American Journal of Food Technology

ISSN 1557-4571

Academic Journals Inc.

www.academicjournals.com

American Journal of Food Technology 7 (8): 487-493, 2012
ISSN 1557-4571 / DOI: 10.3923/ajft.2012.487.493

Proximate Composition and Nutritional Evaluation of Underutilized Legume *Psophocarpus tetragonolobus* (L.) DC. Grown in Manipur, Northeast India

[1]R.D. Ningombam, [1]P.K. Singh and [2]J.S. Salam
[1]Centre of Advanced Studies in Life Sciences, Manipur University, Canchipur-795 003, India
[2]Biochemistry Laboratory, College of Agriculture, Central Agriculture University, Imphal, India

Corresponding Author: Potsangbam Kumar Singh, Centre of Advanced Studies in Life Sciences, Manipur University, Canchipur-795 003, India

ABSTRACT

Psophocarpus tetragonolobus (L.) DC. (Winged bean), a lesser known nutritious leguminous plant is grown luxuriantly in Manipur State, North-east India. Almost all the plant parts; leaves, flowers, immature pods, matured seeds and tubers are edible. Winged bean plant parts viz., seeds (tender, matured and fully matured seed), pods case (tender, matured and fully matured pod case) and tubers were chemically analysed on dry weight basis. The concentration of crude protein, fat, and fibre, total sugar, reducing and non-reducing sugars, starch, total amino acid and minerals (Ca, K, Mg, Fe, Zn, Mn, Cu and Co) were analysed. The results indicated that the highest crude fat (1.7%) was present in mature seed and crude protein was present in fully mature seed (50.7%). The maximum amounts of total sugar (488.90 mg g^{-1}), non-reducing sugar (415.95 mg g^{-1}) and starch (420.60 mg g^{-1}) were recorded in tuber. The plant was also found to have significant quantity of minerals. As regard to the mineral content, mature pod case showed the maximum amount of K (8.9 mg g^{-1}), Ca (8.06 mg g^{-1}) and Mg (5.72 mg g^{-1}). Thus, among the stages taken for analysis, mature pod case contains the maximum amount of macro- and micro-elements. So *P. tetragonolobus* has got a great future prospect, if properly exploited may serve as a supplementary source of protein and minerals, as a subsidiary food material in Manipur.

Key words: *Psophocarpus tetragonolobus*, minerals, biochemicals, nutritional status, macro-elements, micro-elements

INTRODUCTION

In the quest for newer plant sources to combat protein-calorie malnutrition in developing countries, the winged bean (*Psophocarpus tetragonolobus*) with its versatile attributes has received special attention. The entire plant, from flowers and leaves to tuberous roots and seeds, is fit for human consumption. The nutritional advantages of winged bean lie in its seeds which possess protein and oil contents equivalent to that of soybeans. It is now being grown in more than 70 countries where it has met with varied success depending upon the prevailing climate and edaphic conditions (Misra *et al*., 1987).

The winged bean has aroused great interest in recent years as a protein source. NAS of the United States of America (NAS, 1981) reported that winged bean is a promising source of protein and oil. Banerjee (1985) reported the nutritional potential of the winged bean. Misra *et al*. (1987)

reported the assay of some nutritional and antinutritional factors in different cultivars of winged bean seeds of different regions. Kantha *et al.* (1986) studied the nutrient, antinutrient contents and solubility profiles of nitrogen, phytic acid and selected minerals in winged bean flour grown in Sri Lanka. Mnembuka and Eggum (1995) compared the nutritive value of winged bean and other legumes grown in Tanzania. Amoo *et al.* (2006) evaluated the chemical value of winged beans, Pitanga cherries and orchid fruit. Khomdram *et al.* (2011) also gave the dietary values of eight selected herbs of Lamiaceae which are commonly utilized by Manipur, having high content of potassium, nitrogen, magnesium and calcium on dry weight basis. Several studies have indicated the high nutritive value of winged bean seeds.

Winged bean is locally known as Tengnou-manbi in Manipur and constitutes as a favourite supplementary delicacy. The purpose of utilization of this legume is oriented only by traditional boundaries i.e., curries like Iromba and Singju (salads) and people regard them with less importance. Manipur state which extends between 23°59'N-25°47'N and between 92°59'E-94°46'E with total geographical area of 23,327 km^2, lies in the North-eastern part of India and falls under Indo-Myanmar hotspot regions of the world (Myers *et al.*, 2000). Exploitation of underutilized legumes is an important approach to combat the protein-malnutrition in developing countries. The present research programme aimed in providing basic information on the proximate and mineral composition of underexploited and underutilized winged bean of Manipur.

MATERIALS AND METHODS

Winged bean seeds collected locally were grown experimentally in field. The seeds were sown in May, 2008. The first flowering was observed in September, 2008. Sampling of the plants were conducted at three stages where they could be best utilised i.e., (i) Tender Pod Case (TPC) stage (8 days after flowering), (ii) Matured Pod Case (MPC) stage (14 days after flowering) and (iii) Fully Matured Pod Case (FMPC) stage (25 days after flowering), the seeds were categorized into three stages (i) Tender Seed (TS), (ii) Matured Seed (MS), (iii) Fully Matured Seed (FMS) and (iv) Tuber (after one year of growth). All these pods, seeds and tuber at different stages of development were taken and analyzed separately (Fig. 1). Plant samples were air dried at 24±1°C and ground

Fig. 1(a-f): Plant parts of *Psophocarpus tetragonolobus* (L.) DC, (a) Climbing habit, (b) Flower, (c) Pods, (d) Dissected pod showing seeds arrangement, (e) Tuberous root and (f) Different stages of pods

with a Remi grinder and sieved (1 mm). The powder samples were stored in desiccators at room temperature at 24±1°C until analysis. The following determinations were performed on the flour samples of the plant.

Estimation of proximate composition: The moisture content was determined by drying in an oven at 80°C for 24 h and is expressed on a percentage basis. Crude fat content was determined using Soxhlet apparatus method. Crude protein content in plant sample was estimated by the Kjeldahl method (Gupta, 2006). Crude fibre was determined by acid and alkaline digestion method following the procedures of Chopra and Kanwar (1980).

Estimation of carbohydrates, amino acids and proteins: Different methods were followed for estimation of total soluble sugar, reducing sugars, non-reducing sugars and starch. Total soluble sugar was estimated following the method of Dubois *et al.* (1951). Reducing sugars was estimated by dinitrosalicylic method following the procedures described by Sadasivam and Manikam (1992). Estimation of non reducing sugars was estimated following Malhotra and Sarkar (1979). Starch was analysed by following method of Anthrone reagent described by Thimmaiah (2006). The total free amino acid was estimated by following method of Moore and Stein (1948). The total soluble protein content was estimated by the method of Lowry *et al.* (1951).

Estimation of minerals: Wet digestion method of Capar *et al.* (1978) was followed for the analysis of different minerals. K was estimated in a systronics-105 flame photometer. Sulphur and Phosphorus were estimated in a UV-VIS double beam Spectrophotometer following the procedures described by Murthy (2006) and Gupta (2006). Ca, Mg, Mn, Zn, Fe, Cu and Co was analyzed by using Perkin Elmer atomic absorption spectrophotometer, Analyst AA-200.

Statistical analysis: The data obtained were statistically analyzed with one-way ANOVA. Comparison of means was performed using Tukey's HSD test (SPSS.16). Significance differences between means were determined at $p<0.05$. The data were reported as means and ±Standard Deviation (SD).

RESULTS AND DISCUSSION

The proximate composition and biochemical constituents of the winged bean parts at different three stages are given in Table 1. It was observed that the crude fat ranged from 0.47% in FMS and FMPC to 1.7% in MS. Higher value of crude protein (50.7%) was found in FMS while minimum value of crude protein (17%) was noticed in tuber which was higher than values reported by Banerjee (1985), Tadera *et al.* (1984) and Amoo *et al.* (2006). The crude protein present in seed is close proximity with the value reported by Cerny *et al.* (1971). The crude fat content was highest in case of MS (1.7%) and minimum in FMS and FMPC (0.47%). At maturity the pod start drying up and thus decrease in fat content. All the samples showed variation in crude fibre contents ranging from 2.76 to 24.58% (Table 1). In the present study the crude fibre content of the seed samples (5.55 to 12.65%) are in close proximity with those of winged bean seed (6.12 to 8.73%) reported by Misra *et al.* (1987). The value of crude fibre is also comparable to the value reported by Cerny *et al.* (1971). Gajameragedera and Ravindran (1989) reported that crude fibre of seed ranged from 6.1 to 8.8%. As the maturity proceeds, the crude fibre content increases from TS to FMS (5.55 to 12.65%) and also increased from 19.01 to 24.58% (TPC-FMPC) in pod

Table 1: Proximate and biochemical constituents in different plant parts of *Psophocarpus tetragonolobus*

	Plant parts						
Parameters	Tender seed	Mature seed	Fully mature seed	Tender pod case	Mature pod case	Fully mature pod case	Tuber
Moisture (%)	88.30	87.10	86.10	89.70	90.60	92.60	60.10
Crude fat (%)	1.10	1.70	0.47	0.69	0.83	0.47	0.56
Crude protein (%)	45.50	47.20	50.70	44.20	44.60	41.10	17.00
Crude fibre (%)	5.55	8.57	12.65	19.01	21.86	24.58	2.76
Total sugar (mg g^{-1})	145.50±4.91^{a}	154.1±7.21^{a}	161.40±0^{a}	62.60±2.38^{b}	90.30±1.32^{c}	144.20±6.11^{a}	488.90±12.35^{d}
Reducing sugar (mg g^{-1})	76.50±6.5^{a}	95.50±2.92^{b}	115.00±1^{c}	58.50±3.5^{d}	81.50±1.5^{a}	91.50±1.5^{b}	73.00±3.00^{a}
Non-reducing sugar (mg g^{-1})	68.98±1.59^{a}	55.40±7.55^{ab}	46.43±1^{b}	5.50±3.71^{c}	13.20±1.57^{d}	52.73±7.61^{a}	415.95±15.35^{e}
Starch (mg g^{-1})	328.60±18.40	138.2±6.13	396.10±12.26	-	-	-	420.60±18.40
Total amino acid (mg g^{-1})	54.90±1.47^{a}	59.90±2.37^{ab}	64.60±1.77^{b}	38.60±0.59^{cd}	33.50±2.07^{c}	38.80±2.07^{cd}	40.00±2.07^{d}
Total soluble protein (mg g^{-1})	94.40±0.63^{a}	141.6±2.41^{b}	152.70±9.64^{b}	45.50±0.25^{c}	58.20±1.01^{d}	41.30±2.15^{c}	107.10±4.69^{e}

-: Not done, values are Means in the same row followed by the same superscripts are not significantly different at the 5% level of significance

case (Table 1). In the present investigation, the amount of crude protein and crude fat increased significantly because of the maturity. The higher amount of crude protein was recorded in case of MPC (44.6%) and in MS (47.2%) (Table 1). The low crude fibre content of MPC (21.86%) and MS (8.57%) amongst the plant stages makes the mature pod palatability. The total sugar was found to be highest in tuber (488 mg g^{-1}) and minimum in case of TPC (62.6 mg g^{-1}). Starch content in tuber (420.6 mg g^{-1}) is similar to that of potato reported by Tadera *et al.* (1984). Among all the seeds, the fully mature seed of winged bean was the highest (396.10 mg g^{-1}) value of starch. As the maturity approaches, the total amino acid increases from 33.5 to 64.6 mg g^{-1}. The FMS contains maximum amount of total soluble protein (152.70 mg g^{-1}) content and minimum values found in FMPC (41.30 mg g^{-1}) (Table 1).The maximum and minimum reducing sugar content ranged from 115 mg g^{-1} in FMS to 73.0 mg g^{-1} in tuber. The values of non-reducing sugar varied from 5.50 mg g^{-1} in TPC to 415.95 mg g^{-1} in tuber.

Figure 2 and 3 show the mineral contents in different parts of winged bean which is expressed on dry weight basis as mg g^{-1}. Singh *et al.* (2009) also supported the view that, different legumes differ widely in their mineral composition. In the present study, the K content (5.60 to 8.9 mg g^{-1}) was the most abundant mineral in all the parts of the stages. This was in agreement with the observations of Amoo *et al.* (2006) and Gajameragedera and Ravindran (1989). Mg content ranks next to K in abundance in all the stages. Winged bean seeds, pod without seeds and tuber contain significant amounts of minerals during all the developmental stages. The K content of the samples used in this study are generally low compared to K content of winged bean (8.00 to 10.55 mg g^{-1}) as reported by Gajameragedera and Ravindran (1989). However, appreciably higher value of K (4.219 mg g^{-1}) in winged bean had been reported by Amoo *et al.* (2006). The values of sulphur content in the samples are generally low with least value as 0.10 mg g^{-1} in tuber. The value of Ca content ranges from 2.79 mg g^{-1} (TS) to 8.06 mg g^{-1} (MPC). These values were within the ranged with that of the values reported by Gajameragedera and Ravindran (1989). There is significant

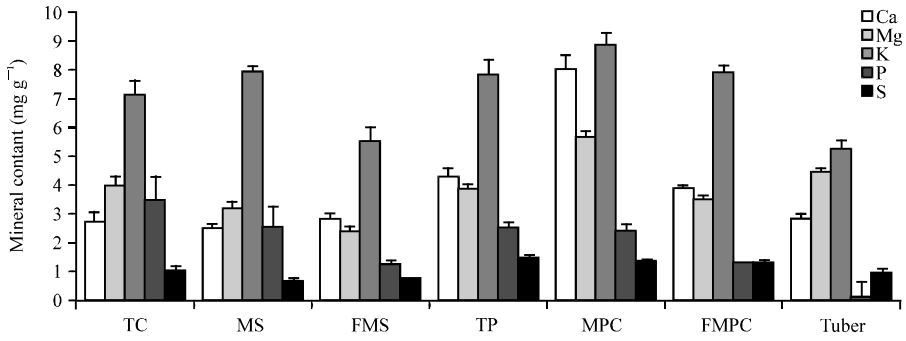

Fig. 2: Macro-element contents in different parts of *Psophocarpus tetragonolobus* on a dry weight basis

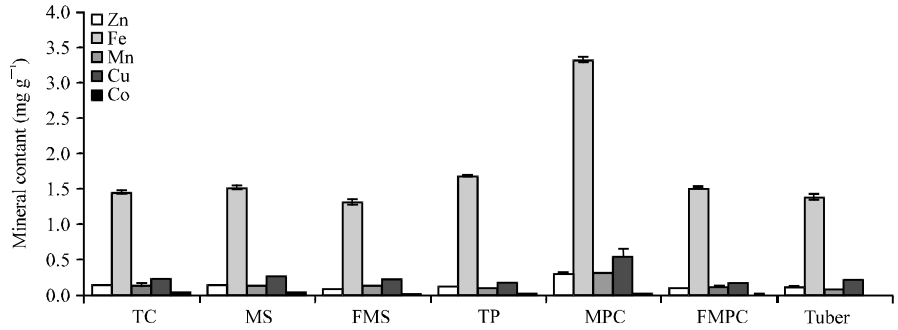

Fig. 3: Micro-element contents in different parts of *Psophocarpus tetragonolobus* on a dry weight basis

difference in the P content of the seeds with highest values found in tender seed (3.57 mg g^{-1}) and lowest values in tuber (0.17 mg g^{-1}). These values are comparatively lower than those values reported by Gajameragedera and Ravindran (1989). Mg contents of 2.49 mg g^{-1} (FMS) to 5.72 mg g^{-1} (MPC) of all the stages are higher than the ranged in winged bean (1.95 to 2.46 mg g^{-1}) reported by Gajameragedera and Ravindran (1989). The Zn content 0.12 mg g^{-1} (FMS) to 0.32 mg g^{-1} (MPC) in the seeds and pods are considerably lower than the values reported by Amoo *et al.* (2006) for seeds of *Psophocarpus tetragonolobus* (364.76 mg kg^{-1}), *Eugenia uniflora* (273.34 mg kg^{-1}) and orchid fruit *Myristica* (310.74 mg kg^{-1}) but higher than those contents reported by Gajameragedera and Ravindran (1989). The pods and seeds are relatively low in Mn content (0.13-0.34 mg g^{-1}). The trace element reported by Gajameragedera and Ravindran (1989) is comparatively low. The Fe contents are relatively low, ranging from 1.33 mg g^{-1} in fully mature seed to 3.33 mg g^{-1} in mature pod case. The values of Cu content in the samples are generally low with the highest values as 0.56 mg g^{-1} in mature pod case and the least value as 0.19 mg g^{-1} in tender pod case. And no marked differences were observed with regard to the trace minerals. Among all the stages the mature pod contain maximum amounts of K (8.9 mg g^{-1}), Ca (8.06 mg g^{-1}), Mg (5.72 mg g^{-1}) and the least concentration of K (5.60 mg g^{-1}) and Mg (2.49 mg g^{-1}) was found in FMS where Ca (2.57 mg g^{-1}) content was found to be minimum in MS. The content of trace-elements are also found maximum in MPC with the values of Fe (3.33 mg g^{-1}), Zn (0.32 mg g^{-1}), Mn (0.34 mg g^{-1}), Cu (0.56 mg g^{-1}) and Co (0.04 mg g^{-1}) and minimum in FMS with

values of Fe (1.33 mg g^{-1}), Zn (0.12 mg g^{-1}), Mn (0.13 mg g^{-1}). At the maturity mostly the content of elements showed slightly high and then decline at fully matured stage. Phosphorus and sulphur are found to be decrease with maturity in all the stages. Thus, among all the stages taken for analysis, mature pod contains the maximum amount of macro-elements and micro-elements.

CONCLUSION

In the present study, the winged bean which is a common leguminous plant is taken by the people of Manipur as vegetables. The plant is found to have significant amount of protein, carbohydrates, amino acid and minerals and higher amount of starch. Potassium is found to be maximum among the minerals. This legume is available at cheaper rate than other preferred legume by the local people. The analytical data suggests that the nutritive winged bean seed can be used as a food source. The bean merits wider use in India and other parts of the Tropics. As its nutritive value is remarkably similar to soybean in view of its nutritional potential, concentrated effort are needed to popularise this economical, protein rich legume as a vegetable for an economically backward state like Manipur.

ACKNOWLEDGMENTS

Authors are grateful to the Head, Centre for Advanced Study in Life Sciences Department, Manipur University and to the Head, Biochemistry Laboratory, College of Agriculture, Central Agriculture University for providing all facilities and encouragements during the research programme.

REFERENCES

Amoo, I.A., O.T. Adebayo and A.O. Oyeleye, 2006. Chemical evaluation of winged beans (*Psophocarpus tetragonolobus*), Pitanga cherries (*Eugenia uniflora*) and orchid fruit (*Orchid fruit myristica*). Afr. J. Food Agric. Nutr. Dev., 6: 1-12.

Banerjee, A., 1985. Nutritional potential of the winged bean. Ind. J. Nutr. Dietet., 22: 49-51.

Capar, S.G., J.T. Tanner, M.H. Friedman and K.W. Boyer, 1978. Multielement analysis of animal waste and sewage sludge. Environ. Sci. Technol., 12: 785-790.

Cerny, K., M. Kordylas, F. Pospisil, O. Svabensky and B. Zajic, 1971. Nutritive value of the winged bean (*Psophocarpus palustris* Desv.). Br. J. Nutr., 26: 293-299.

Chopra, S.L. and J.S. Kanwar, 1980. Analytical Agricultural Chemistry. Kalyani Publishers, New Delhi, pp: 337-346.

Dubois, M., K. Gilles, J.K. Hamilton, P.A. Rebers and F. Smith, 1951. Colorimetric method for determination of sugar. Nature, 168: 167-167.

Gajameragedera, S. and G. Ravindran, 1989. Composition changes in winged bean *Psophocarpus tetragonolobus* (L.) DC seed during maturation. J. Natn. Sci. Coun. Sri Lanka, 17: 131-139.

Gupta, P.K., 2006. Soil, Plant, Water and Fertilizer Analysis. Agrobios Agro House, Behind Nasraru Cinema Chopsail Road, Jodhpur (India), pp: 241.

Kantha, S.S., N.S. Hettiarachchy and J.W. Jr. Erdman, 1986. Nutrient, antinutrient content and solubility profiles of nitrogen, phytic acid and selected minerals in winged bean flour. Cereal Chem., 63: 9-13.

Khomdram, S.D., J.S. Salam and P.K. Singh, 2011. Estimation of nutritive indices in eight Lamiaceae plants of Manipur. Am. J. Food Technol., 6: 924-931.

Lowry, O.H., N.J. Rosebough, A.L. Farr and R.J. Randall, 1951. Proteine measurement with the Folin phenol reagent. J. Biol. Chem., 193: 265-275.

Malhotra, S.S. and S.K. Sarkar, 1979. Effects of sulphur dioxide on sugar and free amino acid content of pine seedlings. Physiologia Plantarum, 47: 223-228.

Misra, P.S., G. Misra, D. Prakash, R.D Tripathi, A.R. Chaudary and P.N. Misra, 1987. Assay of some nutritional and antinutritional factors in different cultivars of winged bean *Psophocarpus tetragonolobus* (L.) DC seeds. Plants Foods Human Nutr., 36: 367-371.

Mnembuka, B.V. and B.O. Eggum, 1995. Comparative nutritive value of winged bean (*Psophocarpus tetragonolobus* (L) DC) and other legumes grown in Tanzania. Plant Foods Hum Nutr., 47: 333-339.

Moore, S. and W.H. Stein, 1948. Photometric method for use in the chromatography of amino acids. J. Biol. Chem., 176: 367-388.

Murthy, Y.L.N., 2006. Estimation of secondary and micronutrients in soil and plant samples. Proceedings of the New Dimensions in Integrated Nutrient Management of Major Field Crops for Sustainable Crop Production, October 5-25, 2006, Directorate of Oilseeds Research, Hyderabad, India, pp: 85-94.

Myers, N., R.A. Mittermeier, C.G. Mittermeier, G.A.B. da Fonseca and J. Kent, 2000. Biodiversity hotspots for conservation priorities. Natures, 403: 853-858.

NAS, 1981. Winged Bean High-Protein Crop for the Tropics. 2nd Edn., National Academy of Sciences, Washington, DC., Pages: 48.

Sadasivam, S. and A. Manickam, 1992. Biochemical Methods for Agricultural Sciences. Wiley Eastern Ltd., New Delhi, India, ISBN: 8122403883.

Singh, S.J., P.K. Singh, B.K. Dutta and U.K. Sahoo, 2009. Chemical composition and nutritive indices in *Parkia roxburghii* G. don, a leguminous plant of India. Indian J. Agric. Biochem., 22: 87-93.

Tadera, K.T., T. Taniguchi, M. Teramoto and M. Arima *et al.*, 1984. Protein and starch in Tubers of winged bean, *Psophocarpus tetragonolobus* (L.) DC. and yam bean, *Pachyrrhizus erosus* (L.) Urban. Mem. Fac. Agr. Kagohima Univ., 20: 73-81.

Thimmaiah, S.R., 2006. Standard Methods of Biochemical Analysis. Kalyani Publishers, New Delhi, India, ISBN-13: 9788176630672, Pages: 545.