Extraction and Characterization of Cashew Nut Oil

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Abstract- **This paper studied the extraction, characterization and utilization of cashew nut oil. Soxhlet apparatus was used for the extraction using hexane as the solvent. The percentage of oil extracted from the shell of the nut was 22.9% while that of the kernel was 8.96%. The results of the physical and chemical analysis showed that the cashew nut shell liquid (CNSL) is a dark brown, non toxic substance whose properties such as the saponification value, refractive index, and iodine value conformed to a greater extent with that exhibited for the linseed oil. This suggests its application in the processing and manufacturing industries. The characterized cashew kernel oil (CKO) is a light yellow non toxic substance whose physical and chemical properties such as the mentioned ones above matched well with that of melon and groundnut oil and thus could be used in the food and pharmaceutical industries.**

I. INTRODUCTION

The cashew plant, "Anacardium Occidentale" is a native of central and South America with its main center of variation in eastern Brazil. Cashew is now grown in many parts of the world where its growth is not limited by cold. The annual world production of cashew nut – the main commercial product of the cashew plant is about 200,000 times and more than 50 percent of these production comes from south Asia and East Africa, especially India and Tanzania. Small quantities of cashew nuts are produced in West Africa, in the Mediterranean area, and in other parts of the world.(Rice et al,1987)

The most important product of the cashew tree is the nut, which is used in confectionery. In addition, the cashew apple is consumed locally and is rich in vitamins A and C. The shell of the nut yields phenol-containing oils which are used for preserving and waterproofing and, after distillation, for oil proof brake lining, inks, cement and so on(Lawrence,1987).

Cashew is an important export crop in southern Asia, Brazil, India and parts of Africa, and is grown locally in many other parts of the lowland tropics at elevation of up to 1000m. Since the crop must be harvested by hand, production is dependent on inexpensive labour for harvesting, the overall requirements for growing the crops, however, are low and plants will grow in relatively dry, infertile soils. (Rice et al., 1987)

However, cashew yields two types of oils. One of these is found between the seed coat (or pericarp) and the nut which is called cashew nut shell liquid (CNSL). It is not triglycerides and contains high proportion of phenolic compounds. It find uses in industry as a raw material for brake lining compounds, as a water proofing agent, a preservative, and in the manufacturing of paints and

plastics. It is non toxic but corrosive to the skin (Macmillan, 1994).

Edible oil can be extracted from cashew nut but no evidence of these being carried out commercially has been found. Due to the high value of cashew nuts even small pieces find a market in a confectionary product. (Lawrence, 1987)

The major producing countries for the cashew nut include Tanzania, India, Mozambique, Srilanka, Kenya, Angola, Madagasca, Thailand, Malaysia, Nigeria, Indonesia and Senegal. The global production from the world bank data estimates that 97% production is from wild trees and only 3% from established plantation (Lawrence, 1987). The cashew seed which develops below the penduncle is kidney shaped contains the kernel or cashew nut of commerce sorrounded by an oily liquid cashew nut shell liquid (CNSL). The kernel contains 47% oil. This shows that it contains a considerable amount of oil compared with other known oil seeds. (Macmillan, 1994)

Leaching is a method of extraction used to obtain the oil from the seeds. This is basically of two methods; either a pressure method or solvent extraction process. (Rice et al, 1987)

Thus, it has become necessary to extract and characterize the oils to expose the uses such as raw materials for brake lining compounds, water proofing agent, preservatives and in the manufacturing of paints and plastics.

II. MATERIALS AND METHODS

The cashew nuts were obtained from Kaduna state, at a farm located in Barnawa, and were sun dried for about two weeks. It was later transferred to the laboratory where it was decorticated and processed by cleaning, soaked in water to avoid scorching. It was then dried again after which shelling took place to separate the kernels from the shell, which are free of cracks. This was done manually by placing them on a flat stone and cracked with a wooden mallet. The resulted products are the kernels and the shell.

A Extraction of Oil

250g of both the dried kernels and the shell were crushed in a mortar separately and screened for homogeneity in size ranges. The kernel was then transferred in batches into the thimble of a soxhlet extractor. 200ml of hexane was added to extract the oil for 4hours. The percentage kernel oil extracted was then calculated and recorded. The same procedure was repeated for the shell.

B. Characterization of Cashew nut Oil

The characterization of the oil obtained was undertaken through physical and chemical analysis.

1) Physical analysis

Standard tests were carried out to determine the specific gravity, boiling point, refractive index, density and the viscosity of the oil.

2) Specific Gravity.

An empty container was weighed on a weighing balance and the weight noted, then it was filled up with water and the weight also noted. The container was emptied and the refilled with cashew nut oil and the weight noted. Therefore, the specific gravity of the oil was calculated by taking the ratio of the weight of the same volume of oil to the volume of water. The values were recorded.

3) Boiling Point

The oil was heated in a container of which a thermometer was inserted until the first bubble was observed. The temperature was noted and recorded.

4) Refractive Index

Few drops of oil were placed on the face of a refractometer and gently spread, then closed and tightened. An ample time was allowed for the oil and process to attain an equilibrium temperature thereafter the refractive index of the oil was read and recorded.

5) Density

The weight of an empty beaker was noted, then 2ml of the cashew nut oil was poured into it and the weight was also noted the difference in weight gives the weight of the oil. The density was then calculated using the expression.

Density = mass / volume

6) Viscosity

The viscosity of the oil was determined by the use of viscometer and the value was read and recorded at a temperature of 40.8^{0}C.(Akpan et al,2004).

C. CHEMICAL ANALYSIS

Standard chemical analysis were carried out to determine the free fatty acid (FFA), acid value, saponification value, iodine value, acid value and the pH of the cashew nut oils.

1) Acid Value

2g of the oil was weighed into a 250ml conical flask and 25ml neutral ethyl alcohol was added. The mixture was heated over a water bath for about 30 minutes. The flask and the content were cooled to room temperature and a few drops of phenolphthalein indicator added. This was titrated with the standard 0.1M solution until a faint permanent pink colour appeared at the end point.

The acid value was then calculated using the formula

$$\text{Acid value} = \frac{5.61Y}{weight(oil)sample}$$

where Y is the no of ml of 0.1M KOH used

5.61 represents the amount of KOH in mg present per each ml of 0.1 of 0.1M KOH solution (100ml of 1MKOH = 56g of KOH).

2) Saponification Value

2.5g of the oil sample weighed and transferred into250 conical flask fitted with a reflux condenser.50ml of 0.5 potassium hydroxide solution in 96% ethanol w saponified under reflux for about 20 minutes exc potassium hydroxide was determined by back titration w an aqueous standard 0.5M hydrochloric acid solution (H in the presence of a phenolphthalein indicator.

A blank experiment was performed using the procedure above but without using the oil, this was titrated with HC above.

The saponification value was calculated using

$$\text{S.V} = \frac{(P-Q)mlX\,28}{weight(oil)sample}$$

where P and Q are the Vol. in ml of HCl in the blank and test experiment respectively.

Note: 1000ml of 0.5M KOH solution contain 56/2 = 28g KOH i.e. 1ml of 0.5M KOH solution contains 28 mg of KOH.

3) Iodine Value

5g of oil was weighed into a 250ml conical flask. 20m carbon tetrachloride (CCl_4) was dissolved in the oil 25ml of iodine (wij's solution) was added. The conten the flask were mixed and stirred, then kept in a cupboard for 30 minutes. The flask was then removed 20ml of 15% potassium iodide solution was added, m well and then 100ml of distill water was added u shaking.

The liberated iodine was slowly titrated with 0.1M of sodium. Thiosulphate solution using 5ml of starch as indicator until the yellow colour changed to blue. Further addition of sodium thiosulphate will decolorize the solution. Blank experiment was performed by repeating the entire procedure without using the oil. The iodine value was then calculated using.

$$IV = \frac{(B-S)mlX126.9}{weight(oil)sample}$$

where B = Blank titre value and S= Titre value

4) Free Fatty Acid

12.5 ml of diethyl ether was mixed with 12.5ml of ethanol in a beaker. The solution was poured on 5g of the oil in the flask and 0.5mg of phenolphthalein was added. The solution was titrated against 0.5 ml of sodium hydroxide with constant shaking until a dark pink colour was observed; the titre value was noted and recorded

5) pH

The pH meter's electrode was lowered into a buffer solution. The temperature was adjusted to 50°C using the temperature control. The instrument was then calibrated at a buffer of pH 7. The electrode was removed from the buffer solution, rinsed and then placed in the beaker containing the oil, the pH of the oil was noted and recorded.(Atofarati,2004)

III. RESULTS AND DISCUSSION

238.75g and 237.5g of dried shell and the kernel of the cashew nut used for the extraction yielded only 22.9% and 8.96% cashew nut shell liquid (CNSL) and cashew kernel oil (CKO) respectively. The results of the physical and chemical properties of the oils are shown in Tables 1 and 2.

From Table 1, the colour of the CNSL and CKO were observed to be dark brown and light yellow respectively. The specific gravity of 0.883 and 0.801 reported for the oils which is lower than that of castor oil (0.958-0.969). (Weiss, 2000). The oils have boiling point of 125°C and 123°C for the CNSL and CKO, and the refractive index of 1.436 and 1.431 at 29°C respectively. These refractive indices are lower than that of melon seed oil (1.4697) and linseed oil (1.4655). (Bertha,1992) and (Weiss,2000) respectively. The refractive index is useful in detecting adulteration of oil which is achieved by comparing the values in the literature with that of the test sample.

From Table 2,the percentage free fatty acid of the oil are 56% and 81% for the CNSL and CKO respectively, the acid value of the CNSL was 3.2mg KOH/g and that of CKO was found to be 3.5mg KOH/g. The saponification value which is a measure of the molecular weight of fatty acid present in the oil was found to be 192mg KOH/g for both oil. The iodine value was 180 for CNSL and 84 for CKO, and it is of the properties of unsaturated organic components and tells the reactivity of the double bond. The pH of the oils was 5.3 and 5.6 for the CNSL and CKO respectively.

Generally, the physical and chemical properties of the characterized kernel oil shows to a greater extent conformity with the standard values obtained for the properties exhibited for the melon oil and groundnut oil as reported by Bertha (1992) and Weiss (2000). This shows that it could be used in the food and pharmaceutical industries (Greencottage, 2004).

The cashew nut shell liquid (CNSL) on the other hand comprised of both the acidic and non acidic substances called the anacardic and the cardol respectively (Adarsharnour, 2004). It also showed to some extent conformity with the standard physical and chemical

properties of the castor and linseed oil (Weiss, 2000). This suggests its application in the processing and manufacturing industries (Adarsharnour, 2004).

IV. CONCLUSION

The oils extracted by Soxhlet apparatus using hexane as solvent has percentage yield of 22.9% of cashew nut shell liquid (CNSL) and 8.96% cashew kernel oil (CKO). The cashew nut shell liquid (CNSL) is dark brown with a characteristic odour while the kernel oil is a light yellow liquid with a sweet odour. The physical and chemical properties of the oils show that they are within specification for the vegetable oils, while there is a slight variation in the specific gravity and the refractive indices. This could be due to the presence of impurities in the oil as they are not in their refined state. The pH values showed that the oils are non toxic. The oils contain some of the materials responsible for their applications in the food/pharmaceutical and manufacturing industries. Therefore, there is need for further research work to determine the properties of these materials and their percentage compositions.

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TABLE 1: RESULTS OF THE PHYSICAL PROPERTIES OF THE CHARACTERIZED OIL

S/No	PROPERTIES	CNSL	CKO
1.	Colour	Dark brown	Light yellow
2.	Odour	Characteristic	Sweet
3.	Specific gravity	0.883	0.801
4.	Boiling Point	125°C	123°C
5.	Refractive index at 29°C	1.436	1.431
6.	Density 29°C	0.907	0.823
7.	Viscosity at 29°C	$3.62x10^{-3}$ kg/m.s	$3.60x10^{-3}$ Kg/m.s

TABLE 2. RESULTS OF THE CHEMICAL PROPERTIES OF THE CHARACTERIZED OIL

S/No	PROPERTIES	CNSL	CKO
1.	Free fatty acid	56%	81%
2.	Acid Value	3.2	3.5
3.	Saponification Value	192mg KOH/g	192mg KOH/g
4.	Iodine Value	180mgKOH/g	84mg KOH/g
5.	pH	5.3	5.6

TABLE 3: SOME STANDARD PROPERTIES OF COMMERCIAL GROUNDNUT OIL (WEISS, 2000)

S/NO	PROPERTIES	VALUES
1.	Melting point	0-3°C
2.	Iodine value	82-106
3.	Saponification value	188-195
4.	Free fatty acids	0.02-0.60%
5.	Refractive index	1.4697-1.4719
6.	Density at 29° C	0.910-0.915
7.	Colour	Light yellow

TABLE 4: SOME STANDARD PROPERTIES OF LINSEED OIL (WEISS, 2000)

S/NO	PROPERTIES	VALUES
1.	Melting point	0°C
2.	Iodine value	180
3.	Saponification value	192
4.	Unsaponification	0.5-1.5%
5.	Refractive index	1.4655
6.	Density at 29° C	0.902-0.907