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Biochemical Evaluation of Some Promising Varieties/Genotypes of Rice Bean [*Vigna umbellata* (Thunb.; Ohwi and Ohashi)]

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The dried seeds of twelve varieties/genotypes of rice bean [*Vigna umbellata* (Thunb; Ohwi and Ohashi)] grown at research farm of NBPGR, Phagli, Shimla during 2008 were analysed for some biochemical constituents of nutritional significance. 100-seed weight ranged from 5.5 to 8.3 g, whereas the moisture content varied from 9.5 to 10.9. Significant variations in quality attributes *viz.,* crude protein, ether extract, crude fibre, ash, carbohydrate, methionine, tryptophan, *in vitro* protein digestibility, tannins, cooking time, calcium, iron, zinc and phosphorus were observed to range from 17.9 to 19.4, 0.48 to 1.15, 4.6 to 6.7, 3.9 to 5.7, 58.0 to 61.2*per cent*, 0.98 to 1.50, 0.84 to 1.36 g per 100 g protein, 83.3 to 88.5 *per cent*, 490 to 860 mg/ 100 g, 44 to 56 minutes, 256 to 385, 3.6 to 7.4, 2.4 to 4.2 and 273.3 to 517.9 mg per 100 g, respectively. The study indicated that varieties/genotypes *viz.,* BC-1 in seed weight; PRR-2007-1, BC-1 and RBL-6 in moisture (exhibiting lowest value); PRR-2007-1 in crude protein; PRR-2007-1 in oil; RL-3 in crude fibre; RBL-1 in ash; LRB-160 in carbohydrates; LRB-470 in methionine; PRR-1 in tryptophan; RBL-1 for *in vitro* protein digestibility; BC-1 in tannins (with its lowest value), RBL-6 in cooking quality; LRB-160 in calcium; BC-1 in iron; PRR-2007-2 in zinc; BC-1 in phosphorus emerged promising for individual quality trait. Besides, based on varietal rating taking into consideration performance of varieties/genotypes with regard to desirable quality attributes *viz.,* protein, fibre, carbohydrates, methionine, tryptophan, *in vitro* protein digestibility, cooking quality, calcium (in descending order) and anti-nutritional factor-tannins (in ascending order) taken together varieties RBL-6, LRB-470 and RBL-1 were identified to be overall superior multipurpose varieties in that order.

***Key words*:** Rice bean, protein, crude fibre, methionine, tryptophan, *in vitro* protein digestibility, tannins, calcium, iron, zinc

Rice bean (*Vigna umbellata* (Thunb.) Ohwi and Ohashi) also known as climbing mountain bean, mambi bean, oriental bean and rajmoongi is the native of South-East Asia. In India, the distribution of the crop is confined to North-Eastern hills, Western and Eastern Ghats and parts of Himachal Pradesh (1). It is one of the promising beans having high yield potential. The nutritional profile of rice bean is very high due to the high content of proteins and essential amino acids (tryptophan and methionine) as compared to the other traditional pulses (2). The mature seeds are also rich in important minerals and water soluble vitamins like thiamin, riboflavin and niacin. The vegetative parts of the crop serve as nutritive forage for animals. Thus, the suitability of rice bean both for food and fodder makes it a dual purpose crop (3). Since rice bean appears to be a new addition to the group of pulses, the pertinent information on biochemical constituents of dietary significance of promising genotypes grown in Himachal Pradesh conditions is still scanty. Thus, the present investigation was carried out to evaluate important nutritional quality attributes of this underutilized food legume, to identify the nutritionally superior multipurpose genotypes for crop improvement.

Materials and Methods

Seed samples of twelve varieties/genotypes of rice bean were grown in randomized block design with three replications at the research farm of NBPGR Regional Station, Phagli, Shimla during the year 2008. The oven dried seed samples were ground in a sample grinder and stored in air tight containers for biochemical analysis. Various varieties/genotypes were analysed in triplicate for moisture, crude protein, ash, crude fibre by following the AOAC method (4) and oil (ether extract) by AOAC method (5). Carbohydrate content was computed as a difference of 100 – (moisture + crude protein + oil + ash + crude fibre). The essential amino acids (methionine and tryptophan), *in vitro* protein digestibility and tannins were estimated by the methods of Horn *et al.* (6), Mertz *et al.* (7), Akeson and Stahman (8) and Makkar *et al*. (9), respectively. Cooking quality of rice bean was determined by recording the cooking time. Five gram of

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sample was put in a beaker with excess of deionized water (20 ml) and kept in boiling water. Seeds were tested for 'doneness' by pressing them between layers of filter paper and cooking time was recorded. Minerals *viz.*, calcium, iron and zinc were digested using the di-acid wet digestion (HNO_3:$HClO_4$) (3:1) and estimated by using Atomic Absorption Spectrophotometer (Model ContrAA 700). However, the phosphorus content in the digested samples was estimated by vanado-molybedo phosphoric acid yellow colour method of Jackson (10). The data was analysed statistically by using analysis of variance as given by Panse and Sukhatme (11).

Results and Discussion

Differences in biochemical constituents of various varieties/genotypes of rice bean are depicted in Table 1. A variation in 100-seed weight was observed from 5.5 to 8.3 g with the highest value in BC-1 and the lowest in PRR-2007-2. Variation in 100 seed weight was in agreement with that reported by Hira *et al.* (12). The moisture content varied from 9.5 (PRR-2007-1, BC-1, RBL-6) to 10.9 (PRR-1) *per cent,* PRR-2007-2 and LRB-160 showed higher values for this parameter. However, the released varieties *viz.,* PRR-2 and RBL-1 exhibited 10.5 and 10.1 *per cent* moisture content. The range of variation in moisture content was in close proximity with earlier reports of Sadana *et al.* (13) in rice bean genotypes. Crude protein content ranged from 17.9 (RBL-6) to 19.4 (BC-1) *per cent* and the released varieties *viz.,* PRR-1, PRR-2, RBL-1 and RBL-6 contained 18.5, 18.0, 10.1 and 9.5 *per cent* in the decline order, respectively. The extent of variation was in agreement with the observations of Saikia *et al.* (14), Sadana *et al.* (13) and Myrna *et al.* (15), respectively. Moreover, Narasinga *et al.* (16) also reported that values for protein content in rice bean are also comparable to some cultivated legume seeds like cowpea (24.1 %), green gram (24.0 %), bengal gram (17.1 %), lentils (25.1 %), moth bean (23.6 %) and peas (19.7 %), respectively but were lower than soy bean (43.2 %). In rice bean seeds, oil (ether extract) content varied from 0.48 to 1.15 *per cent.* The genotype PRR-2007-1 contained more oil content followed by the genotype(s) PRR-2 and PRR-1. RBL-6 exhibited the lowest oil content. The trend of variation for oil content is in consonance with the findings of Saikia *et al.* (14) and Sadana *et al.* (13), who have reported 0.46 to 2.2 *per cent* oil content in this crop. Values in respect of ash and crude fibre content ranged from 3.9 (PRR-2007-1) to 5.7 (RBL-1) *per cent* and 4.6

Table 1: Variation in biochemical constituents of rice bean varieties/genotypes

Parameters	PRR-1*	PRR-2*	PRR-2007-1	PRR-2007-2	PRR-2008-1	PRR-2008-2	BC-1	RL-3	RBL-1*	RBL-6*	LRB-160	LRB-470	SE(±m)	CD(5%)
100-seed weight (g)	7.1	7.0	6.2	5.5	7.1	6.3	8.3	7.9	7.4	6.8	7.5	7.9	0.29	0.84
Moisture (%)	10.9	10.5	9.5	9.9	10.8	10.3	9.5	10.1	10.1	9.5	9.9	10.0	0.16	0.47
Crude protein (%)	18.5	18.0	18.8	18.6	19.2	18.6	19.4	18.1	18.6	17.9	18.1	18.8	0.23	0.67
Oil (Ether extract) (%)	0.60	0.68	1.15	0.58	0.48	0.53	0.55	0.57	0.59	0.48	0.52	0.58	0.02	0.07
Crude fibre (%)	5.1	4.6	6.3	6.4	6.5	6.7	5.4	6.2	5.8	6.6	5.5	5.8	0.03	0.10
Ash (%)	4.3	4.5	3.9	5.2	4.2	4.1	4.2	4.2	5.7	4.1	4.2	4.1	0.07	0.22
Carbohydrates (%)	61.2	60.7	58.0	58.4	60.1	61.0	60.9	60.0	59.1	61.0	60.8	60.7	0.30	0.87
Methionine (g/100g protein)	0.98	1.44	1.32	1.12	1.02	1.08	1.00	1.32	1.22	1.04	1.04	1.50	0.03	0.94
Tryptophan (g/100g protein)	1.36	1.02	0.90	0.84	0.94	0.98	0.86	0.96	1.24	1.26	1.08	1.14	0.02	0.07
**IVPD (%)	85.8	84.9	85.4	83.3	83.6	81.9	85.7	86.8	88.5	88.2	88.0	88.4	0.57	1.66
Total tannins (mg/100 g)	850	740	860	670	600	760	490	590	660	640	530	510	1.46	4.27
Cooking time (min.)	55	54	55	56	53	54	51	48	45	44	48	47	0.37	1.09
Calcium (mg/100 g)	319.5	385.0	292.0	265.0	332.1	324.0	336.5	355.0	347.5	344.0	365.3	337.4	1.06	3.11
Iron (mg/100 g)	3.8	4.3	3.6	5.6	3.8	4.1	7.4	5.2	4.9	5.2	5.3	4.7	0.07	0.21
Zinc (mg/100 g)	3.8	4.0	2.4	4.2	4.0	2.8	4.0	3.6	3.9	3.5	3.5	3.3	0.06	0.17
Phosphorus (mg/100 g)	374.9	454.3	273.3	415.7	462.5	427.7	517.9	383.1	438.5	410.3	459.2	420.1	1.91	5.58

Values on dry weight basis *Released varieties, **IVPD = *In vitro* protein digestibility

(PRR-2) to 6.7 (PRR-2008-2) *per cent*, respectively. The released varieties i.e. PRR-1, PRR-2 and RBL-6 contained 4.3, 4.5 and 4.1 *per cent* ash content, whereas PRR-1, RBL-1 and RBL-6 exhibited 5.1, 5.8 and 6.6 *per cent* crude fibre. The present report is in conformity with the values observed by Sadana *et al.* (13), Saikia *et al.* (14) and Myrna *et al.* (15). Kanwar *et al.* (17) revealed variation in crude fibre content from 4.8 to 6.0 *per cent* in Indian edible legumes *viz.,* bengal gram, cowpeas, green gram, moth beans and peas.

Variation in carbohydrate content of rice bean varieties/ genotypes was 58.0 to 61.2 *per cent*. The genotype PRR-1 showed the highest carbohydrate content followed by PRR-2008-2 and RBL-6 with the lowest value in the genotype PRR-2007-1. The released varieties PRR-2 and RBl-1 showed 60.7 and 59.1 *per cent* carbohydrate content. In the present study the *per cent* of total carbohydrates in different rice bean varieties/genotypes were similar to that observed by Myrna *et al.* (15) with variation in this parameter from 61.09 to 64.73 *per cent*. Total tannins content varied from 490 (BC-1) to 860 (PRR-2007-1) mg/ 100g in whole seeds of rice bean varieties/ genotypes. The released varieties *viz.,* PRR-1, PRR-2, RBL-1 and RBL-6 showed 850, 740, 660 and 640 mg/ 100 g total tannins. Saikia *et al.* (14) also reported 513 to 572 mg/100 g tannins in mature seeds of four cultivars of rice bean. The higher levels of tannins in different rice bean genotypes observed in this study might be attributed to seed testa, colour, genotypic make up and variable agroclimatic conditions. Variation in methionine and tryptophan content was observed from 0.98 (PRR-1) to 1.50 g/ 100g protein (LRB-470) and 0.84 (PRR-2007-2) to 1.36 g/ 100g protein (PRR-1), respectively. The released varieties PRR-2, RBL-1 and RBL-6 exhibited 1.44, 1.22 and 1.04 methionine g/100 g protein and 1.02, 1.24 and 1.26 tryptophan g/100 g protein. The results of the present study are corroborated with the findings of Mohan and Janardhan (18) and Bhagmal (19), who have reported variation from 1.58 to 2.88 g/100 g protein for methionine and 0.79 to 1.10 g/100 g protein for tryptophan content in rice bean, respectively. Values for *in vitro* protein digestibility of dry mature seeds of rice bean varieties/genotypes ranged from 83.3 to 88.5 *per cent*. The values in respect of varieties/genotypes RBL-1, RBL-6 and LRB-470 were found to be the highest over other genotypes. However, the lowest value was observed in PRR-2007-2. The released varieties *viz.,* PRR-1 and PRR-2 showed 85.8 and 84.9 *per cent in vitro* protein digestibility. Hira *et al.* (12) and Myrna *et al.* (15) observed the range of variation from 82 to 90.30 *per cent* for this parameter in rice bean genotypes and the findings of the present investigation are in close proximity with these workers. Cooking time varied from 44 (RBL-6) to 56 (PRR-2007-2) minutes. Hira *et al.* (12) also reported average variation in cooking time from 52 to 55 minutes in rice bean genotypes. The data on variation in mineral content revealed that iron content ranged from 3.6 (PRR-20007-1) to 7.4 (BC-1), calcium from 265 (PRR-2007-2) to 385 (PRR-2), zinc from 2.4 (PRR-2007-1) to 4.2 (PRR-2007-2) and phosphorus from 273.3 to 517.9 mg/100 g, respectively. Earlier Saikia *et al.* (14), Hira *et al.* (12) and Sadana *et al.* (13) also observed similar findings in mineral content of rice bean genotypes of Indian origin.

To identify overall superior varieties /genotypes, grading/ ranking was done in respect of various nutritional quality

Table 2: Varietal grading/ranking of rice bean varieties/genotypes in search of versatile nutritionally superior multipurpose genotypes

Parameters	PRR-1	PRR-2	PRR-2007-1	PRR-2007-2	PRR-2008-1	PRR-2008-2	BC-1	RL-3	RBL-1	RBL-6	LRB-160	LRB-470
Crude protein (%)	7	2	1	6	4	6	3	8	6	9	8	5
Crude fibre (%)	9	8	7	6	5	4	12	1	3	2	11	10
Carbohydrates (%)	2	7	12	11	8	5	4	9	10	3	1	6
Methionine (g/100g protein)	10	2	3	5	8	6	9	3	4	7	7	1
Tryptophan (g/100g protein)	1	6	10	12	9	7	11	8	3	2	5	4
IVPD (%)	6	8	9	11	10	12	7	5	1	3	4	2
Total tannins (mg/100 g)	11	9	12	8	5	10	1	4	7	6	3	2
Cooking time (min.)	8	7	8	9	6	7	5	4	2	1	4	3
Calcium (mg/100 g)	10	7	11	12	8	9	6	2	3	4	1	5
Total*	64	56	73	80	63	66	58	44	39	37	44	38
Cumulative grading	8	5	10	11	7	9	6	4	3	1	4	2

*Genotypes graded in the descending order for nutritionally desirable characters and in the ascending order for nutritionally undesirable characters

attributes *viz.,* protein, fibre, carbohydrates, essential limiting amino acids - methionine and tryptophan, *in vitro* protein digestibility, cooking quality, calcium (in descending order) as well as anti-nutritional factor *viz*., tannins content (in ascending order). The varieties RBL-6, LRB-470 and RBL-1 were thus identified as overall nutritionally superior/versatile varieties in that order (Table 2). In all the study indicated wide variation in individual biochemical parameter(s) of nutritional significance which seems to be useful to the plant breeders and those engaged in rice bean improvement. Moreover, the multipurpose varieties/genotypes identified in the present study based on genotypic rating might be used, after conducting biological feeding experiments, for further dietary intake purpose for optimum human nutrition.

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