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Nutrient composition and food potential of *Parkia roxburghii*, a less known tree legume from northeast India

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The nutrient compositions of *Parkia roxburghii* kernels and pods (i.e. tender, immature and mature) were determined. Protein content of the kernel was 29% and that of pods 13–19%. Similarly, fat content was highest (34%) in the kernel and ranged from 1–16% in the pods. Unsaturated acids Oleic, linoleic and linolenic acids made up 63–68% of the total fat in the pods as well as the kernels. The total essential amino acids amounted to 33%, 36% and 39% in the tender, immature, mature pods, respectively, and 42% in the kernels. The essential amino acid pattern of the kernel was comparable to the FAO/WHO/UNU (1985) amino acid requirement for preschoolers. However, the amino acid scores of the tender, immature and mature pods were 64, 84 and 92, respectively, with sulphur amino acids as the limiting amino acids in all the pod samples. © 1998 Elsevier Science Ltd. All rights reserved

INTRODUCTION

Numerous legume species exist in nature. However, less than twenty species are extensively used as food sources and many more remain to be exploited (NRC/NAS, 1979). Despite the low content of sulphur amino acids (Boulter *et al.*, 1976) or the occurrence of antinutritional factors (Liener and Kakade, 1980; FAO, 1982), legumes are still regarded as potential sources of protein.

Northeast India is a region where the land and climatic conditions are suitable for growth and survival of numerous plants, shrubs and trees. Many of these flora have been stabilised by natural propagation and growth while others are cultivated. Over the ages the local communities in the region have developed ingenious uses of many wild plants within their environment as food sources, perhaps after a good deal of trial and error. Among the numerous less familiar foods used by the local communities in Northeast India is a tree legume, commonly known as tree beans (*Parkia roxburghii*) or yongchak by the local communities in Manipur.

Parkia roxburghii belongs to the family leguminoseae, sub-family *mimosoideae*. The leaves are bipinate with numerous small curved leaflets and flowers in dense turbinate or clavate heads hanging on long peduncles. The fruit comprises bunches of green pods which may be up to 50 cm in length. On maturation, the pods turn black and contain yellow dry powdery pulp in which are embedded several black seeds (CSIR, 1966).

Parkia roxburghii is available from December until March and consumption starts from the tender pods, when it is about 30 cm long until maturity. It is consumed either fresh or cleaned and sundried for future use during off seasons. It is also consumed raw along with condiments or cooked with other vegetables or meat.

A literature search revealed that other species of *Parkia*, such as *Parkia clappertoniana* (Amubode and Fetuga, 1983) *Parkia biglobosa* (Von Maydell, 1986) and *Parkia filicoideae* (Fetuga *et al.*, 1974) are used as food sources in Nigeria. However, there appears to be no information in the literature on the food uses of *Parkia roxburghii*. Hence the present investigation was undertaken to determine the nutrient composition and food potential of *Parkia roxbrughii* at the different stages of its pod maturation as well as that of mature seed kernels.

MATERIALS AND METHODS

Sample collection and processing

The *Parkia roxburghii* samples were purchased randomly from the locals in Imphal, Manipur, at different

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time points from November to April according to the stages of maturity. The tender pods are available in November–December and thereafter the immature and mature pods at monthly intervals. The fully mature kernels were collected in March–April. The samples of tender pods, immature pods, mature pods and mature kernels were taken from several trees and pooled into one of each category. The tender pods were scaled to remove the outer green cover. The cream-coloured pods thus obtained were washed vigorously in water and sun-dried. The immature pods were processed similarly. The partially mature pods were roasted directly over the fire whereby the pods and cover separate. These pods, with beans embedded within, were sun-dried. At this stage the testa of the beans were still soft and light green in colour. The fully mature pods were broken easily to obtain the powdery pulp in which were embedded several black beans. The mature beans were separated out and sun-dried. The sun-dried samples of tender, immature and mature pods as well as the mature beans were transported by air to Hyderabad. Upon arrival at the laboratory, only the mature beans were soaked in water overnight; the testa were removed manually and the kernels thus obtained were sundried. All the samples were then dried in an oven at 60°C overnight, powdered to pass through 40 mesh and stored until analysis.

Chemical analysis

Protein content (Nx6.25) was estimated by the copper catalyst Kjeldahl method (984.13), and moisture (934.01), crude fat or ether extract (920.89) and ash (942.05) were each determined by AOAC (1990) methods. Total carbohydrate, including fibre, was obtained by difference. Mineral analysis was carried out by dry ashing according to the AOAC (1990) procedure. Calcium, chromium, copper, iron, magnesium, manganese and zinc were determined in a Varian Techtron 1000 atomic absorption spectrophotometer (AAS). Phosphorus was determined by the molybdovanadate method (AOAC, 1990).

For amino acid analysis, each sample was hydrolysed in a sealed tube *in vacuo* with 6 N hydrochloric acid at 110°C for 22 h. The total amino acid composition was determined according to the standard procedure (Moore *et al.*, 1958) by a column chromatography technique using a Beckman 199-Cs Amino Acid analyzer (Beckman Instruments, Fullerton, CA).

Oil extracted by the Soxhlet method (AOAC, 1990) was methylated according to the procedures described by Lowenstein *et al.* (1975). The fatty acid compositions of the samples were determined by GLC on a varian 3700 gas chromatograph equipped with flame ionization detector and a 12 ft × 1/4 inch column packed with 10% Silar 10C on chromosorb W. AW (80/100 mesh). The injection and detector ports were maintained at 230°C. The initial column temperature of 160°C was increased at the rate of 3°C min^{-1} and maintained at 226°C for 20 min. Fatty acids were determined by comparing the retention times and peak areas with those of the fatty acid methyl ester standards.

RESULTS AND DISCUSSION

The proximate composition and mineral content of *Parkia roxbrughii* kernels and that of the pods at different stages of maturity are given in Table 1. Protein content of the pod ranged from 12.1% in tender to 18.8% in mature pods. Like any other grain legumes, protein content of the kernels (28.8%) was much higher than the pods. Though, protein content of *Parkia roxbrughii* kernel was lower than soybean (43%) it was higher than most other grain legumes such as bengal gram (23%), cowpea (24%), green gram (24%) and red gram (22%) (Gopalan *et al.*, 1989). The kernel of

Table 1. Proximate composition and inorganic constituents of *Parkia roxburghii* at different stages of maturity

	Parkia roxburghii			
	Tender pod	Immature pod	Mature pod	Mature kernel
Moisture (%)	8.4	7.1	6.7	10.0
Protein (%)	12.1	15.6	18.8	28.8
Fat (%)	1.0	7.8	15.5	33.5
Ash (%)	7.4	6.9	6.1	5.7
Carbohydrate and Fibre (%)	71.1	62.6	52.9	22.0
Energy (kcal)	342	383	426	505
Phosphorus (mg 100 g^{-1})	320	315	298	270
Magnesium (mg 100 g^{-1})	520	505	480	420
Calcium (mg 100 g^{-1})	176	181	172	180
Iron (mg 100 g^{-1})	8.8	8.4	9.1	13.3
Manganese (mg 100 g^{-1})	2.8	2.1	2.4	2.9
Zinc (mg 100 g^{-1})	3.1	3.4	3.3	5.6
Copper (mg 100 g^{-1})	0.6	0.5	0.6	0.7
Chromium (μg 100 g^{-1})	74.0	73.0	71.0	79.0

All values are expressed on dry weight basis.
Values are means of triplicate determinations.

Table 2. Amino acid composition of *Parkia roxburghii* at different stages of maturity (mg g^{-1} protein)

Amino acid	*Parkia roxburghii*			
	Tender pod	Immature pod	Mature pod	Mature kernel
Threonine	38	37	36	34
Valine	36	43	47	44
Cyst(e)ine	06	07	07	10
Methionine	10	14	16	18
Isoleucine	34	35	38	42
Leucine	53	56	70	80
Tyrosine	36	43	47	46
Phenylalanine	35	40	46	565
Lysine	44	52	63	65
Histidine	22	28	29	26
Aspartate	257	150	97	82
Serine	49	50	48	48
Glutamate	89	139	177	162
Proline	52	60	65	48
Glycine	31	34	35	42
Alanine	45	52	53	56
Arginine	44	65	78	86
Total essential amino acid	292	327	370	394
Total amino acid	881	905	952	944
% essential amino acid	33.2	36.1	38.8	41.7

Values are means of duplicate determinations.

another tree legume, *Parkia filicoideae* was reported to contain 30.4% protein and 19.6% fat (Fetuga *et al.*, 1974). Protein content of *Parkia roxbrughii* kernel was slightly lower than *Parkia filicoideae* but fat content was much higher in *Parkia roxbrughii* kernel (33.5%). Though the fat content of *Parkia roxbrughii* kernel was lower than oilseeds such as groundnut (42%) it was higher than other grain legumes such as *Psophocarpus tetragonolobus* (18%) (Udayasekhara and Belavady, 1979) or soybean (20%) (Gopalan *et al.*, 1989). Maturity of the pods led to an increase in protein and fat content accompanied by a decrease in the ash as well as carbohydrate content. Compared to other grain legumes (Gopalan *et al.*, 1989), *Parkia roxbrughii* kernel, as well as the pod samples, showed good mineral contents.

Amino acid composition

The amino acid composition of *Parkia roxbrughii* kernels and pods at different stages of maturity are given in Table 2. Aspartic acid content in tender pods was exceptionally high, accounting for almost 26% of the total amino acid content. However, development of the pod from tender to mature stage led to a rapid decline in aspartic acid with a concomitant increase in the glutamic acid content. Lysine content in tender pod of *Parkia roxbrughii* was comparable to cottonseed meal (4.9 g per 16 g N) whereas the higher lysine contents in immature and mature pods as well as kernel of *Parkia roxbrughii* were comparable to other grain legume such as soybean (6.1 g per 16 g N) (Gopalan *et al.*, 1989), or other tree legumes, such as *Parkia filicoideae* (6.7 g per 16 g N) (Balogun and Odutuga, 1982). The high lysine content in *Parkia roxbrughii* could enhance the nutritive value of foods, provided all the lysine is available. The content of essential amino acid in *Parkia roxbrughii* ranged from 33% in tender pods to 42% in the kernel. The essential amino acid contents in immature and mature pods of *Parkia roxbrughii* were comparable to Peanut (37%) (Bodwell and Hopkins, 1985) while tree bean kernel (42%) was comparable to *Parkia clappertoniana* (Amubode and Fetuga, 1984). The level of essential amino acid in *Parkia roxbrughii* kernel was low compared to animal proteins such as egg (51%) or cows milk (50.4%). Nevertheless, it was comparable to other good quality grain legumes such as soybean (42%) (Bodwell and Hopkins, 1985). Compared to the FAO/WHO/UNU (1985) essential amino acid requirement for preschoolers (2–5 years) the amino acid scores of tender, immature and mature pods were 64, 84 and 92, respectively (Table 3). It appears that the essential amino acid content of the pod increases with maturity of the kernels which are embedded within the pods. It is interesting to note that the essential amino acid content of *Parkia roxbrughii* kernel is comparable to the FAO/WHO/UNU (1985) pattern of essential amino acid requirement. However, compared to whole egg protein (FAO, 1970) the chemical score of *Parkia roxbrughii* kernel was 61 with cyst(e)ine as the limiting amino acid.

Fatty acid composition

The fatty acid composition of tree bean kernel and that of the pods at different stages of maturity showed that palmitic, oleic and linoleic acids were the main fatty acids comprising 82–89% of the total fatty acids

Table 3. Comparison of the essential amino acid (EAA) composition of *Parkia roxburghii* and high quality animal proteins with the suggested FAO/WHO/UNU (1985) EAA pattern of requirement for 2–5 year-old child (mg g^{-1} protein)

Essential amino acid	EAA[a] requirement for pre-school child (2–5 years)	*Parkia roxburghii*				Animal[a] products	
		Tender pod	Immature pod	Mature pod	Mature kernel	Egg	Cows milk
Histidine	19	22	28	29	26	22	27
Isoleucine	28	34	35	38	42	54	47
Leucine	66	53	56	70	80	86	95
Lysine	58	44	52	63	65	70	78
Methionine + cystine	25	16	21	23	28	57	33
Phenylalanine + tyrosine	63	71	83	93	101	93	102
Threonine	34	38	37	36	34	47	44
Valine	35	36	43	47	44	66	64
% EAA		33.2	36.1	38.8	41.7	51.2	50.4
Amino acid score		64	84	92	100	100	100
Limiting amino acid		Sulphur amino acids	Sulphur amino acids	Sulphur amino acids			

[a]Data from FAO/WHO/UNU (1985)..

Table 4. Fatty acid composition of *Parkia roxburghii* at different stages of maturity (values are per cent of total oil)

Fatty acids	*Parkia roxburghii*			
	Tender pod	Immature pod	Mature pod	Mature kernel
$C_{16:0}$ palmitic	29.5	22.4	19.2	19.0
$C_{18:0}$ stearic	3.9	2.8	7.4	6.9
$C_{22:0}$ behenic	2.1	4.6	4.2	5.3
$C_{24:0}$ lignoceric	1.7	2.4	3.8	3.8
$C_{18:1}$ oleic	13.1	18.0	17.3	16.2
$C_{18:2}$ linoleic	41.0	46.0	47.5	47.5
$C_{18:3}$ linolenic	8.7	3.8	1.6	1.3
Total saturates	37.2	32.2	32.6	35.0
Total unsaturates	62.8	67.8	66.4	65.0

Values are means of duplicate determinations.

(Table 4). Palmitic and linolenic acid decreased with maturation of the pods with a concomitant increase in behenic and lignoceric acids. Earlier studies have reported the presence of high molecular weight behenic acid and lignoceric acid in legumes of the *mimosoideae* subdivision (Hilditch and William, 1964; Sengupta and Basu, 1978; Balogun and Fetuga, 1985). They have also reported that the unsaturated fatty acid contents of *leguminoseae* fats resemble each other closely and that unsaturated fatty acids forms 62–80% of the total fatty acid components. Our present study is in agreement with the above observations where 2.7–5.3% behenic acid and 1.7–3.8% lignoceric acids were detected in all *Parkia roxbrughii* samples. In addition, unsaturated fatty acids in the *Parkia roxbrughii* kernel as well as the pods range from 63–67%. The high degree of unsaturation and the substantial amount of fat in the kernels warrants their screening for edible oil production.

In Manipur, the pods and kernels have traditionally been used as a supplementary food source. Unlike other legumes that need to be planted seasonally, *Parkia roxbrughii* requires to be planted just once and very minimum after-care is required. Plants such as *Parkia roxbrughii* appear to be a potential source of protein and fat. To meet the ever increasing protein and fat requirement, efforts should be made to use such underexploited food plants.

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