Fatty Acid Composition of Seed Oils of Some Members of the Meliaceae and Combretaceae Families

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ABSTRACT

Seed oils of some members of the Meliceae (six) and Combretaceae (three) were analyzed for their fatty acid composition. In oils of members of both families palmitic acid was the most abundant saturated acid. Trace amounts of short chain (C12-C14) and long chain (C20-C22) saturated acids were detected in some members of the two families. Oleic acid was the most abundant unsaturated acids in the oils of four members of the Meliaceae. However, in the oils of *Cedrella odorata* and *Lovoa trichilloides*, dienoic acid (C18:2) was the major unsaturated acid. Strikingly high levels of trienoic (C18:3) and monoenoic (C16:1) acids were detected in the seed oils of *C. odorata* and *Enthandrophragma angolense*, respectively. Oleic acid also was the most abundant unsaturated acid in the Combretaceae. The nutritional value and industrial potentials of these oils are given.

INTRODUCTION

Many plants have been found suitable for crop production for obtaining unique fatty acids not normally found in traditional crops. Chemical screening programs (1,2) for new oils have not only identified many plant species with new or unusual kinds of oils that will not compete with the presently used vegetable oils (soybean, cottonseed, peanut and corn), but also those with high industrial promise.

In the developing countries (especially Nigeria), the search for novel, high quality but cheap sources of protein for livestock and humans and for oil of high industrial potential has drawn the attention of nutritionists and food chemists. In this respect, many reports (3,4) have placed emphasis on the development of new crops as alternative protein sources, while little or no attention has been directed to finding alternative sources of oils for domestic and industrial uses. In realization of this objective, a screening program (unpublished) was carried out recently to uncover the potentials of about 60 underutilized wild seeds and nuts as alternative sources of proteins and oils. This program revealed some members of the Meliaceae and Combretaceae have good promise because of their high oil content. The fatty acid compositions of the extracted oils of such members were investigated and are reported in this study.

Experimental Procedures

Seeds belonging to both the Meliaceae and Combretaceae used in this study are listed in Table I. Mature processed seeds of these species were collected from the Forestry Research Institute of Nigeria (FRIN), Ibadan, Nigeria.

Fatty Acid Analysis

Milled samples were extracted for their oils by the Soxhlet method (5). Extracted oils were methylated according to the procedures described by (6), and the dry heptane solution of methyl esters was used for the analyses. Gas chromatography (GC) analyses were done on a Packard 419 Becker gas chromatograph equipped with flame ionization detector and glass columns (1.30m × 2.00mm) packed with 10% polyethylene glycolsuccinate on chromosorb W (80-120) mech). Nitrogen was used as the carrier gas with a flow rate of 45ml/min. The column temperature was 180 C, and the injector port and detector were maintained at 210 C. Fatty acid methyl esters were identified by comparing their retention times to those of authentic standards. The area of each peak was determined by triangulation method. The percentage of each peak area relative to the total area of all peaks was calculated as the percentage of each component.

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TABLE I

Oil content (%) of Seeds of Some Members of the Meliaceae and Combretaceae Families

Species	Family	Oil content[a] (%)
Cedrella odorata	Meliaceae	18.00
Lovoa trichilloides	Meliaceae	25.86
Khaya senegalensis	Meliaceae	45.50
Carapa procera	Meliaceae	53.45
Enthandrophragma angolense	Meliaceae	52.00
Azadirachta indica	Meliaceae	17.44
Terminalia superba	Combretaceae	14.50
Terminalia glucausens	Combretaceae	17.50
Terminalia catappa	Combretaceae	40.15

[a]Average of duplicate analysis.

RESULTS

Fatty acid profiles of members of the Meliaceae and Combretaceae are presented in Table II. Low molecular weight (C10 and C12) and high molecular weight (C22 and C24) saturated acids were not detected in all the members of Meliaceae investigated.

Of the six members, only the seed oil of *Khaya senegalensis* contained a fairly significant level (4.60%) of myristic acid (C14:0). Palmitic acid (C16:0) was the major saturated acid in the oils of *Azadirachta indica* (35.80%), *Carapa procera* (26.83%), *Lovoa trichilloides* (12.72%) and *Cedrella odorata* (12.52%). On the other hand, stearic acid constituted the major saturated acid in the oil of *E. angolense* (18.76%). In the seed of *K. senegalensis*, palmitic acid (11.30%) and stearic acid (13.86%) occurred in almost equal proportions and were the major saturated acids. The unsaturated acids were mainly oleic (C18:1) and linoleic (C18:2) acids. Oleic acid levels were higher than linoleic acid levels in four members, *Carapa procera* (62.45%), *K. senegalensis* (59.36%), *E. angolense* (40.34%) and *A. indica* (36.10%), and was the major unsaturated acid in these oils. *Cedrella odorata* (19.07%) seed oil contained a strikingly high level of linolenic acid (C18:3), while a notably high level of palmiloleic acid (C16:1) was detected in the oil of *E. angolense* (17.68%). In the three members of the Combretaceae investigated, palmitic acid (C16:0) also constituted the major saturated acid. Comparatively low levels of myristic (C14:0) and stearic (C18:0) were detected. *Terminalia glucausens* contained the highest level of palmitic acid (34.96%), but had the lowest myristic acid (0.10%) and stearic acid (4.77%) levels. A level of 5.80% stearic acid in the oil of *Terminalia catappa* was the highest among the members.

This oil also contained 1.21% myristic acid and 1.30% arachidic acid. Among the three members, behenic acid (C22:0) level of 1.18% was detected only in the seed oil of *Terminalia superba*. Oleic acid was the most abundant unsaturated acid. Negligible amounts of linolenic and palmitoleic acids were detected in the oils of this family.

TABLE II

Component Acids of the Seed Oils of Some Members of the Meliaceae and Combretaceae Families (%)

Oils	Family	Composition[a]											
		10:0	12:0	14:0	16:0	16:1	18:0	18:1	18:2	18:3	20:0	22:0	Total saturates	Total unsaturates
C. odorata	Meliaceae	—	—	—	12.52	0.52	4.91	11.56	51.37	19.07	—	—	17.43	82.52
L. trichilloides	Meliaceae	—	—	0.30	12.72	0.23	—	20.67	63.31	0.67	—		13.02	84.88
K. senegalensis	Meliaceae	—	—	4.60	11.30	0.14	13.86	59.36	9.71	0.57	0.51	—	30.27	69.78
C. procera	Meliaceae	—	—	0.17	26.83	—	4.11	62.45	6.28	—	0.13	—	31.28	68.72
E. angolense	Meliaceae	—	0.17	0.03	7.05	17.68	18.76	40.34	24.28	—	1.71	—	27.72	82.30
A. indica	Meliaceae	—	—	—	35.80	—	12.00	36.10	15.10	—	2.00	—	49.80	51.20
T. superba	Combretaceae	—	0.57	3.02	33.64	0.72	5.55	25.75	28.42	0.54	2.52	1.18	46.48	55.43
T. glucausens	Combretaceae	0.36		0.10	34.96	0.45	4.77	32.66	26.71	—	—	—	40.19	59.82
T. catappa	Combretaceae			1.21	30.20	—	5.80	41.52	19.12	0.85	1.30	—	38.51	61.49

[a]Values reported are average of triplicate analysis.

DISCUSSION

The results of this study showed that seed oils of members of the Meliaceae and Combretaceae contained palmitic acid as their most abundant saturated acid, while oleic acid was their major unsaturated acid. In both families, however, oleic plus linoleic acid together constituted well over 50% of the total fatty acids in their seed oils. The present results with respect to palmitic acid and oleic acid content in the oils of members of both families are supported by the findings of (7) and (8). Both authors have reported these two acids to be the major saturated and unsaturated acids in the oils of some members of the two families. It must, however, be noted that the result reported for the seed oil of *Carapa procera* (Meliaceae) in this study is at variance with that reported (7) for the same oil in respect of myristic acid content. For instance, myristic acid (17.90%) was reported (7) as the major saturated acid in the oil of *C. procera.* The present study could not detect such a high level, and in fact only a trace amount of this acid was detected. This discrepancy in results could be explained on the basis of the differences in the analytical techniques used.

It is possible that the GLC technique used in the present study was more sensitive than the older method and was able to separate the C14:0 peak more distinctively from the C16:0 peak. This assumption is supported by the results of (8), who was able to detect trace amount of myristic acid in the oil of *C. procera* using the GLC analytical technique.

Two oils showed unusual fatty acid composition at least among the members of the two families investigated. The first is the oil of *C. odorata* (Meliceae), which contained a very high level of trienoic acid (C18:3), while the second is the oil of *E. angolense* (Meliceae), which contained an exceptionally high level of palmitoleic acid (C16:1). The presence of these acids in these two oils will be discussed later, as these will have significant influences on their utilization.

From the utilization viewpoint and using the classification of (9), the oils of members of both families investigated could be categorized into two based on the fatty acid composition. The first category included those that could find extensive use in nutrition, while the second category included those that possess high industrial potentials. In the first category are the oils of *Lovoa trichilloides, E. angolense, A. indica, T. superba, T. glucausens* and *T. catappa.* This group of oils is rich in oleic (C18:1) and linoleic (C18:2) acids. Such oils are said to possess good semidrying properties (9) and as a result are considered the most adaptable of all oils and excellent edible oils.

In the second category are the oils of *C. odorata, K. senegalensis* and *C. procera.* The oil of *C. odorata* contained a very high proportion of trienoic (18:3) acid. This may reduce its edibility value because linolenic acid has been described as an unusual component of many edible vegetable oils and has been implicated as a majur cause of flavor problems (10). For instance, the poor flavor stability of soybean oil has been attributed to the presence of a high level (7-8%) of linolenic acid (10). The high linolenic acid content in this oil *(C. odorata)* therefore implies that it should have a good drying property (9) and this advantage could easily be utilized in the chemical industry for the manufacture of paints and varnishes. The fatty acid profiles of *K. senegalensis* and *C. procera* revealed that their oils contained very high levels of oleic (C18:1) acid, while that of *E. angolense* contained a significant amount of palmitoleic acid (C16:1). The implication of these is that their oils easily could undergo chemical modification through hydrogenation to produce hard fats. It therefore seems that these oils would find extensive use in the manufacture of margarines.

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The Estimation of the Composition of Edible Oil Mixtures

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ABSTRACT

The fatty acid, sterol and tocopherol contents of edible oils were used to determine the composition of oil mixtures by means of a weighted least squares estimator with backwards elimination. The model was tested on 93 samples containing known amounts of sunflowerseed oil, groundnut oil, soybean oil, cottonseed oil, maize oil, olive oil and palm oil. Of these samples 75 were binary mixtures, seven were ternary mixtures, one contained seven oils and 10 were pure oils.

Satisfactory results were obtained with 79 of the 93 samples (85%). The differences between the actual and estimated concentrations of the main components were greater than 2.7 times the standard error for six samples; the mean of the absolute differences was 4.7% for all 93 samples. The use of this model is considered superior to the matching of a fatty acid composition, but the model still needs a lot of development.

INTRODUCTION

The identification of edible oils and fats has received a great deal of attention over the years. The Codex Alimentarius Committee on Fats and Oils of the Food and Agriculture Organization/World Health Organization (1) compiled a list of fatty acid ranges for 17 commercial fats and oils to be used for the authentication of these fats and oils. Computer programs (2,3) and a graphic procedure (4) using these values have been put forward for the identification of fats and oils. The ranges contained in this list are, however, so wide that several samples could be classified under more than one type of oil (2). The composition of the unsaponifiable fraction has been included in an effort to overcome the problem of insufficient information from the fatty acids (5-10). In using the results of an analysis for the identification of an oil, the authors considered the concentrations of the compounds in the sample separately or in pairs and a complete picture of the composition of the oil could be formed only subjectively.

Multivariate analysis affords a method of considering the various constituents of the oil simultaneously (11). This has been used *int. al.* to determine the origins of the constituents in blends of peppermint oils (12), the quantitative separation of species in fish mixtures (13) and the determination of the proportion of proteins in a mixture (14). Martens et al. (15) used multiple linear regression and factor analysis to estimate the proportion of three oils in margarine samples. The means from pure samples of coconut oil, soybean oil and hydrogenated marine oil, as well as three factors from the hydrogenated marine oil were used to estimate the composition of four margarine samples fairly accurately.

We approached the problem by analyzing authentic samples of five different oils produced in the Republic of South Africa. The study (16) included sunflowerseed oil (40 samples); soybean oil (40 samples); cottonseed oil (12 samples); groundnut oil (47 samples), and maize oil (45 samples). A limited number of locally produced and imported olive oil samples and imported palm oil samples also were analyzed. The fatty acid composition, sterol content and tocopherol content were determined. Using these results, we evaluated the applicability of a generalized least squares estimator and a weighted least squares estimator with backwards elimination for determining the composition of oil mixtures.

EXPERIMENTAL PROCEDURES

Apparatus and Materials

The gas chromatograph used for the fatty acid analyses was a Varian 3700 with a flame ionization detector and splitter inlet. A glass capillary column (40 m × 0.3 mm internal diameter) coated with XE60 was used isothermally at 220 C with helium as carrier gas at 1.6 ml/min. The split ratio was 1:50.

For sterol analysis, a Carlo Erba Fractovap series 4160 gas chromatograph was used with a splitter inlet and flame ionization detector. A glass capillary column (16 m × 0.3 mm internal diameter) coated with OV17 was used isothermally at 230 C with helium as carrier gas at 2.2 ml/min. The split ratio was 1:20.

The high performance liquid chromatograph consisted of a Varian 5000 pump, Valco inlet valve and a Perkin Elmer 650 fluorescence detector. The slit widths on the detector were both set at 5 nm. Two columns (100 × 2.8 mm), packed with 3 μm Nucleosil 100-3 (Machery-Nagel) were used in series.

Peak areas and retention times for the three chromatographic systems were determined with Hewlett-Packard 3390A reporting integrators. A Hewlett-Packard 9845

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