# Apricot Kernel: Physical and Chemical Properties

Sir:

The apricot, *Prunus armeniaca* L., is a member of the Rosaceae, subfamily Prunoideae. Very few apricot cultivars are grown commercially throughout the world. Instead, cultivars tend to be grown in only one region of a country, and most would be virtually unknown outside of that region.

Turkey is the largest producer of apricots (538,000 metric tons/yr) in the world. The hard, outer part of the pits, taken separately, represents about 35,000 metric tons/yr, and the kernels within the pits, taken separately, constitute 7,000 metric tons/yr (1). The kernels are mainly used in production of cosmetics, medicines, and scents, and pits are used as fuel.

The percentage of the kernel in the pit of apricot varies from 18.8 to 38.0%, calculated as [(pits)/(pits + kernels)] × 100 (2–11). The average dimensions of apricot kernels are: length, 14.0–19.17 mm; width, 9.99–10.20 mm; thickness, 3.3–6.27 mm; geometric mean diameter, 9.89–10.31 mm; and mass, 0.47–0.48 g (7,12,13). The 100-kernel weight range is 28.7–65.1 g (6,7,9,10). Physical properties of apricot kernels are relevant in the design of equipment to be used in mechanical processing (14).

Table 1 summarizes the chemical constituents of apricot kernels. The reported protein content of apricot kernel ranged from 14.1 to 45.3% (2,4,6,7,14–18). A PAGE study found that apricot kernel proteins contain 84.7% albumin, 7.65% globulin, 1.17% prolamin, and 3.54% glutelin. Nonprotein nitrogen is 1.17%, and other proteins are 1.85% (7). Research on the physicochemical properties of proteins revealed a UV absorption ($\lambda_{max}$) of 282 nm; a fluorescence spectrum (emission max) of 315 nm; and four subunits with molecular sizes of 58,600, 37,400, 25,200, and 16,500 based on SDS-PAGE (19).

Essential amino acids in apricot kernel constituted 32–34% (15) of the total amino acids. The major essential amino acids (mmol/100 g meal) were arginine (21.7–30.5) and leucine (16.2–21.6), and the predominant nonessential amino acid was glutamic acid (49.9–68.0) (4). Table 2 presents data on *in vitro* protein digestibility values for apricot kernel flour and protein isolate.

Carbohydrate content of apricot kernel was reported variously as 25.5% (w/w) (20), 17.3% (6), and 18.1–27.9% (4). The total sugar content was reported as 4.10% in undefatted kernel and 7.76% in defatted kernel (7). Invert sugar content was 5.86% (10). The sugar content of kernels from different cultivars in Turkey is presented in Table 3 (14).

The oil content of the kernels (Table 1) varies from 27.7 to 66.7% (2,4,6–8,14,15,17,18). Table 4 indicates that the contents of the major FA are oleic (58.3–73.4%) and linoleic (18.8–31.7%) (6–8,14,17,22–26). The contents of unsaturated FA (91.5–91.8%) and saturated FA (7.2–8.3%) (10,14) have been reported, as well as neutral lipids (95.7–95.2%), glycolipids (1.3–1.8%), and phospholipids (2.0%) (10). The kernel oil contains 11.8 mg/100 g campesterol, 9.8 mg/100 g stigmasterol, and 177.0 mg/100 g sitosterol (27).

The values for specific gravity, refractive index, iodine, saponification number, and unsaponifiable matter for apricot kernel oil are presented in Table 5. The ranges are 0.1–1.6 for unsaponifiable matter (4,10,28,29), 187.3–199.0 for saponification number (12,21,28), 90.0–104.8 for iodine value (8,10,21,28,29), 0.876–0.932 for specific gravity (8,12,21,28), and 1.464–1.480 (8,10,21) for the refractive index.

**TABLE 1**
**Chemical Compositions of Apricot Kernels[a]**

| Oil (%) | Protein (%) | Ash (%) | Arginine (mmol/100 g) | Leucine (mmol/100 g) | Glutamic acid (mmol/100 g) | Reference |
|---|---|---|---|---|---|---|
| 43.0–53.0 | 20.2 | 2.3 | | | | 15 |
| | 23.7–25.5 | 1.7–2.5 | | | | 16 |
| 41.9–49.3 | 31.7–38.7 | | 21.7–30.5 | 16.2–21.6 | 49.9–68.0 | 4 |
| 31.6–50.4 | 14.1–18.2 | 2.2–2.5 | | | | 14 |
| 27.7–66.7 | 20.3–45.3 | | | | | 2 |
| 52.0 | 20.6 | 2.9 | | | | 6 |
| 50.9–53.2 | 23.1–24.1 | 2.2–2.5 | | | | 7 |
| 56.0 | 22.2 | 2.2 | | | | 18 |
| 44.2–44.6 | 21.5 | 2.8 | | | | 17 |
| 46.3–51.4 | 23.6–27.7 | 2.1–2.7 | | | | 8 |

[a]These data represent a number of cultivars.

Paper no. J11111 in *JAOCS 82*, 469–471 (May 2006).

**TABLE 2**
***In vitro* Protein Digestibility Values[a] for Apricot Kernel Flour, Apricot Kernel Protein Isolate, and Casein (7)**

| Enzyme system | Digestible protein[b] (%) | | |
|---|---|---|---|
| | Casein | Kernel flour | Kernel protein isolate |
| Pepsin | 33.4 ± 3.1 | 30.6 ± 2.5 | 32.8 ± 2.7 |
| Trypsin | 72.8 ± 2.5 | 30.7 ± 3.0 | 66.9 ± 2.9 |
| Pancreatin | 95.9 ± 1.8 | 35.5 ± 2.6 | 95.9 ± 2.4 |
| Pepsin-pancreatin | 99.1 ± 0.3 | 96.4 ± 1.2 | 98.1 ± 1.5 |

[a]These data reprresent a number of cultivars.
[b]Data are mean ± SD.

Table 6 shows the kernels contain thiamine, riboflavin, niacin, vitamin C (14), α-tocopherol, and δ-tocopherol (27). The ranges for mineral content of apricot kernel (mg/100 g dry matter) were: Na, 35.2–36.8; K, 473–570; Ca, 1.8–2.4, Mg, 113–290; Fe, 2.14–2.82; Zn, 2.33–3.15 (8,14,30); and single reports have appeared for Mn, 0.48; Ni, 0.14; and Co, 0.002 (30).

**TABLE 3**
**Sugar Content (%) of Apricot Kernel (14)**

| Variety | Glucose | Fructose | Sucrose |
|---|---|---|---|
| Hasanbey | 1.03 | 0.45 | 3.01 |
| Aprikoz | 0.60 | 0.43 | 2.18 |
| Hangarish Best | 0.92 | 0.16 | 1.56 |
| Tokaloğlu | 1.01 | 0.19 | 1.57 |
| Hacıhaliloğlu | 0.76 | 0.12 | 1.47 |
| Çataloğlu | 0.28 | 0.33 | 0.85 |
| Kabaaşı | 0.57 | 0.25 | 1.47 |
| Çöloğlu | 0.68 | 1.70 | 0.26 |
| İsmailağa | 0.86 | 1.20 | 0.70 |
| Soğancı | 0.71 | 1.67 | 0.43 |
| Şekerpare | 1.00 | 2.40 | 0.54 |
| Mean ± SD | 0.77 ± 0.23 | 0.81 ± 0.79 | 1.28 ± 0.83 |

The use of apricot kernels for human nutrition is limited because of their content of the toxic, cyanogenic glycoside amygdalin, accompanied by minor amounts of prunasin. Amygdalin, which is used in the treatment of human cancer

**TABLE 4**
**FA (%) Profile of Apricot Kernels[a]**

| Palmitic (16:0) | Palmitoleic (16:1) | Stearic (18:0) | Oleic (18:1) | Linoleic (18:2) | Linolenic (18:3) | Reference |
|---|---|---|---|---|---|---|
| 4.4 | 0.1 | 0.2 | 69.0 | 26.0 | 0.1 | 6 |
| 8.8 | 1.2 | 1.4 | 56.5 | 31.7 | 0.2 | 22 |
| 4.5–6.6 | 0.6–0.9 | 1.1–1.3 | 69.3–71.4 | 18.8–24.0 | 0.1–1.2 | 8 |
| 4.4 | 0.1 | 0.5 | 66.3 | 28.6 | 0.1 | 7 |
| 3.5–4.1 | | 2.0–2.1 | 69.3–73.4 | 20.0–23.2 | | 17 |
| 4.6–5.0 | | 0.2–0.3 | 66.6–71.8 | 23.1–27.7 | | 23 |
| 6.2 | 1.7 | 0.4 | 60.3 | 31.4 | | 24 |
| 6.2 | 0.6 | 0.8 | 72.9 | 19.5 | | 26 |
| 4.8 | 0.7 | 0.8 | 62.1 | 31.6 | | 25 |
| 6.1–8.6 | 1.0–2.0 | 1.2–2.0 | 58.3–66.5 | 24.7–31.6 | | 14 |

[a]These data represent a number of cultivars.

**TABLE 5**
**Properties of Apricot Kernel Oil[a]**

| Specific gravity (g/cm$^3$) | Refractive index (20°C) | Iodine value | Saponification number | Unsponifable matter (%) | Reference |
|---|---|---|---|---|---|
| 0.876–0.879 | 1.471–1.472 | 90–101 | 189.7 | 0.86 | 10 |
| 0.914 | 1.464 | 104 | 193.5–199.0 | | 7 |
| | | 104 | | 0.30–1.58 | 29 |
| | | 105–113 | | 0.56–0.80 | 4 |
| 0.919 | | 92–94 | 187.3–187.7 | 0.10–1.00 | 28 |
| 0.931–0.932 | 1.480 | 105 | | | 8 |

[a]These data represent a number of cultivars.

**TABLE 6**
**Vitamin and Mineral Content of Apricot Kernels[a] (mg/100 g)**

| Na | K | Ca | Mg | Fe | Zn | Mn | Ni | Co | Thiamin | Riboflavin | Niacin | Vitamin C | α-Tocopherol | δ-Tocopherol | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35.2 | 570 | 1.8 | 290 | 2.82 | 2.33 | 0.48 | 0.14 | 0.002 | | | | | | | 30 |
| | | | | | | | | | 0.12–0.38 | 0.18–0.26 | 2.03–6.07 | 1.05–2.14 | | | |
| 36.8 | 473 | 2.4 | 113 | 2.14 | 3.15 | | | | | | | | | | 14 |
| | | | | | | | | | | | | | 5.8 | 32.2 | 27 |
| | | | | 1.07–7.49 | 1.18–4.24 | | | | | | | | | | 8 |

[a]These data represent a number of cultivars.

(31), is present in almond kernels reportedly at about 2–3% by weight (32). Another report indicated that amygdalin content is very high (5.5 g/100 g) in bitter apricot cultivars and is not detected in the sweet ones (15).

Kernels of the wild apricot contain a high concentration of HCN (200 mg/100 g), whereas domestic bitter apricot cultivars contain relatively low levels of HCN (11.7 mg/100 g) (33). The HCN content has been found to be 11.7 (33) and 8.9 mg/100 g (34). Excess consumption of apricot kernels (to produce over 1 mg/L –CN in blood) may cause poisoning. The fatal dose of HCN has been reported as 0.5 mg/g (35).

## REFERENCES


1. FAO, Food and Agricultural Organization of the United Nations, http://faostat.fao.org/faostat, 1998.
2. Kappor, N., K.L. Bedi, and A.K. Bhatia, Chemical Composition of Different Varieties of Apricots and Their Kernels Grown in Ladakha Region, *J. Food Sci. Technol. 24*:141–143 (1987).
3. Pektekin, T.A., Ülkemizde Yetiştirilen Kayısı Çeşitleri ve Özellikleri, *Standart 6*:49–51 (1994).
4. Kamel, B.S., and Y. Kakuda, Characterization of the Seed Oil and Meal from Apricot, Cherry, Nectarine, Peach and Plum, *J. Am. Oil Chem. Soc. 69*:493–494 (1992).
5. Hallabo, S.A.S., F.A. El-Wakeil, and M.K.S. Morsi, Chemical and Physical Properties of Apricot Kernel, Apricot Kernel Oil and Almond Kernel Oil, *Egyptian J. Food Sci. 3*:1–6 (1977).
6. Beyer, R., and L.D. Melton, Composition of New Zealand Apricot Kernels, *N.Z. Crop Hortic. Sci. 18*:39–42 (1990).
7. Abd El Aal, M.H., M.A. Hamza, and E.H. Rahma, *In vitro* Digestibility, Physico-chemical and Functional Properties of Apricot Kernel Proteins, *Food Chem. 19*:197-212 (1986).
8. Özcan, M., Composition of Some Apricot (*Prunus armeniaca* L.) Kernels Grown in Turkey, *Acta Aliment. 29*:289–293 (2000).
9. Gezer, İ., and S. Dikilitaş, The Study of Work Process and Determination of Some Working Parameters in an Apricot Pit Processing Plant in Turkey, *J. Food Eng. 53*:111–114 (2002).
10. Aydemir, T., İ. Yılmaz, İ. Özdemir and N. Arıkan, Kayısı Çekirdeği Yağının Fiziksel ve Kimyasal Özelliklerinin İncelenmesi, *Doğa Türk Kimya Dergisi. 17*:56–61 (1993).
11. Moussa, M.M., and M.A.B. Taiseer, Evalution of Apricot Kernel Proteins, *Alexandria J. Agric. Res. 28*:133–137 (1980).
12. Vursavuş, K., and F. Özgüven, Mechanical Behaviour of Apricot Pit Under Compression Loading, *J. Food Eng. 65*:255–261 (2004).
13. Gezer, İ., H. Hacıseferoğulları, and F. Demir, Some Physical Properties of Hacıhaliloglu Apricot Pit and Its Kernel, *J. Food Eng. 56*:49–57 (2002).
14. Pala, M., F. Açkurt, M. Löker, T. Gürcan, and M. Yıldız, Türkiye'de Yetiştirilen Değişik Kayısı Çeşitlerinin Bileşimi ve Beslenme Fizyolojisi Açısından Değerlendirilmesi, *Gıda Teknol. 1*:34–39 (1996).
15. Femenia, A., C. Rossello, A. Mulet, and J. Canellas, Chemical Composition of Bitter and Sweet Apricot Kernels, *J. Agric. Food Chem. 43*:356–361 (1995).
16. Gabrial, G.N., F.I. El-Nahry, M.Z. Awadalla, and S.M. Girgis, Unconventional Protein Sources: Apricot Seed Kernels. *Z. Ernährungswiss. 20*:208–215 (1981).
17. Joshi, S, R.K. Srivastava, and D.N Dhar, The Chemistry of *Prunus armeniaca, Br. Food J. 88*:74–78, 80 (1986).
18. Salem, S.A., and F.M.A Salem, Egyptian Apricot Kernels Seeds, *Dtsch. Lebensm. Rundsch. 69*:322–324 (1973).
19. El-Adawy, T.A., A.H. Rahma, A.A. El-Badawey, M.A. Gomaa, R. Lasztity, and L. Sarkadi, Biochemical Studies of Some Nonconventional Sources of Proteins. Part 7. Effect of Detoxification Treatments on the Nutritional Quality of Apricot Kernels, *Nahrung 38*:12–20 (1994).
20. Tunçel, G., M.J.R. Nout, L. Brimer, and D. Göktan, Toxicological, Nutritional and Microbiological Evaluation of Tempe Fermentation with *Rhizopus oligosporus* of Bitter and Sweet Apricot Seeds, *Int. J. Food Microbiol. 11*:337–344 (1990).
21. Abd El-Aal, M.H., M.M. Hamza, and E.H Rahma, Apricot Kernel Oil: Characterization, Chemical Composition and Utilization in Some Baked Products, *Food Chem. 19*:287–298 (1986).
22. Ogihara, H., S. Itah, and H. Tsuyuki, Studies on Lipids of Ume Apricot, *J. Jpn. Soc. Food Sci. Technol. 29*:221–227 (1982).
23. Filsoof, M., M. Mehran, and F. Farrohi, Determination and Comparison of Oil Characteristics in Iranian Almond, Apricot and Peach Nuts, *Fette Seifen Anstrichm. 78*:150–151 (1976).
24. Lotti, G., G. Pisano, and S. Baragli, Characterization of Apricot Seed Oils, *Riv. Ital. Sostanze Grasse 47*:867–871 (1970).
25. Farines, M., J. Soulier, and F. Comes, Etude de la Fraction Glyceridique des Huiles de Graines de Quelques Rosaceae Prunoides, *Rev. Fr. Corps Gras 33*:115–117 (1986).
26. Gutfinger, T., S. Romano, and A. Letan, Characterization of Lipids from Seeds of the Rosacea Family, *J. Food Sci. 37*:938–940 (1972).
27. Slover, H.T., Jr., H.R. Thompson, and G.V. Merola, Determination of Tocopherols and Sterols by Capillary Gas Chromatography, *J. Am. Oil Chem. Soc. 60*:1524–1528 (1983).
28. Rafique, M., F.M. Chaudhary, and S.A. Khan, The Fatty Acids of Indigenous Resources for Possible Industrial Applications. IX. Chemical Investigations of *Prunus armeniaca* (apricot) Fruit Stones-Kernel Oils, *Pakistan J. Sci. Ind. Res. 29*:193–195 (1986).
29. Sezen, Ü., and K. Günaydın, Badem, Kayısı ve Şeftali Çekirdek Yağlarının İncelenmesi, *Doğa Bilim Dergisi. Müh/Çev. 6*:15–19 (1982).
30. Normakhmatov, R., and T. Khudaishukurov, Apricot Stone Kernels as a Valuable Commercial By-product, *Konservn. i Ovoshchesush. Prom. 10*:32–33 (1973).
31. Gomez, E., L. Burgos, C. Soriano, and J. Marin, Amygdalin Content in the Seeds of Several Apricot Cultivars, *J. Sci. Food Agric. 77*:184–186 (1998).
32. Diamond, W.J., and W.L. Cowden, *Alternative Medicine: Definitive Guide to Cancer,* Future Medicine Publishing, Puyallup, Washington, 1997, pp. 11–16.
33. Stoewsand, G.S., J.L. Anderson, and R.C. Lamb, Cyanide Content of Apricot Kernels, *J. Food Sci. 40*:1107–1115 (1975).
34. Baytop, T., *Türkiye'de Bitkiler ile Tedavi (Geçmişte ve Bugün),* İstanbul Üniversitesi Yayınları, İstanbul, 1984, pp. 412–414.
35. Gossel, T.A., and J.D. Bricker, *Principles of Clinical Toxicology*, Raven Press, New York, 1984, pp. 90–95.


[Received April 15, 2005; accepted February 6, 2006]

M. Alpaslan* and M. Hayta
Inönü University,
Department of Food Engineering,
44069, Malatya, Turkey

*To whom correspondence should be addressed.
E-mail: malpaslan@inonu.edu.tr