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Extraction, Properties and Utilization Potentials of Cassava Seed Oil

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Abstract: Physical and chemical characteristics of oil extracted from grounded Cassava (*Manihot esculenta* Crantz) seeds with Soxhlet extractor were examined. The extracted oil was liquid at room temperature (25°C), pale yellow, odourless and tasteless with specific gravity of 0.94 at room temperature. It has a lipid content of 25.2%, Iodine value of 90 Wijs. The oil is semi-drying, unsaturated, low in free fatty acid, peroxide and cyanide Analysis of the lipid by colorimetric method showed seven fatty acids including Lauric, palmitic, stearic, linoleic, linolenic and arachidonic acids as present. The major fatty acids being Palmitic (31.26%) Linoleic (35.16%) and Oleic (13.09%). The results obtained are compared with values reported for other convectional vegetable oils available commercially and discussed in terms of potential uses of the oil.

Key words: Cassava-seed oil, *Manihot esculenta,* physico-chemical properties, fatty acids

INTRODUCTION

Roots of Cassava (*Manihot esculenta* Crantz.) is one of the most popular staple foods in Africa, Central and South America, Asia and some other parts of the world. It is also an income earner for majority of small farmers in rural areas in countries where the crop is cultivated. The economic importance of cassava lies in the many uses to which the root which is rich in vitamins, calcium and potassium is put into after some amount of processing, which usually include cooking, grinding, fermenting and drying. The processed roots are then consumed in various forms. In West Africa, it is principally eaten as a fermented meal *gari. Fufu* which is made from fermented and boiled cassava eaten with soups and stew is popular in Nigeria. While in Central and South America *Farinha de manioca* is popular. In the Philippines, *landang* or cassava rice is a popular delicacy (Kay, 1987). A method for the production of cassava instant noddles has been described (Sanni *et al*., 2004), while syrups useful to the soft drinks industries have been made from cassava starch (Brooks and Asamudo, 2004).

Cassava plants produce small seeds in capsules. At maturity, the capsules which are similar in shape and size to those of Castor oil (*Ricinus communis*) seeds turn blackish and explode to release the tiny seeds. Seeds of most plants are known to be rich in oils and fats. However, there are very scanty reports on the properties of oil from cassava seeds as most attention has been focussed on utilization of the roots and the leaves for human consumption and livestock feeds. Apart from a couple of domestic related uses, local communities in Nigeria use oil extracted from cassava seeds for the treatment of infections caused by opportunistic skin pathogenic microorganisms such as *Staphylococcus aureus*, *Propionibacterium acnes*, *Pityrosporum ovale* and *Candida albicans.*

The objective of this study was therefore to extract oil from cassava seeds, assess the physical and chemical characteristics and suggest possible uses for the oil as a prelude to an investigation into the scientific basis for its local use for the treatment of microbial skin infections. Comparisons between cassava-seed oil and vegetable oil from other plant sources that are already enjoying a degree of utilization popularity and acceptability are also made.

MATERIALS AND METHODS

Collection of cassava seeds: Mature green capsules containing cassava seeds were obtained from experimental farms of the Ogun State Agricultural Development Programme (OGADEP) in Abeokuta and experimental plots of International Fund for Agricultural Development (IFAD) farms in Ijebu-Ife, South Western part of Nigeria. Seeds were collected from mature cassava plants between October 2003 and February 2004. The seeds collected were of Cassava Variety TMS 30572. They were dried in the sun for 4-5 days after which the seeds were removed from the capsules.

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Extraction of oil: A known weight of the seeds were grounded into powder and dried in an air circulating oven at 50°C for 1 h. Oil was extracted from the dried grounded seeds with petroleum ether (boiling point 60-80°C) using a Soxhlet extractor. The solvent was distilled off at 80°C. Oil content was calculated from the weight of oil and weight of seeds.

Attempts were also made to extract oil from the seeds using the expeller pressed method. A simple press similar to the type used for pressing oil from smashed pulp of palm fruits in palm oil processing was used for extraction. In another method similar to the press approach, 10 g of dry seeds was wrapped in 2 layers of muslin cloth; oil was then extracted using a mechanical clamp to press the oil from the seeds.

Sensory properties: The colour, smell, taste, sedimentation and other related physical characteristics of oil extracted were noted. A 10 man panel consisting of staff and students from the University community was constituted to evaluate the smell and taste of the oil extracted from the seeds. Colour measurement was done with a Lovibond colorimeter.

Chemical properties: The oil extracted from the seeds was assessed for various chemical properties. Standard methods described by the Association Official of Analytical Chemists (1990) were used for the determination of moisture, ash, crude fibre, lipid and free fatty acids (FFA) contents of the oil sample. Fatty acids and carbohydrate content determination was by colorimetric method, while kjeldahl method was used for the estimation of crude protein content. Iodine value was determined using Wij's method (AOAC, 1990). The procedures of Egan *et al.* (1981) were adopted for the estimation of Saponification values, Unsaponifiable matter content and acid value of the oil samples. Refractive index was measured with a Refractometer (RFM342, Bellingham + Stanley, England).

RESULTS

The three methods used for the extraction of oil from the seeds all seem effective. The recovery rate using the cold expeller methods involving use of mechanical extractors were however less effective compared to the use of Solvent extraction. A large amount of seeds will be required for the mechanical press designed for extraction of oil from palm fruits. Use of mechanical press (clamp) to squeeze oil out the seeds is easy to use as no special skill is required, but the recovery rate is slow. Yield of oil extracted with Soxhlet extractor was 25.02%. In view of the advantages of solvent extraction, as observed in this study, the oil used for analysis was extracted with solvent using a Soxhlet extractor.

Oil extracted from cassava seed is pale yellow, tasteless without impurities. The oil is liquid at room temperature. It contains 25.02% lipid, 20.10% carbohydrate and 20.20% crude protein. The physico-chemical properties of cassava seed oil are given in Table 1 and 2. The acid and peroxide values of the oil were low and similar to those of many commercial vegetable oils. Colorimetric determination of fatty acids of the lipid showed that it contains lauric, palmitic, stearic, oleic, linoleic, linolenic and arachidonic acids. Palmitic, oleic and linoleic acids were present in significant amounts (Table 3). The properties of lipid in cassava-seed oil are comparable in quality to some other processed vegetable oils that are commercially available (Table 4).

Table 1: Physical and sensory attributes of cassava seed oil

Attributes	Characteristics
Colour	Pale yellow, clear and transparent (5¼ on Lovibond meter)
Taste	Neutral, free of bitter taste, free of after- tastes
Smell	Neutral, free of smell coming from plant material
Sediments	Free of sediments
State at room Temperature	Liquid

Table 2: Analytical values of cassava seed oil

Characteristics	Values*
Moisture (%)	0.730
Ash (%)	0.500
Crude fibre (%)	15.200
Crude protein (%)	20.200
Carbohydrate (%)	20.100
Lipid (%)	25.020
Free fatty acid	0.390
Iodine (Wij's)	90.000
Saponification value (mg KOH/g)	270.000
Acid value (mg KOH/g)	0.700
Unsaponifiable fraction (g kg $^{-1}$)	2.000
Specific weight (at room temp.)	0.940
Peroxide value (O_2 mg g $^{-1}$)	2.500
Cyanide (%)	0.027
Refractive index	1.444

*values are mean of 5 readings

Table 3: Fatty acid composition of cassava seed lipid

Fatty acid	Amount*
Lauric acid	4.19
Palmitic acid	31.26
Stearic acid	6.19
Oleic acid	13.09
Linoleic acid	35.16
Linolenic acid	3.23
Arachidonic acid	2.73

*expressed as mg g^{-1} of sample, Values are mean of 5 samples

Table 4: Properties of cassava seed oil compared with other commercial vegetable oil

Properties[a]	Cassava seed oil	Cotton seed oil	Soyabean oil	Cornoil	Sunflower oil
Colour	Pale yellow clear	Light yellow transparent,	Light yellow transparent	Light yellow transparent	Light yellow transparent
Smell	Neutral	Neutral	Neutral	Neutral	Neutral
Taste	Neutral Free of bitter taste	Neutral	Neutral	Neutral	Neutral
FFA (%)	0.39	0.10	0.10	0.10	0.10
Unsaponifiable matter	2.0	1.5	1.5	1.5	1.5
Iodine (Wij's)	90	99-119	120-142	105-130	99-119
Refractive index (RI)[b]	1.444	1.464 -1.468	1.467-1.470	1.465-1.468	1.4666-1.469
Peroxide value (meg/kg)	2.5	2.5	2.5	2.5	2.5
Saponification value (mg /KOH/g)	270	189-198	189-195	187-195	189-198
Specific wt (25°C)	0.94	0.918-0.926	0.919-0.925	0.917-0.925	0.918-0.926

[a]values for cassava seed oil are as obtained in this investigation, Values for other oils (except for RI) are those for commercially sold edible oil made by Cidersan Vegetable and Olive oil Company of Turkey. (Source: http://www.cidersan.com.tr/physical), The values are therefore for processed oil, [b]Source: Food Industries Manual (1993) (Ranken and Kill, 1993)

DISCUSSION

The method of extraction of oil usually reflects on the oil's quality, nutritional value, colour and flavour. This informed the need to pay some attention to the various possible methods of extracting oil from cassava seeds. Although no major differences were observed in the quality of oil extracted using mechanical press methods, extraction with solvent seems more efficient and economical for the extraction of oil from cassava seeds. This is in conformity with the observations of Ajiwe *et al.* (1994). Use of mechanical press methods could be suitable for domestic purposes; it may be adopted for use by farmers who are familiar with a similar process which is commonly used for palm-oil extraction.

The moisture content of cassava seed oil as recorded is very low and falls within acceptable limit expected of edible oils (Ajiwe *et al.*, 1994). The low moisture content of the oil is an advantage when the shelf life of the seeds is considered. Low ash content of the oil indicates of low level of inorganic impurity and that the oil is a good source of mineral elements. The recorded ash value is far less than those reported by Akanni *et al.* (2005) for some non-convectional oil seeds. Specific gravity of 0.94 at 25°C of cassava lipid and the observed melting point of 17.8°C which is lower than the average tropical room temperature of 25°C explains why the oil is liquid at room temperature.

A high saponification value of 270 mg KOH g^{-1} indicates that the oil contain low molecular weight fatty acids. This attribute is of importance in soap making (Kirschenbauer, 1965) as well as in shampoo manufacture (Ajiwe *et al.*, 1994; Akanni *et al.*, 2005). The values obtained are in good agreement with those of groundnut oil and palm oil as reported by De Bussy (1975). Iodine value of 90 Wij's which is in the middle range shows that the oil is semi-drying and unsaturated. This is a further evidence that the oil could be used in liquid soap formulation. Just as the low acid value recorded for the oil could be of significance in the manufacture of paints and varnish (Williams, 1966). Also, the low value of peroxide is an indication that the oil can resist lipolytic hydrolysis and oxidative deterioration. Cassava seed oil can therefore be used in the manufacture of margarine. The amount of unsaponifiable matter in the oil compared well with those recorded for palm oil and maize oil (Okoye and Okonkwo, 1999) this attribute of the oil has a relationship with the low amount of cholesterol it contains.

Analysis of the dietary values of cassava seed oil shows that with the amount of carbohydrate, (20.10%), crude protein (20.20%), crude fibre (15.2%) and lipid 25.02% it contains, it is nutritionally rich. The 25.02% lipid recorded for cassava seed oil is even higher than a value of 22.35% previously reported for soybean oil by Oguntunde and Ajayi (1994) and 5.2% for seed oil of *Aristolochia bracteata* (Hassan *et al.*, 2004). The amount of palmitic acid, stearic acid, oleic acid and linoleic acid in cassava seed oil are far greater than those in oil extracted from an industrial oilseed *Vernonia galamensis* var. *ethiopica* as reported by Thomson *et al.* (1994).

Cassava-seed oil contains 7 fatty acids of which palmitic acid (31.26%), linoleic acid (35.1%) and oleic acid (13.09%) were the major components. Lauric acid, stearic acid, linoleic acid and arachidonic acid were also present in substantial quantities. Both classes of saturated and unsaturated fatty acids are represented in the lipid. All the fatty acids present are important for dietary purposes and therefore confirms the usefulness of the oil in diets. The high content of oleic acid further corroborates the possibility of using oil from cassava seed in dietary formulations. Oils rich in oleic acid are being used in the manufacture of margarine (Devine and William, 1961). The richest common source of linoleic acid is Safflower-seed oil, which is very expensive. Linoleic acid is the highest amount of fatty acid present in cassava seed oil. It therefore can serve as a veritable alternative to safflower as a source of linoleic acid.

Cyanide toxicity has been a limiting factor to cassava products utilisation. Cyanide content of 0.029% was recorded for cassava-seed oil. This value is very low compared to the lethal level of 35 mg/100 mg reported by Oke (1969) therefore the amount of cyanide in the lipid may not pose any serious health risk. It may be necessary to suggest the use of cultivars high in starch and protein with low hydrogen cyanide (HCN) content for the production of oil from cassava-seeds. It is worthy of note that all forms of processing involving boiling and heat treatment substantially destroys HCN and so detoxifies cassava (Kay, 1987). This is an added advantage for the use of solvent as a suitable method of extraction of oil from the seeds

The physical and chemical properties of cassava-seed oil as enumerated in this work, makes it a good substitute to some convectional oils. The oil has good values as edible oil and may also find industrial applications in soap, shampoo and other related cosmetic industries. As the properties of lipid extracted from cassava seeds compares well with those of processed cotton-seed oil, soybean oil, corn oil and sunflower-seed oil, it is suggested that further efforts should be made to discover other possible relevance of lipid from cassava seed. Cassava seed oil has promising potentials which could be tapped for domestic and industrial uses.

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