Technical

Characteristics and Composition of Melon and Grape Seed Oils and Cakes

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ABSTRACT

Watermelon *(Citrullus vulgaris)* and grape *(Vitis vinifera)* seeds were investigated for their nutritional quality and oil characteristics. The yields of seeds on an as is basis (edible portion) were 1.6 and 1.8% for grape and melon, respectively. The melonseed on a dry weight basis consisted of 53.6% testa and 46.4% kernel. The crude protein, fat and fiber content were 16.4, 23.1 and 47.7% for melon and 8.2, 14.0 and 38.6% for grape (dry weight basis). Both seeds were found to contain significant levels of Ca, Mg, P and K. The fatty acid profiles showed an unsaturated fatty acid content of 76.1% for melonseed oil and 88.6% for grapeseed oil. The predominant fatty acid in both seeds was linoleic acid. The iodine value, saponification number and acid value were 116, 248 and 0.97 for melonseed oil and 132, 194 and 1.59 for grapeseed oil. The amino acid profiles of both seed cake proteins were determined and compared with hen's egg protein.

INTRODUCTION

The recovery and use of agricultural and food processing by-products are practical procedures that can lessen waste disposal problems and at the same time augment limited resources. Earlier studies have estimated the extent of winery waste generation and the potential of by-product recovery (1,2). Grapeseeds account for 20-26% of the pomace which is produced in large quantities by wineries. In Canada and the U.S., little is made of pomace, but occasionally it has been used as a soil conditioner, a source of fiber or as an energy source. In Europe, however, pomace is considered to be a valuable by-product for oil extraction and as a source of protein for animal feed and tannins. It has been estimated that the world production of grapeseeds is 1,416,000 metric tons (MT), with possible yields of 77,800 MT protein and 192,000 MT oil (3).

Watermelon seeds are used widely by many nations but not on an industrial scale for oil or protein production. In Nigeria, such seeds are used in oil extraction at the village level. The total production of melonseeds in Nigeria on the basis of the 1963 census was 66,200 MT per year. Many other countries produce melon and possess the potential for utilizing the seeds for oil; also, protein production appears good (4).

The present investigation was carried out to determine the physical and chemical characteristics of the oil extracted from melon and grape seeds and the nutritional quality of the resulting meals.

MATERIALS AND METHODS

Grapeseeds *(Vitis vinifera)*, a mixture of the variety Sweet Emperor and Sweet Ribier were collected from fresh grapes. Watermelon seeds *(Citrullus vulgaris)* from four varieties (Charleston Gray, Crimson Sweet, Congo and Gubble) all were extracted from fresh melons. All chemicals and solvents were of reagent grade.

Moisture was determined directly on the seeds by oven drying at 102 C for 6 hr. The seeds were then ground in a Wiley mill to pass a U.S. standard 20 mesh sieve. The ground seeds were placed in a vacuum oven at 60 C for 6 hr and then stored in a desiccator until analyzed.

Proximate analyses were performed in triplicate in accordance with the AOAC (1975) procedures (5). Crude fat by Soxhlet (AOAC 7.056), crude protein by macro Kjeldahl (%N × 5.3), ash by heating overnight at 550 C, crude fiber by AOAC 2.061 and carbohydrate by difference. Energy values were obtained by calculation using conversion factors of 9 Kcal/g for fat and 4 Kcal/g for protein and carbohydrate.

The samples were dry ashed (AOAC 3.007) for mineral determination. A Varian AA1475 atomic absorption spectrophotometer was employed to measure Mg, Fe, Zn, Cu, Ca and K. Phosphorus was determined by the AOAC 22.042 method.

The amino acid profiles were determined on fat- and moisture-free samples with a Technicon Sequential multisample amino acid analyzer fitted with a retrofil system (Technicon Industries System, Tarrytown, New York). The procedure and parameters used were described in the Technicon field bulletin No. TCI-0233-10. Sample preparation and hydrolysis were described by Kamel (6).

The extraction of oil for physical and chemical testing was performed by using a mixture of chloroform/methanol (2:1, v/v) at a solvent to seed ratio of 20:1. The solvent/seed mixture was homogenized for 4 min on a Waring Blender in stainless steel cups and filtered (7).

The fatty acid profiles were determined by GLC. The methyl esters of the fatty acids were prepared (8) and analyzed on a Hewlett Packard model 5830A gas chromatograph. A 180 cm glass column (3.2 mm I.D.) packed with 20% DEGS on Chromosorb W-AM 80/100 mesh was used for the analysis. The samples were run isothermally at 170 C with injector and detector ports at 190 C and 230 C, respectively. Nitrogen carrier gas flow was 30 ml/min.

The extracted oils were further characterized by refractive index (Fisher refractometer), melting point and solidification range (900 DuPont thermoanalyzer), iodine value (AOCS Cd 1-25), saponification value (AOCS Cd 3-25), unsaponifiable matter (AOCS Ca 6a-40), acid value (AOCS Cd 3a-63) and hydroxyl value (AOCS Cd 13-60) (9). All determinations were performed in triplicate.

RESULTS AND DISCUSSION

The grape samples yielded 1.6% seeds on an as is basis and 6.6% seeds on a dry basis. The melon samples yielded 1.9% seeds on an as is basis and 2.7% based on edible portion. These melon seeds contained 53.6% testa and 46.4% kernel.

The chemical composition of the seeds is shown in Table I. The moisture content in melon and grapeseeds were 50.7% and 43.1%, respectively. On a dry weight basis, the fiber content in both melon and grape were very high due to the presence of the hulls. Substantial levels of crude fat, 23.1% for melon seed and 14.0% for grapeseed, were recovered. The protein content was 16.4% for melon and 8.2% for grapeseeds. Melon kernels had 32.0% protein and 51.4% oil.

The analysis of the ash showed a significant (>1000 ppm) concentration of calcium, phosphorus, magnesium and potassium. Copper, zinc and iron ranged from 9 to 35 ppm (Table II). Similar results were reported by Fazio

TABLE I

Chemical Composition of Melon and Grape Seeds

	Percent dry weight basis	
	Melon seed	Grapeseed
Crude protein[a]	16.4	8.2
Crude protein[a] (kernel)	32.0	
Crude oil	23.1	14.0
Crude oil (kernel)	51.4	
Total ash	2.6	2.2
Crude fiber	47.7	38.6
Carbohydrate (by difference)	10.2	37.0
Percent moisture	50.7	43.1
Food energy, Kcal/g	3.1	3.1

[a]Conversion factor = 5.3.

TABLE II

Mineral Constituents of Melon and Grape Seeds

	Parts per million	
	Melon seed	Grapeseed
Iron	35	33.5
Calcium	988	4026
Zinc	35.3	11.4
Copper	17.8	9.1
Phosphorus	5100	2200
Magnesium	1900	1215
Potassium	5604	4276

TABLE III

Physical and Chemical Characteristics of Melon and Grape Seed Oils

	Melon seed	Grapeseed
Refractive index, n_D^{20}	1.4724	1.4741
Specific gravity, 25/25 C	0.915	0.904
Iodine value	116	132
Saponification value	248	194
Unsaponifiable matter, %	1.11	0.93
Hydroxyl value	7.9	16
Acid value	0.97	1.59
Free fatty acid		
% oleic acid	0.49	0.78
Ester number	247	192

TABLE IV

Fatty Acid Composition of Melon and Grape Seed Oils

	Percent composition	
Fatty acid	Melon seed	Grapeseed
Myristic	0.55	0.08
Palmitic	12.2	7.4
Palmitoleic	0.13	0.60
Stearic	11.2	3.9
Oleic	11.1	15.6
Linoleic	64.7	72.2
Linolenic	0.18	0.24
Total saturate	23.9	11.4
Total unsaturate	76.1	88.6

et al. (10) on the mineral content of 17 samples of grapeseeds.

The physical and chemical characteristics of melon and grapeseed oils are shown in Table III. Both oils stayed liquid at room temperature, as indicated by their approximate melting and solidification ranges of +2 to −40 C for melon seed and −4 to −50 C for grapeseed oils. Melon seed oil had an amber color and a nutty flavor, while grapeseed oil had a greenish-yellow color and a bland flavor. The iodine values were 116 and 132 for melon and grape, respectively.

Linoleic acid was the major fatty acid in both melon seed oil (64.7%) and grapeseed oil (72.2%), Table IV. These high linoleic acid values are similar to those found in safflower and sunflower seed oils. The total unsaturated fatty acid levels were 88.6% and 76.1% for grape and melon seed oils, respectively.

The amino acid profiles of melon seed and grapeseed proteins are shown in Table V. These amino acid levels are lower than values from earlier studies (11,12) and may indicate the presence of non-protein nitrogen in the samples. This may account partially for the relatively low levels of essential amino acids when compared to hen's egg protein. Higher histidine and arginine levels were present in melon protein, while only arginine was higher in grape protein. The limiting levels of lysine and sulphur containing amino acids may require supplementation with complimentary proteins if these seed proteins are to be used as a food source. Tryptophan was not determined, but Oyenuga and Fetuga (11) reported tryptophan levels in melon protein to be greater than in egg protein. These same workers found the digestibility of melon seed protein to be in the range of 91-93%, which is comparable to soybean meal but less than whole hen's egg protein (98.8%).

The potential utilization of grapeseed protein as a food source has been considered by a number of workers (3,13). These researchers looked into the extraction and concentration procedures and how they were affected by the presence of polyphenolic compounds.

TABLE V

Comparative Amino Acid Composition of Melon Seed, Grapeseed and Whole Hen's Egg

	Grams amino acid/16 g N		
Amino acids	Melon seed[a]	Grapeseed[b]	Whole hen's egg[c]
Essential			
Lysine	2.24	2.57	6.99
Histidine	2.84	1.51	2.43
Phenylalanine	3.82	2.80	5.63
Leucine	6.22	5.95	8.79
Isoleucine	3.33	3.03	6.32
Threonine	2.78	2.80	5.12
Methionine	1.36	1.05	3.46
Valine	3.88	4.20	6.85
Arginine	12.0	7.24	6.24
Non-essential			
Aspartic	8.13	3.50	9.02
Serine	3.93	3.85	7.65
Glutamic	16.5	20.5	12.7
Proline	2.78	2.45	4.16
Glycine	5.46	8.29	3.31
Alanine	4.37	4.08	5.92
Cystine	0.66	1.05	2.43
Tyrosine	2.02	1.28	4.16

[a]% N = 2.93.

[b]% N = 1.37.

[c]Oyenuga and Fetuga (11).

Grapeseed oil appears to be an excellent source of linoleic acid. Gattuso et al. (14) examined 17 samples of oil from fresh grapeseed and reported average values of 70.8% for linoleic acid and 88.6% for total unsaturates. Studies performed by Mattich and Rice (15) on several varieties of native American and hybrid grapeseeds showed levels of linoleic acid in excess of 70%, which are in agreement with our results of 72.2% and with results summarized by Kinsella (16) on *V. vinifera* varieties.

The fatty acid composition and physical and chemical characteristics of melonseed oil obtained in our study were in general agreement with results obtained by Girgis and Said (4), Oyenuga and Fetuga (11) and by Chowdhury et al. (17). In these earlier studies, however, the levels of linoleic acid reported ranged from 52-58%, compared to 65% in the present study.

The data presented here suggest that watermelon and grapeseeds may constitute useful products with good nutritional value. The seeds could be extracted for their oil and used for edible purposes, and the meal could be used for animal and poultry feed or as a soil conditioner or fertilizer.

A large number of other plant seeds have been investigated for their amino acid (18-21) and fatty acid (22) compositions. Research should be conducted on the economic feasibility of utilizing these by-products, although it should be recognized that only in areas where these by-products are produced in large quantities and the materials recovered are in limited supply will there be any real benefit.

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Determination of Colored Substances in Soybean Lecithin

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ABSTRACT

Methods to determine carotenoids, chlorophylls and pheophytins in lecithin by derivative spectrometry were developed. Determinations of those as well as of brown substances were made on commercial soybean lecithins, and the effects of bleaching and powder manufacturing upon color are discussed.

INTRODUCTION

The main classes of colored substances which account for the color of soybean lecithin are carotenoids, chlorophyllic pigments and brown substances (1). The principal carotenoid substance present can be β-carotene (2) or lutein (1,3). Among the chlorophyllic pigments, pheophytin A, a degradation product of chlorophyll A, is supposed to be the main constituent (4) which is related to the maximum at 670 nm in soybean lecithin and in soybean oil. The brown substances have the characteristics of aldehyde-amine reaction products and probably are formed in the oil during the solvent stripping operation (1). It also has been suggested (5) that browning in lecithin is the result of aldolic condensations catalized by bases, phosphatidylcholine being the main condensating agent.

Soybean lecithin usually is single bleached with hydrogen peroxide and double bleached with hydrogen peroxide alone or followed by benzoyl peroxide. In order to study the process of bleaching of commercial lecithin and find out its extension on each class of colored substance present, methods were developed and some determinations were made on nonbleached, single and double bleached lecithins. The effect of the acetone extraction upon the color of the insoluble phosphatides also was considered.

METHODS

Although there is an AOCS official method for chlorophyll applicable to refined and bleached oils (6) and two methods were proposed for brown substances (7), no method to determine carotenoids in lecithin without separation was found. The spectrophotometric methods for β-carotene (8) require a chromatographic separation which cannot be avoided in this case because of the absorbance at 400-500 nm due to the brown substances. As brown substances show no maxima in the visible range, their interference easily can be overcome by means of derivative spectrometry. On this base methods to determine carotenoids as well as chlorophylls and pheophytins were developed.

When reference to the "AOCS" method is made in this paper, it means a method similar to the AOCS Official Method Cc 13d-55 for chlorophyll in oils.