

## Extraction, Characterization and Application of Cashew Nut (*Anacardium occidentale*) Oil

\*S.N. Ezem, <sup>1</sup>R.E. Ezem & <sup>2</sup>L.O. Ojokoh

<sup>1</sup> Department of Food Technology  
Akanu Ibiam Federal Polytechnic, Unwana Afikpo, Ebonyi State  
Department of Science Laboratory Technology  
Akanu Ibiam Federal Polytechnic, Unwana Afikpo Ebonyi State

E-mail: stellaezem@gmail.com, ezemreg2006@yahoo.com & ujuezem@gmail.com

### ABSTRACT

The oil was extracted from the sun-dried cashew seeds by soxhlet method. The oil content of the seeds was found to be 40%. The oil extracted was characterized and used for soap-making. The golden yellow oil had saponification and iodine values of 168 and 215 mg g<sup>-1</sup> respectively. It was a non-drying oil. The relative density of the oil was found to be 0.81. The soap produced with the oil was soft and cream colored. The characteristics determined for the soap included alkalinity, chloride and moisture contents, matter insoluble in ethanol and water. The values obtained compared favorably with the specifications of the Nigeria Industrial Standards (NIS).

**Keywords:** Soxhlet extraction, characterization, *Anacardium occidentale*, non-drying oil.

### INTRODUCTION

Natural oils traditionally fall into two main classes – oils from animal origin and oils from vegetable origin. The need to identify and characterize animal oils, such as sperm whale oil, is diminishing owing to world wide efforts to reduce the use of animal-based products. However, the use of vegetable-based oils is on the increase for a wide range of applications. For the most part, the oils are extracted from seeds or nuts and are used for a wide range of application including food products, soap products and cosmetics, various industrial products, such as lubricants, resins, paints, etc and for producing raw materials, such as glycerol, carboxylic acids and various chemical intermediates (Lescano *et al.*, 2015).

Vegetable oils are primarily composed of glyceryl esters in the form of triglycerides of various saturated and unsaturated carboxylic acids.

They are classified in terms of drying (highly unsaturated materials), semi-drying (similar to drying oils but contain less unsaturated materials) and non-drying (usually contain mono-unsaturated compounds) oils. They are differentiated by properties such as freezing point, iodine value and saponification value (Denniston *et al.*, 2008; Carey, 1992).

The cashew tree is one of the plants from which oil is extracted from the nut. The cashew plant belongs to the family Anacardaceae. It was classified based on Hutchinson's system as *Anacardium occidentale*. It is 6-9 m high, a spreading evergreen tree, native of Brazil, but now grown widely in Western Africa and India for its edible nuts and resinous oil. Both the oil and kernel are contained in the shell. It spreads throughout the tropics but its commercial production is centered in India, which handles 90 percent of the world trade. It has a full bearing age of eight years. Its kernel oil is hardly extracted because the nut commands a high price as food delicacy (Hutchinson, 1959).

Annual production of the nuts stands approximately at 0.2 million tons from wild and cultivated trees in tropical Africa, India, East Africa (especially Tanzania) and the Mediterranean areas. The fruit has a large cone shaped apple with a small nut attached to the large end of the apple. The seed, a dicot is whitish with a thin brown covering. Some species are yellow, while others are red when ripe. Both the juicy, fleshy apple and the nut kernel are edible. The cashew apple is very juicy, sweet, delicately scented and acidic. It is an excellent source of Vitamin C, containing 9 times more than an orange (Hutchinson, 1959; Cobley and Steels, 1976; Mac Daniels, 1990).

## MATERIALS AND METHODS

### Sample Collection and Identification

Ripe cashew fruits were harvested from the tree located at the point of entry into Nmasioha Street Afikpo, Afikpo North Local Government Area of Ebonyi State. The fruits were taken to a Chief

Superintendent of Forestry. Mr. N.I. Ndubuisi of Forestry Division, Michael Okpara University of Agriculture, Umudike, Abia State for identification. He identified it as *Anacardium occidentale* based on Hutchinson's system.

### Sample Preparation

The nuts were plucked out from the fruits and sun-dried for seven days before cracking them for the kernels. The kernels were ground in a mortar and stored in a sterile sample bottle.

### Determination of Oil Content

Ground *Anacardium occidentale* seeds 10 grams, were weighed out and placed in a thimble (sample holder) and carefully inserted into the extraction chamber of the soxhlet extractor. 100 cm<sup>3</sup> of pet ether (40-60 °C) were measured into a weighed 250 cm<sup>3</sup> round bottom flask. The round bottom flask contained some anti-bumping chips to ensure a stabilized boiling session. The heating was done by means of a regulated hot plate. The timing was started when the round bottom flask received the first delivery of extract through the inner tube of the soxhlet extractor. The extraction was allowed to run for an hour. The round bottom flask, containing the extract, was next placed on a thermostat heating mantle, and the solvent was carefully distilled and collected into a receiver flask, leaving only the yellow oil in the already weighed flask. The round bottom flask with the extract was kept in the desicator to cool before reweighing. The difference in mass was recorded. A blank was run (with an empty thimble). The percentage oil content was calculated as shown below (Heys, 1973) and the result is presented in table 1.

$$\% \text{ Oil content} = \frac{(a-b) \times 100}{W}$$

Where: a = mass of oil  
b = mass of residue from blank  
W = mass of seed sample

## DETERMINATION OF THE SAPONIFICATION VALUE OF CASHEW NUT OIL

The cashew nut oil 0.5 gram was accurately weighed and placed in a 250 cm<sup>3</sup> conical flask fitted with an air condenser. The oil was dissolved in 10 cm<sup>3</sup> absolute ethanol and thereafter 10 cm<sup>3</sup> of 2.5 M KOH were added. This experiment was performed in duplicate and also a blank (omitting the oil) was run. The two conical flasks were refluxed on a sand bath for two hours and later cooled. Two drops of the phenolphthalein indicator were added and un-reacted potassium (I) hydroxide was titrated with standard 0.25 M oxalic acid until the pink colour just disappeared (Vishnoi, 1979).

### Calculation:

$$\text{Saponification value of oil} = \frac{56 \times (V_1 - V_2) \times 1000}{2000 \times W}$$

Where:  $V_1$  = volume of 0.25 M oxalic acid used for blank  
 $V_2$  = volume of oxalic acid used for sample

$$\begin{aligned} \text{Actual volume of 0.25M oxalic acid used} &= (V_1 - V_2) \text{ cm}^3 \\ &= V_1 - V_2 \text{ of 0.5 M KOH} \end{aligned}$$

solution

$$W = \text{mass of oil used as sample}$$

## DETERMINATION OF THE IODINE VALUE

One gram of the oil was accurately weighed and dissolved in 20 cm<sup>3</sup> chloroform in a 500 cm<sup>3</sup> conical flask. To this was added 25 cm<sup>3</sup> of Wij's solution. The flask was stoppered, swirled and allowed to stand in the dark for one hour (with occasional shaking). Next were the additions of 20.0 cm<sup>3</sup> of potassium (I) oxide solution and 100 cm<sup>3</sup> water. Iodine was liberated. This liberated iodine was titrated with standard sodium thiosulphate solution using freshly prepared starch as indicator. The final disappearance of the blue black colour of the indicator marked the end point and the burette reading was noted. A blank experiment was performed (Vishnoi, 1979).

### Calculation

$$\text{Iodine value} = \frac{(V_1 - V_2) \times M \times 127 \times 100}{W \times 1000}$$

Where:  $V_1$  = volume of sodium thiosulphate used for blank  
 $V_2$  = volume of sodium thiosulphate used for sample  
 $M$  = concentration of sodium thiosulphate solution  
 $W$  = mass of sample (in grams)

### DETERMINATION OF THE RELATIVE DENSITY OF CASHEW NUT OIL

The dry (empty) density bottle was weighed and completely filled with the cashew nut oil. The stopper was inserted, excess oil wiped away and the bottle reweighed (with oil). The bottle was emptied, washed with liquid detergent, rinsed several times with distilled water and later filled to the brim with distilled water. The stopper was inserted, excess water wiped away and the bottled (with distilled water) weighed again, (Moss, 1971).

$$\text{Relative Density (RD)} = \frac{\text{Mass of the substance}}{\text{Mass of an equal volume of water}}$$

$$\text{Relative Density} = \frac{W_2 - W_1}{W_3 - W_1}$$

Where:  $W_1$  = mass of the empty bottle in gram  
 $W_2$  = mass of bottle filled with oil in gram  
 $W_3$  = mass of bottle filled with water in gram

### PREPARATION OF SOAP FROM KERNEL OIL OF THE CASHEW NUT

Fifty grams of the cashew nut oil were heated to 90-95 °C in an evaporating basin over a low argent flame. 20 cm<sup>3</sup> of the caustic soda (32 % w/v) solution were added ( 2 drops at a time), then stirred continuously. When all the caustic soda had been added, the stirring was continued until the whole mass in the dish became emulsified

and the mixture stiffened to such an extent that it got attached to the glass rod. The approximate time of stirring was half an hour. The saponified mass was allowed to cool before scraping it into a 400 cm<sup>3</sup> tall beaker and adding about 60 cm<sup>3</sup> of hot water. It was next heated over a low flame with continuous stirring, and after half an hour when the content of the beaker appeared to be a thick even paste, hot saturated brine solution was added with continuous stirring until the soap just broke quickly and evenly from the surface of a spatula dipped into it. When sufficient brine had been added, the glass rod was removed and the mixture was allowed to stand overnight. By morning time a solid layer had separated and remained on the top of the beaker. The spatula blade was run around the outside of the layer to remove the cake and the 'lye' (the liquid from underneath) was poured away. The soap was kept in a large watch glass to dry and was weighed (Unilever, 1964).

#### DETERMINATION OF THE LATHERING POWER OF THE SOAP

One gram of the soap was placed in a test tube containing 20 cm<sup>3</sup> of tap water and shaken for one minute. The soap produced later abundantly. This was a qualitative test for the lathering power of soap, hence does not require any calculation (Longman, 1975).

#### DETERMINATION OF THE TOTAL FATTY MATTER IN THE SOAP

Five grams of the soap were weighed out, dissolved in 100 cm<sup>3</sup> of water and three drops of methyl orange indicator were added. The solution was transferred into a separating funnel. 15 cm<sup>3</sup> of 30 % H<sub>2</sub>SO<sub>4</sub> were next added to split the fatty acid and the system was allowed to cool. 100 cm<sup>3</sup> of diethyl ether were added into the separating funnel and after shaking, the system was allowed to stand for the layers to separate. More diethyl ether (50 cm<sup>3</sup>) was added, shaken and allowed to separate. The organic layer was collected, washed several times with distilled water until the solution was neutral. The diethyl ether was allowed to evaporate. The residue was

weighed as the total fatty matter. A blank experiment was also run (A.S.T.M., 1975).

### Calculation

$$\% \text{ Total fatty matter (TFM)} = \frac{(c - b) \times 100\%}{W}$$

Where: c = mass of total fatty matter  
b = mass of residue from blank  
W = mass of soap sample

### DETERMINATION OF WATER-INSOLUBLE MATTER IN THE SOAP

Five grams of the soap were placed into 100 cm<sup>3</sup> of distilled water previously placed in a clean, dried beaker and set on a water bath to facilitate dissolution. The system was stirred slowly and continuously by means of a clean glass rod until as much of the sample as possible went into solution. The rod was rinsed to prevent loss of sample. The volume was then made up to 200 cm<sup>3</sup> mark. Filtration of the solution through a dried and previously weighed Whatman number 4 filter papers followed. All the remnants in the beaker were rinsed into the filtering funnel with distilled water. A control experiment was performed using dried and weighed filter paper and distilled water only. The two results were recorded and the difference between them is the correct mass of water-insoluble matter in the soap (A.S.T.M., 1975).

### Calculation

$$\% \text{ Water-insoluble matter} = \frac{(z - y) - b \times 100\%}{W}$$

Where: z = mass of filter paper + residue  
y = mass of filter paper alone  
W = mass of soap sample  
b = mass of residue from blank

## DETERMINATION OF UNSAPONIFIED MATTER IN THE SOAP

Six grams of soap were weighed out and heated and dissolved in 50 cm<sup>3</sup> ethanol: water (1:2). The solution was transferred into a 500 cm<sup>3</sup> separatory funnel and allowed to cool. 100 cm<sup>3</sup> of diethyl ether were next added to the cooled solution, shaken and allowed to stand. The organic and aqueous layers separated. Another 100 cm<sup>3</sup> of diethyl ether were added to the mixture, shaken and allowed to stand. Yet another 100 cm<sup>3</sup> of diethyl ether were added into 20 cm<sup>3</sup> of 10 % KOH, before the final mixture was added into the sample solution and shaken. The aqueous and organic layers separated on standing. The organic layer was collected in a weighed beaker and the organic solvent was allowed to evaporate, leaving the unsaponified matter in the beaker. The beakers with its contents were reweighed. A blank was run without the soap sample (A.S.T.M., 1975).

### Calculation

$$\text{Unsaponified matter} = \frac{W - W_b \times 100}{W_s}$$

Where:  $W$  = mass of unsaponified matter obtained  
 $W_b$  = blank value  
 $W_s$  = mass of soap sample used

## DETERMINATION OF CHLORIDE CONTENT OF SOAP BY TITRIMETRIC METHOD

Ten grams of the soap were weighed and dissolved in 150 cm<sup>3</sup> distilled water in a 250 cm<sup>3</sup> volumetric flask. Twenty cm<sup>3</sup> of 25 % calcium nitrate were added into the soap solution and the mixture was shaken vigorously. The solution (turbid) was made to the mark with distilled water. One hundred cm<sup>3</sup> of the filtrate were transferred into a clean dry conical flask, 3 drops of 1% potassium chromate solution was added as indicator and titrated with 1.0 M silver nitrate solution to a brick brown end point (Jacobplain, 1968).

### Calculation:

$$\text{Chloride content} = \frac{V_t \times C_v \text{ MM} \times 100}{\%}$$



$$100 \times W_o$$

Where:  $V_I$  = titre value i.e volume of the titre at end point  
 $C_v$  = molar concentration of  $AgNO_3$  used  
 $MM$  = molar mass of the chloride ion  
 $W_o$  = mass of soap sample used

## DETERMINATION OF THE MOISTURE CONTENT OF THE SOAP BY INDIRECT METHOD

Five grams of the soap were weighed into a Petri-dish and the gross mass of both was recorded. The Petri-dish (with the soap) was placed in an oven and dried at the temperature of  $105\text{ }^\circ\text{C}$  for  $1\frac{1}{2}$  hours. It was next cooled in a dessicator and weighed. The procedure of drying and cooling before weighing was done repeatedly until a constant mass was obtained. The initial drying period was  $1\frac{1}{2}$  hours, the subsequent ones were 30 minutes each (Jacobplain, 1968).

### Calculation

$$\% \text{ Total moisture content} = \frac{M_2 - M_1}{M_o} \times 100 \%$$

Where:  $M_2$  = mass of Petri-dish + sample before drying  
 $M_1$  = mass of Petri-dish + sample after drying  
 $M_o$  = initial mass of sample

## RESULTS AND DISCUSSION

The characteristics of the oil extracted from the kernels of *Anacardium occidentale* and the soap made from it are shown below, respectively in tables 1 and 2.

### CHARACTERISTICS OF OIL EXTRACTED FROM *Anacardium occidentale*

Table 1: Characteristics of oil extracted from *Anacardium occidentale*

Oil Characteristic	Value obtained
Iodine value	21.5 $\text{mg g}^{-1}$
Saponification value	168 $\text{mg g}^{-1}$
Relative density	0.81
Oil content	40%
Colour	golden yellow

### Physical and Chemical characteristics of the soap

**Table 2:** Characteristics of the soap prepared from *Anacardium occidentale* oil

Soap Characteristic	Experimental value	Specification by the N.I.S. (% mass)
Appearance	Fine	-
Colour	Cream	-
Texture	Soft	-
Total fatty matter (TFM)	69	62 minimum
Matter insoluble in water	0.086	0.20 maximum
Unsaponified matter	0.35	0.2
Chloride content as NaCl	0.68	1.0
Moisture content	12.00	-

The iodine value of the oil obtained was 21.5 mg g<sup>-1</sup>, a low value indicative of the fact that the degree of unsaturation is equally low and that the oil is a non-drying one. A saponification value of 168 mg g<sup>-1</sup> was fair enough to encourage its use for soap making. The quality and quantity of soap produced made the oil attractive for soap making. The Relative density of the oil (0.81) reflects a reasonable parafinic content hence could lend itself to soap production (Ajiwe and Ogunleye, 1997). The percentage oil content (40%) is also encouraging.

The total fatty matter in the soap was good enough and reflects the amount of active matter in the soap as derived from the oil. The total free alkali was determined as excess NaOH. The value obtained was low and showed that the saponification process was stoichiometric enough. The soap was completely soluble in ethanol in practice, but a degree of turbidity was quite visible. The value obtained was low expectedly, since no soap builders were added into the soap. The soap dissolved in water on heating giving a greater turbidity than it gave in ethanol. The unsaponified matter in the soap reflects the presence of such unsaponifiable substances like glycerol, phospholipids, pigments, sterols, carbohydrates, vitamins etc. and lends credit to the suitability of the oil for soap making. The brine went into the soap

making process at the point of salting out (at the end of the saponification process) so if it is present in the finished product it might have been occluded in the soap. However, the value obtained was below the standard (Longman, 1975).

Low moisture will add to the keeping quality or shelf life of the soap. The Nigerian Industrial Standards did not show any specification for moisture content (Ajiwe and Ogunleye, 1997). The quality and quantity of soap (40.0g) produced made the oil attractive for soap making.

## CONCLUSION

The oil extraction by soxhlet extractor was an efficient method. The application of the cashew nut (*Anacardium occidentale*) oil in the soap making proved that it is possible to make good quality soap from the oil but it may not be economical to go into large scale production due to the fact that the kernel commands a high price as food delicacy. If a queue could be taken from India which cultivates the plant and commands 90% of the world trade of the cashew, a lot more oil could be produced from its source and would encourage or enable soap production on a large scale from the oil.

## REFERENCES

- Lescano, C.H.; Oliveira, I. P.; Silva, L.R.; Baldivia, D.S.; Sanjnez-Argandona, E.J.; Arruda, E.J.; Moraes, I.C. F.; Lima, F.F. (2015). Nutrients content, characterization and oil extraction from *Acrocomia aculeate* (Jacq.) Lodd. fruits, *African Journal of Food Science*, 9(3), pp. 113-119.
- Denniston, K.; Topping, J.; Caret, R. (2008). *General, Organic, and Biochemistry*, 6<sup>th</sup> edn., McGraw Hill Companies, New York, U.S.A., pp 581-616.
- Carey, F.A. (1992). *Organic Chemistry*, 2<sup>nd</sup> edn., vol. 1, Hoffman Press Inc., U.S.A., pp. 1058-1093.

Ajiwe, V.I.E. and Ogunleye, G.A. (1997). Application of oils extracted from African Star Apple, House Eye Bean and African Bear Seed, *J.Chem. Soc. Nig.*, vol. 3, pp. 259-262.

American Society for Testing Materials, (1985). Philadelphia, A.S.T.M. Publication division, pp. 48-50.

Cobley, L.C. and Steels, W.N. (1976). *An Introduction to the Botany of Tropical Crops*, 2nd edn., Longman, London, pp. 121-122.

Heys, H.L. (1973). *New Organic Chemistry*, Harrap publishers, London pp. 18-19.

Hutchinson, E.F. (1959). *The Families of Plants in Dicotyledons*, 2<sup>nd</sup> edn. vol.I, Oxford University Press, London, pp. 56-59.

Jacobplain, B. (1968). *Unilever Methods of Analysis*, Eyre and Spottiswoods Ltd, Portsmouth, pp. 1-4.

Longman, G. F. (1975). *The Analysis of Detergents and Detergent Products*, John Wiley and Sons Ltd, London, pp. 333, 434.

Mc-Daniels, L.H. (1990). Cashew In: *McGraw Hill Encyclopedia of Science and Technology*, 6<sup>th</sup> edn., vol. 3, McGraw Hill Book Company, New York, p. 278.

Moss, G. L. (1971). *Practical Physics*, 2<sup>nd</sup> edn., Heinemann Educational Books, London, p. 12. Nigeria Industrial Standard Specification for the Manufacture for Soap.

Unilever, (1964). *The Preparation of Soap, Laboratory Experiments No. 1*, Eyre and Spottiswoode Ltd, Ports-Mouth, pp. 1-4.