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SHORT COMMUNICATION

PHYSICOCHEMICAL ATTRIBUTES OF OILS FROM SEEDS OF DIFFERENT PLANTS IN NIGERIA

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ABSTRACT. The physicochemical qualities of oils from seeds of seven plants grown in Nigeria were evaluated. Physical characterization of the oils includes viscosity, state at room temperature, colour, specific gravity and refractive index. The results showed that they have different colors and are consistently liquid at room temperature. The viscosity of the oils varied; *P. macrophylla* had the highest viscosity of 19.55 cST while *D. edulis* had the least value of 11.00 cST. The specific gravity of all the oils ranged between *D. edulis* (0.84) and *P. macrophylla* (0.92). The oils were further characterized by the determination of the acid, iodine, saponification, ester and peroxide values. The molecular mean masses of the oils were also determined. Apart from *C. inophyllum*, the acid value of the oils (2.79-5.19 mg NaOH/g oil) suggests that they are nutritionally viable as oil sources. The iodine values of the oils (31.50-85.00 mg iodine/100 g) placed them in the non-drying class. The saponification values of all the seven oils (161.29-244.97 mg KOH/g oil) suggest their usefulness in the industry as shaving cream.

KEY WORDS: Seed, Oil, Physico-chemical, Attributes, Plant, Nigeria

INTRODUCTION

Currently, large amount of fruit seeds are discarded yearly at processing plants. This not only wastes an already serious potentially valuable resource but also aggravates an already serious disposal problem [1]. To be economically viable, however, both oil and meal from these fruit seeds must be utilized [2]. Significant amount of oil can be supplied by seed kernels obtained from *A. digitata* Linn., *C. inophyllum* Linn., *D. edulis* (G. Don) H.J. Lam, *M. myristica* Gaertn. Dunat, *P. macrophylla* Benth, *T. occidentalis* Hook and *T. cattapa* Linn. but at present there is no systematic collection and utilization of oils from these materials, thus valuable products with large industrial potential remains unexploited. According to Balogun and Fetuga [3], lack of information on the composition and utilization of the diverse oil seeds indigenous to the tropics is more of problems than the problem of shortage of oils. According to Afolabi *et al.* [4] and Kamel *et al*. [5], two areas that have often been augmenting available raw materials, especially oilseeds, are the use of underutilized and underexploited local substitutes and the lack of production on an industrial scale. In this study, seven underutilized, underexploited oilseeds are investigated for their physicochemical properties. The results are used to determine the suitability of these oilseeds as substitute for the more conventional oilseeds like groundnut, soybean, palm and coconut oil. Previous authors have carried out some work on some aspects of some of these seeds [6, 7].

EXPERIMENTAL

Materials. The seeds were collected from the Botanical Garden and the premises of University of Ibadan campus while some were purchased from Ojo market in Ibadan, Nigeria. They were

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identified according to the flora of West Africa in the Herbarium Unit of University of Ibadan where vouchers of each specimen were already deposited. The collection extended from December to September during three consecutive years [1995-1997]. 100-150 pieces of each seed sample was collected. These seeds were mostly collected out of curiosity.

Sample preparation. The seeds were sun-dried while the shells were manually cracked to obtain the kernels. The kernels were then milled and stored at 4 ^oC until needed for analysis.

Extraction. Oil from each sample was exhaustively extracted with a Soxhlet apparatus using petroleum ether (boiling point range 40-60 ^oC) as the extractant [8, 9] after which they were subjected to physical and chemical characterization.

Physical analysis. Color and state of the oils at room temperature were noted by visual inspection [10]. The determination of the specific gravity (using a 25 mL specific gravity bottle at room temperature) and refractive index (using Abbe refractometer at room temperature) was carried out following the method of Ajayi *et al*. [11] and El-Adawy and Taha [12]. Viscosity measurements (in centistokes) were performed with the Oswald kinematic viscometer equipped with an attached water bath and a thermostat [13]. The viscosity was determined at room temperature.

Chemical analysis. The oils were analyzed for acid, ester and saponification values following the method outlined by Oderinde and Ajayi [14] while the procedures for the determination of peroxide value and iodine value (Wijs' method) were according to AOAC [15]. The estimation of the percentage free fatty acid as oleic acid was according to official method [16]. Mean molecular mass was estimated from the relation (56/SV) × 1000 [17, 18].

Statistical analysis. Results are expressed as the means of three separate contents. The data were statistically analyzed by SAS [19] 2-way analysis of variance [ANOVA]. Means were compared by Duncan's Multiple Range Test [20] at 5% level of significance [$p \leq 0.05$].

RESULTS AND DISCUSSION

Scientific, local and English names with their respective abbreviation of the seven plants seeds investigated are given in Table 1. Physical properties of the oil extracts from the seeds are given in Table 2. The color of the oils greatly varied from reddish brown in MM to golden yellow in AD and PM. The state at room temperature of the oils was generally liquid. The density of the oil relative to that of an equal volume of water (specific gravity) ranged from 0.8400 in AD to 0.9150 in PM. These values are within the range of other oils reported by Onyeike and Acheru [10]. The refractive indices of the oils are closely similar to the values reported for some underutilized legumes by Ajayi *et al.* [21]. It is highest in TO, DE, CI, PM and TC have the same refractive index. The viscosity value of the oils ranged from 11.00 cST for AD to 16.48 cST for TO at the same temperature. This is lower than 13.18-21.88 cST reported by Omode *et al.* [12] for *C. esculentus* and *H. bateri.* Based on the specification reported by Ryan *et al*. [22], the properties of the non-conventional oils studied in this work, especially their low viscosity values; afford them the potential as materials to be used as diesel fuels. This is however subject to further investigation. The viscosities for these seeds were considerably lower than those reported by Kamman and Phillips [23] for some common and tested oils at 30 ^0C. Such oils include soybean (31 cST), cotton seed (36 cST) and sunflower (43 cST). This lower viscosity is an advantage for the non-conventional oils. The tendency for petroleum, a natural gas, to be in shorter supply [24] and the much stable position of the renewal fatty oils in this respect will favour the significance of the renewable oils as indispensible resources in the forthcoming decades.

Table 1. Scientific, family, English and local names of the underexploited seeds investigated.

Scientific name	Family name	English name	Local name	Abbreviation
Adansonia digitata Linn.	Bombacaceae	Baobab	Oshe, Bokky, Muchi, Kuka	AD
Calophyllum inophyllum Linn.	Guttiferae	[a]NA	[a]NA	CI
Dacryodes edulis (G. Don) H.J. Lam	Burseraceae	African pear	Ube	DE
Monodora myristica Gaertn. Dunat	Annonaceae	African nutmeg	[a]NA	MM
Pentaclethra macrophylla Benth	Leguminosae-mimosoideae	African oil bean	Ugba	PM
Terminalia catappa Linn	Combretaceae	[a]NA	Fruit	TC
Telfairia occidentalis Hook. F.	Cucurbitaceae	Fluted pumpkin	Ugwu	TO

[a]NA = not available.

Table 2. Physical properties[a] of oil extracts from the unconventional seed oils.

Species[b]	Viscosity	State at RT[c]	Colour	Specific gravity at RT[c]	Refractive index at RT[c]
AD	11.50[a]	Liquid	Golden colour	0.85[b]	1.47[c]
DE	11.00[a]	Liquid	Dark yellow	0.84[b]	1.47[c]
CI	17.78[a]	Liquid	Greenish yellow	0.88[b]	1.48[c]
MM	11.35[a]	Liquid	Reddish brown	0.85[b]	1.44[c]
PM	19.55[a]	Liquid	Golden yellow	0.92[b]	1.47[c]
TO	16.48[a]	Liquid	Yellow	0.88[b]	1.49[c]
TC	12.01[a]	Liquid	Yellow	0.88[b]	1.47[c]

[a]Values are means of triplicate determination. [b]Values in the same horizontal row sharing different letter are significantly different at the 5% level. [c]RT–Room temperature.

The results of some chemical properties of the oil-seed extracts from the oil-seeds analyzed are presented in Table 3. The oil content varied from one seed to another but most of them showed oil content between 40.29-55.05 g/100 g dry matter. All the species contain oil content levels ranging from a low value of 10.64 g/100 g dry matter for DE to a high value of 55.05 g/100 g dry matter TC. According to oil content classification, most of the seeds can be classified as high oil yielding seeds. All the oil samples have low iodine values which placed them in the non-drying group of oil. The values, which are lower than those reported for *A. heterophyllus* and *T. africana* [9] lie between 31.50 g I/100 g oil for DE to 85.00 g I/100 g oil for MM. The oils, because of their low iodine value, cannot be utilized in the paint industry but could be useful nutritionally. Pearson [25] reported 51-55 g I/100 g and 120-143 g I/100 g as the iodine values of palm oil and soybean oil, respectively. Saponification values were higher than those reported in literature for cotton seed oil [189-198] but lower than those for coconut oil [248-265] [26]. The high saponification values suggest their utilization in the production of liquid soap and shampoos in the manufacture of lather shaving creams [27].

Free fatty acid can stimulate oxidative deterioration of oils by enzymatic and/or chemical oxidation to form off-flavour component. The free fatty acid and acid value of the oil extract from TO, AD and DE are low which indicate that they probably could be stored for a long time without spoilage through oxidative rancidity and could find application as edible oils. Oil extracts from the other samples (CI, MM, TE and PM) will require refining to make them suitable for edible purposes. In the tropics, where vegetable are the most common dietary lipids, it has been shown that it is desirable that the free fatty acid content of cooking oils lies within limits of 0.0-3.0 % [10, 28]. The peroxide values of all the oil extracts (except DE and MM) fall below 10 meq oxygen/kg oil; these values are within the permitted level of not more than 10 meq peroxide oxygen/kg oil for soybean, cotton seed, rapeseed and coconut oils stipulated by the Code Alimentarius Commission [26]. This depicts that the oils are fresh and could be stored for a long period of time without getting rancid. This is of nutritional interest; it suggests that they could be utilized as edible oils.

Table 3. Chemical properties of oil extracts[a] from the unconventional seed oils.

Species[b]	AD	CI	DE	MM	PM	TO	TC
Molecular mean masses	243.47[a]	243.50[a]	311.14[a]	222.13[a]	347.20[a]	242.49[a]	228.60[a]
Oil yield g/100 g dry matter	33.00[b]	49.15[b]	10.64[b]	21.79[b]	40.29[b]	53.63[b]	55.11[b]
Acid value mg NaOH/g oil	5.19[c]	31.88[c]	5.61[c]	14.31[c]	9.87[c]	2.79[c]	8.46[c]
Saponification number mg KOH/g oil	230.01[d]	229.98[d]	179.52[d]	252.11[d]	161.29[d]	233.73[d]	244.97[d]
Iodine value mg iodine/100 g	49.53[e]	67.21[e]	31.50[e]	85.00[e]	63.14[e]	58.77[e]	46.08[e]
%FFA as oleic acid	2.61[f]	16.03[f]	2.815[f]	7.20[f]	4.96[f]	1.40[f]	4.25[f]
Peroxide value mg/g oil	5.25[g]	1.70[g]	20.00[g]	15.90[g]	5.97[g]	3.10[g]	9.35[g]
Ester value mg/KOH/g oil	224.82[h]	198.10[h]	193.91[h]	237.80[h]	151.42[h]	230.94[h]	236.51[h]

[a]Values are means of triplicate determination. [b]Values in the same horizontal row sharing different letter are significantly different at the 5% level.

CONCLUSIONS

The seven seeds studied are, in general, good sources of crude oil. Their oils could find application as substitute for diesel fuels. Percent free fatty acids in five of them were below the maximum desirable limit of 5.0% acid; peroxide value of some of the oil samples was also low. These qualify them as edible oils. Low iodine values imply the presence of few unsaturated bonds and low susceptibility to oxidative rancidity. The results generally offer a scientific basis for use of the seeds in both human diet and some commercial products. The saponification value affords the possibility of using most of the oils in the manufacture of soaps and lather shaving creams.

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