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EVALUATION OF FATTY ACID COMPOSITION OF SOME UNDERUTILIZED PLANT OIL SEEDS FOUND IN AKOKO AREA OF ONDO STATE, NIGERIA

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ABSTRACT

The composition of fatty acids in seed oils of *Chrysophyllum albidum* (CA), *Asimina tribola* (AT), *Sida rhombofolia* (SR), *Luffa cylindrical* (LC), *Telfairia occidentalis* (TO), *Lagenaria ciceraria* (LS), *Dioclea reflexa* (DR), *Bombax glabra (*BG) *and Mucuna sloanei* (MS) found in Akoko area of Ondo State , Nigeria were investigated using Gas Chromatography (GC). The oils yield ranged between 1.60% AT and 51.43% in DR. Both saturated and unsaturated were identified in all the seed oils with the latter being the predominant. The total unsaturated fatty acids ranged between 52.66% in SR and 79.63% in LC. Essential fatty acids (linoleic, ω-6 and linolenic, ω-3) were in abundant and ranged between 29.17% and 52.75% in SR and LC, respectively. The saturated fatty acid ranged from 20.38% in LC to 47.30% in SR seed oils. The oleic to linoleic ratio (O/L) ranged between 0.28 to 2.20 in TO and CA, respectively. The presence of abundant unsaturated fatty acids like oleic, linoleic and linolenic could be of biological and industrial significance to humans.

Keywords: Fatty acids, gas chromatography, seed oils, biological and industrial.

INTRODUCTION

It is widely accepted that wild plants make an important contribution to the life of local communities. They play a significant role as source of fuel wood, in medicines, dyes, fibres, shelter, religious and ceremonial uses. However, the importance of wild plants in subsistence agriculture in developing world as food supplement and as a means of survival had been overlooked and their consumption is still underestimated (FAO, 1999). It has also been reported that, wild plant resources are often ignored and received little recognition from developing communities (Scoones *et al.*, 1992).

Edible oils are made of triacylglycerol molecules, mainly formed by unsaturated and saturated fatty acids esterified by glycerol units. They can be formed from a single fatty acid that could be esterified up to three times into the glycerol backbone, or at least by three different ones. The major fatty acids present in triacylglycerols from edible vegetable oils are the unsaturated oleic, linoleic, and linolenic acids, followed by the saturated acids mainly myristic (Baydar, 2000). Determination of fatty acid composition of edible vegetable oils is essential for evaluating their suitability for different uses in the diet and in the food industry, as well as for the quality control of foods. In view of their importance as alternative sources of plant food, there is, therefore, the

need to evaluate some of the wild plant species as sources of food and for other uses.

The fatty acid composition of oil plants is not fixed because fatty acid synthesis in the plants may vary according to genetic, ecological, morphological, physiological and cultural factors (Baydar, 2000). For instance, temperature increase was reported to result in a decrease in the activity of the enzymes (such as oleoyl- PC desaturase and linoleoyl-PC desaturase) that catalyze the synthesis of linoleic and linolenic acids from oleic acid (Broun and Somerville, 1997). As a result, high temperatures had negative effects on linoleic and linolenic acid syntheses and positive effect on oleic acid synthesis in plants (Weiss, 1983; Stryer, 1986). Statistically significant differences were found between the fatty acid distributions of the ecological regions in different longitudes (Seiler, 1983; Lajara *et al*., 1990). The continuous changes in fatty acid distribution during the period from seed development to maturation are called ontogenetic variability (Baydar, 2000). Therefore because of some factors that affects the chemical composition of plants as a result of geographical location, genetic factor, cultural conditions and environment, crop and post crop processing and different chemotypes and nutritional status of the plant. Therefore, this research was carried out in order to ascertain the fatty acids composition of some of the plant oil seeds found in Akoko area of Ondo State. Nigeria.

MATERIALS AND METHODS

Collection and treatment of sample

Sample of *Chrysophyllum albidum* (CA), *Asimina tribola* (AT), *Sida rhombofolia* (SR), *Luffa cylindrical* (LC), *Telfairia occidentalis* (TO), *Lagenaria ciceraria* (LS), *Dioclea reflexa* (DR), *Bombax glabra (*BG) *and Mucuna sloanei* (MS) were collected from Akungba, Ikare, Arigidi and Oke-Agbe all in Akoko area of Ondo State and identified in the Department of Plant Science and Biotechnology, Adekunle Ajasin University, Akungba-Akoko. Ondo State. Nigeria. The seeds were removed and opened manually. The seeds were sun - dried and dehulled. The dehulled seeds were milled using the laboratory Kenwood grain blender (Miniprocessor Model A90LD, Thom Emi Kenwood Small Appliance Ltd., Hampshire, UK) and stored in polythene bags and kept in a refrigerator at 4^{o}C prior to extraction.

Extraction of oils

Approximately 150.0 kg of each seed sample was extracted by Soxhlet using hexane as solvent for 3 h. The solvent was removed by rotary evaporator and the crude oil extract was made free of water by filtering through the anhydrous sodium sulphate. The oils was weighed and sealed in air tight containers for further treatment prior to gas chromatography analysis.

Fatty acid analysis

Fatty acid methyl ester preparation

The fatty acid methyl ester (FAMES) was prepared by adding 1 ml of hexane into 0.1 ml oil and 1 ml of sodium methoxide (1.55 g of sodium hydroxide in 50ml of methanol) solution to the oil solution. This was stirred vigorously using votex stirrer for 30 s, then left for 10 min for solution to separate out the clear solution of fatty acid methyl ester from the cloudy aqueous layer.

Gas Chromatography (GC) analysis

The FAMES was injected into Hewlett Packard (HP) 6890 GC powered with HP Chemstation Rev.AO 9.01 (1206) software, equipped with flame ionization detector (FID). The column was packed with HP innowax (cross – linked P.E.S); 30.0 m column length; 0.32 nm I.D; 0.50 µm film thickness. The column initial temperature was 60°C for 3 min, later increased at the rate of 8°C/ min to 140 °C, and maintained at this temperature of 140 °C for 5 min and then increased to 250°C at 10°C/ min and maintained constant for 10 min. Injector and detector temperatures were 230°C and 275°C respectively. The carrier gas, nitrogen was maintained at 30.0 psi, while hydrogen pressure was at 22 psi and compressor air pressure was also maintained at 28 psi. FAMES peaks were identified by comparison of their retention time with those of a standard mixture obtained from Sigma Chemical Company.

RESULTS

Fatty acids composition as volatile methyl esters of oil analyzed using gas chromatography equipped with flame ionization detector from

studied seeds is presented in Table 1. *Bombax glabra* (BG) had the highest yield with 51.43% followed by *Telfairia occidentalis* (TO), *Chrysophyllum albidum,* (CA), *Luffa cylindrical (*LC), *Sida rhombofolia* (SR), *Mucuna sloanei* (MS), *Dioclea reflexa* (DR) and *Asimina tribola* (AT) with 51.43%, 26.80%, 19.53%,14.13%, 8.50%, 5.51% and 1.60% yield, respectively.

Table 1: Fatty acid composition (%) of some plant seed oils

Fatty Acid	CA	AT	SR	LC	TO	LS	DR	BG	MS
Capric acid (C10:0)	2.86	-	-	-	-	-	-	-	-
Lauric acid (C12:0)	-	-	-	0.15	-	-	-	-	-
Myristic acid (C14:0)	-	-	-	0.26	-	0.06	-	-	-
Palmitic acid (C16:0)	18.12	9.10	27.19	11.84	10.13	19.72	19.90	15.21	21.22
Palmitoleic acid (C16:1)	-	-	-	0.56	0.25	0.01	0.22	0.35	0.26
Stearic acid(C18:0)	11.36	19.58	18.91	6.93	9.23	11.76	12.55	8.07	12.54
Oleic acid (C18:1) ω-9	24..39	13.84	23.49	25.89	17.13	24.70	14.12	19.12	14.85
Linoleic acid (C18:2) ω-6	11.07	16.26	10.69	52.06	59.21	11.67	42.04	56.03	42.75
Linolenic acid (C18:3) ω-3	28.30	37.92	18.48	0.69	0.43	28.82	4.27	0.47	5.53
Arachidic acid (C20:0)	1.09	0.39	0.04	0.04	0.10	1.09	0.28	-	2.48
Behenic acid (C22:0)	2.19	2.39	0.78	0.70	-	2.29	1.37	-	0.33
Erucic acid (C22:1)	-	-	-	0.43	1.71	-	-	-	-
Lignoceric acid (C24:0)	-	-	-	0.40	1.10	-	-	-	-
Oil yield %	19.53	1.60	11.22	14.13	26.80	-	5.51	51.43	8.50

CA = *Chrysophyllum albidum;* AT = *Asimina tribola;* SR = *Sida rhombofolia;* LC = *Luffa cylindrical;* TO = *Telfairia occidentalis;* LS = *Leganaria ciceraria;* DR = *Dioclea reflexa;* BG = *Bombax glabra;* MS = *Mucuna sloanei.*

Table 2: Fatty acid distribution of the seed oils according to the degree of saturated and unsaturated.

	CA	AT	SR	LC	TO	LS	DR	BG	MS
TSFA	36.22	31.68	47.28	20.36	22.27	34.92	39.37	46.56	37.57
TSFA%	36.40	31.84	47.30	20.38	22.40	35.08	39.37	46.60	37.68
MUSFA	24.39	13.84	23.49	26.88	19.08	24.71	14.34	19.47	15.11
DUSFA	11.07	16.26	10.69	52.06	59.21	11.67	42.04	56.03	42.75
TUSFA	63.76	68.02	52.66	79.63	78.72	64.60	61.63	75.97	63.39
TUSFA%	64.08	68.39	52.69	79.63	79.21	64.91	61.63	76.04	63.58
TEFA	39.37	54.18	29.17	52.75	59.64	40.49	46.31	56.50	48.28
TNEFA	60.13	45.30	70.77	47.24	39.74	59.03	53.69	43.40	51.42
TUSFA/TSFA	1.76	2.13	1.13	3.91	3.53	1.85	1.56	1.63	1.69
O/L ratio	2.20	0.85	2.19	0.49	0.28	2.12	0.34	0.34	0.35

TSFA = Total saturated fatty acid; MUSFA = monounsaturated fatty acid; DUSFA = Diunsaturated fatty acid; TUSFA = Total unsaturated fatty acid; TEFA = Total essential fatty acid; TNEFA = Total non-essential fatty acid; O/L = oleic to linoleic ratio.

Table 1 further shows that the most abundant unsaturated fatty acids were oleic acid (C18:0 ω-9), linoleic acid (C18:2, ω-6) and linolenic acid (C18:3, ω-3) with various concentration, the maximum being 59.21% linoleic acid in TO. Palmitic (C16:0) and Stearic acid (C18:0) was found to be the most abundant saturated fatty acids in the seed oils, the Palmitic acid ranged from 9.10% in AT to 21.22% in MS, respectively while that of Stearic acid ranged between 6.93% in LC to 19.58% AT, respectively.

Table 2 shows the distribution of the seed oils according to the degree of saturated and unsaturated. The seed oils had more total unsaturated fatty acid than total saturated fatty acid. The total unsaturated fatty acid ranged between 52.69% in SR and 79.63% LC, respectively while total saturated fatty acid ranged from 20.38% in LC to 47.30% in SR, respectively. The table also show that the oleic/linoleic (O/L) ranged between 0.28% in TO and 2.20% in CA, respectively.

DISCUSSION

The fatty acid composition of nine seed oils is as presented in table 1. The yield ranged from 1.6% for *Asimina tribola* (AT) to 51.43% *Dioclea reflexa* (DR). The determination of oil yield in plant oil seed is important because of cost of production. However, the most important aspect of oil is the end use of the oil. For instance unsaturated fatty acids are considered for oil to be used for food preparation mostly the essential fatty acids. Therefore, if the oil yield is not much but has a good quality characteristic for human use but underutilized, the yield may be of secondary importance. Coconut and palm kernel oils have yield of over 60 and 50%, respectively but their saturated values ranged from 86% for palm kernel to about 91% for coconut (Marina *et al*., 2009), for this reason the World Health Organization had warned that the oils should not be used as edible oil (WHO/FAO, 1994), however they have a wider application industrially. In this study the only two oils that have more than 40% saturated are SR and BG. The saturated fatty acids present were palmitic (C16:0), stearic acid (C18:0), arachidic acid (C20:0) and behennic acid (C22:0). Palmitic was the most abundant saturated fatty acid which ranged between 9.10% in AT to 27.19% SR followed by stearic acid with minimum of 6.93% in LC to maximum of 19.58% in AT. Other saturated fatty acids were on.

The most abundant unsaturated fatty acids were oleic acid (C18:0 ω-9), linoleic acid (C18:2, ω-6) and linolenic acid (C18:3, ω-3) with various concentration. In general all the investigated plant oils have higher values of unsaturated fatty acids than the saturated fatty acids. The least unsaturated fatty acid was found in SR (52.69%), while others were more than 60% as shown in table 2. Linoleic and linolenic acids are known as essential fatty acids, they are call essential fatty acids because it cannot be synthesized in the body, and it has to be supplied from food. From the result the value ranged from 29.17 % (SR) to 59.64% (TO). This is of significant importance nutritionally. It has been reported by Vles and Gottenbos (1989) that dietary rich in linoleic acid play a natural preventive role in cardiovascular disease because they promote the reduction of both total and high density lipoprotein (HDL) cholesterol (Meigarejo *et al*., 1995; Grande, 1988). The recommendation ratio of linoleic acid (LA) and α-linolenic acid (ALA) in the diet should be between 5:1 and 10:1 (WHO/FAO, 1994). However, since they compete for the same enzymes and different biological roles, the balance between the omega 6 (ω-6) and omega 3 (ω-3) fatty acids in the diet can be of considerable important (WHO/FAO, 1994). From this study only three seed oil meet this requirement, *Dioclea reflexa(*DR), *Bombax glabra (*BG), and *Mucuna sloanei* (MS).

The presence of specific proportion of fatty acids is considered to have high nutritional value (Lagerstedt *et al*., 2001; Leizer *et al*., 2000; James *et al*., 2006). Inappropriate balance of essential fatty acids contributes to various kinds of malfunctioning while a proper balance maintains and even improves health (James *et al*., 2006; Rosenfield, 2002).

Furthermore, the ratios of TUSFA to TSFA (p/s ratio) ranged from 1.13 in SR to 3.91 in LC. This ratio is used to determine the detrimental effects of dietary fats, the higher the p/s ratio the more nutritionally useful the oil. This is because the severity of arteriosclerosis is closely associated with the proportion of the total energy

supplied by saturated fats and polyunsaturated fat (Aremu et al., 2013). The values obtained from this work were relatively high when compared with values from other plant oils like varieties of Africa yam beans (Adeyeye *et al.*, 1999). The oleic/linoleic (O/L) acid ratio has been associated with high stability and potentiality of the oil for deep frying fat (Branch *et al*., 1990). The value ranged from 0.34 to 2.20, therefore only CA, SR, and LS may be useful as deep frying oil.

CONCLUSION

The study had provided the compositional data on concentrations of saturated and unsaturated fatty acids of some underutilized plant oil seeds found in some part of Akoko area, Ondo State in Nigeria. Since fatty acid contents determine the chemical characteristics of oil for edible and industrial use, this paper has revealed the nature of fatty acids present in the seed oils found in the state. In addition that the more unsaturated the oil is the higher nutritional significance. With the present work, all the oils have high unsaturated fatty acids, the least being 52.66% and the essential fatty acids were found to be more than 45% in six seed oils out of nine analyzed, hence they have great nutritional potential. However, further work has to be carried out to determine the antinutritional factors of the seed oils.

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