

Some Physical and Functional Properties of Proso Millet (*Panicum miliaceum* L.) Grown in Assam

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ABSTRACT

The present study was aimed to evaluate the physical and functional properties of proso millet (*Panicum miliaceum* L.) grown in Assam. Whole, dehusked (unpolished) and polished (debranned) grains as well as flours from these milled fractions along with whole grain flour were evaluated for physical and functional properties using standard methods. Results showed that milling significantly reduced grain sizes in terms of length, breadth, thickness and length/breadth ratio. Mean L^* (lightness) and b^* (yellowness) value were highest in polished grain followed by dehusked and whole grain while mean a^* (redness) value was highest in whole grain than dehusked and polished grains. Significant reduction in thousand grain weight and thousand grain volume was found in dehusked and polished grains in comparison to whole grains. Polished grain showed highest bulk density than whole and dehusked grains. Whole grain flour possessed highest water and oil absorption capacity compared to dehusked and polished grain flours. Bulk density was highest in polished flour. Thus, it can be concluded that dehulling and subsequent removal of bran showed a significant effect on both physical and functional properties of proso millet.

Key words: Proso millet, Physical properties, Functional properties

INTRODUCTION

Millets are a type of grain included under the food group cereals and millets and commonly grown in most Asian and African countries, parts of Europe and consumed as a staple food among the majority of people of arid and semiarid tropics of the world¹. It plays a very important role in the agriculture and food of many developing countries because of its ability to grow in marginal areas and under agricultural conditions in which major cereals

fail to give substantial yields² and can grow under adverse weather conditions like limited rainfall³. Millets are store-houses of nutrition as they are superior as compared to wheat and rice and most of the major cereals in terms of carbohydrates, energy, protein, fatty acids, dietary fibre, polyphenols with antioxidant capacity, vitamins, specially B vitamins and certain minerals like iron, calcium, phosphorus and zinc^{4,5,6}.

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As the millets are consumed by the poor, they guard them against food and nutritional insecurity imposed by various agronomic, socio-economic and political factors. Therefore, millets act as a shield against nutritional deficiency disorders and provide nutritional security⁷. Proso millet (*Panicum miliaceum* L.) is the oldest cultivated millet crop and often cultivated in harsh conditions because of its better adaptability to arid and barren lands than most other crops. It is superior to rice and wheat, because it provides protein, mineral and vitamins to the poor where the need for such nutrients is in high demand⁸. Proso millet is rich in minerals and trace elements like iron, zinc, copper and manganese⁹ and is desirable for human food because it is easily digestible and is gluten-free. Hence, proso millet offers many opportunities for utilization in diversified products due to its cost effectiveness and better nutritional qualities. The physical and functional properties of proso millet like those of other grains and seeds are essential for the design of equipment for handling, harvesting, processing, product development, process design, shelf-life and quality. A few varieties of millets including proso millet are sporadically grown and consumed in some parts of Assam especially in lower Assam and adjoining North-Eastern states but it has not been analyzed for its quality parameters. Therefore, considering the importance of proso millet in processing resources, the present study was designed with the following objectives, viz., to determine the physical properties of proso millet grain and to determine the functional properties of proso millet flour.

MATERIAL AND METHODS

Collection of sample

Proso millet was procured from the farmer's field of Gosaigaon, Kokrajhar district of Assam.

Processing of sample

Sample was cleaned thoroughly to remove all foreign matters, broken and immature grains. A known amount of cleaned sample was

dehusked in a *Satake grain dehusker*, debranned in a *Satake grain polisher* for 35 seconds to obtain the different milled fractions i.e. dehusked grain (unpolished) and debranned or polished grain. The whole grain, dehusked grain and the polished grain were then ground to a fine flour to pass through B.S. 60 mesh sieve employing an electrical grinder. The grinding operation was conducted below 40°C. The flours obtained were stored at 4°C in air tight containers and used for analysis.

Determination of physical properties of grain

Physical properties of proso millet were evaluated in terms of length, breadth, thickness, length/breadth ratio, colour, thousand grain weight, thousand grain volume and bulk density.

Length, Breadth and Thickness

The length, breadth and thickness of 10 randomly selected grains from 10 different lots were measured and the average measurements were expressed in mm.

Length/breadth ratio

The length/breadth ratio was obtained by dividing length (mm) by its corresponding breadth (mm).

Colour

Chromatic components, L* (lightness), a* (redness) and b* (yellowness) values of samples taken from 5 different lots were measured in a HunterLab Color Quest XE Colorimeter.

Thousand grain weight

One hundred grains of samples were counted randomly from the five different lots and their weight in grams was determined by weighing in a sensitive electronic balance. Each weight was multiplied by 10 to obtain the thousand-grain weight¹⁰.

Thousand grain volume

One hundred grains of samples were taken randomly from the five different lots and their volume in a graduated cylinder was recorded. Each volume was multiplied by 10 to obtain thousand-grain volume. The thousand-grain volume was expressed in ml.

Bulk density

The bulk density was *calculated* from the bulk volume of 100 g of samples in a 250 ml graduated cylinder. The grains were gently

poured into the cylinder and the cylinder was then tapped on the table for uniform packing. Average of 5 replications was taken. The bulk density was expressed in g/ml¹¹.

$$\text{Bulk density (g/ml)} = \frac{\text{Weight of the sample in air (gm)}}{\text{Volume of sample (ml)}}$$

Determination of functional properties of proso millet flour**Water absorption capacity (WAC)**

The water absorption capacity of the millet flours was determined by the method of Elhardallou and Walker¹². 15 ml of distilled water was added to 1 g of the flour in a weighed 25 ml centrifuge tube. The tube was agitated on a vortex mixer for 2 min. It was centrifuged at 4000 rpm for 20 minutes. The clear supernatant was decanted and discarded. The adhering drops of water was removed and then reweighed. Water absorption capacity is expressed as the weight of water bound by 100 g of dried flour.

Oil absorption capacity (OAC)

Oil absorption capacity (OAC) of the millet flour was determined using the method of

Sathe and Salunkhe¹³. 10 ml of refined corn oil was added to 1 g of the flour in a weighed 25 centrifuge tube. The tube was agitated on a vortex mixer for 2 min. It was centrifuged at 4000 rpm for 20 min. The volume of free oil was recorded and decanted. Oil absorption capacity is expressed as ml of oil bound by 100 g of dried flour.

Bulk density

Bulk density of millet flour was determined using the method of Okezie and Bello¹⁴. 50 g flour sample was put into a 100 ml measuring cylinder. The cylinder was tapped several times on a laboratory bench to obtain a constant volume. The bulk density was expressed as the weight of sample per unit volume of sample (g/ml).

$$\text{Bulk density (g/ml)} = \frac{\text{Weight of Sample (g)}}{\text{Volume of sample after tapping (ml)}}$$

Statistical analysis

The data obtained was subjected to statistical analysis using ‘completely randomized design’ with 5 replications to determine differences between treatment means by using Microsoft excel (2007). The significance difference of the treatment values was tested by F-test at 0.05% probability level. Values are means of five (5) replications ± standard deviation. Means with different superscript within the same row are significantly different at p≤0.05.

RESULTS AND DISCUSSION

Physical properties of proso millet grain

The physical properties of proso millet grains are presented in the Table 1. From the

Table 1, it can be seen that milling significantly (p≤0.05) reduced the grain sizes in terms of length, breadth, thickness and length/ breadth ratio. Whole grain proso millet possessed highest length, breadth and thickness followed by dehusked and brown grains. The reduction in the length, breadth and thickness value of polished and dehusked grains could be attributed to dehusking and debranning factors, as husk and bran removal affect the grain dimensions due to processing loss. The findings of the present study are similar to those of Ravi *et al.*¹⁵ who found reduction in size of an Indian rice in terms of length, breadth, thickness and length/ breadth ratio after removal of husk. In the present

study, the length, breadth and thickness of proso millet grains were in accordance with the study of Hulse *et al.*¹⁶, McDonald *et al.*¹⁷ and Ojediran *et al.*¹⁸. Mean L* (lightness) and b* (yellowness) value were highest in polished grain (63.04±0.60 and 25.17±1.31) followed by dehusked grain (62.14±1.32 and 24.46±1.77) and whole grain (56.37±0.08 and 18.46±0.36), respectively. The change in colour may be due to removal of bran during the processing operation. Mean a* (redness) value was found to be highest in whole grain (4.18±0.27) than in dehusked grain (1.93±0.41) and polished grain (0.79±0.29), due to the presence of pigmented compounds on the husk of the grain. The thousand grain weight of whole, dehusked and polished proso millet grains (Table 1) of the present

investigation was 4.94±0.08 g in whole grain, 4.23±0.03 g in dehusked grain and 4.24±0.04 g in polished grain, respectively. Significant (p≤0.05) reduction in thousand grain weights was found in dehusked and polished grains in comparison to whole grains which may be due to removal of husk of the grain during processing¹⁵. The results of the present study were similar to the work of William *et al.*¹⁹. On the other hand, results showed by Kalinova²⁰ for thousand grain weight of proso millet are found to be higher than the present study. These differences might be due to differences in environmental conditions during plant development, the position in the panicle (the better developed grains are on the top of the panicle) and also the varietal differences.

Table 1: Physical properties of proso millet grain

Properties		Whole	Dehusked	Polished	CD _{0.05}
# Size	Length (mm)	2.99±0.05 ^a	2.18±0.17 ^b	2.00±0.00 ^c	0.10
	Breadth(mm)	1.98±0.03 ^a	1.86±0.06 ^b	1.56±0.05 ^c	0.04
	Thickness(mm)	1.41±0.00 ^a	1.04±0.05 ^b	1.0±0.00 ^c	0.03
	Length/breadth ratio	1.51±0.04 ^a	1.17±0.10 ^c	1.28±0.04 ^b	0.06
Colour	L* (Lightness)	56.37±0.08 ^b	62.14±1.32 ^a	63.04±0.60 ^a	1.32
	a* (Redness)	4.18±0.27 ^a	1.93±0.41 ^b	0.79±0.29 ^c	0.45
	b* (Yellowness)	18.46±0.36 ^b	24.46±1.77 ^a	25.17±1.31 ^a	1.77
Thousand grain weight (g)		4.94±0.08 ^a	4.23±0.03 ^b	4.24±0.04 ^b	0.08
Thousand grain volume(ml)		6.46±0.05 ^a	5.00±0.00 ^b	4.90±0.10 ^c	0.09
Bulk density(g/ml)		0.80±0.01 ^b	0.80±0.02 ^b	0.89±0.00 ^a	0.02

Mean of 10 observations

Thousand grain volume of whole, dehusked and polished proso millet grains were 6.46±0.05 ml, 5.00±0.00 ml and 4.90±0.10 ml, respectively. Values obtained in present study found to be within the range of values reported by Thilagavathi *et al.*²¹. It is evident from the present study that processing of millet in terms of dehulling and debranning caused a significant (p≤0.05) reduction in the volume of the corresponding grains, as a considerable amount of hulls and brans are lost during processing. Bulk density was found to be highest in polished (0.89±0.00 g/ml) grains than whole (0.80±0.01 g/ml) and dehusked

(0.80±0.02 g/ml) grains. Bulk density is related to the kernel shape, (i.e.) length: breadth ratio; the more round the kernel the greater the bulk density and since debranning (polishing) reduced the particle size of the polished grain²², therefore polished grain of proso millet having more bulk density than whole and dehusked grains. The findings of the present study were also consistent with the study of Ojediran *et al.*²³.

Functional properties of proso millet flour

The functional properties of proso millet flours are presented in the Table 2.

Table 2: Functional properties of proso millet flours

Parameters	Whole	Dehusked	Polished	CD _{0.05}
Water absorption capacity (WAC) (g/100g)	111.50±2.52 ^a	102.54±1.54 ^b	93.65±1.08 ^c	2.51
Oil absorption capacity (OAC) (g/100g)	152.63±1.58 ^a	104.30±6.92 ^b	100.67±2.35 ^c	7.49
Bulk density (g/ml)	0.698±0.01 ^c	0.712±0.01 ^b	0.775±00 ^a	0.01

From the Table 2, it can be seen that whole grain flour contained highest water absorption capacity ($p \leq 0.05$) compared to dehusked and polished grain flours. The water absorption capacity decreased significantly upon milling possibly due to the loss of fibre, which has the ability to bind and hold water²⁴. It is also known that polar amino acid residues of proteins have an affinity for water molecules and variations in water absorption capacity of whole and processed millets observed in this study could be due to the content of these amino acids in millets²⁵. Similarly, carbohydrate composition may also be a factor influencing the water holding capacity of the flours. It is known that polysaccharides, which are hydrophilic in nature greatly, affect water absorption capacity. Due to the removal of the husk the hydrophilic polysaccharides may be lost; resulting in the decrease of water absorption capacity by polished grain flour²⁶. It is evident from the present study that upon dehulling and debranning there was significant decrease ($p \leq 0.05$) in oil absorption capacity which is in agreement with the earlier reports of Kamara *et al.*²⁷ and Devisetti *et al.*¹. This may be due to the fact that binding of the lipid depends on the surface availability of hydrophobic amino acids²⁸. Data obtained from the study showed that dehulling and subsequent removal of bran has a significant effect on the bulk density of the flours in milled fractions. Decrease in bulk density of processed grains could be due to the reduction in particle size of the polished grain flours as bulk density increases as fineness of the particle increases²⁹.

CONCLUSION

A considerable variation in the physical and functional properties was found among the

milling fractions. Dehulling and subsequent removal of bran showed a significant effect on both physical and functional properties of the proso millet. Therefore, depending on technological or nutritional demands, appropriate milled fractions could be exploited based on these results for the development of desired end-use food products.

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