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The avant - garde pant mungbean 5 and 6 – physical and nutritional quality evaluation of boosting varieties

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Abstract
In India, Mungbean *(Vigna Radiata)* commonly known as green gram is one of the most widely cultivated and exclusively used pulse crop throughout the country. The present study was undertaken to find out the physical characteristics and cooking time and nutritional quality of these varieties (both raw and germinated) namely newly released varieties of Pant Mung 5 (PM 5), Pant Mung 6 (PM 6) and the third variety was a local variety. Hundred seed weight of the three varieties ranged from 3.14 to 4.91g/100 seeds. Seed volume and seed density values were recorded to be in the range of 2.33 ml to 4 ml /100 seeds and 1.23g to 1.37g/ml. Hydration capacity values were obtained as 5.97g, 4.07g, 4.37g/100seeds for PM 5,PM 6 and of local variety respectively. The swelling capacity values were observed as 5ml, 4.67, 4.17 ml/100 seeds for PM 5, PM 6 and the local variety respectively. The three varieties differed significantly in length of rootlet during germination that was recorded to be in a range of 1.64 cm to 1.80 cm. The moisture content and the crude protein content increased in case of germinated mungbean grain varieties over the raw varieties. However after germination the carbohydrate, crude fat and crude fiber content reduced as compared to raw mungbean grains. Calcium content ranged from 156mg to172.3mg/100g. A significant increase was observed in the protein digestibility of germinated mungbean grains in comparison to raw mungbean grains.

Keywords: Pant Mung 5 (PM 5), Pant Mung 6 (PM 6), Protein Digestibility

1. Introduction
Pulses play a pivotal role in nutritional security of people as they are a good source of protein, energy and minerals. Pulses are cheaper source of protein than animal foods (Singh and Jambunathan, 1991) [22]. Green Gram *(Vigna radiata)* belongs to family Leguminoseae. It is small herbaceous annual plant growing to a height of 30 to 120 centimeters. It is extensively cultivated in India, Burma, Thailand, Iran, Pakistan, Vietnam, China, Philippines, Korea, Indonesia, Sri – Lanka and adjacent countries. It has been recently introduced in the Eastern and Central parts of Africa, West Indies and U.S.A. (Singh, 1991) [22]. Pant Mung 5 (PM 5) was released in 2002 for entire Uttar Pradesh and plains of Uttarakhand for cultivation both in Kharif and Zaid seasons. It is resistant to mungbean yellow mosaic virus disease and yields 12 to 15q/ha (Singh and Khulbe, 2009) [21]. Pant Mung 6 (PM 6) was released in 2007 for North East Hill Zones of India. It yields about 12-15 q/ha and is resistant to powdery mildew, cercospora leaf spot and leaf crinkle virus (Singh and Khulbe, 2009) [21].
The legumes are known to promote good health for their mutual complementation with cereals and for their potential impact in prevention of various diseases. In a large prospective cohort study, a reduced risk of breast cancer was observed to be associated with higher intake of legumes (Velie *et al*., 2005) [23]. Kabir *et al*. (2000) [9] reported that mungbean starch is a low glycemic index carbohydrate. A study by Flight and Clifton (2006) [7] revealed that legume consumption of four times or more per week compared with less than once a week, was associated with 22 percent lower risk of chronic heart disease and 11 percent of cardiovascular diseases. A diet rich in dietary fiber procured from mungbean sprouts when fed to rats for 21 days brought a significant reduction in total plasma cholesterol levels (Nishimura *et al*., 2002) [15]. Mungbean protein has a great potential for incorporation into human food products, not only as protein supplement in diets of undernourished people but also as functional agents in fabricated foods (Rosario and Flores, 1981) [19]. The mungbean concentrate may be used as an aerating agent in whipped toppings, frozen desserts, confectionary,

ice cream and other products. Therefore the aim of the present study was to determine physicochemical properties and cooking time of the three mungbean varieties (i.e. PM 5, PM 6 and a local variety) and the nutritional quality of these three varieties of mungbean grains both raw and germinated.

2.Materials and Methods

2.1 Procurement of raw material

Pant Mung 5(PM 5) and Pant Mung 6(PM 6) were procured from Department of Genetics and Plant Breeding, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttarakhand and commercial local variety of mungbean grains was procured from the local market of Pantnagar.

2.2 Processing of mungbean grains

For processing, all the three varieties of mungbean grains were cleaned by hand to remove the foreign materials.

2.2.1 Preparation of raw mungbean flour

The cleaned mungbean grains were subjected to grinding in grinder. The flour from three varieties of grains so obtained was stored separately in air tight containers for further use.

2.2.2 Preparation of germinated mungbean flour

The cleaned mungbean grains were soaked in water for about 12 hours, covered in a muslin cloth and left to sprout for about 24 hours. Germinated grains were washed with water and dried in a tray drier at 55-60ºC for 24 hours. The dried grains were cooled to room temperature and were subjected to grinding in grinder. The germinated flour was packed in airtight container for further use.

2.3 Physical and physico- chemical parameters for raw mungbean grains

The three varieties were analyzed for Hundred seed weight, Hundred seed volume, Seed density and Swelling capacity using the methods suggested by Williams *et al*. (1983) [25]. Hydration capacity was measured by the method suggested by (Adebowale, Adeyeni and Oshodi, 2005) [1].

2.4 Cooking time evaluation

The samples of all three mungbean grains were separately cooked in an open pan without presoaking for six different timings of 30, 40,45, 50, 55 and 60 minutes. One hundred grains were counted and immersed into 500 ml water. The time at which the water began to boil was recorded. After the specified period of time, water was drained off and cooked grains were judged manually by pressing between the thumb and the index finger. Cooked grains were counted and expressed as percentage.

2.5 Physical properties of germinated mungbean grains

2.5.1 Percent of germination

Percent of germination was measured for all the three varieties of mungbean grains by soaking one hundred grains individually overnight in distilled water. Water was then discarded and the grains were germinated on the double layer of wet filter paper in petri dishes, Number of germinated mungbean grains were counted and expressed in percentage. The analysis of sample was done in triplicate.

2.5.2 Length of rootlet

Thirty germinated mungbean grains of all the three varieties each were traced by ruler for determination of the length of their rootlets Nutritional composition

Mungbean grains were analysed for proximate composition (AOAC, 1995) [5]. The carbohydrate content was determined by subtracting the sum of the values (per 100 g) for moisture, total ash, crude fat, crude fibre and crude protein from hundred. The calorific value (Kcal per 100g) of sample was calculated by summing up the product of multiplication of percent crude protein, crude fat and carbohydrate present in the sample by 4, 9, and 4, respectively. Among minerals, the ash solution was prepared by dry ashing as described by Raghuramulu *et al*. (2003) [16] whereas the calcium content was determined by titrimetric method of AOAC (1975) [4]. The iron content was estimated colorimetrically by Wong's method given by Ranganna (1986) [18]. The in- vitro protein digestibility of samples was estimated by a procedure quoted by Akeson and Stahman (1964) [3].

2.6 Nutritional Composition

The raw and germinated mungbean samples were analysed for proximate composition (AOAC, 1995) [5].

The carbohydrate content was determined by subtracting the sum of the values (per 100 g) for moisture, total ash, crude fat, crude fibre and crude protein from hundred. The calorific value (Kcal per 100g) of sample was calculated by summing up the product of multiplication of percent crude protein, crude fat and carbohydrate present in the sample by 4, 9, and 4, respectively. The total dietary fiber was estimated as per the method described in (AOAC, 1995) [5]. Among minerals, iron was estimated colorimetrically by Wong's method as quoted by (Ranganna 1986) [18]. Calcium content in samples was estimated by titrimetric method, (AOAC, 1995) [5]. The *in vitro* protein digestibility was determined by the method given by Akeson and Stahman (1964) [3].

3. Results and Discussion

Two newly released varieties of mungbean grains namely PM 5, PM 6 and a local variety were analyzed for physical and physico- chemical properties such as seed weight, seed volume, seed density, swelling capacity and hydration capacity respectively as depicted in (Table 1).

Table 1: Physical and physico chemical characteristics of raw mungbean

Characteristics	PM 5	PM 6	LV	F value	Difference	Comparison at 5%
	Mean ± SD	Mean ± SD	Mean ±SD			
Seed weight (g/100 seeds)	4.91± 0.15	3.14 ± 0.06	3.38 ± 0.06	265.46	S	1 2* 3* 2 3*
Seed volume (ml/100 seeds)	4.0 ±0	2.33 ± 0.41	3.00±0	36.53	S	1 2* 3* 2 3*
Seed density (g/ml)	1.23 ±0.03	1.37 ± 0.21	1.29±0.02	2.81	NS	-
Swelling capacity (ml/100 seeds)	5.00±0	4.67 ± 0.41	4.17±0.29	6.16	S	1 2ns 3* 2 3ns
Hydration capacity (g/100 seeds)	5.97±0.42	4.07 ± 0.05	4.37± 0.10	48.04	S	1 2 3 2 3ns

PM 5= Pant Mung 5, PM 6= Pant Mung 6, LV = Local variety

One way ANOVA (f test) was used to find out significant difference between (Snedecor and Cochran, 1967).

Pant Mung 5 was reported to have highest seed weight among the three varieties i.e. 4.91 g per 100 seeds. The lowest seed weight value was recorded for Pant Mung 6 i.e. 3.14g per 100 seeds. The difference was significant among all the three

varieties. The reported values of 100 seeds' weight for previously varieties were in range of 3.37 g per 100 seeds to 5.29 g per 100 seeds (Ranghuvanshi, 2009) [17]. Seed volume of the three varieties was reported in the range of 2.33 ml per 100 seeds to 4 ml per 100 seeds. Amongst all the varieties PM 5 was noted to have the highest value of 4 ml per 100 seeds. All the three varieties were found to be significantly different from each other in terms of seeds volume. The results were found to be comparable with the results of Raghuvanshi (2009) [17] who reported the range of 2.4 to 4.23 ml per 100 seeds. The hydration capacity of PM 5 differed significantly from that of PM 6 and local variety. However the hydration capacity was found to be higher in comparison to the values reported by Aggarwal *et al.* (2004) [2] viz. 3.4 and 3.3 g per 100 seeds respectively.

The difference in the swelling capacity was significant only between PM 5 and local variety. Swelling capacity was found to be less when compared to the values reported by Aggarwal *et al.* (2004) [2] viz. 7.6 ml per 100 seeds.

The data in (Table 2) provides information on cooking time of the three varieties of mungbean grains. PM 5 had cooking time of 60 minutes (for 100 percent coking) followed by the time taken by local variety of 55 minutes and PM 6 of 50 minutes. Aggarwal *et al*. (2004) [2] reported cooking time of 60 to 90 minutes for the two varieties of mungbean.

Table 2: Cooking time of three mungbean varieties

Variety	30 minutes	40 minutes	45 minutes	50 minutes	55 minutes	60 minutes
PM 5	58%	68%	83%	91%	97%	100%
PM 6	74%	94%	97%	100%		
LV	79%	88%	93%	96%	100%	

PM 5= Pant Mung 5, PM 6= Pant Mung 6, LV= Local variety

The variation in cooking time of the three varieties may be attributed to the variation in grain hardness, seed volume and hydration capacities as these parameters are positively correlated with the cooking time.

Percent of germination was 96.67 percent for PM 5, 97.67 percent for PM 6 and 96.67 percent for local variety. The difference among the three varieties was found to be non-significant.

Table 3: Physical properties of germinated mungbean grains

Characteristics	PM 5 Mean± SD	PM 6 Mean± SD	LV Mean ± SD	F value	Difference	Comparison at 5%
Percent of germination	96.67± 0.57	97.67± 0.57	96.67 ± 1.1	1.5	NS	-
Length of rootlet (cm)	1.8± 0.11	1.7± 0.05	1.64± 0.11	20.36	S	1 2 3 2 3

Note: PM 5 = Pant Mung 5, PM 6= Pant Mung 6, LV= Local variety

The new varieties differed significantly in length of rootlet during germination as shown in (Table 3). Length of rootlet ranged from 1.64 cm to 1.80 cm for the three varieties. PM 5 had rootlet length of 1.8 cm, PM 6 had rootlet length of 1.7 cm and local variety had rootlet length of 1.64 cm in germination. Same results were also reported by Khatoon and Prakash (2006) [11]. They reported the sprout length from 1.5 to 2.0 cm for mungbean.

The nutritional evaluation of the three raw mungbean varieties revealed that the moisture content ranged from 11.14 to 11.96 percent as in (Table 4). PM 5 showed the lowest value and local variety showed the highest value of moisture content. On the basis of the computed critical difference (at 5 percent level of significance) it was observed that PM 5 had significant difference with the other two varieties. The results obtained were comparable to those of earlier studies where the moisture content of mungbean ranged from 7.49 percent (Wenho *et al.,* 2010) [24] to 12.38 percent (Raghuvanshi, 2009) [17]. The ash content of the three raw mungbean grains' varieties ranged from 3.02 percent to 3.29 percent. All the three varieties differed insignificantly in terms of ash content. The same results obtained study were agreed by (Khatoon and Prakash, 2006) [11]. The lowest crude protein content was obtained for local variety with a value of 21.81 percent and the highest value was recorded for PM 5 of 26.34 percent. Crude protein content of PM 6 was found to be 24.43 percent and all the three varieties differed significantly in terms of crude protein content. Wenho *et al.* (2010) [24] reported crude protein content of mungbean in range of 24.26 to 28.50 percent. However the statistical analysis of the data revealed that there was a non significant difference in fat content between PM 5 and PM 6. On the other hand both the varieties had had a significant difference with the local variety. Mubarak (2005) [13] reported the fat content as 1.85 percent for mungbean.

The crude fiber content of the three varieties of raw mungbean investigated ranged between 5.26 percent (local variety) to 6.53 percent (PM 5). Statistically significant varitieal difference was observed for tall the three varieties of mungbean grains. High crude fiber content of Pant Mung 5 may be due to its large grain size. The varieties varied significantly with respect to the values of the carbohydrate content by difference because of the significant difference in protein content and fat content respectively.

Table 4: Nutritional composition of raw mungbean grains

Variety	PM 5 Mean ± SD	PM 6 Mean ± SD	LV Mean ± SD	F value	Difference	Comparison at 5%
Moisture (%)	11.14 ± 0.12	11.83 ± 0.23	11.96 ± 0.10	21.39	S	1 2* 3* 2 3ns
Total ash (%)	3.22 ± 0.17	3.02 ± 0.08	3.29 ± 0.19	2.16	NS	-
Crude protein (%)	26.34 ± 0.48	24.43 ± 0.45	21.81 ± 0.68	51.47	S	1 2* 3* 2 3*
Crude fat (%)	1.54 ± 0.01	1.45 ± 0.03	1.61 ± 0.03	11.38	S	1 2ns 3* 2 3*
Crude fiber (%)	6.53 ± 0.13	6.13 ± 0.08	5.26 ± 0.18	69.48	S	1 2* 3* 2 3*
Carbohydrate (%)	58.13 ± 0.37	59.4 ± 0.53	61.40 ± 0.65	28.78	S	1 2* 3* 2 3*
Calcium (mg/100g)	241.53 ± 0.5	251.33 ± 0.58	236.67 ± 0.76	260.57	S	1 2* 3* 2 3*
Iron (mg/100g)	5.33 ± 0.01	5.94 ± 0.07	5.28 ± 0.06	142.72	S	1 2* 3ns 2 3*

PM 5 = Pant Mung 5, PM 6= Pant Mung 6, LV =Local variety

The energy value for the mungbean grains' varied from 347 kcal per 100 g for local variety to 352 kcal per 100 g for PM 5. These values were within the range of values as reported by Debnath *et al.* (1986) [6]. The calcium content of the three varieties ranged from 236.67 mg per 100 mg for the local variety to 251.33 g per 100 mg for PM 6. The average calcium content value was found to be higher than the value reported by Ghavidel and Prakash (2007) [8] who reported the calcium content of 136 mg per 100 g. The total iron content of the three mungbean grain varieties was found to be highest for PM 6 with value of 5.94 mg per 100 g and lowest for local variety with value of 5.28 mg per 100 g.

The moisture content of the germinated mungbean grains ranged from 12.73 percent to 13.58 percent No significant difference was found between PM 6 and local variety of mungbean grains. There was a decrease in th ash content after germination as was also reported by Nautiyal (1998) [14]. This was probably due to the the soaking water of the mungbean grains being drained that might have caused leaching out of some minerals as also reported by different workers. Since ash content is composed of different minerals therefore loss of minerals due to leaching might have been responsible for decreased ash content. There was a significant difference in ash content of PM 6 and local variety. The protein content of all the three varties of mungbean grains increased after germination. The reason explained by Mubarak (2005) [13] for the aforesaid increase is the synthesis of enzymatic protein. Khatoon and Prakash (2006) [11] also reported 4.9 percent increase in crude protein content after germination. The fat content of all the three varieties of mungbean grains was recorded to be lowered after germination that might be attributed to enzymatic activity because as the seed germinates, food reserves are broken down to sustain the developmet of the growing sprout. There was also a decrease in crude fiber content of germinated mungbean grains that might be due to the solubilization of soluble components of dietary fibre like gums, pectins and mucilages during soaking.

The carbohydrate content calculated by difference method was obtained as 56.71 percent for PM 5 which was lowest amongst the three varieties. After germination the carbohydrate content also decreased in comparion to raw mungbean grains which might be due to increased amylase and phosphorylase activities for utilization in respiratory metabolism during the process of germination (Kumar and Venkataraman, 1976) [12]. The energy values decreased after germination that might be in consequence to decrease in fat and carbohydrate content after germination.

Table 5: Nutritional composition of germinated mungbean grains

Variety	PM 5 Mean± SD	PM 6 Mean± SD	LV Mean± SD	F value	Difference	Comparison at 5%
Moisture (%)	12.73 0.05	13.33 0.34	13.58 0.49	14.23	S	1 2* 3* 2 3ns
Total ash (%)	2.92 0.16	2.62 0.06	2.96 0.15	5.76	S	1 2* 3ns 2 3*
Crude protein (%)	27.15 0.55	25.56 0.53	22.73 0.55	49.81	S	1 2* 3* 2 3*
Crude fat (%)	1.45 0.04	1.44 0.05	1.22 0.03	50.46	S	1 2ns 3* 2 3*
Crude fiber (%)	6.02 0.08	5.6 0.12	4.83 0.02	72.84	S	1 2* 3* 2 3*
Carbohydrate (%)	56.71 0.54	58.47 0.5	60.49 0.51	16.41	S	1 2* 3* 2 3*
Calcium (mg/100g)	161.8 0.26	172.3 0.6	156 0.6	138.28	S	1 2* 3* 2 3*
Iron (mg/100g)	4.23 0.02	4.17 0.01	4.19 0.02	142.72	S	1 2* 3* 2 3ns

PM 5 = Pant Mung 5, PM 6= Pant Mung 6, LV =Local variety

The values of calcium content for germinated mungbean grains of three varities were found to be lower in comparison to the calcium content in raw mungbean grains. The loss of calcium after germination could be supported by decrease in ash content of germinated mungbean grains.PM 5 differed significantly from PM 6 and local variety, but there was no signicant difference between PM 6 and the local variety. contrary to the above stated results of decreased iron content, Khatoon and Prakash (2006) [11] showed an increase in total iron content after germination of mungbean.

In – vitro protein digestibility values of raw PM 5, PM 6 and local variety of mungbean grains were found to be 69.34, 70.13 and 68.17 percent respectively as shown in (Table 6).

Table 6: *In – vitro* protein digestibility of raw and germinated mungbean grains

Protein digestibility	PM 5 (%)	PM 6 (%)	LV (%)	F value	Difference	Comparison at 5%
Raw mungbean grain	69.34± 0.68	70.13± 0.8	68.17± 0.04	7.9	S	1 2ns 3ns 2 3*
Germinated Mungbean grain	77.53± 0.37	78.13± 0.02	77.13± 0.01	16.73	S	1 2* 3ns 2 3*

PM 5= Pant Mung 5, PM 6= Pant Mung 6 and LV= Local variety

The highest value of *in vitro* protein digestibility of germinated mungbean grains was obtained for PM 6 to be 78.13 percent and lowest value was recorded for local variety to be 77.13 percent. A significant increase is observed in the protein digestibility of germinated mungbean grains as compared to the raw mungbean grains of 11.41 to 13.14 percent. This improvement in protein digestibility might be attributed to the modification and degradation of storage proteins. Germination causes mobilization of protein with the help of proteases, leading to formation of polypeptides, oligopeptides and free amino acids. Further during germination trypsin inhibitors, tannins and phytate are catabolised, leading to lower levels of these anti nutritional factors in the sprouts which might be responsible for the above state phenomena (Kaur and Kapoor, 1990) [10].

Conclusion

The newly released varieties of mungbean grains (Pant Mung 5 and Pant Mung 6) edge over local variety in terms of protein, fiber and calcium content. It can be concluded from the present study that germination process improved protein quality of mungbean grains by increasing protein content and its digestibility. The newly released varieties can thus be used for preparation of dhals for daily meals and can be incorporated in commercial health foods.

Recommendations

It is recommended that studies can be conducted on

determination of protein quality with respect to amino acid profile, determination of antinutritional factors, vitamin and mineral content, cooking quality by pressure cooking and microwave cooking and preparation of health foods using newly released varieties Pant Mung 5 and Pant Mung 6 respectively.

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