Internet Journal of Food Safety, Vol.8, 2006, p. 49-55

Dose-dependent effects of Fenugreek composite in Diabetes with dislipidaemia

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The prevalence of type 2 Diabetes (NIDDM) and obesity have been increasing at epidemic proportions worldwide. It has become a major global health problem in economically developed as well as in countries undergoing rapid economic expansion. Indians due to their genetic preponderance, diet and life style patterns suffer most from diabetic diseases. Evidence showing that even Indian migrants have a high tendency to develop diabetes led to several national epidemiological studies in India. Availability of uniform criteria for diagnosis and classification of diabetes made comparison between the studies possible. These surveys showed that diabetes was as common in urban India as among migrant Indians. The present study is done to see the effects of different doses of fenugreek in type 2 diabetes with dyslipidaemia. 80 patients were chosen from random rural population suffering from mild type 2 diabetes with dyslipidaemia. Fenugreek seed powder was given in the diet in doses of 25 g, 50 g, 75 g and 100 g/day, consumed by the patients in powdered form mixed with water as a drink. Addition of *Tulsi* (also a mild hypoglycaemic agent) masks the bitter taste of Fenugreek and acts as an anti-diarrhoeal. It was observed that reduction in blood sugar maintained a direct relationship with doses of fenugreek given up to 75 g/day. No significant effects in reduction of blood sugar were observed with further increasing the doses of fenugreek. Serum triglycerides maintain an inverse relationship with increasing doses of fenugreek up to the maximum doses used in the study, that is, 100 g/day. Beneficial changes in lipid profile were observed by the composite, particularly with increase in Fenugreek doses.

Until the 1970s, it was widely believed that the prevalence of diabetes in India was low compared to the western world. But recent statistics now show that India has the world's largest diabetic population. Today, India has 25 million diabetic patients, more than any other country, and the number is expected to rise to 35 million by 2010 and to 57 million by 2025. A World Health Organization report published in diabetic care (1) makes a startling revelation that India is among the countries where the prevalence rate of diabetes was the `fastest'- 5.5 per cent i.e. 31.5 million people in the year 2000 against 3.8 per cent (19.4 million persons) recorded in 1995 (2). The Chennai Urban Population study 1997 showed (3, 4) 12 per cent prevalence of diabetes in the Chennai population which is 70 per cent higher compared to that reported 14 years ago (1989) and The Chennai Urban Rural Epidemiology Study (CURES) which sampled 26,001 persons recorded a prevalence of 16 % (5, 6). This rising trend predicts a significant health burden due to diabetes in India. This problem started developing in the childhood more in the urban areas where children do not have any kind of physical exercise and consequently the life-style pattern is altered. The only things one do is to spend long hours on the computer or the cell phone or watch television (7). Startlingly, epidemiological studies have revealed that Indians are susceptible to diabetes, irrespective of the place they live in. Migrant Asian Indians living in different parts of the world had shown a higher prevalence of diabetes than other ethnic groups living in the same countries (8, 9, 10). The survey also found, from a sample study of Medavakkam town near Chennai, which was a village a decade ago, that the prevalence of diabetes rose from 2.4 per cent to 5 per cent within five years of urbanization (11). So diabetes is not just a disease of the developed countries. It is, however, clearly a disease intensified by development. The prevalence of diabetes in urban India is 10 percent. The sharp increase in the prevalence of heart diseases and diabetes mellitus in India, particularly in rural population of Bengal, may be due to sharp increase in consumption of ω-6 oils used as cooking medium to reduce the cholesterol level and the lipid toxicity of such unsaturated fats (12). In urban India, mortality rates are two fold higher in people with diabetes compared to non-diabetic subjects. Cardiovascular and renal diseases are the commonest causes of death among diabetic subjects (13). There is an increasing prevalence and incidence of diabetes with increasing age and with increased urbanization. Adult diabetics are also at risk of vision threatening retinopathies and other complications. 9–12 millions Indians suffer from

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diabetic retinopathy (4, 14). A study, according to results published in Diabetes Care in January 2002, showed that for every 1 percentage point drop in glycosalated hemoglobin (A_1C) (e.g. from 9 percent to 8 percent), there was a 35 percent reduction in the risk for diabetes-related complications. What's more, each 1 percentage point drop also lowered the risk of fatal and nonfatal heart attacks by 18 percent (15). A survey by the American Diabetes Association and the American College of Cardiology showed neither the diabetic patients have knowledge regarding severity of diabetic complications nor been properly informed by their physicians (16). Neutraceuticals are food based medicines and are in wide use in Germany and Japan. It is commonly believed that there is an association of disease and diet. In a country like India with little Health Service Research (HSR) neutraceuticals can serve as effective health controlling measures and can boost Health Survey Research (HSR). Fenugreek (*Trigonella foenum graecum*) is a common herb. Its seeds are commonly used in Indian homes as a condiment. The seeds can be taken as such after overnight soaking in water or in powder form as a drink in water or buttermilk, 15 minutes before the meal. The fenugreek seed powder can also be incorporated in preparations such as chapati, adai, dhal and vegetables. The mildly bitter taste of the seeds is a drawback and can be masked by the taste of other ingredients. Ocimum sanctum (*Tulsi*) protects against and reduces stress; enhances stamina and endurance; increases the body's efficient use of oxygen; boosts the immune system; reduces inflammation. *Tulsi* contains vitamins C and A, and minerals calcium, zinc and iron, as well as chlorophyll and many other phytonutrients. It also enhances the efficient digestion, absorption and use of nutrients from food and other herbs (17). Aqueous extract of *Tulsi* mixed with diet for eight weeks to diabetic (streptozotocin induced) rats was studied (18). There was significant reduction in fasting blood glucose, serum lipid profile, lipid peroxidation products, (LPO) and improvement in glucose tolerance. The aqueous extract also decreased LPO formation (thiobarbituric acid reactive substances TBARS) and increased antioxidant enzymes superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GPX), glutathione transferase (GT) and one antioxidant reduced glutathione (GSH) in plasma and rat liver, lung, kidney and brain. The decrease in TBARS and increase in GSH, SOD, CAT, GPX, and GT clearly shows the antioxidant property of *Tulsi*. The main objective of the present work is to monitor the effects of Fenugreek and *Tulsi* in the treatment of diabetes with dislipidaemia as evidenced by changes in blood biochemistry of Total Cholesterol (TLC), High Density Lipoprotein Cholesterol (HDLC), Low Density Lipoprotein Cholesterol (LDLC), Very Low Density Lipoprotein Cholesterol (VLDLC), Triglycerides (TG) and Fasting Blood Sugar (FBS). The effects on variation of doses of Fenugreek were also observed. For this purpose, a randomized, placebo-controlled crossover single blind trial for four weeks on 40 human volunteers suffering from Type 2 diabetes was also performed earlier, to see the synergistic effects of *Tulsi* (19).

MATERIALS AND METHODS

This study included 80 randomly selected newly diagnosed type-2 diabetes patients. The patients with known renal and hepatic dysfunction and on lipid lowering therapy were excluded from the study. The patients underwent clinical and anthropometrical evaluation before the study. Initial blood samples were analyzed for plasma glucose and lipid profile.

Fenugreek of good quality can be safely given up to 100 g/day (20, 21). Daily doses used were 25 g, 50 g, 75 g and 100 g respectively in two equally divided doses given to each group of patients 15 minutes before lunch and dinner (22). The preparations are mixed with 2.5 g of *Tulsi* leaves powder to mask the bitterness of fenugreek and also for synergistic anti-diabetic actions of *Tulsi* (23). Each observation of fenugreek- *Tulsi* composite was continued for 2 months and effects observed by monitoring their fasting blood glucose values and lipid profile values monthly.

Measurement of TLC, HDLC, LDLC, VLDLC, TG and FBS and other bio-chemic parameters were done by standard methods as depicted by Boehringer Mannheim (24) by reagents supplied to meet the standard quality.

Eighty subjects with Type 2 diabetes were enrolled in the study after obtaining written consent and ethical approval from Institute ethical committee. Patients were initially divided in 5 groups of 16 each. Group 1 received 25 g, Group 2 received 50 g, Group 3 received 75 g and group 4 received 100 g of fenugreek seeds for 2 months along with 2.5 g of *Tulsi* leaves powder, while Group 5 acted as control. The effects on FBS and lipid profiles of the groups were observed and compared at each month during the entire study. Patients' weight, BMI and other clinical parameters were measured and found to be almost stationary

Descriptive data were compiled using the SPSS software program and by using standard statistical methods. Means and standard deviations were calculated for acceptability of the sensory attributes of the complementary foods. A one-way analysis of variance (ANOVA) was conducted to test for significant differences ($P < 0.05$) in the sensory attributes (appearance and consistency, smell and taste). With the help of Analysis of Variance (ANOVA) it is confirmed that the mean effects of all the blood parameters are not the same. Now to see for which blood parameter the hypothesis of equality of means is getting rejected. Tukey's

multiple comparison test was used for determining the best combination for a particular parameter

RESULTS

The results of clinical and anthropometrical evaluation of the patients before the study:

Age- 46.72 ± 3.29 years
Sex- Males 42, Females 38
Weight- 78.43 ± 8.45 kg
BMI- 22.24 ± 2.22

At the end of the study it was found that in the volunteers the weight became 78.78 ± 8.23 kg and BMI was found to be 22.32 ± 2.12. This variation may be non-identical conditions prevailing during measurements. Initial blood samples as analyzed for plasma glucose and lipid profile were shown in the tables below as initial readings. As the samples were drawn from different patients, having different socio-cultural backgrounds, considering the diversity of Indian population in intake of food, life-styles, socio-cultural believes etc, the variations in the initial readings of different blood parameters in different patients were noted. Clinical Parameters were evaluated at the end of study. All the parameters remained as like before except Blood Pressure values, which show a decrease of Systolic Blood Pressure (SBP) of 10 mm of Hg ($P \leq 0.5$), which may be due to changes in rheological properties of blood. SGPT (Serum Glutamine Pyruvate Transaminase) values (normal 5-40 IU/l) increased by 6 units in the first month and it remained stationary after that ($P \leq 0.25$) and serum alkaline phosphate increased by 2 units in the first month and 3 units in the second month (normal 3-13 K.A units/dl).

Table 1 showing the effects of different doses of Fenugreek in the composite, in the desired blood parameters, showed with 25 g/day of Fenugreek TLC was reduced from initial value of 229 ± 12 mg/dl to 227 ± 10 mg/dl while the effects of 50 g/day of fenugreek was a reduction from initial value of 233 ± 10 mg/dl to 232 ± 7 mg/dl. These reductions of TLC values were statistically insignificant. With 75 g/day of Fenugreek the TLC values were reduced from 230 ± 7 mg/dl to 224 ± 9 mg/dl, a reduction of 2.88% ($P \leq 0.05$). 100 g/day of Fenugreek caused a decrease of TLC values from 232 ± 9 mg/dl to 219 ± 7 mg/dl, a reduction of 6.18% ($P \leq 0.05$). Without the neutraceutical, TLC values in control showed an increase of value from 226 ± 8 mg/dl to 227 ± 8 mg/dl, an increase of 0.5% ($P \leq 0.25$). HDLC values showed that with 25 g/day of Fenugreek, the initial value of 35 ± 4 mg/dl was increased to 38 ± 3 mg/dl, an increase of 8.62% ($P \leq 0.075$). 50 g/day of Fenugreek caused increase of HDLC values from 36 ± 3 mg/dl was increased to 40 ± 5 mg/dl, an increase of 11.12% ($P \leq 0.05$). With 75 g/day of fenugreek dose, HDLC values was

Table 1: Effects of Different doses of Fenugreek in Fenugreek- *Tulsi* composite on TLC, HDLC, LDLC, VLDLC, TG, and FBS

Fenugreek- *Tulsi* composite without diet									
Doses of fenugreek (g/day)	TLC			HDLC			LDLC		
	Months						Months		
	0	1	2	0	1	2	0	1	2
25	229 ± 12	228 ± 11	227 ± 10 (Reduction statistically insignificant)	35 ± 4	37 ± 4	38 ± 3 (Increase of 8.62%)	156 ± 9	155 ± 6	154 ± 5 (Reduction statistically insignificant)
50	233 ± 10	233 ± 9	232 ± 7 (Reduction statistically insignificant)	36 ± 3	38 ± 5	40 ± 5 (Increase of 11.12%)	160 ± 5	160 ± 9	158 ± 6 (Reduction statistically insignificant)
75	230 ± 7	227 ± 6	224 ± 9 (Reduction of 2.88%)	38 ± 5	41 ± 6	44 ± 3 (Increase of 15.15%)	156 ± 5	152 ± 5	147 ± 5 (Reduction of 5.82%)
100	232 ± 9	227 ± 12	219 ± 7 (Reduction of 6.18%)	34 ± 3	38 ± 4	42 ± 5 (Increase of 23.53%)	160 ± 5	154 ± 11	147 ± 9 (Reduction of 8.15%)
Normal diet without Fenugreek- *Tulsi* composite	226 ± 8	227 ± 7	227 ± 8 (Increase of 0.5%)	35 ± 4	36 ± 4	36 ± 3 (Increase of 2.86%)	154 ± 9	154 ± 6	154 ± 5

Table 1. Continued

Fenugreek- *Tulsi* composite without diet									
Doses of fenugreek (g/day)	VLDLC			TG			FBS		
	Months			Months			Months		
	0	1	2	0	1	2	0	1	2
25	36 ± 7	36 ± 3	35 ± 4 (Reduction of 3.01%)	180 ± 12	177 ± 9	175 ± 8 (Reduction of 2.75%)	184 ± 11	181 ± 12	176 ± 7 (Decrease of 4.08%)
50	37 ± 4	36 ± 5	35 ± 8 (Reduction of 5.15%)	185 ± 12	178 ± 9	174 ± 5 (Reduction of 5.94%)	184 ± 7	180 ± 9	170 ± 7 (Reduction of 7.84%)
75	36 ± 8	34 ± 6	33 ± 7 (Reduction of 8.21%)	180 ± 5	174 ± 7	166 ± 6 (Reduction of 7.34%)	183 ± 7	178 ± 6	164 ± 5 (Reduction of 10.38%)
100	38 ± 7	35 ± 7	32 ± 5 (Reduction of 15.75%)	185 ± 9	173 ± 11	160 ± 12 (Reduction of 13.14%)	185 ± 10	176 ± 9	165 ± 7 (Reduction of 10.56%)
Normal diet without Fenugreek-*Tulsi* composite	37 ± 3	37 ± 5	37 ± 4	185 ± 7	185 ± 9	185 ± 7	182 ± 11	184 ± 8	184 ± 7 (Increase statistically insignificant)
Clinical findings at the beginning	Pulse 72 ± 6/min, SBP 124 ± 12 mm of Hg, DBP 90 ± 8 mm of Hg, Respiration 16 ± 2 /min, Temp 97.2 ± 0 .2°C Serum Bilrubin 1.5 ± 0.4 mg, SGPT 32 ± 6 IU, Alkaline Phosphatase 3 ± 1 KA, Total protein 5.4 ± 0.6, Albumin/Globulin ratio 2.2:1, Blood urea 23 ± 5 mg, Serum uric acid 5.85 ± 1.2mg								

increased from 38 ± 5 mg/dl was increased to 44 ± 3 mg/dl, an increase of 15.15% ($P \leq 0.025$). 100 g/day of fenugreek dose caused increase of HDLC values from 34 ± 3 mg/dl to 42 ± 5 mg/dl, an increase of 23.53% ($P \leq 0.25$). Without the neutraceutical, HDLC values in control showed an increase of value from 35 ± 4 mg/dl to 36 ± 3 mg/dl, an increase of 2.86% ($P \leq 0.50$). Analyzing LDLC, 25 g/day of Fenugreek caused reduction of LDLC values from 156 ± 9 mg/dl to 154 ± 5 mg/dl, the reduction was statistically insignificant. With 50 g/day of Fenugreek LDLC values was reduced from 160 ± 5 mg/dl to 158 ± 6 mg/dl, the reduction was also statistically insignificant. 75 g/day of Fenugreek caused a decrease of LDLC values from 156 ± 5 mg/dl to 147 ± 5 mg/dl, a reduction of 5.82% ($P \leq 0.075$). With 100 g/day of Fenugreek LDLC values was reduced from 160 ± 5 mg/dl to 147 ± 9 mg/dl, a reduction of 8.15% ($P \leq 0.05$). Without the neutraceutical, LDLC values in control showed no change of values from 154 ± 9 mg/dl to 154 ± 5 mg/dl. VLDLC values with 25 g/day of Fenugreek showed reduction, from initial of 36 ± 7 mg/dl to 35 ± 4 mg/dl, a reduction of 3.01% ($P \leq 0.05$). With 50 g/day of Fenugreek VLDLC values was reduced from 37 ± 4 mg/dl to 35 ± 8 mg/dl, a reduction of 5.15% ($P \leq 0.05$). 75 g/day of Fenugreek caused reduction of VLDLC values from 36 ± 8 mg/dl to 33 ± 7 mg/dl, a reduction of 8.21% ($P \leq 0.05$). With 100 g/day of Fenugreek VLDLC values was reduced from 38 ± 7 mg/dl to 32 ± 5 mg/dl, a reduction of 15.75% ($P \leq 0.025$). Without the neutraceutical, VLDLC values in control showed no change of values from 37 ± 3 mg/dl to 37 ± 4 mg/dl. Analyzing TG, 25 g/day of Fenugreek caused reduction of TG values from 180 ± 12 mg/dl to 175 ± 8 mg/dl, the reduction was 2.75% ($P \leq 0.05$). With 50 g/day of Fenugreek TG values was reduced from 185 ± 12 mg/dl to 174 ± 5 mg/dl, the reduction was 5.94% ($P \leq 0.05$). 75 g/day of Fenugreek caused a decrease of TG values from 180 ± 5 mg/dl to 166 ± 6 mg/dl, a reduction of 7.34% ($P \leq 0.025$). With 100 g/day of Fenugreek TG values was reduced from 185 ± 9 mg/dl to 160 ± 12 mg/dl, a reduction of 13.14% ($P \leq 0.025$). Without the neutraceutical, TG values in control showed no change of values from 185 ± 7 mg/dl to 185 ± 7 mg/dl. FBS values showed that with 25 g/day of Fenugreek, the initial value of 184 ± 11 mg/dl was reduced to 176 ± 7 mg/dl, a decrease of 4.08% ($P \leq 0.025$). With 50 g/day of Fenugreek FBS values was reduced from 184 ± 7 mg/dl to 170 ± 7 mg/dl, the reduction was 7.84% ($P \leq 0.05$). 75 g/day of Fenugreek caused a decrease of FBS values from 183 ± 7 mg/dl to 164 ± 5 mg/dl, a reduction of 10.38% ($P \leq 0.05$). With 100 g/day of Fenugreek FBS values was reduced from 185 ± 10 mg/dl to 165 ± 7 mg/dl, a reduction of 10.56% ($P \leq 0.05$). Without the neutraceutical,

FBS values in control showed slight increase from 182 ± 11 mg/dl to 184 ± 7 mg/dl, but this was statistically insignificant.

On the basis of Analysis of Varience (ANOVA) the means of the different blood parameters were listed to see whether there is any significant difference between the values before applying the fenugreek-tulsi composite and after applying the composite. This hypothesis got rejected. Then on the basis of Tukey's multiple comparison test which is based on a t-statistic the blood parameter(s) for which the hypothesis of ANOVA got rejected was looked. This resulted in the conclusion that fasting blood glucose levels in the groups over the study period show a significant decline and the decline was dependent on concentration of fenugreek. Cholesterol and various lipoprotein cholesterol levels at baseline and at follow-up were also measured. At baseline as well as in the follow-up the levels of TC, LDLC were not significantly different in doses of fenugreek up to 50 g/day (53 g/day when extrapolated), in the composite while values of serum triglycerides decreased significantly in all the volunteers. HDLC values show moderate increments in all groups.

Comparing the different biochemical values obtained (Table 1) with addition of different doses of fenugreek in the fenugreek-*tulsi* composite it is evident that fenugreek has got profound effects on lowering the values of blood sugar and triglycerides. HDLC, that is, beneficial or good cholesterol, was significantly increased with increment of fenugreek doses, as also reduction of LDLC. Thus higher doses of fenugreek are effective to control dyslipidaemia. As the samples were drawn from a random selection and also groped as random, considering the diversity of Indian population in intake of food, life-styles, socio-cultural believes etc, the variations in the initial readings of different blood parameters in different groups were noted. On the basis of Tukey's multiple comparison test, it was observed that Fenugreek seeds had profound effects on lowering the values of blood sugar and triglycerides. The reduction was dose dependent and in case of glucose it saturates around 77 - 85 g/day with a central value of 82 g/day while in case of triglycerides no such limit was observed in the dose ranges used in the study, that is, up to 100 g/day.

It is known that type 2 diabetes, dyslipidaemia, obesity, hypertension, atherosclerosis are closely related in the spectrum of Reevan's syndrome. The patients' anthropometrical parameters did not change perceptively during the period of experimentation. Clinical parameters, such as blood pressure, show slight decrease in systolic pressure (SBP) in the range of 5-15 mm of Hg ($P \leq 0.25$) while diastolic pressure (DBP) increased by 0-5 mm of Hg ($P \leq 0.50$). ECG observations showed no changes. Though not within the purview of this study serum bilrubin level increased by about 0.2mg/dl ($P \leq 0.025$). SGPT values were increased by 6 units in the 1st month and it remained stationary after that ($P \leq 0.25$) while serum alkaline phosphate increased by 2 units in the first month and 3 units in the second month. Other parameters of liver function tests like serum protein, albumin-globulin ratio, Ultrasonography and CT scan of liver showed no changes before and after the trial.

DISSCUSSION

Fenugreek seed powder in the diet reduces blood sugar and urine sugar with concomitant improvement in glucose tolerance and diabetic symptoms in type 2 diabetic patients. It also lowers the levels of cholesterol and triglyceride. Seeds of fenugreek are a rich source of fiber. It contains mucilaginous fiber and total fiber to the extent of 20% and 50% respectively. Increased dietary fiber helps in the management of some of these metabolic abnormalities. Lipid composition of fenugreek seed (6.9%) shows oleic acid 22.7%, linoleic acid 37.6%, linolenic acid 21.8% and saturated fats 16-17% (25). Seeds of fenugreek have multiple benefits in patients with diabetes such as reduction of blood sugar and its complications (26-31). It was observed that 4-hydroxyisoleucine extracted from fenugreek seeds has insulinotropic activity (32). However effects of fenugreek seeds on lipid levels and insulin metabolism in humans are not well studied (30, 33, 34). This study evaluates effects of different doses of fenugreek seeds in blood sugar and lipid profile values of mild to moderate type-2 diabetic patients.

Studies of Shani et al. (35), Ribes et al. (36), Khosla et al. (37) and Madar et al. (38) showed that fenugreek seeds decreased FBS levels in animals. Madar et al. (28), Jain et al. (39), Sharma et al. (30) and Al Hoobori et al. (26), Abdel-Barry et al (40) showed hypoglycemic effects of fenugreek seeds type 2 diabetics. The mechanism of action is not fully understood and has been attributed to a high percentage (50%) of dietary fibre, polyunsaturated fatty acid, alkaloid teigonelline, saponins and pectins present in these seeds. It was also demonstrated in some studies that fenugreek seeds delayed gastric emptying and caused inhibition of glucose transport as the seeds contain 50% pectin that forms a colloid suspension when hydrated, which can decrease rate of gastric emptying and slow carbohydrate absorption. In vitro study, conducted by us showed reduction of amylase activity upto 22% in presence of 65-82 g of fenugreek powder. It was known that hydroxyisoleucine aminoacids extracted from fenugreek seeds increase glucose induced insulin release through direct effect on isolated islet of Langerhans from both rats and humans (32). Thirunavukkarasu et al. (41) showed fenugreek has a protective effect on ethanol toxicity, which need further study in tribal belts of India where alcoholism and type 2 diabetes goes hand to hand.

Fenugreek seed extract contains high levels of galactomannan, a soluble fiber with a mannose backbone and attached galactose molecules. Viscous galactomannan

forms a gel in the stomach that slows gastric emptying. Glucose absorption is reduced or delayed, which decreases blood sugar spikes and improves insulin response to meals. Weight loss may be promoted since fenugreek galactomannan's gel formation takes up room in the stomach and consumers are likely to eat less. With delayed gastric emptying a full feeling lasts longer, and appetites are suppressed (21).

A randomized, placebo-controlled crossover single blind trial on 40 human volunteers suffering from Type 2 diabetes was performed. During the four-week trial, subjects alternately received a daily dose of 2.5 g of *Tulsi* leaves powder (19) and effects observed showed *Tulsi* produced 17.6 % reduction in fasting blood glucose and 7.3% decline in postprandial blood glucose level to a set of patients and hence adding of *Tulsi* to the Fenugreek dust not only changed the taste but may also had produced synergistic blood glucose lowering actions. Because of its inherent botanical and biochemical complexity, *Tulsi* standardization has, so far, eluded modern science. Perhaps best known of the many active compounds that have been identified and extracted are eugenol, ursolic acid, apigenin and luteolin. Although *Tulsi* is known as a general vitalizer and increases physical endurance, it contains no caffeine or other stimulants (19, 23).

CONCLUSIONS

The present study shows that fenugreek seeds decrease blood glucose and triglyceride levels and have significant effect on LDL or HDL cholesterol when consumed at higher doses. The triglyceride lowering effect may be due to the pectin component that absorbs bile acids. However, it is bitter to taste and at high doses above 50 g/day produce diarrhoea. *Tulsi* leaves in the composite masks the bitterness of fenugreek, act as a remedy to diarrhoea and also act as an additive in reduction of diabetes with dyslididaemia. It is thus ideally suited for diabetics in India.

ACKNOWLEDGEMENT

The authors were deeply indebted to Late Prof. S. K. Sawarkar of Department of Chemical Engineering, Indian Institute of Technology, Kharagpur, India for his valuable suggestions and encouragement throughout the work. The authors were also thankful to Prof. S. Bal of Food and Agricultural Engineering Department and Prof. P. Chattaraj of Chemistry Department, Indian Institute of Technology, Kharagpur, India for their reviews, comments and suggestions. The authors deeply acknowledge the contributions of Prof. S. S. Alam and Prof. A. K. Nanda in the Department of Mathematics and Statistics, Indian Institute of Technology, Kharagpur, India. Lastly, the authors were indebted forever to the volunteers of the study.

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