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Original Article

The effect of soy nut on serum total antioxidant, endothelial function and cardiovascular risk factors in patients with type 2 diabetes

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ABSTRACT

Background: Type 2 diabetes has a high spread and growing process. Using appropriate food diets is among therapeutic approaches has been applied for diabetic patients. Soya utilization has shown effective results in controlling metabolic abnormalities of these patients. The aim of this study is to investigate the effects of soy nut on glycemic conditions, blood pressure, lipid profile, antioxidant effects and vascular endothelial function of these patients.
Methods: 70 patients with type 2 diabetes were randomly divided into two groups of the test (35 people) and control (35 people). The patients in the intervention group were subjected to 60 g soy nut diet as a part of daily protein for 8 weeks and the control group under the usual diet of diabetes. The fasting glucose, blood pressure, lipid profile, brachial blood flow, the level of serum E-Selectin and total antioxidant capacity in control and test group were assessed before and after diet.
Results: Consuming 60 g soy nut for 8 weeks significantly decreased the fasting blood glucose ($P = 0.03$), total serum cholesterol ($P < 0.01$), LDL-c ($P = 0.01$), and E-Selectin ($P < 0.01$) and increased the capacity of serum total antioxidants ($P < 0.01$), brachial blood flow ($P < 0.01$) but didn't have any significant effect on systolic/diastolic blood pressure, HDL-c, and TG.
Conclusion: Soy nut utilization in the patients with type-2 diabetes can significantly improve the glycemic condition, increase brachial blood flow, decrease E-selectin (improvement of endothelial function), increase serum total antioxidants and lipid profile but has no significant effect on blood pressure and HDL-c.

1. Introduction

Diabetes mellitus is a group of metabolic diseases with different etiology. It is expected that the census of diabetics patients which most of them have type 2 diabetes, increase to 438 million people in 2030 from 285 million in 2010 [1].

According to one theory in pathogenicity of both type 1 and 2 diabetes, the increased component of oxidative and inflammatory stress exist that causes resistance to insulin, the increase of free fatty acid and intensification of long-term complications of diabetes [2]. Oxidative stress with endothelial cell dysfunction has a central role in micro- and macro-vascular complications of diabetes. Therefore, potentially using antioxidant compositions is from modern approaches to preventing and controlling diabetes [3,4].

Earlier, the positive effect of eating nuts on decreasing risk factors for cardiovascular disease has been reported [5,6]. Also, eating soy nut can reduce postprandial glycemia, triglyceride, total cholesterol, LDL and other cardiovascular risk factors; however there exist contradictory findings [7,8]. Different studies have reported effective results on the improvement of glycemic disorders, lipid profile, and blood pressure because of eating different compounds of soya in type 2 diabetics [7,9]. Also eating soy nut can have a positive role in reducing inflammation, oxidative stress and insulin resistance without detrimental effect on diabetes [9,10].

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However, more studies are necessary to prove this result.

The aim of the present study is to evaluate soy nut consumption on glycemic, lipid profile, blood pressure, oxidative stress level, brachial blood flow and endothelial function in type 2 diabetics.

2. Materials and methods

This study is a randomized clinical trial with the control group. This study is performed on 70 type 2 diabetics who referred to Clinic of Endocrinology and Metabolism, Golestan hospital in Ahvaz in 2013–2014. During the study, one of the patients of the control group withdraws from the study. Also because of brachial artery deformity (two branches), one of the patients was removed from FMEDD analysis.

The criteria for enrolling type 2 diabetics are age above 30, FBS<250 A1c < 8.5Hb, BMI<35 and excluding criteria are: failures of the liver, kidney, and heart, insulin, allergy to soy consumption and immune suppressor drugs, alcohol, and cigarettes. Since the two groups must be similar in terms of age, sex and BMI, therefore similar couples with regard to entry requirement were selected and were randomly located in the two groups of test and control.

2.1. Demographic study

Basic information of the patients included age, sex, weight, BMI, waist (in the umbilical) and hip circumference (the maximum size). Measuring tools were constant during the study and the data were collected by one person. Blood pressure of patients was measured in a sitting position on left arm and its average was recorded. The patients didn't have anxiety before blood pressure measurement and they didn't have alcohol, tea, coffee and exercise up to 3 h before measurement. Also, a fabric meter with 1 mm accuracy was used for metric measurement and an analog scale with 0.1 kg accuracy for weighting.

2.2. Brachial blood flow

In order to calculate brachial blood flow, the following formula was used:

FMEDD - Flow Mediated Endothelium-Dependent Dilation = D1-D0/D0*100%

D0 the initial diameter of the brachial artery was obtained using Doppler sonography, and D1 is brachial artery diameter after Reactive Hyperemia. Its implementation method was: the patient was supine for at least 10 min and based on Reactive Hyperemia Test which blood pressure cuff of 280 mmHg is placed on the forearm for 5 min. Then Reactive hyperemia has occurred and brachial diameter of 1.5–2 cm above antecubital chain in the times 50, 60 and 90s were measured by Doppler sonography and their mean value was the criterion for D1 (20). Sonography was performed by a sophisticated radiologist, an apparatus and a cuff before and after the intervention.

2.3. Biochemical study

Peripheral blood samples were collected from each of the enrolled patients in the beginning and the end of study for biochemical study after 10 h fasting and the samples were transported to the laboratory within maximum half an hour.

The considered biochemical markers included blood Glucose, lipid profile including triglyceride, high-density lipoprotein (HDL), Low-density lipoprotein (LDL), serum total cholesterol, E-Selectin level, and anti-oxidants.

Glucose, triglyceride, total cholesterol, and LDL were measured by the enzymatic method (Pars Azma kit, Iran) using by auto-analyzer BT-3000.

The capacity of total plasma antioxidants and serum levels of E-selectin were measured by ELISA method respectively using Biospes kit, and Human E-Selectin ELISA Kit, Boster Immunoleader, China.

2.4. Drug and food diets and habits

The patients were not inhibited from consuming glycemic control edible drugs and all patients were subjected to curing with type 2 diabetes edible drug. During this period, all patients were under food diet of TLC (Therapeutic Life Style Changes) and diabetes food advice. The body activity of all patients was similar. Implementing the above dietary pattern in these patients was in a way that all patients were educated TLC for 2 h by nutritionist through the interview and one-to-one training. In the end, the patient food diets were evaluated for two consecutive days and their food calorie and level of macromolecules and its abstraction were evaluated.

2.5. Soy nut diet

Soy nut was supplied to the test group in 30 g packs and they were asked to eat 60 g soy nut in two inter-meals of morning and afternoon for 8 weeks. The patients who didn't observe this diet were removed from the study.

2.6. Ethical considerations

The study was implemented after approve of Ahvaz Jundishapur University of Medical Sciences ethical committee.

2.7. Statistical analysis

Data were analyzed by using SPSS17. The data were expressed as mean value and standard deviation. In order to investigate data normal distribution, Kolmogorov – Smirnov program was used and independent t-tests were used for inter-group comparison and paired *t*-test program for intra-comparison. The significance level was intended to $P < 0.05$.

3. Results

Demographic information shows the patients were equalized as well based on intended variables in two groups ($P < 0.05$) (Table 1).

Generally, the rate of received calorie between two groups after the intervention had no significant difference ($P = 0.2$). Also between the two groups, there was no significant difference in carbohydrates, lipid and protein consumption ($P > 0.05$). But the rate of fiber consumption in the test group was significantly more than the control group because of soya consumption ($P = 0.03$) (Table 2).

Table 1
The demographic information of control and test group.

Variable	Mean ±SD		P value
	Control(34)	case(34)	
Sex			
Male	15	16	0.6
Female	19	19	
Age	50.2 ± 8.3	49.9 ± 9.2	0.3
Waist circumference	100.3 ± 6.8	101 ± 5.1	0.3
Hip circumference	103.1 ± 9	105.4 ± 7.6	0.4
BMI(kg/m^2)	28.2 ± 3.3	29 ± 3.2	0.6

Table 2
Caloric and nutrition compounds intake data in the control and case group.

Variable	Mean ±SD		P value
	Control(N = 34)	Case(N = 34)	
Daily calorie(Kcal)	1735.5 ± 93.3	1864 ± 97.86	0.2
Carbohydrate(gr)	303.7 ± 25.4	383.5 ± 28.5	0.07
Fat(gr)	40.8 ± 5.7	31.9 ± 4.7	0.06
Protein(gr)	53.3 ± 6.0	39.8 ± 5.1	0.1
Fiber(gr)	13.4 ± 1.8	27.1 ± 2.3	0.03

The patients before intervention beginning (basic time) had a uniform distribution for 11 intended parameters in both groups and there was no significant difference between them except diastolic blood pressure (p = 0.02) and so had appropriate distribution.

The results obtained through inter-group comparison after intervention show that soya consumption has a significant effect on improvement of assessed parameters except for HDL, triglycerides and blood pressure (Table 3).

4. Discussion

According to the findings of this study, eating 60 g soy nut daily for 8 weeks significantly increases serum total antioxidant capacity (p = 0.03) and brachial blood flow (p = 0.001) and significantly decreases serum total cholesterol LDL-c (P = 0.01), FPG(p = 0.03), E-selection(p = 0.001) but had no significant effect on systolic and diastolic blood pressure and serum levels of HDL-c and triglycerides.

Up to now, different mechanisms in the effectiveness of soya consumption on the control of glycemic, blood pressure and lipid conditions have been described. The change in the activity of tyrosine kinase inhibitors, the number of insulin receptors, the insulin tendency to its receptor, the intercellular phosphorylation cascade process, the alternative ways of glucose transport to the cell [11], decrease of inflammatory mediators such as IL-18, CRP, increase in NO liberalization [12], oxidative stress decrease which is involved in the pathogenesis of β cell destruction [6], decrease of the vascular cell adhesion molecule level (VCAM-1) and E-Selectin so improvement of vascular endothelial cell function, adjusting the process of atherosclerosis and inflammation, blood pressure reduction and improvement of vascular flow are among the explained possible mechanisms [13–15].

It seems that hyperglycemia and dyslipidemia increase inflammation conditions, oxidative stress in beta cells of the islets of Langerhans and thereby reducing the mass of these cells [16] and also in Endothelial cells decreases vascular blood flow [3,17–20]. Dysfunction of vascular endothelial based on the increase in oxidative stress plays an important role in the development (promoting) of micro and macro-vascular complications of diabetes [21]. Studies have shown that taking rosiglitazone [22] and metformin [23] through reduction of inflammation and oxidative stress conditions improve vascular flow.

While it seems that E-Selectin is not effective in the occurrence of diabetes [24–26], but it is believed that E-Selectin reduction can be proposed as a marker for the endothelial function improving, metabolic conditions controlling, and arteriosclerosis and inflammation slowing in the diabetic patients [14,15,23,27–29].

Soya has various effects on the level of oxidative stress and E-Selectin in the clinical trial. Consuming soy milk for 4 weeks by 16 menopausal women in the study of Barivarz et al. [30] and daily consumption of 25 g of soy nuts for eight weeks by 60 menopausal women with normal blood pressure or high blood pressure in the study of Naska and colleagues [13] didn't show any significant effect on the reduction of inflammatory conditions and oxidative stress which is consistent with our findings. But according to the study by Clerici and his colleagues using 8-week of pasta rich in soy isoflavone (30–33 g) in comparison to conventional pasta, increases antioxidant capacity, decreases LDL oxidation, raises glutathione and improves the brachial blood flow in type II diabetic patients [9].

A high-fiber diet is associated with the reducing or preventing many chronic diseases, including cardiovascular diseases, hypertension, hyperlipidemia, obesity, diabetes, some cancers and gastrointestinal diseases and strengthens the immune system [22,23,31,32]. In soy group, average daily fiber intake was more than the recommended amount (an average of 48 g against 15, 20 g) and more than the control group (14 g) at the end of the study (p = 0.00). It seems that soy fiber in addition to other compounds has also ameliorated the metabolic defects of enrolled patients in our study.

Although in the present study, soya significantly decreased in blood pressure in intra-group comparison, this change was not significant in inter-groups comparison. But in some studies, soya consumption had significant effects on decreasing in the blood pressure. Valti et al. by Studying 56 postmenopausal women with hypertension or normal blood reported that consuming 56 g of soy nuts for eight weeks reduced systolic and diastolic blood pressure with the rates of 9.9% and 6.8% in hypertensive individuals and 5.2% and 2.7% in individuals with normal blood pressure respectively

Table 3
The comparison between the parameter under study in the case and control groups before and after intervention.

Variable	Mean±SD						P value[b]
	Control(N = 34)			Case(N = 34)			
	Before	After	P value[a]	Before	After	P value[a]	
FPG(mg/dl)	161.7 ± 31.2	167.5 ± 32.3	0.3	165.5 ± 41	148.2 ± 38	0.01	0.03
SBP(mmhg)	129.8 ± 15	128.7 ± 13	0.3	132.3 ± 16.2	125.5 ± 14.2	0.01	0.4
DBP (mmhg)	81.8 ± 6.5	83.1 ± 6.8	0.07	86 ± 7.7	79 ± 14.1	0.01	0.2
T-Chol(mg/dl)	179.3 ± 25.8	180.7 ± 24.8	0.08	178 ± 30.3	159.4 ± 29	0.01	0.01
HDL-C(mg/dl)	41.1 ± 7.2	41.3 ± 6.9	0.3	41.6 ± 6.6	40.3 ± 6.3	0.1	0.4
LDC-C(mg/dl)	102.8 ± 22.9	103.9 ± 20.2	0.4	104.7 ± 22	90.8 ± 21.7	0.01	0.01
Tg(mg)	161.6 ± 22.7	1645.1v28.8	0.5	173.1 ± 23.1	163.2 ± 19.9	0.2	0.7
E-selectin	3.16 ± 0.19	3.34 ± 0.34	0.2	3.3 ± 0.24	3.16 ± 0.19	0.001	0.01
TAC(mmol/ml)	2.5 ± 0.8	2.2 ± 0.8	0.8	2.2 ± 0.7	2.5 ± 0.8	0.01	0.03
FMEDD(%)	11.3 ± 1.5	10.9 ± 1.5	0.04	10.38 ± 1.5	12.8 ± 1.94	0.001	0.001

[a] Using paired *t*-test.
[b] Using independent *t*-test.

[33]. Nazca et al. found that consuming 25 g of soya for 8 weeks in hypertensive postmenopausal women is accompanied with an average decline of 9.9% and 6.6% on systolic and diastolic blood pressure (mmHg 15) [13].

Hermansen et al. demonstrated using soya containing diet-soya 70 g daily for 6 weeks-decreases LDL by 10%, triglycerides by 22%, total cholesterol by 8% and had no effect on hemoglobin A1c and blood pressure of type 2 diabetic patients [5]. Chang and colleagues also showed daily consumption of 69 g of soya for 4 weeks by type 2 diabetic patients reduced fasting and after food triglycerides and blood glucose [7]. Lyav and colleagues found that adding 45 g of soya for 8-week to low-calorie diet (Kcal 1200) decrease LDL and total cholesterol [34]. Consistent with our result, they reported the diet didn't have any effect on triglyceride improvement. In contrast to our study, according to the report of the meta-analysis by Liu and colleagues in 2011, soy consumption can't control glycemic conditions. However more clinical studies shed light on these controversial results [10].

Soybean has several ingredients. Nevertheless, it contains large amounts of isoflavones, a group of phytoestrogens and polysaccharides and the effectiveness of each of these components on the lipid and plasma glucose needs to be studied. However, it seems that Soya with the pivotal effect of phytoestrogens on the control of glycemic conditions causes a decrease in weight, TG, LDL, and total cholesterol. This component also facilitates the absorption of glucose by cells and decreases fat tissue [35–37].

Assessment of soybean effects on the more parameters, in the different dosages consumption, and using placebo to achieve more accurate results. This could be as a suggestion for future related studies.

5. Conclusion

Our study showed that daily consumption of 60 g of soy nuts for 8 weeks on two occasions can increase significantly the brachial blood flow and serum total antioxidant levels and decrease significantly the level of E-selectin, LDL-c, and serum total cholesterol. However, no significant effects on HDL, triglycerides, systolic and diastolic blood pressure have been observed.

Ethics code

IR.AJUMS.REC.1393.332.

Conflicts of interest

The authors have declared no conflicts of interest.

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