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Journal of Nutrition & Food Sciences

Research Article

The Effect of Green Coffee Supplement on Glycemic Control, Inflammatory Index, Lipid Profile, and Anthropometry in Type II Diabetic Patients

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ABSTRACT

This study was conducted to determine the effects of green coffee supplementation on glycemic control, oxidative stress, lipid profile and anthropometry measurements in patients with type 2 diabetes. The present study is a randomized clinical trial. 60 diabetic patients were randomly divided into intervention and control groups. Patients received green coffee extract daily for 8 weeks 800 mg supplement capsule (two 400 mg capsules per day). The control group received two placebo capsules daily. The variables evaluated included demographic and anthropometry information, physical activity according to the IPAQ questionnaire, 24-hour food recall (beginning, half and end of the study) and lipid profile, fasting blood sugar, serum insulin, HOMA-IR and TAC before and at the end of the eighth week, it was evaluated in all patients. The mean body weight, Body Mass Index (BMI), and waist circumference at the beginning and end of the study did not differ significantly between the two groups (P-values<0.05). The mean fasting blood sugar in the coffee group at the end of the study was significantly reduced compared with the placebo group (P-value=0.0001). The mean serum insulin in the coffee group at the end of the study was significantly reduced compared with the placebo group (P-value=0.003). Moreover, the mean HOMA-IR at the end of the study in the coffee group was significantly reduced compared with the placebo group (P-value=0.003). LDL and total cholesterol in the coffee group at the end of the study were significantly reduced compared with the placebo group (P-values=0.003). The mean triglyceride at the end of the study was not significantly different in the coffee group (P-values=0.15).

The mean TAC at the end of the study in the coffee group was significantly higher than the placebo group (P-value=0.0001). To sum up, the use of green coffee supplement which reduced the fasting blood sugar and insulin sensitivity and improved the blood lipid profile and TAC in type 2 diabetic patients. But it had no effect on weight, waist circumference, Body Mass Index (BMI) and triglyceride levels. Green coffee supplement can be considered as an adjunct in the control of diabetes in patients.

Keywords: Green coffee bean extract; Chlorogenic acid; Weight; Fasting blood glucose; Lipid profile: Insulin resistance

INTRODUCTION

Diabetes is a chronic heterogeneous disease characterized by chronic hyperglycemia and impaired metabolism of carbohydrates, lipids, and proteins due to lack of secretion or insulin function. Diabetes is not just a disease, but a series of metabolic diseases caused by a disorder in the secretion of insulin insulin. Today, diabetes is one of the most important health problems in the world. According to the World Health Organization, the number of people with diabetes has quadrupled since 1980. The global prevalence of the disease is

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Received: January 18, 2021; **Accepted**: February 01, 2021; **Published**: February 08, 2021

Citation: Moein N, Jahromi ZM, Mazloom Z, Zamani A (2021). The Effect of Green Coffee Supplement on Glycemic Control, Inflammatory Index, Lipid Profile, and Anthropometry in Type II Diabetic Patients. J Nutr Food Sci. 11:800.

reported to be 285 million in 2010 and 371 million in 2012. It is also predicted to increase to about 552 million by 2030 [1].

Coffee is one of the most widely consumed beverages around the world [2]. It is rich in phenolic compounds which are acknowledged as protective agents against chronic degenerative diseases. There is mounting evidence from epidemiological studies that coffee consumption correlates with a lower risk of developing T2DM. Chlorogenic Acids (CGA) are the major phenolic compounds in coffee. In fact, CGAs which are esters of certain cinnamic acids (caffeic, ferulic or coumaric acid) with quinic acid naturally occur in many plant foods [3], but coffee beans are their primary dietary source. As a substantial amount of CGA are lost during the roasting process, Green Coffee (GC) beans are a richer source of CGA [4]. It has been extensively demonstrated in animal studies that CGA possesses anti-diabetes, anti-obesity and anti-lipidaemic properties [5,6] and also could exert ameliorating effects on insulin resistance. In addition, CGA has been reported to be capable of reducing blood pressure and postprandial glucose absorption in human studies. GC has been proposed to have the potentiality to prevent the Mets and T2DM. Despite some null findings, some studies have demonstrated alleviating effects of GC on some of the Mets components such as blood pressure, blood glucose, lipid profile and also main Mets etiological factors including insulin resistance and obesity [7].

The effects of High-Fat Diet (HFD) ingestion with 50, 100 or 200 mg/kg green coffee bean extract (Green coffee supplement) for 6 weeks on HFD-induced obese mice. In this study, a significant reduction in body weight gain, fat mass, glucose, TAG, LDL and Total Cholesterol (TC) concentration and significant elevation in HDL-cholesterol was seen mainly with 100 or 200 mg/kg Green coffee supplement Plus HFD compared with HFD alone [8]. A cross-over study compared the consumption of 40 g/d of green or black coffee in eighteen healthy subjects for 2 weeks. A significant decrease was seen regarding systolic blood pressure (SBP), body weight and BMI with GC compared with black coffee. Also, diastolic blood pressure (DPB), waist circumference and abdominal fat reduced after both interventions. A non-blinded and non-randomized clinical trial on fifteen healthy patients taking 600 mg (three capsules of 200 mg) of decaffeinated Green coffee supplement (DGREEN COFFEE SUPPLEMENT) for 40 days indicated decreased postprandial glycaemia and 3 pounds weight loss. One contradictory animal study which was conducted on mouse model of the Mets exhibited no improvement in the body weight, glucose tolerance and insulin resistance after a 12 week ingestion of 0·5% (w/w) Green coffee supplement plus HFD compared with a HFD-fed group.

Data concerning Green coffee supplement impacts on diabetes components are rather inconsistent. The results of the studies show the positive effects of green coffee consumption in different people, while the studies conducted in this regard are limited in diabetic patients. Also, due to the importance of diabetes and its control in all societies, more studies are necessary to be conducted in this regard.. Therefore, the present study was performed as a randomized clinical trial with the aim of investigating the effect of green coffee supplementation on glycemic control, oxidative stress, lipid profile and antonometric measurements in patients with type 2 diabetes.

METHODS

This study was a randomized, placebo-controlled trial. Men and women aged 40-69 years who were diagnosed with the diabetes were chosen from those referring to Kroni and Mehregan clinics in Shiraz. Definitive diagnosis of type 2 diabetes in patients was made by an associate clinical physician under ADA criteria. The exclusion criteria were insulin administration for controlling blood glucose, having hypo- or hyper-thyroidism, renal failure, routine coffee consumption, pregnancy or breast-feeding, taking corticosteroids, hormone replacement therapy as taking estrogen or progesterone, taking weight loss supplements or following unusual weight loss plans, cancer, experiencing cerebrovascular problems and other cognitive or chronic diseases that impaired their compliance. Also, the patients who altered the type or dose of the medications they used for controlling blood glucose, blood pressure or lipid profile were excluded. Moreover, if a patient had not consumed over 10% of the supplements, he or she was excluded from the study. This was assessed by counting the number of capsules remained in the bottle of supplements at the follow-up visits at the 4th and 8th weeks of the study.

Study design

The procedure of the study was described for eligible clients of the diabetes clinic and a written informed consent was signed by the volunteers. A questionnaire regarding smoking status, present illnesses, drug history, prescribed medications, menopause status and duration of diabetes was filled out by interviewing the volunteer patients. Subjects and investigators were blinded until the end of the study as the bottles of supplements were coded with A or B by the manufacturer before the study. Participants were stratified by sex and randomly allocated to the intervention or placebo groups by stratified blocked randomization method. Blocked randomization was done with block sizes of four concealed in a container by one of the researchers. The blocks were composed of A and B characters representing bottles of capsules coded with A or B to ensure concealment. The other investigator randomly allocated the participants to one of the two groups. The patients were supposed to consume 400 mg of Green coffee supplement or placebo twice per day (800 mg/d) with their main meals for 64 d. A bottle of supplements containing sixty-four capsules, adequate for 32 day, was given to both groups at the time of randomization and the other bottle was given at the time of the 4th-week follow up visit. All the subjects were instructed not to modify their physical activity and coffee intake. Participants were given a 24-hour food questionnaire (One on the last day of the week and two working days) at the beginning, middle, and end of the study to ensure that the participants' dietary intake did not change during the study. This study was approved by the ethics committee of National Nutrition and Food Technology Research Institute of Shiraz University of Medical Sciences and registered at Clinical Trials.

Follow-up

Subjects were followed by making phone calls every 15 day to ensure that they complied with the supplementation protocol. Moreover, a follow-up visit was arranged for each individual in the middle of the study at the 4th week.

Dietary assessment

Dietary intake was assessed at baseline, at the 4th-week and at the end of the study using a 3- d food record. The participants were instructed about how to record their food and beverage intake for 3 days at each time. In order to distinguish the accurate portion sizes, the patients were interviewed to report their intake based on household measures. Subsequently, the portion sizes were converted to grams and analyzed for energy and nutrients content using Nutritionist 4 software, that was modified using the national composition food tables. Physical activity was assessed using International Physical Activity Questionnaire in the beginning and at the end of the trial.

Measurement of anthropometric parameters and weight

Waist circumference of the subjects were measured and BMI was calculated at the baseline and at the end of the intervention. Height was measured barefoot to the nearest 0·5 cm using a tape measure attached to the wall at baseline. Also, weight was measured with a precision of 100 g, wearing light clothes, using Seca digital scale. In addition, waist circumference was measured to the nearest 0·5 cm approximately between the lower margin of the last rib and top of the iliac crest at the level of the navel with a tape measure. BMI was calculated by dividing weight (kg) by squared height (m^2).

Measurement of biochemical parameters

Following a 12 hour fasting period, 5 ml of venous blood sample was drawn from the subjects before and after the intervention. The blood serum was obtained by centrifugation at a rate of 2000 round per min and aliquoted into microtubes. Afterwards, the serums were frozen at −80°C until the time of conducting the experiments [9].

Statistical analyses

Statistical analyses were performed using the 21th version of SPSS Software. The Kolmogorov–Smirnov test was used to determine the normality of data distribution. Qualitative variables were compared between the groups by the $\chi 2$ test. For quantitative variables, the means of the two groups were compared by independent t test and changes within each group were analyzed by the paired sample t test. Also, repeated-measures ANOVA was applied to compare within subjects' dietary intake values of pretrial, middle of the trial and post-trial in each group. All the tests were two-tailed, and P value of <0·05 was considered as the significance level. The quantitative variables are all expressed as means and standard deviations. The minimum sample size estimated for each group was 20 at a power (1− β) of 80% and significance level of 0·05 for a two arm parallel study with two-tailed testing to detect a difference of 47 mg/dl (2·60 mmol/l) in the mean values of FBS with a pooled standard deviation of 53 mg/dl (2·94 mmol/l), obtained from the study of Ebrahimi et al. The hypothesized Cohen's d effect size calculated by dividing difference of means by pooled standard deviation was 0·8 according to the mentioned study.

RESULTS

Sixty patients with type 2 diabetes participated in the study. During the study, two participants were reluctant to continue the study, and were replaced with stwo patient, and at the end all 60 participants completed the study. The age range of the participants in the study was 37 to 63 years with a mean of 47.3 years. As can be seen, there was no statistically significant difference between the two groups regarding the variables compared (Table 1). Moreover, physical activity (MET-h/d) of the participants in the two groups did not have a significant difference at baseline and after the study. (Table 2) Energy and nutrients intake were not significantly different between the two groups (Table 3).

Changes of FBS were different between the groups as GREEN COFFEE SUPPLEMENT treatment had significantly attenuated FBS compared with the placebo (0/0001=P-value). Furthermore, within the GREEN COFFEE SUPPLEMENT group, fasting insulin levels had significantly diminished by (0.0001=P-value). In addition, a significant difference existed between the two groups concerning HOMA-IR index changes (0.0001=P-value).

Table 1: Comparison of fasting blood sugar and blood insulin.

Comparision of fasting blood sugar and blood insulin and HOMA-IR factor in the two groups of coffee and placebo				
Coffee groups			**Placebo groups**	**P**
FBS	before	1/8 ± 46/8	31/19 ± 159	0/175
	after	2/86 ±114/4	32/42 ± 165	0/1
Insulin (µIU/ml)	before	1/8 ± 46/9	2/52 ± 14/6	0/003
	after	1/7 ± 52/4	2/38 ± 13/1	0/001

No significant discrepancy was observed in terms of lipid profile parameters consisting of serum TC, LDL-cholesterol and HDL cholesterol concentrations between and within the groups after conducting the trial. However, at the end of the study in the coffee group, triglyceride levels were significantly lower than in the placebo group (P=0.0001).

Anthropometry measurements at the beginning and end of the study, including body height, Body Mass Index (BMI) and waist circumference were measured in the two groups under the study.

Table 2: Performed with t-test and Chi-square tests.

Comparision of triglycerides, LDL, HDL and total cholesterol in the two groups: coffee and placebo				
Coffee groups			**Placebo groups**	**P**
TG	before	147/5 ± 4/8	154/6 ± 5/8	0/573
	after	135/6 ± 5/1	152/1 ± 4/9	0/0001
HDL	before	46/9 ± 8/1	45/8 ± 8/2	0/465
	after	52/4 ± 7/1	46/3 ± 10/7	0/102
Total cholestrol	before	165/5 ± 31/5	170/5 ± 2/5	0/428
	after	145/1 ± 2/0	177/9 ± 2/6	0/0001

The results have been reported as standard deviation, mean or (percentage) frequency Comparisons between the groups were Comparison of triglycerides, LDL, HDL.

As can be seen, there was no significant difference between the two groups before the study. After the study, the differences between the two groups were not statistically significant in terms of weight variables, waist size and BMI (P-values<0.05). Also, the rate of the change of variables at the end of the study was the same between the two groups compared to the beginning of the study and no significant difference was observed (P-values<0.05). At the beginning of the study, the TAC study in the placebo group was significantly higher than the coffee group (P=0.0001). But at the end of the study in the coffee group, it was more than the placebo group.

DISCUSSION

The present clinical trial was carried out to examine the effects of 800 mg/d of Green coffee supplement for 8 weeks in patients with diabetes. A significant reduction was observed regarding FBS, HOMA-IR, TG after green coffee supplement administration compared with the placebo. Also, post-trial insulin values were lower in the green coffee supplement group. GREEN COFFEE SUPPLEMENT had no significant impact on cholesterol, weight loss and BMI reduction. The GREEN COFFEE SUPPLEMENT dose used in our trial provided 200mg of CGA/d. This amount of CGA can be achievable in the diet through coffee consumption. It has been estimated that coffee drinkers may have daily intake of 0·5–1·0 g CGA/d. Each 1 g of dry Arabica or Robusta GC bean has been reported to provide 68·8 and 88 mg of CGA, respectively [6].

Moreover, GREEN COFFEE SUPPLEMENT in our study was capable of mildly reducing FBS and suppressing its increase compared with placebo. This is consistent with other studies. For instance, examined DGREEN COFFEE SUPPLEMENT impact on the mice fed with a HFD diet with 0·1, 0·3 or 0·9% GREEN COFFEE SUPPLEMENT. The group with 0·3% GREEN COFFEE SUPPLEMENT(300 mg/kg diet equivalent to 1460 mg/60 kg for humans) plus the HFD diet indicated a significant decline in FBS compared with the HFD group after 11 weeks. Another study on diabetic rats compared the GC effects with light and dark roasted coffee. It was observed that GC had the best effect on attenuating glucose level [5]. Also, a recent animal study displayed a significant decrease in FBS with 100 mg/kg green coffee supplement plus HFD diet in comparison to the HFD group after 6 week. The mechanism which corresponds to lowering FBS by CGA is activation of AMP-activated protein kinase (AMPK). Activation of AMPK contributes to increasing GLUT4 translocation to plasma membrane which augments glucose transport to the cells and leads to peripheral glucose disposal. Also, CGA in green coffee supplement can inhibit glucose-6-phosphatase (Glc-6-pase) by 36%, leading to limited glucose production by gluconeogenesis and glycogenolysis [10] Our results also revealed that Green coffee supplement significantly lowered HOMA-IR index and consequently abated insulin resistance. This has been corroborated by some previous studies. In one study, 80 mg/kg of green coffee supplement for 14 weeks resulted in improvement of HFD-induced insulin resistance in the mice [7]. Also, 0·3% green coffee supplement plus HFD for 11 weeks led to attenuation of HOMA-IR values in mice compared with a control group. Nevertheless, one study conducted on the Mets model of mice did not detect any improvement in insulin resistance in the mice fed with a HFD diet with 0·5% (w/w) green coffee supplement for 12 weeks. It has been proposed that green coffee supplement exerts its ameliorating effect on insulin resistance by decreasing phosphorylation of c-Jun N-terminal kinase which leads to activation of insulin receptor substrate-1, resulting in GLUT4 translocation to adipocyte membrane and increasing insulin sensitivity.

In the present study except triglyceride supplement of green coffee supplementation significantly reduced LDL, total cholesterol, and significantly increased HDL. The study compared the effect of eight weeks of aerobic exercise with green coffee on the expression of the ABCG8 gene, leptin and HDL in overweight women. ABCG8 has a positive effect on these two variables by interfering with the reverse cholesterol transfer process and preventing atherosclerosis. In anotherstudy, effects of green coffee extract supplementation on anthropometric indices, glycaemic control, blood pressure, lipid profile, insulin resistance and appetite in patients with the metabolic syndrome: A randomized clinical trial, green coffee supplement administration had an ameliorating effect on some of the Mets components such as high SBP, high FBS and Mets main etiological factors including insulin resistance and abdominal obesity. Furthermore, green coffee supplement could reduce the appetite. No significant discrepancy was observed in terms of lipid profile parameters consisting of serum TAG, TC, LDL-cholesterol and HDL-cholesterol concentrations between and within the groups after conducting the trial [11]. One of the possible mechanisms in the hypocholesterolemic effects of green coffee is the stimulation of the liver enzyme alpha-7 hydroxylase,

which leads to an increase in the conversion of cholesterol to bile acids.

It may also be due to the effective ingredient chlorogenic acid in green coffee, which prevents the absorption of cholesterol, disrupts the hepatic-intestinal cycle of cholesterol, and ultimately increases its excretion. Another mechanism has been suggested that green coffee regulates the enzyme that regulates cholesterol metabolism, hydroxyglutaryl CoA reductase, and inhibits this enzyme, as do cholesterol-lowering drugs such as levastatin. Limitations of our study were first the short time of the trial. Second, we did not have access to professional scales. According to the findings, green coffee supplementation has an increasing effect on the TAC factor. Several studies have also shown that the antioxidant properties of coffee are inversely related to how long it takes to heat coffee, meaning that unheated green coffee has the most antioxidant properties, and the visible heat of coffee destroys coffee polyphenols due to the Millard reaction. However, to confirm the accuracy of these results, further studies are needed to compare the results with the current study. The body composition was analyzed to assess alterations in body fat percentage. Third, due to budget deficit, measuring other factors such as appetite-related hormones was not possible. Further studies with longer durations and larger sample sizes are required to establish the potential GREEN COFFEE SUPPLEMENT effects in patients with diabetes.

CONCLUSION

In conclusion, the GREEN COFFEE SUPPLEMENT in this trial could attenuate reduction of fasting blood sugar, insulin sensitivity and improved the blood lipid profile, and TAC in type 2 diabetic patients can be considered as an adjunct in the control of diabetes in patients.

ACKNOWLEDGEMENT

The authors express their gratitude to the subjects for their participation in this research and the Salamat Gostar Kasra for generously providing the supplements. This study was financially supported by a grant from the National Nutrition and Food Technology Research Institute of shiraz University of science.

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