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Physicochemical properties of several sorghum cultivars

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Abstract
The aim of this analysis was to look at different sorghum cultivars. Chemical and mineral composition of Parbhani moti and Parbhani super moti sorghums were compared in a sample. Parbhani moti (33.5 gm) and (1.21 g/ml) had the maximum 1000 seed weight and bulk density, respectively. The fat, carbohydrate, protein, and fibre content of parbhani moti and super moti were determined. 7.39 percent, 73.20 percent, 7.89 percent, 8.59 percent, and 2.24 percent, 2.59 percent for sorghum, respectively. Furthermore, a comparison of the mineral composition of parbhani moti and parbhani super moti revealed that calcium was 7.56 and 35.27 mg/100g, phosphorus was 318.0 and 379.8 mg/100g, and iron was 12.39 and 4.69 mg/100g, respectively.

Keywords: Sorghum, chemical composition, physical properties, mineral composition

Introduction
Sorghum also known as *jowar* or *milo*, is a major cereal crop in the semi-arid and regions of Africa and Asia where it is used in the preparation of several traditional foods. It is heat and drought resistant than most other cereals (carcea *et al.*,1992). World's sorghum production was 62.2 million tons and more than 35% of sorghum is grown directly for human food. The United States is the largest producer and exporter of sorghum, accounting 20% of world production, and almost 80% of world sorghum export (Dicko *et al.*, 2006 and FAO 2017) [5, 7].
The 75% of area and 85% of production of sorghum is by Maharashtra, Karnataka and Andhra Pradesh. Sorghum is cultivated both during rainy season (*kharif*) and post rainy season (*rabi*). Only about 8% of sorghum area is irrigated. Karnataka is second only to Maharashtra with regard to area coverage in India (Vikas, 2003). In Karnataka, it is grown over an area of 18.91 lakh hectors with a production of 12.38 lakh tons and the productivity of 912 $kgha^{-1}$. Maharashtra produces the maximum sorghum in India, production being supported by the districts Solapur, Pune, Bijapur, Nanded, Akola and Mahaboobnagar (ICRISAT, 2010) [12].
Sorghum is rich in fiber and minerals, apart from having a sufficient quantity of carbohydrates (72%), proteins (11.6%) and fat (1.9%). Starch is the major constituent of the grain. The protein in sorghum contains albumin globulin (15%), prolamin (26%) and glutelin (44%). Sorghum does not contain gluten, hence the dough does not have stickiness, to roll with the chapatti roller. The flour from sorghum is gluten free and is a safe energy source for people allergic to gluten. The minimal amounts of flavanols and phytic acid are present in white sorghum (Chavan and Patil, 2010) [2].
Sorghum has good nutritional composition similar to rice and wheat in some aspects. The grains contain high fiber and non-starchy polysaccharides and starch with some unique characteristics. There is a considerable variation in sorghum for levels of proteins, lysine, lipids, carbohydrates, fiber, calcium, phosphorus, iron, thiamine and niacin (Shobha *et al.*, 2008; Chavan *et al.*, 2009) [20, 4]. Protein quality and essential amino acid profile of sorghum is better than many of the cereals and millets. Sorghum in general is rich source of fiber and B-complex vitamins (Gopalan *et al.*, 2000 and Patil *et al.*, 2010) [9, 3]

Materials and Methods
Materials
Raw materials
Good quality raw materials sorghum (*Sorghum bicolor)* rabi cultivar like Parbhani moti, Parbhani super moti were procured from Sorghum Research Station Parbhani, Maharashtra.
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Chemicals
Chemicals used in this investigation were of analytical grade. They were obtained from Department of Food Process Technology, College of Food Technology, VNMKV Parbhani.

Processing equipments
The equipment's and machineries like Munsell colour chart, Hardness tester, Digital model of Vernier calliper for thickness, electronic balance with the accuracy of 0.0001g for weight measurements, required in the present investigation were used from Department of Food Process Technology, College of Food Technology, VNMKV Parbhani.

Physical properties of sweet sorghum grain
Thousand kernel weight
One thousand grains were counted and weighed by a digital weighing balance in three replication and mean value was recorded.

Thousand kernel volume
Volume was calculated by measuring cylinder and the amount of hexane displayed by 1000 kernels (Dutta *et al.*, 1988) [6].

Bulk density
Twenty five gram of sound grains was weighed on the digital weighing balance and filled into the measuring cylinder earlier filled with reference solution of hexane. The increase in the level of liquid was measured after adding the grains. It is bulk density represented in g/L (Dutta *et al.*, 1988) [6].

$$\text{Bulk Density } (\rho) = \frac{\text{Weight of grains}}{\text{Volume displayed}}$$

True density
Twenty-five of grains were filled into the measuring cylinder and volume occupied by them was measured. It was calculated by following formula and represented in g/ml (Rooney and Murty *et al.*, 1982) [18].

$$\text{True Density } (\rho) = \frac{\text{Weight of grains}}{\text{Volume occupied}}$$

Angle of repose
It is the steepest angle between the base and slope of cone formed on a free vertical fall of grain mass to a horizontal plane when material is free falling or sliding. It was determined by making a circular pile of the grains freely falling. The height of the pile was taken (h) and its radius (r) was measured. Angle of repose was determined using a method described by (Mohsenin, 1986) [14].

Angle of Repose (ϕ) = $\tan^{-1}$ (h/r)

Proximate composition of sorghum:
Raw materials such as sorghum were analyzed for proximate composition including moisture, fat, protein, total carbohydrate, crude fiber, ash and mineral composition was carried out as per the methods given by AOAC, 2005 [1].

Determination of minerals composition of sorghum
Two grams of defatted sample was weighed and heated at 550 ºC. Then, the obtained ash were digested with concentrated Hydrochloric acid (HCL) on hot plate. The digested material was then filtered using whatman No. 42 filter paper and the final volume made to 100ml with distilled water that was further used for analysis with respects to iron, calcium, potassium, contents by using methods Ranganna (1986) [17].

Results and Discussion
Physico Chemical Properties of different sorghum cultivar
Physical properties of different sorghum cultivar
Small parted sorghum presents recognition concerns. These physical characteristics aid in sorghum identification. Physical characteristics of the kernel, such as scale, shape, and weight, have a significant impact on flour yield, colour, chemical composition, and acceptability. The 1000 kernel weight, true density, bulk density, and angle of repose of the selected sorghum genotypes were investigated. Table 1. shows the results of the physical properties of sorghum samples.

Table 1: Physical Parameters of different sorghum cultivar

Physical Parameters	Observation	
	Parbhani Moti	**Parbhani Super Moti**
Colour	Pearly White	Creamy White
Shape	Very Bold	Bold
Wt. of 1000 Seed (g)	33.5	32.2
True Density (g/ml)	1.141	0.71
Bulk Density (g/ml)	1.21	0.60
angle of repose	32°14′	30°27′

*Each value represents the average of three determinations.

The data presented in Table 1 describes the physical properties of different sorghum cultivar. The thousand kernel weight of parbhani moti (220 g) was found to be highest than parbhani super moti (32.2). The result obtained for sorghum was in close resemblance with the result reported by Nimkar and Chattopadhyay, (2001) [15].
The samples were compared with Munsell colour chart and colour was represented in the values of hue, value and chroma (Hoseney, 1994) [11]. Colour of Parbhani Moti and Parbhani super moti were pearly white and creamy white respectively.
The bulk density of parbhani moti was calculated as (1.21 g/ml) and parbhani super moti showed the bulk density (0.60 g/ml) respectively. The true densities of the sorghum were calculated where the value for moti (1.141 g/ml) and for super moti (0.71 g/ml) in their study on physical characteristics of sorghum grains. The result obtained for sorghum was in close resemblance with the result reported by Vannalli *et al*., (2008) [23].
Angle of repose of sorghum grains were calculated and it was found that angle of repose of moti (32°14′) and super moti showed the angle of repose (30°27′) respectively. The result obtained for sorghum was in close resemblance with the result reported by (Rooney and Miller, 1982) [19].

Chemical and mineral composition of different sorghum cultivar
The data pertaining to proximate composition viz., moisture, fat, carbohydrate, protein, ash and crude fiber of sorghum were determined and results obtained are summarized in Table 2.

Table 2: Proximate composition of different sorghum varieties

Chemical properties	Mean Value (%)	
	Parbhani moti	Parbhani super moti
Moisture (%)	8.12	9.24
Ash (%)	1.49	1.32
Total Protein (%)	7.89	8.59
Total Carbohydrate	78.39	73.20
Crude Fibre (%)	2.24	2.59
Crude Fat (%)	1.72	1.98

*Each value represents the average of three determinations

Table 2 revealed the proximate composition of the different sorghum grains. The grains were examined for the different constituents like moisture, crude fat, protein, carbohydrates, crude fibre, ash etc. From the results of proximate of parbhani moti and parbhani super moti it was reported that moisture content 8.12 per cent and 9.24 per cent which is in accordance with Singh *et al*., (2018) [21]. whereas crude fat content was recorded 1.7 per cent and 1.98 per cent the result found are in range with Sule *et al*., (2014) [22].

The results for crude carbohydrate of Parbhani moti was shown to have a highest value of (78.39 percent) and the moderate amount of fat was observed in parbhani super moti (73.20 per cent) the result found are in range with Chavan and Patil, (2010) [16].

The average value of crude fibre was found to be 2.24 per cent and 2.59 per cent respectively. The proximate composition particularly with respect to crude protein content was reported to be 7.89 per cent and 8.59 per cent respectively. These results were in close agreements with the findings of Jambunathan and Subramanian, 1988) [13].

Mineral composition of different sorghum cultivar

The data pertaining to the essential mineral content of different sorghum cultivar is recorded in the Table 3 with respect to important minerals i.e. potassium, calcium, phosphorus, iron, calcium and zinc.

Table 3: Mineral content of different sorghum cultivar

Minerals (mg/100g)	Parbhani Moti (Mg/100gm)	Parbhani Super Moti (Mg/100gm)
Calcium (Ca)	7.56	35.27
Zinc	4.21	3.54
Iron (Fe)	12.39	4.69
Potassium	369.4	339.7
Phosphors	318.2	379.8

*Each value represents the average of three determinations

It is seen from the Table 3 that the Parbhani super moti contained the highest amount of phosphors (379.8 mg/100g), whereas Parbhani moti contained least amount of phosphors (318.2 mg/100g) respectively.

The mineral content of parbhani moti was assessed, and it was discovered that sorghum had the highest potassium content (369.4 mg) compared to the other minerals. It was evident from the results that sorghum is an excellent source of phosphorus. Furthermore, the calcium content was 7.56 mg/100 g, the iron content was 12.39 mg/100 g, and the zinc content was 4.21 mg/100 g, respectively. The study showed that parbhani moti was good sources phosphorus, iron, zinc and calcium. Results are in line with those reported by FAO (1995) [8].

The mineral content of sorghum was evaluated and found that the phosphorus content of parbhani super moti found to be highest (339.7 m/100g) respectively. Moreover, calcium content was 35.27 mg/100g, iron 4.69 mg/100g and zinc content 3.54 mg/100g, respectively. The study showed that parbhani super moti was good sources phosphorus, iron, zinc and calcium. Result reported is in close agreement with these findings of (Jambunathan (1988) [13].

Conclusion

Thus, based on the scientific data collected and analyzed, it can be concluded that physico-chemical studies of different sorghum parbhani moti and parbhani super moti cultivars are vital for the development and production of process equipment as well as the development of higher nutritional quality products.

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