Chemistry and Materials Research
ISSN 2224- 3224 (Print) ISSN 2225- 0956 (Online)
Vol.6 No.9, 2014

Cleaning Agent from Natural Rubber Seed Oil (RSO) and Cassava Peels Ash Extract

O.F Osagie G.K Fekarurhobo
Department of Chemistry, Rivers State University of Science and Technology P.M.B 5080 Port Harcourt. Rivers State
Email: osagieof@gmail.com; fridayomons@yahoo.com

Abstract
The most widely known cleansing agent today is soap. The production of soap using natural rubber seed oil (RSO) and alkali derived from cassava peels ash extract was determined. Prior to the production of soap, physico-chemical analysis of the RSO was determined. The alkali from the cassava peels ash extract was made to react with the RSO to produced the soap. The soap was analysed to determine it chemical composition and efficacy. The values for Foamability, Foam stability, Total fatty matter (TFM), Total free alkali (TFA), Free carbonate alkali, (FCA), Free caustic alkali (Fca) and P^H were found to be 321.10ml, 6.13hrs, 60%, 9.6%, 4.7%, 4.9%, and 10.6 respectively. The value from the produced soap analyses has revealed that the soap produced from locally sourced agro based waste has a quality very similar to any standard soap (Lux) which may be due to the crude nature of the soap and the presence of impurities. These impurities can be removed through purification of the ash alkali extract and the RSO. The result obtained from this study has revealed that soap produced using locally sourced materials from agricultural waste have the potential to compete favourably with any standard soap.
Keywords: Cassava peels, Cleaning agent, Rubber seed oil, Soap, Saponification

INTRODUCTION

Soap is an anionic surfactants used in conjunction with water for washing and cleaning. It consist of sodium or potassium salts of fatty acids and is obtained by reacting common oils or fats with a strong alkaline solution in a process known as saponification. The production of crude soap was initiated 3000 years ago in the Nile valley and other early centres of civilisation. The Romans were also known to be considerable users of soap to the extent that urine was used as a source of ammonium carbonate for cleaning purposes (Wigner, 1940).

Alkali refers to a soluble base, usually the hydroxide or carbonate of potassium or sodium. Locally, it could be produced from ashes by extraction with water. When produced this way, it is usually referred to as potash. It is generally believed that the highest soluble metal is potassium, though this depends on the species of the plant material and the type of soil where the plant grows. In previous works on plant materials, Taiwo and Osinowo (2001), Kevin (2002) and Afrane (1992) reported that the alkalis from the ash were mainly carbonate of potassium and sodium. In the work of Onyegbado *et al*. (2002), Nwoko (1980), Onyekwere (1996) and Kuye and Okorie (1990), it was reported that the alkalis were hydroxides of potassium and sodium. Adewuyi *et al*. (2008) confirmed that the alkalis were mainly carbonates of sodium and potassium. However, it could be observed that the soluble mineral in ashes is not always mainly alkali: high potash content may yield very low alkali, depending on the sources of the ashes. The term soda ash instead of potash may be used if the major alkali metal contained is sodium.

Potash has been described as a white crystalline residue that remains after aqueous extract from ashes is evaporated (Kevin, 2003).

Saponification is the conversion in basic solution, of fats and oils to produce glycerol and salts of fatty acids. This is one way of making soap.

Fat or oil + NaOH $\rightarrow$ glycerol + sodium salt of a fatty acid (soap)

Fat or oil + KOH $\rightarrow$ glycerol + potassium salt of a fatty acid (soap)

Generally, soap making is based on alkaline hydrolysis reaction (saponification), according to the equations:

$C_3H_5(OOCR)_3$ + 3NaOH $\longrightarrow$ 3NaOOCR + C_3H_5OH
(Fat) (Sodium hydroxide) (Soap) (Glycerol)

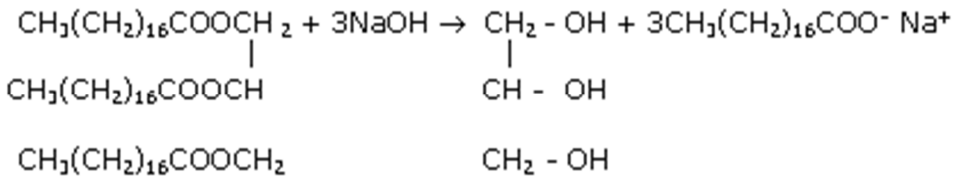
Or

$C_3H_5(OOCR)_3$ + 3KOH $\longrightarrow$ 3KOOCR + C_3H_5OH
(Fat) (Potassium hydroxide) (Soap) (Glycerol)

where R represents the hydrocarbon chain or alkyl group.

One naturally occurring fat is glycerol tristearate. When this is heated with a base such as sodium hydroxide or potassium hydroxide or potassium carbonate conversion occurs forming glycerol and a salt that is soap**.**

fat/oil	+	base	→	glycerol	+	salt (soap)
e.g. glycerol tristearate		e.g. sodium hydroxide				e.g. sodium tristearate



Manufacture of soap and detergents in Nigeria with the use of imported caustic potash as a source of alkali for soap production has caused price of soap to become very high and expensive, due to high exchange rate. In any developing country, small scale industries are sourcing for local substitutes for imported raw material, hence, they are always advocating for available microfinance support from banks.

Although at present, palm oil and palm kernel oil for the local soap making in Nigeria are readily available, nearly all the alkali for soap making are imported. Furthermore, Nigeria at present lack the resources to build a modern alkali plant. Following the call by the Federal government of Nigeria, for industries to as much as possible source their raw materials locally, attention has been shifted to agricultural waste which was reported to contain a good percentage of alkali needed in soap making. Also, the use of Rubber Seed Oil (RSO) in place of palm oil and palm kernel has continuously evolved because, palm kernel oil and palm oil are in short supply due to their importance in food and pharmaceutical industries.

The aim of this study is to explore the use of agricultural waste in liquid soap production by using rubber seed oil and cassava peels as source of alkali.

EXPERIMENTALS

Collection of Cassava Peels and Rubber Seeds

Cassava peels were collected from Luebe Community in Khana Local Government Area, Rivers State, Nigeria. The Rubber (*Hevea brasiliensis*) seeds were obtained from a rubber plantation at Okwale Community in Khana Local Government Area of Rivers State, Nigeria.

Extraction of Oil from Rubber Seed

The rubber seeds were decorticated, cleaned and dried under the sun for a day. The kernel was later dried in the oven for three hours at 35°C to ensure that water and moisture were removed. 500g of the kernel were immediately grounded 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. N-hexane was added to the paste in the container and mix for oil extraction. The mixture was filtered to separate the paste from the oil.The extracted oil was put in an evaporating dish for 24 hours to evaporate the n-hexane The oil was later put in an oven at 60^{o}c for another 24 hours to remove any remaining n-hexane.The oil was then collected and stored in a label airtight container for further used.

Extraction of Alkali from Cassava Peels

1000g of the cassava peel were air dried for 14 days. The dried cassava peels were broken into small pieces and later burnt gradually in an open air. The ash was left to cool and put in a polythene bag. The ash was collected and soaked in 1000ml distilled water for three days. The ash was separated from the liquid extract by filtration using a conical flask, funnels, and filter paper. The resultant extract/filtrate was kept save for further used.The P^{H} of the alkaline solution was measured

Physicochemical analysis of rubber seed oil

Physical characterization

Specific gravity

A dried, clean 50ml capacity density bottle of know weight was filled with RSO the weight of the oil was recorded. The both was washed, dried and cooled in a desiccators the bottle was them filled with water and the weight of water was recorded, the density of the oil was calculated thus:

Specific gravity at 30^{o}c = $\frac{\text{weight of sample (RSO)}}{\text{weight of equal volume of water}}$

Refractive index
In the determination of refractive index, the prison of a refractometer was cleaned using soft paper and acetone after which 5 drops of the RSO were placed on it. The prison was closed firmly and the lamp was swung against it. The switch button at the back of the instrument was used to adjust the alignment mark until the centre mark was aligned on the cross hair and the reading was taken.

Colour
The colour of rubber seed oil sample was determined by physical eye identification.

P^H
P^H meter was dipped into the rubber seed oil and the P^H reading was recorded.

Clarity
The clarity of rubber seed oil sample was determined by physical eye identification.

Odour
The odour of the rubber seed oil was determined by the direct inhalation of its smell with nose.

Chemical Characterization

For acid value
2g of the RSO was dissolved in 50ml of neutralized solvent of equal volume of diethyl ether and absolute ethanol. the resultant solution was titrated with 0.1M KOH solution using phenolphthalein as indicator. The acid value was calculated using the expression;

$$\text{Acid value (AV)} = \frac{(VXMX\ 5.61x0.142)}{2}$$

Where V = volume of titrant (KOH) in ml
M = Molarity of standard KOH
W = Weight of grams of samples.

Free fatty acid
10g of sample was dissolved with 50ml neutral solvent of equal volume of ethanol and diethylether in a 250ml conical flask. This solution was titrated with 0.2M KOH using phenolphthalein as indicator. the free fatty acid (FFA) was expressed in terms of oleic acid and was expressed by the formula,
FFA = V x M x Ma/10w
Where M = Molarity of KOH
Ma = Molecular weight of oleic acid (282)
W = weight in grams of samples and
V = Volume of KOH in ml

Iodine value
The sample under determination was weighed and dissolved in 15ml of carbon tetrachloride and agitated thoroughly and then allowed to stand for about 30mins in dark. 100ml of distilled water and 20ml 10% (w/v) potassium Iodide was added to the mixture and filtered with 0.1M standard sodium thiosulphate using 0.5% (w/v) starch solution as indicator. blank solution was also carried out in similar manner. The iodine value (IV) was calculated as follows:

$$IV = \frac{(b-a) \times M \times 12.69}{W}$$

Where M = Molarity of standard sodium thiosuphate
W = weight of sample in grams used,
b = volume in ml of sodium thiosulphate titrated in blank.
A = volume in ml of sodium titrated in test.

Saponification Value
2g of RSO was dissolved into a 15ml 0.5M ethanolic potassium hydroxide solution in 250mI round buttom flask with a reflux condenser. The flask was heated in a steam bath and occasionally swirled to effect saponification as the solution starts to boil, the heating was effected for 30mins, After heating; the hot soap solution formed was titrated with standard

0.5M hydrochloric acid using phenolphthalein as indicator. A blank titration was also done in the same manner. The saponification value (S.V) was expressed as

$$S.V = \frac{28.0\ 05 \times (b - a)}{W}$$

Where: M = Molarity of hydrochloric acid
W = weight of samples in grammes used
b = Volume in ml of hydrochloric acid titrated in blank and
a = Volume in ml of hydrochloric acid titrated in test.

Preparation of Soap Sample (Saponification Process)
150g of the rubber seed oil was added to 300ml of the alkali extract in a beaker. The mixture was heated to about 50^{o}C with stirring for about 30 minutes. NaCl (table salt) was added to the mixture to separate the soap mass from the glycerol. The mixture was allowed to cool. The soap formed a cake on the surface of the beaker while a solution of glycerol was below. The solution of glycerol was removed by piercing the soap mass and pouring out the solution. The soap sample with a milky colour was stored in a container for further analysis. The P^{H} of the soap was measured.

Physico-chemical analysis of soap sample
Physical analysis
Foamability tests
About 5.0g of the soap sample was dissolved in a 1000ml measuring cylinder containing 10ml of distilled water. The mixture was shaken vigorously so as to generate foams. After shaken, the cylinder was allowed to stand for some time. The height of the foam in the solution was measured and recorded.
The procedure was repeated a second time.

Foam Stability tests
5g of soap sample was dissolved in a measuring cylinder containing 100ml of distilled water. The mixture was shaken vigorously so as to generate foams.
After shaken, the cylinder was allowed to stand for some time. The time taken for the foam/lather to completely dispersed/disappeared was recorded as a measure of the foam stability.The experiment was repeated.

Chemical analysis
Total Fatty Matter (TFM) of Soap Sample
3g of soap sample was dissolved in 30ml-distilled water and the volume adjusted to 10ml. The solution was allowed to cool and then made acidic with 0.1m sulphuric acid. The solution was then extracted with 30ml diethy1 ether and then with another three-15ml portions of diethyl ether. The combined ether extracts was filtered into flask and the ether evaporated. The weight of the total fatty matter was obtained by subtracting the weight of the ether extracts form initial weight of the soap sample.

Total Free Alkali (TFA) of Soap Sample
of soap sample was added to 50ml of neutralized ethanol in a conical flask on steam bath until the soap sample was dissolved. The solution was heated to boiling. 2 drops of phenolphthalein was added to the solution and then titrated with 0.1m sulphuric acid to end point. The total free alkali is calculated as Na_2co_3 oxide using the relationship,
Weight (g) of TFA = molarity of acid * molar mass of oxide * volume of acid used.

Free Caustic Alkali (FCA) of Soap Sample
5g of the soap sample was dissolved in a 100ml volumetric flask containing 50ml of distilled water. 5mls of barium chloride solution and 2 drops of phenolphthalein solution were added to the solution respectively and mix..The precipitate was allow to settle 25ml of the clear liquid was draw off and titrated with 0.1mol sulphuric acid. The amount of free caustic alkali in the soap was calculated using the relationship: FCA = molarity of acid * formula weight of barium chloride * volume of acid used.

Free Carbonate Alkali (Fca) of Soap Sample.
Free carbonate Alkali was determined by subtracting the free caustic alkali from total free alkali. Mathematically,
Free carbonate alkali = TFA - FCA

Wash-Active-Substance (WAS) of Soap Sample

About 20g of the soap sample was put in a 100ml beaker. 30ml of neutralized ethanol was added to the soap sample in the beaker. The solution was refluxed for 50 minutes over steam bath and then allowed to settle down. 2-4 drops phenolphthalein was added. The solution was filtered and the resulting precipitate was washed with 25ml neutral ethanol then boiled and filtered as before into the beaker containing the filtrates. The washings were repeated five times. The combined filtrates were evaporated to dryness over a steam bath and the residue was dried in an oven at 80^{o}c constant weight. The paste obtained is the WAS.

RESULT

The following results were obtained for the RSO before saponification .

TABLE 1: Physicochemical analysis of Rubber Seed Oil

S/N	Parameter	Rubber Seed Oil
1	Color	Yellow
2	Clarity	Clear
3	Odour	Unpleasant
4	Refractive index	1.46768
5	pH	5.4
6	Viscosity	26.843 poise
7	Specific gravity	0.91g/m1
8	Peroxide value	15.1meq/kg
9	Acid value	23.46 mg KOH/g
10	Iodine value	99.60 Ig/100g
11	Saponification value	201.42 mg/KOH/g
12	Free fatty acid	11.73mgKOH/g

TABLE 2 Analysis of the produced cleaning agent (Soap)

Parameters	Value of Prepared Soap sample	Value of Lux Soap (control)	Remark
Foamability (ml)	321.1	330	Marginal difference due to the crude nature of the soap
Foam Stability (hrs)	6.13	6.33	Almost similar
Total Fatty Matter	60	65	Difference in oil used.
Total Free Alkali	9.6	4.6	Difference in the alkalinity of the base.
Free Caustic alkali	4.7	4.6	Similar
Free Carbonate Alkali	4.9	1.3	Difference due to multiple carbonates in ash extract.
Wash – Active – Substance	23.50	35.78	Difference is due to presence of impurities in soap sample
pH	10.6	12	Differences in base.

The result obtained from the analysis of the soap sample for foamability gave 321.10ml. This value is marginally different from the result obtained by Beetseh and Anza (2013) in their study on the Chemical characterization of local black Soap (Chahul Mtse) made by using cassava peels ashes (alkali base) and palm oil (330ml) and the result obtain from the analysis of standard Lux soap (335ml). This marginal difference may be due to the crude nature of the soap sample and raw materials.

The result obtained from the analysis of the soap sample for foam stablity gave 368.00mins (6hrs 13mins). This value is almost similar to the result obtained by Beetseh and Anza (2013) in their study on the Chemical characterization of local black Soap (Chahul Mtse) made by using cassava peels ashes (alkali base) and palm oil (6hrs 33mins) and the result obtain from the analysis of standard Lux soap (6hrs 40mins).

The result obtained from the analysis of the soap sample for total fatty matter (TFM) gave 60.0%. This value is similar to the result obtained by Beetseh and Anza (2013) in their study on the Chemical characterization of local black Soap (Chahul Mtse) made by using cassava peels ashes (alkali base) and palm oil. They found out that the total fatty matter is 62.0%. The result is however lower than the result obtained from the analysis of standard Lux soap (65.0%). The differences in values may be due to the differences in the composition of oil used for the soap production process.

The result obtained from the analysis of the soap sample for total free alkali (TFA) gave 9.6%. This

figure is higher than the result obtained by Beetseh and Anza (2013) in their study on the Chemical characterization of local black Soap (Chahul Mtse) made by using cassava peels ashes (alkali base) and palm oil found the total free alkali to be 6.7%. It is also higher than the result obtain from the analysis of standard Lux soap with 4.6%. This increase may be due to the differences in alkalinity of the soap samples.

The result obtained from the analysis of the soap sample for free caustic alkali (FCA) gave 4.7%. This value is a little higher than the result obtained by Beetseh and Anza (2013) in their study on the Chemical characterization of local black Soap (Chahul Mtse) made by using cassava peels ashes (alkali base) and palm oil (2.95). This result is however almost similar to the result obtain from the analysis of standard Lux soap with 4.6%.

The result obtained from the analysis of the soap sample for free carbonate alkali gave 4.9%. This figure is a little higher than the result obtained by Beetseh and Anza (2013) in their study on the Chemical characterization of local black Soap (Chahul Mtse) made by using cassava peels ashes (alkali base) and palm oil. They found free caustic alkali to be 3.8%. This result is also higher than the result obtained from the analysis of standard Lux soap with 1.3%. This increase may be due to the presence of multiple carbonates in the ash extract.

Wash – Active – Substance

The result obtained from the analysis of the soap sample for wash – active – substance (WAS) gave 23.50%. This figure is a lower than the result obtained by Beetseh and Anza (2013) in their study on the Chemical characterization of local black Soap (Chahul Mtse) made by using cassava peels ashes (alkali base) and palm oil. They found free caustic alkali to be 35.78%. This result is also lower than the result obtained from the analysis of standard Lux soap with 35.80%. This decrease may be due to the present of impurities in soap sample.

CONCLUSION

The result obtained in this research has shown that soap with similar characteristic and washing efficiency can be produced using locally source materials from agricultural waste and non edible oil. It is recommended that if the soap produce from locally source material are well purified, they can compete favourably with other toilet soap. This soap, if well prepared can be used as an inexpensive source of soap for industrial cleaning. Sand or pumice may be added to produce a scouring soap (Helmenstine, 2012). The use of raw materials from agricultural waste for the production of soap have left so much room for manufacturers to explore and satisfy the tastes of soap users, create more jobs as well as make profits and further investments.

REFERENCES

Abdullah, B.M. and Salimon, O. (2009). Physicochemical characteristics of Malaysian rubber (*Hevere brasiliensis*) seed oil. *European Journal of Science.* vol. *31*: 431-445

Adewuyi, G.O., Obi-Egbedi N.O and Babayemi, J.O. (2008) Evaluation of ten different African wood species for potash production. *International Journal of Physical Science*, Vol. 3: 63-68.

Afrane, G. (1992) Leaching of caustic potash from cocoa husk ash. *Journal of Bio-resources Techlonogy*, volume 41: 101-104

Akpan, U.G., Jimoh, A. and Mohammed, A.D. (2006). "Extraction, Characterization and `Modification of Castor Seed Oil". *Leonardo Journal of Sciences,* vol. 8: 43-52

Aigbodion, A. I. and Bakare, I. O (2005) Rubber seed oil quality assessment and authentification. *Journal of American Oil Chemistry. Vol. 82*: 465-469.

Aigbodion, A. I., Okiemen, F. E, Obazee, E. O.; Bakare, I. O (2003). Utilization of malenilized rubber seed oil and its alkyd resin as binders in waterborne coatings. *Prog. Org. Coat.* Vol. *43*: 28-31.

Aigbodion, A. I.; Pillai, C. S. T (2000) Preparation, analysis and applications of rubber seed oil and its derivatives in surface coatings. *Prog. Org. Coat*. Vol. *38*, 187-192

Albright and Wilson (1974) Chemicals: Industrial Chemical Soap, Perfumery and Cosmetics. Albright & Wilson Americas Inc., Glen Allen, Virginia, USA. P. 6

Aremu, M. O.; Olaofe, O.; Atolaiye, B. O.; Amos, V. A (2008) The physicochemical properties and fatty acid composition of sponge luffa *(Luffa cylindrica)* kernel oils. In: Proceedings of the Chemical Society of Nigeria. Petroleum Training Institute, Effurum-Warri, Delta State, Nigeria.

Asuquo, J. E.; Anusiem, A. C. I.; Etim, E. E (2010) Extraction and characterization of shear butter oil. *World J. App. Sci. Tech*., Vol. *2*: 282-288.

Asuquo, J.E. (2008) *Studies on the Adsorption of Some Selected Metallic Soaps onto Hematite*. Ph.D. Dissertation, University of Port Harcourt, Nigeria.

Beetseh, C.I and Anza, M.K. (2013) Chemical characterization of local black Soap (Chahul Mtse) made by using cassava peels ashes (alkali base) and palm oil in North Central Zone of Nigeria. *Journal of Civil and Environmental Research,* 3(4): *2013*

Bwade, K.E., B. Aliyu, and A. M. Kwaji (2013) Physicochemical Properties of Pumpkin Seed Oil Relevant to Bio-diesel Production and other Industrial Applications. *International Journal of Engineering, Business and Enterprise Applications*, 4(1): 73

Chevreul, M.E. (1876) The art of soap making. Crosby Lockwood & Co., London. P. 45

Davis, J.P., Dean, L.O. Faircloth, W.H. Sanders, T. H. (2008). "Physical and Chemical Characterization of Normal and High Oleic Oils from Nine Commercial cultivars of peanut". *Journal American Oil Chemists Society,* vol. 85:235-243

Edewor, J.O. (1984) Chemicals Production From Local Fossil Fuels and the Nigerian Balance of Trade. *Journal of the Nigerian Society of Chemical Engineers, Vol. 3: 5-9.*

Eka, H. D.; Aris, T.Y. and Nadiah, W.A. (2010). Potential use of Malaysian Rubber (Hevea brasiliensis) Seed as Food, Feed and Biofuel. *International Food Research Journal,* vol.17: 527-534

Ekpa, O.D., Akpanabiatu, M., Mauro, A. and Renzo, R. (2000) Varietal Differences and Polymorphism in Palm Oil: A Case Study of Palm Oils Blended with Coconut Oil. *Global Journal of Pure & Applied Science, Volume 2:* 277-282.

Ekop, S.A., Etuk, B.A. and Eddy, N.O (2007) Effect of Some Local Additives on the Chemical Constituent of Palm Oil, *Journal of Applied Science and Environmental Management,* 11(1): 85-89.

FAO (2000). *Cooperate: Document Respiratory Minor Oil Crops*. Available on http.//wwwfao. orgIdocrop;x5043E/X5043EOb.ttm. xxxsen Georg (12).

Fariku, S., Ndonya, A.E., and Bitrus, P.Y. (2007). "Biofuel Characteristics of Beniseed (sesanumindicum) Oil". *African Journal of Biotechnology* 6(21):2442-2443

Finar, L. (2000). Organic Chemistry. The English Language Book Society and Longman Group. 6th ed. London. P. 41

George, K. T.; Reghu, C. P.; Nehru, C. R. (2006). By products and auxiliary source. In: *Natural Rubber Agro-management and Crop Processing*, Gerge P. J. and Furuvilla Jacob C. (Eds.). Rubber Research Institute of India, Kottayam, pp.504-520

Hayes, K.C. and Khosla, P. (1994) Cholesterolaemic Effect of Saturated Fatty Acids of Palm Oil. *Food and Nutrition Bulletin. 15(2):345-349.*

Hosen, B. M., Chin, H. F., Hor, Y. Z (1981) Fruit and seed development in *Hevea* in Malaysia. *Journal of Rubber Research Institute Malaysia*, Vol. *32*, 101-110.

Ikhuoria E.U., Aigbodion A.I., Okiemen F.E, (2004) Enhancing the quality of alkyd resins using methyl ester of rubbers seed oil. *Tropical journal pharmaceutical research*, 3(1) 311-317.

Ikwuagwu, O. E.; Ononogbo, I. C.; Njoku, O. U (2000) Production of biodiesel using rubber seed oil. *Industrial Journal of Crop Production*. Vol. *12*: 57-62.

Irvine, F.R. (1965) West African Crops. Oxford University Press, 3rd Edition, pp 97 -114.

Iyayi, A. F.; Akpaka, P. O.; Ukpeoyibo, U.; Balogun, F. E.; Momodu, I. O. (2007) Rubber seed oil with great potentials. *Chemical Technology Journal*, Vol. *3*: 507-516.

Jacob, C. O.; Srinvas, P.; Prem, E. E.; Manju, M. J.; Mushrif, S.; Idicolla, S. P. (2007) Rubber seed oil for partial substitution of mineral oil used as carrier for copper fungicide in the management of abnormal leaf fall disease of rubber. *Journal of Rubber Research, Vol. 10*: 54-61.

Kelvin, M.D (2002) A primitive alkali: Potash Caveman Chemistry. *Universal Publishers*, Australia, pp. 23-24.

Kinglake, J. (1998), Formulating Liquid Detergent for Domestic Household Use. *Journal of Soap, Perfumery and Cosmetics, Volume 54: 151-155.*

Kingzett, E.O. (1978) In. "Detergent and Emulsifier". Annual Report, New Jessey.

Kirk, R.E. and Othmer, D.F. (1954) Encyclopaedia of Chemical Technology, 2nd Edition, pp 573-589.

Kovo, A. G. and Bawa, A. A. (2007) Extraction and characterization of oil from *Accia- niloticia* seeds by different solvents. *Journal of Engineering. Vol. 2*: 572-575.

Kuye, A.O and Okorie C (1990) Factors Affecting The Lixiviation of Palm Bunch Ash As A Source of Alkali For Soap Production. *Ife Journal of Technology 3(2): 33-37.*

Kyari, M.Z. (2008) Extraction and characterization of seed oils. *Journal of Int. Agrophysics*, Vol. *22*: 139-142.

Laszio, V. (1978) World Consumption of Soap and Detergent. *Journal of Soap, Perfumery and Cosmetics, Volume 53: 581-585.*

Nwankwo, B. A.; Aigbekaen, E. O.; Sagay, G. A (1985) Estimates of rubber (*Hevea brasiliensis*) seed production in Nigeria. In: *Industrial Utilization of Rubber: Seed, Latex and Wood*. Proceeding of Natural Conference, Ephraim E. Enabor (Ed). Rubber Research Institute of Nigeria, pp.78-87.

Nwoko, V.O. (1980) Chemical Processing Development. *Proceedings of the 10th Annual Conference of the Nigerian Society of Chemical Engineers 40 -53*.

Nwoko, V.O. (1982). Effects of Mixing Oils on the Preparation and Properties of Soap. *Private Communications,* vol. 9: 10

Nzikou, J.M., Mvoula-Tsieri, M. Pambou-Tobi, N.P.G. Ndangui, C.B. Kimbonguila, A. Silou, Th. M. Linder,

Scher, J. and Desobry, S. (2010). Proximate Composition and Seed Oil from Terminalia Catappa L. and Their Kinetics of Degradation of the Oil during Heating. *Australian Journal of Basic and Applied Science,* Vol.7: 2039-2047

Onifade, K.R. (1994) The Potential Application of Cocoa Pod Husks for the Manufacture of Caustic Potash. *Journal of Agricultural Technology vol. 2: 59 -64*

Onyegbado, C.O. (1984) Feasibility of Soap Production for Bright Future Soap Industries, *Private Communications*, vol. 22: 17

Oyegbado, C.O; Iyagba, E.T. and Offor, O.J. (2002) Solid Soap production using plantain peels ash as source of alkali. Journal of Applied Science and Environmental Management, Volume 6: 73-77

Onyekwere, C. (1996) Cassava Peels Ash: An Alternative Source of Alkali in Soap Production B.Eng. Thesis Department of Chemical Engineering, University of Port Harcourt, Port Harcourt, Nigeria, 1-33.

Onwuka, G.I. (2005). "Food analysis & instrumentation", Napthali publishers, Lagos, Nigeria, p. 45

Panduranga, R., Thirumala, S.D., and Reddy, B.R. (1971) The Storage Behaviour of Decorticated and Undecortieated Saower Oil. *Journal of Indian Oil Soap, 36(3): 233-238*.

Ramadhas, A. S.; Jayaraj, S.; Muraleedharan, C. Characterization and the effect of using rubber seed oil as fuel in the compression engines. *Journal of Renewable. Energy*. Vol. *30*, 795-803.

Rotondi, E. (1908) In. Simmons W. H. and Appleton H. A. " The Handbook of soap manufacture. Scott, Greenwood & Son, London, p. 17

Swern, D. (1964) Bailey's Industrial Oil and Fat Products, *Journal of Intersciences*, vol. 3: 43-48

Taiwo, O.E. and Osinowo F.A.O. (2001) Evaluation of various agro-wastes for traditional soap production. Journal of Bio-resource Technology, Vol. 79: 95-97

Woollat, E., (1985) The Manufacture of Soap, Other Detergents and Glycerol, 1st ed., *John Wiley & Sons*, New York, p. 474.

Wigner, J. H. (1940) Soap Manufacture: The Chemical Processes. Chemical Publishing Co. Inc., New York, p. 37.

The IISTE is a pioneer in the Open-Access hosting service and academic event management. The aim of the firm is Accelerating Global Knowledge Sharing.

More information about the firm can be found on the homepage:
http://www.iiste.org

CALL FOR JOURNAL PAPERS

There are more than 30 peer-reviewed academic journals hosted under the hosting platform.

Prospective authors of journals can find the submission instruction on the following page: http://www.iiste.org/journals/ All the journals articles are available online to the readers all over the world without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. Paper version of the journals is also available upon request of readers and authors.

MORE RESOURCES

Book publication information: http://www.iiste.org/book/

IISTE Knowledge Sharing Partners

EBSCO, Index Copernicus, Ulrich's Periodicals Directory, JournalTOCS, PKP Open Archives Harvester, Bielefeld Academic Search Engine, Elektronische Zeitschriftenbibliothek EZB, Open J-Gate, OCLC WorldCat, Universe Digtial Library , NewJour, Google Scholar