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Comparative assessment of some physico-chemical properties of seed oils of *Parkia biglobosa* and *Monodora myristica* with some commercial oils

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The demand for oils has increased in recent times as a result of industrial and nutritional processes. There is therefore the need to search for oils from different types of seeds. As part of an on-going work to search for alternate sources of oils, seed oils from *Monodora myristica* and *Parkia biglobosa* were extracted, analysed and some of their physicochemical properties were compared with those of vegetable and palm oils. The results show that seed oils of *M. myristcia* and *P. biglobosa* have some physicochemical properties comparable with those of the commercial oils and hence have great nutritional and industrial potentials. It is therefore recommended that more studies be undertaken for this abundant source of natural nutritious oil.

Key words: Physicochemical properties, vegetable oils, *Monodora myristica, Parkia biglobosa.*

INTRODUCTION

Globally, natural vegetable oils and fats are increasingly becoming important in nutrition and commerce because they are sources of dietary energy, antioxidants, biofuels and raw materials for the manufacture of industrial products. They are used in food, cosmetic, pharmaceutical and chemical industries. Vegetable oils account for 80% of the world's natural oils and fat supply (Okullo et al., 2010). Vegetable oils are sourced from diverse varieties of leguminous plants, which are considered the major sources of dietary proteins. They are consumed worldwide, especially in developing and underdeveloped countries where consumption of animal protein may be limited as a result of economic, social, cultural or religious factors (Oluwole and Oluremi, 2012). In 2011/2012 alone, about 184.6 million tonnes of world production of oils and fats was from vegetable and animal sources (FAO, 2014). With only a limited number of oils and fats available on a commercial scale, it is not surprising that these are sometimes inadequate to meet the physical, nutritional and chemical properties required for use in food products (Gunstone, 2011). Industrial and nutritional processes have increased the demands for oil and this in turn has led to the search for oils from different types of seeds. Fats and oils are nutritionally important because they form one of the three major classes of food (Dhellot et al., 2006).Oils are used for food texturing,

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baking and frying. Industrially, oils are used in the manufacture of soap, detergent, cosmetics, pharmaceuticals, petroleum and oil paints (Dhellot et al., 2006).

In plants, oil is found mainly in the endosperms of the seeds together with carbohydrates where they jointly nourish the embryo (FAO, 2007). Oils can also be found in the mesocarp of some plants, for example, in palm fruits (FAO, 2007). Due to the increase in nutritional and industrial processes, the demands for oils have increased which in turn has led to the search for oils.

Monodora myristica commonly called calabash nutmeg is a perennial edible plant of the family *Annonaceae*. It is found most commonly in the evergreen forests of West Africa (Liberia, Nigeria, Cameroon, Angola, Uganda and west Kenya) and common names are African nutmeg, calabash nutmeg, and in Nigeria, it is called *ehuru, ariwo, ehiri* and *airama* (Burabai et al., 2007). This tropical shrub is of the family of flowering plants (Weiss, 2002; Omobuwajo et al., 2003). *M. myristica* fruit is a berry of 20 cm diameter; it is smooth, green and spherical, and becomes woody at maturity. It is attached to a long stalk which is up to 60 cm long. Inside the fruit are the numerous oblong, pale brown seeds which are usually 1.5 cm long and are surrounded by a whitish fragrant pulp. *M. myristica* is a species of calabash nutmeg, the edible seeds yield a nutmeg-flavoured oil which is used in West Africa for cooking (Eggeling, 2002). *M. myristica* seed extract contains important pharmacological compounds like alkaloids, flavonoids, and vitamins A and E as well as many important lipids (George and Osioma, 2011). Alcoholic extracts of *M. myristica* is known to reverse the toxigenic effect of aflatoxins (Oluwafemi and Taiwo, 2004). In Eastern Nigeria, the seeds are used as condiment and one of the spices used as postpartum tonic. *M. myristica* has been proven to have anti-sickling properties (Uwakwe and Nwaoguikpe, 2008). The essential oil from the leaves contains *β*-caryophyllene, *α*-humulene and *α*-pinene, while that from the seeds contains *α*-phellandrene, *α*-pinene, myrcene, limonene and pinene (Nguefack et al., 2004). Phytochemical screening carried out on *M. myristica* extract revealed the presence of tannin, saponin, flavonoid, steroid, terpenoids, cardiac glycoside, alkaloid and phenol. Earlier determination of the chemical constituents of the seeds revealed the presence of Fiberro-latic oils, resins, terpene, lactose, arocine, saponins, flavonoids and tannins (Iwu, 1993).

In the arid and semi-arid regions of Africa, *Parkia biglobosa* (African locust bean) is very important for food security particularly during food shortage and drought periods (Kourouma et al., 2011). *P. biglobosa* (named after the famous Scottish botanist and surgeon Mungo Park by Robert Brown in 1926) has long been widely recognized as an important indigenous multipurpose fruit tree whose uses include food, medicine, manure, tannin, shade, wind-breaks, bee food, stabilization of degraded environment, livestock feeds, fuel, fibre, fish poison and several other domestic uses (Sadiku, 2010). African locust bean, as it is commonly known, is a tree legume that belongs to the family *Mimosoideae* (Adejumo et al., 2013). It grows in the savannah region of West Africa up to the southern edge of the Sahel zone 13°N (Campbell-Platt, 1980). These trees are not normally cultivated but can be seen in population of two or more in the savannah region of Ghana (Hopkins, 1983). The locust beans are the mature seeds that come from the parkia pods. The pods are harvested and processed into the fermented product known as '*Iru'*, *'Dawadawa*' and '*Ogiri*‟ in the Yoruba, Hausa and Igbo languages, respectively (Sadiku, 2010). It is characterized by its fruits, which are elongated pods, 5-11 inches long and found in clusters. It flowers from December to March and brings out fruits from February to July. The immature fruits are green and brown when it is mature. The mature seeds are made up of husk which is embedded in dark brown pod. The seeds of *Parkia* plants are eaten as food in Ghana, especially Northern Ghana. The seeds are fermented to give condiments and used as ingredients to prepare soup and stew in most cases as alternative to meat in low income families (Irvin, 1961). It has been reported that the husks and pods are good food for livestock (Elemo et al., 2011). Earlier investigations have mentioned the food and nutritive values of *P. biglobosa* and other species seeds (Alabi et al., 2004). Alabi et al. (2005) reported that locust bean is rich in lipid, protein, carbohydrate, soluble sugars and ascorbic acid. The cotyledon is very nutritious, has less fibre and ash contents. The oil content is suitable for consumption since it contains very low acid and iodine contents. The oil has very high saponification value and hence would be useful in the soap industry.

Despite the numerous uses of the seeds of *M. myristica* and *P. biglobosa* seeds, little attention has been paid to their seeds as sources of oil. The study was therefore aimed at the determination of the physicochemical properties of the seed oils of *P. biglobosa* and *M. myristca* and comparing these properties with those of commonly used vegetable oils to ascertain the suitability or otherwise of the seed oils for nutritional and industrial applications.

MATERIALS AND METHODS

Sampling

The seeds of *M. myristica* and *P. biglobosa* were purchased from the local market at Ejura in the Ashanti region of Ghana. The seeds were grounded using an electric grinder into powder and kept in an air-tight Teflon-lined container and capped prior to extraction. Vegetable oil (Frytol oil) and palm oil were purchased from the retail market at Ejura sealed and kept in a cool dry place prior to analysis.

Oil extraction and determination

The oils were extracted using hexane by adopting the method

Table 1. Physico-chemical properties of the oils.

Parameters	*Monodora myristica* oil	palm oil	*Parkia biglobosa* oil	Vegetable oil (Frytol oil)
Density (g ml^{-1})	0.860±.001	0.891±0.002	0.884±0.001	0.881±0.002
Specific gravity	0.956±0.002	0.955±0.002	0.947±0.001	0.944±0.001
Refractive index (D, 20°C)	1.467±0.003	1.450±0.002	1.465±0.002	1.458±0.001
Moisture Content (%)	10.59±1.245	0.35±0.002	3.165±0.234	0.230±0.001
Acid value (mgKOHg^{-1})	21.14±0.003	13.35±0.011	15.23±0.251	1.02±0.002
Free Fatty Acid (%, oleic acid)	10.27±0.654	6.67±0.002	7.62±0.012	0.51±0.001
Peroxide value (meq g^{-1})	0.415 ±0.002	0.601±0.001	1.414±0.012	0.608±0.002
Iodine value (g 100g^{-1})	64.9±1.015	58.42±1.508	61.73±0.569	59.06±1.002
Saponification number (mg KOH g^{-1})	150.07±1.013	138.57±2.021	176.15±1.005	188.22±2.012
Ester value (mg g^{-1})	128.93±4.25	125.21±3.51	160.92±2.50	187.20±6.10

Values of means ± standard deviation of triplicates.

described by AOAC (1990). Oil was extracted from the samples using Soxhlet apparatus with n-hexane as the extracting solvent. After extraction, the solvent was removed in *vacuo*. The oil obtained was stored under refrigeration (4°C), until used for further analysis. Extracted oil was quantified gravimetrically.

Physicochemical analysis

The extracted oil was immediately analysed for moisture content, oil density, specific gravity, refractive index, pH, iodine value, saponification value, free fatty acid, peroxide value, ester and acid values following the method described by the Association of Official Analytical Chemists (AOAC, 2000).

Statistical analysis

All values were expressed as the mean ± S.D of triplicates. Data were analyzed using one-way analysis of variance (ANOVA) followed by the post-hoc Duncan multiple test for analysis of biochemical data using SPSS program (version 17, SPSS Inc., USA). P Values < 0.05 were considered statistically significant.

RESULTS AND DISCUSSION

The studied physicochemical properties oil extracted from two Ghanaian seeds (*M. myristica* and *P. biglobosa*) and two references oils (palm and vegetable) are shown in Table 1. The *P. biglobosa* and *M. myristica* seeds had appreciable amounts of oil (16.50 and 26.8%w/w, respectively). This shows that if commercially exploited, they could serve as one of the major additional sources of oil.

Moisture content is an important characteristic for oils and fats as it determines the rate of rancidity and oxidation process of the oils. It is desirable to keep the moisture content low as it will increase the shelf life by preventing oxidation and rancidity processes (Mansor et al., 2012). The high moisture content will assist in hydrolysis process (Osawa et al., 2007). *M. myristica* seed oil has the highest moisture content whilst the vegetable oil has the least. This means that the *Monodora* seed oil will easily go rancid and thus will have the shortest shelf life whilst the vegetable oil will have the longest shelf life. Also, the higher the moisture content of the oil, the greater the value used for food texturing, baking, and frying and industrially in the manufacture of soaps, detergents, cosmetics and oil paints (Mansor et al., 2012). *Monodora* oil will therefore, require more for its industrial and commercial purposes.

Iodine value is a measure of degree of unsaturation of a lipid (Muhammad et al., 2012). *M. myristica* oil had the highest iodine value whilst palm oil had the lowest. This means that the *M. myristica* oil contained the highest degree of unsaturation and hence had the highest ability to remain in liquid form at room temperature. Palm oil has the lowest iodine value meaning that it is the most saturated. From Table 1, the values classify the tested oils as non-drying oils. The relatively high iodine numbers may be indicative of the presence of much unsaturated bond and high susceptibility to oxidative rancidity (Olaniyi et al., 2014).

The saponification value is a measure of the proportion of low molecular weight triacylglycerols (Oladiji et al., 2010). It also indicates the foaming ability of the oil. Foaming is a desired characteristic of good surfactants with applications in preparation of emulsions, soaps and detergents formulation (Muhammad et al., 2006). Saponification values determined for the four oils were greater than 100, indicating that the oils can be used for making soap (Oladiji et al., 2010). However, vegetable oil is least suitable and palm oil the most suitable ingredient for soap manufacture. Saponification value is an index of average molecular mass of fatty acids in oil sample (Oladiji et al., 2010). The high value of saponification value in the seed oils suggests that the mean molecular weight of fatty acids is high or that the number of ester bonds is high. Also, saponification value basically refers to the mean molecular mass of the fats and oils and has an inverse relationship with the chain length of the fatty acid in fats and oils. This means, the longer the average fatty acid chain length, the smaller the saponification value (Mansor et al., 2012). It can be concluded that vegetable oil contains the fatty acid with the longest chain length followed by *P. biglobosa* oil and *M. myristica* oil with palm oil being the shortest. From Table 1, the values ranged from 138.57- 188.13 mg KOH g^{-1}. The relatively high saponification value recorded for the seed oils is indicative of their potential use in the industry (Amoo et al., 2004).

The peroxide value is an index of rancidity and its susceptibility to oxidation, thus low peroxide value indicates resistance of the oil to peroxidation during storage (Muhammad et al., 2006). The peroxide values of both *P. biglobosa* and *M. myristica* are comparable to the peroxide values obtained for the palm oil and the vegetable oil. All the oils recorded low peroxide values, as compared to the maximum acceptable value of 10 meq KOH/g (meq/Kg or g) set by the Codex Alimentarius Commission for groundnut seed oils. The oils are thus stable and would not easily go rancid (CODEX, 2001).

Peroxide values is used as an indicator of deterioration of oils. Fresh oils have values less than 10 mEq/kg. A rancid taste often begins to be noticeable when the peroxide value is between 20 and 40 mEq/kg (Egan et al., 1981).

The acid value (AV) is a common parameter in the specification of fats and oils. It is a measure of the free fatty acids (FFA) present in the fat or oil (Popoola and Yangomodou, 2006). The acid value is often a good measure of the breakdown of the triacylglycerols into free fatty acids, which has an adverse effect on the quality of many lipids. An increment in the amount of FFA in a sample of oil or fat indicates hydrolysis of triglycerides (Akubugwo et al., 2008). In general, it gives an indication of edibility of the lipid and suitability for used in the paint industry (Olaniyi et al., 2014). Oils with acid values of more than one, indicates an edible oil whilst pharmaceutical oil must not contain acidity at all (Oladiji et al., 2010). The acid values and the free fatty acids values recorded for all the oils were more than one signifying the edibility of the oils (Olaniyi et al., 2014). The oils of *P. biglobosa* and *M. myristica* can therefore be utilized as a source of edible oil. The values recorded for the free fatty acids correspond with that of the acid values, palm oil recorded the highest, followed by *P. biglobosa*, *M. myristica* and vegetable oil.

The mean refractive index recorded for all the oils were within the range 1.466 to 1.470 which is in close agreement with values reported for conventional oils from soybean (Akubugwo et al., 2008). The high refractive index of the oils seems to confirm the high number of carbon atoms in their fatty acids (Akubugwo et al., 2008). Refractive index also increases as the double bond increases meaning high degree of unsaturation (Akubugwo et al., 2008). Based on the recorded values, *M. myristica* oil has the highest refractive index (1.467±0.003) meaning that it has the highest number of carbon atoms and double bonds, followed by *P. biglobosa* seed oil (1.465±0.002), the vegetable oil (1.458±0.001) with palm oil (1.450±0.002) having the lowest number of carbon atoms and double bonds.

The specific gravity of oils ranged between 0.86 to 0.98. These values are within the range of 0.89 and 0.92 at 20°C for specific gravities reported for the fats and waxes (Ajayi and Oderinde, 2002).

CONCLUSION AND RECOMMENDATION

The physico-chemical properties of the *P. biglobosa* and *M. myristica* seed oils determined are comparable to those of palm oil and vegetable oil (frytol oil) and that the seed oils are not inferior to other edible oils used for cooking. It is therefore recommended that more studies such as toxicological study investigations, mycotoxins or alkaloids or glycosides analysis be carried out to explore its viability for both nutritional and industrial use.

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