Technical

Fatty Acid Composition in *Cuphea* Seed Oils from Brazil and Nicaragua

S.A. GRAHAM, Department of Biological Sciences, Kent State University, Kent, OH 44242, and **R. KLEIMAN,** Northern Regional Research Center, Agricultural Research Service, U.S. Department of Agriculture, Peoria, IL 61604

ABSTRACT

Seed oils of *Cuphea* are characterized by a diverse assemblage of fatty acid patterns emphasizing short- and medium-chain fatty acids. For this report, seed oils of 19 populations from 14 species were analyzed. Thirteen species are from Brazil and one from Nicaragua. Fatty acid compositions of oils of eight species are reported for the first time. Lauric acid predominates in 10 species, myristic acid in one, and linoleic acid in three. Small amounts of C20:0 and C20:1 are recorded in one species. The major fatty acid for each taxonomic section is consistent with that reported earlier as characteristic of the section. Seed oil compositions of species previously reported from North or Central American populations are comparable to those of the Brazilian populations.

INTRODUCTION

Research interests in *Cuphea* seed oils increased in the 1960s after the initial discovery that the species from this genus were rich in short and medium chain fatty acids, which are of importance in the manufacture of detergents, lubricants and other products (1). Analysis of seed oils of 65 species followed (2,3), confirming lauric, capric and/or caprylic acids as the predominant fatty acid components. Agricultural development of one or more species of *Cuphea* as a temperate zone source of lauric acid is now underway as a cooperative effort of the Soap and Detergent Association, the U.S. Department of Agriculture and Oregon State University. The goal is to replace partially the present lauric acid sources, coconut and palm kernel oil, currently obtained wholly by import (4), with domestic supplies.

Among the ca. 260 species of *Cuphea*, those high in lauric acid are concentrated in two sections of the genus, *Brachyandra* and *Euandra*, which are primarily Brazilian in distribution. In these, lauric acid accounts for an average 59% of the total fatty acid content in the oils analyzed to date. Characterization of the two sections were based on analyses of the few species whose range extends to North America. This study reports seed oil composition of 19 populations of *Cuphea*, representing 13 species from the states of Parana and Minas Gerais, Brazil and one from Nicaragua, and include 10 species from the critical sections *Brachyandra* and *Euandra*. A problem in the study of *Cuphea* seed oils has been to obtain sufficient mature seed for analysis. Many species are of limited distribution and once located in the field may yield little seed due to seed shattering. For this reason, analyses of oil composition for six species previously reported are presented to augment earlier reports. Fatty acid compositions for eight species are reported for the first time.

Experimental Procedures

Wild seed of *Cuphea* was collected in Brazil in March, 1982 with the permission of the National Council of Scientific and Technological Development (CNPq) of Brazil. Voucher specimens are deposited in the herbarium of the University of Michigan except for *Cuphea tetrapetala* (Nicaragua, Stevens 3528), which is deposited in the herbarium of the Missouri Botanical Garden.

Esterification procedures followed are those outlined in an earlier report (2). Fatty acids of wild seed were determined by gas-liquid chromatography (GLC) after transesterification to their methyl esters (3). Content of single fatty acids was computed as per cent of the total fatty acids.

RESULTS AND DISCUSSION

Fatty acid compositions from seed oils of 19 populations of *Cuphea* representing 14 species are presented in Table I. Composition of two species in sect. *Brachyandra*, *C. calophylla* and *C. carthagenensis*, confirms earlier analyses from populations from North and Central American collections of high percentages of lauric acid (2,3). Average per cent C12:0 for all *C. calophylla* analyzed is 80% of total fatty acid composition, for all *C. carthagenensis*, 68%. Populations of *C. calophylla* varied in C12:0 content from 76.5-85%. In *C. carthagenensis*, C12:0 content varied from 60-81%. Predominance of lauric acid typifies seven of eight species analyzed in this section.

In sect. *Cuphea*, linoleic acid is the major fatty acid in the four species previously studied. *Cuphea fruticosa* follows the pattern of the section, with 67% linoleic acid. Small amounts of C20:0 and C20:1 are present in this species and have been reported previously only in one other species, which also is in sect. *Cuphea* (3). Plants comprising sect. *Cuphea* have several floral and seed characters that indicate they are among the most generalized in the genus. Emphasis on linoleic acid agrees with the primitive status of the section, because linoleic acid is the most common fatty acid occurring in seed oils of the flowering plants; seed oils with linoleic acid as the major constituent are considered the basic type from which other patterns have been derived (5).

Seed oil compositions of six species of sect. *Euandra* are reported for the first time. Lauric acid is the major constituent. A high value of 83% C12:0 is recorded from one population of *C. pseudovaccinium*. This section, which is the largest in the family with ca. 74 species, is almost exclusively Brazilian. Some species are restricted to xerophytic rocky or white sand habitats, others to either marshlands or disturbed sites. Judging from the array of habitats in which the species of the section are found and the extensive vegetative and floral characters expressed, it appears to be a source of great genetic diversity. Germplasm of this section should be collected and maintained in light of the abundant C12:0 present. Unique in the section is the occurrence of 62% linoleic acid in two closely related species, *C. linarioides* and *C. linifolia*.

Myristic acid is the major component of *C. tetrapetala* in sect. *Heteranthus*. The composition is comparable to that of *C. epilobiifolia*, earlier reported for this section and unlike that of a third reported species, *C. setosa*, in which lauric acid predominates. Compositions of *C. melvilla* (sect. *Melvilla*) and *C. lutescens* (sect. *Pseudocircaea*) are similar to earlier populations studied; lauric acid predominates in both. Fatty acid data for the six species previously studied confirm the earlier patterns reported.

TABLE I

Fatty Acid Composition of *Cuphea* Seed Oils

Species	Coll No.	Per cent fatty acid										
		8:0	10:0	12:0	14:0	16:0	18:0	18:1	18:2	18:3	20:0	20:1
Sect. *Brachyandra*												
C. calophylla C & S	839	Tr[a]	8.7	82.8	3.6	1.0	Tr	1.5	2.4	–	–	–
	847	–	0.2	76.5	7.6	4.1	0.5	3.9	6.5	0.7	–	–
	858	0.2	15.1	76.6	2.5	1.4	Tr	1.7	1.9	0.6	–	–
C. carthagenensis Macbr.	850	Tr	5.3	81.4	4.7	1.7	0.2	2.7	3.8	0.2	–	–
	915	0.5	15.8	60.1	7.8	2.4	0.7	5.9	6.7	0.1	–	–
Sect. *Cuphea*												
C. fruticosa Spreng.	916	–	Tr	Tr	0.1	16.8	0.4	12.8	67.2	–	2.0	0.7
Sect. *Euandra*												
C. diosmifolia St.-Hil.	866	Tr	Tr	64.0	31.3	1.8	0.4	1.5	1.0	–	–	–
C. glutinosa C & S	845	Tr	5.4	81.7	2.5	3.0	0.4	1.5	5.2	0.3	–	–
	911	0.6	26.1	59.1	3.8	1.3	0.2	2.8	5.7	0.4	–	–
C. linarioides C & S	840	Tr	0.2	3.2	3.1	17.7	2.1	11.6	62.1	–	–	–
C. linifolia Koehne	857	Tr	Tr	0.4	3.1	17.9	1.9	13.7	62.5	0.5	–	–
C. polymorphoides Koehne	913	Tr	7.4	80.1	3.6	2.0	0.1	2.5	4.3	–	–	–
C. pseudovaccinium St.-Hil.	895	0.5	3.3	68.8	8.0	5.5	1.7	6.5	2.9	2.8	–	–
	901	Tr	10.0	83.0	5.1	0.8	Tr	0.6	0.5	Tr	–	–
C. scelerophylla Koehne	883	Tr	Tr	59.7	27.6	5.3	0.2	2.1	5.1	Tr	–	–
C. thymoides C & S	841	Tr	0.5	55.8	7.0	9.4	1.7	7.9	17.4	0.3	–	–
Sect. *Heteranthus*												
C. tetrapetala Koehne	3528	–	0.4	32.4	51.0	7.0	0.9	1.5	6.4	0.4	0.1	–
Sect. *Melvilla*												
C. melvilla Lindl.	908	Tr	0.3	46.2	13.1	8.7	1.5	11.8	17.2	1.2	–	–
Sect. *Pseudocircaea*												
C. lutescens Koehne	864	Tr	0.1	76.3	19.3	1.6	Tr	1.1	1.2	0.4	–	–

[a]Tr = Trace, < 0.1%.

REFERENCES

1. Miller, R.W., F.R. Earle, I.A. Wolff and Q. Jones, JAOCS 41:279 (1964).
2. Graham, S.A., F. Hirsinger and G. Röbbelen, Am. J. Bot. 68:908 (1981).
3. Wolf, R.B., S.A. Graham and R. Kleiman, JAOCS 60:27 (1983).
4. Pryde, E.H., JAOCS 56:849 (1979).
5. Hegenauer, R., in "The Biology and Chemistry of the Compositae." Vol. I. V. Heywood et al, eds., Academic Press, New York, 1977, pp. 283-335.

[Received May 11, 1984]

♣Processing Characteristics and Oxidative Stability of Soybean Oil Extracted with Supercritical Carbon Dioxide at 50 C and 8,000 psi[1]

G.R. LIST* and **J.P. FRIEDRICH**, Northern Regional Research Center, Agricultural Research Service, U.S. Department of Agriculture, Peoria, IL 61604

ABSTRACT

The crude oil extracted from soy flakes with supercritical carbon dioxide ($SCCO_2$) was characterized for color, free fatty acid, phosphorus, neutral oil loss, unsaponifiable matter, tocopherol and iron content and compared to a commercial hexane-extracted sample of crude degummed oil. Characterization and processing studies indicate that $SCCO_2$ extraction yields a product comparable to a hexane-extracted degummed oil. However, hexane-extracted degummed soybean oils exhibit better oxidative stability because phosphatides, which are natural antioxidants, are essentially absent in $SCCO_2$-extracted oils.

[1] Presented at AOCS Meeting, Toronto, May, 1982.

*To whom correspondence should be sent.

INTRODUCTION

Previous reports from this laboratory have shown that extraction of soy flakes with $SCCO_2$ at 50 C and 8,000 psi yields crude oil similar to degummed hexane-extracted oil (1,2). This report presents some properties and processing data for soybean oils obtained by $SCCO_2$ extraction under the aforementioned conditions.

EXPERIMENTAL

The $SCCO_2$ extraction methodology has been described previously (1,2). Soybeans were Tiger Brand certified seeds. AOCS Official Methods were used for the analyses (3). Processing (4) and oil evaluation methods (5) were described