



Chemical qualities of oils from some fresh and market vegetable crops within Kwara State of Nigeria

Israel Sunmola AFOLABI

Covenant University, College of Science and Technology, Department of Biological Sciences,
Canaan land, Km 10, Idiroko road, P.M.B. 1023, Ota, Ogun State, Nigeria

Received 10 December 2007

MS/No BKM/2007/001, © 2008 Nigerian Society for Experimental Biology. All rights reserved.

Abstract

The potential of Nigeria leading Africa and the world in the area of biofuel and oleochemical production was examined by evaluating the oil yield and chemical qualities of oil extracted from fresh and market sample of some naturally abundant vegetables (*Mangifera indica*, *Prunus dulcis* Miller, *Ricinus communis*, and *Elaeis guineensis*) in Nigeria. Moisture, ash, and crude fat composition, including the free fatty acid, acid and saponification values of the oils were determined, high mineral composition of almond was observed compared to other vegetables. Moisture content of 5.006, 3.500, 4.870, 37.002, 9.147, and 63.650%; crude fat of 59.195, 67.807, 33.490, 32.303, and 12.511, and 0.939%; and ash levels of 4.605, 2.833, 1.903, 1.728, and 1.305% were reported for seeds obtained from almond, castor, palm kernel, groundnut, mango and kola nuts respectively. Polymerization and esterification of fatty acids induced by the hot ambient storage conditions used by our marketer was attributed to the higher molecular weight of fatty acids in market sample for groundnut and palm oil over the corresponding fresh sample. High level of ash content (4.605%) for almond seed was observed, making a good source of mineral nutrition to consumers. Due to their high oil yield and abundance, oils from almond seed and castor seed, in addition to palm oil and groundnut oil may be considered as Nigeria potential asset for biofuel and oleochemical production.

Keywords: Oil palm seed, Mango seed, Sweet almond seed, Castor seed

E-mail: afolabisunmola@yahoo.com, **Tel:** +234-8033923264

INTRODUCTION

Nigeria is one of the countries of the world with a variety of oil seeds notably groundnut, oil palm, soyabean and cotton seeds. The economic importance of oil crops has made it necessary that they be properly investigated, to ascertain their oil quality parameters, since this is an important criterion for marketing and processing seed oil¹. Vegetable oils are used principally for food (mostly as shortening, margarines, and salad and cooking oils) and in the manufacture of soap and detergents, in paints and varnishes, and for a variety of other industrial items². Oil is found in large amounts usually in the seeds of the plants and occasionally in the fleshy part of the fruits, as in the olive and the oil palm. Seeds may contain 1-60% oil. The oil is a reserve of high-energy food for use by the germinating seed, and large amounts of oil are associated with large amount of protein.

Fuel derived from vegetable oil is relatively a new concept worldwide but the idea has been around for as long as the diesel engine itself. Biodiesel "referred to as a miracle fuel" is a fuel that can be made from any fat or vegetable oil³. It is usually produced from soyabean oil in the U.S. (due to its abundance) and it works in any diesel engine with few or no modifications and can be blended with diesel at any level³. Over the last 20years, there has been considerable progress in utilization of vegetable oils and their derivatives in the formulation of biolubricants⁴. The versatility of vegetable-based fluids and downstream esters is now recognized in research projects in many areas where a number of applications may not have been previously possible, but where modification of the equipment or process designs themselves can enable potential advantages for users⁴. The products offer low toxicity, low evaporation rates, low emissions and rapid biodegradability⁴.

The health and nutritional benefit of vegetable oil (e.g. coconut oil) especially as an antiviral, antibacterial and antiprotozoal monoglyceride used by humans or animals to destroy lipid-coated viruses such as HIV had been reported since the oil is metabolized in the body to release monolaurin⁵. Its importance in food industries as biodiesel had also been reported⁵.

Uses of oil palm produce in oleochemicals, biodiesel and potent cleaning agent (methyl ester sulphonates) productions had been reported⁶. Technologies to produce polyols from palm oil and palm kernel oil that are economically competitive to petroleum-based polyols had also been developed⁶.

Castor oil from *Ricinus communis* is used in the production of synthetic resins, plastics, fibers, paints varnishes, and various chemicals including drying oil and plasticizers. In addition to the uses, castor oil and its derivatives are used in cosmetics, hair oils, fungi static (fungus growth-inhibiting) compounds, embalming fluid, printing inks, soap, lubricants, greases and hydraulic fluids, dyeing aids, and textile finishing materials⁷. Castor oil consists of almost entirely of the triglycerides ricinoleic acid. Although it has been taken internally as a cathartic, its use can be harmful. The fruits are attractive but often are removed before they mature because of the poison ricin concentrated in their mottled, beanlike seeds⁷.

Toxalbumins are highly toxic protein molecules that are produced by only a small number of plants. Ricin, a toxalbumin from the castor bean is one of the most toxic substances known⁸ since it is poisonous as with the beans it is used as fertilizer². The first electricity ever seen had been reported for castor oil in Brazil⁹. The growing interest in biodiesel in some European countries led Brasil ecodiesel to hope that large quantities might be exported, as is now beginning to happen with the alcohol from sugar cane, which can also be used to run vehicles.

Nigeria has the potential of leading the world, and sustains its leading role in Africa in the area of oleochemical and biodiesel production from vegetable oil. Some potential seed (okra, baobab, sour sap, ogbono, 'Gawasa' Hausa, oilbean seed, pumpkin fruit, walnut, and African bread fruit) had earlier been reported¹⁰. This work also assessed the oil qualities of some other potential oil crops in Nigeria.

MATERIALS AND METHODS:

A fresh oil palm seed (*Elaeis guineensis*), the market samples of the palm oil and groundnut

oil were purchased from Ganmo local market at the outskirts of Ilorin metropolis. Sweet almond (*Prunus dulcis Miller*), mango seed (*Mangifera indica*) and castor seeds (*Ricinus communis*) were harvested/or collected within NSPRI yard, the fresh oil palm seeds were boiled for 30mins to extract the oil. The floating oil was thereafter decanted and used as fresh palm oil. The resultant kernel collected was broken to collect the seed. This seeds were grinded using mortar and pestle and was used as samples for oil analysis. Three replications were used for each analysis carried out.

Moisture content was analyzed by air oven method of AOAC¹¹ and ash content was determined by igniting the samples at 600°C in a muffle furnace, the inorganic residues obtained were thereafter expressed as percentage ash content. Crude fat was determined by grating the samples, and 5.0g of the grated samples were weighed into a thimble. 250ml round bottom flask that had been previously dried at 103°C for 30mins and cooled was accurately weighed.

Oils from the samples were extracted with petroleum spirit as solvent, using soxhlet apparatus for six hours. The extracted oils were heated in an oven for 30mins at 103°C to evaporate the remaining solvent. The samples were allowed to cool in a desiccator for 3mins after discontinuing the heating process, and weighed. The resultant oils were afterward expressed as percentage of the original sample.

Saponification value

5.0g of oil samples were put in a glass resistant to alkali action. 25ml of potassium hydroxide was afterward added to it and boiled under reflux for 60mins while shaking at intervals. 0.5ml of phenolphthalein was added as an indicator, this was titrated against 0.5N hydrochloric acid while the solution was still hot to determine the excess of alkali. The results were subjected to calculation and expressed in mg per g oil sample.

Free fatty acid and acid value determination

5.0g of the extracted oil were weighed into conical flask (f1); 50ml of absolute ethanol was afterwards put into another flask (f2). The ethanol was boiled to boiling point and then

neutralized with 0.1N potassium hydroxide using 0.5ml phenolphthalein indicator. The neutralized ethanol was then poured into flask (f1) and heated to boiling point. While as hot as possible, the solution was titrated against 0.1N potassium hydroxide until when the addition of a single drop produces a slight but definite color change (pink) persisting for at least 15seconds. The results were subjected to calculation and expressed in mg per g oil sample.

RESULTS AND DISCUSSION

The qualities of some vegetable oil are as indicated in Table 1. Crude fat for almond, castor seed, palm kernel, and fresh groundnuts were between the ranges 32.203-67.807%. These amounts may be considered economical for commercial production of oil in Nigeria. That of mango seed (13.511%) is however low to be considered an oilseed for commercial purposes, but its uses may not be discouraged due to its high level of wastages. The oil yield (32.303%) from groundnuts (*Arachis hypogaea*) in this study is comparable to that reported for less matured groundnut, but less than that reported for fully matured groundnut (40-50%)¹².

Saponification values had been reported to be inversely related to the average molecular weight of the fatty acids in the oil fractions¹. Oil fractions with saponification values of 200mgKOH/g and above had been reported to possess low molecular weight fatty acids¹. Therefore, our work reveals that oils from almond nut, and palm kernel with saponification value of 163.398-191.976 mgKOH/g oil possessed very low molecular weight fatty acids. Closely higher in molecular weight is that from fresh palm oil with saponification value of 94.406 mgKOH/g oil. While that of castor oil, market sample for both groundnut and palm oil consists of very high molecular weight fatty acids. The molecular weight of fatty acids in the market sample of groundnut and palm oil were evidently higher than that of their corresponding fresh sample. The increase in molecular weight may be due to the hot ambient storage conditions used by our marketers, the oils are usually stored in aluminium container for about one year prior to marketing.

Table 1: Chemical Qualities of Some Nigerian Oilseed crops

| Oilseed | Moisture content (%) | Ash content (%) | Crude fat (%) | Free fatty acid (mgKOH/g) | Acidity value (mgKOH/g) | Saponification value (mgKOH/g) |
|------------------------------------|----------------------|-----------------|---------------|---------------------------|-------------------------|--------------------------------|
| Almond nut | 5.006 ± 0.093 | 4.605± 0.001 | 59.195± .675 | 0.388± 0.050 | 0.770± 0.099 | 163.398± 15.800 |
| Castor seed (Wild) | 3.500 ± 0.057 | 2.833± 0.061 | 67.807± 0.618 | 0.141± 0.000 | 0.279± 0.000 | 5.582 ± 0.107 |
| Palm Kernel seed | 4.870 ± 0.141 | 1.903± 0.039 | 33.490± 6.162 | 5.297± 0.885 | 0.834± 0.004 | 191.976± 3.164 |
| Fresh groundnut | 37.002 ± 0.409 | 1.728± 0.272 | 32.303± 0.488 | 18.225± 0.071 | 36.142± 0.141 | 199.196± 6.965 |
| Mango seed | 9.147± 0.178 | 2.732± 0.794 | 13.511± 3.967 | ND | ND | ND |
| Kolanuts | 63.650± 1.811 | 1.305± 0.272 | 0.939± 0.108 | ND | ND | ND |
| Fresh palm oil (hot water extract) | | | | 3.924± 0.050 | 8.584± 0.109 | 94.406± 1.249 |
| Palm oil (market sample) | | | | 4.926± 0.092 | 10.776± 0.201 | 3.502± 0.991 |
| Groundnut oil (market sample) | | | | 0.174± 0.047 | 0.345± 0.093 | 11.146± 3.904 |

ND = not determined

This storage conditions may induce esterification, and/ or polymerization of the unsaturated fatty acids present in the oils. Polyunsaturated fatty acids are very susceptible to polymerization and gum formation caused by oxidation during storage, or by a complex oxidative and thermal polymerization at the higher temperature and pressure of combustion¹³. The increase in unsaturated fatty acids (palmitic, stearic, and oleic acids) was also reported in bath oils upon frying¹⁴, this may be induced by the heat generated during frying.

Acid value represents free fatty acid content due to enzymatic activity and is usually indicative of spoilage. Its maximum acceptable level is 4mgKOH/g oil¹⁵, below which the oil is acceptable for consumption. Free fatty acids (FFA) are not present to any significant level in healthy plant cells, but FFA levels of up to 15% (more in very bad cases) is usually found in commercial crude vegetable oils whether pressed or solvent extracted¹⁶. These FFAs are present as a consequence of cell damage in vegetable tissue during harvesting, storage, transportation, and must be removed during refining. The cell damage can also be caused

by bruising of fruit, seed freezing and thawing cycling, hot conditions or microbial activity (e.g. fungal growth)¹⁶.

The high moisture content of groundnut (37.002%) may be responsible for its high perishability, which may explain the high levels of FFA and acid value reported in this work, despite using a freshly harvested groundnut. Textural factors including crispness and firmness are influenced by moisture content. Low levels of moisture and presence of low levels of polyunsaturated fatty acids in almond had been attributed to its relatively long shelf-life¹⁷. The 5.006% moisture content and 59.195% oil yield reported in this work for almond is higher than the 4.4% and 52.2% earlier reported for its moisture content and oil yield respectively¹⁷. The result indicates high level of ash content (4.605%) for almond seed making it a good source of mineral nutrition to consumers.

The oil yield levels (13.511%) reported in this work for mango seed may be useful in food industries but cannot be considered economical as oilseed when compared to other vegetable oil. This value is however slightly

higher than the 11.0% earlier reported for the kernel¹⁸. However, the mango seed (kernel) is still underutilized in Nigeria, they are discarded after eaten the pulp and skin. There is need for more research on its usefulness for human and livestock feed.

In conclusion, this result may be useful in forming future oilseed standards in Nigeria. Oils from almond seed, and castor seed in addition to palm oil, and groundnut oil due to their high oil yield and abundance may be considered as Nigeria potential asset for biofuel and oleochemical production.

REFERENCES

1. **Abayeh, O. J., Aina, E. A. and Okuonghae, C. O. (1998)** Oil content and oil quality characteristics of some Nigerian oil seeds. *J. Pure and Applied Sci.* **1**: 17-23.
2. **Safra, J. E., Yannias, C. S. and Goulka, J. E. (1998)** Oil plant. In: Encyclopaedia Britannica 15th edition, published by Encyclopaedia Britannica Inc. (U.S.A.) vol. 8, pp. 894.
3. **Higgings, J. (2003)** Fast growing region for oil and fats. *Oils & Fats International* **18**(6), November, 21-25.
4. **Lea, C. (2003)** The versatility of biolubricants. *Oils & Fats International* **29**(1), January, 26-28.
5. **Rethinam, P. (2003)** New approaches to coconut. *Oils & Fats International* **19**(2), March, 22-25.
6. **Ahmad, S. (2003)** Developing non-food palm oil products. *Oils & Fats International* **19**(2), March, 20-21.
7. **Safra, J. E., Yannias, C. S. and Goulka, J. E. (1998)** Castor. In: Encyclopaedia Britannica 15th edition, published by Encyclopaedia Britannica Inc. (U.S.A.) vol. 2, pp. 939.
8. **Safra, J.E., Yannias, C.S. and Goulka, J.E. (1998)** Poison and poisoning. In Encyclopaedia Britannica 15th edition, published by Encyclopaedia Britannica INC. (U.S.A.) vol. 25, pp. 923.
9. **Knight, P. (2004)** First electricity from castor oil. *Oils & Fats international*, vol. **20**(6), November, pp 30.
10. **Okoye, W. I., Okobi, O. O. and Okonkwo, E. U. (1999)** Extraction and characterization of oils from nine lesser known Nigerian oil seeds. Proceedings of 23rd Annual NIFST conference, 25th – 27th October 1999. pp. 232-234.
11. **AOAC (1980)** Fruits and fruit products. In official methods of analysis pp 366-367.
12. **Sanders, T. H. (1993)** Vegetable oils. In Encyclopaedia of Food Sc, Fd Tech and nutrition, first edition Academic press limited (London and San Diego, CA). Edited by Macrae, R., Robinson, R. K. and Sadler, M. J. Vol 7, pp. 4670-4674
13. **Ma, F. and Hanna, M. A. (1999)** Biodiesel production: a review. *Bioresource Technology* **70**: 1-15.
14. **Suleiman, A. E. L., El-Makhzangy, A. and Ramadan, M. F. (2006)** Antiradical performance and physicochemical characteristics of vegetable oils upon frying of French fries: A preliminary comparative study. *J. Food Lipids* **13**: 259-276.
15. **CODEX Alimentarius Commission (1969)** Recommended international standards for edible Arachis oil. Food and Agricultural Organization of the United Nations. World Health Organization, Geneva-Switzerland.
16. **Hammond E. W. (1993)** Vegetable oils. In Encyclopaedia of Food Sc, Fd Tech and nutrition, first edition Academic press limited (London and San Diego, CA). Edited by Macrae,R., Robinson,R.K. and Sadler, M.J. vol 7, pp. 4705-4710.
17. **Kester, D. E. and Kader, A. A. (1993)** Almonds; In Encyclopaedia of Food Sc, Fd Tech and nutrition, first edition Academic press limited (London and San Diego, CA). Edited by Macrae,R.; Robinson,R.K. and Sadler, M.J. vol 1, pp. 124-126.
18. **Morton, J. F. (1993)** Mangoes. In Encyclopaedia of Food Sc, Fd Tech and nutrition, first edition Academic press limited (London and San Diego, CA). Edited by Macrae,R.; Robinson,R.K. and Sadler, M.J. vol 5, pp. 2872-2873