): 79-82.
Asuquo JE, Anusiem ACI & Etim EE 2013b. Extraction and Characterization of Castor seed oil from the South-Eastern Nigeria. *Int. J. Res. & Advan. Physical Sci.*, 3(1): 79-82.
Burkill HM 1997. The Useful Plants of West Tropical Africa. 2nd ed. Royal Botanic Gardens, Kew, pp. 504-505.
Codex Alimentarus Commission 1993. Graisses et huiles vegetables. Division II version abregle, FAO, WHO Codex, Stan 20-1981-23-1981.
Dhellot JR, Matoula EMG, Nsikon JM, Safon-Ngoma DG, Linda M, Desobry S & Parmentier M 2006. Extraction, chemical composition and Nutritional characterization of vegetable oils: Case of *Amaranthus hybridis* (Var. 1 and 2) of Congo Brazzaville. *Afr. J. Biotech.*, 5(11): 1095-1101.
Eka OU 1997. Properties and potentials of rubber seed oil. West African Journal of Biological and Applied Chemistry 20:45-53
FAO 2000. Cooperate: Document Respiratory Minor oil crops. Available on http:/www.fao.org/docrep/CX5043E06.htm
Goh E 1994. Formulation of lauric oil containing food products and their performance in proceedings of world conference on lauric oils. Sources, Processing and Applications/Applewhite. AOCS, Champaign, AOCS: pp. 38-103.
Hosen BM, Chin HF & Hor YZ 1981. Fruit and seed development in *Hevea* in Maylasia. *Institute of Rubber Res. Institute, Maylasia*, 32: 101-110.
Ikwuagu OE, Ononogbo IC & Njoku OU 2000. Production of biodesel using rubber seed oil. *Ind. Crop. Prod.*, 12: 57-62.
Kovo AG & Bawa AA 2007. Extraction and Characterization of oil from *Accia nilotica* seeds by different solvents. *J. Eng. App. J.*, 2: 572-575.
Lewkowitsch JJ 1969. Chemical technology and analysis of oils, fats and waxes. The Macmillan Co. New York, pp. 134-136.
Nwankwo BA, Aigbekaen EO & Sagau GA 1985. Estimate of rubber (*Hevea brasiliensis*) seed production in Nigeria. In:Industrial Utilization of rubber, seed, latex and wood. Proceeding of national conference. Ephraim E. Enabor (ed). Rubber Reasearch Institute of Nigeria, pp. 78-87.
Ramadhas AS, Jayaraj S, Muraleedharam C 2005. Characterization and the effect of using rubber seed oil as fuel in the compression engines. Renew. *Ener*. 30: 795-803.
Rauken MD & Kill RC 1993. Fats and fatty foods: in food industries Manual, 23rd Ed. Longman, London, pp. 288-327.
Roger AB, Rebbecca RA, Georges A & Mathia IO 2010. Chemical characterizationof oil from germinated nuts of several coconut cultivars (*Cocos nuciferhl*). *Eur. J. Scient. Res*, 39(4): 514-522,
Sepidar S, Zurina ZA, Robiah Y & Azhari M 2009. Extraction of oil from Jatropha seed-Optimization and Kinetics. *Am. J. Appl. Sci.*, 6(7): 1390-1395.
Sonau H, Picard N, Lovett PN, Dembele M, Koko A, Diarrisso JB & Bouvet JM 2006. Phenotypic variation of agromorphological traits of the shea tree, *Vitellaria paradoxa*, C.F, Geartinin mail. *Genetic Resources and Crop Evol*., (53): 145-161.
Tella AB 1979. Preliminary studies on nasal decongestant activities from seed of the shea butter tree (*Butyrospernum parkii*). *Pharmacology*, 7(5): 495-497.