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Physicochemical Properties, Fatty Acids Profiles and Antioxidant Properties of Seed Oil of Breadfruit(*Treculia africana*).

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ABSTRACT

Oil extracted from seed of *Treculia Africana* (breadfruit) was analyzed for physicochemical properties, free fatty acids profiles and antioxidant properties as part of an on-going screening process for plant constituents of nutritional and economic significance. Physicochemical characteristics showed that the light yellow oil had a density of 0.89±0.01 g/cm^3 , moisture content 9.44±1.50%, and percentage yield of 7.50±3.01%. The iodine value was 52.64±3.56mg/g, acid value was 77.7±6.67mg/g, peroxide value was 100.78±2.39mEq/Kg, saponification value was 246.09±50 mgKOH/g and unsaponifiable matter was 29.67±3.12g/kg. The component phospholipid of the breadfruit was Phosphatidylethanolamine, while that neutral lipid was free fatty acids. Linoleic acid (27.96%), petrooselenic acid(15.66%), palmitic acid(13.63%), steric acid(11.24%) and alph-monoolein(10.83%) were higher in breadfruit seed oil while oleic acid(1.63%), eicosanoic acid(1.12%) and behenic acid(3.11%) were lower. The antioxidant property was averagely low. Overall results suggest that the oil will be a good candidate for conventional oil and good raw material for soap, paint and food industries

KEYWORDS: *Treculia Africana*, physicochemical, phospholipid, neutral lipid, fatty acid

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INTRODUCTION

The bread fruit, *Treculia African*, is known in Nigeria and other countries such as Senegal, Sudan and Angola. *Treculia African* is of the family *moraceae* and is native of the East Indies. It is generally cultivated in the tropics and its tree is 40-50ft high. As in the mulberry, female flowers grow together to form one large fleshly mass, the so-called fruit, which is roughly spherical and is about 6 in diameter. It is mark with hexagonal knobs, corresponding to separate fruitless, and is yellow when ripe. The seeds as shown in figure 1 below from the fruit are edible and are of high nutritional values[1]. It seed is said to contain oil of about 20.83% when fully extracted[2].

Figure 1: Breadfruit seed

Seed oils are important sources of nutritional oils, industrial raw materials and nutraceuticals. The characteristics of oils from different sources depend mainly on their compositions; no oil from a single source can be suitable for all purposes thus the study of their constituents is important. Many consumers are looking for variety in their diets and aware of the health benefits of fresh fruits and vegetables and of special interest are food sources rich in antioxidants[3]. Omega -3 fatty acids are essential for normal growth and development and may play an important role in the prevention and treatment of coronary artery disease, hypertension, diabetics, arthritis, other inflammatory and autoimmune disorders and cancer[4]. Edible wide plants have been reported to provide alpha-linolenic acid and several polyunsaturated fatty acids in addition to their major natural sources of fat tissues of ruminants; meat and dairy products[5].

The importance of lipids in human diet cannot be over emphasized. In normal diet, about 20-50% of the caloric intake consists of fats and oil. The substances are most concentrated form of energy in human diet when metabolized; fats produced about 9.5 kcal/g[6].

Little work has been done on the physicochemical of the seed oil by Ajiwe[2]. Fatty acids profiles and antioxidant properties have not been done till date. The aim of the studies is to ascertain its physicochemical properties, fatty acids profiles and antioxidant properties for their nutritional and economic significance.

MATERIALS AND METHODS

Breadfruit seed

The seed of breadfruit seeds were obtained from Karu Market in Nassarawa State Nigeria.

Chemicals and reagents

All the chemical and reagents used in this study were of analytical grade were products of British Drug House Laboratory, England.

Extraction of oil from seed.

The breadfruit seeds were pulverized using and electric blender and thereafter stored in polythen bag in a refrigerator. The oil was extracted from the resulting powder by adopting the method describe by Association of Official Analytical Chemist[7], which entailed using soxhlet apparatus to extract with petroleum spirit of boiling point between 40-60^{o}C. 200g of the ground breadfruit seeds were packed in muslin cloth and inserted into the soxhlet extractor and petroleum spirit was used as the extracting solvent for a period of eight hours. At the end of this period, the solvent was recovered by rotary evaporator and residual oil was oven-dried at 75^{o}C for one hour. The oil was then transferred to a desiccator and allowed to cool before being weighed. The drying, cooling and weighing was repeated until a constant dry weight was obtained. The extracted oil sample was sealed in dark brown coloured glass bottle and kept for analytical tests.

Determination of physicochemical properties of oil

The acid value, saponification value, iodine value, peroxide value and unsaponifiable matter were determined using the procedures described by Person[8]. The moisture content was determined by the procedure specified by Weiss[9].The density was determined by dividing the weight of the oil by its volume.

Free Radical scavenging activity measured by I, 1-Diphenyl-2-picryi-hydrazil (DPPH)

The free radical scavenging activity was measured in terms of hydrogen donating or radical scavenging ability using the stable radical DPPH[10]. About 0.1mM of DPPH in ethanol was prepared and 1ml of this solution was added to 3ml of extract solution in ethanol at different concentration (0.5, 0.25, 0.125, 0.0625 and 0.03125mg/l). Thirty minutes later, the absorbance was measured at 517nm. Lower absorbance of the reaction mixture indicated higher radical scavenging activity. The same experiment was carried out on butylated hydroxylanisole(BHA), Quercetin and Ascorbic acid which are known antioxidants. All test and analysis were run in triplicate and the results obtained were averaged. Radical scavenging activity was expressed as the inhibition percentage of free radical by the same sample and was calculated using the following formula:

$$\% \text{ Inhibition} = \frac{A0 - At}{Ao} \; x \; 100$$

Where A_o was the absorbance of the control (blank without extract) and A_t was the absorbance in the presence of the extract.

Determination of lipid content of the oil.

The neutral and phospholipid components of the oil were determined using the thin-layer chromatography (TLC) technique describe by Ackman[11]. The oil was spotted on two TLC plates (one for neutral lipid and other for phospholipids) using a capillary tube. The plates were letter air-dried and placed in a chromatographic tank containing chloroform:methanol:water(65:25:4 v/v/v), for phospholipid and petroleum ether:diethyl ether:acetic acid(80:20:1 v/v/v) for neutral lipids. The separated spots were visualized by placing the plates in iodine vapour for 5 minutes, and the spot outline were marked immediately. The separated lipid components were identified from the calculated Rf values compared with those of the standard[12].

Fatty Acid composition and analysis.

A 100mg oil sample was saponified with 1.2ml of 0.5M methanolic KOH at 60^{o}C for 10mins, neutralized with 0.7M HCl and methylated with 3.0ml BF_3-CH_3OH for about 10minutes in a water bath at 60^{o}C. The product was then extracted with petroleum ether (40-60^{o}C). The fatty acid methyl ester (FAME) was separated by a GCMS-QP2010 PLUS SHIMADZU, JAPAN. The FAME was injected and separation was on an HP capillary column. The carrier gas was helium at pressure of 116.9kPa. The column oven temperature of 70^{o}C, flow rate 1.80ml/min with split ratio of 20:0 was

employed. The fatty acids were identified by comparing their retention times with those of standards. The content of fatty acids was expressed as percentage of total acids.

RESULTS AND DISCUSSION

Table 1: Physical properties of the oil from breadfruit seed

Parameters	Value
Percentage yield	7.50±3.01%
Colour	Light yellow
Density	0.89±0.01 g/cm^3
Moisture	9.44±1.50%

Table 2: Chemical properties of the oil from breadfruit seed.

Parameters	Values
Acid value	77.7±6.67mg/g
Peroxide value	100.78±2.39mEq/Kg
Iodine value	52.64±3.56mg/g
Free Fatty Acid	38.85±3.34
Saponification value	246.09±50mgKOH/g
Unsaponifiable matter	29.67±3.12g/kg

Table 3: Phospholipid and neutral lipid components of oil from breadfruit seed

Rf values for breadfruit oil	Reference value	Inferences
0.79	0.70-0.80	Phosphatidylethanolamine
0.30	0.31-0.50	Free Fatty Acids

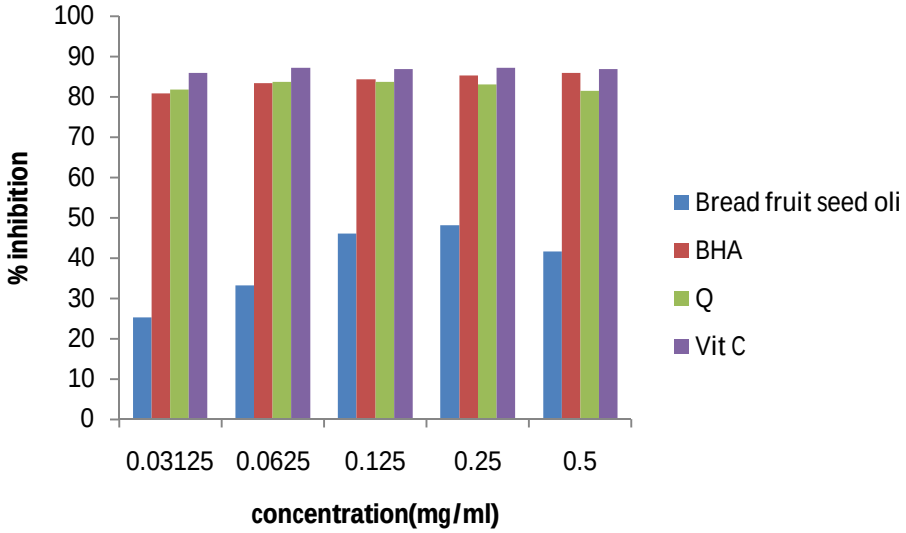

Figure 2: DPPH radicals scavenging activity. Bread fruit seed oil; percentage of free DPPH radicals scavenging by breadfruit seed oil. BHA; percentage of free DPPH radicals scavenging by butylated hydroxylanisole. Q; percentage of free DPPH radicals scavenging by quercetin. Vit C; percentage of free DPPH radicals scavenging by Vitamin C.

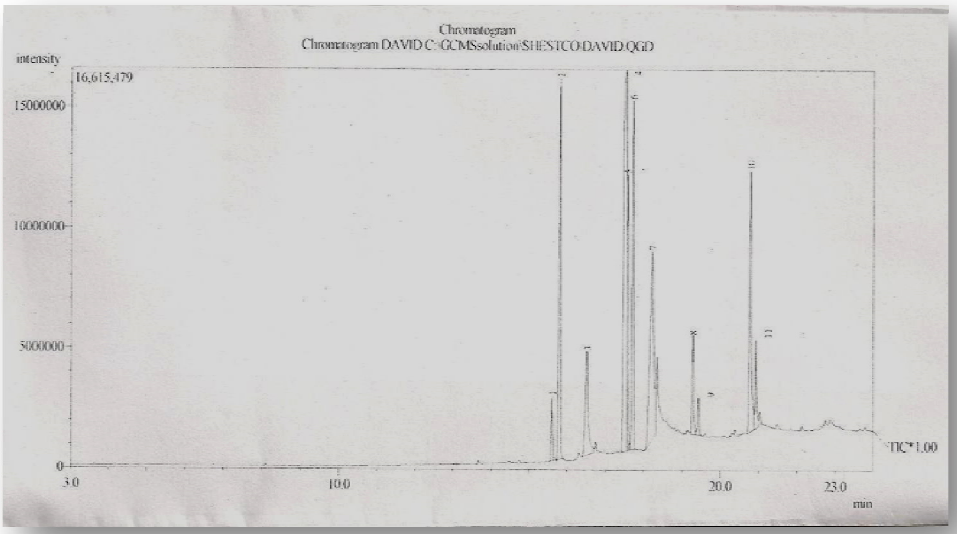

Figure 3: the chromatogram for fatty acid profile

Table 4: Fatty acid composition of the breadfruit seed oil

Line	Fatty acid	C	Relative percentage
1	Oleic acid	19:1	1.63
2	Palmitic acid	17:0	13.63
3	Hexadecanoic acid	16:0	6.41
4	Linoleic acid	19:2	27.96
5	Elaidic acid	19:1	5.35
6	Steric acid	19:0	11.24
7	Petroselinic acid	18:1	15.66
8	Behenic acid	44:0	3.11
9	Eicosanoic acid	21:0	1.12
10	Alph-monoolein	21:1	10.83
11	Octadecanoic acid	21:0	3.06

Table 1 gives the physical properties of the oil. The percentage yield of the oil from breadfruit seed was 7.5% is considered to be very low. Therefore, the seed is classified as low oil yielding seed. The oil colour is light yellow which is in line with most oils which their colour are yellow-red or amber liquids. The colour is from the presence of chlorophylls and carotenoids[13].

Table 2 gives the chemical properties of the seed oil. Acid value is an important index of physicochemical property of oil which is used to indicate the quality, age, edibility and suitability of oil use in industries such as paint[14]. According to Demain[15], acid values are used to measure the extent to which glycerides in the oil has been decomposed by lipase and other physical factors such as light and heat. Thus, the higher acid value of the breadfruit seed oil suggests that the oil is more susceptible to lipase action. This value of 77mg/g is much higher compare to 0.6mg/g proposed by Usoro[16] for edible vegetable oils. The iodine value of breadfruit seed oil is 52.64. This is an indication of relative high saturation in this oil and thus it become more vulnerable to oxidation. The iodine value of oil does not indicate the position of the double bonds or amount of olefinic carbon but rather provides an overall status of unsaturation of the oil, so it is not possible to point out the position of double bond(s) which are more susceptible to oxidation[17]. Thus this oil can be classified as semi drying oil.

Peroxide value is used as a measure of extent to which rancidity reactions have occurred during storage. The higher peroxide value of breadfruit seed oil of 100.78 mEq/Kg indicated a more susceptibility to oxidation. Again, it falls outside the range of 1-10mEq/Kg stipulated for freshly prepared oil[18]. Saponification value is an index of average molecular mass of fatty acids in oil sample. The higher saponification value of breadfruit seed oil (246.09 mgKOH/g), suggest that the mean molecular weight of fatty acid or number of ester bond is high, thus the fat molecules were intact[19]. Therefore the higher saponification of the breadfruit seed oil will be highly useful in the saponification industry. In general, unsaponifiable matters are present in edible oils less than 2%[20,21], which include tocophenols/tocotrienols, other phenolics, phytosterols, hydrocarbons, among others. The unsaponifiable matters of breadfruit seed oil is 29.67k/kg which is within the range of the edible oils.

Phosphatidylethanolamine and free fatty acids for phospholipids and neutral lipid in table 3 respectively are presence in breadfruit seed oil. Phospholipids has been reported to be an important component of cell membrane fluidity and functionality while the neutral lipids serve as store of energy and constituents of membrane structure[22]. The presence of phosphatidylethanolamine may enhanced integrity and functionality of cell membrane if consumed[23].

The model of scavenging the stable DPPH radical is a widely used method to evaluate the free radical scavenging ability of various samples[24]. DPPH is a staple nitrogen-centred free radical the colour of which changes from violet to yellow upon reduction by either the process of hydrogen- or electron-donations substances which are able to perform this reaction can be considered as antioxidants and therefore radical scavengers[25]. It was found that the radical-scavenging activities of the breadfruit seed oil as seen in figure 2 is low compared to that of the standards(Vitamin C, quercetin and butylateed hydroxylanisole).

Table 4 reports the fatty acids constituents of the breadfruit seed oil. The oil contains 38.57% of saturated fatty acids, 33.47% of monounsaturated fatty acids and 27.96% of polyunsaturated fatty acids. Linoleic acid was 27.96% as one of the major fatty acids constituents of the breadfruit seed oil. This acid is one of the most important polyunsaturated fatty acids in human food because of its prevention of distinct heart and vascular diseases. Apart from preventing cardiovascular disorder such as coronary heart diseases and atherosclerosis, linoleic acid prevents high blood pressure. Also linoleic derivatives serve as structural components of the plasma membrane and as precursors of some

metabolic regulatory compounds[26]. Palmitic acid (13.63%) is mainly used to produce soaps, cosmetics, and release agents. This gives its high saponification value. According to the World Health organization, evidences is "convincing" that consumption of palmitic acid increases risk of developing cardiovascular diseases, placing it in the same evidence category as trans fatty acids[27].

Petroselinic acid (15.66%) is classified as a monounsaturated omega-12 fatty acid which is mainly used in cosmetics. Stearic acid (11.24%), is mainly used in the production of detergents, soaps, and cosmetics such as shampoos and shaving cream products. This account to high saponification value in the breadfruit seed oil. It can also be used to produce dietary supplements[28]. Alpha monoolein (10.83%) act as food emulsifier for all kinds of food processing and medicine[30].

CONCLUSION

This study showed that Treculia *Africana* (breadfruit) seed oil is a good source of edible oil. Its fatty acids composition is comparable to that of some conventional oils. Therefore, the oil will be a good candidate for conventional oil and good raw material for soap, paint, food and even pharmaceutical industries

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