

Physico-Chemical Properties of Fenugreek (*Trigonella Foenum* - *Graceum* L.) Seeds

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Abstract: In the present study, physico-chemical properties of fenugreek seeds were evaluated. Physical properties were evaluated for storage and equipment design whereas chemical properties were evaluated for nutritional study and product development. The average length, width, thickness, seed mass and geometric mean of the seed ranged as 3.461 mm, 2.061 mm, 1.067 mm, 0.0177 g and 1.990 mm respectively. The average sphericity, 1000 seed mass, bulk density, kernel density, porosity and angle of repose were ranged as 55.81%, 14.40 g, 6.51 (g/ml), 1.190(g/ml), 42.51% and 13.53° respectively. Chemical properties such as moisture, fat, protein and ash content (% dry basis) were found to be 11.21%, 07%, 23.30% and 03% respectively in raw fenugreek seeds where as 13.50%, 6.24%, 24.12% and 3.14% respectively in germinated fenugreek seeds. Germinated fenugreek seeds have higher moisture, protein and ash content where as low fat content as compared to raw fenugreek seeds.

Key words: Fenugreek seeds, Nutritive value, physical properties and chemical properties.

I. INTRODUCTION

Fenugreek (*Trigonella foenum-graecum* L.) is one of the most ancient medicinal plants belonging to family Leguminosae. It is cultivated world wide as semi-arid crop. The seeds are used as a spice and the leaves are consumed as a green vegetable. Fenugreek is native to Southern Europe, the Mediterranean region and Western Asia. India is a major producer of fenugreek and also a major consumer of it for culinary uses and medicinal applications. Over 80% of the total world's production is contributed by India. Rajasthan accounts for over 80% of India's output [1]. It is known as 'methi' in hindi.

In recent trends, fenugreek is also used as spice adjunct. It is used in functional food, traditional food, nutraceuticals as well as in physiological utilization such as antibacterial, anticancer, antiulcer, anthelmintic, hypocholesterolemic, hypoglycaemic, antioxidant and antidiabetic agent. It has beneficial influence on digestion and also has the ability to modify food texture. Fenugreek seeds are traditionally used for the treatment of many diseases. Studies show that the seeds have antioxidant properties. Many medicinal properties are attributed to fenugreek seed and leaves. Fenugreek is a leguminous plant that helps in nitrogen fixation and soil enrichment [2].

The fenugreek seeds are the most important and useful part of fenugreek plant. These seeds are golden yellow in colour, small in size, hard and have four- faced stone like structure [3]. Raw fenugreek seeds have maple flavour and bitter taste due to the presence of bitter

saponins, which limit their acceptability in foods. It has been possible to debitter fenugreek seeds by employing various processing methods such as soaking, germination, roasting etc., their bitterness can be reduced and flavour can be enhanced. Germinated seeds have several beneficial properties over ungerminated seeds. Germination improves in vitro protein digestion, as well as fat absorption capacity [4]. The whole seeds or its ground powder is used in pickles, vegetables dishes and spice powder. Dried seeds are used as condiments. Fenugreek seeds are gummy, fibrous and sticky in nature. Biologically, its seeds are endospermic in nature [2].

Recently fenugreek seeds are used as a cheap source of good quality protein. Fenugreek seeds can be a good supplement to cereals because of its high protein (25%), lysine (5.7g/16g N), soluble (20%) and insoluble (28%) dietary fiber besides being rich in calcium, iron and beta-carotene [5]. Fenugreek endosperm is rich in protein such as globulin, histidine, albumin and lecithin and 100g of fenugreek seed contains 25.4g protein. It has a high proportion of protein ranging from 20 to 30% as well as amino 4-hydroxyisoleucine in particular, which has high potential for insulin-stimulating activity. Fenugreek contains saponins, hemicelluloses, mucilage, tannins and pectin and these compounds helps to decrease the level of low density lipoprotein cholesterol (LDL) in blood by inhibiting the salts re-absorption in the colon.

The objective of this study was to determine the physical properties of fenugreek seeds namely size dimensions (length, width, thickness, seed mass and geometric mean diameter), thousand seed mass, sphericity, kernel density, bulk density, porosity and angle of repose. And the chemical properties of fenugreek seeds namely moisture, fat, protein and ash content. The knowledge about physical properties is essential to design equipment for aeration and storage as well as to improve the relevant machines and facilities for harvesting, storing, handling and processing. Chemical properties were evaluated for nutritional study and product development.

II. MATERIALS AND METHODS

The fenugreek seeds used in this study were obtained from a local market in Parbhani city of India. The samples were cleaned manually to remove all foreign matter, dust and dirt, broken and immature seeds.

A. Physical Properties

Physical properties owing to fenugreek seeds were evaluated according to methods given by [3] and [6].

1) *Length*: The length of seeds was measured by a vernier calliper with an accuracy of 0.01 mm.

2) *Width*: The width of seeds was measured by a vernier calliper with an accuracy of 0.01 mm.

3) *Thickness*: The thickness of seeds was measured by a vernier caliper with an accuracy of 0.01 mm.

4) *1000 Seed Mass*: To obtain the unit mass of seed, 1000 seed mass were measured by an electronic balance to an accuracy of 0.001 g.

5) *Geometric Mean Diameter*: The geometric mean diameter D_g of fenugreek seeds were calculated according to following formula,

$$D_g = (LWT)^{1/3} \quad (1)$$

Where, L is length, W is width, and T is thickness in cm.

6) *Sphericity*: The sphericity ϕ of fenugreek seeds was calculated by using the following formulae [6].

$$\phi = \{(LWT)^{1/3}/L\} \times 100 \quad (2)$$

Where, L is the length, W is the width and T is the thickness in mm.

7) *Thousand seed mass*: To evaluate 1000 seed mass, 100 randomly selected seeds were selected from bulk and were averaged.

8) *Kernel Density*: The kernel density of a seed is defined as the ratio of the mass of a sample of a seed to the solid volume occupied by the sample. The kernel density of fenugreek seeds was determined using the liquid displacement method. Fluids typically used include alcohol, toluene and tetrachloethylene. Toluene was used in place of water because it is absorbed by the seeds to a lesser extent.

9) *Bulk Density*: The bulk density is the ratio of the mass of a sample of a seed to its total volume.

10) *Porosity*: The porosity ϵ of bulk seed was calculated from bulk and kernel densities using the relationship.

$$\epsilon = \{(p_k - p_b)/p_k\} \times 100 \quad (3)$$

Where p_k is the kernel density in g/ml and p_b is bulk density in g/ml.

11) *Angle of Repose*: The angle of repose is the angle with the horizontal at which the material will stand when piled. This was determined by using a topless and bottomless cylinder of 300 mm diameter and 500 mm height. The cylinder was placed at the centre of a raised circular plate and filled with fenugreek seeds. The cylinder was raised slowly until it formed a cone on a circular plate. The angle of repose was calculated from the measurement of height of the cone and diameter of the cone.

B. Chemical properties of fenugreek

The chemical properties of raw and germinated fenugreek seeds on percent dry basis were analyzed such as moisture, fat, protein, ash and carbohydrate content [7].

III. RESULT AND DISCUSSION

A. Physical Properties

1) *Length*: The seeds have length ranging from 3.02 mm to 4.09 mm. The average length of fenugreek seeds was 3.461 mm.

2) *Width*: The seeds have width ranging from 2.02 mm to 2.09 mm. The average width of fenugreek seeds was 2.061mm.

3) *Thickness*: The seeds have a thickness ranging from 1.03 mm to 1.15 mm. The average thickness of fenugreek seeds was 1.067 mm.

4) *Seed Mass*: The seeds have unit mass ranging from 0.01 g to 0.023 g. The average seed mass of fenugreek seeds was 0.0177 g.

5) *Geometric Mean Diameter*: The geometric mean diameter of fenugreek seeds ranged from 1.86 to 2.10 mm. The average geometric mean diameter was 1.990 mm.

The results obtained of seed dimensions such as length, width, thickness, seed mass and geometric mean were in line with the findings of [8]

6) *Sphericity*: The sphericity was calculated by using the data on geometric mean diameter of fenugreek seed and results were obtained. The sphericity of fenugreek seeds ranged from 49.99% to 63.09%. The average sphericity of fenugreek seeds was 55.81 %.

7) *1000 Seed Mass*: The 1000 seed mass of fenugreek seeds ranged from 14.05 to 14.85 g. The average weight of thousand seeds was 14.45 g.

8) *Bulk density*: The bulk density of fenugreek seeds ranged from 6.21 to 6.98 g/ml. The average bulk density of fenugreek seeds was 6.59 g/ml.

9) *Kernel density*: The kernel density of fenugreek seeds ranged from 1.121 to 1.230 g/ml. The average kernel density of fenugreek seed was 1.175 g/ml.

10) *Porosity*: The porosity was calculated by using the data on bulk and kernel densities of fenugreek seeds. The porosity of fenugreek seeds were 42.56 to 42.73%. The average porosity of fenugreek seeds was 42.64 %.

11) *Angle of repose*: The angle of repose of fenugreek seeds were 13.23° to 13.86°. The average angle of repose of fenugreek seeds was 13.54°.

The results obtained of sphericity, 1000 seed mass, bulk density, kernel density, porosity and angle of repose were in correspondence with the findings of [6]

Table 1: Physical properties of fenugreek seeds

Parameters	Observations
Length (mm)	3.461
Width (mm)	2.061
Thickness (mm)	1.067
Seed Mass (g)	0.0177
Geometric Mean Diameter (mm)	1.990
Sphericity (%)	55.81
1000 seed mass (g)	14.40
Bulk Density (g/ml)	6.51
Kernel Density (g/ml)	1.190
Porosity (%)	42.51
Angle of Repose (°)	13.53

* Each Value is representative of three determinations.

B. Chemical Properties

1) *Moisture content*: The moisture content of raw fenugreek seed sample was 11.21 % and moisture content of germinated fenugreek seed sample was 13.50 %.

2) *Fat Content*: The fat content of raw fenugreek seed sample was 7 % and fat content of germinated fenugreek seed sample was 6.24 %. The extracts of seeds of fenugreek have been shown to possess hypoglycemic activity and are nontoxic.

3) *Protein Content*: The protein content of raw fenugreek seed sample was 23.30 % and protein content of germinated fenugreek seed sample was 24.12 %. Fenugreek seed contains 20-30 % of proteins as well as amino acid 4-hydroxyisoleucine in particular, which has high potential for insulin-stimulating activity. The basic element of biomolecules is proteins in addition to their roles in connectivity process and in all of biochemical reactions.

4) *Ash Content*: The ash content of raw fenugreek seed sample was 3 % and ash content of germinated fenugreek seed powder was 3.14 %, the presence of ash in such quantities are satisfying, because of the high importance of minerals for health maintenance and development.

5) *Carbohydrate content*: The carbohydrate content of raw fenugreek seed sample was 55.49 % and carbohydrate content of germinated fenugreek seed powder was 53 %.

The results pertaining to chemical analysis of fenugreek seeds were found to be more or less similar to the findings of [9].

Table 2: Chemical properties of fenugreek seeds

Name of sample	Moisture (%)	Fat (%)	Protein (%)	Ash (%)	Carbohydrate (%)
Raw fenugreek seeds	11.21	7	23.30	3	55.49
Germinated fenugreek seeds	13.50	6.24	24.12	3.14	53

*Each Value is representative of three determinations.

IV. CONCLUSION

The following conclusions are drawn from investigation on physical and chemical properties of fenugreek seeds.

1) The average length, width, thickness, seed mass and geometric mean diameter of fenugreek seeds was 3.461 mm, 2.061 mm, 1.067 mm, 0.0177 g and 1.990 mm respectively.

2) The average sphericity, thousand seed mass, bulk density, kernel density, porosity and angle of repose of fenugreek seeds was 55.81 %, 14.45 g, 6.59 g/ml, 1.175 g/ml, 42.64 % and 13.54° respectively.

3) The average moisture, fat, protein, ash and carbohydrate content of raw fenugreek seeds was 11.21 %, 7 %, 23.30 %, 3 % and 55.49 % respectively and moisture, fat, protein, ash and carbohydrate content of germinated fenugreek seeds were 13.50 %, 6.24 %, 24.12 %, 3.14 % and 53 % respectively. Results show that fenugreek seeds contain a highest percentage of proteins and lowest percentage of ash. The germinated fenugreek seed sample showed higher moisture, protein and ash content as compared to raw fenugreek seed sample but the fat content of germinated fenugreek seed sample was lower as compared to raw fenugreek seed sample.

4) Physical properties were evaluated for storage and equipment design whereas chemical properties were evaluated for nutritional study and product development.

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