

Effect of Eight Weeks' Endurance Training along with Fenugreek Ingestion on Lipid Profile, Body Composition, Insulin Resistance and VO_{2max} in Obese Women's with Type2 Diabetes

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Abstract

Background: Physical activity combined with some herbal supplementations can affect body energy metabolism, blood lipids and physical fitness levels. However, the effect of exercise training combined with fenugreek on lipid metabolism and body composition in patients with type2 diabetes is unknown.

Objective: The aim of present study was to investigate the effects of eight weeks' endurance training along with fenugreek seed supplement on lipid profile, body composition, insulin resistance and VO_{2max} in obese women with type2 diabetes.

Methods: For conducting present study, 40 obese women with type2 diabetes and mean age 44.2 ± 2.5 years and body mass index (BMI) 32.58 ± 1.67 kg/m² assigned in four groups (each group 10 person) include Placebo, Fenugreek, Exercise training and Exercise training+Fenugreek groups. Running endurance training program performed for eight weeks, three sessions in a week and 30-55 minutes in each session. Training intensity increased from %45 reserve heart rate in the first week to %65 reserve heart rate in the last week. Subjects in Fenugreek and Exercise training+Fenugreek groups consumed daily 15g fenugreek seeds mixed with yogurt in three meals (each meal five g) include morning, noon and night.

Results: results indicate a significant decrease of percent body fat and significant increase of VO_{2max} in both trained groups ($P < 0.05$). Moreover, lipid profile improvement and glucose and insulin resistance decrease in Exercise training groups were significant. In addition, HDL-c increase and LDL-c decrease in Exercise+Fenugreek group was also significant compared to Exercise alone.

Conclusion: Fenugreek consumption increases the endurance training induced adaptations in obese women afflicted with type 2 diabetes.

Keywords: Body composition, Diabetes mellitus, Endurance training, Fenugreek seeds

Introduction

Type 2 diabetes mellitus is a major metabolic disorders that afflict many people throughout the world and account for 90% to 95% of all diagnosed cases of diabetes. Type 2 diabetes is associated with many complications such as diabetic nephropathy, neuropathy and retinopathy [1]. The patient population with type2 diabetes have been doubled over the past three decades that made this disease to most important health challenge in worldwide [2]. Type 2 diabetes in some countries such as United States, is the main reason of blindness, end-stage renal disease, and nontraumatic loss of limb and associated health care costs estimated to exceed \$130 billion per year [3]. It seems that lifestyle changes consist of excess energy intake and sedentary lifestyle (lack of exercise) have led to obesity and, in turn, to the diabetes epidemic [4]. Obesity, especially excess visceral adipose tissue cause of insulin resistance, hypertension, dyslipidemia and hyperglycemia (metabolic syndrome). These changes in metabolic situation are associated with increase the type 2 diabetes development and cardiovascular diseases that enhance the rates of mortality and morbidity [5]. Generally, the prevalence of type 2 diabetes is increasing rapidly parallel to the increase in obesity and reduction in physical activity, and dietary changes [7]. Therefore, with regards to role of obesity and physical inactivity in progression of type 2 diabetes, the first step in the management of this disease is changing the lifestyle, weight loss and take part in physical activity and exercise program [8].

Regular physical exercise program in combination with an ideal diet cause reduction

in metabolic disorders that are related to type 2 diabetes and also reduce weight and improve insulin sensitivity [9]. Many researchers have studied the effect of aerobic (endurance) exercises training in patients with type 2 diabetes. The results of these studies indicated that the prevalence of obesity (BMI reduction), total fat mass and waist-to-hip ratio significantly decreased. Moreover, improving of the cardiovascular risk profile (increase HDL/LDL ratio, modulating lipid profile and decrease in systolic and diastolic arterial blood pressure), decrease of fasting blood glucose or significant increase of insulin sensitivity have been reported [10]. Type 2 diabetes is also associated with low to moderate hypertriglyceridemia, low level of HDL and over production of VLDL [11]. But in contrast, positive effect of different exercise training in improving lipid profile of diabetic patient has been proved [12].

For management of diabetes with different methods, including insulin or drug, diet have a remarkable importance. By this way, is indicating that plants and foods of medicinal value are very useful, that one of them is fenugreek seed [1]. The fenugreek seeds contain lysine and L-tryptophan rich proteins, mucilaginous fiber and other rare chemical constituents, including saponins, coumarin, fenugreekine, nicotinic acid, saponin, phytic acid, scopoletin and trigonelline, which are thought to account for many of its presumed therapeutic effects, may inhibit cholesterol absorption and thought to help lower sugar levels. So, fenugreek seeds are used as a traditional remedy for the treatment of diabetes and hypercholesterolemia [13]. Specially, the

antihyperlipidemic properties of oral fenugreek seed powder have been suggested [14]. In regard to positive effects of exercise training along with fenugreek supplementations in diabetes status, Jalali Dehkordi et al (2013) reported that six weeks swimming training in combination with fenugreek seed extract (0.5 mg/kg), decrease plasma levels of glucose and are associated with increasing cardiac antioxidant enzymes in streptozotocin-induced diabetic rats [15]. However, Roghani et al (2005) in another study reported that eight-week Intraperitoneal injection of Fenugreek Extract (100-200 mg/kg) in diabetic rat's result in decrease cholesterol levels, although don't observe remarkable changes in others circulating lipoprotein [16]. Generally, limited study conducted about fenugreek supplementation alone or in combination with exercise training in diabetic subjects and result especially in human patients is controversial. In fact, despite the proven positive effects of exercise training in type2 diabetes management and antidiabetic effect of fenugreek seed, the combination effect of aerobic exercise training and fenugreek supplement on body composition and lipid profile of diabetic patients is unknown. Therefore, the aim of the present study was to investigate the effect of eight weeks' endurance training with fenugreek seed supplementation on lipid profile, glucose, insulin resistance, body composition and VO_{2max} in obese women's with type2 diabetes.

Materials and Methods

This study is a semi-experimental research that conducted with pre and posttest design. The

present study subjects including 40 obese women with type2 diabetes who don't inject insulin an average age of 44.2 ± 2.5 years and body mass index (BMI) 32.58 ± 1.67 kg/m². Subjects except for diabetes, don't have any systemic (e.g. cancer) or diabetes related diseases such as cardiovascular, renal or other diseases. None of the subjects participated in the regular exercise training program at least in the last year and they don't have any physical and physiological problem and limitations for take part in exercise protocol were conducted in present study and all of them have a BMI more than 30 kg/m² Then subjects were called to a laboratory for familiarization with protocol design and the positive and negative effects of exercise training described for all of patients and finally informed consent was obtained from all of them. This study conducted as placebo-controlled double-blind, randomized, method and subjects randomly assigned to four groups and each group consist of 10 patients, including: placebo (n=10), Fenugreek supplement (n=10), Exercise (n=10) and Exercise+ Fenugreek supplement (n=10) groups. All of the subject consumed antidiabetic drugs and they were asked to change their type and dosage of consuming drugs during the course of the research only in consultation with their doctor. Subjects were then asked for blood sampling and body composition determine in the pretest stage after 12 hours of overnight fasting. Two days after the pre-test measurements, the research protocol conducted for eight weeks.

Training protocol

The subjects in placebo and fenugreek group were wanted to continue daily routine activities and avoided from take part in an exercise

training program. Subjects in Exercise and Exercise+ Fenugreek supplement groups performed aerobic exercise training (running and walking) for eight-weeks and three sessions per week on the treadmill. Training session duration and intensity is presented in table 1 [17].

Training intensity during exercise session controlled by polar heart rate monitoring watch. Before and after each exercise session, 10-minute warm-up and cool-down performed respectively.

Fenugreek seed supplement

Fenugreek seed supplement consumed for eight weeks, daily 15 grams at three time including the morning, noon and at night, and 5 grams per serving were consumed 30 minutes before meals and mixed with yogurt (100 g) by Fenugreek supplement and Exercise+ Fenugreek supplement groups as before mentioned [1]. and Placebo group consumed daily 100 g yoghurt with flavors. According to previous studies, this dose of fenugreek consumption is safe for diabetic patients and daily fenugreek consumption ranging from 10 to 25 grams were suggested [1, 11]. Fenugreek seeds were prepared in 100 grams' packages from the Narin Gol Company (code: herbs-11).

Measuring the studied variables

VO_{2max} determined by Rockport one-mile

fitness walking test in the pre and posttest periods. For this purpose, the subjects were asked to walk one mile on treadmill as fast as possible. Immediately after the exercise test, the subjects heart rate was measured and VO_{2max} determined by the aforementioned formula [18]. At the end of research protocol and 48 hours after the last exercise session in order to eliminate the acute effects of the last session exercise or last meal consumption of fenugreek seed, blood samples collected again like as pretest period. Blood samples were centrifuged and frizzed in -80 freezer. The plasma levels of glucose, total cholesterol. TG, LDL-C and HDL-C were measured using commercially available enzyme assay kits (Pars Azmon kit, Iran). Moreover, insulin levels determined by Mercodia Insulin ELISA kit. For determine body fat percent (PBF), three-point skinfolds including thighs, triceps and super iliac were measured by caliper and PBF calculate by Jackson-Pollock formula. The results analyzed by SPSS-24 software. Kolmogorov Smirnov test was used to ensure that data distribution is normal and to comparisons between group changes, analyze covariance (ANCOVA) test and for intra-group analyze paired t test were used. The differences were considered significant if p value was less than 0.05.

Table 1- Training sessions features during eight weeks in trained groups

Weeks	Duration (min)	Intensity (percent of reserve heart rate)
1-2	30	% 45
3-4	40	% 45-50
5-6	50	% 65
7-8	55	% 65

Results

All of 40 subjects complete the research protocol and were included in the analysis. In the table 2, physical and physiological characteristics of subjects in four groups (1. Placebo, 2. Fenugreek, 3. Exercise and 4. Exercise+ Fenugreek) at the baseline and after eight weeks' intervention described. This results indicated that body fat percent, weight and BMI significantly decreased in Exercise and Exercise+Fenugreek seed supplement groups ($p=0.001$). Against, VO_{2max} significantly increased in exercise and Exercise+Fenugreek seed supplement group ($p=0.001$). However, difference between Exercise and Exercise+Fenugreek group wasn't significant for any below variables.

Results of lipid profile, glucose, insulin and insulin resistance (HOMA.IR) have been reported in table 3. These result indicated that

Cholesterol, Triglyceride and insulin significantly decreased in both trained groups (Exercise and Exercise+Fenugreek) compared to placebo and supplement groups. But no difference observed between Placebo and Fenugreek groups for above mentioned variables. Moreover, observed that LDL-c, glucose and insulin resistance significantly decreased in both trained groups in comparison to Placebo and Fenugreek groups, which decrease in LDL-c and HOMA.IR in Exercise+Fenugreek was significant compared to Exercise training alone. Furthermore, glucose and LDL-c significantly decreased in Fenugreek supplement group in comparison to Placebo group. HDL-c indicated significant increase in both trained group, which increase in Exercise+Fenugreek was significantly more than Exercise alone. In addition, increase in HDL-c levels in Fenugreek supplement was significant compared to Placebo group.

Table 2- Physical and physiological characteristics of subjects

Groups variable	Time of measurement	Placebo	Fenugreek	Exercise	Exercise+ Fenugreek
Weight (kg)	Pre	82.47±2.5	82.64±3.01	81.43±2.72	82.79±2.76
	Post	83.95±2.51	83.91±3.0	74.9±2.87*§	77.03±2.66*§
	p value	0.87	0.72	0.003	0.001
BMI (kg/m ²)	Pre	32.86±1.88	33.11±1.01	31.78±1.34	32.56±2.15
	Post	33.41±1.86	33.62±1.05	29.23±1.39*§	30.28±1.91*§
	p value	0.48	0.65	0.041	0.024
Percent body fat (Kg)	Pre	35.65±2.37	37.25±2.37	34.53±1.87	36.5±2.78
	Post	36.44±1.80	37.79±2.84	32.32±1.73*§	33.79±2.61*§
	p value	0.55	0.7	0.019	0.008
VO_{2max} (ml.kg.min)	Pre	29.92±6.88	31.28±8.31	30.78±7.24	29.65±7.15
	Post	29.54±6.75	31.1±8.05	31.98±7.51*§	31.04±7.91*§
	p value	0.38	0.47	0.015	0.030

* Significant difference from placebo and Fenugreek groups.

§ Significant difference from pre-test.

Table 3- Changes in lipid profile, insulin and glucose in subjects after eight weeks' interventions

Groups variable	Time of measurement	placebo	fenugreek	exercise	Exercise+ supplement
Cholesterol (mg/dl)	Pre	257.8±11.34	265.8±6.44	265.3±6.94	260.9±9.75
	Post	259.4±14.84	257.3±8.16	220.6±19.77*§	203.7±11.9*§
p value		0.22	0.18	0.001	0.001
LDL-c (mg/dl)	Pre	200.10±13.72	203.4±15.45	194.9±14.5	196.2±17.01
	Post	201.5±14.4	190.7±15.36*§	158.0±17.15*#§	149.0±17.86*#¥§
p value		0.51	0.047	0.009	0.001
HDL-c (mg/dl)	Pre	39.3±3.12	42.3±4.54	42.5±4.88	44.3±5.55
	Post	39.1±3.34	48.2±5.3*§	51.4±4.06*§	63.2±6.49*¥§
p value		0.35	0.05	0.029	0.001
Triglyceride (mg/dl)	Pre	164.04±10.01	160.87±12.24	167.73±9.02	156.68±13.25
	Post	161.69±9.60	155.46±13.03	156.68±13.25*§	144.18±13.16*§
p value		0.83	0.09	0.012	0.005
glucose (mg/dl)	Pre	215.3±20.49	200.1±16.57	198.5±18.8	194.7±14.70
	Post	216.1±26.32	185.4±17.25*§	153.8±14.34*#§	143.3±8.71*#§
p value		0.56	0.036	0.001	0.001
insulin (mU/ml)	Pre	9.43±0.68	9.59±0.62	9.46±0.62	9.29±0.66
	Post	9.36±0.64	9.39±0.61	8.48±0.69*§	7.88±0.67*§
p value		0.44	0.31	0.01	0.004
HOMA.IR	Pre	5.01±1.18	4.73±1.54	4.63±1.35	4.46±1.15
	Post	4.93±1.24	4.29±1.42	3.22±1.06*§	2.78±0.89*¥§
p value		0.18	0.22	0.022	0.006

* Significant difference from Placebo group

Significant difference from Placebo and Fenugreek groups

¥ Significant difference from Placebo, Fenugreek and Exercise+ Fenugreek groups

§ Significant difference from pre-test.

Discussion

The aim of present study was to determine the effect of eight weeks' endurance training in combination with fenugreek seed supplementation on lipid profile, body composition, insulin resistance and VO_{2max} in obese women's with type2 diabetes. The main result of present study is that fenugreek seed supplement can magnitude the antidiabetic

effects of aerobic exercise training. Lipid profile and glucose data indicated that fenugreek alone can also be effective in modulating LDL-c, HDL-c and glucose levels and its consumption with exercise training, increase the effectiveness of training in diabetic patients. Fenugreek is one of those plants that has given a lot of attention and is now widely used to treat diabetes and hyperlipidemia [19].

Fenugreek is very important in treating and managing diabetes. It improves blood glucose control and insulin resistance in diabetic patients. It's reported that eating Fenugreek seeds after soaking in hot water causes a significant decrease in fasting blood glucose and triglyceride [20]. In this regard, Present study results also confirmed above results and indicated that fenugreek can decrease LDL-c and glucose and are associated with increase of HDL-c in diabetic women patients. Moosa et al (2006) examined the effect of three and six weeks' fenugreek seed powder ingestion on the lipid profile in patients with type 2 diabetes. These results showed that after 3 weeks' fenugreek powder consumption, cholesterol and triglyceride decreased significantly, while changes in LDL-c and HDL-c wasn't significant at the third week. Re-evaluation of lipid profiles in the 6th week indicated that LDL-c levels also decreased significantly, but no significant changes were observed in HDL-c levels [11]. However, dose of fenugreek consumption (25 g daily) in Moosa et al (2006) research was different from this study (15 g daily). Therefore, it seems that long term fenugreek supplementation can be effective in modulating lipid profile and glycemic control. In relation to effects of fenugreek supplement consumption along with exercise training, limited studies have been conducted. Arshadi et al (2015) reported that six weeks of swimming aerobic exercise training in diabetic rats along with fenugreek supplement consumption are associated with reduced glucose levels. However, swimming training alone did not have a significant effect on circulating glucose [21]. Training intensity, duration, type and

studied subjects (rat against obese women's) in Arshadi et al (2015) research were different from the present study. In this way, Hypoglycemic and anti-hyperglycemic effects of fenugreek have been observed in diabetic and non-diabetic rats and fenugreek improve body weight and liver glycogen and has a significant effect on the key metabolic enzymes of carbohydrates in diabetic rats [22].

Another result of the present study is that eight weeks' exercise training alone or with fenugreek supplement is associated with improvement lipid profile, decrease insulin resistance and body fat percent and increase in VO_{2max} in diabetic women's. Some study confirmed this finding. In this regard, it's reported that eight weeks' low intensity aerobic exercise training (%40-50 VO_{2max}) significantly decrease body fat, weight and BMI in overweight women's [23]. These similar results were reported despite the lower intensity of exercise in comparison to the present study intensity that represent effectiveness of aerobic exercise training in improvement body composition. Balducci et al (2012) reported a significant increase of VO_{2max} after three months combined (aerobic and resistance) exercise training with low or high intensity in patients with type2 diabetes. However, VO_{2max} increase in group with high intensity was further [24]. These results, emphasize the importance of exercise intensity in physiological adaptations. In support of exercise intensity importance, Grace et al (2017) in one metanalysis reported that higher intensity of exercise training is associated with more improvement in glycemic control, VO_{2peak} and body composition in type2 diabetic patients

[25]. Moreover, it seems that training period duration are also important in exercise training effectiveness in diabetes situations. It's reported that one-week endurance exercise training with 80-85 percent of maximum heart rate can't improve body weight, BMI, body fat and VO_{2max} in obese diabetic patients [26]. Araiza et al (2006) indicated that six-week low intensity aerobic training (walking) don't affect body fat percent and BMI in patients with type2 diabetes [27]. The Araiza et al (2006) results emphasize the importance of training duration for positive effects in diabetes. According to present and afore mentioned results, it seems that present study duration and intensity can be optimal and efficient for inducing of positive effect of exercise training in diabetic patients.

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Conclusion

In conclusion, Since the present study results indicated that endurance exercise training especially in combination with fenugreek consumption can improve lipid profile, body composition and insulin resistance in type2 diabetic patients, Moreover fenugreek supplementations alone are effective in diabetic status, it seem that exercise training in combination with herbal supplementations (Fenugreek) are safe and have a synergic effect and can increase positive effects of exercise training in improving glycemic and metabolic situation in diabetic patients.

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