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Effects of Cinnamon Consumption on Glycemic Status, Lipid Profile and Body Composition in Type 2 Diabetic Patients

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ABSTRACT

Objective: Type 2 diabetes is the most common metabolic disorder worldwide. Traditional herbs and spices can be used to control blood glucose concentrations. The objective of this study was to evaluate the effects of the daily intake of three grams cinnamon over eight weeks on glycemic status, lipid profiles and body composition in type 2 diabetic patients.

Methods: A double blind, randomized, placebo controlled clinical trial was conducted on 44 patients with type 2 diabetes. Participants were randomly assigned to take either a three g/day cinnamon supplement (n=22) or a placebo (n=22) for eight weeks. Weight, height, body fat mass and systolic and diastolic blood pressure were measured at baseline and after intervention. The fasting blood glucose, insulin, HbA1c, total cholesterol, LDL C, HDL C, Apo lipoprotein A I and B were measured at baseline and endpoint.

Results: From 44 subjects participated in this study 37 completed the study. There were no significant differences in baseline characteristics, dietary intake and physical activity between groups. In the treatment group, the levels of fasting blood glucose, HbA1c, triglyceride, weight, BMI and body fat mass decreased significantly compared to baseline, but not in placebo group. No significant differences were observed in glycemic status indicators, lipid profile and anthropometric indicators between the groups at the end of intervention.

Conclusion: These data suggest that cinnamon may have a moderate effect in improving glycemic status indicators.

Keywords: Cinnamon, glycemic status, lipid profile, type 2 diabetes

Original Article

INTRODUCTION

Type 2 diabetes is the most common metabolic disorder worldwide and its prevalence is growing at an alarming rate in both developed and developing countries.[1,2] It is characterized by abnormalities in carbohydrate, lipid and lipoprotein metabolism, which lead to hyperglycemia and many complications such hyperlipidemia, hyperinsulinemia, hypertension and atherosclerosis.[3,4]

Lifestyle changes, weight control, physical activity and healthy nutrition practices are vital for persons with diabetes to maintain quality of life and longevity.[4] Also as an alternative approach, medicinal herbs with antihyperglycemic activities are increasingly sought by diabetic patients and health care professionals.[5]

Cinnamon is the bark of cinnamomum zeylanicum and has been used as traditional folk herbs to treat disease thousands of years in Asia. Both *in vitro* and *in vivo* studies have shown that cinnamon is an insulin sensitizer.[6-10] In 3T3 L1 adipocyte, cinnamon extract stimulates glucose uptake, glycogen synthesis and activated glycogen synthase.[8] In rats cinnamon enhanced glucose uptake by enhancing insulin stimulated tyrosine phosphorylation of insulin receptor β, insulin receptor substrate 1, and phosphatidylinositol 3 kinase in a dose dependent fashion.[9,11]

Several clinical trials[12-16] have investigated the impact of cinnamon on glucose and plasma lipid concentrations in patients with diabetes but yielded conflicting results. Khan *et al*. presented the first data on the effects of cinnamon supplementation in humans. They reported a substantial reduction in fasting serum glucose (18-29%) and blood lipid profile after 40 d of daily supplementation with one, three, or six grams of whole cinnamon in patients with type 2 diabetes.[13] More recently, Mang *et al*. reported a 10.3% reduction in FBG after four months of supplementation with a purified aqueous cinnamon extract.[14] However, data from Vanschoonbeek *et al*. shows no effect of cinnamon spice ingestion on whole body insulin sensitivity, oral glucose tolerance or lipid profiles in postmenopausal type 2 diabetic patients.[15]

The present study investigated the proposed benefit of cinnamon use in patients with type 2 diabetes. Therefore a randomized, placebo controlled, double blind study was performed in 44 patients with type 2 diabetes. In this study, we assessed the effects of eight weeks of three grams per day cinnamon supplementation (Cinnamomum Zeylanicum) on glycemic status, lipid profiles, blood pressure and body composition in type 2 diabetic patients.

METHODS

Subjects

The study was approved by the Medical Ethical Committee of Tehran University of Medical Science (code P/26/D5/147) and was supported by grants from Vice Chancellor of Research (grant number P/608). A total of 44 individuals with type 2 diabetes were selected to participate in this study. Type 2 diabetes was verified according to the criteria set by the WHO in 1999.[17] The objectives of study and risks of experimental procedures were explained to the volunteers, after which their written informed consent was obtained. Inclusion criteria were non-insulin dependent type 2 diabetes, aged between 30-65 years, HbA1c between 6-8% and FBG levels between 126-160 mg/dl. Exclusion criteria were cholesterol >240 mg/dl, triglyceride >400 mg/dl, smoking and alcohol consumption, pregnancy and lactation, allergy to cinnamon, liver or renal or thyroid diseases and hemolytic anemia. All subjects were stable because medication had not modified over the last month and there were homogeneity regarding their treatments (Metformin: 1-1.5 gr/d, Gliclazide: 160-240 mg/d).

Study design and dietary intervention

Subjects were selected based on inclusion criteria among patients who came to the Endocrinology and Metabolism center, Tehran University of Medical Sciences and randomly assigned to cinnamon (*n*=22) or placebo group (*n*=22). Investigators and subjects were blinded to group assignment and to capsule content. Cinnamon and wheat flour were ground finely and put into capsules which could not be distinguished by color, odor, or taste. Each capsule contained 500 mg product. Subjects were instructed to ingest two capsules at each main meal (breakfast, lunch and dinner) for eight weeks.

Compliance to the supplementation protocol was supervised by a research technician who contacted the subjects once a week. Each subject was required to return the original bottle of their respective supplement for capsule counts and compliance was monitored by counting the unconsumed capsules each week. We chose this dose because it is achievable if we want to use it as a spice in future and there is no side effect for this dose in this target group based on literature.[13-16] All medication was continued as usual and subjects were advised to maintain their normal diet and continue their habitual physical activity throughout the study. To verify this, subjects completed three day food records (two weekday and one weekend day) at baseline and end of study. Food records were analyzed by Nutritionist IV (N Squared Computing, San Bruno CA). Physical activity levels were measured with International Physical Activity Questionnaire at baseline and end of study. Seven patients were excluded during the study. Two moved and five were unwilling to continue; so 37 patients completed the study (19 patients in the intervention group and 18 in the control group).

Weight, height, body composition and blood pressure were measured in the fasting state with minimal clothing and without shoes in the beginning and end of study. Subjects were weighed on balance scales (Seca, Germany). Standing height was measured using a wall mounted stadiometer and body composition was measured with *e body 205* (body composition analyzer). Blood pressure was measured by a trained nurse using a mercury sphygmomanometer.

After 10-12 h overnight fasting, blood sample was collected from each subject at the beginning and at the end of eight week trial. All blood samples were taken in the morning at approximately the same time of day to minimize diurnal variation and immediately centrifuged at ×3000 g for 10 min at 20°C. Fasting plasma glucose and HbA1c were analyzed immediately; aliquots of plasma were stored at −70°C until lipid profile and insulin analysis.

Biochemical measurements

Fasting plasma glucose was analyzed by the glucose oxidase method (Pars Azmoon kit, Iran). HbA1c was measured by high performance liquid chromatography (HPLC). Insulin was analyzed by immunoradiometric assay (IRMA) method (Immunotech Co. Kit, France). Serum concentrations of triglyceride and total cholesterol were analyzed using the glycerol-3-phosphate oxidase-phenol+aminophenazone (GPO PAP) kit as described in our previous study[18] and the cholesterol oxidase-phenol+aminophenazone (CHOD PAP) kit, respectively (Pars Azmoon kit, Iran). HDL cholesterol was analyzed by sedimentary method. LDL cholesterol was calculated by the Friedewald formula. Apo lipoproteins AI and B were analyzed by immunoturbidometry method by using auto analyzer Cobas (Pars Azmoon kit, Iran).

Statistics

Data are presented as mean±SD or percentage. Statistical analyses were performed using Statistical Package for the Social Sciences (SPSS) software (version 14; SPSS Inc, Chicago, USA). The normal distribution of the variable was checked by Kolmogorov–Smirnov test. Qualitative variables, such as physical activity, were analyzed using Chi square test. For comparison variables before and after the intervention within each group, paired *t* test was used. Significant differences between groups were determined by using an independent *t* test. Adjustment for differences in baseline covariates and changes in variables during study were performed by Analysis of Covariance (ANCOVA). Statistical significance was set at $P<0.05$.

RESULTS

Baseline characteristics did not differ between the two groups of the study population [Table 1]. Energy intake, macronutrient and micronutrient composition of the diet did not differ between groups at baseline and did not change in the placebo or cinnamon group during the intervention period. Physical activity levels did not differ between groups at baseline and did not change during the study. Table 2 shows the fasting plasma glucose concentrations, HbA1c, serum lipids, anthropometric variables and the corresponding differences of these variables for the cinnamon and placebo groups. While the FBG, HbA1c and triglyceride levels in the cinnamon group was significantly reduced after the intervention compared with baseline ($P=0.005$, $P=0.008$, $P=0.038$ respectively), no such effect were observed in the placebo group. No significant intragroup differences were observed in insulin or lipid profile (total cholesterol, HDL cholesterol, LDL cholesterol, Apo lipoproteins AI and B). Body weight and BMI in both groups were significantly reduced after the intervention compared with baseline ($P=0.017$, $P=0.010$ respectively). Fat body mass was significantly reduced in cinnamon group, (*P*=0.047) but not in placebo group. No significant intergroup differences were observed in glycemic parameters, lipid profile, anthropometric variables and blood pressure. No adverse effects were observed.

DISCUSSION

Our findings indicate that consuming three gram per day of cinnamon for eight weeks leads to significant reduction in some biochemical and anthropometric variables compared with baseline (i.e., FBG decreased by 9.2%, HbA1c decreased by 6.12%, triglyceride decreased by 15.38%, body weight decreased by 1.19%, BMI decreased by 1.54% and fat body mass decreased by 1.36%). But these reductions were not significant compare to placebo group. Khan *et al*. studied the effects of one, three, and six grams per day of whole cinnamon powder on FBG and serum lipids in 60 people with poorly controlled type 2 diabetes from Pakistan.[13] After 40 days of supplementation, FBG decreased by 18-29%, cholesterol decreased by 12-26%, LDL cholesterol decreased by 7-27%, and triacylglycerol decreased by 23-30%.[13] Consequently the authors concluded that small amount of cinnamon represent a safe and effective mean to reduce the risk factors associated with type 2 diabetes. In the cinnamon group, we observed a significant reduction of plasma glucose (9.2%) after eight weeks of treatment but not in the placebo group. The observed reduction in FBG in our study is less than that of Khan *et al*. and similar in magnitude to Mang *et al*. who supplemented 79 diabetic patients with three grams per day cinnamon powder or a placebo for four months.[14] Although no changes in blood lipids or HBA1c were noted in their study, researchers did find a 10.3% reduction in FBG. Also the decrease in plasma

Table 1: Baseline characteristics of the study population*

Variable	Cinnamon group (*n*=19)	Placebo group (*n*=18)
Age, years	54.11 ± 10.37	55.67 ± 7.98
Gender		
Men (%)	16.2 (*n*=6)	18.9 (*n*=7)
Women (%)	35.1 (*n*=13)	29.7 (*n*=11)
Body weight, kg	74.94 ± 13.34	73.02 ± 10.38
BMI, kg/m^2	29.23 ± 3.98	28.59 ± 3.54
Time since diagnosis, years	5.58 ± 4.51	7.39 ± 5.41

*Values are means±SD or percentage. The groups did not differ for any variables, *P*>0.05

Table 2: Biochemical and anthropometric variables at baseline and after the intervention period

	Cinnamon group (*n*=19)			Placebo group (*n*=18)		
	Before	After	Differences	Before	After	Differences
Fasting blood glucose, mg/dl	139.28 ± 9.11	126.47 ± 17.73*	−12.87 ± 17.63	136.28 ± 9.11	131.72 ± 11.78	−4.55 ± 9.38
Insulin,	9.8 ± 5.44	9.19 ± 4.85	−0.61 ± 2.64	9.73 ± 7.83	9.02 ± 6.71	−0.7 ± 1.95
HbA1c, %	7.35 ± 0.51	6.9 ± 0.77*	−0.44 ± 0.65	7.28 ± 0.56	7.18 ± 0.74	−0.1 ± 0.72
Triglyceride, mg/dl	163.32 ± 52.66	138.21 ± 43.55*	−25.1 ± 48.82	135.67 ± 40.52	146.28 ± 39.34	10.61 ± 35.51
Total cholesterol, mg/dl	169.37 ± 32.69	160 ± 34.69	−9.36 ± 44	155.44 ± 35.3	147.94 ± 31.21	−7.5 ± 25.24
LDL cholesterol, mg/dl	94.37 ± 29.9	95.21 ± 31.84	0.84 ± 37.22	92.39 ± 32.45	85.06 ± 25.83	−7.33 ± 26.66
HDL cholesterol, mg/dl	43.32 ± 4.08	43.44 ± 4.73	0.1 ± 3.71	41.06 ± 5.38	42.72 ± 3.1	1.66 ± 4.11
Apo-lipoproteins AI, mg/dl	123.21 ± 20.16	128.32 ± 21.78	5.1 ± 11.85	124.33 ± 25.63	122.83 ± 23.79	−1.5 ± 13.1
Apo-lipoproteins B, mg/dl	89 ± 17.66	95.21 ± 1742	6.21 ± 19.53	79.72 ± 20.77	84.28 ± 16.6	4.55 ± 11.2
Body weight, kg	74.94 ± 13.34	74.05 ± 12.8*	−0.89 ± 1.48	73.02 ± 10.38	72.58 ± 10.14*	−0.44 ± 0.63
BMI, kg/m^2	29.23 ± 3.98	28.87 ± 3.63*	−0.36 ± 0.54	28.59 ± 3.54	28.41 ± 3.44*	−0.17 ± 0.25
Fat body mass, %	33.19 ± 5.34	32.74 ± 4.82*	−0.44 ± 0.91	31.73 ± 4.75	31.51 ± 4.83	0.22 ± 0.7
Diastolic blood pressure, mmHg	80 ± 6.87	79.21 ± 3.01	−.078 ± 5.33	80.56 ± 6.39	80 ± 3.34	0.55 ± 4.16
Systolic blood pressure, mmHg	123.42 ± 11.9	121.05 ± 5.67	−2.36 ± 8.39	125.56 ± 11.49	123.06 ± 5.46	−2.5 ± 7.52

*Significantly different from baseline (*P*<0.05) glucose correlated significantly with the baseline concentrations indicated that subjects with a higher initial plasma glucose level may show more reduction after cinnamon intake.[14] However data from Vanschoonbeek *et al*. showed no effect of cinnamon spice ingestion on whole body insulin sensitivity, oral glucose tolerance or lipid profiles in a postmenopausal type 2 diabetes mellitus (T2DM) group.[16]

The positive correlation between baseline plasma glucose and the decrease of plasma glucose in Mang *et al*. study and the strong decrease of serum glucose in the poorly controlled Pakistani diabetics (mean fasting glucose (140-400 mg/dl) concentrations),[13] suggest that subjects with poor glycemic control may benefit more from cinnamon intake.[14] No significant intergroup and intragroup differences were observed in lipid profile except in triglyceride that decreased significantly in cinnamon group compared with the baseline. Insulin resistance leads to the overproduction of very low density lipoproteins (VLDLs) and to reduce lipoprotein lipase activity, thereby resulting in dyslipidemia. Therefore, attainment of better glycemic control may improve the lipid profile.[14] Obviously, the decrease of plasma glucose concentrations in our study was not sufficient to induce an improvement in the lipoprotein concentrations. Also our subjects' lipid levels were not abnormal, while Pakistani subjects in Khan *et al*. study have abnormal lipid levels.[13]

No significant intergroup differences were observed in anthropometric variables. There were no changes regarding the systolic/diastolic blood pressure after the intervention compared with baseline in our study. Ziegenfuss *et al*. reported statistically significant decrease in systolic BP (from 133 to 129 mm Hg) and increases in lean mass (+1.1%) compared with the placebo group.[16] Additionally, within-group analyses uncovered small, but statistically significant decreases in body fat (–0.7%) in the cinnamon group. It is possible that the improvements in FBG, as well as plasma antioxidant status are responsible, at least in part, for cinnamon's beneficial effects on body composition and features of the metabolic syndrome like blood pressure.[16] Couturier *et al*. suggested that in animals fed a high fat/high fructose diet to induce insulin resistance, cinnamon alters body composition in association with improved insulin sensitivity.[19] The decreases of plasma glucose and insulin concentrations and weight in our study were not sufficient to induce an improvement of the blood pressure.

Regarding the limitations of our study, we can point to the duration of study (eight weeks) and dose of the cinnamon (three grams per day). There are some studies with longer duration[14] and it would be better if we could have possibility for continuing the intervention which it was impossible because subjects had time limitations to come to the study center (Endocrinology and Metabolism center, Tehran University of Medical Sciences) and compliance was limited if we extend the time. There are some studies that use more than three grams per day cinnamon and detect significant effects[13] and it would be better if we could have another group with higher dose of cinnamon for comparing doses that was impossible because of financial limitations.

CONCLUSION

In conclusion, our study shows that in type 2 diabetic patients, the intake of three grams per day cinnamon may lead to a moderate effect on glycemic status indicators, but does not improve blood pressure, blood lipid profile or body composition parameters.

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