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Fatty Acid Composition of Certain Oil Seeds from Nigeria

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Abstract. Fatty acids of certain oil seeds from Nigeria were determined by gas liquid chromatography and their identification was based on comparison by authentic samples. Seeds studied in this study were *Aframomum danielli* K. Schum, *Arachidis hypogeal* L., *Glycine max* L., *Elaesis guineensis* var. tenera, *Piper guineense* Thonn. ex Schumach and *Treculia africana* Decne. ex Trec. The fatty acid composition of the oil seeds showed that they (except *E. guineensis*) all contained more of unsaturated fatty acids ranging from 62.80% to 86.70% for *P. guineense* and *A. hypogeal* (L.), respectively. The oils with the exception of *A. danielli* (7.50%) and *E. guineensis* (3.30%) contained linoleic acid, which is an essential fatty acid with cholesterol-lowering activity in high amount in the range of 23.10% (*A. hypogeae*) to 34.10% (*T. africana*) with *G. max*, having the highest percentage of 56.40%. Four of the oils also contained linolenic acid in the range of 1.20% for *A. danielli* to 21.60% for *P. guineense*.

Keywords: fatty acids, gas liquid chromatography, oil seeds

Introduction

Seeds have nutritive and calorific values which make them necessary item in diets. They are also good sources of edible oils and fats, which are essential nutrients (Odoemelam, 2005). Vegetable oils provide energy and essential linoleic and linolenic acids that are responsible for growth (Fasina *et al.*, 2006). Advances in nutrition research has led to awareness of beneficial and harmful effects of various dietary fats and oils (Dunford, 2001).

Seeds of *A. danielli* K. Schum are used as a traditional food spice among the Edo and Niger delta people of Nigeria, and also as an anti-inflammatory agent by rubbing of the alcohol and petrol extracts on the allergic and eczematous swelling. *A. hypogeae* (L.) is a leguminous plant that is mainly grown for its seeds. They are eaten raw, roasted and can be made into a paste used in soups and stew. *Glycine max* (L.) Merr, popularly known as soybean, is a legume that is increasingly consumed for economical and nutritional reasons. In Nigeria, it is usually roasted, dehulled, grounded and used as additives in making infant cereal and soy milk; they can also be made into paste and used in soups and stew. The palm kernel (*Elaeis guineensis* var. tenera) is taken from the oil palm; it is surrounded by an edible reddish oily palm. It can be eaten raw or with roasted or cooked maize. *P. guineense* Thonn. ex Schumach., is a seed that is not commonly eaten in Nigeria; it is closely by related to cubeb pepper, black pepper and long pepper. *T. africana* Decne. ex Trec., seeds are aromatic and have a flavour much like groundnut. They are eaten raw, roasted, boiled or fried more usually to stews.

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The present study was conducted to compare the fatty acid composition of different oils extracted from different seeds that are available in Nigeria, in order to establish a similarity/difference between them and also to determine their potential and hence their possible usage for edible or industrial purposes. There are literature reports on various works that have been carried out on some of these seeds (Ajayi, 2008; Onyeike and Acheru, 2002; Garcia *et al.*, 1998; Oderinde and Ajayi, 1998; Kindu *et al*., 1987); however, there is no report on the comparative study of the fatty acids of these seed oils.

Materials and Methods

Plant materials and sample collection. The family, scientific, local, english names and abbreviations of the seeds, whose oil extracts are being examined in this study are given in Table 1. These seeds were purchased from local markets in Ibadan, Oyo State, Nigeria. The seeds were identified in the herbarium unit of the Botany department, university of Ibadan, Ibadan, Nigeria, where vouchers of each specimen were already deposited. These seeds were chosen out of interest.

Table 1. Scientific family, english and local names of the plants investigated

Scientific name	Family	English name	Local name	Abbreviation
Aframomum danielli K. Schum	Zangiberaceae	Alligator pepper	Atare aja	AD
Arachidis hypogeae L.	Fabaceae	Groundnut	Epa	AH
Glycine max. (L.) Merr	Fabaceae	Soybean	Ewa soya	GM
Piper guineense Thonn. ex Schumach.	Piperaceae	West African pepper	Kale, masoro	PG
Treculia africana Decne. ex Trec.	Moraceae	Achi	Ukpo	TA
Elaeis guineensis var. tenera	Palmae	Palm kernel	Ekuro	EG

Sample preparation and extraction. The seeds were deshelled manually by cracking to remove the kernels. The kernels were then ground to powder in a hammer mill and stored in air tight sample bottle in a refrigerator (4 °C) until needed for analysis. Seed oils were extracted with *n*-hexane for 8 h using a Soxhlet extractor. The solvent was removed completely and the oils obtained were used for this study. All chemicals used were supplied by British Drug House (BDH).

Fatty acid analysis. Fatty acid analysis of the seed oils was carried out at the Mass Spectrometry Laboratory, University of Sao Paulo, Ribeirao Preto, Brazil. The methyl ester of the raw oil was prepared according to Idouraine *et al.* (1996) with some slight modifications. Oil-solvent mixture was evaporated to dryness under nitrogen and then transesterified with H_2SO_4 in the presence of methanol for 2 h at 7 °C. To the resulting fatty acid methyl ester was added 40 mL of water after which the organics were extracted with petroleum ether (40-60 °C) and then dried under nitrogen. The fatty acid methyl esters were redissolved in hexane and analysed in a gas chromatograph (Shimadzu™ GC-17A) coupled to mass spectrometer (Shimadzu GCMS-QP5000™), under the following conditions: injector temperature: 250 °C; interface temperature: 270 °C; oven temperature 80 °C 1600 increasing to 160 °C and to 240 °C at 2 °C per 0.5 min; column pressure: 70 KPa, split ratio: 1:50. The column used was the DB-wax 250 (30 m×0.25 mm from J & W Scientific). The internal standards used were heptadecanóico acid (C_{17}: 0) and the methyl ester of tricosanóico acid (C_{23}: 0) (from Supelco™). To identify the peaks, fatty acid component FAME Mix 37 standard (Supelco™) was used from which the dilutions were made and used to construct the calibration curve in 6, 8 and 10 µg/µL F. It was not possible to detect any fatty acid at concentration below 6 µg/µL.

Results and Discussion

Fatty acid composition of the investigated oils is presented in Table 2. Nine fatty acids have been identified in six oil samples; these are lauric, myristic, palmitic, palmtolenic, stearic, oleic, linoleic, linolenic and arachidonic acids. Palmitic acid was the main saturated component in all the seed oils ranging from *A. hypogeae* (9.80%) to *P. guinesis* (26.00%). Even though *E. guineensis* kernel oil contains palmitic acid (10.70%), it has $C_{12::0}$ acid (44.90%) as its main fatty acid. Three of the oils contain palmitolenic acid; this ranged from *A. danielli* (1.20%) to *E. guineensis* (22.00%). All the oils with the exception of *A. danielli* (7.50%) and *E. guineensis* (3.30%) contain linoleic acid in high amount in the range of 23.10% (*A. hypogeal*) to 34.10% (*T. africana*) with *G. max*, having the highest percentage that is 56.40%. Studies on human subjects using diets rich in linoleic acid showed that, in the groups provided with higher amounts of soybean oil (50% linoleic acid content), the mortality rate due to coronary artery decreases significantly (Younis *et al.*, 2000). Ajayi (2009) reports oleic and linoleic acids as the main fatty acids in some seed oils from Nigeria. Sánchez-Manchado *et al.* (2004) also reports the range of 16.10±3.31% to 69.11±9.01% as the polyunsaturated fatty acids (PUFA) contents of some processed edible seaweeds studied.

Most vegetable oils are very good sources of linoleic acid but only very few oils contribute significant amount of linolenic acid in the diet (Longvah *et al.*, 2000). Among the oils examined, *A. danielli*, *G. max*, *P. guineense* and *T. africana* were found to contain linolenic acid ranging from 1.20% for *A. danielli* to 21.60% for *P. guinesis*; this is nutritionally significant. The consumption of Perilla oil which contains 57% linolenic acid has been reported in literature to improve learning ability, retinal function and suppression of carcinogenesis, metastasis, thrombosis and allergy (Longvah *et al*., 2000). The

Table 2. Fatty acid composition (%)[a] of the seed oils

Fatty acid composition	*A. danielli*	*A. hypogeae*	*G. max*	*P. guineense*	*T. africana*	*E. guineensis*
$C_{12:0}$	-	-	-	-	-	44.90
$C_{14:0}$	1.20	-	-	4.50	0.20	22.00
$C_{16:0}$	21.50	9.80	10.70	26.00	20.60	10.70
$C_{16:1}$	1.10	-	-	0.80	1.20	-
$C_{18:0}$	2.70	3.50	3.50	4.20	16.50	3.60
$C_{18:1}$	63.40	63.60	20.70	9.90	26.20	15.50
$C_{18:2}$	7.50	23.10	56.40	31.00	34.10	3.30
$C_{18:3}$	1.20	-	8.60	21.60	1.30	-
$C_{20:4}$	1.40	-	-	1.80	-	-

[a] = percentage by weight of total fatty acid identified as FAME.

Table 3. Oleic, linoleic, MUFA[a], PUFA[b], UFA[c], SAFA[d], oleic/linoleic, MUFA/PUFA, SAFA/UFA contents of the seed oils

Parameters	*A. danielli*	*A. hypogeae*	*G. max*	*P. guineense*	*T. africana*	*E. guineensis*
MUFA[a]	64.50	63.60	20.70	10.70	27.40	15.50
PUFA[b]	10.10	23.10	65.00	54.40	35.40	3.30
UFA[c]	74.60	86.70	85.70	65.10	62.80	18.80
SAFA[d]	25.40	13.30	14.20	34.70	37.30	81.20
Oleic/Linoleic	8.45	2.75	0.37	0.32	0.77	4.70
MUFA/PUFA	6.39	2.75	0.32	0.20	0.77	4.70
SAFA/UFA	0.34	0.15	0.17	0.53	0.59	4.32

[a] = monounsaturated fatty acids; [b] = polyunsaturated fatty acids; [c] = unsaturated fatty acids; [d] = saturated fatty acids.

consumption of *P. guineense*, if the oil is non-toxic, may probably has the same effect that Perilla oil has. *A. danielli*, *G. max*, *P. guineense* and *T. africana* may be considered for highest nutritional significance because of the presence of linolenic acid. Two of the oils; *A. danielli* and *P. guineense* contain arachidonic acid. Sanchez-Machado *et al.* (2004) also reports the presence of arachidonic acid in seaweeds. Generally, the percentage level of unsaturation in the oils is high except for *E. guineensis* kernel oil; it varied between 62.80% in *T. africana* and 86.70% in *A. hypogeal*. The percentage unsaturated fatty acids reported for three of the oils in this study, mainly *A. hypogeal*, *A. danielli* and *G. max* is higher than the one reported in literature for *T. occidentalis* (Ajayi *et al.*, 2004).

Oleic, linoleic, monounsaturated fatty acid (MUFA), polyunsaturated fatty acid (PUFA), unsaturated fatty acid (UFA), saturated fatty acid (SAFA) oleic/linoleic, MUFA/PUFA, SAFA/UFA contents of the seed oils are presented in Table 3. The saturated/unsaturated ratio of the *E. guineensis* kernel oil is 4.32; while, it is less than 1 in all the other oils. This suggests that all the examined oils (except *E. guineensis* kernel oil) could probably be suitable as edible oil. The MUFA/PUFA ratio of three of the oils is greater than 1; this shows that half of the oils contain more of PUFA than MUFA. Half of the oils also have their oleic to linoleic acid ratio to be greater than 1. This is of great nutritional value since polyunsaturated fatty acids and their derivatives are important essential nutritive additives in mammal, especially in humans (Stransky *et al.*, 2005; Kamal-Eldin and Yanishlieva, 2002; Ziboh *et al.*, 2002).

Conclusion

All the studied oils (except *E. guineensis* kernel) are highly unsaturated with some of them containing two of the essential fatty acids. The relatively high level of PUFA in the oil extracts (apart from *E. guineensis* kernel) may make them healthy. However, further work needs to be carried out on some of these oils to determine their toxicity.

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References

Ajayi, I.A. 2009. Comparative study of the fatty acid composition of some seed oils from Nigeria. *The African Journal of Plant Science and Biotechnology*, **3:** 59-62.

Ajayi, I.A. 2008. Comparative study of the chemical composition and mineral element content of *Artocarpus heterophyllus* and *Treculia africana* seeds and seed oil. *Bioresource Technology*, **99:** 5125-5129.

Ajayi, I.A., Oderinde, R.A., Taiwo, V.O., Agbedana, E.O. 2004. Dietary effects on plasma lipid and tissues of rats fed with non-conventional oil of *Telfairia occidentalis*. *Journal of Science Food and Agriculture*, **84:** 1715-1721.

Dunford, N.T. 2001. Health benefits and processing of lipid-based nutritionals. *Food Technology*, **55:** 38-44.

Fasina, O.O., Hallman, H., Craig-Schmidt, M., Clements, C. 2006. Predicting temperature-dependence viscosity of vegetable oils from fatty acid composition. *Journal of The American Oil Chemist's Society*, **83:** 899-903.

Garcia, M.C., Marina, M.L., Laborda, F., Torre, M. 1998. Chemical characterization of commercial soybean products. *Food Chemistry*, **42:** 325-331.

Idouraine, A., Kohlhepp, E.A., Weber, C.W., Warid, W.A., Martinez-Tellez, J. 1996. Nutrient constituent from eight lines of naked squash (*Cucurbita pepo* L.). *Journal of Agricultural Food Chemistry*, **44:** 721-724.

Kamal-Eldin, A., Yanishlieva, N.V. 2002. N-3 fatty acids for human nutrition: stability concentration, *European Journal of Lipid Science and Technology*, **104:** 825-836.

Kindu, S.F., Mgadini, B., Sondergani, B.L. 1987. A new labdane diterpenoid from the seed of *Aframum danielli*. *Journal of Natural Product*, **50:** 230-231.

Longvah, T., Deosthale, Y.G., Uday Kumar, P. 2000. Nutritional and short term toxicological evaluation of Perilla seed oil. *Food Chemistry*, **70:** 13-16.

Oderinde, R.A., Ajayi, I.A. 1998. Composition of *Entada pursaetha* seed and seed oil grown in Nigeria. *La Rivista Italiana Delle Sostanze Grasse*, **75:** 457-459.

Odoemelam, S.A. 2005. Proximate composition and selected physicochemical properties of African oil bean (*Pentaclethra macrophylla*). *Pakistan Journal of Nutrition*, **4:** 382-383.

Onyeike, E.N., Acheru, G.N. 2002. Chemical composition of selected Nigerian oil seeds and physicochemical properties of the oil extracts. *Food Chemistry*, **77:** 431-437.

Sanchez-Machado, D.I., Lopez-Cervantes, J., Lopez-Hernandez, J., Paseiro-Losada, P. 2004. Fatty acids, total lipid, protein and ash contents of processed edible seaweeds. *Food Chemistry*, **85:** 439-444.

Stransky, K., Zarevucka, M., Wimmer, Z. 2005. Gas chromatography analysis of blackcurrant oil in relation to its stability. *Food Chemistry*, **92:** 569-573.

Younis, Y.M.H., Ghirmay, S., Al-Shihry, S.S. 2000. African *Cucurbita pepo* L., properties of seed and variability in fatty acid composition of seed oil *Phytochemistry*, **54:** 71-75.

Ziboh, V.A., Cho, Y.H., Mani, L., Xi, S.D. 2002. Biological significance of essential fatty acids/ lipoxygenase-derived monohydroxy fatty acids in the skin. *Archives of Pharmacal Research*, **25:** 747-758.