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Physical and chemical evaluation of oils from selected underutilized oilseeds

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ABSTRACT

Oils were solvent-extracted from castor bean seed (Ricinus communis L.), African oil bean seed (Pentaclethra macrophylla Benth), African locust bean seed (Parkia filicoidea Welw), and "egusi" melon seed (Citrullus vulgaris L.) which are among the lesser-known underutilized oilseeds existing both as wild and cultivated types in rainforest areas of West tropical Africa. The oils were subsequently evaluated for some physical and chemical properties. The percentage oil yields were as follows: castor bean 42.22± 0.51%, African oil bean 43.75± 0.85%, locust bean 20.68 ±0.71 and "egusi" melon 45.52 ±0.82%. These values are indicative of the high potentials of the seeds for viable commercial vegetable oil production. The results of refractive index for all the oil samples were within the range 1.452 – 1.464 which is a clear indication of their relative purity. Specific gravity values fell within the range obtained for other vegetable oils. Locust bean seed oil with high saponification value (358.69mg/g) contained low molecular weight fatty acids and may not be useful in soap making. The results of peroxide value determination revealed that melon seed oil could easily be disposed to rancidity compared to the other oils evaluated. The acid values (1.80 -2.83mg/g) were within the range commonly reported for most unrefined vegetable oils. It is expected that refining the oils would reduce their predisposition to rancidity.

Key words: underutilized oilseeds, solvent extraction, oils, physical and chemical properties

INTRODUCTION

Oilseeds are primarily grown as sources of oil (1) and although they have been cultivated since prehistoric times, many species, especially in the developing countries still remain relatively unknown and grossly underutilized. Some of these lesser-known under-exploited oilseeds are highly rich in nutrients (2,3) and can conveniently serve as supplements in the mainly starchy diets of teeming populations in the third world. However, while some unconventional oilseeds are mainly used as protein supplements, others are mostly cultivated because of their oil contents. Oils and fats are a vital component of the human diet because of their use as energy sources and carriers of fat soluble vitamins.

The underutilization of some oilseeds, especially those found in the less-developed parts of the world, could be traced to scanty knowledge of their nutritional importance as well as insufficient data on their cultivation and growth characteristics. For example, in parts of West Tropical Africa where seeds of the African oil bean (*Pentaclethra macrophylla* Benth), Castor bean (*Ricinus communis* L.) and Locust bean (*Parkia filicoidea* Welw) are found in abundance, they occur mostly as the wild uncultivated types. Moreover, some of these seed crops contain anti-nutritional and toxic factors in their edible portions, and these have posed serious impediments to their full utilization (4). The requirement for rigorous combinations of hydrothermal treatments and fermentation before these seeds are consumed has consistently limited their exploitation to the rural and uncivilized areas where they are mostly used as condiments.

With the current research trend towards the use of unconventional oilseeds for commercial vegetable oil production, it would be considered worth while to examine the physico-chemical characteristics of oils from some of these less-common seeds that, at present, exist as uncultivated types in order to explore their wider exploitation. The present study evaluates the quality of solvent–extracted oils from seeds of the African oil bean, castor bean, locust bean and "egusi" melon which are included in the group of underutilized oilseeds. It is expected that this will give more insight into their full utilization and commercialization.

MATERIALS AND METHODS

Seeds Source and Oil Extraction:

The African oil bean, castor bean, locust bean and "egusi" melon seeds used in the study were all purchased from Akure main market (Oja Oba) in Ondo State, Nigeria. The seeds were dehulled and ground to fine particle size (≤ 250µm) using a ball mill. The milled powders (samples) were then kept in airtight containers at 4^oC until use.

Oils were extracted from the samples using Soxhlet apparatus with n-hexane as the extracting solvent. After extraction, the solvent was removed *in vacuo* and the extracted oils were subsequently used for analysis.

Physical and Chemical Analysis:

The percentage oil content of each seed was determined by gravimetrically quantifying the oil residues after exhaustive extraction and reclaiming of the solvent via vacuum distillation. The refractive indices and specific gravities, at 20^oC, of the extracted oils were measured using refractometer and specific gravity bottle, respectively. Visual examination of the colour of each sample was also carried out.

The methods of chemical analyses (determination of iodine value, acid value, saponification value, peroxide value and free fatty acids) followed the standard procedures of Association of official Analytical Chemists (5) as described by Enujiugha *et al.* (6). Free fatty acids were determined by titrating ethanol-sample solution against 0.1M potassium hydroxide solution.

RESULTS AND DISCUSSION

The results of the present study show that apart from locust bean seed, all oilseeds examined contained oil that could be exploited commercially (Table 1). Locust bean oil, greenish yellow and occurring at <20.68% by weight compared to the oil content of each of the other seeds, may not be economically useful in commercial vegetable oil production. The oil content of African oil bean seed fell within the range (42 - 45%) reported by Onwuka *et al*. (7). The results of specific gravity measurement show that only castor bean oil had value within the range (0.89-0.92 at 20^oC) specified by Theodore (8). That of melon seed oil was slightly lower than the value (0.81) given by Achinewhu (9), but the difference is not significant ($p>0.05$). Specific gravity reveals the extent of adulteration and is usually used as a measure of acceptance of oil as a raw material in industry. The oils examined in the present study manifested relative purity. With regard to the refractive indices of the seed oils there was no significant difference ($p>0.05$) in the results, although an apparent lower quality oil in locust bean seed could be inferred (Table 1).

Table 2 shows the chemical properties of the extracted seed oils. The proximate chemical characteristics of the oils compared favourably with those of some of the more common vegetable oils. The iodine values ranged between 108.66mg/g to 142.50mg/g, indicating much higher degrees of unsaturation compared to 97.0mg/g for groundnut (10) and much lower degrees of unsaturation compared to 204mg/g for conophor nut (2). The iodine value is used as an indication of oil suitability for human consumption and its drying character (11). It is also a measure of unsaturation, with higher iodine values indicating greater inclination to oxidative rancidity. The results of the present study show that African oil bean seed oil is comparatively the least disposed to rancidity and could be effectively used as a drying oil.

The saponification value for melon seed oil was lower than the value (162.7±3.1mg/g) obtained by Achinewhu (9); while that of African oil bean seed oil was higher than the value (151.20mg/g) obtained in a previous study (12). The average molecular weight of the fatty acids in locust bean oil was much lower than in the other oils, as evidenced from the very high saponification value of the oil. The acid values were within the range commonly reported for most vegetable oils, which is not significantly (p>0.05) different from what was obtained in the present study. The much higher acid value obtained for melon seed oil could be attributed to high lipolytic activity of the native lipases. This is indicative of the high state of rancidity of the oil, which could be due to poor handling, improper storage as well as length of time between harvesting and oil extraction. The acid value is a measure of the level of deterioration of the oil during storage. A previous study (13) has already shown that the activity of seed lipases could predispose these oils to faster deterioration during storage.

The results of the peroxide value determination show that locust bean seed oil was relatively the least disposed to oxidative rancidity; while melon seed oil was relatively unstable and could easily go rancid, followed by castor bean seed oil in the unrefined form.

The peroxide value of the African oil bean seed oil was not significantly (p>0.05) different from what was obtained in previous studies (12,14). The free fatty acids in the seed oils occurred in levels typical of unrefined vegetable oils. The level for melon seed is much higher than that obtained for a crude oil extract by Achinewhu (9). The results show that African oil bean seed oil with a very high level of free fatty acids could be more predisposed to spoilage by hydrolytic rancidity. However, it is expected that refining the oils could reduce free fatty acids contents to acceptable levels.

Table 1: Oil yields and physical properties of the seed oils

Material	%oil yield	oil colour	Refractive Index	Specific gravity
Castor oil bean seed	42.22^{a}±0.51	Golden brown	1.461^{a}	0.8945^{a}
African oil bean seed	43.75^{a}±0.85	Golden yellow	1.462^{a}	0.8629^{a}
Locust bean seed	20.68^{b}±0.71	Greenish yellow	1.452^{a}	0.8428^{ab}
"Egusi" melon seed	45.52^{a}±0.82	Yellowish brown	1.464^{a}	0.7935^{b}

Values in same column with same following letters in superscript are not significantly different (p<0.05)

Table 2: Chemical Properties of the extracted seed oils

Oil sample	Acid value (mg/g)	Saponification value (mg/g)	Iodine value (mg/g)	Free fatty acid (% oleic)	Peroxide value (meq./kg)
Castor seed	1.80^{b}	147.04^{bc}	131.45^{a}	8.223^{b}	11.79^{b}
African oil bean seed	1.10^{a}	172.50^{b}	108.66^{b}	10.416^{a}	7.94^{c}
Locust bean seed	1.89^{b}	358.69^{a}	125.42^{a}	8.468^{b}	5.86^{c}
"Egusi" melon seed	2.83^{a}	130.53^{c}	142.50^{a}	8.218^{b}	17.89^{a}

Values in same column with same following letters in superscript are not significantly different (p<0.05)

CONCLUSION

The results of the present study have demonstrated the high oil potentials of some less-common oil seeds, namely, African oil bean, "egusi" melon and castor bean, which could be exploited in commercial vegetable oil production. Oil content of locust bean seed was found insufficient to justify its commercial exploitation. Refining of the oils is suggested as a necessary step in their exploitation, as they could easily be affected by oxidative and/or hydrolytic rancidity.

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