ADVANCES IN BIORESEARCH, Vol 1 [2] DECEMBER 2010: 105 - 116

http://www.soeagra.com
ISSN 0976-4585

Research Paper

Chemical Composition and Nutritional Evaluation of Lesser Known Pulses of the Genus, *Mucuna*

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ABSTRACT
Two samples of seed materials of the Indian tribal pulse, Mucuna pruriens var.utilis were collected from Karaiyar, Tirunelveli district, Western Ghats, Tamil Nadu .The seeds of another tribal pulse, M.deeringiana were collected from Maruthuvazhmalai, Kanyakumari district, Western Ghats, Tamil Nadu. The mature seed samples were analysed for proximate and mineral compositions, vitamins (niacin and ascorbic acid), Fatty acid profiles, amino acid composition and antinutritional factors. The investigated seed samples of M.pruriens var.utilis and M.deeringiana contained higher amounts of crude protein and crude lipid when compared with most of the commonly consumed pulses. The investigated seeds were rich in minerals such as calcium, potassium, phosphorus, magnesium, iron and manganese. The fatty acid profiles of both samples of M.pruriens var.utilis and M.deeringiana revealed that the seed lipids contained higher concentration of palmitic acid and linoleic acid. The seed proteins of both samples of M.pruriens var.utilis and M.deeringiana contained higher levels of the essential amino acids such as, threonine, valine, isoleucine, tyrosine, phenylalanine and histidine. The antinutritional substances, total free phenolics, tannins, L-Dopa, phytic acid, hydrogen cyanide, total oxalate, trypsin inhibitor activity, oligosaccharides and phytohaemagglutinating activity were also analysed.
***KEY WORDS**: Tribal pulses; Amino acid profiles; Antinutrients.*

INTRODUCTION

Increasing population pressure, fast depletion of natural resources, poverty and low agricultural production are some of the problems faced by the developing countries. It is well documented that the developing countries do not produce enough food and of the right nutritional quality to meet daily needs [1]. The prevalence of hunger and protein malnutrition in the tropical and subtropical areas of the world is well recognized and appreciated [2]. The dearth in food supply especially of protein is of such magnitude the developing nations have to depend mostly on cereals, grains, starch roots, and tubers for energy and protein need [3]. The net effect of this protein deficit in the developing countries is manifested in the prevalence of various forms of protein calorie malnutrition (PCM) diseases such as Kwashiorkor, marasmus and mental deficiencies [4].

In view of prevalent food shortage, attention is currently being focused on the exploitation of lesser known and non- traditional plant resources [5]. Exploitation of under utilized wild legumes is an important approach to combat the protein-malnutrition in developing countries. Food legumes constitute an important part of diet of a larger section of population in the developing world, as a good source of protein, carbohydrates, minerals and vitamins. Being rich in protein, carbohydrate, calorific value, fibre, and vitamins, legumes constitute staple food in many countries [6].

Among the wild legumes, the genus *Mucuna* is widespread in tropical and sub-tropical regions of world and is considered as an alternative protein source. *Mucuna pruriens* (L.) DC. var utilis (Wall.ex Wight) Bak. ex Burck. (velvet bean) is an under-utilized legume species grown predominantly in Asia, Africa and in parts of the Americas [7]. Traditionally in India, the mature seeds of *Mucuna* bean are consumed by a South Indian hill tribe, the *Kanikkars*, after repeated boiling [8]. Recently Dravidan tribes in the Tirunelveli district have started cultivating it for use as a pulse [9]. Various preparation of the bean is also traditionally consumed in several parts of Srilanka by low-income groups [10].In parts of Asia, and Africa, the seeds are roasted and eaten [11].

The *Mucuna* bean is also used in indigenous Ayurvedic medicine [12] and L-DOPA extracted from it used to provide symptomatic relief in Parkinson's disease [13]. The beans were also employed as a powerful aphrodisiac in Ayurveda [14] and have been used to treat nervous disorders [15, 16] and arthritis [16]. The bean, if applied as a paste on scorpion stings, is presumed to absorb poison [15]. The non-protein aminoacid, L-DOPA (3, 4 dihydroxy phenylalanine) found in this under-utilized legume seed resists attack from insects and thus controls biological infestation during storage. Further L-DOPA has been extracted from the seed to provide commercial drugs for the treatment of Parkinson's disease [11]

Despite the potential of this under-utilized species as a source of less consumed food and medicine, to our knowledge, meagre information is available on the germplasm collection from South India and its evaluation for chemical composition. In South India, the tropical forests of Western Ghats , one of the 18 biodiversity hot spots of the world [17]) has a large group of under-utilized food plants from leguminosae, whose chemical potential hitherto remains untapped. In this context, in the present study an attempt was made to understand the biochemical composition and assess the nutritional value of two samples of the tribal pulse *Mucuna pruriens* var. *utilis* (black and white coloured seed coat) and one sample of *Mucuna deeringiana*. The mature seeds of *Mucuna pruriens* var. *utilis* and *Mucuna deeringiana* are known to be eaten by Indian tribal sect called *Kannikars*.

MATERIALS AND METHODS

Collection of seed samples

Two samples of velvet bean, *Mucuna pruriens* (L.) DC var. *utilis* (Wall.ex Wight) Bak. ex Burck (black and white coloured seed coat) were collected from Karaiyar a semi evergreen forest in the Tirunelveli district, south eastern slopes of Western Ghats, Tamil Nadu, during June 2008 (late summer). The seeds of another tribal pulse, *Mucuna deeringiana* (Bort) Merril were collected from Marunthuvazhmalai, an evergreen forest in the Kanyakumari district, a south eastern slopes of Western Ghats, Tamil Nadu, during April 2008 (early summer). With help of keys by Wilmot-Dear [18], the samples were botanically identified. After thoroughly drying in the sun the pods were thrashed to remove seeds. The seeds, after thorough cleaning and removal of broken seeds, foreign materials and immature seeds were stored in airtight plastic jars at room temperature (25^{o}C).

Proximate composition

The moisture content was determined by drying 50 transversely cut seed in an oven at 80°C for 24 hr and is expressed on a percentage basis. The air-dried samples were powdered separately in a Willy mill (Scientific Equipment, Delhi, India) to 60-mesh size and stored in screw capped bottles at room temperature for further analysis.

The nitrogen content was estimated by the micro-Kjeldahl method [19] and the crude protein content was calculated (N x 6.25). Crude lipid content was determined using Soxhlet apparatus [20]. The ash content was determined by heating 2g of the dried sample in a silica dish at 600°C for 6hr [20]. Total dietary fibre (TDF) was estimated by the non-enzymatic-gravimetric method [21]. The nitrogen free extract (NFE) was obtained by difference [22]. 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 [23].

Minerals and vitamins analysis

Five hundred milligrams of the ground legume seed was digested with a mixture of 10ml concentrated nitric acid, 4ml of 60% perchloric acid and 1ml of concentrated sulphuric acid. After cooling, the digest was diluted with 50ml of deionised distilled water, filtered with Whatman No. 42 filter paper and the filtrates were made up to 100ml in a glass volumetric flask with deionised distilled water. All the minerals except phosphorus were analysed from a triple acid-digested sample by an atomic absorption spectrophotometer – ECIL (Electronic Corporation of India Ltd., India) [24]. The phosphorus content in the triple acid digested extract was determined colorimetrically [25]. Ascorbic acid and niacin contents were extracted and estimated as per the method given by Sadasivam and Manickam [26].

Lipid extraction and fatty acid analysis

The total lipid was extracted from the seeds according to the method of Folch *et al*., [27] using chloroform and methanol mixture in ratio of 2: 1 (v/v). Methyl esters were prepared from the total lipids by the method of Metcalfe *et al*., [28]. 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 (2mX3mm) 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.

Amino acid analysis

The total seed protein was extracted by a modified method of Basha *et al*., [29]. 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 hr. The sealed tube was broken and the acid removed completely by repeated flash evaporation after the addition of de-ionized water. Dilution was effected by means of citrate buffer pH 2.2 to such an extent that the solution contained 0.5 mg protein ml^{-1}. The solution was passed through a millipore filter (0.45µM) and derivitized with O-phthaldialdehyde by using an automated pre-column (OPA). Aminoacids were analysed by a reverse – phase HPLC (Method L 7400, HITACHI, Japan) fitted with a denali C_{18} 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 method [30]. 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 hr. The tryptophan contents of the alkaline hydrolysates were determined colorimetrically using the method of Spies and Chambers [31] as modified by Rama Rao *et a*l., [32]. The contents of the different amino acids were expressed as g100g-1 proteins and were compared with FAO/WHO 1991 reference pattern [33]. The essential amino acid score was calculated as follows:

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

Analysis of anti-nutritional compounds

The anti-nutritional compounds, total free phenolics [34], tannins [35], the non-protein amino acid, L-DOPA (3, 4-dihydroxyphenylalanine) [36], phytic acid [37], hydrogen cyanide [38] and total oxalate [39] were quantified. Trypsin inhibitor activity was determined by the enzyme assay of Kakade *et al*., [40] 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. Extraction and TLC separation of oligosaccharides were by the method of Somiari and Balogh [41]. The eluted individual oligosaccharides were estimated by the method of Tanaka *et al*., [42]. Lectin activity was determined by the method of Almedia *et al*., [43]. One g of air-dried seed flour was stirred with 10ml of 0.15N sodium chloride solution for 2hours and the pH was adjusted to 4.0. The contents were centrifuged at 10,000 X g for 20min. and the supernatants were collected separately. The protein content was estimated by the Lowry *et al*., [44] method.

Blood erythrocyte suspensions were prepared by washing the blood samples separately with phosphate-buffered saline and centrifuged for 3min at low speed. Supernatants were removed with Pasteur pipettes. The washing procedure was repeated three times. The washed cells were diluted by one drop of cells with 24 drops of phosphate – buffered saline. Human blood (blood groups A, B and O) was procured from the blood bank of Jothi Clinical Laboratory, Tuticorin. The determination of lectine was done by the method of Tan *et al*., [45].

Determination of *in vitro* protein digestibility (IVPD)

This was determined using the multi-enzyme technique [46]. 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 1h. 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 containing protein with a multi-enzyme mixture

(trypsin , ∝-chymotrypsin and peptidase) at 37°C followed by protease at 55°C. The pH drop of the samples from pH 8.0 was recorded after 20min of incubation. The VPD was calculated according to the regression equation $Y = 234.84 - 22.56\ X$, where Y is the % digestibility and X the pH drop.

Statistical analysis

Proximate composition, minerals, vitamins (niacin and ascorbic acid), anti-nutritional factors were estimated in triplicate determinations. Data were analysed using the stastical analysis system SPSS (SPSS software for windows release 10.0; SPS Inc., Chicago IL USA). Estimates of mean, standard error for aforesaid parameters were calculated.

RESULTS AND DISCUSSIONS

The proximate composition of the two samples of *Mucuna pruriens* var. *utilis* (white and black coloured seed coat) and *M.deeringiana* are given in Table-1.

Table-1: Proximate composition of the seeds of *Mucuna pruriens* var. *utilis* and *M.deeringiana* ($g100g^{-1}$)[a]

Component	*M.pruriens* var. *utilis* (White coloured seed coat)	*M.pruriens* var. *utilis* (Black coloured seed coat)	*M.deeringiana*
Moisture	11.25 ± 0.11	10.35 ± 0.08	9.60 ± 0.04
Crudeprotein(Kjeldahl N x 6.25)	30.63 ± 0.14	28.75 ± 0.17	24.50 ± 0.31
Crude lipid	8.74 ± 0.07	9.36 ± 0.05	7.74 ± 0.13
Total Dietary fibre (TDF)	8.56 ± 0.05	7.68 ± 0.06	8.96 ± 0.21
Ash	4.12 ± 0.09	5.12 ± 0.01	5.54 ± 0.05
Nitrogen Free Extractive (NFE)	47.95	49.09	53.26
Calorific value($kJ100g^{-1}$ DM)	1641.78	1652.80	1590.39

[a]All values are means of triplicate determination expressed on a dry weight basis
±denotes standard error

The crude protein (24.50-30.63%) and crude lipid (7.74-9.36%) contents were found to be higher than the pulse crops commonly consumed in India, such as, black gram, green gram, pigeon pea, chick pea and cowpea which have been reported earlier [47, 48 ,49, 50].To meet the protein demands in developing countries where animal protein is grossly inadequate, considerable attention is being paid to less consumed protein sources, especially in legumes [51] which are considered as protein tablets [52]. The crude protein levels of the studied samples suggest its usefulness as alternative source of protein. The total dietary fibre content of samples ranged from 7.68 to 8.96% which is higher than the tribal pulses *Dolichos trilobus*, *Vigna radiata* var. *sublobata* and *V.unguiculata* subsp. *cylindrica* [53]. The ash content of *Mucuna pruriens* var. *utilis* (both samples) and *M.deeringiana* (4.12-5.54%) would be important to the extent that it contains nutritionally important mineral elements, which are presented in the Table-2. All the three samples registered higher range of energy (1590-1652$kJ100g^{-1}$ DM) than the cultivated pulse crops like cowpea, green gram, horse gram, moth bean and peas [54] which are in the range of 1318-1394kJ $100g^{-1}$ DM.

Food legumes have been recognized as important sources of several minerals in Indian diets [55]. Table -2 shows the mineral composition of the seed samples. The seed samples of *M.pruriens* var. *utilis* contained higher levels of sodium, potassium, calcium, phosphorous, magnesium, iron and manganese, when compared with other legumes, *Phaseolus vulgaris*, *P. limeneis*, *V.unguiculata*, *Cicer arietinum*, *Pisum sativum* and *lens culinaris* [56]. Similarly, the seeds of *M.deeringiana* registered a higher level of calcium, potassium, phosphorus, magnesium, iron, manganese, zinc and copper than those in other *Mucuna* species [57]. In the present investigation, all the seed samples registered a higher level of potassium when compared with recommended dietary allowance value (RDA) of infants and children (< 1550mg) NRC/NAS [58]. The high content of potassium can be utilized beneficially in the diets of people who take diuretics to control hypertension and suffer from excessive excretion of potassium through the body fluid [59].

In the presently investigated tribal pulses, *M.pruriens* var. *utilis* (both samples) and *M.deeringiana*

exhibits the highest level of niacin content (Table-2), which was found to be higher than an earlier reports in *Cajanus cajan*, *Dolichos lablab*, *Dolichos biflorus*, *M.pruriens*, *P.mungo*, *Vigna catjang* and *vigna sp* [60]; *Rhynchosia filipes*, *Vigna unguiculata* var. *unguiculata* , *Entada rheedi* and *R. suaveolens* [61, 53]).The level of ascorbic acid in all the three samples were higher than *C.arietinum* [62], *Atylosia scarabaeoides*, *Dolichos trilobus* and *Teramnus labialis* [61, 53].

The data on fatty acid composition of the total lipids of two samples of *M. pruriens* var. *utilis* and *M.deeringiana* are summarized in Table-3. Fatty acid profiles of two samples of *M. pruriens* var. *utilis* and *M.deeringiana* reveals that the lipids as good source of the nutritionally essential linoleic acid and oleic acids.

Table-2: Mineral composition and Vitamins (Niacin and Ascorbic acid) of the seeds of *Mucuna pruriens* var. *utilis* and *M.deeringiana* (mg100g $^{-1}$) [a]

Mineral	***M.pruriens* var. *utilis* (White coloured seed coat)**	***M.pruriens* var. *utilis* (Black coloured seed coat)**	***M.deeringiana***
Sodium	88.30 ± 0.41	64.32 ± 0.17	44.00±0.21
Potassium	1964.24 ± 2.21	2250.48 ± 1.68	2018.30 ±1.12
Calcium	659.00 ± 0.76	578.34 ± 0.34	194.30 ± 0.68
Magnesium	348.10 ± 0.33	430.12 ± 0.15	240.16 ± 1.34
Phosphorus	564.30 ± 0.58	369.00 ± 0.31	440.30 ± 1.74
Iron	11.87 ± 0.14	9.35 ± 0.05	10.54 ± 0.18
Zinc	2.44 ± 0.03	2.05± 0.02	2.80 ± 0.05
Copper	0.44 ± 0.01	0.32 ± 0.03	1.21 ± 0.03
Manganese	10.30 ± 0.17	7.40 ± 0.11	10.44 ± 0.16
Vitamin Niacin	54.32	42.20	38.12
Ascorbic acid	57.30	64.32	54.18

[a]All values are means of triplicate determination expressed on a dry weight basis
±denotes standard error

Table-3: Fatty acid composition of lipids of *Mucuna pruriens* var. *utilis* and *deeringiana*

Fatty acid (%)	*M.pruriens* var. *utilis* (White coloured seedcoat)	*M.pruriens* var. *utilis* (Blackcoloured seedcoat)	*M.deeingiana*
Palmiticacid (C16:0)	26.80	29.43	22.40
Stearic acid (C18:0)	13.38	15.38	18.36
Oleic acid (C18:1)	19.20	20.70	17.39
Linoleic acid (C18:2)	31.48	24.48	29.40
Linolenic acid (C18:3)	8.10	7.71	8.71
Behenic acid (C22:0)	1.84	2.30	3.74

Linoleic acid was the dominating fatty acid, followed by palmitic acid and oleic acid. The nutritional value of linoleic acid is due to its metabolism at tissue levels which produce the hormone like prostaglandins. The activity of these prostaglandins includes lowering of blood pressure and constriction of smooth muscle [63]. Linoleic acid and linolenic acids are the most important essential fatty acids required for the growth, physiological functions and maintenance [64]. In the present study, most of the fatty acids were unsaturated fatty acids. The fatty acid composition and high amounts of unsaturated fatty acids make *M. pruriens* var. *utilis* and *M.deeringiana* a special legume, suitable for nutritional applications. The fatty acid composition of the presently investigated tribal pulses is comparable with some edible legumes such as *Vigna radiata*, *V.mungo* [65], *V.unguiculata* and *Phaseolus vugaris* [66]. Oleic acid in both samples of *M. pruriens var. utilis* is higher than the previous study in the same pulse [57]. The antinutritional fatty acid, behenic acid is detected in all the three samples. Earlier reports indicate the detection of behenic acid in ground nut [67], winged bean

[68, 69, 70], *Parkia roxburgii*, *Entada phaseoloides* [71], *M.utilis* (both the samples) and *M.monosperma* [57].

The amino acid profiles of purified seed protein and the essential amino acids score are presented in Table-4. The protein quality, also known as the nutritional value of a food depends on its amino acid content and on the physiological utilization of specific amino acid after ingestion, absorption and minimal obligatory rates of oxidation [72]. The essential amino acids such as threonine, valine, isoleucine, tyrosine, phenylalanine and histidine are found to be higher in all the three investigated pulses than those of FAO/WHO 1991 requirement pattern [33]

Among the three samples of *M*ucuna beans, the *Mucuna pruriens* var. *utilis* (black coloured seed coat) exhibits highest level of *in vitro* protein digestibility (76.40%) which is found to be higher (Table-5) than the Thachenmalai and Valanad (black coloured seed coat) accession of *Mucuna* bean [73].

Although legumes constitute one of richest and least expensive sources of protein in human /animal diets their utilization is limited because of the presence of certain antinutritional compounds [74, 75]. In view of this, in the present investigation an attempt has been made to detect the presence of certain antinutritional factors such as total free phenolics, tannins, L-DOPA, phytic acid, hydrogen cyanide, trypsin inhibitor activity, oligosaccharides and phytohaemagglutinating activity. (Table-5).

The content of total free phenolics of currently investigated samples of *M.pruriens* var. *utilis* and *M.deeringiana* were found to be higher when compared with other tribal pulses such as, *Dolichos trilobus*, *Rhynchosia cana*, *R. suaveolens*, *Vigna radiata* var. *sublobata* and *Terammus labialis* [53]. Phenolic compounds inhibit the activity of digestive as well as

hydrolytic enzymes such as amylase, trypsin, chymotrypsin and lipase [65]. Recently phenolics have been suggested to exhibit health related functional properities such as anticarcinogenic, antiviral, antimicrobial, anti-inflammatory, hypotensive and antioxidant activites[76]. Tannin content of the investigated samples was relatively lower than the domesticated legumes like black gram, chickpea, cowpea and green gram [77, 78] and certain tribal pulses [53]. Tannins are known to inhibit the active digestive enzymes [79] and hence the presence of even a low level of tannin is not desirable from nutritional point of view. The concentration of the non-protein amino acid L-DOPA in *Mucuna pruriens* var. *utilis* (both samples) was high compared with those of other tribal pulses such as *M. utilis* and *M.monosperma* [57]; *M.Pruriens* var. *utilis* [80] and *M. atropurpurea* [53]. It has been demonstrated that in *M.pruriens*, the level of L-DOPA is significantly eliminated by dry heat treatment [23], cooking and soaking [81]. The high range of L-DOPA is encouraging from the point of view of pharmaceutical industries. The seeds of *Mucuna* have great demand in local markets, mainly for the presence of L-DOPA, a potential neurotransmitter used in the treatment of Parkinson's disease [13, 82].

Phytic acid has an anti-nutritional property because of its ability to lower the bioavailability of essential minerals and to form a complex with proteins, thereby inhibiting the enzymatic digestion of ingested protein [83]. Phytic acid content in the seeds of *M. pruriens* var. *utilis* (both samples) and *M.deeringiana* was low compared with those of *M. pruriens* [81]. It is worth-while to note that the phytate content in *Mucuna* beans could be substantially eliminated by processing methods such as soaking and cooking [81]. Hydrogen cyanide is known to cause acute or chronic toxicity. The content of HCN level in the presently investigated seed samples of *M. pruriens* var. *utilis* and *M.deeringiana* was far below the lethal level (i.e., 36mg/100g) [84]) and comparable with those of *Vigna sinensis* and *Pisum sativum* [85]; *Atylosia scarabaeoides* and *Tamarindus indica* [61, 53]. The total oxalate content of presently investigated three samples was found to be lower when compared with earlier studies on *Mucuna beans*. [86].

The range of trypsin inhibitor activity (43.70 – 47.20 $TIUmg^{-1}$ protein) was found to be low compared to *Cajanus cajan* var. Part A-2 and UPAS-120 [87] and *Glycine max* [88]. The oligosaccharide content of both the samples of *M.pruriens* var. *utilis* and *M.deeringiana* was comparable with that of five accessions of *M.pruriens var. utilis* [89]. The verbascose seem to be principle oligosaccharide in *M.pruriens* [81].

Phytohaemagglutinins (lectins) are substances possessing the property to agglutinate the human blood erythrocytes. In the current study, all the three samples registered higher haemagglutinating activity with respect to 'A' blood group of human erythrocytes. And all the samples have low levels of phytohaemagglutinating activity with respect to erythrocytes of 'O' blood group. This was good agreement with earlier reports in *Mucuna* beans [81, 23].

Table-4: Amino acid profiles of acid-hydrolysed, purified total seed proteins of *Mucuna pruriens* var. *utilis* and *M.deeringiana* (g $100g^{-1}$)[a]

Amino acid	*M. pruriens* var. *utilis* (White coloured seed coat)	EAAS	*M.pruriens* var. *utilis* (Black coloured seed coat)	EAAS	*M.deeringiana*	EAAS	FAO/WHO (1991) requirement pattern
Glutamic acid	11.60		13.28		14.30		
Aspartic acid	13.28		14.30		12.36		
Serine	4.54		4.63		3.83		
Threonine	3.54	104.11	3.68	108.24	4.14	121.76	3.4
Proline	3.09		3.66		2.94		
Alanine	4.16		4.06		5.28		
Glycine	5.22		5.94		4.38		
Valine	3.63	103.71	4.72	134.86	3.54	101.14	3.5
Cystine	1.11	} 75.6	1.24	} 75.2	0.78	} 57.6	2.5
Methionine	0.78		0.64		0.66		
Isoleucine	6.68		7.24	258.57	6.31	225.36	2.8
		238.57					
Leucine	5.24	79.39	6.04	91.52	5.78		6.6
						87.58	
Tyrosine	3.31	} 116.51	4.41	} 141.11	3.76	} 132.06	6.3
Phenylalanine	4.03		4.48		4.56		
Lysine	5.20	89.66	5.78	99.66	5.14	88.62	5.8
Histidine	2.94	154.74	3.33	175.26	2.74	144.21	1.9
Tryptophan	1.01	91.82	0.76	69.09	0.48	43.64	1.1
Arginine	6.74		7.26		5.26		

EAAS- Essential amino acid score

Table-5: Data on IVPD and antinutritional factors of seeds *Mucuna pruriens* var. *utilis* and *Mucuna deeringiana*

Components	***M.pruriens* var. *utilis* (White coloured seed coat)**			***M.pruriens* var. *utilis* (Black coloured seed coat)**			***M.deeringiana***		
In-vitro protein digestibility (%)[a]	73.28			76.40			71.26		
Total free phenolics[b] ($g100g^{-1}$)	3.68±0.06			4.06± 0.09			2.46± 0.05		
Tannins[b] ($g100g^{-1}$)	0.14± 0.01			0.18 ±0.01			0.18± 0.02		
L-DOPA [b] ($g100g^{-1}$)	7.55± 0.12			7.93±0.17			3.60±0.10		
Phytic acid [b] ($mg100g^{-1}$)	483.00±0.41			634.12±0.78			548.10±1.21		
Hydrogen cyanide [b] ($mg100g^{-1}$)	0.16			0.24			0.21		
Total oxalate [b] ($mg100g^{-1}$)	0.12			0.09			0.11		
Trypsin inhibitor Activity (TIU mg^{-1} protein)[a]	46.40			43.70			47.20		
Oligisaccharides[b]	Raffinose	Stahyose	Verbascose	Raffinose	Stahyose	Verbascose	Raffinose	Stahyose	Verbascose
($g100g^{-1}$)	1.06±0.06	1.24±0.05	3.48± 0.21	0.94±0.03	1.22±0.01	4.16± 0.14	1.04± 0.01	1.10±0.04	4.30± 0.07
Phyto haemagglutinating activity[a] ($HUmg^{-1}$protein)	A group	B group	O group	A group	B group	O group	A group	B group	O group
	180	66	14	176	74	10	164	84	18

±denotes standard error

[a]all values are of two independent experiments

[b]all values are means of triplicate determination expressed on a dry weight basis

The observation made in present study show that both seed samples of *M.pruriens var. utilis* and *M.deeringiana* are rich in crude protein, most of the essential amino acids, fatty acid such as linoleic, palmitic and oleic acids and some minerals. This study reveals that the nutritional profile of two samples of *M.pruriens var. utilis* and *M.deeringiana* seems to be similar to or higher than that of the other *Mucuna* species/accessions reported earlier and can also be explored as an alternate protein source to alleviate protein-energy- malnutrition among economically weaker sections of peoples 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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