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Nutritive Value of the Chebulic Myrobalan (*Terminalia chebula* Retz.) and its Potential as a Food Source

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ABSTRACT

*The edible fruit tissue of the chebulic myrobalan (*Terminalia chebula *Retz.) was analyzed for certain organic and mineral nutrients. Compared with commercial apples the tissue contained 10·3 and 14·5 times more vitamin C and protein, respectively. Of the 14 macro- and micro-nutrients studied, the minimum Recommended Dietary Allowance (RDA) for Se, K, Mn, Fe and Cu can be met (100, 63·5, 32, 30 and 28·5%, respectively) if 100 g of the raw fruit is eaten. Aspartic acid, glutamic acid, arginine, proline and lysine constituted 39·6, 8·6, 6·7, 6·4 and 5·0%, respectively, of the total amino acids. These results demonstrate that the chebulic myrobalan is highly nutritious and could be an important source of dietary supplement in vitamin C, energy, protein and mineral nutrients.*

INTRODUCTION

The tropical rainforests not only influence the global environment but also contain valuable resources of food suitable for human consumption. The continual erosion of these forests signals the urgency to identify and

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chemically analyze the edible fruits before they disappear. One such fruit indigenous to India and Southeast Asia is chebulic myrobalan (*Terminalia chebula* Retz.) from the family Combretaceae. Tanning, anti-microbial and medicinal properties of this fruit have previously been explored (Saleh *et al.*, 1952; Hathway, 1959; Ray, 1976; Thatte & Dahanukar, 1989). However, an extensive search of the literature from 1945 until the present failed to reveal any useful information on the chemical composition of this fruit and its potential as a source for human food and nutrition. This lack of information and the potential loss of food sources motivated the present study. There is an on-going project in this laboratory to generate data on the chemical composition of the edible fruits of the tropical rainforests and thereby increase the potential food base of mankind (Kermasha *et al.*, 1987*a,b*; Barthakur & Arnold, 1989).

The objectives of this paper are: (1) to determine certain organic and inorganic constituents in the mature fruit of chebulic myrobalan, and (2) to evaluate it as a source for human food and nutrition by comparing it with the known food and nutritive values of apples (*Malus pumila* Mill.).

MATERIALS AND METHODS

Materials

Mature fruits of *T. chebula* were collected from home gardens at Dibrugarh (27° 29′ N; 94° 55′ E) in the province of Assam, India. The freshly harvested fruits (75) 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 from local markets in Montreal were also analyzed for comparative purposes.

Determination of chemical composition

Fresh fruit pulp was analyzed for pH, moisture content, titratable acidity, ash and total water insoluble solids according to AOAC (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 & 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 (AOAC, 1984) and total reducing substances such as glucose were determined with a Technicon Autoanalyzer II (Harvey *et al.*, 1969).

N was analyzed by Kjeldahl method (Anon., 1981), using a 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 reported.

Minerals

Fruit pulp was lyophilized for the mineral analysis. The digestion procedure of Van Lierop (1976) was used for sample preparations of P, K, Ca and Mg and that of Gorsuch (1959) for the preparations 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 analyzed by molybdovanadophosphoric acid method using a Technicon Autoanalyzer II (Flannery & Marcus, 1969; Anon., 1976), B by quinalizarin method, and Cl by potentiometric technique (AOAC, 1984). S content of the tissue was obtained by $MgNO_3$ method; Si by gravimetry (AOAC, 1984) and Se by the diaminobenzidine reaction (APHA, 1979).

Amino acid analysis

Amino acids were determined by procedures described in detail elsewhere (Barthakur *et al.*, 1990).

RESULTS AND DISCUSSION

Pomological characteristics

The fruit has a spindle-shape with an average diameter at the mid-section of 1·5 cm and an average length of 3·2 cm. The smooth skin is thin which encloses the crisp pulp and the core of the fruit contains a stone of oblate spheroidal shape. The fruit is green during development and matures to a greenish-yellow colour.

Proximate analysis

The proximate composition of *T. chebula* fruit shows important differences when compared with commercial apples (*M. pumila* Mill.) (Table 1). For example, a 100 g portion of the fresh chebula provides 61·5% of the RDA

TABLE 1
Chemical Composition of the Fruits on Fresh Weight Basis. Bracketed Values were Taken from Adams (1975)

Parameter	T. chebula	M. pumila (*commercial apple*)		*RDA*[a]
pH	4·63	3·44		—
Moisture (%)	58·2	87·0	(84·4)	—
Titratable acidity (ml 0·1N NaOH/100 g)	816·0	69·0		—
Water insoluble solids (%)	17·3	0·73		—
Ash (%)	3·07	0·16		—
Pulp weight (g)	2·99	—		—
Peel weight (g)	0·40	—		—
Seed weight (g)	1·51	—		—
Ascorbic acid (ppm)	369	36	(38·9)	60 mg
Reducing sugars (%)	7·56	6·80		—
Sucrose (%)	3·74	2·11		—
Reducing substances (%)	11·50	9·03		—
Starch (%)	1·22	0·25		—
Carbohydrate (%)	9·21	16·41	(13·33)	—
Total N (%)	0·61	0·04		—
Protein (%) (N × 6·25)	3·78	0·26	(0·3)	56 g
Energy (kJ/g)	6·36	—	(2·2)	11·3 MJ

[a] Recommended Dietary Allowance for adults (Shells & Young, 1988).

requirements for vitamin C compared with about 6% for apple. Although fruits are not considered an excellent source of protein, the chebulic myrobalan contained almost 14·5 times more protein than apple. Moreover, the energy value of chebula is almost three times greater than the reference fruit and the percentage of ash is 19 times higher than in apples. The high ash content would seem to indicate the presence of a concentration of high molecular weight compounds some of which are of pharmacological importance (Saleh *et al.*, 1952).

Compared with apples, *T. chebula* was found to be rich in macro- and micro-nutrients (Table 2). It contains 7·9, 9·1, 29·1 and 20·4 times more P, K, Ca and Mg, and 2·7, 7·0, and 16·5 times more Fe, Zn and B, respectively, than apple. K was the most highly concentrated element in chebula followed by chloride and Ca. The minimum RDA in Se, K, Mn, Fe and Cu (100, 63·5, 32, 30 and 28·5%, respectively), could be met by eating only 100 g of the fresh fruit. Fe, an important part of the human diet, is known to be absorbed in greater quantities in the presence of ascorbic acid (Shells & Young, 1988). Since *T. chebula* is rich in both, it is recommended that the fruit be eaten regularly. This is important for those on vegetarian diets which do not

TABLE 2
Macro- and Micro-Mineral Contents of the Fruits on Fresh Weight Basis (mg/100 g). Bracketed Values from Adams (1975)

Mineral	T. chebula	M. pumila (*commercial apple*)		*RDA*[a] (*mg*)
Phosphorus	64·6	8·2	(9·4)	800–1 200
Potassium	968·2	106·0	(101·1)	1 525–4 575
Calcium	128·1	4·4	(6·7)	800–1 200
Magnesium	67·3	3·3		300–400
Sulphur	67·1	8·2		—
Iron	3·0	1·1	(0·28)	10–18
Manganese	0·8	<0·01		2·5–5·0
Zinc	3·5	0·5		15
Boron	3·3	0·2		—
Copper	0·57	0·16		2–3
Sodium	6·8	2·1	(1·1)	1 100–3 300
Chloride	141·8	8·9		1 700–5 100
Selenium	0·18	0·08		0·05–0·20
Silica	54·5	29·3		—

[a] Recommended Dietary Allowance for adults (Shells & Young, 1988).

usually include easily absorbable Fe (Zeman & Ney, 1988). Thus, this fruit can be considered as an excellent source of important minerals that far exceeds the concentrations of the same elements found in apples. Of the 17 amino acids analyzed, the chebulic myrobalan contained 39·6% aspartic acid, 8·6% glutamic acid, 6·7% arginine, 6·4% proline and 5·0% lysine (Table 3). Although there was no cystine in this fruit, the other sulphur-containing amino acid methionine was present in small concentration. The most limiting amino acids in plant proteins are known to be lysine and methionine (Zeman & Ney, 1988). However, the chebulic myrobalan contained 5% lysine which would therefore increase the biological value of its protein. The Human Daily Requirement (HDR) for adult male shows that if 100 g of the fresh fruit is eaten, it should provide about 8·6% of all essential amino acids, except cystine, for a 70 kg person.

The present results indicate that the chebulic myrobalan is highly nutritious and should be cultivated to supplement human dietary requirements. With the disappearance of the rainforests, valuable fruits like the myrobalan will also be lost if the trees are not cultivated. The dietary importance of this fruit therefore cannot be overemphasized as it could be an inexpensive source of minerals, amino acids and vitamin C. The raw fruit tastes slighly bitter on first bite; however, the bitterness substantially decreases and a pleasant taste develops in the mouth as the fruit continues to be eaten.

TABLE 3
Amino Acid Content of *T. chebula*. The Values for *M. pumila* Were Taken from Adams (1975) on Weight Basis (mg/100 g)

Amino acid	T. chebula	M. pumila (*commercial apple*)	*HDR*[a]
Alanine	61·8	—	—
Arginine	121·5	5·8	—
Aspartic acid	724·9	—	—
Cystine	0	2·9	7
Glutamic acid	156·4	—	—
Glycine	71·4	—	—
Histidine	47·4	2·9	10
Isoleucine	51·9	8·0	10
Leucine	80·8	12·3	14
Lysine	91·3	12·3	12
Methionine	24·1	2·2	7
Phenylalanine	51·0	5·1	7
Proline	116·3	—	—
Serine	63·9	—	—
Threonine	46·8	7·2	7
Tyrosine	62·1	4·3	7
Valine	50·4	8·7	10
Total	1 822·0	—	—
NH_3	129·0	—	—

[a] Human Daily Requirement for adult male (mg/kg of body weight from FAO/WHO, 1984).

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