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Studies on physic-chemical and mineral evaluation of pearl millet, sorghum and soybean

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Abstract
The present work was proposed to study the physico-chemical and nutritional properties of row pearl millet, sorghum and soybean were investigated. The combination of cereals and pulses forms complete food for human beings hence these three ingredients can be used to improve specific or overall quality of diet or processed products. The study was carried out to evaluate proximate physical, chemical and mineral composition of raw pearl millet, sorghum and soybean. 1000 kernel weight, bulk density, true density, porosity and angle of repose was 14.01g, 0.62gm/cm³, 1.29gm/cm³, 37.6% and 28° in pearl millet respectively, similarly in sorghum 30.2 g, 0.67 g/cm^3, 1.36 g/cm^3 61.6%, 32˚30 and in soybean 110.28 g. 0.74 g/cm^3, 1.46 g/cm^{3,} 47.02% and 40°48 respectively. Chemical study of pearl millet, sorghum and soybean revealed that the cereals that is pearl millet and sorghum both are good source of carbohydrate 71.9% and 73.01% respectively. The protein content of soybean was found to be high 38.52%. Soybean and sorghum are good source of phosphorus 671.43 mg/100g and 489 mg/100g respectively. Soybean conten 3.40% fiber.

Keywords: Pearl millet, sorghum, soybean, physicochemical properties, mineral composition

Introduction
Pearl millet (Pennisetum glaucum) is a flexible cereal fertilize for food, feed and for ages (Arora *et al*., 2003) [3] mostly in African and Asian countries (Nambiar *et al*., 2011) [24]. Around all the millet varieties, 29 million hectare and more area is occupied by pearl millet. Pearl millet contain higher protein, fat, fiber and ash content (Sade, 2009) [29]. Pearl millet is contain good protein quality in term of its tryptophan and threonine content (Elyas *et al*., 2002) [9] along with higher content of calcium, iron as well as zinc (Yadav *et al*., 2014 [33]; Sade, 2009 [29]; Lestienne *et al*., 2007 [22]) makes this crop very useful for human. Energy content of pearl millet is greater than sorghum and equivalent to brown rice due to its rich unsaturated fatty acids (75 per cent) and linoleic acid (46.3 per cent) contents (Jaybhaye *et al*., 2014).
In Maharashtra, Karnataka and Andhra Pradesh sorghum (*Sorghum bicolar (L) Moench*) crop is primarily develop. Madhya Pradesh, Gujarat and Rajasthan are another state for producing sorghum (Chavan *et al*., 2015). In rural areas like central Maharashtra, per capita annual consumption of sorghum is around 60 kg, consider for almost half of per capita consumption of all cereals (Parthasarthy *et al*., 2010). Sorghum protein is preferable to wheat protein in biological value and digestibility. Gluten are not present in sorghum and it contains more fiber and micronutrients. Though people suffering from diabetes in India are used sorghum which is digested slowly and an excellent health food (Klopfenstein & Hoseney, 1995) [18]. Triglycerides lipids are mostly present in sorghum which are rich in the unsaturated fatty acids, oleic and linoleic, their percentages being 33 and 47, respectively (Salunke *et al*., 1977; Hall, 2000 [13]; Kleih *et al*., 2000 [17]).
Soybean *(Glycine max* L. *Merril*) is the world‘s most important seed legume, which arrive to 25% of the global edible oil, about two-thirds of the world‘s protein concentrate for livestock feeding. Soybean meal is a helpful ingredient in formulated feeds for poultry and fish. Soybean has become an important oilseed crop in India in a very short period with approximately 10-million ha area under its cultivation. Madhya Pradesh, Maharashtra, Rajasthan, Karnataka, Andhra Pradesh and Chattisgarh are the major soybean growing states (Agarwal *et al.*, 2013) [1].

Soybean protein contain reliable amount of essential amino acid such as histidine, isoleucine, leucine, lysine, phenylalanine, tyrosine, threonine, tryptophan and valine which is recommended for daily intake as a balanced diet (Erdman & Fordyce, 1989) [10]. Soybean protein are useful in diabetes because of its contian glycine and arginine, which acts to reduce blood insulin levels. Soybean fibre may be helpful due to its insulin-moderated effect. Soybean also helps to reduce CVD chances soybean protein as well as reducing cholesterol and triglycerides levels, may produce an increase of lipoprotein A, which is potentially detrimental in antiatherogenic therapy (Inmaculada *et al.*, 2008) [14], improvement in bone mineral density (Kreijkamp *et al.*, 2004) [20].

Materials and methods

The good quality of flaxseed was procured from Parbhani local market. The seeds were cleaned manually. The moisture content of seed was determined using the hot air oven method (AOAC, 2000).

Analytical Methods

The pearl millet, sorghum and soybean were analyzed for chemical composition namely moisture, protein, fat, ash, crude fiber and minerals composition includes calcium, phosphorus, iron and magnesium was carried out as per the method given by (AOAC, 2005) [2]. Nutrient were analyzed in duplicate and result were expressed on dry weight basis.

Proximate analysis

Different chemical properties of samples were analyzed for moisture content, ash, fat, protein and total carbohydrate. All the determinations were done in triplicate and the results were expressed as the average value.

Moisture content

Moisture content was determined as per the method given by (AOAC, 2005) [2]. It was calculated using following formula.

$$\% \text{ Moisture} = \frac{\text{Initial weight} - \text{final weight}}{\text{Total weight of sample}} \times 100$$

Ash: Drying the sample at 100°C and churned over an electric heater. It was then ashes in muffle furnace at 550 °C for 5 hrs. It was calculated using the following formula:

$$\% \text{ Ash} = \frac{\text{Weight of crucible with ash} - \text{weight of empty crucible}}{\text{Total weight of sample}} \times 100$$

Fat

AOAC (2005) [2] method using soxhlet apparatus was used to determined crude fat content of the sample. The percent of crude fat was expressed as follows:

$$(\%) \text{ Crude fat} = \frac{\text{Final weight of flask} - \text{Empty weight of flask}}{\text{Weight of sample}} \times 100$$

Protein

Protein content was determined using AOAC (2005) [2] method. Percentage of nitrogen and protein calculated by the following equation:

$$\%N = \frac{(\text{Sample-blank}) \times \text{Normality of } H_2SO_4 \times \text{Vol. made for distillation} \times 0.014 \times 100}{\text{Aliquot taken for distillation (ml)} \times \text{Weight of sample (g)}}$$

Total Protein = % Nitrogen × 6.25

Total carbohydrate

Total carbohydrate content of the samples was determined as total carbohydrate by difference, calculated by subtracting the measured protein, fat, ash and moisture from 100.

Determination of minerals

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 what man 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 S. 1986) [27].

Results and Discussion

Physical properties of pearl millet, sorghum and soybean

Different physical properties such as thousand kernel weight, bulk density, true density, porosity and angle of repose of pearl millet, sorghum and soybean were evaluated, and results obtained are presented in table

Table 1: Physical properties of pearl millet, sorghum and soybean

Parameters	Mean value		
	Peral millet	Sorghum	Soybean
1000 kernel weight (g)	14.01	30.2	110.28
Bulk density (g/cm^3)	0.62	0.67	0.74
True density (g/cm^3)	1.29	1.36	1.46
Porosity (%)	37.6	61.6	47.02
Angle of repose (°)	28	32°30	40°48

Each value is average of three determinations

Data from tables 1 showed that the average 1000 kernel weight of pearl millet was recorded 14.01 g, bulk density of millets was found to be 0.62 gm/cm³, True density was 1.29 g/cm³, porosity was calculated and recorded 37.6% whereas pearl millet showed the angle of repose of 28°. Engineering properties of pearl millet grain were calculated and it was found that result of pearl millet grain were similar with (Chhabra, 2017) [6].

Data from tables 1 showed that the physical properties of sorghum were evaluated 1000 kernel weight, bulk density, true density and angle of repose was 30.2 g/cm^3, 0.67 g/cm^3, 1.36 g/cm^3, 32^{0}30 respectively. The resistance to air flow of

bulk grain is the function of porosity. The highest value of porosity was recorded in sorghum was 61.6%. The similar results were obtained by (Butti *et al.*, 2017) [4].

Similarly the data in table 1 revealed that 1000 kernel weight of soybean seed was found highest 110.28 g. Due to size difference large deviation was recorded in 1000 kernel weight. The bulk density and true density of soybean were 0.74 g/cm^3 and 1.46 g/cm^3 respectively. The porosity of soybean was 47.02%. The angle of repose of soybean was 40°48. The results of soybean were close agreement to the results obtained by (Tavakoli *et al.*, 2009) [31]. The bulk density and angle of repose founded similar with result of (Chigbo, 2016) [7].

Chemical composition of pearl millet, sorghum and soybean

Chemical composition generally represents the nutritional quality of product. It is necessary to determine the proximate composition of pearl millet so as to judge its effect on final product after utilization as a novel ingredient. The chemical parameters like moisture content, protein, fat, carbohydrate, crude fiber and ash content of pearl millet, sorghum and soybean were estimated and obtained data was noted in the table 2 as shown below.

Table 2: Chemical composition of pearl millet, sorghum and soybean

Composition	Mean value		
	Peral millet	Sorghum	Soybean
Moisture (%)	9.59±0.25	9.9±0.31	7.8±0.2
Fat (%)	2.2±0.21	1.58±0.21	19.5±0.54
Carbohydrates (%)	71.9±0.50	73.01±0.41	27.88±0.75
Protein (%)	12.8±0.30	11.5±0.34	38.52±0.38
Ash (%)	1.53±0.12	1.51±0.11	2.90±0.22
Fiber	2.0±0.11	2.5±0.14	3.4±0.31

Each value is average of three determinations

It is observed that the moisture content of pearl millet found to be 9.59 per cent. The fat content of pearl millet was noted to be 2.2 percent. The carbohydrate content was calculated and recorded to be 71.9 percent in pearl millet. Protein content in pearl millet was noted to be 12.8 percent. Pearl millet has reported to have crude fiber and ash conten 2.0 and 1.53 percent respectively. The result obtained is similar to the study of (Malik, 2015) and (Taylor *et al.*, 2010) [23, 32].

The proximate composition of the sorghum flour was analyzed. Table 4.2 data show that compare to pearl millet and soybean, sorghum contain more amount of carbohydrate. The moisture, total fat, carbohydrates, total protein, crude fiber and total ash of sorghum are 9.9 percent, 1.58 percent, 73.01 percent, 11.5 percent, 2.5 per cent and 1.51 per cent respectively. The similar results were obtained by that (Patekar *et al.*, 2017), (Chavan *et al.*, 2009) [5] and (Jambamma *et al.*, 2011) [15].

It was observed from the data presented in table 4.2 that the soybean flour contained 7.8 percent of moisture. Crude fat, carbohydrate, crude protein and crude fiber of soybean flour were observed 19.5 percent, 27.88 percent, 38.52 percent and 3.40 percent respectively. Compare to pearl millet and sorghum, soybean contain more amount of protein, carbohydrates and fiber. Ash content of full fat soybean flour contained about 2.9 percent. Ash content is an indication of the level of minerals present in food material this suggests that soybean can help in boosting the mineral content of prepared product. The obtained results for the proximate composition of full fat soybean flour were found similar to that of results of (Kokani & Ranganathan 2018), (Chinma & Gernah 2007) [19, 8]. The results for the ash and crude fat are comparable to the results obtained by the (Kuzniar *et al.*, 2016) [21].

Mineral composition of pearl millet, sorghum and soybean

Mineral know as the micro components and inorganic elements needed by the body as structural component and regulators of body processes. The mineral like phosphorus, calcium, iron, magnesium of pearl millet, sorghum and soybean were estimated and results presented in the table 3.

Table 3: Mineral composition of pearl millet, sorghum and soybean

Minerals	Mean value		
	Peral millet	Sorghum	Soybean
Phosphrous(mg/100g)	288	489	671.43
Calcium(mg/100g)	41	34.12	245.23
Iron(mg/100g)	8	4.42	12.60
Magnesium(mg/100)	131	160	150

*Each value is average of three determinations

The data regarding calcium, phosphorus, magnesium, iron of pearl millet depicted in table pearl millet contain calcium 41 mg/100g. Phosphorus content of pearl millet was 288 mg/100g. Magnesium content in pearl millet was observed 131 mg/100g. The concentration of iron content 8 mg/100g was found in the pearl millet. The results obtained are more or less similar to the study findings of (Gopalan *et al.*, 2004) [11], (Nithya *et al.*, 2006) and (Gull *et al.*, 2014) [25, 12]

The data regarding phosphorus, calcium, iron and magnesium of sorghum and soybean was depicted in table 4.3. The concentration of phosphorus and calcium is higher in soybean as compare to sorghum was recorded to be 671 mg/100g, 245.23 mg/100g and 489 mg/100g, 34.12 mg/100g respectively.

The concentration of iron and magnesium of sorghum was found to be 4.42 mg/100g and 160 mg/100g respectively. All mineral composition of sorghum grain are comparable values were obtained by (Kayode, 2006). The concentration of iron and magnesium of soybean was found to be 12.60 mg/100g and 150 mg/100g respectively. The similar results were obtained with (Rohini *et al.*, 2015) [28] and (Gopalan *et al.*, 1989).

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