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EFFECTS OF EXTRACTION METHODS ON PHYSICO-CHEMICAL PROPERTIES OF OIL FROM CASHEW NUTS (*Anarcardium occidentale*)

S. E. ADEBAYO[1], P. A. ADEOYE[2]
[1,2]Department of Agricultural and Bio-resources Engineering, Federal University of Technology Minna, P. M. B. 65, Niger State
oluvictor4life@yahoo.com

[2] Department of Biological and Agricultural Engineering, University Putra, Malaysia

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ABSTRACT

With a view to studying the impact of methods of extraction on properties of oil from cashew nuts, two extraction methods were adopted to obtain oils from cashew nuts. The methods are solvent extraction using n-hexane as extractive solvent and traditional hydraulic press methods. The physico-chemical properties of the extracted oil samples were analyzed and compared to each other. Percentage oil yields were 53.25% and 46.89% for the solvent extracted and hydraulic press oils respectively. The oil sample's odour was not offensive at room temperature for either method. Specific gravity was 0.86g/kg for solvent extracted oil and 0.94g/kg for oil obtained through hydraulic press. Saponification value ranged from 85.5 g/kg for hydraulic press oil to 96.62 g/kg for solvent extracted oil. pH values for both samples were below 7.0, and the refractive index for both samples was 1.47. The relative density value ranged from 0.9 to 0.92 at 29°C (room temperature). Both oil samples were in liquid state at room temperature and boiling points varied from 94°C to 98°C for solvent extracted oil and hydraulic press oil respectively. The results showed that the method of extraction imposed significant changes on specific gravity, saponification value, iodine value, acid value, peroxide value and relative density. However, no significant differences were recorded in parameters like free fatty acid, peroxide value and refractive index values.
Key words: Cashew nut, Solvent extraction, Hydraulic press, Physico-chemical properties

1. INTRODUCTION

Over the years, there has been a spectacular increase in the world demand for both oils and oil meals with attending uptrend in prices. The non-edible uses of oilseeds declined substantially at a time due to the availability of inexpensive oil derived from fossil reserves. It has however been realized that the fossil reserves are exhaustible or it become shorter in supply and are not renewable. Therefore looking into alternative oil sources from various seeds which abound in nature should remain a subject of active investigation. Although such oils are not expected to replace petrochemicals in their entirety, their applications as lubricating oils, emulsifiers, retardant agents or components of cosmetics, for example could be very important (Onyeike and Acheru, 2002).

Oilseed production is an important part of the agricultural economy of many countries. Some oilseed plants grow only in tropical regions, some in Mediterranean regions while others grow in temperate climates. Some of these seeds are grown all over Nigeria while some are grown and known better in some parts or regions of the country. Some of these oilseeds are underutilized considering their nutritional potentials as good sources of edible oils and fats diet, which were being researched on and put to different uses in meeting up with the human quest for better nutritional requirements, domestic and various industrial purposes. In recent times, the desire to conserve resources spent on importation of oils for domestic and industrial purposes has paved way for renewed impetus in the

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search for modern sources to complement the traditional sources already in existence. For this reason, there is renewed interest in conventional seed oils for more varying research works to analyze their hidden nutritional, medicinal and other non-edible potentials. Several of these under-exploited oil seed plants are available in abundance in Nigeria (Akanni *et al.*, 2005).

Cashew plant is known all over Nigeria. Cashew is a tropical evergreen tree cultivated for its edible nuts. The cashew tree, native to the Americas, is now widely cultivated in Asia and Africa for its nuts and other products. It grows as high as 12 m and has leathery, oval leaves, and pear-shaped fruits, called cashew apples, which are reddish or yellowish. At the end of each fruit is a kidney-shaped ovary, the nut, with a hard double shell. Between the shells is caustic, black oil that has to be removed by a difficult roasting process. Another roasting removes the second shell, freeing the nut. The trunk of the tree yields a milky gum also used to make varnish. The sour fruits can be eaten after processing and are used in making condiments. The oil is used in the plastics and varnish industries. The importance of fats and oil in human diet cannot be overemphasized. In normal human diet, about 20-25% of the calories intake consists of fats and oil. These substances are the most concentrated form of energy in human diet, when metabolized fats produce about 9.5 kilocalories per gram (Oshodi *et al.*, 1998).
The oil embedded in agricultural products is extracted using different methods. Mechanical method of oil extraction involves the direct application of pressure to the wrapped pastes of these oil-bearing materials, forcing a relative reduction in their volumes to initiate the expulsion of the oil from the materials, (Amoo *et al.*, 2004). The hydraulic press has been employed in the extraction of oil from oil seeds. It involves the use of levers, wedges and screws, as means of applying this pressure (Ibemesi, 1992). Solvent extraction method involves the leaching out of the soluble solid structures of the oilseeds by the use of volatile organic solvents like n-Hexane, Isopropanol, Butanol and Acetone. These compounds enable more oil to be extracted from the primary oil bearing materials. The extracted oil could be recovered from the oil-solvent mixture through various separation techniques e.g. distillation, or could be placed in an oven to evaporate, (Nwabueze, 2007).

Due to high level of awareness on public health issues and concern for safety of lives, the concerned regulatory authorities have restricted the range of solvents employed for use in various food processing industries. The choice is however dependent on the primary end product desired. The objective of the work reported in this paper was to extract oil from cashew nut using solvent extraction and hydraulic press methods, to characterize of the extracted oil samples and to conduct comparative studies to ascertain if the methods of extraction impose any changes on the properties of the oils.

2. MATERIALS AND METHODS.

2.1 Collection and Preparation of Samples

The cashew nuts were bought from Minna Central market, in Minna, Niger State. The nuts were thoroughly screened to remove the bad ones and stones. The nuts were cut into two halves using a kitchen knife and hands covered with gloves to protect the hands from the toxic Cashew Nut Shell Liquid (CNSL). The nuts were removed, shelled and dried in the Gallenkamp Oven Dryer' at 104^{0}C for 1 hour. The 6 kg of the nuts were ground into 5mm sizes using the Thomas Willey (Model ED-5) Electric Grinder.

2.2 Oil Extraction and Characterization

Ground Cashew nuts were divided into two parts each weighing 3 kg. 1 kg each was used in three replicates for the two extraction methods. The first part extracted with 800ml sohxlet apparatus analar grade (BDH, London) n-Hexane (60-80^{0}C) for 10 hours (James, 1996). The mixture was then distilled to obtain the oil. The other sample meant for the Hydraulic Press extraction was tied in

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amuslin cloth, placed inside the extracting chamber of the press and pressure was applied to expel the oils. The oil samples were collected in a conical flask and used in the characterization of the physicochemical properties using AOAC, (1990) methods. The physicochemical properties analysed are colour, taste, percentage oil yield, saponification value, specific gravity, relative density, peroxide value, pH, refractive index, iodine value and free fatty acid. The data obtained from these experiments were subjected to statistical analysis. The values obtained for Cashew oil from the hydraulic press and solvent extraction methods were compared using the student's t-test at $t<0.05$.

3. RESULTS AND DISCUSSIONS

The results for the physicochemical properties of Cashew nuts oils are shown in Tables 1 and 2. The results of the students' t-test statistical analysis which related and compared the physicochemical properties for cashew nut oil by hydraulic press method and solvent extraction, are also shown in Table 3.

Table 1: Physical Properties

Sample	Oil Yield (%)	Boiling Point (°C)	Taste	Colour	Specific Gravity, g/kg	Odour	State at 29°C
Press Extraction	46.89	98	Extremely sweet	Brown	0.86	Non-offensive	Liquid
Solvent Extraction	53.25	94	Moderately sweet	Light Brown	0.94	Non-offensive	Liquid

Table 2: Chemical Properties

Sample	FFA Value (mg/l)	pH Value	Peroxide Value (mg/l)	Acid Value (mg/l)	Iodine Value (mg/l)	Refractive Index (mg/l)	Saponification Value (mg/l)	Relative Density
Press Extraction	3.20	5.74	1.10	6.32	35.6	1.47	85,50	0.90
Solvent Extraction	3.18	5.20	3.35	1.20	27.8	1.47	96.62	0.92

Table 3: Values for Statistical Analysis

Parameter	Hydraulic Press Extraction	Solvent Extraction	t-Value
% Oil Yield	46.89±0.000	53.25±0.150	0.015*
S. V (g/kg)	85.55±0.070	96.63±0.560	0.028*
Unsap. V (g/kg)	89.40±2.000	66.40±3.500	0.149
Specific Gravity	0.86±0.005	0.94±0.001	0.040*
Relative Density	0.91±0.000	0.92±0.001	0.049*
Peroxide Value	1.10±0.100	3.35±0.175	0.021*
pH	5.74±0.060	5.20±0.100	0.047*
Refractive Index	1.47 ±0.038	1..47±0.007	0.979
Iodine Value	35.6±0.080	27.8±0.000	0.013*
FFA Value	3.20±0.000	3.18±0.030	0.626

*Significantly different at 5% level ($t<0.05$) SEM: Standard Error of Mean

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3.1 Physical Properties

The studentized t-test showed that there was a significant difference in the mean oil yield between the oils extracted by hydraulic press and solvent extraction methods ($t<0.05$). The percentage yield of cashew oil obtained by solvent extraction was significantly higher than that obtained through the process of the traditional hydraulic press. The recorded percentage oil yield for cashew nut oil was high. The oil yield is high and compared favourably with the values reported in seeds of neem seed 46%, cotton seed 24% and groundnut 46% (Abdullahi et al., 1991). This indicates that the seed is a good source of abundant oil. The mean boiling point values of the oils were also not significantly different ($t>0.05$). High boiling point values of fixed oils waste oils during frying.

The result showed that the solvent extracted oil was moderately sweet, while the traditional hydraulic extracted oil was extremely sweet to the taste. The colour of the solvent extracted cashew nut oil was light brown, while that of the traditional hydraulic press method was brown. The odour of both the solvent extracted and the hydraulic pressed oils were non-offensive. Both the solvent extracted and the traditional hydraulic extracted oils exists in their liquid states at 29 °C. Several factors could affect the state of existence of oil at 29 °C, either to exist as a liquid or in the viscous state, some of these factors may be the type of oil seed, method of extraction of oil, etc.

Studentized t-test showed that there was significant difference in the mean specific gravity between the oils extracted by Hydraulic Press and Solvent Extraction methods ($t<0.05$). The specific gravity of cashew oil obtained by solvent extraction (0.94g/kg) was significantly higher than that obtained by the traditional hydraulic press (0.86g/kg). These values are within the range of specific gravities reported for other fats and waxes (Ajayi and Oderinde, 2002). The specific gravity of both the extracted oils of cashew nuts indicates that the oil is less dense than water. This value is consistent with those obtained by Belewu *et al.*, (2010) and Tint and Mya (2009) for *Jatropha curcas* seed oil.
Studentized t-test showed that there was significant difference in the mean relative densities between the cashew nut oils extracted by Hydraulic Press and Solvent Extraction methods ($t<0.05$). The relative density of cashew oil obtained by solvent extraction (0.92) was significantly higher than that obtained by the traditional hydraulic press (0.90).

3.2 Chemical Properties

The pH values of the 2 oil samples were significantly different $t<0.05$. The pH value of cashew oil obtained by solvent extraction (5.20) was significantly lower than that obtained by the traditional hydraulic press (5.74). This variation could have affected the values of vitamins observed in this study as pH < 7 has been reported to affect the stability of vitamin A and its precursors (Inoh *et al.*, 1997).

The mean refractive index of oils extracted by the two methods were not significantly different ($t>0.05$). The Refractive Index of the oil (1.459 ± 0.13), is also within the range of some edible oils like cottonseeds and groundnut (Kamal and Kamal, 1992). There was significant difference in the mean peroxide values between the cashew nut oils extracted by Hydraulic Press and Solvent Extraction methods ($t<0.05$). The peroxide value of cashew oil obtained by solvent extraction (3.35) was significantly higher than that obtained by the traditional hydraulic press (1.10).

The peroxide value is used as an indicator of deterioration of oils. Fresh oils have values less than 10 mEq Kg-1. Values between 20 and 40 result to rancid taste. The peroxide value 1.10meq/kg for the hydraulic pressed cashew nut is close to that of cotton seed oil (2.5meq/kg) (Popoola and Yangomodou, 2006). The low value indicates that the oil can resist lipolytic hydrolysis and oxidative deterioration (Ezeagu *et al.*, 1998).
The studentized t-test also showed that there was significant difference in the mean saponification values between the two samples ($t<0.05$). The saponification value of cashew oil obtained by solvent

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extraction was significantly higher than that obtained by the traditional hydraulic press. High Saponification value and low acid value indicates that the oil may be suitable for soap making. As reported by Pearson (1976) oils with high Saponification value contain high proportion of lower fatty acids.

There was significant difference in the mean iodine values between the two oil samples ($t < 0.05$). The iodine value of cashew oil obtained by solvent extraction (27.8) was significantly lower than that obtained by the traditional hydraulic press (35.6). Iodine value of about 38.71g/100g indicates low degree of unsaturation and classified the oil as non-drying oil (80-100g/100g) as recorded for most edible oil, Pearson (1981). Similar non-drying oil values have been reported for *Dacryodes edulis* pulp and seed and *Cucurbita maxima* seed (Ajayi and Oderinde. 2002; Amoo *et al.* 2004). The low iodine value indicates that the oil has a low content of unsaturated fatty acids thus resembles olive oil and groundnut oil, could be employed for manufacture of soaps, lubricating oils and lighting candles which traditionally requires fats or saturated oils (Dosunmu and Ochu, 1995). Thus, the oil will not attract high interest in the paint and coatings industry unless it undergoes dehydration before use (Abayeh *et al.*, 1998). The iodine value is also an index for assessing the ability of oil to go rancid (Eka and Chidi, 2007; Amoo *et al.*, 2004).

There was significant difference in the mean acid values between the oils extracted by Hydraulic Press and Solvent Extraction methods ($t<0.05$). The acid value of cashew oil obtained by solvent extraction (1.20) was significantly lower than that obtained by the traditional hydraulic press (6.32). Low acid value and percentage free fatty acid indicates that the oil may have long shelf-life (Passera, 1981). Low acid value of about 3.5±0.3mg shows that oil is good as edible oil (Eka and Chidi, 2009).

4. CONCLUSION

This work has shown significantly that more quantity of oil is extracted from the Cashew nuts through the process of Solvent Extractions when compared with the oil obtained through the process of Hydraulic Press. It could be explained that the presence of an extractive solvent i.e. N-Hexane used for the solvent extraction processes is responsible for the more expulsion of these oil materials, since it is used as an agitator to release the oils from their bearing materials after drying, grinding and soaking. The obtained oils from the solvent extraction methods were placed in an oven dryer to evaporate the N-Hexane which is present in the oil after extraction, therefore essential oils obtained through the method of solvent extraction is considered safe as the solvent is evaporated from the oils after production. The Traditional Hydraulic press method is also another good oil expulsion process but its usage produce limited quantity of oil when compared to that of the solvent extraction method. The results of the iodine value, specific gravity determinations and other physico-chemical analysis of the oil extracted from the African star apple seeds compared favourably with those of other conventional seed oils such as groundnut, soybean and palm kernel oil as well as those reported by other researchers (Abayeh *et al.*, 1998; Ezeagu *et al.*, 1998; Fernando and Akujobi, 1987; Klein, 1994).

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