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Evaluation of the fixed oil of two commonly consumed spices, *Monodora myristica* and *Myristica fragrans*, as adjunct in food formulations

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The seeds of two commonly consumed spices; *Monodora myristica* (Mm) and *Myristica fragrans* (Mf) were separately defatted with n-hexane and the resulting oils were analyzed for their physicochemical properties and fatty acids profile with a view to assessing their nutritional potentials. Results revealed that Mm and Mf had respective percentage oil yields of 25% and 37.7%; free fatty acid of 32.52 and 1.71%; saponification values of 240.95 and 230.47 mgKOH/g; iodine values of 89.75 and 97.75 gI_2/100g oil; peroxide values of 2.32 and 1.65 MeqKOH/g. Oleic acid (36.35%), linoleic acid (50.27%) and linolenic (1.55%) acids were the major unsaturated fatty acids detected in *M. myristica* spice oil while palmitic acid (8.78%) and butyric acid (3.74%) were the few saturated fatty acids contained in the oil. In *Monodora fragran s*oil, palmitoleic (1.78%), oleic (14.82%) and linolenic (3.36 %) were the unsaturated fatty acids obtained, while butyric (24.20%), hexanoic (6.74%), lauric (16.71%), myristic (3.40%), palmitic (26.72%) and stearic (2.57%) were the saturated fatty acids detected in the oil. *M. myristica* contained higher proportion of polyunsaturated fatty acids compared to *Monodora fragrans.* The high free fatty acids with low iodine value in Mm and high saturated fatty acids in Mf called for caution in their encapsulation in food formulations.

Key words: *Monodora myristica, Myristica fragrans*, fatty acids profile, food formulations.

INTRODUCTION

In developing countries several plants give edible products, fruits, seeds, leaves, flowers, nuts and oils which take a large place in the local diet and could strongly overcome or ameliorate food and health problems. Some of these edible food parts are used as spices to season foods while most are used as food and drug. The distinction between food and drug is not always clear because most of the edible seeds possess these two properties (Koudou et al., 2007). Typical examples of seeds that possess both characteristics and also serve as spices are *M. myristica* and *Myristica fragrans*.

M. myristica (Annonaceae) commonly known as 'Ariwo' in South Western Nigeria is a tropical tree that grows wild in many African countries including Nigeria (Okafor, 1987; Fournier, 1999). Nutritional values of *M. myristica* center on its usefulness as seasoning because of its

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Table 1. Physicochemical properties of the spice oils.

Property	*Monodora myristica* oil	*Myristica fragrans* oil
Colour	Amber	Light yellow
Oil yield (%)	25.40 ± 0.25	37.72 ± 0.42
Specific gravity	0.8634 ± 0.003	0.634 ± 0.002
Refractive index at 28°C	1.469 ± 0.001	1.686 ± 0.001
Free fatty acid value (%)	32.52 ± 0.20	1.71 ± 0.22
Saponification value (mgKOH/g)	240.95 ± 0.20	230.47 ± 0.25
Iodine value (gI_2/ 100 g)	89.75 ± 0.20	97.75 ± 0.20
Peroxide value (MeqKOH/g)	2.32 ± 0.22	1.65 ± 0.10

Mean ± SD of triplicate determinations.

aromatic flavor. The kernel obtained from the seeds is a popular condiment used as spicing agent in both African and Continental cuisines in Nigeria (Ekeanyanwu et al., 2010). The seeds are aromatic and used as stimulating addition to snuff and medicine (Uwakwe and Nwaoguikpe, 2008). Several of its medicinal uses have been reported; the bark is used in the treatment of stomach-aches, febrile pain, eye diseases and heamorrhoids (Weiss, 2002). In Central African Republic, the seeds are used as condiment and drugs in the treatment of head ache and hypertension (Koudou et al., 2007).

Also, *M. fragrans* Houtt (family: Myristicaceae) is indigenous to the Malay Peninsula and Penang but now cultivated in many tropical countries of both the hemispheres (Evans, 1996). The use of *M. fragrans* as a spice, was introduced into the Europe probably during the twelfth century. *M. fragrans* commonly known as nutmeg has been reported to have aromatic, stimulant, narcotic, carminative, astringent, aphrodisiac, hypolipidemic, antithrombotic, anti-platelet aggregation, antifungal, anti-dysenteric, anti-inflammatory activities (Janssen and Laeckman, 1990). It is used as a remedy for stomach ache, rheumatism and vomiting in pregnancy. The kernel contains volatile oil, a fixed oil, protein, fats, starch and mucilage, and the acetone soluble part of n-hexane extract of *M. fragrans* have been reported to possess anxiogenic, sedative and analgesic activity (Sonavane et al., 2001). However, there is limited information on the physicochemical properties and fatty acids profile of the fixed oils of both spices. In view of this, the present study characterized the spices fixed oils to determine the suitability for encapsulation as food additives.

MATERIALS AND METHODS

M. myristica and *M. fragrans* were purchased at 'Jagun' market, Ogbomoso, Oyo State, South West Nigeria. The seeds were removed from the pod and separated from any dirt. The seeds removed were dried to a constant weight in a Gallen kamp Oven BS Model DV-160 at a temperature of 105°C and milled using a Kenwood blender. The milled samples were then stored in airtight container prior to analyses.

Analysis of extracted oils

The oil exhaustively extracted from the dried samples in a Soxhlet apparatus using n-hexane as the extractant was concentrated by rotary evaporator and all solvent completely expelled. The refractive index of the oils was measured at room temperature using the Abbey refractometer (Prince Optical Works, MalkaGanj Delhi, India). Specific gravity was also determined using a specific gravity bottle (BS 733, Jaytec, Hastings, UK). The oil obtained were analyzed for the acid value, saponification value, free fatty acid, iodine value and peroxide value using standard methods of the American Oil Chemist Society (AOCS, 1973).

Fatty acid composition

A 100 mg oil sample was saponified with 1.2 ml of 0.5 M methanolic KOH at 60°C for 10 min, neutralized with 0.7 M HCl and methylated with 3.0 ml BF_3–CH_3OH for about 10 min in a water bath at 60°C. The product was then extracted with petroleum ether (40 to 60°C). The fatty acid methyl ester was separated by a Perkin Elmer Autosampler XL gas chromatograph with BPX-70.02; 30 m × 0.25 mm (i.d.); 0.25 µm film thickness column. Helium was the carrier gas at a flow rate 20 Psi and a split injector (220°C, split flow rate, 40:1). The temperature was programmed from 60°C at 10°C min^{-1}, then 180°C at 4°C min^{-1} and finally 235°C. The total run time was 27.7 min. Detection was by FID at 220°C. Identification and quantification of the methyl esters was made by comparison of retention times with standard fatty acid methyl esters obtained from Sigma aldrich chemicals.

RESULTS AND DISCUSSION

The physicochemical properties of both spices were reported in Table 1. *M. myristica* oil was amber red colour while *M. fragrans* was light yellow. *M. myristica* spice yielded 25.4% oil while *M. fragrans* yielded 37.7% oil. These values were higher than 18.90% yield in another spice; *Syzygium aromaticum* (Bello and Jimoh, 2012). Both oils have specific gravity less than one indicating that they are less dense than water. This is an advantage since they can act as potential fuel source in biodiesel

Table 2. Fatty acids compositions of *Monodora myristica* (Mm) *and Myristica fragrans* (Mf).

Fatty acids	*Monodora myristica* (%)	*Myristica fragrans* (%)
Butyric	3.74	24.20
Hexanoic	---	6.74
Lauric	---	16.71
Myristic	---	3.40
Palmitic	8.78	26.72
Palmitoleic	---	1.78
Stearic	---	2.57
Oleic	36.65	14.82
Linoleic	50.27	---
Linolenic	1.55	3.36
Total saturated fatty acids	12.52	80.34
Total unsaturated fatty acids	88.47	19.96

production for fuel injector engines which depends on fuel with very low density. The specific gravity of biodiesel ranges between 860 to 900 kg/m^3 at 15°C. Both oils have iodine values of 89.75 and 97.75 g I_2/ 100g oil, which is less than 100, and are comparable to castor seed oil (Akpan et al., 2006). Oils with an iodine value less than 100 is classified as non-drying oils which has a wide variety of industrial uses; thus they are suitable for preparing soaps and cleansers, cosmetics, lubricants, leather dressings and candles. During use, they will not deteriorate to any appreciable extent due to oxidation and polymerization. The spice oils investigated in this study will have a longer shelf life compared to some conventional oils with iodine value above 100, such as corn oil (103 - 128 g I_2/ 100 g oil), cotton seed oil (99 - 119 g I_2/ 100 g oil) which are more suitable for use in the food industries (Noor and Ikram, 2009). The low peroxide values 2.32 and 1.65 MeqKOH/g *M. myristica* and *Myristica fragran s*oils respectively show that the oils could be stable to relative oxidation. The free fatty acid (FFA) is the amount of fatty acid that is not triglycerides; it is an important variable in considering the quality of oil, because the lower the FFA values, the better the quality of oil. The %FFA (32.52) obtained for *M. myristica* in the present study was similar to 34.55% FFA reported by Faleyimu and Oluwalana (2008) in their study. This means there could be higher proportion of other lipid associated substances like sterols, fat soluble vitamins in *M. myristica*. The percentage FFA in *M. fragrans* was however lower (1.71%). The high amount of free fatty acids in the oils is of concern especially when considered as adjunct in food formulations; the oils might be more suitable for industrial applications.

The fatty acids profile obtained (Table 2) showed that the major fatty acids present in *M. myristica* was butyric acid (3.74%), palmitic acid (8.78%), oleic acid (36.65%), linoleicacid (50.27%) and linolenic acid (1.55%). *M. myristica* contains a high percentage of polyunsaturated fatty acids (PUFA) and monoene. Linoleic acid ($C_{18:2}$), is the dominant PUFA (50.27%) in *M. myristica* which compared closely and favourably with linoleic acid content (57.59%) in *Crotalaria cleomifolia* seed oil and sunflower, cottonseed, corn, and sesame seed (Noor and Ikram, 2009). The oil also contain linolenic acid ($C_{18:3}$) and higher level of a monoene, oleic acid ($C_{18:1}$). The proportion of oleic acid (36.65%) and linolenic acid (1.55%) in *M. myristica* oil compared favourably with 38.7% oleic acid in palm oil and higher than 1.0% of linolenic acid in maize oil (Matos et al., 2009). Linoleic and linolenic acids are important essential fatty acids required for growth, physiological functions and maintenance. The oil contain minor amount of saturated acids butyric acid (3.74%) and palmitic acid (8.78%). The total amount of saturated and unsaturated fatty acids in *M. myristica* is 12.52 and 88.47%, respectively. Although, oil with high level of unsaturated fatty acids have been reported to reduce the risk of heart diseases associated with cholesterol (Law, 2000), the high proportion of free fatty acids in the oil might be a disadvantage for its use in food formulations.

Also in Table 2, *M. fragrans* also contain monoenes and PUFA. The unsaturated acids include, oleic ($C_{18:1}$) 14.82%, linolenic ($C_{18:3}$) 3.36% and palmitoleic acid ($C_{16:1}$) 1.78%. The proportion is very low compared to the saturated acids. Major saturated fatty acids present include palmitic acid ($C_{16:0}$) 26.72%, butyric acid ($C_{4:0}$) 24.20%, lauric acid ($C_{12:0}$) 16.71%, hexanoic acid ($C_{6:0}$) 6.74%, myristic acid ($C_{14:0}$) 3.40% and stearic acid ($C_{18:0}$) 2.57%.The total amount of saturated and unsaturated fatty acids in *M. fragrans* is 80.34 and 19.96% respectively. The high proportion of the saturated fatty acids (80.34%) in the oil is also of concern because of the health risk (antherosclerosis or heart disease) associated with oils containing high percentage of saturated fatty acids (Matos et al., 2009). However, it can be suitable for industrial uses such as preparing of soaps

and cleansers, cosmetics, lubricants, leather dressings and candles.

Conclusion

The oils from the seeds of *M. myristica* and *M. fragrans* were analyzed for their physicochemical properties and fatty acids profile. The two seeds have demonstrated a good potential as an oil seed with satisfactory percentage oil content. The oils can also be a good source of fuel in biodiesel application based on their relatively low density. The chemical properties of the oils indicated their suitability for several industrial applications because of their ability to withstand degradation due to oxidation. Lastly, the high level of free fatty acids in *M. myristica* (32.52%) and high level of saturated fatty acids in *M. fragrans* (80.34%) called for caution in their incorporation as food additives.

Conflict of interests

The author(s) have not declared any conflict of interests.

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