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Properties of Vegetable Oils from Three Underutilized Indigenous Seeds

[1]I.O. Igwenyi, [1]O. Dickson, [2]I.P. Igwenyi, [1]P.C. Ugwu Okechukwu, [1]N. Edwin and [1]E.U. Alum

[1]Department of Biochemistry, Ebonyi State University, Abakaliki Ebonyi State, Nigeria
[2]Department of Human Kinetics and Health Education,
Ebonyi State University, Abakaliki Ebonyi State, Nigeria

Abstract: Investigation into the vegetable oil properties of four seeds used in south eastern part of Nigeria revealed that *Mucuna sloanei, Brachystegia nigerica* and *Deutarium microcarpum* have 6.25%, 7.91% and 7.41% oil contents respectively. *Deutarium microcarpum* has moisture content of 5.80%, *Brachystegia nigerica* 4.30%, *Mucuna sloanei* 4.07% and *Afzelia africana* 2.80%. The acid value ranged from 0.20 for *Deutarium microcarpum* to 4.90 mgKOH/g for *Mucuna sloanei*. The free fatty acid content ranged from 2.60 for *Detarium microcarpum* to 14.00% in *Brachystegia nigerica.* The saponification value of *Mucuna sloanei, Brachystegia nigerica* and *Detarium microcarpum* were 182.00, 162.90 and 123.3 mgKOH/g respectively while the iodine values were found to be less than 100. *Mucuna sloanei* was found to be composed of 67.12% palmitic acid, 6.19% myristic acid and 4.71% myristoleic acid. The fatty acid profile of *Brachystegia nigerica* revealed 52.36% palmitic acid, 18.09% oleic acid, 14.12% stearic acid, 4.08% myristic acid and 1.46% lauric acid. *Detarium microcarpum* contained 6.86% myristoleic acid, 5.87% myristic acid and 2.28% linolenic acid. These results were further confirmed by the iodine values of the samples. *Mucuna sloanei, Brachystegia nigerica and Detarium microcarpum* had 6.79, 25.70 and 55.00 (Wij's) respectively. This result revealed that the vegetable oils may find useful application in the industries in the areas of soap manufacture, fuel and biodiesel production and edible vegetable.

Key words: Vegetable Oil · Indigenous Seeds · *Mucuna sloanei* · *Brachystegia nigerica* and *Deutarium microcarpum* · Fatty Acid Profile

INTRODUCTION

The presence of green plants (autotrophs) makes it possible for the existence of animals (heterotrophs) on earth. From the earliest times, man has derived food, shelter, medicine and decoration from plants. In most of the ancient civilization, one can find some references to plants [1-3].

A substantial amount of human calories is taken in the form of fats and oils which are abundant in seeds. Food use of fats and oils has increased as well as its industrial need which is also associated with increase in world population. This has also led to a gradual decline per capital consumption in industrial products and a big problem to feed the ever increasing world population. Some seeds are used as soup thickeners and some as soup condiments. This calls for more investigative data on the nature of their compositions and properties of these constituents so as to ascertain their actual nutritional essence. However, these nutritional seeds may also have other possible industrial applications that may put pressure on its food use and encourage their planting, cultivation and appreciation. These soup thickeners include *Mucuna sloanei* (Igbo: okobo), *Brachystegia nigerica* (Igbo: achi) and *Detarium microcarpum* (Igbo: ofor). These seeds are the most commonly used thickening agents in south eastern part of Nigeria.

Mucuna species are found throughout the tropics and have proven to be excellent green manure and cover crops. Over 100 species of mucuna have been described, among which is *Mucuna sloanei*, with seeds that are used as soup thickeners. Most of the species are used for medicinal and therapeutic applications [4- 8].

Brachystegia nigerica (achi) belongs to the family of *leguminocea* and the sub family *caesalpiniaces* flowering plants. It grows mainly along river bank or swampy areas,

Corresponding Author: I. Igwenyi, Department of Biochemistry, Ebonyi State University, Abakaliki Ebonyi State, Nigeria.

though it can be found in well drained soils. It is found in Nigeria, Cameroon, Ghana and Ivory Coast [9-12]. The tree bears pods that contain 3-12 seeds that are dispersed by explosive mechanism. The seeds are flat, shiny, dark brown, spherical and disc shaped.

Deuterium microcapum is particularly associated with dry savannah. It grows naturally in forest parts of Africa, flowering throughout the wet season and bear fruits between November and January, though it may also bear in May [13-16].

These seeds are mainly used as thickeners because of its thickening properties in soups. However, an investigation and comparism of the oil content and physicochemical properties will help in the prediction of the overall nutritional essence and other possible useful applications. Such parameters to investigate include percentage oil composition, moisture content, percentage total fatty matter, fatty acid content, free fatty acid content, saponifiable matter, iodine value, refractive index and peroxide value.

Some of these parameters may have been investigated and originality or novelty is an important consideration. However, simply because a research problem has been investigated in the past does not mean that it is no longer worthy of study. At times, it is appropriate to replicate or repeat a study to verify its conclusion or to extend the validity of its findings to a different situation, location or region, environment, species or population [17].

MATERIAL AND METHODS

Fresh samples were bought from Eke-Aba market, in Abakaliki metropolis, the headquarter of seed hunters in the Sub Saharan Africa, controlled by merchants from Okposi in Ohaozara Local Government Area, Ebonyi State Nigeria. The shells were removed, the seeds dried and milled. The percentage oil content was obtained using the Soxhlet extraction method [1] and percentage oil content calculated based on the formula of PORIM [15]. The acid value was determined as milligrams of potassium hydroxide required to neutralize 1g of fat while the peroxide value was determined following procedures described in Hamilton *et al*.[6] as the amount of substance in a sample expressed in terms of milli equivalents of "active oxygen" per kilogram of fat which oxidizes potassium iodide. The iodine value was derived according to Wij's method as the number of grams of halogen added to the double bonds of 100g fat and expressed as equivalent number of grams of iodine [10].

RESULTS AND DISCUSSION

Pants and their resources have been used by humans as source of food, medicine and raw materials for industries. The search for oil and economically viable sources of oil is endless. This is because of the important niche oil occupies in nutrition and world economy.

There are about 300,000 known plant species, out of which only about 3,000 have been tried as sources of useful materials and less than 300 are exploited in organized agriculture. However, only about 100 tropical and sub-tropical plants belonging to about 40 different botanical families are presently known to have oil-bearing seeds and fruits with sufficient oil to attract commercial interest while fewer than 25 provide the principal vegetable oil of international trade [4]. These thickeners are only exploited mainly for their nutritional essence but consideration of the fatty acid profile can give an insight into some possible therapeutic application such as relationship with heart related diseases and oxidative stress.

The extraction and characterization of oil from seeds used as soup thickeners in Table 1 revealed that *Mucuna sloanei, Brachystegia nigerica* and *Deutarium microcarpum* have 6.25%, 7.91% and 7.41% respectively. *Deutarium microcarpum* has moisture content of 5.80%, *Brachystegia nigerica* 4.30% and *Mucuna sloanei* 4.07%. These values are moderately high and may cause a serious degradation of the fatty materials by hydrolysis and microbial attack. Their storage therefore would require a careful reduction of the moisture content by drying.

The physical and chemical properties of the oil were investigated as shown in Table 2 and it revealed that the acid value ranged from 0.204±0.02 for *Deutarium microcarpum* to 4.90±0.04mgKOH/g. The moisture content was highest in *Deutarium microcarpum* and least in *Afzelia africana.* The peroxide value ranged from 3.34 in *Mucuna sloanei* to 6.90meq/g in *Brachystegia nigerica.* These are comparable to raphia mesocarp oil 2-6 meq/kg (Igwenyi *et al.,* 2008) and rubber seed oil 3-4 meq/kg [11]. This showed that the oil would be stable and this stability could be attributed to the presence of natural anti-oxidants in the oil which are quite effective in slowing down the rate of oxygen absorption by reacting with the fatty acid peroxy free radical [7]. The saponification value of *Mucuna sloanei, Brachystegia nigerica* and *Detarium microcarpum* were 182.00, 162.90 and 123.3mgKOH/g respectively. The iodine values were found to be less than 100, indicating that there are non-drying oils. Such oils are liquid at room temperature and are incapable of forming

Table 1: Extraction of oil from fresh soup thickeners

Parameters	*Mucuna sloanei*	*Brachystegia nigerica*	*Detarium microcarpum*
Oil content	6.25±2.02	7.91±1.10	7.41±2.61
Moisture content	4.07±1.02	4.30±0.82	5.80±1.20
Total fatty matter	79.28±0.80	89.00±1.60	52.90±1.00

Table 2: Physicochemical characterization of oil from four selected soup thickeners

Parameters	*Mucuna sloanei*	*Brachystegia nigerica*	*Detarium microcarpum*
Refractive index			
@ 40°C	1.43±0.00	1.43±0.00	1.47±0.00
Acid value (mgKOH/g)	4.90±0.04	3.80±0.10	0.204±0.02
Free fatty acid (%)	5.10±0.02	14.00±1.81	2.60±0.20
Peroxide value (meq/g)	3.34±0.01	6.90±0.50	4.60±0.20
Sap. Value (mgKOH/g)	182.00±1.20	162.90±2.56	123.3±2.46
Iodine value (Wij's)	6.79±0.10	25.70±2.10	55.00±1.40

Table 3: Determination of chain length distribution of FAMES's of *Mucuna sloanei* (Method number: SO29P Packed GC)

	Fresh seeds				
Peak #	Ret Time (Min)	Width (min)	Area (PA*S)	Area (%)	Name of fatty acid
1	6.151	0.4855	1633.39380	5.99009	?
2	7.148	0.4384	1687.07507	6.18696	C14
3	7.479	0.3846	1284.61353	4.71102	C14:1
4	9.289	0.8806	4365.94678	16.0110	?
5	9.806	2.6798	1.8298	67.10083	C16
Totals: 2.72683e4					

Table 4: Determination of chain length distribution of FAMES's of *Brachystegia nigerica* (Method number: SO29P Packed GC)

	Fresh seeds				
Peak #	Ret Time (Min)	Width (min)	Area (PA*S)	Area (%)	Name of fatty acid
1	4.689	0.4264	1735.44727	1.46392	C12
2	6.253	0.5630	2406.03442	2.02959	?
3	7.201	0.6727	4834.47998	4.07808	C14
4	9.452	0.6837	5871.42773	4.95279	?
5	9.830	1.4495	6.207e4	52.36222	C16
6	13.385	0.4973	3437.57520	2.89973	?
7	14.404	0.5883	1.67398e4	14.12073	C18
8	16.639	0.7024	2.14488e4	18.09294	C18:2
Totals: 1.18548e5					

Table 5: Determination of chain length distribution of FAMES'S *Detarium microcarpum* (Method number: SO29P Packed GC)

	Fresh seeds				
Peak #	Ret Time (Min)	Width (min)	Area (PA*S)	Area (%)	Name of Fatty Acid
1	6.169	0.8584	3786.36743	5.86516	C14
2	7.693	0.7892	4427.20703	6.85784	C14:1
3	8.523	0.5203	3252.51758	5.03822	?
4	8.959	0.4711	3345.84619	5.18279	?
5	9.541	6.3443	4.82745e4	74.77827	?
6	18.457	1.1294	1470.42297	2.27772	C18:3
Totals: 6.45569e4					

elastic films even after a long time exposure to air as they do not react with atmospheric oxygen. This is further confirmed by the fact that such oils are largely composed of glycerides of saturated acids and oleic acid, with little or no linoleic or linolenic acids. These non-drying oils are of no use in paints, vanish or lacquer industries but are very useful in the manufacture of soaps, lubricants and as food.

The industrial value of a vegetable oil depends on its specified fatty acids and the ease with which it can be modified or combined with other chemicals. Currently, only about 10% of the vegetable oils produced are used in the non-food applications [5]. The investigation into the fatty acid contents of the samples revealed that *Mucuna sloanei* was found to be composed of 67.12% palmitic acid (C16), 6.19% myristic acid (C14) and 4.71% myristoleic acid (C14:1). The fatty acid profile of *Brachystegia nigerica* revealed 52.36% palmitic acid (C16), 18.09% oleic acid (C18:1), 14.12% stearic acid (C18), 4.08% myristic acid (C14) and 1.46% lauric acid (C12). *Detarium microcarpum* contained 6.86% myristoleic acid (C14:1), 5.87% myristic acid (C14) and 2.28% linolenic acid (C18:3). These results were further confirmed by the iodine values of the samples which showed that *Mucuna sloanei, Brachystogia nigerica and Detarium microcarpum* had iodine values of 6.79, 25.70 and 55.00 (Wij's) respectively showing that the oils were non-drying at room temperature [11].

Brachystegia nigerica and *Detarium microcarpum* were observed to contain essential fatty acids. *Brachystogia nigerica* contained 18.09% linoleic acid (C18:2) while *Detarium microcarpum* contained 2.28% linolenic acid (C18:3). These essential fatty acids are important in maintaining cell membrane structure and in capillary wall integrity and serve as starting materials for the synthesis of other unsaturated fatty acid derivatives such as prostaglandins [10]. These results support the use of these seeds as thickeners due to their fatty acids composition and also provide baseline data for further systematic research.

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