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Chemical analysis of the emblic (*Phyllanthus emblica* L.) and its potential as a food source

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ABSTRACT

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The edible fruit tissue of the emblic (*Phyllanthus emblica* L.), a member of the Euphorbiaceae, contained about three times as much protein and 160 times as much ascorbic acid as apples (*Malus pumila* Mill.). The fruits also contained considerably higher concentrations of most minerals and amino acids than apples. Glutamic acid, proline, aspartic acid, alanine and lysine constituted 29.6, 14.6, 8.1, 5.4 and 5.3%, respectively, of the total amino acids. The concentration of each amino acid, except cystine, was much higher than in apples. The emblic is therefore highly nutritious, and could be an important dietary source of vitamin C, minerals and amino acids.

Keywords: ascorbic acid; chemical composition; *Phyllanthus emblica* L.; tropical fruit.

INTRODUCTION

The emblic (*Phyllanthus emblica* L.) is an edible fruit indigenous to tropical India and Southeast Asia. Its medicinal and tanning properties have been explored (Rao and Siddique, 1964; Giri and Banerjee, 1986) and the food, dietary, medicinal and other economic uses of this fruit have been reviewed by Morton (1960). Although the emblic is grown in Asia, principally in small-scale horticulture, it is almost unknown in the Western hemisphere.

The objectives of the study reported here were to determine the organic and inorganic constituents of the mature fruit of the emblic, so as to evaluate it as a source for human food and nutrition.

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MATERIALS AND METHODS

Plant material. – Mature fruits of *P. emblica* were collected from home gardens at Dibrugarh (27°29′N; 94°55′E) in the province of Assam, India. One hundred freshly harvested fruits were sent by air to the laboratory of Macdonald College of McGill University, Montreal, Canada, and the chemical composition of the fruits was determined in Agriculture Canada laboratories. Commercial apples (*Malus pumila* Mill.) from local markets in Montreal were also analysed for comparative purposes.

Determination of chemical composition. – Fresh fruit pulp was analysed for pH, moisture content, titratable acidity, ash and total water-insoluble solids according to Association of Official Analytical Chemists (A.O.A.C.) (1984) procedures, total soluble carbohydrate by the modified anthrone method (Fairbairn, 1953) with a Philips UV/VIS Spectrophotometer-PU-8800 and starch by the iodine (KI-reagent) colorimetric method (Gaines and Meudt, 1968). Reducing sugars and sucrose were measured by the Munson–Walker general method, ascorbic acid by titration with a standard solution of 2,6-dichlorophenol-indophenol (A.O.A.C., 1984) and total reducing substances such as glucose were determined with a Technicon Autoanalyzer II (Harvey et al., 1969). N was analysed by the Kjeldahl method (Anon., 1981), using the Tecator Kjeltec Auto 1030 Analyzer. The protein content of the fruit was calculated as total N×6.25. Total energy value was measured with an oxygen bomb calorimeter. The analyses were carried out in duplicate and the mean values are reported.

Minerals. – Fruit pulp was lyophilized for mineral analysis. The digestion procedure of Van Lierop (1976) was used in preparing samples for measurements of P, K, Ca and Mg, and that of Gorsuch (1959) in preparing samples for measurements of Cu, Fe, Mn, Na and Zn. K and Na were determined by flame emission, and Ca, Cu, Fe, Mg, Mn and Zn by flame absorption, using a Varian Spectra AA-30 Spectrophotometer according to recommended procedures (Anon., 1979). P was analysed by the molybdovanadophosphoric acid method using a Technicon Autoanalyzer II (Flannery and Marcus, 1969; Anon., 1976), B by the quinalizarin method and Cl by the potentiometric technique (A.O.A.C., 1984). The S content of the tissue was obtained by the $MgNO_3$ method, Si by gravimetry (A.O.A.C., 1984) and Se by the diaminobenzidine reaction (American Public Health Association, 1979).

Amino acid analysis. – Amino acids were determined from 20–30 mg of lyophilized sample hydrolysed in 4 ml of 6 N HCl under vacuum at 110°C for 23 h (Moore and Stein, 1963) and the hydrolysate washed through a glass wool column with distilled water and brought to volume in a 10 ml volumet-

ric flask. The HCl from a 0.5 ml aliquot was evaporated in a desiccator with KOH pellets and the residue taken up in 1 ml of pH 2.2 sodium citrate buffer (0.2 N) which contained 250 nmol ml^{-1} of norleucine as an internal standard. The Beckman amino acid standard for hydrolysate analysis was utilized to calibrate the analyser. The unit was a Beckman Model 121MB, Beckman Instruments, Inc., Spinco Division, Palo Alto, CA, fitted with a single column (2.8 mm bore × 300 mm in length) packed to a height of 210 mm with type AA-10 Beckman spherical cation exchange resin. The chromatographic conditions that were used in these experiments have been described elsewhere (Moore et al., 1958).

RESULTS AND DISCUSSION

Pomological characteristics. – The emblic fruit is spherical, smooth and has six ridges extending from the base to the apex that divide it into six segments. The average diameter of the present sample was 3 cm, although much larger fruits were grown in other parts of India (Ammal and Raghavan, 1958). In Florida, the diameter ranged from 2.5 to 3.2 cm (Morton, 1960). The fruit becomes a dull greenish-yellow at maturity. The skin which encloses the crisp

TABLE 1

Proximate composition of the emblic fruit on a fresh weight basis

Parameter	*P. emblica* L.	*M. pumila* Mill. commercial apple	RDA[1]
pH	2.94	3.44	–
Moisture (%)	79.8	87.0	–
Titratable acidity (ml 0.1 N NaOH per 100 g)	377.3	69.0	–
Water-insoluble solids (%)	3.10	0.73	–
Ash (%)	0.62	0.16	–
Pulp weight (g)	8.93	–	–
Peel weight (g)	1.36	–	–
Seed weight (g)	1.00	–	–
Ascorbic acid (p.p.m.)	5889	36	60 mg
Reducing sugars (%)	6.70	6.80	–
Sucrose (%)	0.26	2.11	–
Reducing substances (%)	6.95	9.03	–
Starch (%)	0.18	0.25	–
Soluble carbohydrate (%)	6.63	16.41	–
Total N (%)	0.11	0.04	–
Protein (%) (N × 6.25)	0.69	0.26	56 g
Energy (kJ g^{-1})	2.90	–	11.3 MJ

[1]Recommended dietary allowance for adults (Shells and Young, 1987).

TABLE 2

Macro- and micro-mineral contents of the emblic and apples on a fresh weight basis (mg per 100 g)

Mineral	*P. emblic* L.	*M. pumila* Mill. commercial apple	RDA[1] (mg)
Phosphorus	28.2	8.2	800–1200
Potassium	282.0	106.0	1525–4575
Calcium	27.6	4.4	800–1200
Magnesium	11.8	3.3	300–400
Sulphur	16.6	8.2	–
Iron	3.3	1.1	10–18
Manganese	1.1	<0.01	2.5–5.0
Zinc	1.8	0.5	15
Boron	0.22	0.20	–
Copper	0.28	0.16	2–3
Sodium	4.2	2.1	1100–3300
Chloride	35.5	8.9	1700–5100
Selenium	0.24	0.08	0.05–0.2
Silica	23.5	29.3	–

[1]Recommended dietary allowance for adults (Shells and Young, 1987).

and juicy pulp is thin and translucent, and the core of the fruit, hexagonal in shape, contains six small seeds. The fruit matures in winter and early spring.

Proximate analysis. – The proximate composition of *P. emblica* fruit shows marked differences from that of apples (Table 1). The ascorbic acid content of the emblic was very high, such that the consumption of only 10 g (one average-size fruit) would meet the recommended dietary allowance (RDA) for vitamin C. Mustard (1952) also found the ascorbic acid content of the emblic to be the highest of 22 fruits investigated and gave the fruit a rating of 1561.1 mg per 100 g compared with acerola or Barbados-cherry which had a an average value of 959.0 mg per 100 g. The difference between the ascorbic acid content reported in this study and that found by Mustard may be attributed to the diversity in environmental and cultural conditions in which the fruits were grown, and fruit size. Mustard's fruits came from nurseries and botanical gardens in Florida, whereas our fruits were collected from untended trees from Assam, India. The difference in fruit size also seems to be important since Ammal and Raghavan (1958) found the ascorbic acid content in small and large fruits of the emblic to be 412 and 900 mg per 100 g, respectively. In addition, the difference in the amount of ascorbic acid detected between the A.O.A.C. analytical method employed in this study and that used by Mustard may also partly explain the disparity between the results.

The ascorbic acid in the emblic is known to be highly stable even after prolonged cold storage or drying (Pillay and Iyer, 1958). This remarkable stability has been attributed to tannins and polyphenols which retard the oxidation

TABLE 3

Amino acid content of the emblic and apples (mg per 100 g) on a fresh weight basis

Amino acid	*P. emblic* L.	*M. pumila* Mill. commercial apple[1]	HDR[2]
Alanine	24.0	–	–
Arginine	17.6	5.8	–
Aspartic acid	36.1	–	–
Cystine	0	2.9	7
Glutamic acid	132.0	–	–
Glycine	19.8	–	–
Histidine	13.3	2.9	10
Isoleucine	12.0	8.0	10
Leucine	21.9	12.3	14
Lysine	23.6	12.3	12
Methionine	7.2	2.2	7
Phenylalanine	13.3	5.1	7
Proline	65.2	–	–
Serine	18.3	–	–
Threonine	13.5	7.2	7
Tyrosine	11.6	4.3	7
Valine	15.9	8.7	10
Total	445.3	–	–
NH_3	41.0	–	–

[1]Adams (1975); Pennington and Church (1985).
[2]Human daily requirement for adult male (mg kg^{-1} of body weight) (Food and Agriculture Organization/World Health Organization, 1984).

of ascorbic acid. Dhar et al. (1956) reported findings of as many as 13 separate tannins and three to four colloidal complexes in the emblic fruit tissue. Generally, fruits are not considered as excellent sources of proteins; however, the emblic contained almost 2.7 times more protein than apples (Table 1). The low energy value of this fruit is due to relatively low concentrations of carbohydrate and sugars.

Compared with apples, *P. emblica* was found to be rich in macro- and micro-nutrients (Table 2). Depending on a particular mineral nutrient, it contained several times higher concentrations of P, K, Ca, Mg, S, Fe, Mn, Zn, Cu, Na, chloride and Se than apples. Fe, an important part of the human diet, is known to be absorbed in greater quantities in the presence of ascorbic acid (Shells and Young, 1987). Since *P. emblica* is rich in both, it could be recommended as a valuable source of Fe and vitamin C.

Of the 17 amino acids analysed, the emblic contained 29.6% glutamic acid, 14.6% proline, 8.1% aspartic acid, 5.4% alanine and 5.3% lysine (Table 3).

The total amino acid concentration of 0.45%, with the exclusion of four amino acids, was expected to be less than the protein content of 0.69% in the proximate analysis (Table 1). Although there was no detectable cystine in this fruit, the other sulphur-containing amino acid, methionine, was present in low concentration. The most limiting amino acids in plant proteins are known to be lysine and methionine (Zeman and Ney, 1988). However, the emblic contained a considerable amount of lysine which would increase the biological value of its protein.

Our results indicate that the emblic fruit is highly nutritious. In addition, ease of long-distance transportation (Morton, 1960) and vitamin C stability are properties of the fruit that make it of interest for commercial exploitation.

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