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COMPOSITION AND NUTRITIVE VALUE OF TENDER PODS OF MANGROVE WILD LEGUME *Canavalia cathartica* OF SOUTHWEST COAST OF INDIA

[COMPOSICIÓN Y VALOR NUTRICIO DE VAINAS TIERNAS DE LA LEGUMINOSA SILVESTRE *Canavalia cathartica* DE LA COSTA SUROESTE DE LA INDIA]

B. Bhagya and K.R. Sridhar*

Microbiology and Biotechnology, Department of Biosciences, Mangalore University, Mangalagangotri, Mangalore 574 199, Karnataka, India
Fax, 91 824 2287 367; E-mail, sirikr@yahoo.com
**Corresponding author*

SUMMARY

Raw and pressure-cooked tender pods of mangrove wild legume *Canavalia cathartica* of southwest India were evaluated for proximate and mineral composition, protein and carbohydrate fractions, amino acid and fatty acid profiles, antinutritional factors, *in vitro* protein and starch digestibility in comparison with ripened beans. Proteins of raw (23.3%) and cooked pods (14%) are similar or more than seeds of many wild legumes. Pods are poor source of crude lipids (1.1-2.3%). The pod fiber (11.1-15.3%) is remarkably more than ripened beans (8.3-9.1%) and dry seeds (2.5%). Crude carbohydrates of pods (54.2-69.8 %) are lower than ripened beans (58.5-73.3%), but cooking elevated its content. The calorific value of pods is less than ripened beans (1383-1444 vs. 1516-1517 kJ 100 g^{-1}). Mineral constituents of the raw and cooked pods are comparable with ripened beans. In pods, Ca is high (246-382 mg 100 g^{-1}) followed by Mg (95-109 mg 100 g^{-1}). Cooking drained minerals in pods as well as ripened beans, but unlike other minerals, Se did not (12.9 vs. 12.6 mg 100 g^{-1}). Mg, Zn and Mn of both raw and cooked pods surpass the NRC/NAS requirement for infants. The true protein is higher in raw pods than cooked pods (17.3 vs. 11.4%) as in ripened beans (21.9 vs. 12.5%). Among protein fractions, globulins are highest (6.6%) followed by albumins (5.6%) in raw pods similar to ripened beans. Non-protein nitrogen is more in pods than ripened beans (0.4-1 vs. 0.2-0.6%). Starch is a major carbohydrate fraction in pods (34.6-49.3%) as well as ripened beans (44.7-52%), which is further elevated on cooking. Total and reducing sugars are higher in raw pods than ripened beans, while non-reducing sugars in raw ripened beans. Among essential amino acids (EAA), threonine, valine, isoleucine, leucine and lysine in raw and cooked pods, phenylalanine and histidine in raw pods surpassed FAO/WHO/UNU recommended pattern for adults. Histidine of raw pods (2.15%) surpassed the FAO/WHO recommended pattern (1.9%). The sum of saturated fatty acids, polyunsaturated fatty acids and essential fatty acids were higher in raw pods. Among essential fatty acids, raw pods possess linoleic and linolenic acids, while cooked pods linolenic and arachidonic acids. Tender pods are devoid of trypsin inhibitors, while total phenolics, orthodihydric phenols and tannins of raw pods decreased considerably on cooking. The phytohemagglutination activity of raw pods lowered on cooking. As *in vitro* protein digestibility, protein digestibility corrected to EAA score of pods was not encouraging and reflects interference of antinutritional factors. The *in vitro* starch digestibility of pods doubled on cooking (maltose: 1.3 vs. 2.6 mg hr^{-1} 100 g^{-1}).

Key words*: Canavalia cathartica*, wild legume, tender pods, nutritive value, digestibility.

RESUMEN

Vainas tiernas, crudas y cocidas a presión, de la leguminosa silvestre *Canavalia cathartica* de la costa Suroeste de la India fueron evaluadas para su composición proximal, mineral, fracciones de proteína y carbohidratos, amino ácidos, perfil de ácidos grasos, factores antinutricional y la digestibilidad de la proteína y almidón en comparación con frijoles maduros. El contenido de proteína de la vaina cruda (23.3%) y cocida (14%) es similar o mayor a de la semilla de muchas leguminosas silvestres. Las vainas son una buena fuente de lípidos (1.1-2.3%). El contenido de fibra (11.1-15.3%) es mayor al de los frijoles maduros (8.3-9.1%). Los carbohidratos (54.2-69.8 %) son menores que los frijoles maduros (58.5-73.3%), pero la cocción elevó su contenido. El valor energético de las vainas es menor al del frijol maduro (1383-1444 vs. 1516-1517 kJ 100 g^{-1}). El contenido mineral de las vainas crudas o cocidas es similar al de los frijoles maduros. En las vainas el contenido de Ca es elevado (246-382 mg 100 g^{-1}) seguido de Mg (95-109 mg 100 g^{-1}). La cocción redujo el contenido mineral en las vainas y frijoles maduros, excepto en el

caso del Se (12.9 vs. 12.6 mg 100 g^{-1}). El contenido de Mg, Zn y Mn en ambos casos fue mayor que la recomendación de la NRC/NAS para infantes. La proteína verdadera es mayor en las vainas crudas (17.3 vs. 11.4%) y en las maduras (21.9 vs. 12.5%). Entre las fracciones de proteína, las globulinas fueron mayores (6.6%) seguidas de las albúminas (5.6%) y fue similar en las vainas crudas y frijoles maduros. El nitrógeno no proteico es mayor en las vainas que en los frijoles maduros (0.4-1 vs. 0.2-0.6%). El almidón es la fracción principal de los carbohidratos de la vaina (34.6-49.3%) y las semillas maduras (44.7-52%), y se incrementa con la cocción. Azúcares totales y reductores son mayors en vainas crudas que en frijoles maduros, mientras que los azúcares no reductores en frijoles maduros crudos. Entre los amino ácidos esenciales (EAA), treonina, valina, isoleucina, leucina y lisina en vainas crudas y cocidas, fenilalanina e histidina en vainas cruda sobrepasaron las recomendaciones de la FAO/WHO/UNU para adultos. Histidina en las vainas cocidas (2.15%) también fue mayor que la recomendación (1.9%). Los ácidos grasos saturados, poliinsaturados y esenciales fueron mayores en las vainas crudas. Entre los ácidos grasos esenciales, la vaina cruda posee linoleíco y linolénico, mientras que las vainas cocidas contienen linolénico y araquidónico. Vainas tiernas no contienen inhibidores de tripsina. Los fenoles, taninos y actividad fitohemaglutinante se reducen con la cocción. La digestibilidad *in vitro* de la proteína y la digestibilidad corregida por EAA de las vainas no es promisoria y refleja la interferencia de factores antinutricionales. La digestibilidad *in vitro* del almidón de las vainas se duplicó con la cocción (maltosa: 1.3 vs. 2.6 mg hr^{-1} 100 g^{-1}).

Palabras clave*: Canavalia cathartica*, leguminosa silvestre, vainas tiernas, valor nutritivo, digestibilidad.

INTRODUCTION

Exploitation of underutilized wild legumes is one of the important approaches to combat protein-energy malnutrition in developing countries. Legumes become staple food in developing countries due to their proteins, carbohydrates, energy, fiber, polyunsaturated fatty acids and vitamins (Deshpande, 1992). Their wide use has become limited because of antinutrient components, which interferes with human and animal nutrition. In spite of cultivating about 14 edible legumes in India, protein-energy malnutrition is one of the major problems due to over population. Coastal dwellers of India face constant threat of protein energy-malnutrition due to unfavourable climatic conditions. Marginalization of pulse production in India resulted in import of 0.5 million tones per annum (Ali and Kumar, 2003). Research efforts need to be strengthened to identify and evaluate less known wild legumes as they are well adapted to adverse environmental conditions and resistant to diseases and pests. Among the wild legumes, the genus *Canavalia* encompasses 51 species with a wide geographical distribution in pantropical areas (Smartt, 1990). *Canavalia cathartica* Thouars [synonym: *C. microcarpa* (DC.) Piper; *C. turgida* Graham ex A. Gray; *C. virosa* (Roxb.) Wight *et* Arn.; *Dolichos virosus* Roxb.; *Lablab microcarpus* DC.] is an under explored wild legume distributed in mangroves and coastal sand dunes of southwest India (Arun *et al*., 1999, Bhagya *et al*., 2005). In and around mangrove habitats and plantations adjacent to coastal sand dunes, *C. cathartica* grow naturally or cultivated as green manure and mulch crop to serve agricultural needs. The whole plant occasionally serves as pasture for livestock and tender pods or ripened beans serve as vegetable for coastal dwellers (Arun *et al*., 1999, Bhat *et al.*, 2005, Seena and Sridhar, 2006). Although dry seeds of mangrove *C. cathartica* possess high proteins, carbohydrates, energy and essential amino acids, presence of antinutritional factors limits its edible value (Seena and Sridhar, 2004; Seena *et al*., 2006). Thus, the objectives of the current study is to evaluate chemical composition, nutritional value, protein and starch digestibility of raw and pressure-cooked tender pods of mangrove *C. cathartica* as an alternative to dry seeds.

MATERIALS AND METHODS

Pods and processing

Tender pods of *C. cathartica* were collected during post-monsoon season (September-October, 2003) from the mangroves of River Nethravathi (12º 50' 27" N, 74º 51' 45" E) of Southwest coast of India. Physical properties, dimensions, fresh and dry weights were recorded. Each pod was cut into four pieces and pod pieces were divided into two sets. The first set was sun-dried and the second was pressure-cooked (Prestige, *ttk* product, Bangalore, India) with freshwater (1:3 v/v) and sun-dried. Dried raw and cooked pods were ground (Wiley Mill, 30 mesh) and stored in airtight containers in refrigerator until use.

Proximate and mineral composition

The moisture of the pod flours were gravimetrically assessed on drying at 100°C until reaching constant weight. Total nitrogen and the crude protein (CP) ($N \times 6.25$) were determined by micro-Kjeldahl method (Humphries, 1956). Crude lipid (EE) on soxhlet extraction, crude fiber (CF) and ash were estimated based on the procedures outlined in AOAC (1990).

Total carbohydrate (TC) of pod flours was calculated based on the formula of Müller and Tobin (1980):

$$TC(\%) = 100 - [CP(\%) + EE(\%) + CF(\%) + ash\ (\%)]$$

Gross energy (GE kJ 100g DM) of pod flours was determined according to Osborne and Voogt (1978):

$$GE = [CP(\%) \times 4] + [EE(\%) \times 9] + [TC(\%) \times 4]$$

For estimation of ascorbic acid of pod flours, a known volume of extracted sample (in 0.4% oxalic acid) was titrated against 2,6-dichlorophenol indophenol dye (Sigma) in the presence of 0.4% oxalic acid and ascorbic acid (Sigma) in 0.4% oxalic acid (0-500 µg) served as standard (Roe, 1954).

For extraction of minerals, the pod flours were digested with HCl (1:4 v/v), ashed and filtered. Sodium, potassium and calcium were determined using flame emission photometry (Systronics, Mediflame 127 Sr. # 2083, India) according to method of AOAC (1990). Magnesium, iron, copper, zinc, manganese and selenium were estimated by atomic absorption spectrophotometer (GBC 904AA, Germany) (AOAC, 1990). Total phosphorus was determined as orthophosphate using ascorbic acid method after acid digestion and neutralization by phenolphthalein indicator and combined reagent (APHA, 1995). The absorbance was read at 880 nm (Spectronic 21 D, Miltonroy, India) and KH_2PO_4 (Merck) (200 – 1200 µg) served as standard.

Protein and carbohydrate fractions

Total protein of raw and cooked pods flours was extracted according to Basha *et al.* (1976) with a slight modification. Protein fractions were extracted (1:10 w/v) (albumins, distilled water; globulins, 0.25M NaCl; prolamins, 70% ethanol; glutelins, 0.05N NaOH), incubated (28°C, 1hr) and centrifuged (20,000 g, 15 min). Proteins in the supernatants were precipitated with 10% trichloroacetic acid (TCA) (Merck), centrifuged (20,000 g, 10 min) and decanted. The precipitate was digested to determine nitrogen (Humphries, 1956) and protein (N × 6.25). The non-protein nitrogen was estimated based on the procedure by Sadasivam and Manickam (1992) on precipitating protein in pod flour (100 mg in 10 ml 10% TCA), centrifuged, supernatant was collected and the process was repeated. Pooled supernatant was made up to 25 ml with TCA (10%) and nitrogen was estimated following micro-Kjeldahl method (Humphries, 1956).

The starch of pod flours was estimated based on Clegg (1956). The pod flours were defatted using diethyl ether on soxhlet extraction. Defatted pod flour (100 mg) was extracted on boiling (10 min) with ethanol (30 ml, 80%), dried (70°C, 4 hr) residue was digested (28°C, 15 min) with $HClO_4$ (52%, 10 ml), made up to 25 ml with distilled water and filtered (Whatman # 1). The total sugars and starch (total sugars × 0.9) was detected by following method of Dubois *et al*. (1951). To a known volume of digested sample (20 µl made up to 1 ml with distilled water), phenol (5%, 1 ml) and H_2SO_4 (36 N, 5 ml) was added and the absorbance was read at 490 nm by spectrophotometer (Spectronic 21 D, Miltonroy, India). D-Glucose (Sigma) (20-100 µg) served as standard.

For estimation of total sugars, defatted pod flour (100 mg) was extracted with 30 ml ethanol (80%) on boiling (10 min). After cooling, ethanol extract was decanted, concentrated (70-80ºC) and distilled water (5 ml) was added. To this mixture Dowex 50 H^+ (cationic gel) (Sigma) (3 ml) was incorporated, shaken (1 hr, 28ºC) and allowed to settle (4ºC, 12 hr). Anionic gel, Dowex 1 (formate-form) (Sigma) (3 ml) was added to the decanted supernatant and the process was repeated like cationic gel. The supernatant was made up to 5 ml with distilled water and total sugars were determined based on the method of Dubois *et al*. (1951).

The reducing sugars of pod flours were estimated according to Nelson (1944). Defatted pod flour was fractionated by ion exchange chromatography using cation-anion exchange resins. The neutral fraction after concentration is used for estimation of reducing sugars. Supernatant with free-sugars (1 ml) was mixed with reaction mixture (1 ml) [25:1, copper reagent A (sodium carbonate, 25 g; sodium potassium tartrate salt, 25 g; sodium bicarbonate, 20 g and sodium sulphate, 200 g in 800 ml water diluted to 1000 ml) copper reagent B (15% copper sulphate, in 2 drops of concentrated sulphuric acid 100 ml^{-1})] and boiled (20 min). After cooling, arsenomolybdate reagent (1 ml) was added and the volume was made up to 25 ml with distilled water. The absorbance was read after 15 minutes at 500 nm by spectrophotometer (Spectronic 21 D, Miltonroy, India) with maltose (Sigma) (0-100 µg) as standard. Non-reducing sugars was calculated by subtracting reducing sugar from total sugars.

Amino acids and fatty acids

To determine amino acids in pod flours, method outlined by Hofmann *et al*. (1997, 2003) was followed. Known quantity of samples was hydrolyzed (4 hr, 145ºC) with 6 N HCl (15 ml). After cooling, HCl was eliminated in a rotoevaporator (Büchi Laboratoriumstechnik AG RE121; Switzerland) combined with a diaphragm vacuum pump (MC2C; Vacuubrand GmbH, Germany). Trans-4-(Aminomethyl)-cyclohexanecarboxylic acid (Aldrich, 85765-3; purity, 97%) was added to each sample as

internal standard. Derivatization step was done by esterification with trifluoroacetylation (Brand *et al*., 1994). Standards were dried using CH_2Cl_2 under a gentle stream of helium and slow heating in an oil bath (40-60°C) to remove traces of water. Freshly prepared acidified isoporpanol (acetyl chloride, 3 ml + 2-propanol, 12 ml) was added (12 ml) and the mixture heated (110°C, 1 hr). The cooled samples were filtered through glass fiber paper and the reagent was eliminated with a gentle stream of helium (60°C), followed by combined evaporation with aliquots of CH_2Cl_2. Dried residue was acetylated with trifluoroacetic anhydride (200 µl) overnight at room temperature. Amino acids were determined using a Gas Chromatography-Combustion-Isotope Ratio Mass Spectrometer (GC-C-IRMS/MS). The GC-C-IRMS/MS measurements were carried out with a Hewlett-Packard 58590 II gas chromatograph, connected via a split with a combustion interface to the IRMS system (GC-C-II to MAT 252, Finnigan MAT; Germany) for the isotopic determination of nitrogen and via a transfer line with a mass spectrometer (GCQ, Finnigan MAT; Germany) for qualitative analysis and quantification of the amino acids. The capillary column of GC was a 50 m × 0.32 mm i.d. × 0.5 µm BPX5 (SGE), operating with the carrier gas flow of 1.5 ml min^{-1} with following temperature and pressure: initial 50°C (1 min), increased to 100°C at 10°C min^{-1} (10 min), increased to 175°C at 3°C min^{-1} (10 min), increased to 250°C min^{-1} (10 min); head pressure, 13 psi (90 kpa). The essential amino acid (EAA) score was determined:

EAA score = EAATP ÷ EAAFAO × 100

Where:
EAATP = EAA in 100 g test protein (g)
EAAFAO= EAA in 100 g FAO/WHO/UNU (1985) reference pattern (g)

The fatty acid methyl esters (FAMEs) were estimated following the methods of Garces and Mancha (1993). Lipid from pod flours (5g) was extracted with chloroform:methanol (2:1) (v/v) mixture (15 ml) twice using pestle and mortar. The extract was filtered through a lipid-free Whatman filter paper. To the filtrate, about one-third volume of distilled water was added, vortexed to remove water-soluble impurities and upper layer discarded. To eliminate the moisture, small amount of sodium sulphate crystals were added, vortexed (crystals without clumping indicates the filtrate is free of moisture). The filtrate was transferred to pre-weighed bottle (A) and dried in a rotoevaporator (Büchi Laboratoriumstechnik AG RE121, Switzerland). Reweighed the bottle (B) with dried lipid to detect the quantity of lipid (B-A). Lipid extracted from pod flours (50 mg) along with standard fatty acids [American Oil Chemists Society (AOCS); Merck, Germany] were transferred to tubes with teflon-lined caps and methylated with a mixture containing methanol; benzene; 2, 2-dimethoxypropane (DMP) and H_2SO_4 (37:20:5:2) (v/v). The above mixture (2.1 ml) with heptane (total volume, 5 ml) were placed in water bath (80ºC, 2 hr), cooled and shaken to separate two phases. The upper layer containing FAMEs was injected (1 ml) to Gas liquid chromatograph (GLC) (Sigma Instruments, Baroda, India) in a glass column (Silar, 10%) packed with ethylene glycol succinate (5%) on Supelcoport (80/100 isothermically, 200ºC). Analysis was performed at the following conditions: carrier gas, N_2; injector temperature, 225ºC; FID detector temperature, 265ºC; oven temperature, 200ºC; flow rate, N_2, 35 ml min^{-1}; H_2, 30 ml min^{-1}; O_2, 75 ml min^{-1}. Polyunsaturated and saturated fatty acid ratio (P/S ratio) was calculated on dividing sum of saturated fatty acids by sum of polyunsaturated fatty acids.

Antinutritional factors

Total phenolics of pod flours was estimated according to Rosset *et al*., (1982). The flour (100 mg) was extracted with methanol (50%) twice (95ºC, 10 min) and the extracts were pooled (10 ml). A known volume (0.5 ml) of extracted sample was mixed with distilled water (0.5 ml) and treated with Na_2CO_3 (in 0.1 N NaOH, 5 ml). After 10 min, Folin-Ciocalteu's reagent (diluted 1:2 with distilled water; 0.5 ml) (Merck) was added and the colour was read at 725 nm using tannic acid (Merck) (100-500 µg) as standard.

Orthodidydric phenols were estimated by the method outlined by Mahadevan (1966). Defatted pod flour was fractionated by ion exchange chromatography using both cation and anion exchange resins. The anionic gel was extracted with formic acid (6 N) and made up to a known volume (1 ml). The formic acid extract (250 µl) was mixed with hydrochloric acid (0.05 N, 1 ml), Arnow's reagent (1 ml) (sodium nitrate, 10 g; sodium molybdate, 10 g in distilled water, 100 ml), distilled water (10 ml), and sodium hydroxide (1 N, 2 ml). Pink color developed immediately after the addition of the alkali was read at 515 nm using spectrophotometer (Spectronic 21 Miltonroy) with caeffic acid (Sigma) (20-100 µl) as standard.

Tannins were estimated by vanillin-HCl method (Burns, 1971). The pod flour sample (1 g) was treated with methanol (10 ml, 28ºC, 12 hr), vortexed and decanted. The process was repeated with the precipitate. The pooled supernatant was made up to 25 ml. The extract (1 ml) was treated with reagent mixture (5 ml) (1:1, 4% vanillin in methanol and 8% concentrated HCl in methanol). After 20 min the color developed was read at 500 nm (Spectronic 21,

Miltonroy, India) and catechin (Sigma) (50-250 µg) served as standard.

Typsin inhibitory activity was assayed by employing enzymatic method of Kakade *et al.* (1974). Known quantity of raw and cooked pod flours (1 g) was extracted with NaOH (0.01 N, 50 ml) for 1 hr. Each portion (0-1.8 ml) was made up to 2 ml with distilled water. The trypsin solution (2 ml) (4 mg in 200 ml 0.001 M HCl) was added to each sample and incubated (37 ºC, 10 min). To each tube, BAPNA (5 ml) (40 mg *N*-a-Benzoyl-DL-Arginine *p*-nitroanilide hydrochloride) (Aldrich, 85711-4; purity, ≥99%) in dimethyl sulfoxide (1 ml) diluted to 100 ml with *tris*-buffer (37 ºC) was added and later (10 min) the reaction was terminated by adding acetic acid (30%, 1 ml), mixed thoroughly, filtered and the absorbance was measured at 410 nm against reagent blank (1 ml) [(acetic acid, 30% + trypsin (2 ml) + distilled water (2 ml) + BAPNA (5 ml)].

To determine the phytohemagglutination activity, trypsin-treated suspension of rabbit erythrocyte was used (Hankins *et al*., 1980). Alsever's solution (glucose, 60 mM; citric acid, 40 mM; NaCl, 70 mM) was used as an anticoagulant (pH 6.1, autoclaved). Three ml blood was collected from six-month-old rabbit (New Zealand White) by ear vein puncturing (Gordon, 1981) and taken into a graduated tube containing Alsever's solution (1 ml). The blood suspension was mixed gently and centrifuged (1,000 g, 5 min, 4ºC). It was rinsed thrice with phosphate buffered saline (PBS) (sodium phosphate, 10 mM; NaCl, 150 mM; pH 7.2) and centrifuged (1000 g, 5 min, 4ºC). The erythrocytes were treated with trypsin (50 µg ml^{-1}) (0.04 BTEE units mg^{-1} solid) (1 hr, 28ºC) and centrifuged to remove trypsin. Trypsinized erythrocytes were washed thrice with excess PBS by centrifugation to prepare 2% cell suspension (Hankins *et al.*, 1980). Two-fold serial dilutions of 25 µl (50 mg sample ml^{-1} PBS) crude lectin in saline (0.3 M NaCl) were mixed with trypsinized rabbit erythrocyte suspension (50 µl, 2%) on hemagglutination slabs and incubated (28ºC, 30 min). The slabs were observed for agglutination under a low power microscope. The highest dilution, which showed positive hemagglutination was considered as the titre value. The amount of protein present at this dilution represents nearly the minimum quantity of protein necessary for agglutination and is defined as one unit. Specific activity is defined in this method as the number of units per milligram protein.

Protein and starch digestibility

The *in vitro* protein digestibility (IVPD) was estimated according to Akeson and Stahmann (1964). Samples (100 mg each) defatted test flours were incubated (37°C, 3 hr) with pepsin (Sigma, 3165 units mg^{-1} protein) (1.5 mg 2.5 ml^{-1} 0.1N HCl) followed by inactivation (0.25 ml 1N NaOH). Incubation was continued (24 hr, 37 °C) with trypsin (Sigma, 16,100 units mg^{-1} protein) and α-chymotrypsin (Sigma, 76 units mg^{-1} protein) (2 mg each 2.5 ml^{-1} potassium phosphate buffer, pH 8.0, 0.1M) followed by inactivation (0.7 ml 100% TCA). Zero-time control was maintained by inactivating the enzyme before addition of substrate. The inactivated reaction mixtures were centrifuged and supernatant was collected. The residue was washed (2 ml 10% TCA) and centrifuged. The combined supernatant was extracted with 10 ml diethyl ether twice and ether layer removed by aspiration. The aqueous layer was heated on a boiling water bath (15min) to remove traces of ether. The solution is made up to 25 ml with distilled water. Nitrogen (in 5 ml aliquots) was determined to estimate protein in the digest:

$$IVPD\ (\%) = PD \div PDF \times 100$$

Where:
PD = Protein in digest
PDF = Protein in defatted flour

The protein digestibility corrected amino acid score (PDCAAS) of EAA was calculated based on EAA requirements for adults (FAO/WHO/UNU, 1985):

$$PDCAAS\ (\%) = EAATP \div EAAFAO \times D$$

Where:
EAATP = EAA in 100 g test protein (g)
EAAFAO = EAA in 100 g FAO/WHO/UNU reference pattern (g)
D = *in vitro* protein digestibility (%)

The *in vitro* starch digestibility of starch was estimated based on Beutler (1984). Samples (100 mg each) of defatted test flour were incubated (37ºC, 3 hr) with diastase [(α-amylase, 1300 units g^{-1}) (Hi-Media, Mumbai, India) (2 mg 12.5 ml^{-1} 0.02 M potassium phosphate buffer, pH 7.0)] followed by inactivation with NaOH (0.5 N, 1 ml). Zero-time control was maintained by inactivating the enzyme prior to addition of substrate. The inactivated reaction mixture was centrifuged and supernatants were made up to 10 ml with distilled water. Maltose liberated by the enzyme was estimated according to Nelson (1944).

Statistical analysis

Differences in proximate composition, minerals, protein and carbohydrate fractions, antinutritional factors and starch digestibility of raw pods vs. cooked pods were assessed by paired t-test (Stat Soft Inc., 1995).

RESULTS AND DISCUSSION

Pod features

In mangrove habitats, *C. cathartica* prefers relatively low saline areas and grows luxuriously as climber of mangrove vegetation, while in coastal sand dunes it spreads on mid and hind dunes horizontally as mat-forming creeper with stunted growth due to xerophytic conditions. Fresh weight, dry weight, length, width and thickness of tender pods of mangrove *C. cathartica* are significantly higher than coastal sand dune *C. cathartica* ($P<0.05$) (Bhagya *et al*. (2006a) (Table 1) possibly due to variation in salinity and availability of nutrients in their habitats. Physical properties and dimensions of tender pods of *C. cathartica* are ideal as green vegetable for human or livestock consumption.

Table 1. Characteristics of tender pods of mangrove *Canavalia cathartica* compared with coastal sand dune *C. cathartica* (n=20; mean±SD).

Features	Mangrove	Sand dune*
Fresh weight (g pod^{-1})	13.83±3.25^{a}	8.7±1.51^{b}
Dry weight (g pod^{-1})	3.56±0.74^{a}	2.2±0.27^{b}
Length (cm pod^{-1})	12.33±20^{a}	8.3±1.76^{b}
Width (cm pod^{-1})	3.84±0.29^{a}	2.6±0.38^{b}
Thickness (cm pod^{-1})	2.68±0.39^{a}	2.3±0.35^{b}

*Bhagya *et al*. (2006a).
Figures across the column with different letters are significantly different ($p<0.05$, paired t-test).

Proximate and mineral value

The crude carbohydrates and energy were significantly elevated in cooked pods than raw pods ($P<0.05$), while the rest of the proximal features were significantly lower in cooked pods than raw pods (Table 2). The moisture of raw pod flour was double than cooked pod flour (10.9 vs. 5.1%) unlike ripened bean flours (6.3 vs. 5.4%) (Bhagya *et al*., 2006b). The crude protein of raw pods was lower than raw ripened beans (23.3 vs. 25.9%), while similar between cooked pods and ripened beans (14 vs. 13.8%). Raw (23.3%) and cooked pods (14%) of *C. cathartica* proves to be a good source of protein as it is comparable to or surpassed the seeds of many wild legumes (e.g. *Atylosia scarbaeoides*, 17.3%; *Erythrina indica*, 21.5%; *Neonotonia wightii*, 15.1%; *Rhynchosia filipes*, 16.9%; *Tamarindus indica*, 14%), edible legumes (*Cajnus cajan*, 19.4%, *Cicer arietinum*, 20.7%; *Vigna trilobata*, 20.2%, and *V. unguiculata*, 15.9%), wheat flour (8.6%), parboiled rice (7.7%) and egg (12.6%) (Jambunathan and Singh, 1980; Nwokolo, 1987; Livsmedelsverk, 1988; Arinathan *et al*., 2003). It also shows the possibility of elevating protein of cooked pod flour on blending with cereal-based flours.

Crude lipid of pod flour was poor and lower than ripened beans (1.1-2.3 vs. 1.5-2.7%), so also dry seeds of *Canavalia* spp. (1.6-1.8%) and other wild legumes (4.6-11.3%) (Seena and Sridhar, 2004). Pod fiber was remarkably higher than ripened beans (11.1-15.3 vs. 8.3-9.1%) and dry seeds of mangrove *C. cathartica* of India (2.5%) (Seena and Sridhar, 2004) and dry seeds of *C. ensiformis* (8.5%), *C. gladiata* (12.8%) and *C. maritima* (17.3%) of Central America (Bressani *et al.*, 1987). High crude fiber is known to trap proteins and carbohydrates and prevents hydrolytic breakdown, which results in low digestibility (Oyenuga and Fetuga, 1975; Balogun and Fetuga, 1986). However, high crude fiber also promotes health benefits, particularly decreasing the blood cholesterol and reduces the risk of large bowel cancers (Salvin *et al*., 1997; Anderson *et al*., 1995).

The high fiber in *C. cathartica* pods can be brought down to a desirable level on blending with appropriate cereal flours. Raw pods showed higher ash than raw ripened beans (4.9 vs. 3.8%), so also cooked pods and cooked ripened beans (4 vs. 3%) indicating abundance of minerals in pods (see Table 3). The crude carbohydrates of pods are lower than ripened beans (54.2-69.8 vs. 58.5-73.3%), but surpassed the dry seeds of *C. maritima* of coastal sand dunes (50.5%), *Arachis hypogea* (26.1%) and *Glycine max* (20.9%) (Rao *et al*., 1999; Seena *et al*., 2005). Pressure-cooking elevated the crude carbohydrates in pods (15.6%) as well as ripened beans (14.9%) like cooked and roasted dry seeds of mangrove *C. cathartica* (60.4 vs. 62.5 and 65%) (Seena *et al*., 2006).

Tender pods of mangrove *C. cathartica* possess gummy mucilage in inner layers, it might have elevated the crude carbohydrates. Polysaccharides are important in nutrition particularly in re-absorption of glucose and legume carbohydrates are also known to reduce the plasma cholesterol and gradually elevate the levels of blood glucose (Leeds, 1982; Walker, 1982).

The calorific value of pods was lower than ripened beans (1383-1444 vs. 1516-1517 kJ 100 g^{-1}), but comparable with common edible pulse crops (1358-1426 kJ 100 g^{-1}) (Kuzayali *et al*., 1966). The high energy in mangrove *C. cathartica* pods against edible legumes can be attributed to high protein as well as carbohydrates. The vitamin C of raw pods was lower than edible pulses (green gram, bengal gram and horse gram) (0.44 vs. 2.4-3.9 mg 100 g^{-1}) (Naveeda and Jamuna, 2005), which further lowered on cooking (0.3 mg 100 g^{-1}).

Table 2. Proximate composition of tender pods of *Canavalia cathartica* on dry weight basis (g 100 g^{-1} except were stated; n=5; mean±SD).

Component	Raw	Cooked
Moisture (%)	10.89±1.44[a]	5.06±0.75[b]
Crude protein	23.28±0.78[a]	13.98±0.81[b]
Crude lipid	2.26±0.27[a]	1.08±0.08[b]
Crude fiber	15.34±0.45[a]	11.14±0.18[b]
Ash	4.88±0.15[a]	3.98±0.22[b]
Crude carbohydrates	54.24±0.33[a]	69.82±0.76[b]
Energy (kJ 100 g^{-1})	1383±10.86[a]	1444±3.87[b]
Vitamin C (mg 100 g^{-1})	0.442±0.005[a]	0.3±0.06[b]

Figures across the column with different letters are significantly different (p<0.05, paired t-test).

Table 3. Mineral compositions of tender pods of *Canavalia cathartica* on dry weight basis (mg 100g^{-1}) (n=5; mean±SD).

Minerals	Raw	Cooked	NRC*
Na	48.17±2.09[a]	36.76±2.27[b]	120-200
K	102.18±8.85[a]	83.25±3.16[b]	500-700
Ca	382.26±14.02[a]	246.25±7.15[b]	600
P	78.96±10.95[a]	53.99±3.72[b]	500
Mg	108.75±9.8[a]	94.83±2.14[b]	60
Fe	0.84±0.04[a]	0.041±0.01[b]	10
Cu	0.19±0.007[a]	0.049±0.005[b]	0.6-0.7
Zn	11.93±1.05[a]	5.16±0.4[b]	5
Mn	10.82±0.68[a]	7.95±0.14[b]	0.3-1
Se	12.91±0.14[a]	12.63±0.08[b]	-

*NRC/NAS (1989) pattern for infants.
Figures across the column with different letters are significantly different (p<0.05, paired t-test).

Mineral constituents of raw pods significantly decreased on cooking (P<0.05) (Table 3) and comparable with ripened beans (Bhagya *et al*., 2006b). In pods, calcium was dominant (346-382 mg 100 g^{-1}) followed by magnesium (95-109 mg 100 g^{-1}), while they were low in dry seeds (Ca, 27 mg; Mg, 7 mg 100 g^{-1}) (Seena *et al*., 2006). Surprisingly, tender pods of coastal sand dune *C. cathartica* possess highest potassium followed by calcium/phosphours (Bhagya *et al*., 2006a). Such mineral variations in pods can be attributed to variation in legume genetic origin, geographic source, level of soil fertility and efficiency of mineral uptake (Vadivel and Janardhanan, 2001b). Cooking drained minerals in pods as well as ripened beans like dry seeds (Seena *et al*., 2006). Interestingly, unlike other minerals, selenium did not leach too much on cooking pods (12.9 vs. 12.6 mg 100 g^{-1}), similar feature was reflected in tender pods of coastal sand dunes (10.2 vs. 9.7 mg 100 g^{-1}) (Bhagya *et al*., 2006a). Aletor and Ojo (1989) attributed mineral drain in legume seeds due to increased permeability of seed coat. Magnesium, zinc and manganese of both raw and cooked pods surpassed the NRC/NAS (1989) requirement for infants. Minerals have vital roles in several body processes: enzyme systems, skeletal structures (e.g. calcium and phosphorus), blood (calcium for neuromuscular irritability and clotting). Adequate magnesium, zinc and selenium in diet prevent cardiomyopathy, muscle degeneration, growth retardation, alopecia, dermatitis, immunologic dysfunction, gonadal atrophy, impaired spermatogenesis, congenital malformations and bleeding disorders (Chaturvedi *et al*., 2004). Selenium as an antioxidant protects cells against free radicals and also prevents the toxic effects of some heavy metals (arsenic, cadmium, mercury and tin) (Combs and Gray, 1998). Presence of micromineral selenium in tender pods of *C. cathartica* seems to be advantageous.

Protein and carbohydrate fractions

Protein and carbohydrate fractions of raw pods significantly decreased on cooking (P<0.05) (Table 4). Total protein was higher in raw pods than cooked pods (17.3 vs. 11.4%) as seen in ripened beans (21.9 vs. 12.5%) (Bhagya *et al*., 2006b). True protein of raw pods surpassed the winged bean (15.2%) and comparable with *Cassia floribunda* (16.3-17.7%) (Vadivel and Janardhanan, 2001a; Viswanathan *et al*., 2001). Nutritional quality of the pods is influenced by the proportion of the protein fractions (Chan and Philips 1994). Like many edible legumes, among protein fractions in raw pods, globulins were highest (6.6%) followed by albumins (5.6%), which was similar to ripened beans (12 vs. 6.1%) (Derbyshire *et al*., 1976; Chan and Philips, 1994). Cooking drained more albumins than globulins in pods as well as ripened beans. As albumins are rich in sulphur-amino acids and other EAA (Baudoin and Maquet, 1999), its drainage resulted in severe decrease in cystine and methionine in cooked pods (see Table 5). Although pressure-cooking reduced the quantity of globulins in pods, it was still a major fraction. As globulin fraction is resistant to enzymatic attack, it resulted in decreased protein digestibility in rats (Walker and Kochhar, 1983 Nielsen *et al*., 1988; Laurena *et al*., 1991; Oliveira *et al*., 1994). Non-protein nitrogen (NPN) was higher in pods than ripened beans (0.4-1 vs. 0.2-0.6%). The NPN in legumes is composed of free amino acids, nucleic acids, puric and pyrimidinic bases, polyamines, alkaloids and small peptides (Urbano *et al*., 2005). Toxic amino acid, L-canavanine (arginine analogue) contributes a major part of NPN (Gomes *et al*., 1988). Canavanine was found in alfalfa sprouts, broad beans, jack beans and other legume foods

including animal feeds up to 2.4% dry matter (Bell, 1978). It is known to interfere with normal ammonia disposal (Thomas and Rosenthal 1987), charge t-RNA arg result in synthesis of canavanyl proteins (Crine and Lemieux, 1982) and prevent normal reproduction in arthropods and rodents (Brown, 1994; Rosenthal, 1981). Most studies on canavanine have been carried on *C. ensiformis* (Belmar *et al*., 1999). Possibly, pods of *C. cathartica* possess canavanine as a defence substance to prevent herbivory and its removal might help prevent toxicity.

Starch forms the major carbohydrate fraction in pods (34.6-49.3%) as well as ripened beans (44.7-52%), which was elevated on cooking. Starch is essential for several health-related benefits. Apart from calorific value, starch also contributes to the texture and organoleptic properties of food (Tharanathan and Mahadevamma, 2003). Starch-protein interaction in legumes causes decreased glycemic index and is beneficial in the diet of diabetics and hyperlipidemia patients (Geervani and Theophilus, 1981). Total and reducing sugars were high in raw pods than ripened beans, while non-reducing sugars were higher in raw ripened beans. Cooking drained total, reducing and non-reducing sugars in pods.

Table 4. Protein and carbohydrate fractions (g 100 g^{-1}) of tender pods of *Canavalia cathartica* on dry weight basis (n=5; mean±SD) (percent in parenthesis).

Protein fractions	Raw	Cooked
Total protein	17.3±0.13 [a] (100)	11.38±0.4 [b] (100)
Albumins	5.57±0.17 [a] (32.2)	2.29±0.32 [b] (20.12)
Globulins	6.56±0.16 [a] (37.92)	5.37±0.18 [b] (47.19)
Prolamins	1.08±0.06 [a] (6.24)	0.69±0.08 [b] (6.06)
Glutelins	4.09±0.2 [a] (26.4)	3.03±0.17 [b] (26.63)
Non-protein nitrogen	0.96±0.04[a]	0.39±0.07[b]
Starch	34.56±2.05[a]	49.33±0.47[b]
Total sugars	6.83±0.38 [a] (100)	3.77±0.45 [b] (100)
Reducing sugars	4.81±0.43 [a] (70.4)	2.72±0.42 [b] (72.2)
Non-reducing sugars	2.02±0.65 [a] (29.5)	1.05±0.32 [b] (27.9)

Figures across the column with different letters are significantly different ($p<0.05$, paired t-test).

Amino acid and fatty acid profiles

Aspartic acid was highest in raw pods followed by glutamic acid (Table 5), while it was reverse in raw ripened beans (Bhagya *et al*., 2006b). The EAA, Threonine, valine, isoleucine, leucine and lysine in raw and cooked pods, phenylalanine and histidine in raw pods surpassed FAO/WHO/UNU (1985) recommended pattern for adults. This pattern was more or less similar to ripened beans (Bhagya *et al*., 2006b). Tryptophan was not detectable in pods like ripened beans and constitutes the most limiting EAA. The sulphur-amino acids (Cystine and methionine) were the second most limiting amino acids in pods as well as ripened beans. Usually edible legumes are known for high lysine and low sulphur-amino acids (Norton *et al.*, 1985; Jansman, 1996). In *C. cathartica* raw pods, threonine (3.2%) and lysine (3.9%) is comparable with rice (3.2, 3.7%) (Livsmedelsverk, 1988). The histidine of raw pods (2.2%) surpassed the FAO/WHO (1991) pattern (1.9%) and was comparable with whole egg protein (2.4%) (FAO, 1970), threonine and lysine of raw pods with rice (3.2 vs. 3.2%; 3.9 vs. 3.7%) (Livsmedelsverk, 1988).

Table 5. Amino acid composition of tender pods of *Canavalia cathartica* (g 100 g^{-1} protein).

Amino acid	Raw	Cooked	FAO[a]
Glutamic acid	7.37	5.20	
Aspartic acid	18.46	15.87	
Serine	3.08	1.46	
Threonine	3.15	1.72	0.9
Proline	4.22	2.84	
Alanine	3.15	1.63	
Glycine	2.65	1.29	
Valine	3.65	1.98	1.3
Cystine	0.64	0.30	
Methionine	0.57	0.34	1.7[b]
Isoleucine	2.93	1.59	1.3
Leucine	4.43	2.10	1.9
Tyrosine	2.43	1.20	
Phenylalanine	2.65	1.29	1.9[c]
Tryptophan	ND	ND	0.5
Lysine	3.86	1.76	1.6
Histidine	2.15	1.29	1.6
Arginine	2.58	1.16	

[a]Essential amino acids pattern for adults (FAO/WHO/UNU, 1985).
[b]Methionine+Cystine.
[c]Phenylalanine+Tyrosine.
ND, Not detectable.

The sum of saturated fatty acids, polyunsaturated fatty acids and essential fatty acids of raw pods (Table 6) surpassed the cooked pods and raw and cooked ripened beans (Bhagya *et al*., 2006b). The major saturated fatty was lignoceric acid and unsaturated fatty acid was linolenic acid in raw pods, while it was arachidic and eicosadienoic acid in cooked pods. Among essential fatty acids, raw pods possess linoleic

and linolenic acids, while cooked pods linolenic and arachidonic acids. Linoleic acid is one of the most important essential fatty acids necessary for growth, physiological functions and maintenance of body (Salunkhe *et al*., 1985).

Table 6. Fatty acid composition of tender pods of *Canavalia cathartica* (mg g^{-1} lipid; n=3, mean).

	Raw	Cooked
Saturated fatty acids		
Lauric acid ($C_{12:0}$)	17.393	0.444
Tridecanoic acid ($C_{13:0}$)	-	-
Myristic acid ($C_{14:0}$)	0.447	0.0004
Pentadecanoic acid ($C_{15:0}$)	0.400	0.418
Palmitic acid ($C_{16:0}$)	1.401	-
Heptadeconoic acid ($C_{17:0}$)	-	0.070
Stearic acid ($C_{18:0}$)	1.221	0.430
Nonadeconoic acid ($C_{19:0}$)	-	0.001
Arachidic acid ($C_{20:0}$)	-	4.131
Heneicosanoic acid ($C_{21:0}$)	-	-
Behenic acid ($C_{22:0}$)	-	-
Lignoceric acid ($C_{24:0}$)	61.951	1.844
Pentacosanoic acid ($C_{25:0}$)	41.582	-
Polyunsaturated fatty acids		
Myristoleic acid ($C_{14:1}$)	0.020	-
Palmitoleic acid ($C_{16:1}$)	2.323	0.070
Oleic acid ($C_{18:1}$)	0.065	-
Linoleic acid ($C_{18:2}$)	0.346	-
Linolenic acid ($C_{18:3}$)	16.760	0.023
Eicosenoic acid ($C_{20:1}$)	12.732	-
Eicosadienoic acid ($C_{20:2}$)	-	0.565
Arachidonic acid ($C_{20:4}$)	-	0.005
Nervonic acid ($C_{24:1}$)	-	0.005
Sum essential fatty acids	17.100	0.028
Sum saturated fatty acids	124	7.340
Sum polyunsaturated fatty acids	32.200	0.668
P/S ratio*	0.26	0.091

-, Not detectable.
*Ratio of polyunsaturated/saturated fatty acids.

Antinutritional features

Tender pods were devoid of trypsin inhibition activity (Table 7) like ripened beans (Bhagya *et al*., 2006b). Total phenolics, orthodihydric phenols and tannins of raw pods significantly decreased on cooking ($P<0.05$). As penolics and tannins are water-soluble, they may be eliminated by decortication, soaking or cooking (Reddy *et al*., 1985). Phenolics and tannins are known to decrease digestibility on inactivating the digestive enzymes (Bate-Smith, 1973), which leads to growth-depression in rats (Umoren *et al*., 2005), but at low levels they are health-promoting as antioxidants (Siddhuraju *et al*., 2001). Phenolics, orthodihydric phenols and tannins have beneficial effects to plants on conferring resistance against diseases and pests. The phytohemagglutination activity of raw pods considerably decreased on cooking. Usually, thermal-treatments enhance the nutritive value of legumes through inactivation of hemagglutinins (Swaminathan, 1974). Lectins bind to the cells that line the intestinal mucosa and in turn reduce the absorption of nutrients and feed intake (Liener, 1994). Lectins interact with specific glycoconjugates on the cell membrane, disrupt the brush border, atrophy of the microvilli, hyperplasia of the crypt cells and loss of viability of the epithelial cells (Oliveira *et al*., 1988). This suggests that the practice of household pressure-cooking is not fully efficient in eliminating the lectin activity of tender pods, thus demands combination of methods or alternate thermal-treatment to make tender pods edible.

Table 7. Antinutritional components of tender pods of *Canavalia cathartica* (g $100g^{-1}$) (n=5; mean ±SD).

Component	Raw	Cooked
Total phenolics	3.17 ± 0.05^a	2.59 ± 0.11^b
Orthodihydric phenols	17.93 ± 1.77^a	2.30 ± 0.96^b
Tannins	0.272 ± 0.02^a	0.176 ± 0.005^b
Trypsin inhibition activity	NP	NP
Hemagglutinin activity (rabbit RBC)*	14	6

Figures across the column with different letters are significantly different ($p<0.05$, paired t-test).
NP, Not present.
* Titre: maximum dilution where agglutination was observed.

Protein and starch digestibility

The results of EAA score, IVPD and PDCAAS of tender pods are presented in Table 8. In EAA score, tryptophan and sulphur-amino acids (cystine + methionine) in both raw and cooked pods were limiting, in addition, histidine is limiting in cooked pods. This result is comparable to ripened beans (Bhagya *et al*., 2006b) and suggests that to uplift the utility of cooked tender pods of *C. cathartica*, blending suitable foodstuff consisting of sulphur-amino acids, tryptophan and histidine is necessary. The IVPD of pods was lower than ripened beans (14.5-19.5 vs. 53.7-82.3%). The low IVPD as well as PDCAAS of pods reflect the interference of antinutritional factors and demand their inactivation by alternate process.

Cooked pods showed significantly higher starch digestibility than raw pods (2.64±0.14 vs. 1.29±0.37 mg maltose hr^{-1} 100 g^{-1}) ($P<0.05$), but not comparable to ripened beans (6.6 vs. 1 mg maltose hr^{-1} 100 g^{-1}) (Bhagya *et al*., 2006b). Low digestibility of starch is

known to promote slow to moderate postprandial glucose and insulin responses (Jenkins *et al*., 1980) and is beneficial in management of diabetes and hyperlipidemia (Jenkins *et al*., 1994, 1998). The digestibility of legume starch is affected by the cell-wall structural features (Tovar *et al*., 1991) and antinutrients such as amylase inhibitors (Lajolo *et al*., 1991), phytates (Urooj and Puttaraj, 1994) and polyphenols (Thompson and Yon, 1984, Yadav and Khetarpaul 1994). The improvement of starch digestibility of pods after thermal treatments can be attributed to disruption of protein structures and cell wall-encapsulated starch, starch gelatinization and physical disintegration of the legume seeds (Tovar *et al*., 1991; Bjorck *et al*., 1994, Bravo *et al*., 1998).

Table 8. Essential amino acid (EAA) score, *in vitro* protein digestibility (IVPD) and protein digestibility corrected EAA score (PDCAAS) of tender pods of *Canavalia cathartica.*

EAA/IVPD/PDCAAS	Raw	Cooked
*EAA score**		
Threonine	350.00	191.11
Valine	280.77	152.31
Cystine + Methionine	71.18	37.65
Isoleucine	225.38	122.31
Leucine	233.16	110.53
Tyrosine + Phenylalanine	267.37	131.05
Tryptophan	ND	ND
Lysine	241.25	110.00
Histidine	134.38	80.63
IVPD (%)		
Digestibility	14.456	19.53
PDCAAS (%)		
Threonine	54.10	37.32
Valine	40.59	29.75
Cystine + Methionine	10.29	7.35
Isoleucine	32.58	23.89
Leucine	33.71	21.59
Tyrosine + Phenylalanine	38.65	25.59
Tryptophan	ND	ND
Lysine	34.88	21.48
Histidine	19.43	15.75

*Calculated according to FAO/WHO/UNU (1985) pattern for adults.
ND, Not detectable.

CONCLUSIONS

Physical properties and dimensions of tender pods of mangrove *Canavalia cathartica* of southwest coast of India are ideal as green vegetable for human or livestock consumption. The raw and household pressure-cooked tender pods consist of proteins equivalent to many wild legumes, edible legumes, wheat, rice and egg (14-23.3 vs. 7.7-21.5%). They possess high crude fiber (11.1-15.3%) and carbohydrates (54.2-69.8 %). The high fiber in pods can be modified to a desirable level on blending with appropriate cereal flours. High protein and carbohydrates elevated the calorific value of pods, which is comparable to edible pulses (1383-1444 vs. 1358-1426 kJ 100 g^{-1}). Among minerals, calcium is high (246-382 mg 100 g^{-1}), while magnesium, zinc and manganese surpass the NRC/NAS requirement for infants. Unlike other minerals, selenium did not leach out in pods on cooking. Globulins are the major protein fractions in raw as well as cooked pods. Starch constitutes a major carbohydrate fraction and elevated on cooking. Essential amino acids (EAA): threonine, valine, isoleucine, leucine and lysine in raw and cooked pods, phenylalanine and histidine in raw pods surpassed FAO/WHO/UNU recommended pattern for adults. Pods possess all essential fatty acids and devoid of trypsin inhibitors. Total phenolics, orthodihydric phenols, tannins and hemagglutination activity of pods decreased substantially on cooking. Although *in vitro* starch digestibility doubled in cooked pods, the *in vitro* protein digestibility and protein digestibility corrected to EAA score reflects interference of antinutritional factors. The available information on antinutritional factors suggests that hemagglutinins (lectins) may be responsible for the low nutritive value of pods. Even though pressure-cooking reduced the hemagglutination activity of pods to some extent, lack of improvement in protein digestibility indicates lectins may not be solely responsible for toxicity. Alternate methods of processing (e.g. soaking, autoclaving, extrusion cooking) may help in elimination of toxins or decrease to safe levels. This study reveals that household pressure-cooking is not efficient to fully eliminate the toxic principles of tender pods and suggests combination of methods or alternate thermal-treatment. Being perennial creeper, mangrove *C. cathartica* merits as a future economic crop of developing countries. In view of alarming rate of degradation of mangroves due to human interference, the underexploited gene pool of mangrove *C. cathartica* need special attention for conservation and domestication.

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