Fatty Acid Composition of Melon Seed Oil Lipids and Phospholipids

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Fatty acid compositions of crude melon seed oil from two different sources were compared. Melon seeds from *Citrullus vulgaris* (syn. *C. lanatus*) contained phosphatidylcholine (PC), lysophosphatidylcholine (LPC) and phosphatidylserine (PS), whereas melon seeds from *Citrullus colocynthis* contained only PC and LPC, but not PS. Analysis of the total lipids revealed that the major fatty acid of the oils was 18:2n-6. *Citrullus vulgaris* seed oil contained 71.3% and *C. colocynthis* contained 63.4% of 18:2n-6. The predominant fatty acids in the *C. vulgaris* PC were 18:2n-6 (32.2%), 18:1n-9 (26.4%) and 16:0 (22.2%), whereas the *C. colocynthis* PC contained 44.6% of 18:1n-9 as the major fatty acid. The level of monoenes in the *C. colocynthis* variety (46.2%) was different from the *C. vulgaris* (27.3%). The major fatty acid in the LPC was 18:1n-9 for both varieties. Notably, the *C. colocynthis* variety did not contain any PS. The major fatty acids in the *C. vulgaris* PS were 18:1n-9 (37.9%) and 18:2n-6 (33.7%). Of all the phospholipids, LPC contained the greatest amount of monoenes, 48.6–52.4%.

KEY WORDS: Fatty acids, melon seed oil, phospholipids, total lipids.

Melon seeds are used for oil production at subsistence level in Nigeria, in several other African countries and in the Middle East (1,2). They are used for cooking oil in these countries (1,3,4). Because of the unique flavor of the oil, melon seeds also are used as soup thickeners in Nigeria. In most developing countries, greater emphasis has been placed on exploring new protein sources to combat malnutrition rather than exploring new lipid sources, especially from underutilized plant seeds. Melon seed oil also may be used for frying, but to date no large-scale or industrial production of the seed or the oil exists in any of the developing countries. The seed is rich in oil (23–55%) and protein (16–25%) (2,4–6), and may serve as an excellent source for both. For example, the protein can be used as an additive to local foods or for making relishes (6). Melon cultivation is simple, and large gourds can be produced with more than 500 seeds per gourd. It is estimated that one melon plant can produce up to 10 gourds. In Nigeria, more than 66,000 metric tons of melon seeds are produced per year (2). The potential for mass production and extraction of oil from melon seed as an alternative to vegetable oil appears to be great and needs to be investigated. In order to select the best variety and optimum production conditions it is imperative to study the differences in fatty acid composition of melon seeds from more than one source.

Phospholipids are found in both plant and animal tissues (7). They are responsible for the proper functioning of cell membranes, such as maintaining membrane fluidity. Animal tissues are known to contain phosphatidylcholine (PC), phosphatidylinositol (PI), phosphatidylserine (PS), lysophosphatidylcholine (LPC) and sphingomyelin. PC (lecithin) is the most abundant phospholipid in higher plants and animals. To date, no report has been published on the phospholipids of melon seed. Therefore, the aim of the present investigation was to compare the fatty acid composition of the total lipids and phospholipid classes of melon seed oil from two different sources.

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MATERIALS AND METHODS

Materials. Dried melon seeds [*Citrullus vulgaris* (L.) Schrader [syn. *C. lanatus* (Thunb.) Matsum. & Nakai] and *Citrullus colocynthis* (L.) Schrader] of the Cucurbitaceae family were obtained from Sands African Imports Ltd. (Newark, NJ; imported mainly from Aba, Nigeria and Accra, Ghana) and directly from a local market in Onitsha, Nigeria, respectively. Fatty acid methyl esters (FAME) standards and heptadecanoic acid were from NuChek Prep (Elysian, MN). Silica gel 60 plates were from Merck (Darmstadt, Germany). 8-Anilino-1-napthalenesulfonic acid ammonium salt (ANS) was from Aldrich Chemical Co. (Milwaukee, WI).

Extraction and analysis of lipids. Five grams (a composite of approximately 56–57) of seeds were ground with mortar and pestle and the lipids were extracted by the method of Folch *et al.* (8) in the presence of 0.005% butylated hydroxytoluene (BHT) to prevent oxidation. Total lipids were determined gravimetrically after drying in an air oven at 80°C. The individual phospholipid classes were separated by thin-layer chromatography (TLC) on silica gel 60 plates with chloroform/methanol/acetic acid/water (50:37.5:3:2, v/v/v/v) as previously described (9). Bands were detected under ultraviolet light after spraying with 0.1% ANS. For fatty acid composition analysis, a known amount of heptadecanoic acid was added as an internal standard to the total lipids or to the isolated phospholipids, such as PC, LPC and PS classes prior to transesterification (10). The scraped phospholipid or total lipid bands were dissolved in 3 mL of 6% anhydrous methanolic HCl and incubated at 80°C for 2 hr. The reaction mixture was cooled, 1 mL 0.1 M KCl was added, and the solution was extracted twice with 2 mL hexane. The hexane phase was passed through anhydrous sodium sulfate, and the FAME were analyzed on a Hewlett-Packard 5890A gas chromatograph (Palo Alto, CA) equipped with a DB-225 30-m fused silica capillary column (i.d. 0.25 mm, J&W Scientific, Folsom, CA). Helium carrier gas flow was 20 mL/min, split ratio was 1:66 and oven temperature was isothermal at 200°C. Fatty acid identification was made by comparison with retention times of known standards. The values were then converted to mol %.

RESULTS AND DISCUSSION

Table 1 shows the fatty acid compositions of crude melon seed oil total lipids, PC and LPC from two different sources. The predominant fatty acid in both *Citrullus vulgaris* and *Citrullus colocynthis* oils was 18:2n-6, repre-

TABLE 1

Fatty Acid Composition of Crude Melon Seed Oil Total Lipids, PC and LPC[a]

	Total lipids		PC		LPC	
Fatty acids	*C. vulgaris*	*C. colocynthis*	*C. vulgaris*	*C. colocynthis*	*C. vulgaris*	*C. colocynthis*
14:0	0.1	0.1	2.5	1.4	3.5	3.1
15:0	tr[b]	tr	1.6	0.7	—	—
16:0	11.2	11.9	22.2	15.3	16.9	17.7
16:1n-7	0.1	0.1	0.9	1.7	3.3	1.3
18:0	6.7	10.6	12.3	6.2	6.4	6.7
18:1n-9	10.2	13.5	26.4	44.6	49.1	47.3
18:2n-6	71.3	63.4	32.2	29.2	21.0	23.9
18:3n-3	0.2	0.1	2.0	1.1	—	—
20:0	0.2	0.3	—	—	—	—
20:1n-9	0.1	tr	—	—	—	—
Saturated	18.2	22.9	38.6	23.6	26.8	27.5
Monoenes	10.4	13.6	27.3	46.2	52.4	48.6
PUFA[c]	71.5	63.5	34.2	30.3	21.0	23.9

[a]Values (mol %) are averages of two determinations from composites of 57 seeds each.

[b]tr, Trace, less than 0.1%.

[c]PUFA, polyunsaturated fatty acids.

senting 71.3% and 63.4%, respectively. There were no differences in the 14:0, 16:0, 16:1n-7, 18:3n-3, 20:0 and 20:1 contents of the oils. However, 18:0, 18:1n-9 and 18:2n-6 concentrations were different among different varieties. The total saturated, monoenes and polyunsaturated fatty acids (PUFA) were also different. These differences may be due to time of harvest, variety, source, drying condition, seasonal variation, soil and storage conditions and level of maturity. The levels of total polyunsaturated fatty acids were 71.5% and 63.5% for *C. vulgaris* and *C. colocynthis*, respectively. The fatty acid profile of the melon seed oil total lipids resembled those reported by Kamel *et al.* (2), in which the 18:2n-6 concentration was 64.7%, and of other melon seeds (6) (64.6%). Our results for 18:1n-9 are similar to those previously reported (2), but they differ from those reported by Sawaya *et al.* (4) and Lazos (6); our samples contained lower amounts (10.2–13.5%) as compared to the 20–25% reported previously (4,6). The concentration of 18:2n-6 reported here is similar to that found in other vegetable oils, such as sunflower, safflower and corn oil, and may indicate that these oils can be used as a replacement for commercial vegetable oils for cooking and frying by the producing countries. The level of 18:1n-9 in safflower and sunflower oils closely resembles the amounts reported here. The level of 16:0 was not different from that found in corn and soybean oil. In general, melon seed oil contained small amounts (18–23%) of totally saturated fatty acids, which may be an advantage in view of the fact that diets low in saturated fats may benefit patients with cardiovascular diseases. Melon seeds from *Citrullus vulgaris* contained more total lipids (20 g/100 g) than the seeds from *Citrullus colocynthis* (18 g/100 g). Again, this may be due to the stage of maturity, seasonal variation and variety. Others (2,4,6) have reported 23–55% crude fat from melon seeds.

TLC analysis of the melon seed oils showed that the major phospholipid was PC (approximately 50%), followed by PS and LPC. There were smaller amounts of LPC in the *C. colocynthis* variety. Also, the *C. colocynthis* variety contained only PC and LPC, whereas *C. vulgaris* contained PS. Surprisingly, we did not find sphingomyelin and PI. In some cases, the bands that may contain phosphatidylethanolamine (PE) and neutral lipids were not separable, due to the high content of neutral lipids. Therefore, no attempt was made to quantitate the PE and the PI. TLC separation in the presence of authentic phospholipid standards indicated the presence of PS (Rf = 0.65), PC (Rf = 0.35) and LPC (Rf = 0.09). Table 1 shows the fatty acid composition of melon seed oil PC and LPC. The major fatty acids in both varieties appear to differ from each other. For example, 16:0 and 18:0 were different, with *C. vulgaris* having higher concentrations. The predominant fatty acid in *C. vulgaris* PC was 18:2n-6 (32.2%), whereas that of *C. colocynthis* was 18:1n-9 (44.6%), followed by 18:2n-6 (29.2%). Levels of total saturated and monoenes were significantly different in *C. colocynthis* compared to *C. vulgaris*. *Citrullus colocynthis* had a lower concentration of total saturated fatty acids (23.6%) than did *C. vulgaris* (38.6%). In most vegetable oil PC, the major fatty acid is 18:2n-6, followed by 16:0 and 18:1n-9 (7,11,12). There were no differences in the fatty acid profiles of LPC between the two varieties. However, *C. vulgaris* seemed to contain more total monoenes (52.4%) than the *C. colocynthis* counterpart (48.6%). PC and LPC are important in membrane properties such as formation of lipid bilayer and liposome formation. They are useful as emulsifiers in food and pharmaceutical applications and, thus, the melon seed may be an alternative source of these phospholipids. The PS of melon seed oil from *C. vulgaris* contains 1.1% 14:0, 16.2% 16:0, 7.2% 18:0, 37.9% 18:1n-9, 1.4% 18:1n-7, 33.7% 18:2n-6 and 2.7% 18:3n-3. Interestingly, there were no comparable data for *C. colocynthis* because TLC revealed no detectable amounts of PS. The predominant fatty acids were 18:1n-9 (37.9%), 18:2n-6 (33.7%) and 16:0 (16.2%). The level of PUFA was high in PS (36.4%) as compared to the levels found in PC and LPC of both varieties.

The results of this investigation showed that melon seed oil contains large amounts of PUFA and monoenes and low amounts of saturated fatty acids. This report represents the first detailed report on the phospholipids of

melon seed oil. Additional studies are necessary to determine the cause of variation in fatty acid composition, optimum harvesting season and maturity. Melon seed oils have the potential of being produced in large quantities for human consumption as cooking and frying oils, and as a source of phospholipids in food processing.

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REFERENCES

1. Girgis, P., and F. Said, *J. Sci. Food Agric. 19*:615 (1968).
2. Kamel, B.S., H. Dawson and Y. Kakuda, *J. Am. Oil Chem. Soc. 62*:881 (1985).
3. Curtis, L.C., *Proc. Am. Hort. Sci. 52*:403 (1948).
4. Sawaya, W.N., N.J. Daghir and P. Khan, *J. Food Sci. 48*:104 (1983).
5. Kroll, J., and F.R. Hassanien, *Nahrung 27*:K1 (1983).
6. Lazos, E.S., *J. Food Sci. 51*:1382 (1986).
7. Scholfield, C.R., in *Lecithins*, edited by B.F. Szuhaj and G.R. List, American Oil Chemists' Society, Champaign, 1985, pp. 1–20.
8. Folch, J., M. Lees and G.H. Sloane-Stanley, *J. Biol. Chem. 226*:497 (1957).
9. Akoh, C.C., and R.S. Chapkin, *Lipids 25*:613 (1990).
10. Chapkin, R.S., S.D. Somers and K.L. Erickson, *Ibid. 23*:766 (1988).
11. Weber, E.J., in *Lecithins*, edited by B.F. Szuhaj and G.R. List, American Oil Chemists' Society, Champaign, 1985, pp. 39–55.
12. Cherry, J.P., *Ibid.*, 1985, pp. 57–78.

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