Chinese Melon (*Momordica charantia* L.) Seed: Composition and Potential Use

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ABSTRACT: Chinese melon (*Momordica charantia* L.), also known as bitter gourd, is a tropical crop, grown throughout Asian countries for use as food and medicinals. In 1993, four cultivars of Chinese melon were grown in Mississippi and the seeds were collected. Oil contents of the seeds ranged from 41 to 45% and the oils contained 63–68% eleostearic acid and 22–27% stearic acid. Industrially important tung oil, a "fast-drying oil" used in paints and varnishes, contains 90% eleostearic and 2–3% stearic acid. The ratio of stearic to eleostearic in Chinese melon seed oil is ten times greater than that in tung oil. The higher ratio should reduce the rate of drying and crosslinking and could be advantageous in the paint industry. The defatted meals contained 52–61% protein and would be a good source of methionine.

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KEY WORDS: Chinese melon seed, eleostearic acid, meal, oil, protein, tung oil.

Chinese melon (*Momordica charantia* L.), also known as bitter gourd, is a monoecious climbing vine. It is a tropical crop, grown throughout Asia for food and medicinals (1). The fruits are ovoid, 10–30 cm long, with a muriculate-tuberculate surface. Each fruit produces 20–40 ovate seeds each, 13–16 mm long. The seeds contain oil in which the major fatty acid is eleostearic (ESA) (2). ESA is also a major component of oil from tung nuts and is the constituent responsible for the "drying" characteristic of tung oil (3). The latter is used extensively in paints, coatings, inks, etc. Since the 1970s, industries in the United States, Europe, and Japan have been dependent upon tung oil from South America. Between 1989 and 1993, the price of tung oil rose from \$0.41 to \$1.06 (4), and the availability and quality were erratic. Because of the similarity in composition of oils from Chinese melon seeds and tung nuts, melons may provide a new source of a "drying oil" (5). Chinese melons are grown to the mature stage as ornamentals in the Botanical Garden, City Park (New Orleans, LA) and to the immature (green) stage for food in home gardens in the southeastern United States. They have the potential to become a new industrial crop for that area.

In 1993, four cultivars of Chinese melon were grown in Mississippi. After the melons were harvested, seeds were collected, and the composition of the oil and the meal from these seeds determined. The objectives of this research were: (i) to compare the compositions of oil and meal from the four cultivars, (ii) to compare the composition of the oil to that of tung oil, and (iii) to compare meal composition with that of soybean meal, a common livestock feed.

EXPERIMENTAL PROCEDURES

Three cultivars of Chinese melons were obtained from the ARS Plant Introduction Research Unit (Griffin, GA): PI418996, China; PI489700, Mexico; and PI490022, Malaysia. The fourth cultivar, provided by O.P. Vadhwa, was from India. They were planted in McNeill, Mississippi, May 3, 1993, and harvested at the edible (immature) stage weekly, from June 28, 1993 through August 1993.

Seeds were separated from the fruit, freed from mucilaginous material, and divided into samples of fifty seeds each. Shells and kernels were separated, weighed, frozen, and lyophilized. Moisture content was calculated as the difference in weight before and after lyophilization. We demonstrated that calculation of moisture content by this method gave values equal to conventional procedures. A minimum of 12 samples per cultivar were used for analysis. Oil contents were determined as described by Chang *et al.* (6). Tung nuts were collected at Poplarville, Mississippi, in 1992. Tung oil was extracted with petroleum ether as described by Conkerton *et al.* (7). Duplicate, representative samples of the oils and oil-free meals were used for analysis.

Oils. Triglyceride content was determined by high-performance liquid chromatography (HPLC) as described by Chang *et al.* (8). Fatty acid methyl esters were prepared and determined by gas chromatography according to Conkerton *et al.* (9).

Meals. Mineral content of the meals was determined by X-ray fluorescence with a Kevex EDX 771 X-ray fluorescence Spectrometer (Fisons Instruments, San Carlos, CA). Nitrogen contents were determined by a commercial laboratory using the combustion procedure (10). Amino acid content was determined by a commercial laboratory using ion-exchange

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chromatography with post-column derivatization using a Beckman Model 126AA system (Fullerton, CA).

RESULTS AND DISCUSSION

The moisture content of the fresh seeds was high, 45–55%; therefore they would have to be dried before processing. The kernel represents approximately 50% of the seed by weight. The oil contents of kernels from the four cultivars were similar, ranging from 41–45% (Table 1). Protein content varied from 50–60% among the cultivars. Ash content varied from 5–6%. The oil content of the kernels was double that found in soybeans (11). Meals from solvent-extracted soybeans contain 40–48% protein and 6% ash (11), i.e., slightly less protein and about the same amount of ash as Chinese melon seeds.

The triglyceride compositions of oils from the four cultivars of Chinese melon seed were virtually identical. A typical HPLC analysis is shown in Figure 1A. The predominant peak is dieleosteroylstearin, and the other four peaks are trieleostearin and substituted dieleostearins. Tung oil contains the same triglycerides as Chinese melon seed oil, but the predominant peak is trieleostearin (Fig. 1B). The fatty acid profile of the oil from the seed of the four cultivars of Chinese melon is shown in Table 2 and is compared to tung oil. Although Chinese melon seed oil contains about 20% less ESA than tung oil, it contains about 20% more stearic acid. The higher stearic acid content of Chinese melon seed oil may provide advantages for this oil over tung oil. The latter, in many formulations, dries too quickly and additional stearic acid could retard drying.

The mineral content of defatted meals from the four cultivars of Chinese melon seeds are listed in Table 3. The magnesium, phosphorus, and sulfur contents of Chinese melon seeds were higher than those reported for soybean meal (12); the potassium and calcium contents were lower. Chinese melon seed meal, however, would still be a good source of potassium and calcium.

The total amino acid content of all four cultivars was 51–54 g per 100 g of meal. Among the cultivars, only slight variations in the individual amino acids were noted. The profile was typical of that for oilseeds, i.e., high amounts of aspartic and glutamic acids, and low amounts of methionine and cystine. The range of essential amino acid contents found in the four cultivars is shown in Table 4. Chinese melon seed meal contains significantly higher amounts of methionine and cystine, slightly less lysine, and almost double the amount of arginine as found in soybean meal. One disadvantage to the use of tung nuts to produce oil is the toxicity of the meal generated as a by-product. Tung meal contains a saponin and a protein that are toxic to animals (13). While detoxification is possible, the detoxified meal is of little value as a protein supplement (14). In India, swine feed on vines and mature melon flesh and seeds at the conclusion of the growing season. Therefore, defatted Chinese melon seed meal should be applicable in animal feeds.

TABLE 1
Protein, Oil, and Ash Content of Kernels from Four Cultivars of Chinese Melon Seeds

Cultivars[a]	Oil[b] %	Protein[c] %	Ash[b] %
CHI	40.6 ± 4.8	53.6 ± 3	4.95
IND	44.5 ± 4.3	51.9 ± 6	5.78
MAL	42.2 ± 4.6	56.5 ± 5	5.77
MEX	43.6 ± 3.4	61.4 ± 2	5.93

[a] CHI = China, PI418996; MEX = Mexico, PI489700; MAL = Malaysia, PI490022; IND = from India, provided by O.P. Vadhwa.
[b] % In dried kernels (w/w).
[c] % In defatted kernels (w/w).

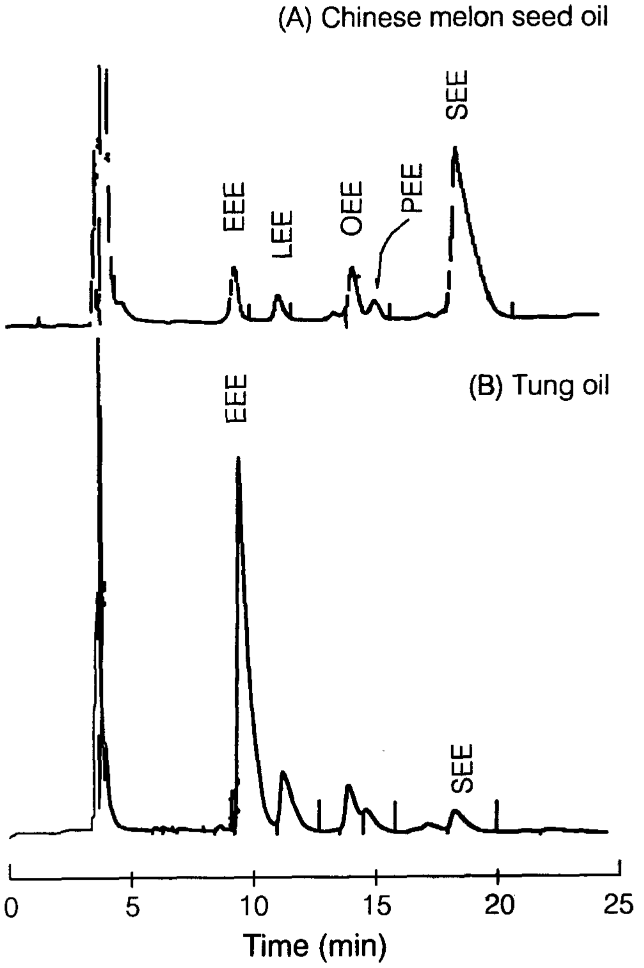

FIG. 1. High-performance liquid chromatography triglyceride profiles (A) Chinese melon seed oil; (B) tung oil: E = eleostearic, L = linoleic, O = oleic, P = palmitic, S = stearic. See Chang *et al.* (Ref. 8) for procedure.

Chinese melons are suitable for production in the southeastern United States. Vine growth is rapid and prolific, and seed yield is similar in magnitude to that of other oilseed crops (6). Further research is needed to compare the physical properties of the oil with those of tung or other drying oils. The higher content of stearic acid in Chinese melon seed oil may provide an advantage in paint and coating formulations over tung oil. These melons, therefore, have potential to be-

TABLE 2
Range of Fatty Acid[a] in Four Cultivars of Chinese Melon Seed Oil (CMSO) and Tung Oil (TGO)

	Palmitic	Palmitoleic	Stearic	Oleic	Linoleic	Linolenic	Eleostearic
CMSO	1.6–1.9	0.12–0.16	21.7–26.5	2.6–4.0	3.1–4.6	0.54–0.63	63.4–67.9
TGO	0.6–1.0	0.11–0.55	1.6–2.9	1.2–2.5	1.7–3.9	0	88.6–93.4

[a] % Of total fatty acid.

TABLE 3
Mineral Contents[a] of Oil-Free Meal from Seeds of Four Cultivars of Chinese Melon Seeds (CMS) and Soybeans[b] (SOY)

	Mg (%)[c]	P (%)	S (%)	K (%)	Ca (%)	Mn (ppm)	Fe (ppm)	Cu (ppm)	Zn (ppm)
CMS	0.70–0.84	1.25–1.48	0.92–1.04	0.95–1.06	0.14–0.18	23–40	93–140	11–16	66–84
SOY	0.27	0.65	0.43	2	0.29	29	120	36	27

[a] Range in the four cultivars.

[b] Solvent extracted soybean meal (Ref. 11).

[c] % By weight.

TABLE 4
Essential[a] Amino Acid Content[b] of Meal from Chinese Melon Seeds (CMS) and Soybeans[c] (SOY)

	Threonine	Valine	Methionine	Isoleucine	Leucine	Phenylalanine	Lysine	Histidine	Arginine
CMS	1.6–1.8	2.5–2.8	0.9–1.6	2.2–2.8	4.1–4.6	2.4–2.5	2.0–2.3	1.6–1.8	6.1–6.5
SOY	1.8	2.3	0.7	2.4	3.5	2.3	2.9	1.2	3.3

[a] Essential with respect to growth of rats.

[b] Range in four cultivars, % by weight, average SD ± 0.03%.

[c] Average composition of soybean meal used in animal feeds (Ref. 11).

come a new, important industrial crop for the southeastern United States.

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