Characterization of the Seed Oil and Meal from Apricot, Cherry, Nectarine, Peach and Plum

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The oil and meal from apricot, cherry, nectarine, peach and plum seeds were characterized for their physico-chemical properties. The wt% seed/fruit ranged from 2.8–7.6% and the wt% kernel/seed ranged from 6.8–31.6%. Kernel moisture ranged from 38.8–72.4%. The proximate composition of whole seeds on a dry weight basis ranged from 1.3–6.9% protein, 0.6–14.5% fat, 51.0–72.3% fiber, 0.4–1.2% ash, and 18.1–27.9% carbohydrate (by difference). The kernels contained 41.9–49.3% fat, and the resulting meals contained 31.7–38.7% protein. The major fatty acids were oleic (52.9–66.3%) and linoleic (26.8%–35.0%). The major essential amino acids were arginine (21.7–30.5 mmoles/100 g meal) and leucine (16.2–21.6), and the predominant nonessential amino acid was glutamic acid (49.9–68.0). The iodine values ranged from 105 to 113, hydroxyl value from 5.5 to 7.0 and the unsaponifiables from 0.56–0.80%. The mineral composition (Cu, Fe, Ca, Mg, Zn, P) was also determined on the meals.

KEY WORDS: Amino acids, apricot, cherry, meal, nectarine, oil, peach, physical chemical properties, plum, proximate analysis.

To maintain a steady supply of fats and oils for an ever-changing and demanding market place, it has become necessary to not only develop new varieties of oilseeds with improved physical and chemical properties, but to also search for new and nonconventional sources. Currently, millions of pounds of fruit seeds are discarded yearly at processing plants. This not only wastes a potentially valuable resource, but also aggravates an already serious disposal problem. To be economically viable, however, both oil and meal from these fruit seeds must be utilized. Also, the search for new oils with unique fatty acid compositions required for specific industrial uses or nutritional needs is of prime importance.

The seeds from the fruits of the *Prunus* genus can supply significant amounts of edible protein and oil. The total fruit production in Canada and the U.S. of apricots, peaches, nectarines, cherries and plums totalled two million tons in 1982 (1). If calculated on a dry weight basis, the seed will yield more weight than the edible part of the fruit. At the present time, little seed is commercially processed but interest appears to be increasing (2). It is understandable that some of the seeds will be difficult to collect because of the direct consumption of the fresh fruit by consumers, but the bulk of the fruits is used in food processing plants where the seeds can be easily collected for further processing. To achieve the most economical and efficient utilization of these seeds, more information on the properties of the oil and meal is required. The sparsity of data in the literature (3–7) on the fatty acid composition, amino acid profile, yields and physical characteristics of the oils and meals extracted from fruit seeds, stimulated this investigation.

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MATERIALS AND METHODS

Seeds of apricots (*Prunus armeniaca* L.), sweet cherries (*P. avium* L.), sour cherries (*P. cerasus* L.), nectarines [*P. persica* var. *nectarina* (Aiton) Maxim.], peaches [*P. persica* (L.) Batsch var. *persica*] and plums (*P. domestica* L.) were purchased from local markets. All chemicals and solvents were of reagent grade.

Kernel moisture was determined gravimetrically by placing a small amount of kernels (separated by hand) into a forced-air oven at 102°C for 6 hr. Whole seeds (for proximate analysis) were oven-dried at 65°C for 6 hr, ground in a Wiley or hammer mill to pass through a U.S. standard 20-mesh sieve. The ground material was then completely dried in a vacuum oven at 60°C for 6 hr before storage in a desiccator at 4°C. The proximate composition was determined in triplicate in accordance with the 1980 AOAC procedures (8): crude fat by Soxhlet (7.056), crude protein by macro Kjeldahl (%N × 5.3) (2.057), ash (3.004) by overnight heating at 550°C, crude fiber (7.061–7.065), and carbohydrate by difference. Food energy values were calculated by using the conversion factor 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 AA 1475 atomic absorption spectrophotometer (Varian, Palo Alto, CA) was employed to measure Cu, Fe, Ca, Mg, and Zn. Phosphorus was determined by the spectrophotometric molybdovanadate method (AOAC 22.042).

For the physico-chemical studies, the seed kernels were ground and extracted with chloroform/methanol (2:1 vol/vol) at a solvent-to-seed ratio of 20:1. The seed-solvent mixture was blended with a Sorval Omni Mixer (Dupont Canada, Mississauga, Ontario, Canada) for 3 min following the procedure of Folch, Lees and Stanley (9). The extracted oils were characterized by the AOCS methods (10) for iodine value (AOCS Cd-I-25), saponification number (AOCS Cd-3-25), unsaponifiable matter (AOCS Ca-6a-40), acid value (AOCS Cd-3a-63) and hydroxyl value (AOCS Cd-13-60). All analyses were performed in triplicate.

Fatty acid methyl esters were prepared by AOCS Method Ce 2-66 (10) on a portion of the lipid extract and analyzed by gas-liquid chromatography (GVC) with a Varian 3700 gas chromatograph equipped with a 2-m stainless steel column packed with 15% DEGS on Chromosorb W-HP 80/100 mesh (Chromatographic Specialties Inc., Brookville, Ontario, Canada). The samples were run isothermally at 180°C with injector and flame-ionization detector ports at 250°C.

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, NY). Sample preparation and hydrolysis were described by Kamel (11). Histidine and arginine were analyzed by high-performance liquid chromatography (HPLC) (12,13).

RESULTS AND DISCUSSION

The potential supply of fruit seeds for oil and meal extraction can be estimated from the data in Table 1. Over

TABLE 1

Annual Production of Apricots, Nectarines, Cherries, Peaches and Plums in Canada and the United States

	Tons		
	Canada[a]		United States[b]
Fruits	Production	Total supply	Production
Apricot	3,047	4,062	113,000
Cherry	11,860	20,768	314,000
Nectarine[c]	—	—	173,000
Peach	38,000	55,055	1,146,000
Plum	7,568	27,607	581,000

[a]Extracted from 1983 Market Commentary, Commodity Market Analysis, Division of the Marketing and Economic Branch Agriculture Canada. Total fruit production for 1982 was 785,412 tons.

[b]1983 Agricultural Statistics, U.S. Department of Agriculture, Washington, D.C.

[c]Ontario, Canada imports 15,310 tons in 1982.

TABLE 2

Percent Seed Based on Fruit Weight, Percent Kernel Based on Seed Weight and Percent Moisture of Kernels[a]

Fruit	Seed (SD) (%)	Kernel (SD) (%)	Kernel moisture (SD) (%)
Apricot	7.1 ± 0.5	31.5 ± 4.6	40.1 ± 5.2
Cherry	6.3 ± 1.3	26.6 ± 9.7	38.8 ± 5.8
Nectarine	7.6 ± 0.8	7.3 ± 1.7	72.4 ± 6.4
Peach	5.8 ± 0.7	6.8 ± 1.3	70.3 ± 4.4
Plum	2.8 ± 0.2	9.1 ± 4.0	58.1 ± 4.5

[a]Number of fruits examined is a minimum of 300.

TABLE 3

Proximate Composition of the Whole Seeds[a]

Seed	Protein (%)	Carbohydrate[b] (%)	Fat (%)	Fiber (%)	Ash (%)	Food energy (%)
Apricot	6.9	27.9	13.1	51.0	1.1	10.8
Cherry	6.2	18.1	14.5	60.0	1.2	9.6
Nectarine	3.4	22.4	11.0	62.2	1.0	8.5
Peach	1.3	25.4	0.6	72.3	0.4	4.7
Plum	3.0	22.4	11.6	62.4	0.6	8.6

[a]On dry weight basis.

[b]Carbohydrate obtained by difference.

TABLE 4

Mineral Constituents of Whole Seed

	PPM					
Seed	Copper	Iron	Calcium	Magnesium	Zinc	Phosphorus
Apricot	32	55	949	347	41	93
Cherry	23	78	1,254	496	12	263
Nectarine	28	69	560	249	24	144
Peach	16	80	445	154	33	123
Plum	24	40	991	148	15	93

TABLE 5

Crude Fat and Protein Content of the Kernel

Kernel	Crude fat (%)	Crude protein[a] (%)
Apricot	49.3	37.4
Cherry	41.9	31.7
Nectarine	43.8	38.7
Peach	42.2	33.4
Plum	45.9	35.9

[a]Defatted sample, conversion factor (%N × 5.3).

780,000 tons of fresh fruit are produced annually in Canada with approximately 60,000 tons representing apricots, cherries, peaches and plums. This value increases to over 122,000 tons when imports are included. The U.S. production for the five *Prunus* fruits is over 2.3 million tons. Considering that the precentage of edible matter can range from 90–97%, there will be a substantial amount of waste seeds produced.

The relative percentages of seed and kernel are given in Table 2. The wt% seed based on fruit weight ranged from 2.8% for plum to 7.6% for nectarine. The wt% kernel based on seed weight is high for apricot (31.5%) and cherry (26.6%) but only 6.8 to 9.1% for nectarine, peach and plum. Similar results were reported by Filsoof *et al.* (3) on apricot (31.4%) and peach (10.7%) and by Weckel and Lee (5) on cherry (27.0%).

If the seeds are to be used as an animal feed supplement, the entire seed has to be reduced to a powder. The data in Table 3 represents the proximate analysis of ground or milled whole seeds. As expected, the fiber levels were high. Peach had the highest fiber content (72.3%) and the lowest protein (1.3%) and fat (0.6%) levels. For apricot, cherry, nectarine and plum, the levels of protein (3–6.9%) and fat (11–13.1%) were much higher. Whole seed results on cherries were also determined by Weckel and Lee (5). Their crude protein and oil values were 7.6% (N × 6.25) and 10.4%, respectively, on a dry weight basis. The whole seed is also a good source of trace minerals, with high levels of calcium (445–1254 ppm), magnesium (148–496 ppm) and phosphorus (93–263 ppm) (Table 4).

If the seeds are to be used as a source of oil and protein for human consumption, the kernels would have to be separated and extracted. The crude oil content of the dried kernels ranged from 42–49% (Table 5). The oils are a good source of oleic (52–66%) and linoleic (28–35%) acids. The levels of saturated fatty acids were low (5.8–11.3), and linolenic acid was not detected (Table 6). Oils with a similar profile include groundnut oil with 53–71% oleic and 13–27% linoleic (14), sesame oil with 37–49% oleic and 35–47% linoleic (14) and canola oil with 55% oleic and 26% linoleic (15). Canola oil differs, however, in having significant levels of linolenic acid. Other studies have reported only trace levels of linolenic acid in these species (6,16).

A comparison of sweet almond, peach and apricot showed that almond has a similar oleic acid (74%) and linoleic acid (18%) content to peach and apricot (3). Other physicochemical characteristics of the kernel oils are given in Table 7.

The defatted kernel meal contains a high level of protein that ranged from 31–38% (Table 5). Table 8 lists the essential and nonessential amino acid composition of this

TABLE 6

Fatty Acid Composition of Seed Kernel Oils

Fatty acid	Apricot (%)	Cherry (%)	Nectarine (%)	Peach (%)	Plum (%)
C16:0	4.6	7.6	6.1	8.1	6.3
C16:1	—	0.3	0.5	0.4	0.5
C18:0	1.0	2.3	—	—	1.4
C18:1	65.7	52.9	66.3	58.5	62.0
C18:2	28.5	35.0	26.8	32.8	29.6
C20:0	0.2	1.4	0.3	0.3	0.3
Total saturate	5.8	11.3	6.4	8.4	8.0
Total unsaturate	94.2	88.2	93.6	91.7	92.1

TABLE 7

Physical and Chemical Characteristics of the Kernel Oils

Analyses	Apricot	Cherry	Nectarine	Peach	Plum
Acid number	1.56	0.75	0.90	0.87	1.3
FFA (%)	0.87	0.38	0.50	0.44	0.90
Saponification number	191	192	192	192	192
Iodine value	105	113	108	107	108
Hydroxyl value	6.3	5.5	7.0	6.7	6.5
Unsaponifiables (%)	0.56	0.66	0.80	0.71	0.60

TABLE 8

Amino Acid Composition of Kernel Meal

	MMoles/100 g[a]				
Amino acids	Apricot	Cherry	Nectarine	Peach	Plum
Essential					
Lysine	3.9	6.5	5.7	4.9	6.7
Histidine[b]	7.5	7.2	7.5	4.1	7.4
Phenylalanine	11.9	10.2	12.0	8.6	11.9
Leucine	20.6	18.4	21.6	16.2	20.4
Isoleucine	10.5	9.1	10.2	8.7	9.1
Threonine	9.1	8.7	9.7	7.9	9.0
Methionine	1.7	2.3	1.8	1.2	1.6
Valine	14.5	12.4	14.5	11.8	13.9
Arginine[b]	23.8	21.7	30.5	21.7	27.4
Non-essential					
Aspartic	30.9	27.4	36.0	39.1	33.1
Serine	16.2	15.4	17.6	13.1	16.5
Glutamic	62.4	52.7	68.0	49.9	62.2
Proline	15.0	13.5	16.0	12.0	15.3
Glycine	29.3	30.8	31.4	24.3	29.8
Alanine	21.2	18.3	22.1	16.4	20.1
Tyrosine	5.4	4.7	5.9	4.5	5.2
% N (defatted sample)	7.06	5.98	7.30	6.30	6.77

[a]Defatted and dried meal.

[b]Analyzed by HPLC.

protein. The values were consistent across the five species. The major essential amino acids in the five species were: arginine (21.7-27.4 mmoles/100 g meal), leucine (16.2-21.6), valine (11.8-14.5), phenylalanine (8.6-12.0) and isoleucine (8.7-10.5). The essential amino acid methionine was low in all five fruits. Javed *et al.* (7) reported similar low values on apricot and prune but not on peach. Our low values for methionine in peach are in agreement with those of Rahma and Abd El-Aal (6). The major nonessential amino acid and the highest among all the acids in the five species was glutamic acid (49.9-68.0%). The other nonessential amino acids found in significant amounts are aspartic acid, glycine, alanine, serine and proline. Because of the low methionine levels, blending with other vegetable proteins or other meals may be necessary.

One of the problems in using stone fruit kernels as a feed or food is the occurrence of the poisonous cyanogentic glycosides, amygdalin, which upon hydrolysis yields hydrocyanic acid (17). These complex glycosides are widely distributed and can be found in approximately 150 species. Values ranging from 0.01% to 0.18% in apricot kernel have been determined (4,18,19). The minimum lethal dose of about 2-4 mg/g body weight for cyanide salts (20) would indicate that apricot kernels should be detoxified before consumption. Procedures have been tested to produce a defatted flour and protein isolate free of these toxic substances (4).

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