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Original Article

Lipid Lowering Effects of Coriandrum Sativum Extract and Endurance Training in Streptozotocin Induced Diabetic Rats

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Abstract

Introduction: Diabetes is a metabolic disease which induces increase in lipid profile. The present research aimed to review the lipid lowering effects of coriandrum sativum extract and endurance training in diabetic rats.

Methods: Thirty two diabetic rats were selected and divided into four groups of eight rats (1) coriandrum sativum extract, (2) endurance training, (3) endurance training with coriandrum sativum extract and (4) control. Rats of groups 2 and 3 ran on treadmill four weeks, five sessions per week and 60 minutes per session; also, rats of groups 1 and 3 received four weeks 100 mg/kg coriandrum sativum extract daily. For statistical analysis of data were used K- S and two way ANOVA tests ($p \leq 0.05$).

Results: Endurance training has significant effect on reduction of LDL, VLDL, TG and Cho of diabetic rats ($p \leq 0.05$); Coriandrum sativum has significant effect on reduction of LDL, VLDL, TG and Cho of diabetic rats ($p \leq 0.05$); also endurance training with coriandrum sativum has interactional effect on the reduction of LDL, VLDL, TG and Cho and increase of HDL of diabetic rats ($p \leq 0.05$).

Conclusion: It appears that endurance training increases the lipid lowering effects of coriandrum sativum in diabetic rats.

Keywords: Coriandrum, Exercise, Lipids, Diabetes Mellitus

Introduction

Diabetes mellitus is a metabolic disorder that has affected the lives of people in industrialized societies (1). Diabetes mellitus is a syndrome of carbohydrate metabolism, fat and protein that results from the lack of insulin secretion or insulin sensitivity (2). Diabetes is known as a disabling disease due to its many consequences and various disabilities among people. The environmental and genetic factors, insulin resistance, and beta cellular dysfunction are involved in the development of disease; it is also clear that the increasing prevalence of obesity and sedentary lifestyle are also important factors in the incidence of this disease (3). Undoubtedly, the habit of proper exercise is important in this regard. Moderate-intensity aerobic exercise even if administered at a low level per week, results in a decrease in beta-protein and TG; decreases LDL and increases HDL (4, 5). The role of sports activities in obesity and diabetes is well known in improving insulin sensitivity and lipid profiles, and research has shown that with increased exercise activity, metabolic syndrome associated with insulin resistance improves in diabetic patients (6- 12). Regardless of the foregoing, the treatment regimen is generally considered as the first step in the treatment of diabetic patients. The use of herbal remedies from ancient times has been common in ancient civilizations and today, herbal remedies in various forms, including the use of herbal products or their total extracts, is common throughout the world (2). Because, with the industrial advances in the pharmaceutical industry, many synthetic drugs have entered the market, which often have many adverse effects (11). The medicinal plant of coriander is of great importance in the pharmaceutical, food, cosmetics and sanitary industries due to its essential oil composition and the main ingredient of linalool. The scientific name of this plant is known as Coriandrum Sativum L (13). Coriander does not only have anti-hyperglycemic properties but also has antioxidant properties and an increase in dietary intake of coriander seeds reduces oxidative load in diabetes mellitus (14). Coriander is rich in antioxidants and fiber, which helps to improve lipid profile (15). In various studies, coriander has been used in the traditional treatment of diabetes. Recent studies have shown that Coriander extract has the properties of lowering blood glucose and lipid profiles (16- 24). Given that in the current population, diabetic patients have been pushed to the use of medicinal herbs to reduce diabetic and lipid disorders, several studies have shown the beneficial effects of coriander drugs such as reducing blood glucose, blood lipids, and their beneficial effects on insulin production, both in diabetic patients and in diabetic laboratory animals. In addition to nutrition, physical activities are also one of the main pillars of diabetes care and management. Therefore, it is important to develop a physical training program as well as nutrition for diabetic patients. In this vein, the present study seeks to investigate the synergistic effects of endurance training and coriander consumption in diabetic rats; if these two lipid lowering agents in diabetic patients have interactive and synergistic effects in improving lipid profiles, they can be managed with appropriate prescribing doses of coriander and endurance exercises for lipid profile in diabetic patients. Since the results of studies on the effect of coriander consumption and endurance training on lipid profiles are consistent with each other, and no study has been conducted to examine and compare the simultaneous effects of these two variables; this study is aimed to investigate the synergistic effects of lipid lowering of coriander extract and endurance training in streptozotocin induced diabetic rats.

Methods

To conduct this experimental study, at first, 50 male Sprague Dawley adult male rats with an approximate age of 8 weeks who were replicated at the Animal Breeding Center located at Islamic Azad University of Fars Science and Research Branch, were selected and transmitted to the Laboratory of Sport Physiology of this academic branch. To maintain the rats, transparent polycarbonate cages with autoclave capability were used. To remove urine and feces of animals and their comfort, chips and sterile wood cuts were used. Also, the cages were washed every day and wood chips were replaced. After eight days period of adaptation, on the eighth day, after a night of fasting, all rats were injected intraperitoneally (60 mg per kg body weight) with streptozotocin (sigma chemical, St. Louis, MO, USA) (2). After four days, fasting blood glucose in rats was measured using a glucometer device by punching the tail. 32 rats with blood glucose greater than 300 mg/ dl were selected as the statistical sample, and based on fasting glucose were put into four groups of eight rats: (1) extract of coriander, (2) endurance training, (3) endurance training with coriander extract, and (4) control. Groups 2 and 3, were given five sessions training per week. In Addition, methanolic extracts of coriander was injected intraperitoneally to groups 1 and 3 daily, 100 mg/ kg body weight. In implementing the endurance training protocol, the animals were first placed on a treadmill to familiarize themselves with the procedure of their endurance training, and ran at a speed of 8 m/ min with a zero-degree slope for 10 minutes. At the end of the treadmill, a very weak electrical shock was induced to force the animals to continue to move. To prevent potential damage by electrical shock, animals were conditioned from the beginning by quietly treading the treadmill and creating a relatively weak sound or by touching the animal's tail. The endurance training protocol included four weeks of increasing running on a slope less treadmill (zero slope) at a speed of 8 to 16 m/ min, 60 minutes per session, and five sessions per week. To warm the animals during training sessions, after placing animals on the treadmill, first they ran 10 minutes at speed of 8 m/ min and then the exercise program was performed. Upon completion of the training program, in order to run the cooling program, the speed of the device was reduced inversely to speed the machine to zero. This program lasted about five to seven minutes (11). In order to extract coriander extract, 100 g of coriander powder was dissolved in 150 ml of methanol and kept at laboratory temperature for 24 hours. After two to three times filtration, the liquid obtained in Ben-Mari was placed at 50 ° C until the alcohol was completely evaporated and concentrated extract was obtained. The extract was stored at -20 ° C until use. The extract solution with lower concentrations was obtained by dissolving it in cold physiologic saline solution (13). The entire study period lasted four weeks. After four weeks, blood samples were taken from the rats after 16 hours of fasting. Measurement of lipid profiles was performed by enzymatic method using commercial biochemical kits prepared by *Yasa teb*. To analyze the results of the study, the statistical tests of Kolmogorov-Smirnov and two-way analysis of variance were used ($p \leq 0.05$). It should be noted that the protocol of this study is based on the international rules on the support of experimental animals and approved by the Ethics Committee of the University.

Results

The lipid profiles of the four groups of research are presented in Figures 1 and 2. The results of the two-way analysis of variance analysis in Table 1 show that endurance training (F= 69.17 and p= 0.001, with effect size of 0.71) and coriander consumption (F= 16.66 and p= 0.001, with effect size 0.37) have significant effects on LDL decrease in diabetic rats. Also, endurance training and coriander consumption have interactive effects on decreasing LDL in diabetic rats (F= 43.27 and p= 0.001, with effect size of 0.60); endurance training (F= 119.79 and p= 0.001, with an effect size of 0.81) and coriander consumption (F= 0.67 and p= 0.001, with effect size of 0.69) had a significant effect on VLDL reduction in diabetic rats. Also, endurance training and coriander consumption have interactive effects on reducing VLDL in diabetic rats (F= 79.69 and p= 0.001, with effect size of 0.73); endurance training (F= 2.20 and p= 0.16, with effect size of 0.06) and coriander consumption (F= 0.19 and p= 0.66, with effect size of 0.007) had no significant effect on HDL increase in diabetic rats. However, endurance training and coriander consumption have interactive effects on increasing HDL in diabetic rats (F= 10.19 and p= 0.003, with effect size of 0.26); endurance training (F= 119.79 and p= 0.001, with effect size of 0.81) and coriander consumption (F= 62.77 and p= 0.001, with effect size of 0.69) have significant effects on the reduction of TG of diabetic rats. Also, endurance training and coriander consumption have interactive effects on reducing TG in diabetic rats (F= 79.69 and p= 0.001, with effect size of 0.73), and endurance training (F= 148.31 and p= 0.001, with effect size of 0. 84) and coriander consumption (F= 45.45 and p= 0.001, with effect size 0.61) had a significant effect on the reduction of Cho in diabetic rats. Also, endurance training and coriander consumption have interactive effects on the reduction of Cho in diabetic rats (F= 74.41 and p= 0.001, with effect size of 0.72).

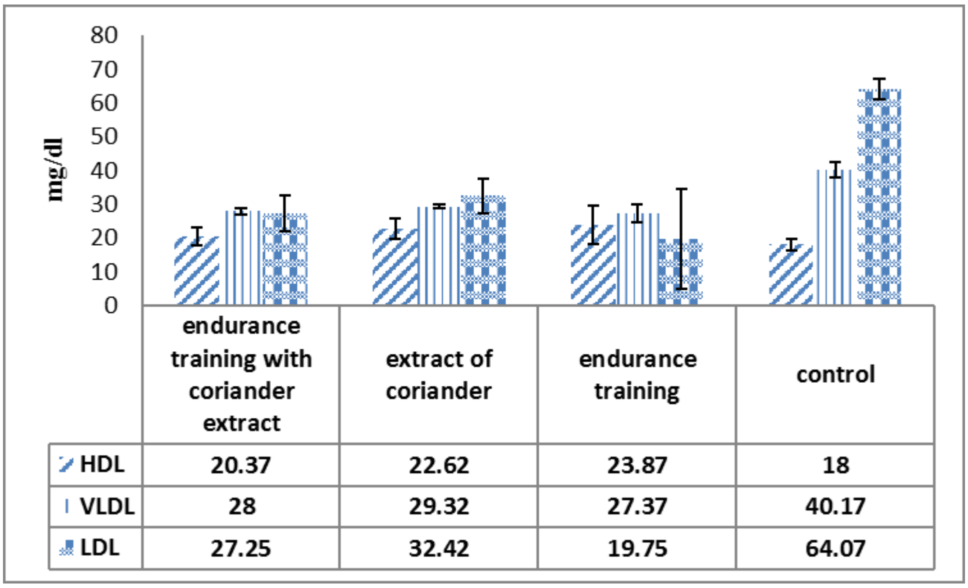

Figure 1. Levels of HDL, VLDL, and LDL of rats in four research groups

Table 1. Two-way analysis of variance analysis to study the effect of endurance training, coriander consumption and interaction of endurance and coriander consumption

Variable		**Mean square**	**F**	**Level of significance**	**Effect size**
LDL	Endurance training	4900.50	69.17	0.001	0.71
	Coriander consumption	1166.44	16.46	0.001	0.31
	Interactive effect of endurance training and coriander consumption	3065.44	43.27	0.001	0.60
VLDL	Endurance training	209.10	119.79	0.001	0.81
	Coriander consumption	263.35	62.77	0.001	0.69
	Interactive effect of endurance training and coriander consumption	3.33	79.06	0.001	0.73
HDL	Endurance training	26.28	2.02	0.16	0.06
	Coriander consumption	2.53	0.19	0.66	0.007
	Interactive effect of endurance training and coriander consumption	132.03	10.19	0.003	0.26
TG	Endurance training	5227.83	119.79	0.001	0.81
	Coriander consumption	6583.78	62.77	0.001	0.69
	Interactive effect of endurance training and coriander consumption	83.27	79.06	0.001	0.73
Cho	Endurance training	7200	148.31	0.001	0.84
	Coriander consumption	2211.12	45.54	0.001	0.61
	Interactive effect of endurance training and coriander consumption	3612.50	74.41	0.001	0.72

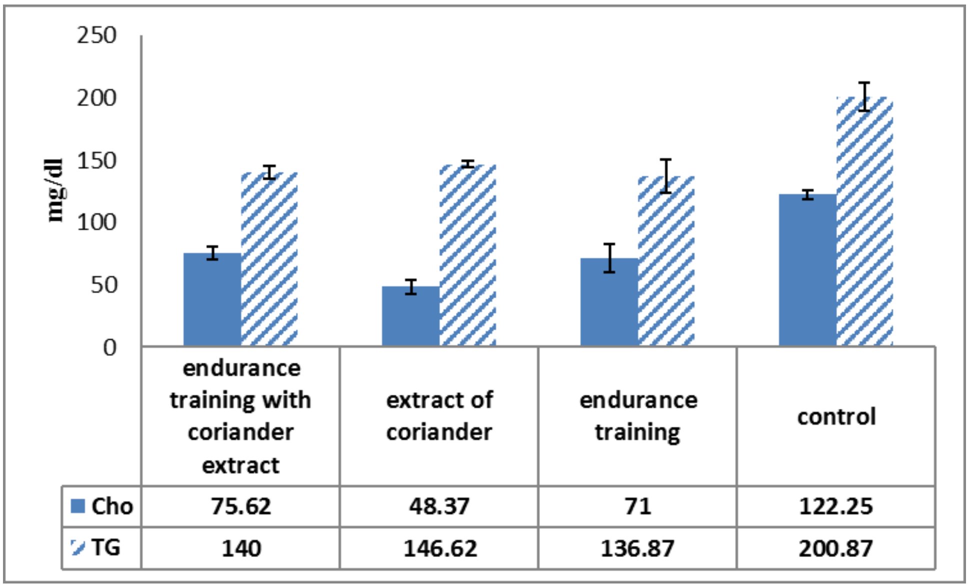

Figure 2. Cho and TG levels of rats in four research groups

Discussion

Results of this study showed that four weeks of endurance training had a significant effect on decreasing LDL, VLDL, TG and Cho cholesterol levels in streptozotocin induced diabetic rats. In various studies, the effects of exercise activities on controlling and treating diabetes are known, as most studies point to the beneficial effects of exercise activities on improving lipid profiles in diabetic subjects (7 and 9), as well as in diabetic rats (8, 10 , 11 and 25). For example, three weeks, five sessions per week and 45 minutes each session, the endurance training of running on treadmill improved lipid profile in rats significantly (11). Among the reasons for the results of this study being in line with the findings of the current study, the similarity of the prescriptive exercises and almost identical duration of both training protocols can be noted.

It was also reported that 4 weeks of endurance training, 5 sessions per week and 60 minutes of treadmill running at 20 m/ min resulted in a significant reduction in lipid profiles of streptozotocin induced diabetic rats (8).

As a reason for the consistent findings of this study with the current study, one can refer to the same method of diabetizing rats as well as the duration of daily exercises, so that it seems that the daily caloric intake of the study subjects and the present study may have been consistent. Endurance-aerobic trainings can be considered as an effective way to change the lipid profiles of patients with diabetes (12). This effect may be due to increased and improved lipoprotein lipase enzyme activity, following aerobic training, which may be due to increased lipoprotein lipase in muscle capillaries (26). Exercise activities may have beneficial effects on TG and HDL with the effect on muscle and liver lipoprotein lipase activity. Changes in lipoprotein lipase activity will lead to more VLDL entry from the liver to the circulation and clear it from the circulation (25). Lipoprotein lipase enzyme is effective in converting VLDL to HDL. On the other hand, Listerine Cholesterol Acyl Transfers, in addition to LDL, converts cholesterol into HDL particles (27). The increase in this enzyme may be responsible for increasing HDL due to endurance training in the present study.

Regarding the results of the present study that four weeks of endurance training could significantly affect Cho, TG, LDL and VLDL levels in diabetic rats, endurance training can be beneficial for treating and preventing the onset of the cardiovascular diseases. One of the possible adaptations resulting from endurance training in this study can be increased mitochondrial volume followed by lipolysis enzymes activity, which leads to an increase in the ability of the catabolism of lipid profiles (28). In addition to addressing exercise activities, treating regimen can be considered as one of the effective steps in the treatment of diabetic patients.

Due to the insulin-like effects of coriander, various studies have investigated the anti-diabetic effects of this plant (29). The results of this study showed that four weeks consumption of coriander extract had a significant effect on improvement of lipid profile (lowering LDL, VLDL, TG and Cho) in streptozotocin induced diabetic rats. Most studies have reported the lipid-lowering effects of coriander oil (15-25), although some studies have shown that coriander has no effect on lipid profiles (30-32). In line with the findings of this study, coriander has been shown to affect colon cancer and decrease cholesterol levels and reduce the conversion of cholesterol to phospholipid in the blood (16); Triacylglycerol cholesterol density of adipose tissue in rats was affected by coriander diet and decreased (18). Daily consumption of coriander seed powder capsule in 50 patients with type 2 diabetes for 6 weeks resulted in a significant decrease in Cho, TG and LDL, but did not have a significant effect on HDL changes (17). In line with this study, the findings of the present study showed that four weeks of coriander consumption had no significant effect on HDL increase in diabetic rats, thus it seems that coriander consumption in short-term is not effective on HDL changes. However, 30 days of coriander extract consumption of 25 mg/ kg resulted in a significant decrease in glucose, insulin, insulin resistance, Cho, TG and LDL, and a significant increase in HDL in hyperlipidemic rats (21). Although in this study coriander intake of less than the prescribed dose (25 mg/ kg versus 100 mg/ kg) resulted in a significant increase in HDL in rats, it seems that the inconsistencies in results are due to the difference in the type of subjects (hyperlipidemic obese rats versus streptozotocin induced diabetic rats), since It has been reported that the initial levels of HDL can affect its changes following taking herbs. Despite the consistency of the above studies with the results of this study, it was shown that eight days of consumption of 250 mg/ kg body weight of coriander seed extract had no significant effect on fasting blood glucose and cholesterol level in healthy rabbits (30). Also, 5 weeks of daily consumption of 500 mg/ kg of coriander extract had no significant effect on body weight, free fatty acid plasma, and TG concentration in healthy female rats (31), which these results are not consistent with the results of this study. Of the reasons for the inconsistencies of the results of the studies are the type of subject, the initial levels of lipid profiles, the duration of the study, the dosage, and also the control of effective factors such as the use of special drugs. For example, one of the reasons for not affecting coriander extract in healthy rabbits (30) and healthy rats (31) reported above (despite high doses) can be the primary levels of lipid profiles, so that the subjects of most studies similar to the present study were diabetic rats with either streptozotocin or alloxan.

In diabetic induction with streptozotocin, levels of lipoprotein lipase decrease; therefore, lipid profile levels increase, so that increased levels of TG in diabetic rats can be due to increased VLDL synthesis in the liver and its catabolism reduction (34). Therefore, effective coriander products can potentially return enzyme activity to normal rate by acting on the system and may affect lipid profile improvement (14, 33). Concerning the effect of coriander extract on lipid profile, it can be stated that the reduction of lipid profile by coriander extract can be due to the involvement of the polyphenolic section of the extract in preventing the formation of AGEs in diabetic rats (21). The fibers contained in the coriander can delay the absorption of glucose and fatty acids from the upper intestine, so there is less substrate available for the synthesis of triglycerides (33). Concerning the interactive effects, the findings of this study showed that four weeks of endurance training with coriander extract consumption had interactive effects on reduced LDL, VLDL, TG and Cho and increased HDL in streptozotocin induced diabetic rats. In fact, by examining the effect size of endurance exercises, coriander consumption and endurance training along with coriander consumption, it seems that four weeks of coriander administration has led to improved lipid profiles of diabetic rats. And the implementation of endurance training simultaneously with the use of coriander extract led to an increase in lipid lowering effects (decreased LDL, VLDL, TG and Cho and increased HDL) of coriander extract in diabetic rats. Regarding the effects of coriander lipid lowering agent, the improvement of lipid profile with coriander extract may be due to the effect of this plant on increasing lipoprotein lipase activity in diabetic rats, which decreases the activity of this enzyme in experimental models of diabetic (35). Also, coriander extract with a strong removal effect on free radicals significantly increases the activity of various antioxidant enzymes and inhibits peroxidation of lipids in the liver and decreases glucose and lipid levels (35). Given that in the experimental model of the streptozotocin induced diabetes, the lipoprotein lipase activity decreases, therefore, effective coriander material can potentially return enzyme activity to normal rate through affecting this system. This mechanism can partly justify reduced level of serum lipids (36). Therefore, the interactive effects of lipid lowering of endurance training and consumption of coriander extract in this study can indicate that considering that sports activities with effects on muscle and liver lipoprotein lipase activity can produce beneficial effects on TG and HDL (25), therefore, it seems that in the present study, endurance trainings have strengthened coriander effect on lipoprotein lipase activity and led to further decrease in serum LDL, VLDL, TG and Cho blood levels in streptozotocin induced diabetic rats.

Conclusion

In this study, although four weeks of consumption of 100 mg/ kg of coriander extract resulted in improvement of lipid profile in diabetic rats, the implementation of endurance trainings with simultaneous consumption of coriander extract resulted in increased lipid lowering effect of coriander extract in diabetic rats.

Ethical issues

No applicable.

Authors' contributions

All authors equally contributed to the writing and revision of this paper.

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References

1. Salemi Z, EskandariMehrabadi M. Comparison of serum nesfatin-1 level in type 1 and 2 diabetic rats. Arak Med Univ J. 2016; 19 (8) :1-7
2. Hosseini SA, nikbakht H, Azarbayjani M.A. The Effect of Aqua Extract of

Saffron with Resistance Training on Glycemic Indexes of Streptozotocin Induced Diabetic Rats. Yasuj Med Univ J. 2014; 18 (4): 284- 294.

1. Yavari A, Najafipoor F, Aliasgarzadeh A, Mobasseri M, Nikookheslat S. Effect of Aerobic Exercise, Resistance Training or Combined Training on Glycemic Control and Cardiovascular Risk Factors in Patients with Type 2 Diabetes Mellitus. Tabriz Uni Med J. 2011; 33 (4): 82- 91.
2. Hamasaki H. Daily Physical Activity and Type 2 Diabetes: A Review. World J Diabetes. 2016; 7 (12): 243- 251.
3. Joseph JJ, Echouffo-Tcheugui JB, Golden SH. Physical Activity, Sedentary Behaviors and the Incidence of Type 2 Diabetes Mellitus: the Multi-Ethnic Study of Atherosclerosis (MESA). BMJ Open Diabetes Res & Care. 2016; 4 (1): 185-197.
4. Shojae T, Hosseini SA, & Hosseini, SA. Review the Effect of Endurance Training on Glycemic Indexes of Streptozotocin Induced Diabetic Rats. Jahesh J. 2013; 15: 39- 46.
5. Hojjati Z, Shahsavari S. Acute Effects of Aerobic and Combined Exercise on Serum Lipid Profile in Women with Type II Diabetes. Iran J Health Sci. 2015; 3 (2): 31- 37.
6. Heo M, Kim E. Effects of Endurance Training on Lipid Metabolism and Glycosylated Hemoglobin Levels in Streptozotocin-induced Type 2 Diabetic Rats on a High-fat Diet. J Phys Ther Sci. 2013; 25 (8): 989- 992.
7. Barzegari A, Amouzad Mahdirejei H. Effect of 8 Weeks Resistance Training on Plasma Vaspin and Lipid Profile Levels in Adult Men with Type 2 Diabetes. Caspian J Intern Med. 2014; 5 (2): 103–108.
8. Arshadi S, Azarbayjani MA, Hajiaghaalipour F, Peeri M, Bakhtiyari S, Stannard R, et al. Evaluation of Trigonella Foenum-graecum Extract in Combination with Swimming Exercise Compared to Glibenclamide Consumption on Type 2 Diabetic Rodents. Food & Nutr Res. 2015; 59: 297- 307.
9. Farkhaie F, Hosseini SA, Edalat Manesh MA. The Effect of Endurance Training with Niglla Sativa Extract on Lipid Profile of Diabetic Rats. Jahesh J. 2013; 14: 11-18.
10. Dehghan F, Hajiaghaalipour F, Yusof A, Muniandy S, Hosseini SA, Heydari S, et al. Saffron with Resistance Exercise Improves Diabetic Parameters Through the GLUT4/AMPK Pathway in-vitro and in-vivo. Sci Rep. 2016; 6: 1- 12.
11. Karimi E, Gholami J, Rezaei P, Mazidi M. The Effect of Oral Coriander Seed Extracts on Lipids, Blood Glucose, and Oxidative Stress Indicators in Streptozotocin- Induced Diabetic Rats. Qom Univ Med Sci J. 2015; 8(5):85- 92.
12. Deepa B, Anuradha CV. Antioxidant Potential of Coriandrum Sativum L. Seed Extract. Indian J Exp Biol. 2011; 49 (1): 30- 38.
13. Emamghoreishi M, Heidari-Hamedani GH. Effect of Extract and Essential Oil of Coriandrum Sativum Seed Against Pentylenetetrazole-Induced Seizure. Pharma Sci J. 2008; 14: 1-10.
14. Chithra V, Leelamma S. Coriandrum Sativum- Effect on Lipid Metabolism in 1, 2- Dimethyl Hydrazine Induced Colon Cancer. Ethnopharmacol J. 2000; 71: 457–463.
15. Parsaeyan N. The Effect of Coriander Seed Powder Consumption on Atherosclerotic and Cardioprotective Indices of Type 2 Diabetic Patients. IJDO. 2012; 4 (2): 86- 90.
16. Weber N, Schowieses Klein E, Yaukherjee KD. Adipose Tissue Triacylglycerols of Rats are Modulated Differently by Dietary: Isomeric Octadecenemic Acids from Corianderiol and High Oleic Sunflower Oil. J Nut. 1999; 129: 2206- 2211.

17. Dhanapakiam P, Joseph JM, Ramaswamy VK, Moorthi M, Kumar AS. The Cholesterol Lowering Property of Coriander Seeds (Coriandrum Sativum): Mechanism of Action. J Environ Biol. 2008; 29 (1): 53- 56.
18. Waheed A, Miana GA, Ahmad SI, Khan MA. Clinical Investigation of Hypoglycemic Effect of Coriandrun Sativum in Type 2 Diabetic Patients. Pakistan J Pharma. 2006; 23 (1): 7- 11.
19. Aissaoui A, Zizi S, Israili ZH, Lyoussi B. Hypoglycemic and Hypolipidemic Effects of Coriandrum Sativum L. in Merionesshawi Rats. J Ethnopharmacol. 2011; 137 (1): 652- 661.
20. Ramadan M, Amer M, Awad A. Coriandrum Sativum Seed Oil Improves Plasma Lipid Profile in Rats Fed a Diet Containing Cholesterol. Eur Food Res Technol. 2008; 227: 1173- 1182.
21. Eidi M; Eidi A, Oryan S, Saeidi A. Effect of Coriandrum Sativum L. Seeds on Blood Glucose in Streptozotocin Induced Diabetic Rats. Iranian Pharma Res J. 2004; 3 (Supplement 2): 59- 59.
22. Kazemi S, Asgari S, Moshtaghian S, Rafieian M, Mahzooni P. Preventive Effect of Pumpkin (Cucurbita Pepo L.) on Diabetic Index and Histopathology of Pancreas in Alloxan-Induced Diabetes in Rats. Isfahan Med School J. 2011; 28 (117): 1108- 1117.
23. Zar A, Hoseini SA, Ahmadi F, Rezaei M. Effects of Ginger with Swimming Training on Blood Fat Profiles in Adult Streptozotocin Induced Diabetic Rats. Iranian Nutr Sci Food Tech J. 2016; 11 (2): 65- 74.
24. Lambers S, Van Laethem C, Van Acker Sint K, Calder P, Calders B. Influence of Combined Exercise Training on Indices of Obesity, Diabetes and Cardiovascular Risk in Type 2 Diabetes Patients. Clinical Rehab J. 2008; 22 (6): 483- 492.
25. Fergusen MA, Aldorson NL, Trost SG, Essig DA, Burke JR, Durstine JL. Effect of 4 Different Single Exercise Sessions on Lipids and Lipoproteins Lipase. Apple Physiol J. 2001; 85 (3): 1169- 1174.
26. Plotnikoff RC, Courneya KS, Trinh L, Karunamuni N, Sigal RJ. Aerobic Physical Activity and Resistance Training: An Application of the Theory of Planned Behavior Among Adults with type 2 Diabetes in a Random National Sample of Canadians. Int J Behav Nutr Phys Act. 2008; 5: 61- 75.
27. Ullagaddi R, Bondada A. Review on Medicinal Benefits of Coriandrum Sativum L. Spatula DD. 2011; 1 (1): 51- 58.
28. Al –Suhaimi E. Effect of Coriandrum Sativum, a Common Herbal Medicine, on Endocrine and Reproductive Organ Structure and Function. Alternative Med J. 2008; 7 (2): 1- 6.
29. Nyakudya T, Makaula S, Mkumla N, Erlwanger K. Dietary Supplementation with Coriander (Coriandrum Sativum) Seed: Effect on Growth Performance, Circulating Metabolic Substrates and Lipid Profile of the Liver and Visceral Adipose Tissue in Healthy Female Rats. Int J Agric Biol. 2014; 16: 125- 131.
30. Zahmatkesh M, Khodashenas M. Comparing the Therapeutic Effects of three Herbal Medicine (Cinnamon, Fenugreek, and Coriandrum Sativum) on Hemoglobin A1C and Blood Lipids in Type II Diabetic Patients. Chron Dis J. 2013; 1 (2): 74- 82.
31. Sreelatha S, Inbavalli R. Antioxidant, Antihyperglycemic, and Antihyperlipidemic Effects of Coriandrum Sativum Leaf and Stem in Alloxan Induced Diabetic Rats. Food Sci J. 2012; 77 (7): 119- 123.
32. Byambaa E, Zeynep O, Erdembileg A, Lars B. Postprandial Lipoproteins and Cardiovascular Disease Risk in Diabetes Mellitus. Curr Diab Rep. 2010; 10: 61- 69.

33. Abdi A. The effect of aerobic training with coriander seed extract on lipoprotein A-1, Lipid Profile and Insulin Resistance in streptozotocin-induced diabetic rats. CMJA. 2017; 7 (3): 1989- 2000.

34. Karimi E, Gholami J, Rezaei P, Mazidi M. The effect of oral coriander seed extracts on lipids, blood glucose, and oxidative stress indicators in streptozotocin-induced diabetic rats. Qom Univ Med Sci J. 2015; 8 (S1): 85- 92.