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Landge AR

PG Scholar, Department of Food Process Technology College of Food Technology, VNMKV, Parbhani, Maharashtra, India

Sadawarte SK

Assistant Professor, College of Food Technology, VNMKV, Parbhani, Maharashtra, India

Pawar VS

Head of Dept of Food Process Technology, college of Food technology, VNMKV, Parbhani, Maharashtra, India

Physicochemical properties of legumes (Viz., black gram splits, moth bean splits and fenugreek seeds)

Landge AR, Sadawarte SK and Pawar VS

Abstract

The present research was carried out to study the physical and chemical properties of three legumes which are black gram splits, moth bean splits and fenugreek seed. Thousand seeds weight of black gram splits, moth bean splits and fenugreek seed was determined to be (20.56±0.57), (19.13±0.88) and (15.89±0.96) and bulk density, was found to be (0.88±0.05), (0.76±0.08) and (0.76±0.07), respectively. The fat, carbohydrate, protein and fiber determined for black gram splits were 1.8, 59.8, 23.6 and 0.8, respectively, whereas for moth bean splits were 1.22, 59.8, 22.8 and 1.56, respectively. Proximate composition for fenugreek including fat, carbohydrate, protein and fiber were found to be 6.83, 43.67, 25.86 and 6.31, respectively.

Keywords: Physical properties, chemical properties, black gram splits, moth bean splits, fenugreek seeds, true density, bulk density, proximate composition

Introduction

Pulses are considered to be the second most significant crop in agricultural sector in India after cereal grains because of their high protein content and significant importance in human diet. At an average productivity of 764 kg ha⁻¹, India produces 19.3 million tonnes of pulses. Farmers do not favour pulses over cereals due to their high risk and low return; as a result, the production of pulses is sufficiently low (FAO/WHO, 1973) [4].

Black gram (*Vigna mungo* L.) belongs to family *Fabaceae* sub family *Papilionaceae*, is being grown as one of the principal pulse crops. In India black gram is a grown in 3.11 Mha area with total production of 1.90 MT and average productivity is 642 kg/ha (Anonymous, 2013) [2]. Black Gram has occupied a significant position in human nutrition as a rich protein source in the Indian and Western diets of consumers. Black gram protein is easier to digest, almost as nutritious as meat, and a very good source of vitamins and phosphoric acid. Additionally, it contains sufficient amounts of sulfide-containing amino acids. In India, black gram is consumed as dhal. In fermented foods, it serves as a source for microorganisms. It is also preferred when making a variety of fermented dishes like idlis, dosas, and vada (Liener, 1994) [6]. It contains on average 10.9% moisture, 24% protein, 1.4% fat, 0.9% fibre and 59.6% carbohydrate as main component (Sharon *et al.*, 2015) [10]. Physical characteristics of black gram with a moisture content of 10.7%, 1000 kernel weight was determined to be 52 g, along with actual density (1330 kg/m³), bulk density (0.82 g/ml), porosity (39.70%), and angle of repose (26.56°). Average dimensions were 5.20 mm in length, 4.10 mm in breadth, and 3.54 mm in thickness (Talpade 2018) [12].

Moth bean (*Vigna aconitifolia* L.) is a member of the *Fabaceae* family, which is frequently cultivated in dry and semiarid environments. The resilient moth bean, also known as matki, mat bean, dew bean or Turkish gram (NAS, 1979) [7]. It contains 23.7 gram of protein, 2.8 gram of fat, 3.0 gram of ash, 10.3 gram of moisture, 4.3 gram of fibre, 8.3 gram of iron, and 1.8 gram of vitamin C per 100 grams respectively. It consists of magnesium (225), potassium (1096), Iron (9.5), calcium (202), phosphorus (230) and copper (0.85) mg/100 gram, correspondingly (Kamboj and Nanda 2017) [5].

Fenugreek (*Trigonella foenum-graecum* L.), a plant belonging to the Leguminosae (i.e., *Fabaceae*) family, is extensively grown all across the nation, with Rajasthan accounting for more than 70% of the total production (Sharma, 1989) [9]. Fenugreek is also known to be an age-old remedy that has long been prized because of both its culinary and therapeutic uses. Fenugreek seeds have L-tryptophan-rich proteins and lysine, mucilaginous fibre, and other uncommon chemical components like saponins, sapogenins, trigonelline and coumarine that are believed to be responsible for many of its purported therapeutic effects (Pinki Saini

Corresponding Author:**Landge AR**

PG Scholar, Department of Food Process Technology College of Food Technology, VNMKV, Parbhani, Maharashtra, India

et al., 2016)^[8].

Fenugreek consist of protein 2.74%, fat 6.33% and carbohydrate 77.04%. The average amounts of vitamins B1, B2, B6, and B12 is 0.1137 mg/g, 0.0366 mg/g, 0.0495 mg/g, and 0.8710 mg/g, respectively, while the amounts of vitamin C and folic acid is 10.5400 mg/g and 0.0386 mg/g, respectively (Buba *et al.*, 2015)^[3].

Materials and Methods

Materials

Raw materials required during present investigation were procured from local market of Parbhani, Maharashtra such as black gram splits, moth bean splits, fenugreek seeds. Chemicals (analytical grade) and glassware required during experiments were used from Department of Food Process Technology, College of Food Technology, VNMKV Parbhani.

Methods

Physical properties of Black gram splits, Moth bean splits and Fenugreek seeds

Physical properties of above-mentioned raw ingredients were determined, including colour, thousand kernel weight, bulk density, true density, thousand kernel volume, porosity, and angle of repose.

Color

The colour of black gram splits, moth bean splits and fenugreek seeds were determined by visual observations using moon shell colour chart.

Shape

The shape black gram splits, moth bean splits and fenugreek seeds were determined by visual observation.

Thousand Kernel weight

The weight of 1000 seeds was calculated by counting 100 randomly selected grains and weighing them with an electronic balance with an accuracy of 0.001 g, then multiplying the weight by 10.

Bulk Density

The bulk density of food grains and powders was calculated by dividing the mass of a quantity of grains by its volume, which was measured with a constant volume cylinder and expressed as kg.m-3.

$$\text{Bulk Density } (\rho') = \frac{\text{mass of grains (g)}}{\text{volum occupied (ml)}}$$

True density

True density of food grains and powders were measure by toluene displacement method. In a measuring cylinder, 50 ml of toluene was placed. The measuring cylinder was filled with

a known weight of grain sample, and the rise in the toluene level was recorded. The real density of the grain was estimated using the method below (Sunil *et al.*, 2016)^[11].

$$\text{True density } (\rho) = \frac{\text{weight of grains (g)}}{\text{volume of grains excluding void space (ml)}}$$

Porosity

Porosity is the fraction of bulk grain space that is not occupied by grain. The given equation was used to calculate porosity (%) from true and bulk density (Vanramkhasti *et al.*, 2008)^[15].

$$\text{Porosity (\%)} = \frac{\text{true density} - \text{bulk density}}{\text{true density}} \times 100$$

Angle of repose

The angle of repose is the angle produced between the cone's base and slope during a free vertical fall of grains to the horizontal plane. It was determined using the method given by Sunil *et al.*, (2016)^[11]. It was discovered by applying the phrase to calculate the height (h, mm) and radius (r, mm) of grains stacked in natural heaps.

$$\text{Angle of repose } (^{\circ}) = \tan^{-1} \{h/r\}$$

Where, h = Height of heap; r = Radius of base of heap

Proximate composition of legumes

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].

Mineral analysis

A defatted sample weighing two gram was kept at 550 °C. On a heated plate, strong hydrochloric acid (HCL) was then used to digest the resulting ash. The digested material was then filtered using Whatman No. 42 filter paper, and the final volume was made to 100 ml with distilled water. This volume was then utilised for analysis of Fe, Cu, Zn and Mn using atomic absorption spectroscopy.

Results and Discussion

Physical properties of Black gram split, Moth bean split and Fenugreek seeds

Physical properties play an important role in designing the machinery and equipment during the harvesting, post harvesting, milling operations and food processing. These properties help in the operation like separation, sorting and transfer. Different physical properties such as color, shape, bulk density, true density, thousand kernel weight, porosity and angle of repose were evaluated and the obtained data of results are summarized in table 1.

Table 1: Physical properties of Black gram split, Moth bean split and Fenugreek seeds

Physical Parameters	Black gram split	Moth bean split	Fenugreek
Colour	Pale Yellow	Yellow	Golden-yellowish
Shape	Oblong Semi-cylindrical	Oblong Semi- cylindrical	Cuboid
Wt. of 1000 seeds (g)	20.56±0.57	19.13±0.88	15.89±0.96
True Density (g/ml)	1.26±0.09	1.156±0.08	1.35±0.08
Bulk density (g/ml)	0.88±0.05	0.76±0.08	0.76±0.07
Porosity (%)	30.29±1.06	34.37±3.26	43.42±4.75
Angle of repose (°)	28 ⁰ 47'±0.68	22 ⁰ 63'±0.88	15 ⁰ 04'±0.63

*Each value represents the average of three determinations

Data presented in table 1 indicates that colour and shape of black gram splits were observed to be pale yellow and oblong semi-cylindrical whereas the moth bean splits were yellow and oblong semi-cylindrical in shape. It is also observed that colour and shape of fenugreek seeds were golden-yellowish and cuboid. Weight of 1000 seeds, true density, bulk density, porosity and angle of repose of black gram split was reported to be 20.56 (g), 1.26 (g/ml), 0.88 (g/ml), 30.29 percent and 28°47' degree respectively.

It is observed that weight of 1000 seeds, true density, bulk density, porosity and angle of repose of moth bean splits was reported to be 19.13 (g), 1.156 (g/ml), 0.76 (g/ml), 34.37 percent and 22°63' degree respectively. It is also observed that weight of 1000 seeds, true density, bulk density, porosity and angle of repose of fenugreek seeds was reported to be 15.89 (g), 1.35 (g/ml), 0.76 (g/ml), 43.42 percent and 15°04' degree respectively.

Nutritional composition of Black gram split, Moth bean split and Fenugreek seeds

The chemical parameters like moisture content, protein, fat, carbohydrate, crude fiber and ash content for the black gram splits, moth bean splits and fenugreek seeds were analysed and obtained results are represented in the table 2 as below.

Table 2: Nutritional composition of Black gram split, Moth bean split and Fenugreek seeds

Chemical Parameters	Black gram split	Moth bean split	Fenugreek seeds
Moisture (%)	10.8±0.55	8.56±0.15	13.63±0.06
Crude Fat (%)	1.8±0.3	1.22±0.10	6.83±0.02
Crude Protein (%)	23.6±0.45	22.8±0.4	25.86±0.03
Total Carbohydrates (%)	59.8±0.5	61.02±0.96	43.67±0.12
Ash (%)	3.63±0.30	3.26±0.15	3.27±0.05
Crude Fibre (%)	0.8±0.21	1.56±0.20	6.31±0.09

*Each value represents the average of three determinations

The proximate contents of black gram splits like moisture, crude fats, crude protein, carbohydrates, ash and crude fibre were estimated and it is found to be 10.8 percent, 1.8 percent, 23.6 percent, 59.8 percent, 3.63 percent, 0.8 percent respectively. Similar results were reported by Kamboj and Nanda, (2017)^[5] for different legumes.

It could be revealed from table 2 that the nutritional composition of moth bean splits pretends to have moisture, crude fats, crude protein, carbohydrates, ash and crude fibre were found to be 8.56 percent, 1.22 percent, 22.8 percent, 61.02 percent, 3.26 percent, 1.56 percent respectively. Similar results were observed by Vale *et al.*, (2010)^[13]. Data from table 2 showed that black splits and moth bean splits have approximately similar nutritional composition.

The proximate contents of raw fenugreek seeds like moisture, crude fats, crude protein, carbohydrates, ash and crude fibre were estimated and it is found to be 13.63 percent, 6.83 percent, 25.86 percent, 43.67 percent, 3.27 percent, 6.31 percent respectively.

Mineral composition of Black gram split, Moth bean split and Fenugreek seeds

The data pertaining to the essential mineral content of Black gram split, Moth bean split and Fenugreek seeds is recorded in the Table 3.

Table 3: Mineral composition of Black gram split, Moth bean split and Fenugreek seeds

Mineral	Black gram split	Moth bean split	Fenugreek seeds
Calcium (mg/100 g)	139±5.56	165.33±16.04	69.86±2.40
Phosphorus (mg/100 g)	386.33±19.13	492±17.69	557.4±25.03
Iron (mg/100 g)	4.57±0.32	4.59±0.02	10.73±2.92
Potassium (mg/100 g)	960±56.20	1157.33±31.26	670±21
Zinc (mg/100 g)	2.71±0.36	1.91±0.07	5.53±0.65
Manganese (mg/100 g)	1.15±0.11	0.91±0.06	0.94±0.18
Copper (mg/100 g)	0.64±0.09	0.67±0.05	1.46±0.26

Black gram splits consist of calcium, phosphorus, iron, potassium, zinc, manganese and copper 139 mg/100 g, 386.33 mg/100 g, 4.57 mg/100 g, 960 mg/100 g, 2.71 mg/100 g, 1.15, 0.64 mg/100 g respectively. Similar results were reported by Kamboj and Nanda, (2017)^[5] for different legumes. Moth bean splits consist of calcium, phosphorus, iron, potassium, zinc, manganese and copper 165.33 mg/100 g, 492 mg/100 g, 4.59 mg/100 g, 1157.33 mg/100 g, 1.91 mg/100 g, 0.91 mg/100 g and 0.67 mg/100 g respectively. Vale *et al.*, (2010)^[13].

Fenugreek seeds consist of calcium, phosphorus, iron, potassium, zinc, manganese and copper 69. Similar results were observed by 86 mg/100 g, 557.4 mg/100 g, 10.73 mg/100 g, 670 mg/100 g, 5.53 mg/100 g, 0.94 mg/100 g and 1.46 mg/100 g respectively. Similar results were observed by Ziwar (2009)^[14].

Conclusion

Thus, based on the scientific data collected and analyzed, it can be concluded that physico-chemical studies of different legumes *viz.*, black gram splits, moth bean splits and fenugreek seeds are vital for the development and production of process equipment as well as the development of higher nutritional quality products

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