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Studies on physico-chemical properties of wheat, finger millet and guar gum

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Abstract
The present investigation was carried out to study the physical and chemical properties of finger millet, wheat and guar gum. Physical properties such as 1000 kernel weight, porosity, bulk density, true density, compressibility index, angle of repose were determined. Moisture content, protein, fat and carbohydrates were also evaluated. Further, chemical composition was reported and results showed that the moisture content 11.45 percent, fat 0.81 percent, carbohydrate 71.68 percent, protein 11.88 percent, ash 0.7 percent and crude fiber 2.7 percent were found in wheat semolina and moisture content 12.23 percent, fat 1.2 percent, carbohydrate 75.4 percent, protein 7 percent , ash 2.06 percent and crude fibe 3.3 percent were found in finger millet. The results pertaining to chemical analysis of guar gum was moisture 8.47 percent, fat 0.82 percent, protein 5.16 percent, carbohydrate 83.40 percent, crude fiber 2.23 and ash 0.63 percent. The study is significant for the designers and processers in designing equipment for processing. Results are likely to be beneficial in evaluating the quality of grains used for processing.

Keywords: wheat, finger millet, guar gum, physical properties, chemical properties

Introduction
Wheat (*Triticum aestivum*) is a staple food crop in India that ranks second only to rice. After China, India is the world's second-largest producer of wheat. Punjab produces maximum wheat grain in India. In the 2007-08 crop year, India's wheat production was 78.40 million tonnes, the region under wheat cultivation was 28.15 million hectares, and the yield was 2785 kg/ha. (Anonymous, 2008a) [2, 3], During the year 2007-08, Maharashtra's share of India's wheat production was 2081 thousand tonnes, with an area of 1237 thousand hectares (Anonymous, 2008b) [2, 3]. More than 1000 million people consume wheat in different types. The production of wheat has also showed an increasing trend, from 87.39 to 94.57 million tonnes from 2012–2013 to 2017–2018 with a magnitude of 7.18 million tonnes (8.22%).
After grinding wheat kernels into flour, it is used for a variety of food applications. Wheat flour is used to make chapatti, pizza, and bakery goods like cakes, cookies, crackers, doughnuts, sweet rolls and biscuits.
Finger millet, also known as ragi (Takhellambam *et al.*, 2016) [28] or tamba (Jideani *et al.*, 1996) [11], is a non-dehulled grain (Gull *et al.*, 2015) [8]. In certain parts of Africa and India, the grains are a staple cereal meal (Saleh *et al.*, 2013; Siwela *et al.*, 2010) [20, 23]. Finger millet is a gluten-free grain with a low glycemic index that has nutritional and nutraceutical benefits. However, it is overlooked and underutilised (Amadou *et al.,* 2013; Jideani *et al.*, 2011) [5, 10]. Finger millet is a member of the Poaceae family that originated in Ethiopia before making its way to India (Shiihii *et al.*, 2011) [26]. Finger millet ranks fourth in semi-arid area production after sorghum, finger millet and foxtail millet (Shiihii *et al.*, 2011; Upadhyaya *et al.*, 2011) [26, 30].
In terms of production in semi- arid regions, Finger millet ranks fourth after sorghum, finger millet and foxtail millet (Shiihii *et al.*, 2011; Upadhyaya *et al.*, 2011) [26, 30]. Calcium is an important macronutrient for growing children, pregnant women, and the elderly, and it is abundant in the grains. Finger millet is also high in essential amino acids like methionine, tryptophan, and lysine, according to reports. (Jideani, 2012). Finger millet has a low fat content, which helps to reduce the risk of diabetes and gastro-intestinal disorders (Muthamilarasan *et al.*, 2016) [17]. Finger millet grains are also a good source of carbohydrate, phosphorus, magnesium, and iron, according to (Jideani, 2012) Vitamin B complex vitamins such as thiamine, riboflavin, folic acid, and niacin are also abundant in the grains. (Gull *et al.*, 2015; Saleh., 2013) [8, 20]. The plant is used as a folk medicine to treat liver disease, measles, pleurisy, pneumonia, and small pox, among other ailments (Bachar *et al*., 2013).

In the pharmaceutical industry, starch derived from FM grains is used to make granules for tablet and capsule dosages (Shiihii *et al*., 2011) [26]. Finger millet used in baked goods, composite flour, weaning foods, beverage and non-beverage products (Poutanen, 2012; Verma and Patel, 2013) [19].

The guar plant (*Cyamopsis tetragonoloba* (L) Taub), also known as cluster bean, is a drought-tolerant leguminous crop. Guar is grown for seed, green fodder, vegetable and green maturing, among other things. It's an annual plant with large leaves and clusters of pods that grows around 4 feet tall and vertically stacked. It's also known as Cluster Bean *Cyamopsis*. Each pod is 5-8 cm long and contains 6-9 small greyish white pea-shaped seeds on average. Apart from the industrial extraction of guar gum, the pods are used as a green vegetable or cattle feed (Sharma *et al*., 2007) [25]. Guar gum is a galactomannan polysaccharide with a straight chain. Guar gum has a chemical structure that consists of a linear chain of D-mannose units connected together by -(1-4) glycosidic linkages, with certain D-mannose units having a single D-galactose unit joined by a -(1–6) glycosidic linkage. D-galactose units alternate with Dmannose units (Whistler, 1954) [32]. The D-manopyranosyl to D-galactopyranosyl unit ratio is approximately 1.8:1. (Whistler and Hymowitz, 1979) [33]. Guar gum has a molecular weight of 1-2 x 106 Dalton (Boggs, 1949), which means that the polymer is made up of a chain of 1–4 connected -P-mannopyranosyl units, with every second unit bearing a single unit side chain consisting of -D-galactopyranosyl group on carbon atom C_6 (Whistle).

Guar gum is primarily used in the food industry for frozen foods, baked foods, sauce and salad preparations, confections, drinks and pet food, among other applications. It's used in a various industries, including textiles, paper and explosives, as well as oil and gas exploration, mining, manufacturing, pharmaceuticals and many others. Guar is grown in India, Pakistan, Sudan, the United States, South Africa, Brazil, Zaire and Australia (Sharma *et al.*, 2007) [25]. Gum powder is used in the pharmaceutical industry as a gelling, viscosifying, and thickening agent, as well as a stabiliser and emulsifier, and for preservation, water retention, water phase control, binding, process aid and pour control (Chudzikowski, 1971) [6].

Materials and methods

1000 kernel weight

Thousand sample weight was determined by weighing, recording the weight and counting manually the number of the sample. The grain samples were weighed using digital electronic balance with 0.01 g accuracy (Adam CPW plus-150p, USA) (Sangamithra *et al*., 2016) [21].

Bulk density

It is the ratio of mass of sample to its volume. It was determined by filling a 500 mL cylinder with grains using method of (Mariotti *et al*., 2006) [15]. Bulk density (kg/ m^3) was calculated as a ratio between the sample weight and the volume of the cylinder.

Tapped density is an increased bulk density, attained after mechanically tapping a container containing the powdered sample. The tapped density was obtained by mechanically tapping a graduated measuring cylinder containing the powdered sample. Values were noted after the cylinder was manually tapped 150 times, for the particles to consolidate.

True density

The true density (ρt) was determined by toluene displacement method (Mohsenin, 1980) [16].

Porosity

Porosity (%) is defined as the fraction of the space in bulk grain that is not occupied by the grain (Sangamithra *et al*., 2016) [21]. It was calculated using Eq. (6) from the true density and bulk density using method of (Vanrnamkhasti *et al*., 2008) [31].

Compressibility index

Compressibility index of the powdered gums was calculated of the samples were calculated (US Pharmacopeia 2005).

Angle of repose

Angle of repose gives indication of nature of pile formed by the material. It is angle with respect to horizontal at which material stands when piled. The cylinder was filled with material and inclined slowly allowing the grains to fall freely. The height and the radius was measured using scale. (Firouzi and Alizabed, 2012) [7].

Static Co-efficient of Friction

The static coefficient of friction 'μ' was determined for four different structural materials, namely plywood, glass, steel and aluminium, using a tilting table. The powdered gums were placed parallel to the direction of motion and the table was raised gently by a screw device; the angle at which the gum heap began to slide (the angle of inclination) was read from a graduated scale on the tilting table; this was repeated thrice for each powdered gum. The coefficient of friction was calculated as the tangent of this angle (Olaoye, 2000) [18].

Proximate composition

Proximate analysis

Different chemical properties of sample were analysed for moisture content, fat, protein, ash and total carbohydrate. All the determination were done in triplicate and the result were expressed as the average value.by using method given by AOAC (2005) [4].

Result and Discussion

Physical properties of wheat and finger millet

Importance of studying physical properties are considered as the basic data in designing the machinery and equipment used during milling of wheat flour. Importance of these properties in determining the size of the machines hoper. The understanding of physical quality attributes is critical in determining the consumer acceptability of product. Different physical properties such as 1000 kernel weight, bulk density, true density, angle of repose, porosity and results obtained are presented in Table no.1.

Table 1: Physical properties of wheat and finger miilet

Physical parameter	*Values	
	Wheat	Finger millet
1000 kernal weight (g)	43.13 ± 0.86	2.7 ± 0.1
Bulk density (kg. m-3)	789.66 ± 22.12	837± 70.08
True density (kg. m-3)	1263 ± 158.89	1250 ± 55.97
Porosity(%)	37.39± 6.4	33 ± 5.4
Angle of repose (º)	21.52 ± 0.28	29.81 ± 1.92

*Each value is average of three determinations

Data from table 1 shown the physical properties of wheat were observed 1000 kernal weight (43.13 ± 0.86 gm), bulk density 789.66± 22.12 (kg m^{-3}), true density 1263 ± 158.89 (kg m^{-3}), Porosity 37.39± 6.4, angle of repose 21.52 ± 0.28(^{0}). The size, shape, moisture content and orientation of the particles influence the angle of repose. similar result reported by (Ljiljiana Babic *et al*., 2010) . From table no.1 it can revealed that physical properties of finger milllet were observed 1000 kernal weight 2.7 ± 0.1 (gm), bulk density 837 ± 70.08 (kg m^{-3}), true density 1250 ± 55.97(kg m^{-3}), porosity (33±5.4), angle of repose 29.81 ± 1.92(°). Similar result reported by (Shivabasappa *et al*., 2012) [27] and (Kumar *et al*., 2019).

Chemical properties of wheat (semolina) and finger millet

The quality of final product is a function of raw materials quality and the wheat flour(semolina) was the base ingredient used in preparation of vermicelli with incorporation of guar gum. It is necessary to study the chemical composition of wheat flour (semolina) to assess its suitability in preparation of vermicelli. The present investigation was initiated to study chemical composition of wheat flour (semolina) and the data is summarized in Table no 2.

Table 2: Chemical properties of wheat and finger millet.

Chemical parameter	*Values(%)	
	Wheat	Finger millet
Moisture	11.45±0.87	12.23±0.30
Protein	11.88±0.65	7±0.2
Fat	0.81±0.06	1.2±0.02
Ash	0.7±0.02	2.06±0.02
Crude fiber	2.7±0.12	3.3±0.15
Carbohydrate	71.68±1.2	75.4±0.25

*Each value is average of three determinations

The results pertaining to chemical analysis of wheat flour (semolina) are presented in (Table 2). It was revealed that, the moisture for wheat flour (semolina) (11.45±0.87 per cent), crude fat (0.81±0.06 per cent), protein (11.88±0.65 per cent), carbohydrate (71.68±1.2per cent), crude fibre (2.7±0.12per cent) and ash (0.7±0.02 per cent).The result of chemical analysis of wheat semolina are in close agreement with the result of (Jeffrey *et al.*, 2019) [9]. The results of the chemical analysis of the finger millet summarized in Table no. 2 The moisture (12.23±0.30 per cent), fat (1.2±0.02per cent), protein (7±0.2 per cent.), carbohydrate (75.4±0.25per cent), crude fiber (3.3±0.15 per cent) and ash (2.06±0.02per cent). The results of chemical composition of millet is in close agreement with the results of (Ladkat *et al.*,2019) [13] and (Tiwari *et al*., 2018) [29].

Physical properties of guar gum

Different physical properties such as bulk density, true density, true density, compressibility index,angle of repose, tapped density and static co-efficent of friction were measured and result obtained are presented in Table no. 3.

Table 3: Physical properties of guar gum

Parameters	*Values
Bulk density (gm/ml)	0.54 ± 0.13
True density (gm/ml)	0.5 ± 0.1
Compressibility index	24.42 ± 2.02
Angle of repose(^{0})	32.7 ± 0.26
Tapped density	0.62±0.4
Static co-efficent of friction	0.82 ± 0.015

*Each value is average of three determinations

From table no 3 it was observed that bulk density 0.54 ± 0.13 (gm/ml),true density 0.5 ± 0.1 (gm/ml) , tapped density (0.62±0.4), compressibility index 24.42 ± 2.02 (%), angle of repose 32.7 ± 0.26(^{0})., static co-efficent of friction 0.82 ± 0.015. similar result reported by (sarkar *et al*., 2018) [22].

Chemical properties of guar gum

Data pertaining to various chemical properties like moisture, fat, carbohydrate, ash and protein were investigated obtained and result obtained are depicted in table no. 4.

Table 4: Chemical properties of guar gum

Parameters	*Values(%)
Moisture	9.83±0.82
Protein	4.36±0.15
Fat	0.82±0.04
Ash	0.63±0.03
Crude fiber	1.72±0.22
Carbohydrate	83.40±1.07

*Each value is average of three determinations

The results of the chemical analysis of the guar gum summarized in Table no 4 moisture (9.83±0.82 per cent), fat (0.82±0.04 per cent), protein (4.36±0.02 per cent), carbohydrate (83.40±1.07 per cent), crude fiber (1.72±0.22) and ash (0.63±0.03per cent). These values of chemical properties recorded in the present study are similar to the values reported earlier by (Eldirany *et al*., 2015).

Conclusion

Overall it can be concluded that the importance of studying physical properties are considered as the basic data in designing the machinery and equipment used during the harvesting and in the post-harvest such as storage operations. Importance of these properties in determining the size of the machines particularly that of the separation, transfer, and sorting equipment. Finally, it can be concluded from the results that wheat semolina, finger millet are highly nutritious and make it potentially useful in preparation and value addition of food products. The grains of are converted into flours for preparation of products like noodles, vermicelli, porridge, puddings, pancakes, biscuits, roti, bread and other snacks.

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