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CHEMICAL COMPOSITION OF *PROSOPIS JULIFLORA* (SW.) D.C (MOSQUITO BEAN)

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ABSTRACT : Four accessions of the under-exploited legume, *Prosopis juliflora* (Sw.) D.C (mosquito bean) collected as pod from natural stands of four different agro-climatic regions of Nilgiri Biosphere Reserve (NBR) Western Ghats, Tamil Nadu, India were analyzed for their proximate composition, seed protein fractions, amino acid profiles of total seed proteins, fatty acid profiles, mineral composition, *in vitro* protein digestibility (IVPD) and certain anti-nutritional factors, to determine their potential as an alternative source to alleviate protein-energy-malnutrition among the people of Tamil Nadu. The crude protein ranged from 26.69 - 29.84%, crude lipid 11.89 - 13.75%, total crude fibre 8.78 - 9.89%, ash 3.99 - 4.95% and carbohydrates 42.45 - 46.37%. The energy level of the seed (1684.94 - 1725.62 $kJ100g^{-1}$ DM) was comparable with commonly consumed Indian pulses. The albumins and glutelins constitute the major bulk of seed proteins. The essential amino acid profile of total seed proteins compared favorably with FAO/WHO (1991) requirement pattern, except that there were deficiencies of sulphur containing amino acids in all the four accessions. The fatty acid profiles revealed that the seed lipids contained higher concentrations of oleic and linoleic acid. The investigated seeds were rich in minerals such as K, Ca, Mg and P. The IVPD of the four accessions ranged from 50.65 - 63.18%. The range of anti-nutritional factors were as follows: total free phenolics, 4.93 - 8.58%, tannins, 6.81 - 9.15%, L-DOPA, 2.21 - 4.52%, phytic acid, 0.33 - 0.89 $g100g^{-1}$, and trypsin inhibitor activity, 40.4 - 48.2 TIU mg^{-1} protein. Lower levels of phytohaemagglutinating activity for human erythrocytes of "O" blood group than for "A" and "B" blood groups were found. The anti-nutritional fatty acid, behenic acid (0.47 - 1.37%) was also detected.

Key words: *Prosopis juliflora*, Proximate and Mineral Composition, Protein fractions and anti-nutritional factors

INTRODUCTION

Inadequate availability and consumption of protein food in India due to both population explosion and urbanization, if efforts are not being taken toward the finding alternate and cheaper sources of proteins. In spite of an urgent need to meet the nutritional requirements of the ever increasing populations (Murthy *et al*., 2011). With increasing in new food sources, the seeds of wild plants, including the tribal pulses are received more attention because they are well adopted to adverse environmental conditions, highly resistant to disease and pests and exhibit good nutritional qualities (Maikhuri *et al*., 1991). In contrast to their undesirable effects as under-exploited legume *Prosopis juliflora* (Sw.) D.C (mosquito bean) is a valuable multi-purpose resources in their native range, providing timber, firewood, livestock feed, human food, shade, shelter and soil improvement. The pods, which are high in sugars, carbohydrates and protein, have been a historic source of food for human populations in North and South America providing flour and other edible products.

However, this indigenous knowledge has not followed the *Prosopis* trees and the fruit are unused or provide only fodder for livestock in most of Africa and Asia. Preliminary analyses of *P. juliflora* seed flour indicate good nutritional properties, but also the presence of aflatoxins and Ochratoxin A. These plants are fast-growing, drought-resistant, nitrogen-fixing trees or shrubs adapted to poor and saline soils in arid and semi-arid zones. Several species from South and Central America, especially the tropical *P. juliflora* have been distributed around the world over the last 200 years and are now widespread in dry parts including India (Pasiecznik *et al.*, 2001) and it has been declared a noxious weed with legal disputes over compensation for its spread and subsequent loss of livelihoods, especially in pastoral regions.

Despite of the desirable nutritional features, *P. juliflora* seeds are not extensively utilized as a food / feed mainly due to the presence of certain anti-nutritional compounds (Pugalenthi *et al*., 2004). Presence of various anti-nutritional compounds such as total free phenolics, tannins, phytic acid, L-DOPA, trypsin inhibitor activity and lectins are reported in the seeds of *P. juliflora.* Since, the total free phenolics and tannins were considered as major anti-nutrients present in high concentration in *P. juliflora* seeds. The total free phenolics and tannins are water soluble compounds (Uzogara *et al.*, 1990) and they can be eliminated by dehulling, soaking and heat treatment or cooking process (Singh, 1993; Kataria *et al.,* 1989; Singh and Singh, 1992). Although, few reports are available on the nutritional value and anti-nutritional compounds of *P. juliflora* seeds. Therefore, in the present study, an attempt has been made to understand the nutritional and anti-nutritional factors of the under - exploited tree pulse *P. juliflora* with a view to assessing their nutritional quality. In Indian tribal's made flour and dough with the dried or toasted pulp from ripe pods (Simpson, 1977).

MATERIALS AND METHODS

Preparation of seed flour

Four accessions of under-exploited legume, *Prosopis juliflora* (Sw.) D.C. (mosquito bean) were collected as pod from natural stands of four different agro-climatic regions of Nilgiri Biosphere Reserve (NBR) Western Ghats, Tamil Nadu, India. After drying it thoroughly in the sun, the pods were thrashed to remove seeds. After cleaning, removal of broken seeds, foreign materials and mature seeds were stored in airtight plastic jars at room temperature for future analysis.

Table 1. Collection of four accessions of *Prosopis juliflora* seeds

Locality	District	Date of collection
Palamalai	Coimbatore	25.06.2009
Mettupalayam	Coimbatore	15.05.2009
Kunjapanai	Coimbatore	19.04.2009
Kallar	Coimbatore	03.04.2009

Proximate composition

Seed moisture content, on a percent basis, was determined by drying 50 transversely cut seeds in an oven at 80°C for 24h. The air-dried samples were powdered separately in a Wiley mill (Scientific Equipment, Delhi, India) to 60-mesh size and stored in screw capped bottles at room temperature for further analysis. Nitrogen content was estimated by the micro-Kjeldahl method (Humphries, 1956) and the crude protein content was calculated (N x 6.25). Crude lipid content was determined using Soxhlet apparatus (AOAC, 2005).

Ash was determined by heating 2g of the dried sample in a silica dish at 600°C for 6h (AOAC, 2005). Total dietary fibre (TDF) was estimated by the non-enzymatic-gravimetric method proposed by Li and Cardozo (1994). To determine the TDF, duplicate 500mg ground samples were taken in separate 250ml beakers. To each beaker 25ml water was added and gently stirred until samples were thoroughly wetted, (i.e. no clumps present); the beakers were then covered with Al foil and allowed to stand 90min without stirring in an incubator maintained at 37°C; after that, 100ml 95% ethanol were added to each beaker and allowed to stand for 1hr at room temperature (25±2°C). The residue was collected under vacuum in a pre-weighed crucible containing filter aid. The residue was washed successively with 20ml of 78% ethanol, 10ml of 95% ethanol and 10ml acetone. The crucible containing the residue was dried >2 h at 105°C and then cooled > 2h in a desiccator and weighed. One crucible containing residue was used for ash determination at 525°C for 5h. The ash-containing crucible was cooled for > 2h in a desiccator and weighed. The residue from the remaining duplicate crucible was used for crude protein determination by the micro-Kjeldahl method as already mentioned. The TDF was calculated as follows.

$$TDF\% = 100 \times \frac{Wr - [(P+A)/100]\,Wr}{Ws}$$

Where *Wr* is the mg residue, *P* is the % protein in the residue; *A* is the % ash in the residue, and *Ws* is the mg sample.

The nitrogen free extract (NFE) was obtained by difference (Muller and Tobin, 1980). The energy value of the seed (kJ) was estimated by multiplying the percentages of crude protein, crude lipid and NFE by the factors 16.7, 37.7 and 16.7, respectively (Siddhuraju *et al.*, 1996).

Amino acid analysis

The total seed protein was extracted by a modified method by Basha *et al.,* (1976). The extracted proteins were purified by precipitation with cold 20% trichloroacetic acid (TCA). A protein sample of 30mg was hydrolysed by 6N HCL (5ml) in an evacuated sealed tube, which was kept in an air oven maintained at 110°C for 24 hours. The sealed tube was broken and the acid removed completely by repeated flash evaporation after the addition of deionized H2O. Dilution was effected by means of citrate buffer pH 2.2 to such an extent that the solution contained 0.5mg protein ml-1. The solution was passed through a millipore filter (0.45µM) and derivatized with O-phthaldialdehyde by using an automated pre-column (OPA). Amino acids were analyzed by a reverse – phase HPLC (Method L 7400, HITACHI, Japan) fitted with a denali C18 5 micron column (4.6X 150mm). The flow rate was 1 ml min^{-1} with fluorescence detector. The cystine content of protein sample was obtained separately by the Liddell and Saville (1959) method. For the determination of tryptophan content of proteins, aliquots containing known amounts of proteins were dispersed into glass ampoules together with 1 ml 5M NaOH. The ampoules were flame sealed and incubated at 110°C for 18 hours. The tryptophan content of the alkaline hydrolysates were determined calorimetrically using the method by Spies and Chambers (1949) as modified by Rao *et al.* (1974). The contents of the different amino acids were expressed as g100g-1 proteins and were compared with FAO/WHO (1991) reference pattern. The essential amino acid score is calculated as follows:

$$\text{Essential amino acid score} = \frac{\text{grams of essential amino acid in 100g of the test protein}}{\text{grams of essential amino acid in 100g of FAO / WHO (1991) reference pattern.}} \times 100$$

Lipid extraction and fatty acid analysis

Total lipids were extracted from the seeds according to the method by Folch *et al.,* (1957) using chloroform and methanol mixture in ratio of 2: 1 (v/v). Methyl esters were prepared from the total lipids (Metcalfe *et al*., 1966). Fatty acid analysis was performed by gas chromatography (ASHMACO, Japan; Model No: ABD20A) using an instrument equipped with a flame ionization detector and a glass column (2m x 3mm) packed with 1% diethylene glycol succinate on chromosorb W. The temperature conditions for GC were injector 200°C and detector 210°C. The temperature of the oven was programmed from 180°C and the carrier gas was nitrogen at a flow rate of 30ml/min. Peaks were identified by comparison with authentic standards, quantified by peak area integration and expressed as weight percentage of total methyl esters; the relative weight percentage of each fatty acid was determined from integrated peak areas.

Analysis of minerals

Five hundred milligrams of the ground legume seed were digested with a mixture of 10ml concentrated nitric acid, 4ml of 60% perchloric acid and 1ml concentrated sulphuric acid. After cooling, the digest was diluted with 50ml of deionised H_2O, filtered through Whatman No. 42 filter paper and filtrates were made up to 100ml with deionised H2O in a glass volumetric flask. All minerals, except phosphorus, were analyzed from a triple acid-digested sample by atomic absorption spectrophotometry, ECIL (Electronic Corporation of India Ltd., India) (Issac and Johnson, 1975). The phosphorus content in the triple acid digested extract was determined calorimetrically (Dickman and Bray, 1940).

Determination of *in vitro* protein digestibility (IVPD)

The determination of *in vitro* protein digestibility was determined using the multi-enzyme technique (Hsu *et al.*, 1977). The enzymes used for IVPD were purchased from Sigma Chemical Co., St. Louis, MO, USA. Calculated amounts of the control (casein) and sample were weighed out, hydrated in 10ml of distilled water and refrigerated at 5°C for 1hr. The samples containing protein and enzymes were all adjusted to pH 8.0 at 37°C. The IVPD was determined by the sequential digestion of the samples with a multi-enzyme mixture [trypsin (porcine pancreatic trypsin–type IX with 14190 BAEE unites per mg protein), α-chymotrypsin (bovine pancreatic chymotrypsin–type II, 60 units per mg powder) and peptidase (porcine intestinal peptidase–grade III, 40 units per g powder)] at 37°C followed by protease (type IV from *Streptomyces griseus*) at 55°C. The pH drop of the samples from pH 8.0 was recorded after 20min of incubation. The IVPD was calculated according to the regression equation $Y = 234.84 – 22.56\ X$, where Y is the % digestibility and X the pH drop.

Analysis of anti-nutritional compounds

The anti-nutritional compounds, total free phenolics (Bray and Thorne, 1954), tannins (Burns, 1971), the non-protein amino acid, L-DOPA (3,4-dihydroxyphenylalanine) (Brain, 1976) and phytic acid (Wheeler and Ferrel, 1971) were quantified. Trypsin inhibitor activity was determined by the enzyme assay Kakade *et al.* (1974) by using benzoil-DL-arginin-*p*-nitroanilide (BAPNA) as a substrate. One trypsin inhibitor unit (TIU) has been expressed as an increase of 0.01 absorbance units per 10ml of reaction mixture at 410nm. Trypsin inhibitor activity has been defined in terms of trypsin units inhibited per mg protein.

Quantitative determination of phytoheamagglutinating (Lectin) activity

Lectin activity was determined by the method of Almedia *et al.* (1991). One gram of air-dried seed flour was stirred with 10ml of 0.15N sodium chloride solution for 2hr and the pH 4.0 was adjusted. The contents were centrifuged at 10,000 x g for 20min. and the supernatants were collected separately. Protein content was estimated after Lowry *et al.* (1951) method.

Blood erythrocyte suspensions were prepared by washing the blood samples separately with phosphate-buffered saline and centrifuged for 3min at low speed (3,000 g for 10 min at room temperature). Supernatants were removed with Pasteur pipettes. The washing procedure was repeated three times. The washed cells were diluted by one drop of cells with 24drops of phosphate – buffered saline. Human blood (blood groups A, B and O) was procured from the blood bank of Micro Clinical Laboratory, Coimbatore.

The determination of lectin was done by the method of Tan *et al.* (1983). Clear supernatant (50µl) was poured into the depression (pit) on a microtitration plate and serially diluted 1:2 with normal saline. The human blood erythrocyte (A, B and O blood groups) suspensions (25µl) were added to each of the twenty depressions. The plates were incubated for 3hours at room temperature. After the incubation period, the titer values were recorded. One Haemagglutinating unit is defined as the least amount of heamagglutinin that will produce positive evidence of agglutination of 25µl of a blood group erythrocyte after 3hr incubation at room temperature. The phytoheamagglutinating activity was expressed as heamagglutinating units (HU)/mg protein.

Statistical analysis

Analysis of Variance (ANOVA) and Duncan's Multiple Range Test (DMRT) were used for analysis [MSTAT – 'C' software (version 1.4.1 Michigan State University, MI, USA)] of any significant difference in chemical compositions among the fifteen wild / under-exploited legumes. Significance was accepted at $p < 0.05$.

RESULTS AND DISCUSSION

The results of proximate analysis are shown in table 2. The mosquito beans contain 26.69 - 29.84% of protein, a range that is higher than those reported for food legumes such as *Cajanus cajan* (Kumar *et al*., 1991) and *Cicer arietinum* (Srivastav *et al*., 1990; Hira and Chopra, 1995). These two legumes are used extensively in typical Indian diets and are expected to play a significant role in improving protein nutrition in India. The recommended its protein source to alleviate protein malnutrition among the economically weaker sections of peoples in developing countries. The crude lipid content is high in Kallar (13.75%) and low in Mettupalayam (11.89%) accessions. Nonetheless, the crude lipid content does not qualify the beans as an oil rich legume, especially when compared with groundnut and soybeans which have lipid contents of about 25.3% and 19.5% respectively (Narasinga Rao *et al*., 1989). The crude fibre ranged 8.78 - 9.97%. The ranges of ash contents in this legume (3.99 - 4.95%) are important because nutritionally important mineral elements are provided (Table 6). It appears that mosquito beans have a higher range of carbohydrate (42.45 - 46.37%), because of their low fat content. Groundnut and soybeans have lower carbohydrate values of 26.1% and 20.9% (Narasinga Rao *et al*., 1989). All the four accessions had a higher energy range (1684.94 - 1725. 62 kJ 100g-1 DM) than commonly cultivated legume crops like cowpea, green gram, horse gram and peas (Narasinga Rao *et al*., 1989), which are in the range of 1318 - 1394 kJ $100g^{-1}$DM.

The data on protein fractionation (Table 3) show that the albumins and glutelins constitute the major bulk of seed proteins, as in some of the commonly consumed pulses such as *Cajanus cajan* and *Vigna mungo* (Mahajan *et al*., 1988) and *Cicer arietinum* (Singh and Jambunathan, 1982). The occurrence of high levels of albumins seems to be nutritionally significant because of the presence of relatively high levels of essential amino acids especially cystine and methionine (Murray and Roxburg, 1984; Siddhuraju *et al*., 1996) and tryptophan (Siddhuraju *et al.,* 1997).

Table 2. Data on the proximate composition of *Prosopis juliflora* germplasm [1, 2] (g 100 g^{-1} seed flour)

Components	Palamalai	Mettupalayam	Kunjapanai	Kallar
Moisture	7.89 ± 0.12b	7.12 ± 0.11a	7.55 ± 0.10ab	7.69 ± 0.13b
Crude protein (Kjeldahl N x 6.25)	26.29 ± 0.19c	28.51 ± 0.10b	29.84 ± 0.11b	28.20 ± 0.12a
Crude lipid	12.33 ± 0.13b	11.89 ± 0.16c	13.58 ± 0.15a	13.75 ± 0.11ab
Crude fibre	9.89 ± 0.06c	8.78 ± 0.04c	9.62 ± 0.08b	9.97 ± 0.09a
Ash	4.72 ± 0.05a	4.95 ± 0.06ab	4.51 ± 0.07b	3.99 ± 0.09b
Nitrogen Free Extractives (NFE)	46.37	45.87	42.45	44.09
Calorific value (kJ 100g-1DM)	1684.94	1690.40	1719.21	1725.62

1 - Values are the means of triplicate determinations and ± - Standard error

2 - Mean values in the same row sharing different superscript are significantly different (P < 0.05)

Table 3. Total protein and different protein fractions of four different germplasm seed materials of *Prosopis juliflora* [1, 2] (g 100 g^{-1})

Protein fraction	Palamalai		Mettupalayam		Kunjapanai		Kallar	
	seed flour	seed protein	seed flour	seed protein	seed flour	seed protein	seed flour	seed protein
Total protein	25.37 ± 0.20c	100	26.72 ± 0.11b	100	27.48 ± 0.10b	100	26.96 ± 0.09a	100
Albumins	8.92± 0.10c	35.16	9.43 ± 0.11b	35.29	9.95 ± 0.06b	36.21	9.27 ± 0.07a	34.38
Globulins	6.65 ± 0.06c	26.21	7.52 ± 0.09b	28.14	7.28 ± 0.05b	26.49	7.73 ± 0.07a	28.67
Prolamins	1.94 ± 0.06a	7.65	1.24 ± 0.05b	4.64	1.58 ± 0.04a	5.75	1.50 ± 0.09ab	5.56
Glutelins	7.86 ± 0.06a	30.98	8.53 ± 0.03c	31.92	8.67 ± 0.04b	31.55	8.46 ± 0.04ab	31.38

1 - Values are the means of triplicate determinations and ± - Standard error

2 - Mean values in the same row sharing different superscript are significantly different (P < 0.05)

The amino acid profiles of the purified seed proteins and the essential amino acid scores are presented in Table 4. The levels of cystine, methionine, tyrosine, phenylalanine and histidine seem to be deficient whereas the levels of valine, isoleucine and lysine are found to be higher compared to FAO / WHO (1991) requirement pattern. In general, the amino acid profiles are incomplete; it is because some amino acids are destroyed during the preparation of the samples by acid digestion.

The data on fatty acid composition of the total lipids indicate that linoleic, palmitic and oleic acids are the predominant fatty acids. The occurrence of high levels of unsaturated fatty acids which account for above 66% of the total lipids is comparable with some other edible legumes like *Psophocarpus tetragonolobus* and *Glycine max* (Rao and Belavady, 1979) and *Phaseolus vulgaris* and *Vigna unguiculata* (Omogbai, 1990).

Data related to the mineral elements analysed in the present investigation are given in the Table 6. Of all the macro elements, potassium was the most abundant, ranging from 1120.63 mg/100g in Mettupalayam accession to 1853.20 mg/100g in Kallar. Sodium levels were generally low in all accessions with values ranging from 13.94 mg/100g to 15.65 mg/100g. Among the microelements, zinc concentration ranged between 1.79 mg/100g in Palamalai accession and 2.55 mg/100g in Kunjapanai accession; iron ranged between 1.38 mg/100g in Palamalai accession and 2.69 mg/100g in Kunjapanai accession.

Table 4. Amino acid profiles of four different germplasm seed materials of *Prosopis juliflora*

Amino acid	Palamalai		Mettupalayam		Kunjapanai		Kallar		FAO/WHO (1991) requirement pattern
	g 100 g–1 protein	EAA Score	g 100 g–1 protein	EAA Score	g 100 g–1 protein	EAA Score	g 100 g–1 protein	EAA Score	
Glutamic acid	18.8		16.7		17.3		18.1		
Aspartic acid	11.4		10.6		11.0		10.9		
Serine	2.7		2.5		2.2		2.4		
Threonine	2.3	92.00	2.0	58.82	2.5	73.53	2.1	61.76	3.4
Proline	3.4		3.3		3.6		3.7		
Alanine	4.1		4.6		4.0		4.2		
Glycine	4.7		4.1		4.8		4.5		
Valine	5.2	148.57	5.0	142.86	5.8	165.71	5.8	165.71	3.5
Cystine	Trace	-	Trace	-	Trace	-	Trace	-	2.5
Methionine	Trace		Trace		Trace		Trace		
Isoleucine	2.8	100.00	3.1	110.71	3.3	117.86	2.9	103.57	2.8
Leucine	8.6	130.30	8.4	127.27	8.7	131.82	8.5	128.79	6.6
Tyrosine	2.4	71.43	2.2	76.19	2.0	76.19	2.3	68.25	6.3
Phenylalanine	2.1		2.6		2.8		2.0		
Lysine	7.9	103.95	7.5	129.31	7.6	131.03	8.2	141.38	5.8
Histidine	1.5	93.75	1.2	63.16	1.6	84.21	1.8	94.74	1.9
Tryptophan	N.D		N.D		N.D		N.D		1.1
Argnine	8.7		8.6		8.4		8.8		

N.D. - Not Detected EAA - Essential amino acid

The Mn range (0.94 – 1.79 mg/100g) was generally low in all accessions. The variation in the mineral contents may be related to genetic origin, geographical source, soil fertility and the efficiency of uptake from the soil. However, in all presently analysed seed samples, the contents of Ca, Mg and P were found to be high compared to *Cicer arietinum*, *Phaseolus vulgaris*, *Pisum sativum* and *Vigna unguiculata* (Meiners *et al.,* 1976). Among the four accessions of seed materials of *P. juliflora*, the Kallar accession registered highest level of *in vitro* protein digestibility (63.18%) than that of an earlier investigation in some wild legumes such as *Acacia concina, Caesalpinia pulcherrima, Delonix regia* and *Uraria picta* (Pandey and Srivastava, 1991).

Table 5. Fatty acid composition of the four germplasm seed materials of *Prosopis juliflora* (%)

Fatty acid	Palamalai	Mettupalayam	Kunjapanai	Kallar
Palmitic acid (C 16:0)	15.32	15.24	14.95	14.43
Pamitolic acid (C 16:1)	0.91	1.25	1.50	1.40
Stearic acid (C 18:0)	6.10	5.43	6.54	6.42
Oleic acid (C 18:1)	39.45	38.63	37.21	37.39
Linoleic acid (C 18:2)	35.22	36.29	35.34	36.11
Linolenic acid (C18:3)	1.73	1.20	1.68	1.43
Arachidic acid (C 20:0)	0.80	1.13	1.41	1.62
Behenic acid (C 22:0)	0.47	0.83	1.37	1.20

Table 6. Data on the mineral composition of *Prosopis juliflora* germplasm [1, 2] (mg 100 g^{-1} seed flour)

Components	Palamalai	Mettupalayam	Kunjapanai	Kallar
Sodium	13.94 ± 0.13a	15.65 ± 0.15b	14.45 ± 0.12a	15.29 ± 0.11b
Potassium	1278.65 ± 0.90b	1120.63 ± 0.54a	1446.73 ± 0.45c	1853.20 ± 0.67d
Calcium	99.76 ± 0.53a	114.32 ± 0.61b	136.41 ± 0.53c	193.17 ± 0.43d

The presence of anti-nutritional factors is one of the major drawbacks limiting the nutritional and food qualities of the legumes (Salunkhe, 1982). For this reason, a preliminary evaluation of some of these factors in raw mosquito bean is made (Table 7). Total free phenolics occurred within the range of 4.93 - 8.58 % and tannins ranged from 6.81- 9.15%. Tannins have been claimed to affect adversely protein digestibility (Sathe and Salunkhe, 1984). The tannins and total free phenolic compounds are generally found in the seed coat. The tannins and phenolics are water soluble compounds (Uzogara *et al.*, 1990) and they can be eliminated by dehulling, soaking and heat treatment or cooking process (Singh, 1993; Kataria *et al.,* 1989; Singh and Singh, 1992). In the present study, among the four accession, the Kallar accession contained the highest level of L-DOPA (4.52%); the lowest amount of L-DOPA (2.21%) were found in the Kunjapanai accession of the seed. This value seems to be higher than that of an earlier report in *P. chilensis* (Rajaram and Janardhanan, 1991). It has been demonstrated that in *Mucuna pruriens*, the level of L-DOPA is significantly eliminated by dry-heat treatment (Siddhuraju *et al.,* 1996) and cooking and autoclaving (Vijayakumari *et al.*, 1996). The range of trypsin inhibitor activity (17.29 - 30.41 TIU mg^{-1} protein) (Table 7) is found to be low compared to *Cajanus cajan* var. Pant A-2 and UPAS-120 (Singh and Eggum, 1984). Recently, significant reduction of trypsin inhibitor activity in some tribal pulses has been noticed when subjected to both dry heat treatment and autoclaving (Siddhuraju *et al.,* 1996). Phytic acid is known to be the major storage form of phosphorus in legumes and is considered as an anti-nutritive factor (Bishnoi *et al*., 1994). In the present study, all the accession seed materials are found to contain lower percentage of phytic acid than the common legumes like *Arachis hypogea, Cajanus cajan, Cicer arietinum, Glycine max, Pisum sativum, Vigna mungo, V. radiata* and *V. unguiculata* (Obah, 2006; Igbedioh *et al*., 1994; Chitra *et al.*, 1995; Estevez *et al*., 1991; Zdunczyk *et al*., 1994). Pressure-cooking of soaked-dehulled seeds appear to be more beneficial for lowering down the phytic acid and the present loss range from 41 to 51 over the control value (Bishnoi *et al*., 1994). Lectins combine with the cells that line the intestinal mucosa and cause a nonspecific interference with the absorption of available nutrients, and also reduce feed intake (Liener, 1994). Phytohaemagglutinating activity of all four accessions of *P. juliflora* registers higher activity with respect to, "A" blood group of human erythrocytes. All the accessions had low levels of phytohaemagglutinating activity with respect to erythrocytes of, "O" blood group. This is in good agreement with earlier reports in the other *Mucuna* species (Vijayakumari *et al.*, 1996). However, dry-heat and autoclaving are known to inactivate completely the trypsin inhibitors and phytohaemagglutins in *Mucuna* beans (Siddhuraju *et al.*, 1996).

Conclusion

The observations made in the present study reveal that the nutritional profiles of *P. juliflora* seeds can also be explored as an alternate protein source to protein-energy-malnutrition (PEM) among the economically weaker sections of people in developing countries. The presence of anti-nutritional factors identified in the current report should not pose a problem for humans if the beans are properly processed.

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