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Effect of Sprouting on the Physico-Chemical Properties of Mung Bean Seeds

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Authors' contributions

This work was carried out in collaboration among all authors. Author MHK performed Methodology, Data compilation and Writing initial draft of the article. Author KV did Methodology. Author SS did Statistical analysis and edited the manuscript. Author SR helped in Methodology, Wrote and reviewed the manuscript and did statistical analysis, and final editing. All authors read and approved the final manuscript.

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ABSTRACT

The physico-chemical properties of seed are significant in designing equipment, marketing for evaluating seed quality. In this context, physico-chemical properties of three varieties of mung bean seeds, physical properties and germination properties during the sprouting period were evaluated. The average length, width and thickness were 4.64 mm, 3.64 mm and 3.26 mm at moisture content 10.70% on a dry weight basis. Hydration capacity ranged from 0.041 to 0.050 g/seed and hydration index ranged from 0.921 to 1.062, whereas swelling capacity ranged from 0.035 to 0.045 ml/seed and swelling index ranged from 0.927 to 1.447. Maximum sprout length and the germination rate were recorded in the variety SGC-20 at 96 h germination period as 45.56 mm and 96.67% respectively followed by the variety SGC-16 while IPM-02-3 reported lower sprout length and germination rate. Hence, the variety SGC-20 is best for consumption as sprouts among the three varieties.

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Keywords: Mung beans; sprouts; physico-chemical; hydration index; swelling capacity.

1. INTRODUCTION

Bean is a common term used for the variety of plants that have taken their origin from the family "Fabaceae". The most common bean includes mung bean, soyabean, urd bean and chickpea. In the early years, mung bean was first placed in genus Phaseolus and then moved to Vigna. Mung bean/Green gram [*Vigna radiata* (L.) R. Wilczek] is a widely grown crop next to chickpea and pigeon pea. The origin of mung bean is India and now grown throughout South East Asia, Africa, warmer parts of China, southern provinces of Turkey and U. S. It has been grown in India since ancient times because of its short duration with 55-60 days of maturity from the date of planting, low water requirement, wide adaptability and grown as a pure crop or as intercrop in multiple cropping/double cropping system with a yield varying from 350 to 2250 kg/ha. At the time of storing small stems, dirt, insects, immature parts and other debris materials are removed. Mung beans are stored in grain bins at 12% moisture condition, previously fumigated to defend bean weevils. Mung bean grain color is a quality indicator for the consumers and they appear green in color but other colors are also noticed [1]. In India, Korea, Taiwan, Indonesia and Philippines yellow colored varieties account for 4% only [2].

India is the world's largest producer and consumer accounting for 22% and 33% of production and global area of legumes respectively. In India, mung bean is widely popular as food products such as sweets, snacks, dhals and savoury foods and products like noodles, sprouts, cakes and soups evolved in countries like Philippines [3], China [4], Thailand [5] and in Iran [6]. Mung beans are high in nutrients, antioxidants, protect against heart stroke, aid digestive health, and promote weight loss, lowers bad LDL cholesterol, blood pressure and blood sugar levels. According to the reports of Mehla and his co-workers [7] volume of seed, swelling capacity and hydration capacity are important characters in determining the quality traits. The physical properties like density and volume of seed are significant in designing equipment and structures for milling and marketing [8] for evaluating seed quality [9] and in handling, transporting, processing and storage [10]. Bulk and handling properties have been reported for several crops like pigeon pea [11], lentil [12], green soyabeans [13], rapeseeds [14], makhana [15], sorghum [16] and rice [17]. A search on existing literature reveals that very limited research has been conducted on the physico-chemical properties of mung bean. So, the present study aims to investigate physico-chemical properties like 100-seed weight, 100-seed volume, bulk density, hydration capacity, hydration index, swelling capacity, swelling index; physical properties like length, width, thickness and germination properties like sprout length and sprouting rate for three varieties of mung bean seeds during the sprouting period from Assam which will help to assess the quality of the seeds as sprouts.

2. MATERIALS AND METHODS

2.1 Materials

Three mung beans varieties (SGC-16, SGC-20 and IPM-02-3) were obtained from Regional Agricultural Research Station (RARS), Shillongoni, Assam Agricultural University, Assam during the harvesting season in June-July 2018.

2.2 Physico-Chemical Properties

The observations for physic-chemical properties were recorded as per William et al. [18] and Khattak et al. [19].

2.2.1 Hundred-seed weight

The 100-seed weight of the mung bean seeds was determined by a random selection of 100 seeds and weighing them using a sensitive electronic balance and weight was recorded in grams.

2.2.2 Hundred-seed volume

Three random samples of 100 seeds were taken and transferred to a 100 ml measuring cylinder, and 50 ml of water was added to it. The increase in the volume was recorded as seed volume.

2.2.3 Bulk density (g/ml)

The density of the seed was recorded as the ratio between seed weight and volume (weight of 100 seeds/volume of 100 seeds).

2.2.4 Hydration capacity

Hydration capacity was calculated as gain in weight after overnight (24 h) soaking in distilled water (weight of 100 seeds after 24 h soaking – weight of 100 seeds before soaking)/100.

2.2.5 Hydration index

Hydration index was determined as hydration capacity divided by seed size (hydration capacity/seed size).

2.2.6 Swelling capacity

The swelling capacity was recorded as volume gained by seed after overnight (24 h) soaking in water. (Volume of 100 seeds after 24 h soaking – volume of 100 seeds before soaking)/100.

2.2.7 Swelling index

The swelling index was recorded as the ratio between swelling capacity and volume of seed (swelling capacity/seed volume).

2.3 Physical Properties

Length, width and thickness of sprouted mung bean seeds were recorded with the help of digital callipers. Ten seeds were randomly selected and their mean values were recorded.

2.3.1 Germination properties

Mung bean seeds were disinfected in 1% sodium hypochlorite and then rinsed twice with distilled water. Mung bean seeds (100 nos. of each variety) were soaked with distilled water (1:3 w/v) in seed germinator and kept at 25±2°C and allowed to germinate in dark and seeds were collected after 24, 48, 72, 96 h respectively. The length of the sprouts was recorded and for sprouting rate/germination rate, the number of seeds germinated per 100 seeds was also recorded.

2.4 Statistical Analysis

Results are expressed as the mean values of three separate determinations. Data were subjected to analysis of variance using a completely randomized design following the IBM SPSS Statistics 25 package. Significance was defined as $P<0.05$.

3. RESULTS AND DISCUSSION

3.1 Physico-Chemical Properties of Mung Bean Seeds

Seed size is an important criterion for selecting genetic material, processing operations and larger seeds are considered of better quality and preferred by consumers and fetch a better price in the export market [20]. Water uptake by seed is a desirable attribute of pulse grain used for food. The rate of water uptake is affected by seed size, permeability of the seed coat to water and seed hardness [21] Seed water uptake behavior is of importance from the consumer point of view [22]. Bulk densities of seeds are necessary to design the instruments for processing and storage such as hullers, aeration systems, dryers and bins. Therefore, the estimation of these properties has an important role in the industry sector [10].

The physico-chemical properties of mung bean seeds at 10.70% moisture content are summarized in Table 1. All the parameters studied had differed significantly ($P<0.05$). Hundred seed weight and hundred seed volume were highest in IPM-02-3 (5.501 g) followed by SGC-20 (4.144 g) and then SGC-16 (3.859 g). Nimkar and Chattopadhyay [23] studied various physical properties of green gram and reported that the thousand grain mass was 28.19 g (hundred grain mass is 2.819 g) at the moisture content of 8.39% d.b. These variations may be due to variety, region specificity, seed size, maturity etc. Bulk density was found highest in SGC-16 (1.258 g/ml). Nimkar and Chattopadhyay [23] studied some physical properties of mung bean and reported that the grain bulk density at moisture content in the range of 8.39 to 33.40% d.b. varied from 807.0 to 708.0 kg m^{-3} (0.807 to 0.708 g/ml) and indicated a decrease in bulk density with an increase in moisture content. This variation in the present data might be due to region specific, variety, maturity, light and climatic conditions etc. Even though hydration capacity values were the same for SGC-16 and SGC-20 varieties they are not because actual values were 0.0408 and 0.0409 respectively and they differed significantly. Hydration capacity was reported highest in IPM-02-3 (0.050 g/seed). Hydration index was recorded as 1.062, 1.008 and 0.921 in SGC-16, SGC-20 and IPM-02-3 varieties respectively. Swelling capacity also varied significantly among all the three varieties as 0.045 ml/seed in IPM-02-3 and 0.044 ml/seed and 0.035 ml/seed in SGC-16 and SGC-20 respectively. The swelling index was recorded maximum in SGC-16 (1.447), followed by SGC-20 (0.961) and the minimum was found in IPM-02-3 (0.927). Aurangzeb et al. [24] studied fifteen mung bean genotypes and reported that density, hydration capacity, hydration index, swelling capacity, and swelling index range from 0.985 to 1.498 g, 0.022 to 0.03 g, 0.6329 to 0.9212, 0.019 to 0.04 ml, and 0.66 to 1.67, respectively which are in line with the present findings.

Table 1. Physico-chemical properties of mung bean seeds

Physico-chemical properties	Variety		
	SGC-16	SGC-20	IPM-02-3
100-seed weight (g)	3.859±0.117[c]	4.144±0.142[b]	5.501±0.105[a]
100-Seed volume (ml)	3.067±0.058[c]	3.567±0.115[b]	4.900±0.264[a]
Bulk density (g/ml)	1.258±0.014[a]	1.162±0.038[b]	1.131±0.037[c]
Hydration capacity (g/seed)	0.041±0.001[c]	0.041±0.002[b]	0.050±0.001[a]
Hydration index	1.062±0.036[a]	1.008±0.086[b]	0.921±0.015[c]
Swelling capacity (ml/seed)	0.044±0.001[b]	0.035±0.004[c]	0.045±0.002[a]
Swelling Index	1.447±0.061[a]	0.961±0.176[b]	0.927±0.070[c]

[a-c]*Means in the same row with different superscript were significantly different (P<0.05)*
Values are means of three determinations

Table 2. Physical properties of mung bean seeds at different sprouting periods

Physical parameters	Variety	Sprouting periods (hrs)					Mean±SD
		0	24	48	72	96	
Length	SGC-16	4.43±0.023	6.40±0.200	7.00±0.346	7.73±0.416	7.80±0.529	6.67±1.309[c]
	SGC-20	4.33±0.200	6.47±0.902	7.70±1.212	8.40±0.200	8.67±0.115	7.11±1.743[a]
	IPM-02-3	5.17±0.416	6.33±1.060	6.87±0.416	7.53±0.115	7.67±0.115	6.71±1.049[b]
	Mean	4.64±0.459[e]	6.40±0.705[d]	7.19±0.769[c]	7.89±0.459[b]	8.04±0.545[a]	
Width	SGC-16	3.50±0.100	4.23±0.378	4.73±0.115	5.40±0.173	5.57±0.208	4.69±0.810[b]
	SGC-20	3.53±0.115	4.63±0.153	5.20±0.529	5.63±0.404	6.03±0.208	5.01±0.942[a]
	IPM-02-3	3.90±0.264	3.93±0.643	4.33±0.462	5.33±0.643	5.37±0.324	4.57±0.793[c]
	Mean	3.64±0.245[e]	4.27±0.487[d]	4.75±0.517[c]	5.45±0.413[b]	5.65±0.368[a]	
Thickness	SGC-16	3.30±0.006	4.12±0.010	4.42±0.011	5.12±0.011	5.15±0.006	4.42±0.711[b]
	SGC-20	3.31±0.011	4.42±0.017	5.01±0.010	5.41±0.011	5.46±0.011	4.72±0.825[a]
	IPM-02-3	3.16±0.006	3.89±0.006	4.23±0.006	5.04±0.017	5.21±0.006	4.31±0.782[c]
	Mean	3.26±0.076[e]	4.14±0.230[d]	4.55±0.354[c]	5.19±0.170[b]	5.27±0.141[a]	

[a-e]*Means in the same row and column with different superscript were significantly different (P<0.05)*
Values are means of three determinations

Table 3. Germination properties of mung bean seeds at different sprouting periods

Germination properties	Variety	Sprouting periods (hrs)				Mean±SD
		24	48	72	96	
Sprout length	SGC-16	5.67±1.155	20.33±3.512	30.67±3.055	45.33±3.214	25.50±15.336[a]
	SGC-20	6.00±1.000	16.33±3.786	27.67±2.517	45.56±3.786	23.92±15.576[b]
	IPM-02-3	2.33±0.577	11.67±1.527	21.67±1.527	36.67±3.214	18.08±13.392[c]
	Mean	4.67±1.936[d]	16.11±4.622[c]	26.67±4.500[b]	42.56±5.318[a]	
Sprouting rate (%)	SGC-16	80.67±1.155	83.33±1.155	89.33±1.155	92.67±2.309	86.50±5.126[b]
	SGC-20	84.67±1.155	86.00±0.000	96.00±0.000	96.67±1.155	90.83±5.813[a]
	IPM-02-3	40.00±0.000	44.67±1.155	56.67±5.773	67.33±2.309	52.17±11.456[c]
	Mean	68.44±21.419[d]	71.33±20.050[c]	80.67±18.467[b]	85.56±13.884[a]	

[a-d]Means in the same row and column with different superscript were significantly different (P<0.05)

**Values are means of three determinations*

3.2 Physical Properties of Mung Bean Seeds at Different Sprouting Periods

Mung bean seed dimensions like length, width and thickness at different sprouting periods are represented in Table 2. All the parameters were significantly ($P<0.05$) different. The highest length, width and thickness of the seed were obtained in the variety SGC-20 at 96 h of the sprouting period as 8.67, 6.03 and 5.46 mm respectively. The average moisture content at 0, 24, 48, 72 and 96 h of sprouting was measured as 10.70, 54.16, 59.29, 69.78 and 84.09% respectively. The variations in the length, width and thickness of the mung bean seeds were due to difference in moisture contents at the time of measurements [23]. They studied various physical properties of green gram and reported that the average length, width, and thickness were 4.21 mm, 3.17 mm, and 3.08 mm at a moisture content of 8.39% d.b.

3.3 Germination Properties of Mung Bean Seeds at Different Sprouting Periods

The mung bean sprout length at different sprouting periods is represented in Table 3. Significant ($P<0.05$) increase in sprout length was observed. This increase in the sprout length could be due to increase in water uptake of a seed with time. Highest length of mung bean sprout was observed at 96 h in the variety SGC-20 (45.56 mm). The variety SGC-16 showed maximum growth at constant increase.

The number of mung bean seeds germinated at different sprouting periods is represented in Table 3 and results obtained were significantly ($P<0.05$) different giving a meaning that there is an increase in the germination of total seeds from time to time. The sprouting rate was highest at 96 h in the variety SGC-20 as 96.67% while IPM-02-3 reported lowest germinate rate (67.33%).

4. CONCLUSION

It has been observed that the mung bean variety IPM-02-3 has maximum seed size and volume but seeds had not hydrated or swollen much during the germination. So, these seeds cannot be preferred for usage as sprouts. The varieties SGC-16 and SGC-20 absorbed more water and their sprout length was also high and can preferably be used as sprouts for human consumption. Besides, the germination percentage of SGC-16 (85%) and SGC-20 (91%) were predominantly higher than IPM-02-3 over all the time periods. Likewise, SGC-16 and SGC-20 shown greater germination at 96 hrs sprouting period.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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