AMERICAN JOURNAL OF PHARMTECH RESEARCH

Journal home page: http://www.ajptr.com/

A Review On Trigonella Foenum-Graceum Linn (Fenugreek)

Prasad S. Dhamane[1]*, Prashant S. Malpure[1], Gokul S. Talele[2], Rahul N. Chaudhari[1]

1.Department of Pharmaceutics, Matoshri College of Pharmacy, Eklahare, Maharashtra, Nashik

2.Department of Pharmaceutical Chemistry, Matoshri College of Pharmacy, Eklahare, Maharashtra, Nashik

ABSTRACT

The goal of the current work is to use the wet granulation technology to make medication tablets using fenugreek extract. Additionally, research was done on the impact of sodium starch glycolate, a super disintegrant, on drug release and disintegration. Mucilage found in fenugreek extract slows down the disintegration of tablets, resulting in a slower release of the medication. Therefore, sodium starch glycolate was employed as a super disintegrant to enhance disintegration and, consequently, in vitro drug release. Wet granulation was used to make tablet formulations both with and without sodium starch glycolate. It was done to evaluate the granules' flow characteristics and characterize the physicochemical makeup of tablet formulations. The fundamental cause of fenugreek's antidiabetic effect is the alkaloid trigonelline, which is present in large amounts. For the treatment of diabetes, this study concludes that fenugreek seed extracts in tablet form with super disintegrants will be more desirable, useful, and therapeutically more effective than combining the plant components directly for a quicker commencement of action.

Keywords: Tablet; sodium starch glycolate; fenugreek.

*Corresponding Author Email: dhamaneprasad2000@gmail.com

Received 22 October 2024, Accepted 25 November 2024

Please cite this article as: Dhamane PS *et al*., A Review On Trigonella Foenum-Graceum Linn (Fenugreek). American Journal of PharmTech Research 2024.

INTRODUCTION

Patients and doctors a like favor tablets, which are the most widely used oral forms on the market. Because they are more affordable, easier to find locally, and environmentally friendlier than synthetic items imported from other countries, plant-based products are a good substitute for synthetic ones. Aqueous root extract of Ervatamia and ethanolic extract of Hiptage benghalensis leaves are two examples of the herbal extracts that have been formulated into traditional tablet dosage forms for instant release, according to several writers[1]. Heyneana [2], Alstonia boonei stem bark extract, Rhin acanthus nasutus root methanolic extracts, Puma's bolus [5] ethanolic extract, and Croton membranous root ethanolic extract are among the substances investigated. One of the first known medicinal plants is Trigonella foenum-graecum, or fenugreek, which is a member of the Leguminosae family and was utilized as a culinary and medical herb by the ancient Egyptians, Greeks, and Romans. An annual herb with a long, upright, velvety stalk is fenugreek. Leaflets are 2-2.5cm long and obovate to oblanceolate in form; leaves are 5cm long with triangular stipules and lanceolate leaflets. There are one to two flowers per raceme, which are axillary, sessile, and pale yellow in color. Pods are 5–7.5 cm long, without transverse reticulations, frequently falcate, and have a long, persistent beak. They also contain 10–20 quadrilateral seeds. The seeds are firm, tiny, and brownish yellow in color. They have a rhomboidal shape and are flattened. The antidiabetic action of fenugreek is thought to be attributed to a variety of components, including coumarins, 4-hydroxyisoleucine, alkaloids, and saponins [9]. Therefore, rather than using the isolated ingredient in the production of oral tablet dosage forms, crude extracts of fenugreek were used. Stable plant products make up pure chemical components in crude extracts. To improve their efficacy and stability and make them suitable for oral use, suitable formulations must be developed. The process of disintegration has drawn a lot of interest as a crucial step in achieving quicker medication release. Disintegrating pills is important, as seen by the emphasis on the drug's availability. To enhance the disintegration processes, super disintegrants—chemically modified disintegrants—have recently been produced. Super disintegrants are substances added to tablets and some encapsulated formulations that encourage the tablet and capsule "slugs" to break up into smaller pieces in an aqueous environment. This increases the surface area of the medicine that is available and promotes a faster release of the drug. They are usually employed in solid dosage form at low concentrations, usually 2-5% by weight in relation to the dosage unit's total weight. To alter the drug release from traditional dosage forms, a variety of synthetic materials have been employed as super disintegrating agents in tablet formulations, including Sodium Starch Glycolate, Ac-di-Sol, Crosspointe, and Kyron T314 [10]. Super disintegrants, which have longer disintegration

and dissolving parameters in standard formulas, were found to increase drug release from tablet dosage forms containing a large proportion of polyherbal dry extract (Vijaya S et al., 2011).

Trigonella foenum-graecum (Fenugreek Seeds)

Figure 1: Fenugreek Seeds

Synonym: Methi

Biological source: It consists of the herb and seeds of Trigonella foenum-graceum Linn.

Family: Papilionaceae.

It is an aromatic, annual, 30-60 cm tall herb, widely cultivated in many parts of India. The leaves are pinnate, 3-foliolate; flowers white or yellowish-white, pods up to 15 cm long; seeds 10-20, greenish brown, oblong.

Pharmacology

Administration of a seed extract to rats enhanced food consumption and motivation to cat and induced hyperinsulinemia and hypocholesterolemia. Seed extract exhibited mild anti-implantation activity in female rats and showed antibiotic activity against Micrococcus pyogens var. aureus.

Chemical constituents

The endosperm of the seeds is rich in galacto-mannan (15%). The mature seeds yield amino acids, e.g., 4-hydroxyisoleucine and fatty acids on hydrolysis, carotene, vitamins, saponins, viz., graecunins H-N (glycosides of diosgenin), tenugrin B, sapogenins, e.g., diosgenin, gitogenin, neogitogenin, homoorientin, vitexin, saponaretin, its tetrosides B and C; trigonelloside C, 3,26-bisglycoside, flavone C-glycoside-vitexin-2"-0-p-coumarate, vicenin-1 and vicenin-2.The alkaloids, trigonelline, choline, 7-acetoxy-4-methyl coumarin, furastanol glycoside,kaempferol, luteolin and quercetin are also present the leaves give saponins, viz., diosgenin, its glycoside (graecunin B), graecunins A-G, gitogenin, tigogenin, kaempferol, quercetin and B-sitosterol. The plant also contains trigo coumarin, trigoforin, 1-methyl-7-acetoxycoumarin, P-coumaric acid,

luteolin and quercetin. The seed oil is composed of linoleic (50.5%), palmitic, stearic, oleic (59%), linoleic (~50%) and linolenic acids.

Medicinal Uses:

Vitamin deficiency disease called beriberi, mouth ulcers, boils, tuberculosis, chronic coughs, chapped lips, baldness, cancer, and lowering blood sugar in people with diabetes.

Taxonomy:

Kingdom: Plantae

Clade: Tracheophytes

Clade: Eudicots

Clade: Rosids

Family: Fabaceae

Subfamily: Faboideae

Genus: Trigonella

Species: T. foenum-graecum

ANTI DIABETIC EFFECTS

Since the beginning of medicine, diabetes mellitus (DM) has been known to be a common condition (Best, 1962; West, 1978). Prior to the development of insulin and oral hypoglycemic medications, the mainstay of treatment was herbal medicine. It is known that over 400 plants have been recommended, and new research has confirmed that some of these therapies may be beneficial (Marles and Farnsworth, 1995; Bailey and Day, 1989). Many plants used as antidiabetic medicines have been shown to have hypoglycemic and/or antihyperglycemic effects; the mechanisms behind these effects are now being investigated (Marles and Farnsworth, 1995).

There are also ongoing chemical investigations aimed at identifying, isolating, and purifying the compounds with the antidiabetic effect. For a very long time, fenugreek seeds have been recognized for their ability to prevent diabetes. Fourier (1948) noted that giving humans with severe diabetes fenugreek seeds that had been roughly powdered helped their condition. This characteristic was subsequently verified in rats with alloxan-induced diabetes, in which the seed extract produced a notable hypoglycemic effect (Bever and Zahnd, 1979; Khosla et al., 1995a). Additionally, studies have demonstrated that an extract of fenugreek prevented the hyperglycemia in rats caused by cadmium and alloxan. additionally demonstrated that diabetic mice given with a 20% fenugreek diet five weeks before receiving an injection of streptozotocin exhibited a general improvement in their clinical condition. Significant reductions were observed in hyperglycemia, free fatty acids, cholesterol, and triglycerides. However, if the pretreatment phase was skipped, a

fenugreek supplementary diet after diabetes induction did not ameliorate the diabetic state as determined by lipid and blood glucose levels. Consequently, it has been proposed that fenugreek may protect against chemically induced diabetes. Numerous studies have also demonstrated a positive effect on pre-existing diabetic states. Whole and extracted fenugreek seeds were found to reduce hyperglycaemia in both normal and diabetic subjects (Sharma, 1986b; Sharma et al., 1990). These subjects also showed significant reductions in fasting blood glucose, 24-hour urine sugar excretion, and serum cholesterol. Although there was a significant reduction in postprandial glucose, in some studies, no significant change in plasma insulin was observed following fenugreek administration to non-insulin dependent diabetics (Madar et al., 1988), rats (Madar, 1984), or dogs (Ribes et al., 1984, 1986). On the other hand, other studies in chemically induced diabetic rats showed significant increases in plasma insulin levels (Sharma, 1986b; Petit et al., 1993, 1995a). These findings may be due to variations in the type of fenugreek used in the experiments. According to Petit et al. (1993), the administration of an ethanol extract of fenugreek to rats resulted in an increase in plasma insulin levels. This increase could be attributed to either a direct stimulatory effect on the cells or an indirect effect related to the extract's palatability and theta 4-enhancer properties. The latter theory was advanced in accordance with the impact of saccharin solution's sweet taste, which has been shown to cause an insulin response that is rapidly cephalic c phase when there is no discernible glycemic change (Berthoud et al., 1981). Nevertheless, it has also been noted that fenugreek contains 4-hydroxyisoleucine, an ingredient that stimulates the release of insulin. Fenugreek seeds not only improved the biochemistry but also significantly reduced the clinical symptoms of diabetes, including polyuria, polydipsia, weakness and weight losses. Additionally, it has been shown that roasting or heating fenugreek does not eliminate its hypoglycemic qualities. Numerous studies have been conducted in an attempt to pinpoint the elements and processes behind fenugreek's antidiabetic properties. A single study team examined two different seed fractions: the lipid extract and the defatted seed material, which is rich in proteins, saponins, and bres.

Antioxidant Effects

Oxidative damage at the cellular or subcellular level is now considered to be a major event in disease processes like coronary vascular disease, inflammatory disease, diabetes, carcinogenesis, and aging. Reactive oxygen radicals are detrimental to cells at both membrane and genetic levels. They induce lipid peroxidation in cellular membranes, generating lipid peroxides that cause extensive damage to membranes and membrane mediated chromosomal damage. Dietary fenugreek seed has been shown to counter the increased lipid peroxidation and alterations in the

content of circulating antioxidant molecules, such as glutathione, β-carotene and α-tocopherol, in alloxan-diabetic rats.[12] The influence of fenugreek seed powder supplementation in the diet (for 30 days at a dosage of 2 g/kg body weight) on lipid peroxidation and antioxidant status has been studied in alloxan-diabetic rats.[12] The enhanced lipid peroxidation and increased susceptibility to oxidative stress associated with depletion of antioxidants in liver, kidney and pancreas observed in diabetic rats were observed to be normalized with fenugreek seed powder treatment. The protective effect of the aqueous extract of the seeds on the activity of calcium-dependent adeno sine tri phosphatase (Ca2+-ATPase) in liver homogenate in the presence of Fe2+/ascorbate in vitro was also investigated. Ca2+-ATPase activity in liver was protected by the aqueous extract to nearly 80% of the initial activity. (30) The findings suggest that the soluble portion of the seeds could be responsible for the antioxidant property. Oxygen free radicals are presumably responsible for the severity and complications of diabetes. The activities of antioxidant enzymes catalase, superoxide dismutase and glutathione peroxidase as well as the oxidative damage were examined in the tissues of diabetic rats treated with fenugreek. [14] After 3 weeks of diabetes, the activity of Cholesterol acyl transferase was significantly increased in heart in diabetes (about 6-fold) but decreased in liver. The superoxide dismutase activity decreased significantly in liver but increased in brain. The activity of glutathione peroxidase decreased significantly in liver and increased in kidney. A significant increase was observed in oxidative damage in heart and kidney and a small increase in brain with decrease in liver and muscle. Fenugreek administration to diabetic animals showed a reversal of the disturbed antioxidant levels and peroxidative damage, thus suggesting that oxidative stress plays a key role in the complications of diabetes. Fenugreek seeds show an encouraging antioxidant property that can be exploited for the treatment/reversal of the complications of diabetes.

HYPO CHOLESTEROLAEMIC EFFECTS

The association of raised serum cholesterol with cardiovascular disease is well known (Gordon, et al., 1977). Some studies suggest that elevated serum triglyceride may also be a risk factor (Carlson et al., 1979; Carlson and Bottiger, 1985) especially in individuals with diabetes (West et al., 1983); there is often a marked hyperlipidemia in diabetes (Maison and Boucher, 1978; Betteridge, 1989). Moreover, diabetic patients experience a 2±3-fold increase in cardiovascular morbidity and mortality when compared with non-diabetics. The beneficial effect of lowering elevated serum cholesterol levels on the prevention of coronary heart disease (CHD) has been well established (Lipid Research Clinics Program, 1984). Dietary intervention has been recommended for all subjects with a low-density lipoprotein (LDL) level of more than 160 mg/dL (Report of the

National Cholesterol Education Program, 1988). In addition to the quantity of fat and the polyunsaturated/ saturated fat ratio, other dietary factors also play a role in the management of hyperlipidemia (Grundy, 1987). Several studies have shown that dietary, particularly soluble, has considerable influence on serum cholesterol levels (Kitchens, 1982; Dreher, 1987; Miettinen, 1987). Research carried out on legumes has led to the belief that they are beneficial in lowering total cholesterol levels in humans (Madar and Odes. 1990; Sharma et al., 1990; Sharma et al., 1996a). Scientific reports indicate that fenugreek does indeed have therapeutic properties that may be beneficial in treating hypercholesterolemia. Fenugreek seeds have been shown to possess hypocholesterolemia effect in rats (Singhal et al., 1982; Sharma, 1984, 1986a; Stark and Madar, 1993; Khosla et al., 1995b) and dogs (Valette et al., 1984). Elevation of cholesterol levels in the rat was prevented by adding fenugreek at 15%±60% to a hyper cholesterol anemia inducing diet (Sharma, 1984). Fenugreek was demon started to have a greater effect on exogenous cholesterol (when given with a hyper cholesterol anemia-inducing diet containing 1% cholesterol) than on endogenous cholesterol (fenugreek given with a cholesterol-free stock diet) (Sharma, 1984). Defatted fenugreek (100 g) incorporated in the experimental diet of hyperlipidemic non-diabetic subjects significantly reduced serum total cholesterol, LDL and very low-density lipoprotein (VLDL)-cholesterol and triglyceride levels (Sharma et al., 1991), with no observed changes in high density lipoprotein (HDL) cholesterol. As a result, there was a significant increase in the ratio of HDL to total cholesterol and HDL to that of LDL and VLDL-cholesterol, which have been shown to be reliable risk assessment factors of CHD (Kannel, 1983). In a short-term study, fenugreek seeds were also found to exert hypocholesterolemia activity in diabetic patients (Sharma and Raghuram, 1990; (Sharma et al., 1990). In NIDDM patients, ingestion of an experimental diet containing 25 g fenugreek seed powder for 24 weeks resulted in a significant reduction of total cholesterol, LDL- and VLDL-cholesterol and triglyceride levels (Sharma et al., 1996a). Serum cholesterol was significantly reduced and this fall was mainly due to a reduction in LDL and VLDL fractions. Triglyceride levels also showed a similar change. On the other hand, HDL cholesterol show deadlight rise. The overall results are in agreement with earlier observations made in diabetic patients (Sharma,1986a; Sharmaetal.,1990). All the lipid parameters improved rapidly during the initial weeks after the incorporation of fenugreek with a slower change thereafter (Sharma et al., 1996a). An increase in HDL-cholesterol was also observed in diabetic rats fed 2±8g/kg body weight of unroasted and roasted fenugreek seeds for 2weeks (Khosla et al., 1995b). These results indicate a potential beneficial effect of fenugreek seeds in the lipid profile of diabetic subjects in addition to the effect son glycaemia review earlier. The ability of fenugreek to

selectively reduce the LDL and VLDL fraction of total cholesterol could be beneficial in preventing at hero sclerosis. A similar selective effect on LDL-cholesterol was observed with dietary fibers such as oat bran (Kirbyetal., 1981) and guar gum (Jenkinsetal.,1980). Natural carbohydrates rich in fiber content have been found to be effect vie against hyper lipidaemia and ischemic heart disease (Trowell, 1972). Insulin secretion has been showing nonregulated VLD Land triglyceride concentration (SparksandSparks, 1994); the hormone has been found to stimulate hepatic production of VLDL. Based on this, a high fiber diet which reduces insulin secretion was used in the treatment of hyperlipidemia in diabetic subjects (Paiseyetal.1984). Thus, the alterations in lipid profiles observed after ingestion of fenugreek, which contains dietary fiber, may have been due to a decreased synthesis of VLDL in the liver. However, since ingestion of fenugreek extracts was reported to stimulate insulin secretion in diabetic rats (Sharma, 1986b; Petit et al., 1993, 1995a) the intermediary role of insulin in altering lipid profile secular. Among the fenugreek fractions, the lipid extract and 0.12%trigonellinehadnohypocholesterolaemic effect while the defatted fractions, gum isolate and the crude saponins, fed to normal and diabetic rats at equivalent amounts to that present in a diet containing30% fenugreek seed, showed hypo cholesterol oligemic activity without any significant effect on the triglyceride level (Sharma, 1986a). Further studies by Reseal. (1987) showed that although subfraction `a' (79.6%fibre) displays both an antidiabetic and hypocholesterolemia activity, subfraction `b' (52.8% proteins and 7.2% saponins) has a clear hypo lipidemic effect since it reduces elevated cholesterol and triglyceride ide levels in diabetic dogs. This latter subfraction was further subdivided to two fractions `s' which contains all the saponins (22.2%) and subfraction `p' containing the totality of the proteins (70.5%). Administration of subfraction `p', rich in proteins, had no effect on the high levels of cholesterol and triglycerides in diabetic dogs, thus ruling out the possibility of a role for the lysine/arginine ratio. This conclusion is in accordance with that of Sharma (1984) demonstrating that the active principle was not related to the amino acids, contrary to the belief that the lysine/arginine ratio might be important in the elevation of serum cholesterol. However, the presence of saponins seems essential for the hypolipidemic activity of fenugreek seeds (Ribes et al., 1987; Sauvaire et al., 1991). Saponins are plant glycosides whose aglycone structure is triterpenoid or steroidal. They are a heterogeneous group of amphiphilic compounds, are highly surface active and have a number of properties. Most saponins are hemolytic, can bind cholesterol, and form stable foams (Price et al., 1987). Studies reported so far on the effects of saponins on cholesterol homeostasis concern mainly the triterpenoid saponins from lucerne and steroidal saponin from soya bean (Sidhu et al., 1987) which reduce intestinal uptake of cholesterol. It has also been reported that a steroidal saponin, digitonin,

prevents or lowers hypercholesterolemia in monkeys (Malinow et al., 1978, Oakenfull and Fenwick, 1978) without modifying HDL-cholesterol levels (Malinow et al., 1981). In contrast, Gibney et al. (1982) reported no effect of a commercial saponin when fed to rats and hamsters. However, this study mentioned neither the chemical structure nor the origin of the saponin used. Saponins derived from lucerne (Medicago sativa, alfalfa) were found to reduce plasma cholesterol levels by direct binding of dietary saponins with cholesterol in the digestive tract and subsequent excretion in the faces (Malinow et al., 1977, 1981; Story et al., 1984). Other types of saponins affect cholesterol metabolism in directly by interacting with bile acids and increasing their faecal excretion (Oakenfull et al., 1984). Although experiments with lucerne saponins show that they directly interact with cholesterol (Gestetner et al., 1971), soya bean saponins do not (Birk, 1969). The results of Stark and Madar (1993) indicated that the saponins present in fenugreek, similar to soybean saponins, do not interact directly with cholesterol. However, using the inverted sac technique, an ethanol extract of fenugreek exhibited a strong inhibitory effect on bile salt absorption (Stark and Madar, 1993), in a quantitative manner. These results are in agreement with that of Bhat et al. (1985) and Sharma (1984) where the fenugreek enriched diets were found to increase both faecal weight and excretion of bile acids. The mechanism that causes this effect is still not clear. One possibility is that large mixed micelles are formed containing bile salts and saponins, and these large molecules are not available for absorption (Sidhu and Oakenfull, 1986). Lowering of blood and hepatic cholesterol may be due to increased conversion of cholesterol to bile acids by the liver. Fenugreek seed saponins are of steroidal nature with diosgenin as the main sapogenin (Mahato et al., 1982). Diosgenin has various effects on cholesterol metabolism, one of the most important being the capacity to lower plasma cholesterol concentration in chickens and rabbits fed cholesterol 4. This hypocholesterolemia effect has been suggested to be dependent on the capacity of diosgenin to inhibit cholesterol absorption, to decrease liver cholesterol concentration, to increase biliary cholesterol secretion and increase faecal excretion of neutral sterols (Cayen and Dvornikov, 1979; Uchida et al., 1984; Ulloa and Nervi, 1985). Furthermore, Malinow (1985) has shown that diosgenin glucoside was more efficient than diosgenin in reducing intestinal absorption of cholesterol. At comparable small doses, diosgenin glucoside inhibited cholesterol absorption in vivo and in vitro, whereas diosgenin did not (Malinow, 1985; Malinow et al., 1987).

Other Beneficial Effects

Gastroprotective effect of fenugreek seeds has been evidenced by a study on ethanol induced gastric ulcer. [(15)] The aqueous extract and a gel fraction isolated from the seeds showed significant

ulcer protective effects. The cytoprotective effect of the seeds seemed to be not only due to the anti secretory action but also to the effects on mucosal glycoproteins. In addition, the fenugreek seeds prevented the rise in lipid peroxidation induced by ethanol presumably by enhancing antioxidant potential of the gastric mucosa and thereby, lowering mucosal injury. Aqueous extract of fenugreek seeds was found to have protective effect in experimental ethanol toxicity in rats. [17] Simultaneous administration of aqueous extract of fenugreek seeds with ethanol for 60 days prevented the leakage of enzyme activities aspartate transaminase, alanine transaminase and alkaline phosphatase into serum, and the rise in lipid peroxidation in liver and brain as a result of ethanol toxicity. Fenugreek aqueous extract also enhanced the antioxidant potential in terms of countering the reduced activities of superoxide dismutase, catalase, glutathione peroxidase, glutathione S-transferase and glutathione reductase in liver and brain, and countering the depletion in glutathione, ascorbic acid, and α-tocopherol concentrations. The protection of aqueous extract of fenugreek against ethanol toxicity was further evidenced by histopathological examination of liver and brain.

The effect of fenugreek seeds on the activities of β-glucuronidase and mucinase during 1, 2-dimethylhydrazine (DMH)-induced colon carcinogenesis in rats was studied.[19] Rats were given a weekly subcutaneous injection of DMH at a dose of 20 mg/kg body weight for 15 weeks. Fenugreek seed powder was given through diet at a dose of 2 g/kg body weight. After an experimental period of 30 weeks, the activity of β-glucuronidase significantly increased in the colon, which may increase the hydrolysis of carcinogen glucuronide conjugate, liberating carcinogen within the colonic lumen. Inclusion of fenugreek seed powder in the diet significantly decreased the activity of β-glucuronidase and of mucinase in the colon. This study shows that supplementation of fenugreek seeds in the diet inhibits colon carcinogenesis, by modulating the activities of β-glucuronidase and mucinoses. The beneficial effect may be attributed to the presence of fiber, flavonoids, and/or saponins.

Immunomodulatory activity of aqueous extract of fenugreek seeds was evaluated in male Swiss albino mice by treating the animals with three doses of extract (50, 100, and 250 mg/kg body weight) for 10 days.(72) Overall, fenugreek showed a stimulatory effect on immune functions in mice, as indicated by Body weight, relative thymus weight, cellularity of lymphoid organs (thymus and bone marrow), delayed type of hypersensitivity response, plaque-forming cell assay, hemagglutination titer, quantitative hemolysis assay, phagocytosis, and lymph proliferation and a significant increase in phagocytic index and phagocytic capacity of macrophages. The effect of fenugreek seed extracts (200 mg/kg body wt.) has been evidenced for its ameliorative potential in

the L-thyroxine-induced hyperthyroidic rat model, which was rendered hyperthyroidic by daily injections of L-thyroxine. Propyl-thiouracil, an antithyroid drug, was used as a reference compound. Alterations in serum triiodothyronine, thyroxine, glucose, hepatic glucose-6-phosphatase, and oxygen consumption were studied as end parameters. Immunomodulatory activity of aqueous extract of fenugreek seeds was evaluated in male Swiss albino mice by treating the animals with three doses of extract (50, 100, and 250 mg/kg body weight) for 10 days.(72) Overall, fenugreek showed a stimulatory effect on immune functions in mice, as indicated by Body weight, relative thymus weight, cellularity of lymphoid organs (thymus and bone marrow), delayed type of hypersensitivity response, plaque-forming cell assay, hemagglutination titer, quantitative hemolysis assay, phagocytosis, and lymph proliferation and a significant increase in phagocytic index and phagocytic capacity of macrophages. The effect of fenugreek seed extracts (200 mg/kg body wt.) has been evidenced for its ameliorative potential in the L-thyroxine-induced hyperthyroidic rat model, which was rendered hyperthyroidic by daily injections of L-thyroxine Propyl-thiouracil, an antithyroid drug, was used as a reference compound. Alterations in serum triiodothyronine, thyroxine, glucose, hepatic glucose-6-phosphatase, and oxygen consumption were studied as end parameters.

Preparation of Extraction

- Conventional Methods
- Infusion
- Soxhlet extraction
- Decoction

Infusion

In this method, extraction consist in soaking the solids plants powder either cold or boiling water for a short period of time. The plant material is grinded into the powder, and then placed inside a clean container. The extraction solvent hot or cold is then poured on top of the material, soaked, and kept for a short period of time. This method is suitable for extraction bioactive constituents that are readily soluble Infusions are generally prepared for immediate use, as preservatives are absent.

Figure 2: Infusion

Soxhlet extraction

This tool consists of several parts including a heat source, round bottom flask, Soxhlet extractor, and condenser. The solid material which is to be extracted is placed in thimble. and placed in an extractor. The bottom end of the extractor is connected to a round bottom flask containing a solvent, and is connected to a reflux condenser.

The bottom flask is heated to boil the solvent, the vapor rises through the branch pipe of the extractor, is condensed and drops into the thimble and the solvent is contacted with the solid for extraction. When the solvent surface exceeds the highest point of the siphon, the solvent containing the extract is return back to the round bottom flask. This cycle is repeated until the all the material extracted from the solid sample. Small amount of solvent is reused to perform an extraction many times. This means that much less solvent is used in a Soxhlet extraction, making it more time and cost effective. Also, the Soxhlet extractor can run continuously without any further operation, making it an excellent choice for extracting compounds over hours or even days. Filtration is not required So it save lot of time, energy and financial inputs.

Figure 3: Soxhlet extraction

Decoction

In this process, the drug is boiled with water for a stated period usually 10 minutes. After boiling, the liquid is strained and water is passed through the content of the strainer to make the required volume. This process is mainly used for vegetable drugs of hard and woody nature having thermostable water-Soluble constituents.

Figure 4: Decoction

Preparation of Tablet Formulation Containing Fenugreek Extract

Conventional tablets were prepared by wet granulation method. Dried extract (500mg) was mixed with lactose till it produces coherent mass. Then required quantity of starch powder (5%) was added and then powder blend was passed through # 12 to produce granules. Granules were gently spread and dried at temperature below 60°C. Dry granules were weighed and their weight was recorded. Further dry granules were degranulated by passing through # 16 placed on oversize # 44 to get uniform sized granules. Granules retained on # 44 were collected and weighed. Fines which passed through # 44 were also weighed. Fines equivalent to 15% of the weight of granules were mixed with granules and other ingredients such as starch powder, talc and magnesium stearate were added in required quantities. Tablets were prepared by compressing granules in rotary tablet machine (MT Rimek -rotary tablet machine) using 9mm flat surface punches. Conventional tablet formulation was modified by addition of Sodium Starch Glycolate (2-5%) as super disintegrant and increasing the percentage of starch powder to 15%. The incorporation of super disintegrants i.e. Sodium Starch Glycolate (5%) in the dosage forms is done prior to compression. In vitro dissolution study of conventional tablets containing fenugreek extract were done which did not show satisfactory drug release, hence an attempt was made in order to enhance drug release by incorporating the super disintegrants. Conventional tablet formulation was modified by addition of

Sodium Starch Glycolate (2-5%)) as super disintegrant and increasing the percentage of starch powder to 15%

Evaluation of tablets [11-13]

All the tablets were evaluated for different physical parameters as weight variation, hardness, friability, disintegration time, wetting time, drug content and in vitro dissolution study

Thickness

The thicknesses of the formulated tablets were measured by using Vernier calipers.

Weight variation

The formulated tablets were tested for weight uniformity. For these 20 tablets were weighed collectively and individually. From the collective weight, average weight was calculated. Each tablet's weight was then compared with average weight to ascertain whether it was within permissible limits or not. % Weight variation = Average weight Average Weight-Individual weight ×100

Hardness

Hardness of tablets was measured using Pfizer type hardness tester. Three tablets were selected from each formulation randomly and their hardness was measured. The means of hardness values were calculated.

Friability

Friability of the tablets was determined by using Roche friabilator. The weight of 20 tablets (initial weight) was subjected to friabilator at 25 revolutions per 4 min. Tablets were then dedusted, reweighed (final weight) and percentage loss was calculated. Friability is obtained by the following formula: % Friability = Initial weight Initial Weight-Final weight ×100

Wetting time and water absorption ratio

A double folded tissue paper was placed in a Petri dish. 6 mL of water containing a water-soluble dye (eosin) was added to the Petri dish. A tablet (pre-weighed) was carefully placed on the surface of tissue paper. The time required for water to reach the upper surface of the tablet was noted as the wetting time. The wetted tablet was then weighed and the water absorption ratio (R) was determined by using the equation:

$$R=100\ (Wb-Wa)/Wb$$

Where Wa and Wb are the weights of tablet before (dry weight) and after water absorption (wet weight) respectively.

Drug content

Twenty tablets were weighed and powdered. The quantity of powder equivalent to 50 mg of diclofenac sodium was dissolved in phosphate buffer pH 6.8 diluted to 100 mL with the same and the solution was filtered and suitably diluted. The drug content was estimated spectrometrically at 276 nm.

In vitro disintegration test

In vitro disintegration time was determined by using disintegration test apparatus (Electrolab, USP model ED2L, Mumbai) without disk for six tablets. The disintegration medium was 900 mL of distilled water kept at (37.0+0.5) °C and stirred at a rate of (30+-2) r/min. The time was measured in seconds for complete disintegration of the tablet with no palpable mass remaining in the apparatus. The test was carried out in triplicate.

In vitro dissolution studies

Dissolution rate was studied by using USP type II paddle dissolution apparatus, in 900 mL of phosphate buffer pH 6.8 at (37.0 依 0.5) °C at 75 r/min. Aliquot of dissolution medium was withdrawn at regular time intervals and the same volume of pre-warmed (37 依 0.5) °C fresh dissolution medium was replaced. The samples were filtered and drug content of diclofenac sodium in each sample was analyzed after suitable dilution by Shimadzu UV-spectrophotometer at 276 n

CONCLUSION

Fenugreek extracts are known to have the antidiabetic effect. In order to improve the patient compliance, the extract can be made into oral tablet dosage form. Addition of super disintegrants to the tablet formulations makes the immediate and complete release of antidiabetic constituent (Trigonelline) within short period of time which is necessary for producing faster onset of antidiabetic effect.

REFERENCES

1. Brahmbhatt T, Shah B, Patel U, Kadikar H. Development and evaluation of various oral erbal Formulations for anti-asthmatic plant extracts. Int. J. Pharm. Res. Biosci. h2012;1(3):317-327.
2. Sati H, Sati B, Bhatt PC. Formulation and evaluation of herbal tablets containing Ervatamia heyneana extract for analgesic and anti-inflammatory Activity. Pharm. Res. 2011;4(12):4458-4460.
3. Majekodunmia SO, Adegokeb OA, Odeku OA. Formulation of the extract of the stem bark of Alstonia boonei as tablet dosage form. Trop. J.Pharm.Res. 2008;7(2):987- 994.

4. Rongsriyam Y, Trongtokit Y, Kosalam's N, Sinchaipanich N, Apiwathnasorn C, Mitrejet A. Formulation of tablets from the crude extract of Rhinacanthus nasutus (thai local plant) against Aedes aegypti and Culex quinquefasciatus larvae: A preliminary study. Southeast. Asian. J. Trop. Med. Public. Health. 2006;37(2):265- 271.
5. Palma -S Lujan C, Llabot JM, Barboza G, Manzo RH, Allemandi DA. Design of Peumus boldus tablets by direct compression using a novel dry plant extract. Int. J. Pharmaceuts. 2002; 233:191– 198.
6. Johnson R, Gbedema SY, Bayor MT. The oral capsule- the most appropriate dosage form for croton membranous. Int.J. Pharm.Res& Sci. 2011; 2(1):41-48.
7. Snehlata HS, Payal DR. Fenugreek (Trigonella foenum-graecum L.): an overview. Int J of Curr Pharmaceuts Rev Res. 2012;2(4):169-87.
8. Kirtikar KR, Basu BD. Indian Medicinal plants. Dehradun: International Book Distributers 1999;700-1.
9. Jyothi D, Koland M, Priya S, James JP. Formulation of Herbal Capsule Containing Trigonella Foenum-Graecum Seed Extract for the Treatment of Diabetes. J Young Pharmacists. 2017;9(3):1-5.
10. Dhiman A, Nanda A, Ahmad S. Novel Herbal Drug Delivery System (NHDDS): the need of Hour. Int. J. Environ.Chem & Biol. 2012; 49:171-175. Jyothi; JPRI, 33(51A): 47-53, 2021; Article no. JPRI.77249 53
11. Allen LV, Popovich NG, Ansel HC. Ansel's pharmaceutical dosage forms and drug delivery system. 9th ed. Illinois, USA: Lippincott Williams & Wilkins; 2011, p. 233.
12. Jani GK, Shah DP. Evaluation of mucilage of Hibiscus rosasinensis Linn as rate controlling matrix for sustained release of diclofenac. Drug Dev Ind Pharm 2008; 34(8): 807-816.
13. Rangole US, Kawtikwar PS, Sakarkar DM. Formulation and in vitro evaluation of rapidly disintegrating tablets using hydrochlorothiazide as a model drug. Res J Pharm Tech 2008; 1(4): 349-352. Vijaya SRR, Anithakumari, Ramesh RV, Duraipandi S. Design and development of tablets containing high amount of polyherbal aqueous extract with improved disintegration time. Int. J. Pharma and Bio Sci. 2011;2(4):135-139
14. Kokate CK, Purohit PA, Gokhale BS. Pharmacognosy.22nd ed. Pune: Nirali Prakashan. 203:207-232.
15. Trease GE, Evans WC, Pharmacognosy. Bailliere Tindall Press, London. 1983; 309– 706.
16. Chopra S, Motwani SK, Iqbal Z, Ahmad FJ, Khar RK. Simple, sensitive, selective and validated spectrophotometric methods for the estimation of a biomarker trigonelline from

polyherbal gels. Mol Biomol Spectrosc. 2007;68(3):516-22. Available: https://doi.org/10.1016/j.saa.200 6.12.021; PMid: 17336136.

17. Lachman L, Lieberman HA, Kanig JL. The theory and practice of industrial pharmacy, 3rd ed. Mumbai: Varghese Publishing House; 1987.
18. Sharma S, Gupta GD. Formulation and characterization of fast dissolving tablet of promethazine theoclate. Asian J Pharm. 2008;2(1):70-72.
19. Jain NK and Sharma SN. A Text book of professional pharmacy, 4th ed. Vallabh Prakashan; 2004.
20. Vijaya SK, Ravishanker D, Kumar A, Annapurna MM. Binding efficacy of Trigonella foenum-graecum seed powder: tablet excipients. Drug Invent Today. 2012;4(12):644-8.
21. Senthil V, Sripreethi D. Formulation and evaluation of paracetamol suspension from Trigonella foenum graecum mucilage. J Adv Pharm Educ Res. 2011;1(5):225-33.
22. Gowthamrajan K, Kulkarni GT, Muthukumar A. Evaluation of fenugreek mucilage as gelling agent. Int J Pharma. 2002; 3:16-9.
23. Ali N, Hossein N, Afagh K, Tarifeh SHV, Ford JL. An in vitro evaluation of fenugreek mucilage as a potential excipient for oral controlled-release matrix tablet. Drug Dev Ind Pharm. 2008;34(3):323–9. Available: https://doi.org/10.1080/03639040 701662594 PMid: 18363148
24. Chadha, Y.R., (Ed.) The Wealth of India; Council of Scientific and Industrial Research: New Delhi, 1985. 5. Shankaracharya, N.B., Anandaraman, S., Natarajan, C.P. Chemical composition of raw and roasted fenugreek. J. Food Sci. Technol. 1973, 10, 179–181.
25. Udayasekhara Rao, Sharma, R.D. An evaluation of protein quality of fenugreek seeds (Trigo nella foenum-graecum) and their supplementary effects. Food Chemistry 1987, 24, 1–9.
26. Ambasta, S.P., (Ed.), Useful Plants of India; National Institute of Science Communication: New Delhi, 2000.
27. Udayasekhara Rao, P. Short term nutritional and safety evaluation of fenugreek. Nutr. Res. 1996, 16, 1495–1505.
28. Muralidhara, Narasimhamurthy, K., Viswanatha, S., Ramesh, B.S. Acute and subchronic toxic ity assessment of debitterized fenugreek powder in the mouse and rat. Food Chem. Toxicol. 1999, 37, 831–838.
29. Srinivasan, K. Plant foods in the management of diabetes mellitus: Spices as potential antidiabetic agents. Int. J. Food Sci. Nutr. 2005, 56, 399–414.

30. Shani, J., Goldschmied, A., Joseph, B., Ahronson, Z., Sulman, F.G. Hypoglycaemic effect of Trigonella foenum-graecum and Lupinus termis seed and their major alkaloids in alloxan diabetic and normal rats. Arch. Int. Pharmacodynamic. Ther. 1974, 210, 27–37.
31. Madar, Z. Fenugreek (Trigonella foenum-graecum) as a means of reducing post-prandial glucose level in diabetic rats. Nutr. Rep. Int. 1984, 29, 1267–1272.
32. Amin Riyad, M., Abdul Ghani, Abdul Salam, S., Suleiman, S.M. Effect of fenugreek and lupine seeds on the development of experimental diabetes in rats. Planta Medica 1988, 54, 286–290. 14. Nahar, N., Nur-e-Alam, Nasreen, T., Mosihuzzaman, M., Ali, L., Begum, R., Khan, A.K.A. Studies of blood glucose lowering effects of Trigonella foenum-graecum seeds. Med. Arom. Plants 1992, Abstr.
33. 2264. 15. Khosla, P., Gupta, D.D., Nagpal, R.K. Effect of Trigonella foenum-graecum (Fenugreek) on blood glucose in normal and diabetic rats. Indian J. Physiol. Pharmocol. 1995, 39, 173–174.
34. Ali, L., Khan, A.K.A., Hasssan, Z. Characterization of the hypoglycaemic effect of Trigonella foenum-graecum seeds. Planta Medica 1995, 61, 358–360.
35. Ahmad, M., Ismail, N., Ismail, Z. Pharmacogenetic profile of Trigonella seed and its hypoglycaemic activity. Natural Product Sciences 1995, 1, 25–30.
36. Gupta, D., Raju, J., Baquer, N.Z. Modulation of some gluconeogenic enzyme activities in diabetic rat liver and kidney: Effect of antidiabetic compounds. Indian J. Exp. Biol. 1999, 37, 196–199.
37. Raju, J., Gupta, D., Rao, A.R., Yadava, P.K., Baquer, N.Z. Foenum-graecum seed powder improves glucose homeostasis in alloxan diabetic rat tissues by reversing the altered glycolytic, gluconeogenic and lipogenic enzymes. Mol. Cell. Beachem. 2001, 224, 45–51.