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Nutritional potential and biochemical compounds in *Cajanus albicans* (wight & arn) van der maesan for food and agriculture

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The chemical and nutritional composition of *Cajanus albicans* (Wight & Arn.) van der Maesan underexploited tribal pulses in Eastern Ghats of Andhra Pradesh were determined. The mature seed samples were analyzed for proximate composition, total (true) seed protein fractions, amino acid composition, fatty acids profile, mineral and anti-nutritional factors. The investigated seed samples contained higher amount of crude protein, crude fat, ash and nitrogen free extractives constitute of 21.35, 3.90, 3.80 and 53.90/100 seed powder, respectively of the seed weight. The calorific value of 100g dry matter of seed material was 1783.92 kj/100 Dm. The essential amino acids, isoleucine, tyrosine and phenylalanine, were presented in relatively large quantities. The fatty acid profiles revealed that the seed lipids contained higher concentrations of palmitic and linoleic acids. The seeds were rich in sodium, phosphorus, calcium, zinc, manganese and iron. Anti-nutritional factors such as total free phenols, (3.76%) tannins (7.18%), L -DOPA (0.97%), hydrogen cyanide (1.25%) and phytic acid (6.32%) were presented in variable quantities. These antinutritional factors were potentially eliminated using the conventional methods of soaking the seeds in water, boiling with water and decanting prior to consumption. From the results, these plant have a good potential as food crops in Andhra Pradesh. Their cultivation and utilization should be encouraged. This would positively contribute toward improving food security.

Key words: *Cajanus albicans* (Leguminosae-Papilionoideae) proximate composition, amino acids, fatty acids. protein fractions, antinutritional factors

Introduction

Legumes have a high protein contents and they are an important source of cheap protein in many countries where animal protein is expensive. Seeds are second in important to cereals as sources of food but they are two to three times rich in protein then cereals (National Academy of Sciences, NAS 1979). Knowledge of the chemical composition of foods is the key recommendations

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of foods for providing a balanced nutritional diet. A table of food composition is used at the macro-level in planning food demand and supply, and at the micro level in developing prescribed diet as well as in determining and correcting the nutritional values of a given diet (Southgate, 1974). Inadequate availability and consumption of protein foods in India due to both population explosion and urbanization, if efforts are not being taken towards the finding alternate and cheaper sources of proteins. In spite of an urgent need to meet the nutritional requirements of the ever increasing populations, the available cheap protein resources have remained relatively unexplored (Murthy *et al.*, 2003 and Thangadurai *et al*., 2006). 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).

Wild seeds are commonly used as proteinaceous foods in different parts of the world (Amubode and Fetuga, 1983). There are some 28 wild legumes commonly consumed by different tribal sects of India. (Arora *et al.,* 1980 and Murthy and Pullaiah, 2005). However, most of the Indian legumes remain uninvestigated biochemically and nutritionally. The tribal communities living in the forests of Eastern Ghats in the vegetation of tropical moist deciduous and semi-evergreen forests, collected the seeds of wild legumes genetic resource, randomly in the vicinity of the forests, soak in water and consumed the seed meal after boiling and decanting for four to twelve times. This was tempted to study the biochemical composition of the seeds for its potential use in human nutrition.

Materials and methods

Preparation of seeds

The seeds of *Cajanus albicans* (Wight & Arn.) van der Maesan were collected from the dry deciduous forests near Talakona Forest of Chittoor district of Seshanchalam forest of Andhra Pradesh, during February 2005 near the vicinity of tribal hamlets and were used for analysis. The accessions were botanically identified by using the botanical keys of Pullaiah and Murthy, 2001 and deposited in the Herbarium of the Department of Biotechnology, Montessori Mahila Kalasala Herbarium. The moisture content was determined by drying 100 transversely cut seeds in an oven at 80^{o} C for 24 hours and was expressed on a percentage basis. The oven dried and air-dried seeds were powdered separately in a Kemi Mill (Scientific equipment works, Kerala), for 60-mesh size.

Chemical analysis

The fine powder obtained was used for further analysis. The total carbohydrate content was estimated (Conrad and Palmer, 1976). The crude protein content was calculated by multiplying the factor of 6.25 time's percent Kjeldahl nitrogen following Humphries method (1956). The crude fibre content was determined according to the methods described by Eggum and Beame (1983). The contents of nitrogen free extractives (NFEs), crude fat and ash were estimated by AOAC methods (1970). The energy content was determined by multiplying the percentage of crude protein, crude fat and nitrogen free extractives by factors of 4, 9, and 4 respectively (Osborne and Voogt, 1978).

Protein fractionation

The total true proteins were extracted by the method of Rajaram and Janardhanan (1990). The extracted protein was purified by precipitation with 20% cold TCA and determined by the method of Lowry *et al*., (1951). The seed protein fractions, albumins and globulins were extracted following the method of Murray (1979), from the remaining pellet; the prolamine protein fraction was extracted by treating it with 80% ethanol (1:5 w/v) overnight. After centrifugation at 20,000 x g for 20 minutes the supernatant containing prolamine was air dried and dissolved in 0.1 N Na OH. The remaining pellet was extracted with 0.4 N Na OH (1:10 w/v) overnight and centrifuged at 20,000 x g for 20 minutes. The supernatant thus obtained was assumed to be the glutelin protein.

The purified total seed proteins were acid hydrolyzed with 6 N HCl at 100^0 C for 24 h in vaccuo. After evaporation, the dried residue was dissolved in citrate buffer (pH 2.2), known aliquots were analyzed in LKB-Biochrome Automated Amino acid Analyzer Model 4151-Alpha Plus. For the determination of cystine, samples were oxidized with formic acid and hydrogen peroxide. Methionine amino acids recovered were presented as mg/100g proteins. The contents of different amino acids recovered were presented as mg/g protein. The essential amino acids were scored and compared with FAO, WHO, UNO (1985) reference pattern.

Fatty acids

The total lipids from the seed flours were extracted by method of Folch, *et al*., 1957 using chloroform and methanol mixtures in the ratio of 2:1 (V/V). Methyl esters were prepared from the total lipids by the method of Metcalfe *et*

al., (1966). Fatty acid analysis was prepared according to the work of Mohan and Janandhanan, 1993 by gas chromatography (Shimadzu, Model-RIA) using an instrument equipped with a flame ionization detector and a glass column (2 m x 3 mm) packed with 1% diethylene glycol succinate on chromosorb W (Silanised 80/100 mesh). The carrier gas was nitrogen, at flow rate of 32 ml/mim. The column temperature was 190 ^{0} C. Peaks were identified by comparison with authentic standards, quantified by peak area integration and relative weight percentage of each fatty acid was determined from integrated peak areas.

Minerals

The macro minerals and trace elements were estimated by the method of Issac and Johanson (1975), and Meines *et al*., (1976) in Perkin Elmer Model 5000 Atomic Absorption Spectrophotometer. Dry ashing procedures were used for the preparation of mineral solutions. The samples were ignited at 450^{0} C for 12 h in a muffle furnace and dissolved in 3 N HNO3. For correction of error for the determination of calcium and magnesium, a 1 % lanthanum solution was added to the sample. Phosphorus was measured by calorimetric means according to Virmani and Narula (1995).

Antinutritional factors

Antinutritional factors like total free Phenols, tannins, L-DOPA (3, 4,-dihydroxy phenylalanine), hydrogen cyanide and phytic acid were qualitative. The concentration of total free phenols was determined using the method of Mole and Waterman (1987). Tannins were captured and determined in a polyamide chromatography column following the method described by Burns (1971). L-DOPA content was determined by Brain method (1976). Hydrogen Cyanide was estimated by extraction with 0.1. M orthophosphoric acid. After extraction, sample was neutralized and estimated with chloramines T and barbituric acid reagent (Cooke and Madugwu, 1978 and Nambisan and Sundaresan, 1984). The calorimetric technique of wheeler and Ferrel (1971) as modified by Reddy, Pubols, and Mc J Ginnis (1978) was used to estimate phytic acid.

Results and discussion

Legumes seeds are valuable source of protein, carbohydrates, minerals, vitamins etc. and play an important role in human nutrition mainly in developing countries as stated by Yanez *et al*., (1995). In the present study

(Table 1) *Cajanus albicans* seed meal contained high amount crude protein of 21.35 %, crude fat of 3.90 % (Table 1) than in other as in commonly consumed legumes *Cicer arietinum* as previous works of Srivastava and Ali (2004), *Vigna umbellata* (Rajaram and Janardhanan, 1990) and *Canavalia virosa* (Thangadurai, *et al*., 2001). The food energy value of the seed was 1783.92 kj. due to the protein, lipid and NFEs rich nature. The seed protein fractionations content of *Cajanus albicans is* given in Table 2. Albumins and globulins were 8.64 and 2.95g/100g, respectively constitute the major bulk of the seed proteins as in many other legumes, and the percentage distribution of both proteins are more or less equal to that table by many workers *Vigna sesquipedalis* Rajaram and Janardhanan (1990), *Vigna trilobata* (Sidduraju *et al*., 1992), *Phaseolus lunatus* (Vijayakumari, *et al*., 1993) and *Abrus precatorius* (Mohan and Janardhanan 1995). The data on fatty acid composition of the seed lipids indicated that palmitic, linoleic, oleic and linolenic acid are the predominant fatty acids. (Table 3) Mohan and Janardhanan (1995) stated that The occurence of unsaturated fatty acids, which account for more than 60% of the seed lipids were compared with some other wild legumes The level of 34.87 and 25.76 g/100g of palmitic and linoleic acids, respectively (Table 3), were more than the cultivated legumes of *Vigna* according to the work of Salunkhe *et al*., 1982.

The data on amino acids profile of the purified seed proteins revealed that the essential amino acids, cystine, methionine and tryptophan are the conspicuous limiting amino acids. Whereas, the other essential amino acids leucine, lysine, isoleucine, valine, threionine and histidine are present in higher concentrations (95, 41, 46, 38, 44 and 31mg/100g crude protein, respectively) when compared with FAO / WHO / UNO (1985) provisional pattern adequate for human maintenance and normal growth (Table 4). The seeds were found to be a potential source of minerals (Table 5) such as calcium, potassium, magnesium, manganese and copper more than the previous work of Duke (1981) in the legumes of *Phaseolus lunatus, Leucaena leucocephala* and *Lathyrus sativus* and in comparison with recommended dietary content is more than in the legumes of *Abrus precatrius* and *Cassia obtusifolia* as stated by Mohan and Janardhanan (1995).

The anti-nutritional factors of seed flour are presented variably in Table 6. The seed contains relatively higher amount of 3.76 and 1.32 g of total free phenols and phytic acids, respectively, than the commonly cultivated legumes as observed earlier from Bressani *et al*. (1983), Khan, *et al*. (1979), Rajaram and Janardhanan, (1992) and Rodrigues and Thorne, (1991). The contents of tannin and non-protein amino acids L-DOPA are found to be very low (3.18 and 0.973 g respectively) when compared with other species in *Vigna* (Rajaram and Janardhanan, 1990; Siddhuraju *et al*., 1992). Apart from these anti-

nutritional factors, the presence of negligible amount of hydrogen cyanide (0.0125 g/100 g seed flour) was also noticeable. The phytohaemagglutinating activity of albumins and globulins were similar showing out with any specificity against human ABO system as observed earlier by iddhuraju *et al*., (1992).

Geervani and Theophilus, (1981) stated that The conventional method of repeated soaking and boiling of seeds in water followed by decanting five to six times before consumption is being practiced by the local tribes to eliminate most of the antinutritional factors. All the antinutritional factors reported except L-DOPA are heat labile. Hence they can be removed by wet or dry thermal treatments. In an earlier study, it has been demonstrated that the L-DOPA contents can also be significantly reduced by repeated soaking and boiling of the seeds in water, under optimum heat conditions to realize the maximum nutritional advantages (Thangadurai *et al*., 1999). Therefore, the presence of these antinutritional factors may not be limited factor in the utilization of these seeds for food and other purpose.

C. albicans may further be exploited in breeding programmes and popularized for mass cultivation and consumption in third world countries such as India to alleviate hunger and poverty. From the results of this study, it can be concluded that the carbohydrate, crude fat, crude protein and potassium contents of the flour of *C. albicans* significantly varied. More agronomic studies should be done on this legume with a view of cultivating it. Further studies could include amino acids and fatty acids contents of this legume. There are a cheap source of nutrients and could be useful in formulating balanced diets. As its domestication for commercial exploitation is considered in a number of biogeographical regions, such nutritional information is also very crucial overcome to the food crisis of ever expanding world's population.

Table 1. Proximate composition *Cajanus albicans*.

Component	Percentage
Moisture	11.49*
Total carbohydrates	52.12
Crude protein (Kjeldahl N x 6.25)	21.35
Crude fat	3.90
Crude fibre	7.23
Ash	3.80
Nitrogen Free Extractives (NFE)	53.90
kj 100 g^{-1} Dm	1783.92

* Mean of triplicate determinations expressed on dry weight basis (except moisture)

Table 2. Protein fractions of seeds of *Cajanus albicans**.

Protein fractions	g/100g seed flour
Total Protein (True protein)	24.59
Albumins	8.64
Globulins	12.95
Prolamines	1.05
Glutelins	2.15

*Mean of triplicate determinations expressed on dry weight basis

Table 3. Fatty acid composition of seeds of *Cajanus albicans**.

Fatty acids	Percentage
Palmitic acid (C_{16} : 0)	34.87
Stearic acid (C_{18} : 0)	13.90
Oleic acid C_{16} : 1)	18.69
Linoleic acid (C_{16} : 2)	25.76
Linolenic acid (C_{16} : 3)	6.78

*Mean of triplicate determinations expressed on dry weight basis.

Table 4. Amino acid composition of acid hydrolysed purified total seed proteins of *Cajanus albicans* (mg/100g crude protein).

Amino acids	g/100g seed protein Availability quantity	FAO/WHO/UNO recommended amino acid requirements (1985)			
		Infant	Pre-school child (2-5 years)	School child (10-12 years)	Adult
Glutamine	86				
Asparagine	56				
Serine	21				
Threonine	44	43	34	28	9
Proline	38				
Alanine	19				
Glycine	22				
Valine	38	55	35	25	13
Cysteine +Methionine	41+12	42	25	22	17
Leucine	95	93	66	44	19
Isoleucine	46	46	28	28	13
Tyrosine + Phenylalanine	16+25	72	63	22	19
Lysine	41	66	58	44	18
Histidine	31	26	19	19	16
Tryptophan	12	17	11	9	5
Arginine	168				

Table 5. Data on selected mineral composition of *Cajanus albicans* seed meal*

Mineral	Availability quantity * (mg/100g seed flour)	FAO/WHO/UNO recommended dietary allowances in mg/100 g seed protein (1989)				
		Adult (Male)	Adult (Female)	Children (7-10 years)	Infant	Pregnant and Lactating women
Sodium	43.3	500	500	400	120-200	500
Potassium	872.90	2000	2000	1600	500-700	2000
Calcium	1522.00	800	800	800	600	1200
Magnesium	20.40	350	280	170	60	355
Phosphorus	340.70	800	800	800	500	1200
Zinc	48.70	15	12	10	5	19
Manganese	13.60	2-5	2-5	2-3	0.3-1.0	2-5
Iron	72.10	10	15	10	10	13
Copper	1.20	1.5-3	1.5-3	1-2	0.6-0.7	1.5-3

* Mean of triplicate determinations expressed on dry weight basis

Table 6. Antinutritional factors present in the seed flour of *Cajanus albicans* *.

Components	g/100g seed flour
Total free phenols	3.76
Tannins	3.18
L-DOPA	0.973
Hydrogen cyanide	0.0125
Phytic acid	1.32

* Mean of triplicate determinations expressed on dry weight basis.

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