

# A preliminary observational study on some morphological and physical features of Fenugreek seeds from Sudan

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## ABSTRACT

The fenugreek (*Trigonella foenum-graecum*) seeds are called "Hilba" in Sudan and nearby countries and are used in food flavoring and in curing many health problems such as diabetes and GIT disturbances, but still, the official approval of using Hilba as medicine is controversial. Sudanese Hilba seeds called "Baladi Hilba" were green colored differing from the Indian yellow Hilba seeds. This study was based on an observational approach using simple techniques, to avoid the complicated and sophisticated instrumentation which are scarce in our underdeveloped countries. Some differences in the characteristics between the green Baladi seeds and the yellow seeds were observed and reported as photographs. The Baladi green Hilba seeds appear to be larger than the yellow Indian seeds, around 3.5 mm × 2 mm. The Wt of 1000 green seeds was higher than that of yellow seeds (14 g, and 12 g, respectively), while the bulk density of green Hilba seeds was lower than the bulk density of yellow seeds (0.5770 g/cm<sup>3</sup>, and 0.6553 g/cm<sup>3</sup>, respectively). When soaked in water for 36 hrs, the expansion rate of yellow seeds and Baladi seeds were 4.00 and 4.25, respectively. Local expert people in medicinal plants in Sudan declared that treating different GIT disorders depend on the way of taking Hilba either in dry form or as cooked seeds. The two terms Hilba and Fenugreek were used alternatively through this study for the same meaning.

**Key words:** Fenugreek (*Trigonella foenum-graecum*), Hilba seeds, Baladi, Sudan.

## Introduction

The term "Hilba" also spelled Hulba, refers to Fenugreek seeds and plant (*Trigonella foenum-graecum*) which is derived from Latin *faenugraecum*, *faenum Graecum* meaning "Greek hay" (Beekes, 2010), it is called "methi" in India, *Abish* in Ethiopia, *tiltanin* Hebrew language (Gall, 2009; Petropoulos, 2002; Mehrafarin Rezazadeh, 2011), and *Hu luba* in Chinese language (Madar and Stark, 2002). Fenugreek (Hilba) is an annual plant, cultivated worldwide as a semiarid crop, with leaves consisting of three small obovate to oblong leaflets. India

still holds the largest fenugreek harvested area in the world (Acharya and Srichamroen, 2006).

The Hilba is used in food flavoring and for making a local traditional diet called "*madeeda*" in Sudan (Abdel Moneim, Ali and Julia, 2008), and in Yemen (Mizrachi, Avshalom, 2018), and in making some other foodstuffs such as the cured dried beef called *Basterma*. The seeds were used whether as a whole or ground seeds to flavor many foods mostly curry powders; teas and spice blend (Betty, 2008).

Hilba seeds were rich in many nutritive elements such as proteins and carbohydrates (23%, 58% respectively), and contain minerals such as manga-

nese andiron, in addition to B vitamins (Ouzir *et al.* 2016; Mehrafarin *et al.*, 2010). Many studies referred the distinctive maple syrup smell and aroma of fenugreek to the chemical molecule sotolone (Pub Chem, US National Library of Medicine, 2019; National Center for Complementary, 2020). The seeds consist of 50% mucilaginous fiber; their oil has a bitter taste and a disagreeable odor (Abdo and Kafawi, 1968).

Hilba is also known as a medicinal herb in many countries, recently it is under focus by pharmaceuticals due to its rich medicinal properties (Acharya and Srichamroen, 2006), used for many disease and disorders of the lung, digestive system, and had many uses for treating diabetes (Azam Khan, 2004), the Hilba cures blood poverty and body weakness and many chest diseases (Abuzied, 1986), it had been mentioned in Islamic culture as a traditional medicine. It has been used to relieve colds, bronchial complaints, influenza, asthma, catarrh, constipation, sinusitis, pleurisy, pneumonia, sore throat, laryngitis, hay fever, tuberculosis, and emphysema (Anonymous, 2013).

Fenugreek is also known for its lymphatic cleansing activity through its vital role in cells' irrigation and elimination of toxic wastes, dead cells, and trapped proteins from the body (Sajad, 2016).

The seeds of fenugreek have been used orally as an insulin substitute for the reduction of blood glucose (Madar and Stark, 2002; Adedapo and Ofuegbe, 2014; Gupta, 2001; Baquer, 2011; Hannan, 2003; Losso, 2009). They may lower the absorption of glucose from the large intestine and improve the activity of beta cells in the pancreatic Islet's of Langerhans (Khan *et al.*, 2018; Sajad, 2016). Many studies mentioned the usage of Fenugreek seeds for diabetes and mild asthma treatment (Majid Emtiazy *et al.*, 2018; Mohamed Gad *et al.* 2006). These antidiabetic and hypocholesterolemic effects may be attributable to the intrinsic dietary fiber constituent which composes 25% of Hilbaseeds (Srinivasan, 2006).

Some scientists reported that Fenugreek can increase a nursing mother's milk supply within 24–72 h after first taking the herb (Snehlata and Payal, 2012), so it also has been recommended for the promotion of lactation (Madar and Stark, 2002). Breasts are modified sweat glands and Fenugreek has been found to stimulate sweat production and so increase milk formation.

Fenugreek had a beneficial influence on digestion, the Chinese used it for treating abdominal pain

(Madar and Stark, 2002), Egyptian women are still using it to relieve menstrual cramps, as well as making Hilba tea to ease other kinds of abdominal pain. When Hilba seeds were eaten raw as sprouts, their maple aroma and flavor lead to the imitation of maple syrup (Madar and Stark, 2002). Due to the pungent aroma of Fenugreek, its smell appears on the skin and in under-arm perspiration. Whole seeds are swallowed as antiacid and against dysentery and stomach disturbances (Gorafi, 1983).

The Fenugreek oil has potent antimicrobial activity against all tested microorganisms, however, the highest antimicrobial activity against all tested organisms was found against *Aspergillus niger* where a complete inhibition (100%) was recorded (Suliaman *et al.*, 2008a). Besides the antimicrobial properties, Fenugreek has been also reported to be rich in antioxidants (Acharya, Paul, and Basu, 2011; Thomas, Basu, and Acharya, 2006). The anti-inflammatory effects of Fenugreek seeds have also been demonstrated (Sharififar *et al.*, 2009; Naidu Shyamala *et al.*, 2011; Thirunavukkarasu *et al.* 2003; Murugesan *et al.*, 2011).

Many studies mentioned the wide dose range, and reporting the good toleration of Fenugreek seed powder, with no serious side effects when used in a daily dose of 25 g (Vijayakumar and Bhat, 2008). Despite that, always there is some doubt about the efficiency and safety of using Fenugreek herb (Gong *et al.*, 2016; Pattanittum *et al.*, 2016). Some studies had mentioned some increased risk under frequent medicinal use of Fenugreek (National Center for Complementary, 2020). The governmental health agencies didn't recommend officially the use of Fenugreek as a medicinal drug, still, the safety and efficiency of Fenugreek usage as a drug is controversial (Majid Emtiazy *et al.* 2018). Some studies were speaking about "trials" confirming the efficacy of Fenugreek as a medicinal herb that treats many diseases (Acharya and Srichamroen, 2006; Acharya and Blade, 2007; Zandi *et al.*, 2011). Some unlikely effects were also shown by Fenugreek sprouts such as a diuretic, maple-syrup odor, and bitter smell (Khan *et al.*, 2018).

This preliminary study had a target of observing and reporting some characteristics of Hilba (Fenugreek) seeds, comparing seeds from Sudan with seeds from India, and a secondary target to encourage researchers for conducting such observational researches by utilizing the available tools and instrumentation.

## Methodology

### Approach

Our study was observational, home-done, to get approximate results almost nearly accurate measures, values, and dimensions. Such a home-made study uses tools available in our houses and nearby shops, without looking for laboratory tools and instruments. It depends on observations by the naked eye, reporting observed notes in real-time, and photographing. Creating and innovating calculation correlations and comparisons with results reported in the published literature. Evaluating the use of available household tools in conducting scientific researches, by comparing the accuracy of their results with previous results of studies conducted using laboratory tools (Our case study was: Some physical properties of fenugreek seeds from Sudan).

Our under-develop countries were suffering from a lack of well-equipped and well-established laboratories that can give accurate real researches' results, besides the scarcity of expert persons who could interpret the results of the complicated laboratory instruments.

We require creating simple applicable methods to conduct researches in many fields particularly on our rich area having different ecological and biological elements including medical herbs which represent a fertile area for research.

Our country (Sudan) had been suffering under a political embargo for many years, which limits conducting and developing scientific researches, besides prevention of importing sophisticated instrumentation to the country. Even our universities and institutes couldn't present serious scientific researches adequately. This article tries to encourage researchers to use the available research tools and create simple research methods.

The data collected from expert people, by personal communication and questionnaire forms, can represent a valuable source of information. In this study, we had investigated people who had an actual knowledge of the use of natural Hilba seeds for curing disease in local societies.

Although considered as preliminary, these observational studies may enrich science knowledge and open wide streets for more advanced researches.

### Materials and Methods

Two types of Fenugreek seeds (Hilba)

(*Trigonella foenum graecum* L.) were purchased from the local Omdurman market, Sudan. Green seeds were called Hilba Baladi (means local) green colored, while the yellow Hilba seeds called "Indian Hilba" as it was imported from India.

The weight of 1000 seeds was measured using a weighing balance (g/mg). The axial dimensions of Hilba seeds were measured using a plastic commercial ruler which is used by students. A syringe tube brought from the pharmacy shop was used for adding an accurate volume of water. A transparent glass cub of an internal volume of 194.57 cm<sup>3</sup> was used as an alternative to the measuring cylinder usually used in laboratories. Average bulk density was determined using this glass cub, and it was expressed as the ratio of mass by volume. This method had been used by Balasubramanian and Viswanathan (2010) who used a measuring cylinder filled with the seeds to a constant height.

Some 5000 seeds from each Hilba type had been counted by hand (manually), and then put in the glass cub. The number of these seeds proportionate to the volume unit (Cm<sup>3</sup>). After filling each cub with some 5000 seeds of each Hilba type, the height of each type was measured and multiplied by the area of the circular base of the cub as follows:

The volume occupied by seed bulk = Height of seed bulk x Area of the circular base

The ratio of the volume occupied to the number of seeds of the two types had been compared, to obtain an idea about the difference in bulk density between green and yellow Hilba types. This measure gives us a good idea about the bulk density of fenugreek seeds. For comparison, the same method was applied for both Hilba seed types simultaneously. Comparing our results with previously reported bulk densities of Hilba seeds will help us to evaluate the bulk density of our tested Hilba seeds.

A volume of 100 ml filtered water were added to each cup containing the two Hilba types (initial height of bulk column was 2 cm), the water volume was measured by a tube of medical syringe brought from a pharmacy shop, then the soaked seeds were kept for 36 hours in a closed box at room temperature (about 25° C), then the new volumes of both seed bulk were calculated and compared. By calculating the difference in occupied volumes of soaked seeds, we could gain the difference in absorption ability or efficiency of the two types. Bulk density is defined as the mass of many particles of the material divided by the total volume they occupy. The total

volume includes particle volume, inter-particle void volume, and internal pore volume (Sharanagat, 1996).

## Results and Discussion

### The general appearance and characteristics

Our samples included two types of Hilba seeds (fenugreek), the Hilba Baladi (Sudanese local seeds), which was either dark green or light brownish-green, while the Indian Hilba seeds (imported from India) were yellow or brownish-yellow to amber (Fig. 1-a; Fig. 1-b). Hilba seeds were described in the Feedipedia as green-olive or brownish, with an oblong or square shape (Heuzé *et al.*, 2019). Naidu Shyamala (2011) described Fenugreek seeds as slightly sweet with a pleasantly bitter.

Khan *et al.* (2018) in their study described the Fenugreek (Hilba) seeds as corneous and comparatively large layer surrounding a central hard and yellow embryo; they described this outer layer as a white and semi-transparent endosperm.

Some Studies from Egypt (Madar, and Stark, 2002) and Yemen (Mizrachi, and Avshalom, 2018) had shown seeds with nearly similar green color, this similarity between Baladi Hilba, and Hilba from some other countries, may be due to the neighboring and common borders of these countries, and almost their similar ecology.

Hilba seeds shapes were not identical, in general, the shapes of the Hilba seeds were irregular, most of them described as cuboids-shaped, others were in the shape of the symbol of a heart drawn in art, while other seeds look like irregular triangles or



Fig. 1a: Hilba Baladi (Sudanese local seeds) either present as dark green or light brownish-green



Fig. 1b. The general appearance of the Indian Hilba yellow seeds.

squares, and can be described as ovate globular with longitudinal ridges on the surface (Fig. 2).

We observed that almost all dry seeds were intact non-broken, which indicates their rigidity and non-fragility, despite the exposure to many mechanical pressures during the supply chain from farms up to markets, buyers and end consumers.



Fig. 2. A collection of photos of different Hilba seeds shapes

Some spherical particles, seen as small balls, almost black, were observed distributed within yellow Hilba seeds, these spherical particles may be a spoiled or immature Hilba seeds (Fig. 3), but also they may be a foreign substances of an unknown source. However, although their amount may not exceed 0.02%, they must be removed when consuming Hilba seeds in food or feeding.

In this regard, it may be beneficial to remind with the accident of the *Escherichia coli* outbreaks (O104 strain) linked to Egyptian fenugreek seeds exported to Europe, which occurred in 2011 (Lisa Schnirring, 2011), which means that fenugreek seeds are prone to bacterial pollution.

### Size, Weight, and Bulk density

The length of Hilba seed is around 3- 3.5 mm long, while its width around 2 mm (Fig. 4). Some studies had reported Fenugreek length as 6-8 mm (Heuzé et al. 2019).

The Baladi green Hilba seeds appear to be larger than the yellow Indian seeds, this observation was confirmed by the longer height of the bulk Baladi seeds in the glass cup compared to that of the yellow seeds (Fig. 5).



Fig. 3. The presence of some spherical particles between Hilba seeds

Although the Wt of 1000 green seeds was higher than that of yellow seeds (14 g, and 12 g, respect.), the bulk density of green Hilba seeds is lower than the bulk density of yellow seeds (0.5770 g/cm<sup>3</sup>, and 0.6553 g/cm<sup>3</sup>, respectively), as shown by the following calculations:

Wt of 1000 green seeds (Baladi) = 14 g

Wt of 1000 yellow seeds (Indian) = 12 g

Wt of 5000 green seeds = 70 g

Wt of 5000 yellow seeds = 60 g

The volume occupied by 5000 green seeds = 121.32 cm<sup>3</sup>

Bulk density = Mass over Volume = 70 over 121.32 = 0.5770 g/cm<sup>3</sup>

The volume occupied by 5000 yellow seeds = 91.56 cm<sup>3</sup>

Bulk density = Mass over Volume = 60 over 91.56 = 0.6553 g/cm<sup>3</sup>

12.63, 13.47, 9.90, 10.93, and 13.60 of twenty genotypes of Fenugreek. The study of Sulieman *et al.*, 2008b had mentioned that the Weight of 1000 seeds (g) was 2.063 g.

### Absorbing efficiencies of Hilba seeds

Results of the soaking Hilba seeds in water showed that both types had expanded on the absorption of water, the green color of Baladi seeds was disappeared (bleached) after absorbing water (Fig. 6).

Calculations of bulk densities after 36 hrs soaking of Hilba seeds in water:

- The height of seeds bulk before soaking (both Hilba types) = 2 cm;

Volume = 2 x 2.7 x 2.7 x 3.14 = 45.78

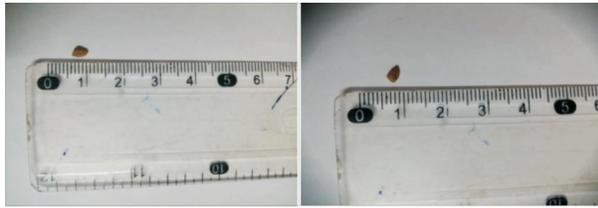


Fig. 4. Hilba seed size

- The height of **yellow** Hilba seeds bulk after soaking = 8 cm;

$$\text{Volume} = 8 \times 2.7 \times 2.7 \times 3.14 = 183.12 \text{ cm}^3$$

- The height of Baladi Hilba seeds bulk after soaking = 8.5 cm;

$$\text{Volume} = 8.5 \times 2.7 \times 2.7 \times 3.14 = 194.57 \text{ cm}^3$$

Expansion rate of yellow seeds =  $183.12 / 45.78 = 4.00$

Expansion rate of Baladi seeds =  $194.57 / 45.78 = 4.25$

These results mean that after soaking in water for 36 hrs, Hilba seeds were expanded by 4 fold (yellow seeds), and 4.25 fold (Baladi seeds), with an approximate mean of 4.125 fold. This number may give an



Fig. 5. A collection of photos of a pair of cups, one filled with green Hilba seeds, and the other filled with yellow Hilba seeds (5000 seeds).

idea about the absorbing efficiency of Hilba seeds. (Fig. 6)

We didn't compare the bulk density of Hilba seeds before and after soaking in water, but in the literature, Ebubekir Altunta<sup>o</sup>*et al.* (2005) found that as the moisture content increased, the bulk density was decreased. Other studies such as Altuntas *et al.* (2005) study have reported the moisture dependence of physical and mechanical properties of Fenugreek.

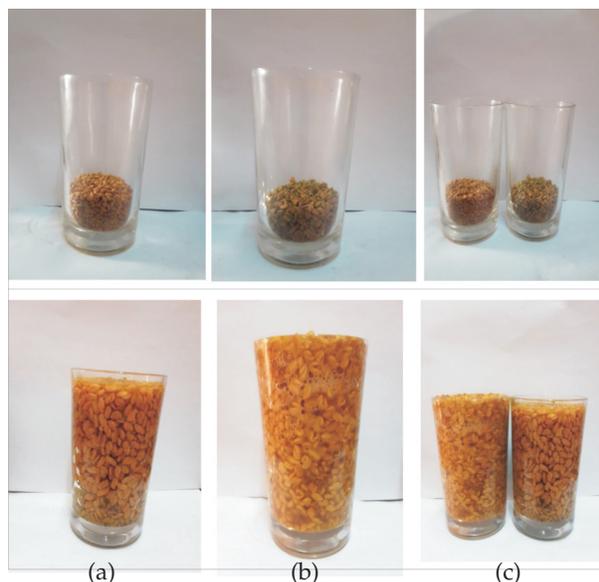
The initial moisture content of Fenugreek was reported by many studies, it was 7.49 (Sowmya and Rajyalakshmi, 1999); 4.00% (Singh and Goswami, 1996); 9.3% (Mounir *et al.*, (1978); 3.4% (Abdel Aal *et al.*, 1986); and 2.4% (Pudayasekhara and Sharma, 1987). For comparison, the initial moisture content of the *Coriander* seed was reported by Balasubramanian *et al.* (2012) as 7.0% d.b.

#### Dietary and medicinal use in Sudan

In Sudan, Fenugreek seeds (Hilba) are grown mainly in the northern part of the country whereby the prevalent environmental conditions are favorable. The Sudanese Fenugreek seeds have different sizes, shapes, and colors (Gorafi, 1983). Sudanese Fenugreek seed (Hilba Baladi) shows much promise as a commercial source of sapogenins mostly diosgenin and yamogenin (Nour, 1991).

Although most of the respondents of the questioned expert people were ensuring that the Sudanese green Hilba (Hilba Baladi) seeds had a stronger odor, taste, and flavor than the yellow seeds imported from India, we couldn't observe these differences clearly (Statistics of the questionnaire results were not shown in this research paper).

Local experts in the field of medicinal plants in Sudan declared that treating different GIT disorders depend on the way of taking the Hilba, for example, the treatment of diarrhea being with taking dry Hilba seeds, while the treatment of constipation being with taking moist seeds or Hilba soup. They had their own interpretation, that dry seeds may absorb the liquidity of diarrhea, while moist seeds assist in liquefying constipation. Sudanese believe in the benefits of Hilba seeds for treating any digestion problems, which was also mentioned in Khan, Negi, and Kumar (2018) study, who reported that Fenugreek improves digestion. The anti-diarrheal activity of Fenugreek was also confirmed by Jain and Lohiya (1987) study. In general, most studies had reported the use of Fenugreek (Hilba) for treatment of diar-



**Fig. 6.** Both types of Hilba seeds before soaking (2 cm h), and after 36 hrs soaking in water. (a): Yellow Hilba; (b): Baladi Hilba; (c): Both types.

rhea and diabetes (Ouzir *et al.*, 2016), in addition to many other diseases such as respiratory and skin problems and others (Khan *et al.*, 2018).

The most famous medicinal usage of Hilbah in the Western world is for hair curing and nourishing, and to some extent for reducing blood sugar and blood cholesterol levels (Basu, 2006). But in Sudan Hilbah is one of the GIT natural medicines particularly for treating diarrhea and colitis or colon irritations, I used Hilba for my won colon disturbances. Also, a special porridge (madidat-hilba) is made from wheat flour to which whole or ground Hilba seeds are added for fattening women, and usually used by lactating mothers in a form of thin porridge (Goraf, 1983) to enhance milk formation and secretion.

We didn't find enough information about the characteristics of oil of Sudanese Fenugreek seeds, the study of Sulieman *et al.*, 2008 had reported some differences between Hilba oil and other seed oils such as olive and sesame, and he categorized Fenugreek seed oils as drying oils as they get tough when exposed to air.

## Conclusion

Our countries are poor of well-established and well-equipped laboratories so that we conducted this preliminary observational study by a simple tech-

nique based on real-time observations using available analytical tools. Fenugreek called Hilba in Sudan is known as a herbal flavoring and traditional agent for treating diabetes and some GIT diseases. Some differences between the Hilba seeds from Sudan (Baladi green Hilba) and the yellow Indian seeds were reported. The Baladi Hilba seeds had a higher volume, and weight, but a lower bulk density compared with the Indian seeds. More detailed studies were recommended about the medicinal benefits of Sudanese Baladi Hilba.

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