Extraction and Physiochemical Studies of Oil from Dry Cashew (Anarcardium occidentale) Seed from Wukari Taraba State Nigeria

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Abstract:
In this study, Soxhlet extraction approach was followed in the extraction of oils from dry cashew as well as determine it physical and chemical composition for maximum utilization. The oil yield from both the cashew shell and kernel were 35% and 15% respectively. The cashew shell oil had a dark brown coloration, while the kernel oil was light yellow in colour. The density of the oil from the cashew kernel (CKO) was 0.875 and 1.050 for the nut shell liquid (CNSL). The properties of CKO were found to be closely related to the properties exhibited by oils of melon and groundnut; the CNSL had properties similar to those of linseed. Therefore, oils from both the kernel and shell of cashew can be utilized in the processing and production of foods and pharmaceuticals.

Keywords:
Extraction, cashew, oil, physical, chemical, composition, processing.

1. INTRODUCTION:

The cashew plant is commonly found in Asia and South American countries like Brazil. It is a cash crop in American, Madagascar, Malaysia and India [1].Globally, the cashew industry occupies the third place in terms of production of edible nuts; in year 2000 alone, about 2 million tons worth US$2billion was achieved from cashew production either grown wild or through cultivation. India, Brazil, Nigeria and Tanzania are adjudged the major cashew producing regions worldwide, and in the last decades, Nigeria has scaled up the production of cashew from 30,000 tons in 1990 to 176,000 tons in 2000 [2].

Major areas in Nigeria where cashew is grown includes; Enugu, Abia, Imo, Anambra, Ebonyi states in south east, Cross River State in the south south part of the country; Oyo, Osun, Ondo, Ekiti and Ogun States in south west, as well as Kwara, Kogi, Nassarawa, Benue, Taraba, and FCT in the Middle Belt and also Sokoto and Kebbi State in the North West part of the country with the highest export of the commodity coming from the western and Eastern parts of Nigeria [3].

Different parts of the plant can be used for different purposes; for instance, the cashew apple can be eaten raw or used as sweetener, the juice may be used as wine after fermentation, the fruits may also be eaten when roasted and shelled [4].

Also, from the shells, acidic vesicant oil may be extracted which can be used as a preservative with diverse industrial applications[5].Cashew tree itself serves as wind break and control erosion in area where it is planted.

Also, cashew has found wide applications in the formulation of natural insecticides, resins and adhesives. Cashew kernel is rich source of fats, protein, calcium, phosphate, iron and vitamin C and the bark of cashew tree is use to cure ringworms [4].

2. MATERIALS AND METHODS

Sample Collection and Preparation

The cashew nuts were obtained from a farm located at Pwazu Area-Wukari, Taraba state North Eastern Nigeria and dried under direct sunlight for a period of two weeks. It was followed by decortication, soaking in water, drying and shelling in order to obtain kernels that are cracks free. This was achieved manually using stone and wooden mallet. About 250 kg each of the resulting kernels and shells were separately crushed using mortar so as to achieve homogeneity of particle sizes.

Oil Extraction and Characterization

Exhaustive extraction of oil from the sample was achieved using the Konte-USA made of soxhlet extractor. 5 g, 10 g, 15 g, and 20 g of the samples weighed differently using a digital weighing apparatus were introduced into the extractor containing 250ml of the solvent at a temperature of 90^0c.

The extracted oil was characterized; physiochemical studies were done using approach of AOAC and cited by [6] as summarized below.

Density

Density is the degree of compactness of a substance and is measure in mass per volume. Density determined using the following relationship:

$$\text{Density} = \frac{\text{mass}}{\text{Volume}}$$

Viscosity

Viscometer was used. The sample for viscosity determination was contained in a beaker with a temperature maintained at 32^0C using thermostat. R4 spindle fastened to the viscometer axle and immersed half way into the oil. The viscometer was switched on and the reading recorded.

Color

Visual assessment of the oil was done.

Specific Gravity

A specific gravity bottle after it was cleaned with a suitable solvent (acetone) and oven dried at 60^0C. The weight of the empty gravity bottle was taken and recorded 'W', thereafter, 10 mL oil sample was poured into the bottle, covered, weighed and recorded as 'W_0'. Finally, the bottle was washed cleaned and 10 mL distilled water was poured into the bottle, covered and weighed, recorded as 'W_1'. Specific gravity was then computed using the mathematical relationship below;

$$\text{Specific gravity} = \frac{w0 - w}{w1 - w}$$

Acid Value

A mixture of 25 cm^3 diethyl ether and 25 cm^3ethanol was used to dissolve 2 g of the sample. Neutralizing the mixture with 0.1 M NaOH with 1% phenolphthalein, it was shaken until a faint pink colouration was observed. The acid value was then computed thus;

$$\text{Acid value} = \frac{\text{titrevalue} * 5 * 61 * 0.00282}{\text{weightofsample (g)}} = \text{mgKOH/g}$$

Free Fatty Acid

Free fatty acid content of the extracted oil was evaluated as half of the acid value [7].

$$\text{Free Fatty Acid} = \frac{\text{Acidvalue}}{2}$$

Iodine Value About 0.2 g of the sample was weighed and transferred into a titration vessel with the addition of 10 mL cyclohexane, followed by addition of 0.5 mL mercuric acetate and 20 mL glacial acetic acid. Wij's solution was then added and after about 5 minutes, 10 mL 15% KI was also added and the titration automatically commenced. The use of Wij's solution with done at slight room lightening. The iodine value was evaluated using the relationship below;

$$Iodine\ Factor(IF) = \frac{0.01269 \times M\ Na_2S_2O_3}{0.1}$$

$$Iodine\ Value\ (IV) = \frac{((blank - titration) \times IF \times 100)}{sample\ mass, g}$$

.**Saponification Value**

A reflux apparatus was used to titrate a hot solution of 0.5 M KOH made in 95% ethanol and 2 cm^3 blank solution against 0.5 M HCl using 1 cm^3 phenolphthalein. In each case, the amount of acid needed to neutralize the bases was recorded. From here, the saponification value was calculated thus;

Saponification Value, (S.V) $= \frac{56.1 * T(Vo - V1)}{M}$

Where, T= Molarity of KOH solution used, V_0 = Volume of acid used for the titration with oil sample, V_1= Volume of acid used for the titration of the blank solution, M= Mass of the oil used.

pH

A mixture of 13ml of hot distilled water and 2 g of oil was made in a 25 mL beaker, it was cool to a temperature of 25 °C using cold water bath, and thereafter a standardized pH electrode was immersed into the mixture, and the pH recorded accordingly [7].

3. RESULTS AND DISCUSSION

The results of the physiochemical properties of the extracted oil are shown on Table1 and 2.

Table1. Physical properties of the extracted oils

Parameter	Cashew kernel oil (CKO)	Cashew nut shell liquid (CNSL)
Percentage Yield	15%	35%
Color	Light Yellow	Dark Brown
Odour	Sweet smell	Choke smell
Density (g/cm^3)	0.875	1.050
Specific Gravity (g/cm^3)	0.919	1.062
Viscosity mpa.S @ 32^0C	78.00	546.50

Specific Gravity

The specific gravity of CKO and CNSL was 0.919 and 1.050 respectively. It can be inferred from the above that CKO will have more floating ability on water while the cashew shell oil will sink in water.

Viscosity

The viscosity obtained at 32°C for CKO and CNSL was 78mpa.s and 546.50mpa.s. The viscosity of the cashew kernel oil was low implying that it is unsaturated which make it healthy for the consumption of human and the cashew nut shell liquid was high implying that it is highly saturated. Vegetable oils can find applications as fuels, as well as blends when mixed with diesel [7]. However, given high viscosity values of the cashew nut shell oil, incomplete combustion will result because of low atomization of fuels in the engines and poor mixing of fuel and air [9, 10]. Also, injector

coking can occur with extended hours of operating the engine leading to thickening of the lubricants [11].

Table2.Chemical properties of theextracted oils

Parameter	Cashew kernel oil (CKO)	Cashew nut shell liquid (CNSL)
Acid Value (mg/L)	2.13	33.66
Free Acid (mg/L)	2.55	16.83
Saponification (mg/L)	230.00	23.84
pH Value	6.60	4.90
Iodine value (mg/L)	86.7	177.8

Acid Value

The extracted CKO in the present study had an acid value of 2.13, while CNSL was 33.66. The CKO value is closely related to 0.56 ± 2.24 reported by [12] indicate that, the low acid value of CKO shows that it is good dietary oil but the CNSL is not good for the health but toxic to the body. The acid values obtained here are higher than 0.82, 10.7, 5.99 mgKOH/g previously reported respectively [13, 14, 15] for groundnut oil. The low acid values for CKO in this present study is an indication that their lipids are stable, non-degradable and falls within the limits desirable of oils for application in formulation of paints/varnishes [12, 16].

Free Fatty Acid

From the study, the free fatty acid values of 1.11% and 16.83% were respectively obtained CKO and CNSL, the CKO free fatty value at the same range as reported by [12]. While CNSL is lower than 36.09 ± 1.12 % reported by [12]. This means that if CKO is subjected to refining, edible grade oil will be formed; it also means that deterioration through oxidation can occur leading to production of off-flavor [17].

Saponification Value

The results of the study gave saponification values of 230mgKOH/g and 23.84mgKOH/g for CKO and CNSL. The CKO is higher compared with187.196mgKOH/g previously reported [6]. This show that the both cashew kernel oil (CKO) and cashew nut shell liquid (CNSL) will be good for soap making.

The pH value

CKO had a pH of 6.60, while CNSL was 4.90; impliedly, CNSL was more acidic. Some of the parameters reported here show a little variation from previous workers as reported [14]. The difference could be attributed to a number of factors such as extraction procedures, plant species as well geographical location.

Iodine Value

CNSL had iodine value of 177.8 mg/L and 86.7 mg/L for CKO. This means high and low degree of unsaturation respectively for CNSL and CKO. This also means that CKO can be classified as non-drying oil since most edible oils have been reported to have 80-100 g/100 g [15]. The physiochemical characterization of the extracted CKO shows close relation to properties reported for most seed oils[6, 18]; CNSL has properties similar to those of castor and

linseed oils suggesting its usefulness for industrial applications [19, 20].

Conclusion:

Soxhlet extraction of oils from dry cashew seed was done successfully using hexane. CKO had 15% yield and 35% in the case of CNSL. The result of physiochemical characterization of the oils showed that CKO was light yellow in colour, sweet smell nontoxic oil and therefore can be used as vegetable oil when refined; while CNSL was dark brown with choking smell, not suitable for consumption but can be used for industrial applications in soap making.

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