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TRIGONELLA FOENUM-GRAECUM: A HERBAL PLANT REVIEW

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ABSTRACT

Fenugreek is an aromatic annual herb obtained from Trigonella foenum-graecum linn. family leguminosae. The plant is widely used for medicinal purpose also it has major role in cosmeceuticals and food. It is an erect hairy annual of the bean family, reaching 30-60 cm. It is cold season crop and is fairly tolerant to frost and very low temperature. It can also grow on black cotton soils. The main chemical components of Trigonella foenum-graceum are fibers, flavonoids, polysaccharides, saponins, fixed oils, proteins, amino acid, vitamins, lipids and some identified alkaloids. Fenugreek contains a number of steroidal sapogenins. The leaves contain 7 saponins, known as graecunins. The chemical components of fenugreek seeds include a large carbohydrate fraction; 20-30% proteins high in tryptophan and lysine; pyridine-type alkaloids; flavonoids; free amino acids; saponins; glycosides; vitamins, minerals, mucilage, proteids, 5% of a stronger-smelling, bitter fixed oil, volatile oils. Bitterness is mainly due to the oil, steroidal saponins and alkaloids. Seeds contain 0.1% to 0.9% diosgenin and are extracted on a commercial basis. Fenugreek is used for diabetes, painful menstruation, menopause, polycystic ovary syndrome, arthritis, poor thyroid function, and obesity. It is also used for conditions that affect heart health such as atherosclerosis and for high blood levels of certain fats including cholesterol and triglycerides. Because of its wide applications fenugreek has very vast therapeutic uses. The present review paper will be useful for preparation of various pharmaceutical products using fenugreek as a drug or as an excipient.

KEYWORDS: Trigonella foenum-graecum, three-angled, galactogague, graecunins, trigonelline, appetide.

INTRODUCTION

Fenugreek is an annual herb obtained from Trigonella foenum-graecum belonging to family leguminosae listed by "Council of Europe" as a natural source of food flavouring. Fenugreek (Trigonella foenum-graecum L.) plant is widely distributed throughout the world belonging to the family Fabaceae.[1]

The Fabaceae or Leguminosae, commonly known as the legume, pea, or bean family, are a large and economically important family of flowering plants. It includes trees, shrubs, and perennial or annual herbaceous plants, which are easily recognized by their fruit (legume) and their compound, stipulate leaves. Many legumes have characteristic flowers and fruits. The family is widely distributed, and is the third-largest land plant family in number of species, behind only the Orchidaceae and Asteraceae, with about 751 genera and about 19,000 known species. The five largest of the genera are *Astragalus* (over 3,000 species), Acacia (over 1000 species), Indigofera (around 700 species), Crotalaria (around 700 species), and Mimosa (around 400 species), which constitute about a quarter of all legume species.[2] Trigonella foenum-graecum L. (Fenugreek) commonly known as methi (in Hindi) has been used as a culinary spice, a flavoring agent and as a medicinal plant from ancient time. Among the spices, the Fenugreek is used as esoteric food adjacent to enhance the flavor and colour of the food and make it tasty and also used to modify the texture of food. The name of the genus, Trigonella, is derived from the old Greek name, denoting 'three-angled', probably referring to the triangular shape of the flowers. The first recorded use of fenugreek is described on an ancient Egyptian papyrus dated 1500 B.C. Taxonomists such as Linnaeus suggested that as many as 260 species of Fenugreek may exist, of which a total of only 18 species of Trigonella are currently recognized.

Fig.no 1: Fenugreek seed and leaves.

Vernacular name

Table 1: vernacular names of fenugreek.

Common name	Language
English	Fenugreek
Hindi, Marathi	Methi
Sanskrit	Methika, peetbeeja
Latin	Trigonellafoenum-graecum
Italian	Fieno Greco
Arabic	Hulba
Chinese	Hu-lu-ba, Hu-lu-pa
Norwegian	Bukkehonrklr
Dutch	Fenegriek
Portuguese	Alforva, feno-grego
Farsi	Sambelil
Russian	Pazhitnik
Finnish	Sarviapila
French	Fenugrec
Spanish	Alholva
German	Bockshornsamen

Table 2: Scientific classification.

Kingdom	Plantae
Division	Magnoliophyta
Class	Magnoliopsidaa
Order	Fabales
Family	Fabaceae
Genus	Trigonella
Species	Foenum-graecum
Bionomial name	Trigonella foenum-graecum

Plant description[3,4,5]

The fenugreek plant may have a single stem or may be branched at the stem base. The plant has an erect growth habit and a strong, sweet aroma. The origin of fenugreek is unknown but it is indigenous to the western Mediterranean. It is an erect hairy annual of the bean family, reaching 30-60 cm. The plant grows to a height of about three feet, has three part leaves, the long slender stems bear tripartite, toothed, grey-green obovate leaves, 20-25 mm (3/4-1 in) long. Fenugreek is a leguminous, herbaceous, rainfed crop. Trigonella foenum-graecum has long stalked leaves up to 5 cm long stipules triangular, lanceolate, leaflets about 2.5 cms long, obovate to obanceolate. The root is a mass of fingery structures.

The sissile axillary flowers are white or pale yellow. Flowers are 1-2, axillary, sessile, racemed, whitish or lemon yellow that bloom from June to July. The flowering season for the herb fenugreek is generally midsummer.

The thin, sword-shaped pods are 10-15 cm (4-6 in), with a curved beak-like tip, each carrying 10-20 seeds. Seeds are small (5 mm. long), hard, and brownish yellow the colour may varies. They are flattened and have a very characteristic rhomboidal outline. Nearly in the centre of one of the long, narrow sides is a small depression in which hilum and micropyle are situated, the former being distinctly visible as a whitish point; this depression is continued in the form of a furrow running diagonally across part of each of the adjoining sides, thus dividing the seed into two unequal lobes. If the seed is cut in a direction transverse to the side in which the hilum lies, so as to pass through both lobes of the seed, it will be found that the larger lobe contains two accumbent cotyledons - the smaller, the radical. Both are yellowish in colour, and surrounded by a darker, horny, translucent endosperm, which separates the radicle from the cotyledons. When it is soaked in water the endosperm swells and yields mucilage to the surrounding liquid. Entire seeds macerated in warm water burst their seed-coats by the swelling of the mucilage, and disclose the structure of the seed.

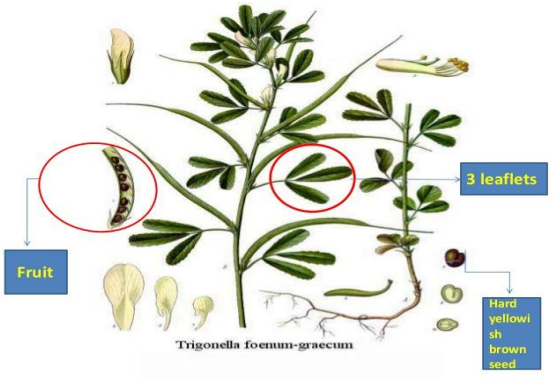

Fig.no.2: Morphology of fenugreek.

Morphology[3]

Table 3: Morphology of fenugreek

Plant height	30-60cm (about 3 feet)
Leaves	20-25mm
Flower	1-2
Seeds	5mm long
Sword shaped pods	10-15cm
Odour	Spicy
Taste	Bitter
Plant mature in	About 4 months

Standards[3]

Table 4: Standards of fenugreek.

Foreign matters	Not more than 2%
Total ash	Not more than 4%
Acid-insoluble as	Not more than 0.5%
Alcohol-soluble derivatives	Not less than 5%

Season and months

It can be grown in plains throughout the year. Mostly Rabbi season good for the cultivation.

- **Rainy Season:** June – July; **Winter Season:** September – October.

Microscopy

Microscopical character of fenugreek seed and leaf[6]

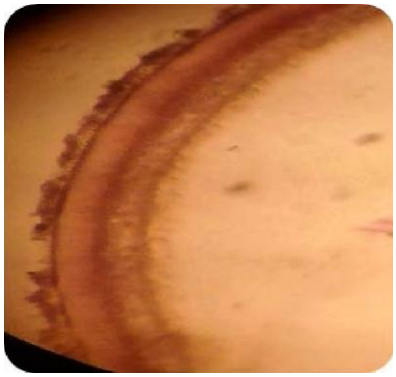

Fig.no.3: Transverse section of seed.

Fig.no.4: Transverse section of leaf

Powdered fenugreek seed is yellowish in colour, with strong characteristic odour and a mucilaginous slightly bitter taste. It is characterized microscopically (Figure 5) by the presence of the following[7]

1.Fragments of the testa showing palisade-like epidermal cells (5 A) that are radially elongated with thick cellulosic lamellated walls, and a conical-shaped lumen, narrow at the upper extremity and rounded at the base, in surface view, composed of small polygonal cells with thickened pitted walls and lumina narrower at the top (5 B) than the base (5 C).

2. Fragments of the testa showing basket-like cells of the sub-epidermal layer (hypodermis) (5 D). Cells being large, narrow at the upper end, wide at the base and constricted in the middle, with radial walls having bar-like thickenings (side view), and appearing polygonal with barlike thickenings extending to the upper and lower walls (surface view).

3. Parenchyma of the aleurone layer (5 E) formed of elongated, rectangular cells with slightly thickened walls containing aleurone grains consisting of globoids only.

4. Fragments of endosperm cells which are polygonal to elongated, unevenly thickened and filled with stratified mucilage (5 F) stained blue with methylene blue.

5. Fragments of cotyledons with parenchymatous thin walled elongated cells containing fixed oil and aleurone grains stained yellow with picric acid (5 G).

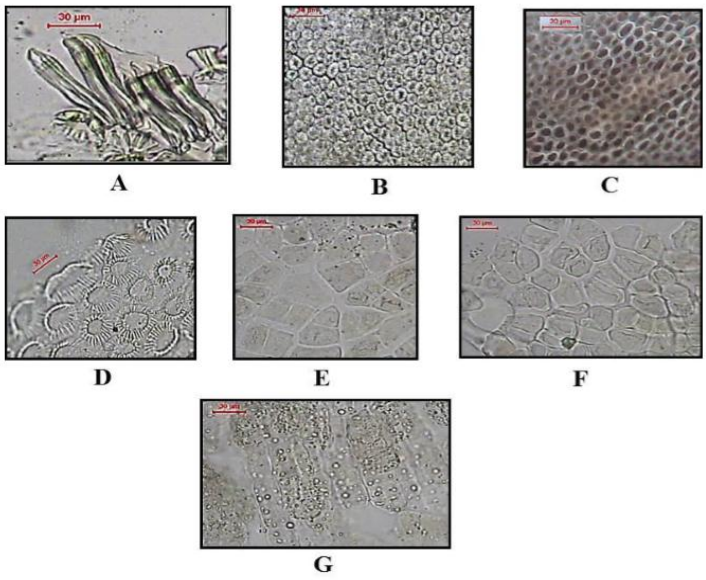

Fig.No.5: Powdered seeds of Trigonella foenum graecum L. A. palisade like epidermis (side view), B. palisade like epidermis (top view), C. palisade like epidermis (basal view), D. hypodermis (side and surface views), E. aleurone layer, F. endosperm, G. cotyledon cells.

The amino acid profile of fenugreek seeds[7]

Table 5: Amino acid profile of fenugreek seeds.

Amino Acid		**Amount g/100 g in**
Essential Amino Acid	Histidine	0.954
	Isoleucine	1.733
	Leucine	2.972
	Lysine	2.671
	Methionine	0.049
	Phenyl alanine	0.0802
	Threonine	0.532
	Valine	1.729
Non-essential amino acid	Alanine	2.751
	Arginine	0.049
	Aspartic acid	4.788
	Glutamic acid	5.476
	Glycine	4.077
	Proline	0.000
	Serine	1.820

	Tyrosine	0.726
Total essential amino acid		11.442
Total non-essential amino acid		19.687
Total determined amino acids		31.129
***Amino acid also classified as semi-essential amino acids**		

Cultivation[8]

Fenugreek is best grown as an annual crop from seeds, by the line sowing method. The land should be prepared but related ploughing and harrowing. In India, it is used as green leafy vegetable as well as spice. The plant is cultivated as a semi-arid crop. It is cold season crop and is fairly tolerant to frost and very low temperature. It can also grow on black cotton soils. Fenugreek requires well-drained, good soil of medium texture. Tolerated pH range is 5.3 to 8.2. Needs full sunlight, and requires watering during dry periods.

Geographical indications[9]

Fenugreek is an annual herb indigenous to the countries bordering on the eastern shores of the Mediterranean and largely cultivated in India, Egypt, US, Africa, Europe, Morocco and occasionally in England. In India, Rajasthan accounts for over 80% of India's output.

Trigonella foenum-graecum originated from South-Eastern Europe and Western Asia. In North Africa, it has been grown for fodder in Saharan oases from very early times. The Greek named the plant “telis”, which means "green" and the Romans learned from the Greeks that this plant was a valuable fodder. Fenugreek is now widespread in India and neighbouring countries, in Northern Africa, Near East, Western Asia, Ethiopia, Chile, Argentina, China and the USA. In the semi-arid regions of North America it is considered a high yielding niche crop. In Europe, it is grown in Austria, Belgium, France, Hungary and Spain.[13]

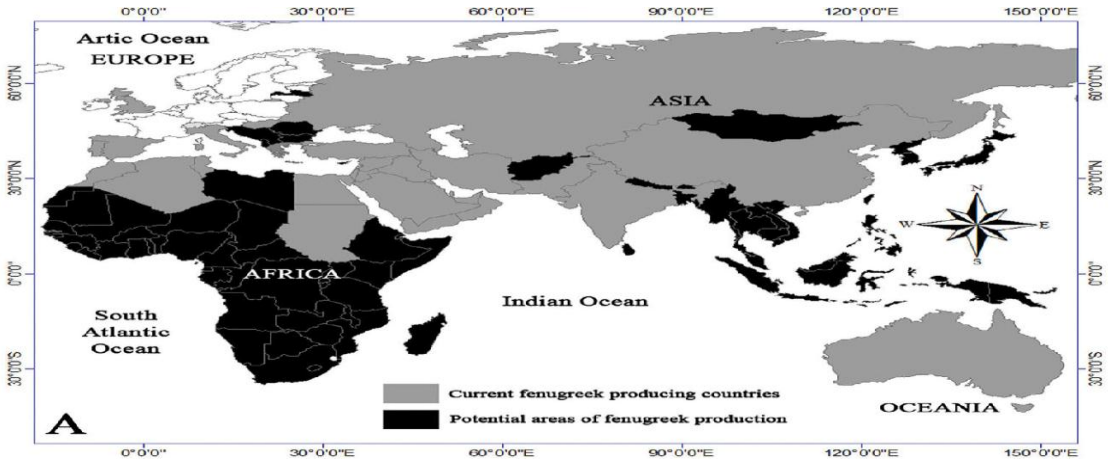

Fig.no.6: Geographical indication of fenugreek.

Phytochemical Constituents[1, 3, 10]

The main chemical components of Trigonella foenum-graceum are fibers, flavonoids, polysaccharides, saponins, fixed oils, proteins, amino acid, vitamins, lipids and some identified alkaloids.

Stem: Fenugreek contains a number of steroidal sapogenins. The diosgenin were found in the oily embryo. Two furastanol glycosides, F-ring opened precursors of diosgenin have been reported, as also hederagin glycosides. The alkaloid trigonelline, trigocoumarin, trimethyl coumarin and nicotinic acid are present in stem. About 28% mucilage; 5% of a stronger-smelling, bitter fixed oil, 22% proteins; a volatile oil; two alkaloids, Trigonelline and Choline, and a yellow colouring substance are present in stem.[11]

Leaves: The leaves contain 7 saponins, known as graecunins. These compounds are glycosides of diosgenin. Leaves contain moisture 86.1%, protein 4.4%, fat 0.9%, minerals 1.5%, fiber 1.1%, and carbohydrates 6%. The mineral and vitamins contents are calcium, iron, phosphorous, carotene, thiamine, riboflavin, niacin and vitamine C.[12]

Seed: Fenugreek Seeds are aromatic, bitter, carminative, galactogouge, antibacterial and may be eaten raw or cooked. Bulk of the seed is dietary fiber (50%) and protein (30%) both of which have no taste or flavor. The chemical components of fenugreek seeds include a large carbohydrate fraction (mucilaginous fiber, galactomannan); 20-30% proteins high in tryptophan and lysine; pyridine-type alkaloids; flavonoids; free amino acids (4-hydroxyisoleucine, arginine, lysine, histidine); saponins; glycosides; vitamins, minerals, 28% mucilage, 22% proteids, 5% of a stronger-smelling, bitter fixed oil, volatile oils. Bitterness is mainly due to the oil, steroidal saponins and alkaloids.[13]

Seeds contain 0.1% to 0.9% diosgenin and are extracted on a commercial basis. Plant tissue cultures from seeds grown under optimal conditions have been found to produce as much as 2% diosgenin with smaller amounts of gitongenin and trigogenin. The seeds also contain the saponin fenugrin B. Several coumarin compounds have been identified in fenugreek seeds as well as a number of alkaloids (eg. trigonelline, gentianine, carpaine). A large proportion of the trigonelline is degraded to nicotinic acid and related pyridines during roasting. These degradation products are, in part, responsible for the flavor of the seed. The seeds also yield as much as 8% of a fixed, foul-smelling oil. Three minor steroidal sapogenins also have been found in the seeds: smilagenin, sarsapogenin, and yuccagenin.

Fig.no.7: fenugreek seeds.

Table 6: Major Constituents.

Major alkaloids	Gentianine and trigonelline
Steroidal sapogenins	Diosgenin and yamogenin
Trigofoenosides	A,D,F,G
Trigoneosides	IIa, IIb
Graecunins	H,I,J,K,L,M,N
Proximate chemical composition of the dried fenugreek seeds parameter (%)	
Protein	28.55
Fat	4.00
Fiber	6.50
Ash	3.20
Moisture	4.00
Carbohydrates	46.25

Medicinal properties and uses

Fenugreek is taken by mouth for digestive problems such as loss of appetite, upset stomach, constipation, inflammation of the stomach (gastritis). Fenugreek is also used for diabetes, painful menstruation, menopause, polycystic ovary syndrome, arthritis, poor thyroid function, and obesity. It is also used for conditions that affect heart health such as "hardening of the arteries" (atherosclerosis) and for high blood levels of certain fats including cholesterol and triglycerides.[14]

Leaves are used both internally and externally for their cooling properties. An infusion of seeds is given to smallpox patients as a cooling drink. Alkaloid trigonelline has shown potential for use in cancer therapy. Saponins (seed) important substances in synthesis of oral contraceptives and sex hormones.[4]

Fenugreek is used for kidney ailments, a vitamin deficiency disease called beriberi, mouth ulcers, boils, bronchitis, infection of the tissues beneath the surface of the skin (cellulitis), tuberculosis, chronic coughs, chapped lips, baldness, cancer, Parkinson's disease, and exercise performance. Some men use fenugreek for hernia, erectile dysfunction (ED), male infertility,

and other male problems. Both men and women use fenugreek to improve sexual interest. Women who are breast-feeding sometimes use fenugreek to promote milk flow. Fenugreek is sometimes used as a poultice. That means it is wrapped in cloth, warmed, and applied directly to the skin to treat local pain and swelling (inflammation), muscle pain, pain and swelling of lymph nodes (lymphadenitis), pain in the toes (gout), wounds, leg ulcers, and eczema. In foods, fenugreek is included as an ingredient in spice blends. It is also used as a flavoring agent in imitation maple syrup, foods, beverages, and tobacco. In manufacturing, fenugreek extracts are used in soaps and cosmetics.[14]

Fenugreek leaves and seeds are consumed in different countries around the world for different purposes such as medicinal uses (anti-diabetic, lowering blood sugar and cholesterol level, anti-cancer, antimicrobial, etc.), making food (stew with rice in Iran, flavor cheese in Switzerland, syrup and bitter run in Germany, mixed seed powder with flour for making flat bread in Egypt, curries, dyes, young seedlings eaten as a vegetable, etc.), roasted grain as coffee-substitute (in Africa), controlling insects in grain storages, perfume industries, and etc. Fenugreek can be a very useful legume crop for incorporation into short-term rotation and for hay and silage for livestock feed, for fixation of nitrogen in soil and its fertility, and etc.

Dosing[14]

The following doses have been studied in scientific research.

By Mouth

- **For diabetes**: 5-100 grams of powdered fenugreek seed added to one or two meals daily for 4 days to 3 years has been used. A dose of 1 gram daily of an extract of fenugreek seeds has been used.
- **For painful menstruation (dysmenorrhea)**: 1800-2700 mg of fenugreek seed powder three times daily for the first 3 days of menstruation, followed by 900 mg three times daily for the remainder of two menstrual cycles, has been used.
- **For increasing interest in sex**: 600 mg of fenugreek seed extract (Libifem, Gencor Pacific Ltd.) each day for two menstrual cycles.
- **For improving sexual performance**: 600 mg of fenugreek seed extract (Testofen, Gencor Pacific Ltd) each day alone or with magnesium 34 mg, zinc 30 mg, and vitamin B6 10 mg, for 6-12 weeks has been used.

Interactions[14,15]

Moderate Interaction

- **Medications for diabetes (Antidiabetes drugs) interacts with Fenugreek**

Fenugreek might decrease blood sugar. Diabetes medications are also used to lower blood sugar. Taking fenugreek along with diabetes medications might cause blood sugar to go too low.

Medications that slow blood clotting (Anticoagulant / Antiplatelet drugs) interacts with Fenugreek

Fenugreek might slow blood clotting. Taking fenugreek along with medications that also slow clotting might increase the chances of bruising and bleeding.

Warfarin (Coumadin) interacts with Fenugreek

Warfarin (Coumadin) is used to slow blood clotting. Fenugreek might also slow blood clotting. Taking fenugreek along with warfarin (Coumadin) might increase the chances of bruising and bleeding.

Possibly effective for[11]

- **Diabetes.** Some research shows that consuming fenugreek seed, mixed with food during a meal, lowers blood sugar levels after the meal in people with type 2 diabetes. However, while taking 5-50 grams of fenugreek seed once or twice daily seems to work, lower doses of 2.5 grams don't seem to work. In people with type 1 diabetes, taking 50 grams of fenugreek seed powder twice daily seems to reduce the amount of sugar in the urine.
- **Painful menstrual periods (dysmenorrhea).** Taking 1800-2700 mg of fenugreek seed powder three times daily for the first 3 days of a menstrual period followed by 900 mg three times daily for the remainder of two menstrual cycles reduces pain in women with painful menstrual periods. The need for painkillers was also reduced.

Insufficient evidence for[14]

- **Exercise performance.** There are conflicting results regarding the effects of fenugreek on exercise performance. Some early research shows that taking 500 mg of fenugreek supplement (Indus Biotech, India) for 8 weeks decreases body fat and increases testosterone levels, but does not change muscle strength or endurance in young men. However, other research shows that taking 500 mg of fenugreek extract (Torabolic, Indus Biotech) daily for 8 weeks reduces body fat and increases leg and bench press performance in a similar group of young men. Also, other early research shows that taking 300 mg fenugreek chemicals (Fenu-FG, Indus Biotech Private

Limited, Pune, India) each day might help men do more bench press exercises. But it does not seem to help them lift more weight or do more leg press exercises.

- **Heartburn.** Research shows that taking a specific fenugreek product (FenuLife, Frutarom Belgium) before the two biggest meals of the day reduces symptoms of heartburn.
- **High cholesterol.** There is conflicting evidence about the effects of fenugreek on cholesterol levels. Early research shows that taking fenugreek seed reduces total and low-density lipoprotein (LDL or "bad") cholesterol. But the effects of fenugreek seed on high-density lipoprotein (HDL or "good") cholesterol and triglycerides are inconsistent.
- **Breast milk production.** There are some reports that taking fenugreek capsules or drinking fenugreek tea beginning shortly after giving birth can increase milk production in breastfeeding women. Fenugreek seems to help the most when it is started a day or two after giving birth. But not all research agrees. And some research shows that taking fenugreek is less beneficial than taking Indian borage or palm date.
- **Male infertility.** Early research suggests that taking fenugreek seed oil drops by mouth three times daily for 4 months improves sperm count in men with a low concentration of sperm. But taking the other parts of the fenugreek seed does not seem to have this effect.
- **Weight loss.** Early research shows that a fenugreek seed extract can reduce daily fat intake in overweight men when taken by mouth at a dose of 392 mg three times daily for 2-6 weeks. But a lower dose does not appear to have this effect. Neither dose affects weight, appetite, or fullness. Adding 4 or 8 grams of fenugreek fiber to breakfast seems to increase feelings of fullness and reduce hunger at lunchtime. But it's not clear if this increases weight loss.
- **Parkinson's disease.** Research suggests that taking fenugreek seed extract (Indus Biotech Private Limited, Pune) twice daily for 6 months does not improve symptoms in people with Parkinson's disease.
- **Ovarian cysts (polycystic ovary syndrome).** There are conflicting results regarding the effect of fenugreek for ovarian cysts. Research suggests that taking fenugreek seed extract (Goldarou Pharmaceutical Co. Isfahan Iran) daily for 8 weeks does not improve symptoms for women with ovarian cysts. However, other early research suggests that taking 1000 mg of a specific type of fenugreek seed extract (Furocyst, Cepham Inc., Piscataway, NJ) each day might reduce the size of the ovarian cysts and help to regulate the length of the menstrual cycle and time between having a period.

Fenugreek is likely safe for people when taken by mouth in amounts normally found in foods. It is possibly safe when taken by mouth in amounts used for medicinal purposes (amounts larger

than normally found in food) for up to 6 months. Side effects include diarrhea, stomach upset, bloating, gas, dizziness, headache, and a "maple syrup" odor in urine. Fenugreek can cause nasal congestion, coughing, wheezing, facial swelling, and severe allergic reactions in hypersensitive people. Fenugreek might lower blood sugar.

Fenugreek as food[16]

In addition to its medicinal properties, fenugreek is also recognized for its culinary value. The plant is widely used as a spice that not only improves the taste of food, but also contributes to metabolic functions and overall health. Biscuits supplemented with 10% germinated fenugreek had the highest 1076 polyphenol content and were characterized by high nutritional value. Supplementation of wheat flour with 5% and 10% of fenugreek flour increased vitamin B2 and carotene concentrations in biscuits.

According to the cited study, fenugreek products have restorative properties and may be beneficial for patients suffering from iron-deficiency anemia. However, low dietary intake of fenugreek seeds could exert favorable skeletal effects, whereas high doses could damage the skeletal system. Fenugreek seeds are used as spice for flavoring selected types of cheese, mainly parmesan. Powdered or crushed seeds are added to salads and cottage cheese spreads. Fenugreek seeds enhance the flavor and aroma of dishes. They are added to curry sauce and are a traditional ingredient of the Bulgarian spice chubritza. Fenugreek seeds are also used to flavor coffee and vanilla extracts.

Fenugreek seeds and extracts aid digestion and enhance nutrient absorption, in particular amino acids. They contribute to muscle and body mass growth and have nourishing and strengthening properties. Food supplements containing fenugreek have hypoglycemic properties and are recommended for diabetic patients. Fenugreek seeds are roasted for direct consumption and are added to broth and tea. Fenugreek leaves are fried in butter, added to salads and used as spice in the powdered form. A study comparing the quality of honey with various pollen content revealed that the most nutritious types of honey were heterofloral, and samples with the highest antibacterial activity against Pseudomonas aeruginosa, Escherichia coli and Staphylococcus aureus were characterized by a predominance of fenugreek pollen.

The examined honey was more effective in eliminating the said bacteria than antibiotics. Fenugreek does not have adverse effects on the human body, even if consumed in large amounts. In India, normal consumption of fenugreek seeds by adults is estimated at 0.3 to 0.6 g

per day. In both humans and animals, diets where the above intake levels were exceeded 50- to 100-fold delivered health benefits. Such diets include dishes with liberal amounts of fenugreek seeds, which are very popular in southern India. Fenugreek hay contains more soluble protein than alfalfa hay, and there is a growing interest in Canada in fenugreek as an alternative feed crop for dairy cows. The addition of fenugreek to cattle diets improved milk quality parameters and animal metabolism. Ground fenugreek seeds and fenugreek oil are also used in the production of fish bait in the form of protein balls.

Forage management[17]

Fenugreek is grown and harvested principally for the seeds and only secondarily for forage.

Forage yield

Once high-valued forage, fenugreek is now a minor forage species. There are numerous varieties, adapted to different cultivation conditions that yield variable amounts of green fodder. Fresh matter yield was about 13-17.5 t/ha in California, and only 9-10 t/ha in India. In this latter country DM yields ranged from 1.5 to 2.75 t/ha in 1975. DM yield was about 5.8 t/ha under rain-fed conditions of Southern Alberta, in Canada. Irrigation did not improve DM yield a lot, with 6 tons DM/ha in Southern Alberta and, exceptionally, 10 tons DM/ha. After seed harvest, the amount of fenugreek straw was estimated at 1.85 t/ha.

Sowing

Fenugreek intended for forage can be either sown in spring or autumn, according to climate. As forage it should be broadcast or drilled at 20-30 kg/ha in pure stands or often mixed with oats. Mixtures with small cereals are best for haymaking.

Time of harvest

Time of harvest should be a trade-off between forage quality and forage yield. If harvested too late, fenugreek sheds its leaves and forage palatability is reduced, while if harvested too early, dry matter content is low and the plant is difficult to cure. The best period of harvest for green fodder is thus when the plant is still tender with only basal pods at the first stage of their development. For hay, the most important goal is to save the most leaves on the stems. This corresponds to pods being in the second stage of their development and containing well formed seeds, which increase the crude protein content of the plant.

Methods of harvest

Fenugreek can be hand-cut or mechanically harvested by farm cutting equipment or by conventional mowers, conditioners and rakes. The use of rectangular balers and forage harvesters has also been recommended. If fenugreek is cut under dry conditions, the plant can be left in thin layers to cure on the soil. If harvesting conditions are wet, it is recommended to oven-dry the plant or to make it into silage. Another way to use fenugreek forage is to cut it after seed harvest, forage being thus similar to straw, with a relatively low palatability.

Seed management

Seed yield

The expected yield of fenugreek seeds is 0.5-3.8 t/ha.

Seed crop management

When fenugreek is grown for seed it is usually grown in rows about 50 cm apart and thinned to 5-10 cm. The ripe crop is hand-cut, and is often dried on the field before threshing. Seed rates vary widely from 10 to 40 kg/ha, the lower rates being for rainfed crops.

Environmental impact[17]

Soil improver and water saver

Trigonella foenum-graecum is an N-fixing plant, thus reducing the need of nitrogen fertilizers for subsequent crops. It has low water requirements and its cultivation might reduce the cost of irrigation, save water, reduce the eutrophication of surface waters, and limit the contamination of ground water sources. Dryland adaptation of fenugreek is of major significance in western Canada and drier parts of the USA as fresh water resources are shrinking in these areas.

Methane emissions

Raw and roasted fenugreek seeds added to a mixture of straw and concentrate in the ratio 60:40 resulted in both cases in higher in vitro gas production and in lower methane emissions. It was concluded that 2% raw or roasted seeds of fenugreek had potential to reduce methane emissions from ruminants and to improve DM digestibility.

Some examples of available Market products of Fenugreek[21]

Fig.no.8: Different types of Fenugreek Capsules for various purpose.

Fig. no. 9: Hair Oil

Fig.no.10: Syrup

Fig.no.11: Facewash

CONCLUSION

Consumers of natural remedies are continuously increasing worldwide. This necessitates strict regulatory measures during processing of herbal raw materials prior manufacture and launching of final products in the market. Fenugreek (Trigonella foenum-graecum L.), plant is widely distributed throughout the world and which belongs to the family Fabacecae. The yields can be significant increase in quantity and quality through the suitable management of cultivation, irrigation and harvesting. The plant contains active constituents such as alkaloids, flavonoids, steroids, Saponins etc. It is an old medicinal plant. It has been commonly used as a traditional food and medicine. Fenugreek is known to have hypoglycemic, and hypocholesterolaemic effects, Anti-inflammatory effect, kidney ailments also in cosmetics.

As rich sources of protein, lipids, fatty acids and minerals, fenugreek seeds and leaves cater to the body's needs for essential nutrients and deliver numerous health benefits. This ecofriendly

plant has a high number of potential applications in the production of food and feed, medicine, cosmetics and pharmaceutical industries due to its nutrient and nutraceutical content. The findings presented in this review paper will be useful for consumers hoping to improve their health by incorporating healthy biogenic elements and fatty acids into their diets. Also it will help to use fenugreek as a drug or an excipient in different dosage forms.

REFERENCES

1. Charles W. Fetrow(Pharm D), Juan R. Avila (Pharm D). The complete guide to Herbal medicine. Springhouse Corporation, Springhouse (PA), 2000; 193-194.
2. Fabaceae: http://en.m.wikipedia.org.
3. A.K.Gupta, Neeraj Tandon, Madhu Sharma. Quality Standard of Indian Medicinal Plants, Volume 4, Indian councilof Medicinal Research, New Delhi, 2006; 232-241.
4. A. K. Seth. Textbook of Pharmacognosy and Phytochemistry 2nd edition by Biren Shah. 2014 Elsevier, 513: 518-582.
5. L.D. Kapoor. Handbook of Ayurvedic Medicinal Plants. Herbal Reference Library, CRC Press, Boca Raton London New York Washington, D.C, No. 327.
6. Rashmi Yadav, Richa Tiwari, Partha Chowdhary, Chandan Kumar Pradhan. A Pharmacognostical Monograph of Trigonella Foenum Graceum seeds. International Journal of Pharmacy and Pharmacutical Sciences, 2011; 3(5).
7. Marwa Y. Issa, Soheir M. El Zalabani, Hesham I. El Askary, Riham Salah El Dine, Miriam F. Yousif. Microscopical, Physicochemical and Nutritional Characterisation of three herbal Hepatoprotectives. World Journal of Pharmaceutical Sciences, 2014; 3(5): 1430-1446.
8. Sabyasacchi Chatterjee. Fenugreek (Trigonella Foenum Graceum) and its necessity (A Review Paper). ResearchGate Fire Journal of Engineering Technology, 2015; 1(1): 66-67.
9. Peiman Zandi, Saikat kumar Basu, Lella Bazrkar Khatibai. Fenugreek (Trigonella foenum-graecum L.): An important medicinal and aromatic crop. Active ingredients from aromatic and medicinal plants, 207-224.
10. Rahul Kaushik. A study of Phytochemical constitute and Pharmacological action of Trigonella foenum graceum linn: A Review. International Journal of Pharmacy and Technology, 2011.
11. Fenugreek: Archeology, Properties, Constituents and Biochemicals. Available from: http://www.mdidea.com/products/new/new00405.html.
12. Herb Asia. Fenugreek extract, 1-3.

13. Helambe S. Snehalata, Dande R. Payal. Fenugreek (Trigonella Foenum Graceum): An overview. International Journal of Current Pharmaceutical Review and Research, 2(4) Nov 2011-Jan1 2, 2(4): 169-187.
14. https://www.webmd.com/vitamins/ai/ingredientmono-733/fenugreek.
15. https://www.encyclopedia.com/plants-and-animals/plants/plants/fenugreek.
16. Zulk- Golaszuska, Jadwiya Wirzbowska. Fenugreek: Productivity, Nutritional Value and Uses Krystyna. Journal of Elementology, 2017.
17. https://www.feedipedia.org/node/242.
18. Botinical.com. fenugreek. available from: http://www.botanical.com/botanical/mgmh/f/fenugr07.html#des.
19. Herbs at a glance. U.S. Department of Health and Human Services. Available from: www.ods.od.nih.gov.
20. Sajad Ahmad Wani, Pradhyum Kumar. Fenugreek: A Review on its Nutraceutical properties and utilization of its various food product. Journal of Saudi Society of Agriculture Science, 2018; 17: 97-106.
21. http://www.google.com/marketproducts/fenugreek.
22. Ayurvedic herb fenugreek. Available from: http://www.indianmirror.com/ayurveda/fenugreek.html.
23. Naser Tavakoli, Jalesh Varshosaz, Alireza Ghannadi, Neda Bavarsad. Evaluation of Trigonella Foenum Graecum seeds gum as a Novel tablet binder. IJPSR, 2012; 1(1).
24. Dharmendra kumar, Aditi singhal, Sumedha Bansal, S.K. Gupta. Extraction, isolation and evaluation of Trigonell Foenum Graceum as a mucoadhesive agent for nasal gel drug delivery. Journal of NPA, 2014.
25. Nasroallah Moradi kor, Mohamad Bagher Didarshetaban, Hamid Raza, Saeid Pour. Fenugreek as a valuable medicinal plant. IJABR, 2013; 1(2).