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Original Article

Effects of Sour Tea (*Hibiscus sabdariffa*) on Lipid Profile and Lipoproteins in Patients with Type II Diabetes

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Abstract

Objectives: There is increasing evidence that intake of sour tea (*Hibiscus sabdariffa*) has hypoglycemic and hypolipidemic effects and may benefit patients suffering from metabolic disorders such as diabetes. The objective of the present study was to investigate the hypolipidemic effects of sour tea in patients with diabetes and compare them with those of black tea.

Design: In this sequential randomized controlled clinical trial, 60 patients with diabetes were recruited and randomly assigned into two groups: sour tea (ST) and black tea (BT). They were instructed to consume sour tea or black tea two times a day for 1 month.

Outcome measures: Fasting blood samples were taken at the beginning and at the end of the study for evaluation of lipids, lipoproteins, and apoproteins.

Results: Fifty-three (53) patients concluded the study. In the ST group, mean of high-density lipoprotein-cholesterol (HDLc) increased significantly ($p = 0.002$) at the end of the study, whereas changes in apolipoprotein-A1, and lipoprotein (a) were not significant. Also, a significant decrease in the mean of total cholesterol, low density lipoprotein-cholesterol, triglycerides, and Apo-B100 were seen in this group. In the BT group, only HDLc showed significant change ($p = 0.002$) at the end of the study and changes in the other measures were not statistically significant.

Conclusions: The results of the present study showed that ST has a significant effect on blood lipid profile in patients with diabetes.

Introduction

Diabetes mellitus is a chronic metabolic disease caused by inherited or acquired deficiency in insulin secretion and/or by decreased responsiveness of the organs to secreted insulin. Such a deficiency results in increased blood glucose level, which in turn can damage many of the body's systems, including blood vessels and nerves.[1] Global prevalence of diabetes in 2000 has been reported as 2.8%, and it is estimated to be 4.4% in 2025 (i.e., there will be 366 million patients with diabetes in 2025 in the world).[2] In Iran, the prevalence of diabetes was reported as 5.5% and 5.7% in 1995 and 2000 respectively, and it will increase to 6.8% in 2025.[3]

One therapeutic approach for controlling diabetes is to decrease the postprandial hyperglycemia. This is usually done by retarding the absorption of glucose through inhibition of the carbohydrate hydrolyzing enzymes such as α-glucosidase and α-amylase in the digestive tract.[4–8] Many natural resources have been investigated for suppression of glucose production from carbohydrates in the gut or glucose absorption from intestine, and many studies have recently been isolated those carbohydrate blockers from herbal products.

Sour tea (*Hibiscus sabdariffa*) is a genus of the Malvaceae family. It has been called by different local names in various countries. In English-speaking countries it is named roselle or red sorrel and in Arabic it is called karkade. In Iran, it is mainly known as sour tea. The phytochemical, pharmacologic, and toxicologic properties of *H. sabdariffa* have been investigated in many studies. The calyces of *H. sabdariffa* are used in many parts of the world to make cold and hot drinks. Sour tea contains many chemical constituents including alkaloids, L-ascorbic acid, anisaldehyde, anthocyanin, ß-carotene, ß-sitosterol, citric acid, cyanidin-3 rutinoside, delphinidin, galactose, gossypetin, hibiscetin, mucopolysaccharide, pectin, protocatechuic acid, polysaccharide, quercetin, stearic acid, and wax. In folk medicine, the calyx extracts are used for the treatment of several complaints, including high blood

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pressure, liver diseases, and fever. In view of its reported nutritional and pharmacologic properties and relative safety, *H. sabdariffa* and compounds isolated from it could be a source of therapeutically useful products.[9–11] Different studies, especially in animals, have shown that extracts of sour tea inhibit development of atherosclerosis.[12] Lin et al. reported that sour tea infusions reduce cholesterol by 8.3–14.4% after 4 weeks.[13] Chen et al. showed that sour tea extracts reduce triglycerides (TG), cholesterol, low-density lipoprotein-cholesterol (LDLc), and LDLc/high-density lipoprotein-cholesterol (HDLc) in hyperlipidemic rats.[14]

On the basis of the general perception in many nations that favors drinking tea and also knowing that herbal drugs do not have adverse effects as chemical drugs do, this study was designed to assess effects of consuming sour tea infusions on lipids and lipoproteins in patients with diabetes.

Materials and Methods

Subjects and study design

This sequential randomized controlled trial was conducted on 60 patients with diabetes in Yazd Diabetes Research Centre in 2006 and 2007. Inclusion criteria were having type II diabetes mellitus for more than 5 years and not taking antihyperlipidemic drugs. Exclusion criteria were having allergy to tea, and suffering from other diseases that required taking medicine for or any change in routine medication for diabetes.

After obtaining informed consent from all patients, they were randomly assigned into one of these two groups: sour tea (ST) group and black tea (BT) group. Assigning into the two groups was done by using a sequential list prepared based on a randomized numbers table. The patients in the ST group were given sour tea sachets and the patients in the BT group were given similar sachets, in shape and weight, containing black tea. Instructions for preparing and consuming black or sour tea were given. The patients were instructed to use one glass of the decoction (two spoonfuls of blended tea in one glass of boiled water boiled for 20–30 minutes) 2 times a day and not to drink other types of tea during the study. On the first day of the study, an overnight fasting blood sample was taken for assessing the lipid profile, lipoproteins, and apoproteins. These lab tests were repeated at the end of the study.

Study Duration and Tea Preparation Directions

According to various studies, consuming tea was continued for 1 month, 2 times a day (one glass in the morning and another one in the afternoon), between the main meals. The patients were asked to pour the content of one tea sachet, weighing 2 g, in a tea pot, add 240 mL of boiling water, and drink it after a steeping time of 20–30 minutes with one cube of sugar (5 g). They were prohibited from drinking any other type or amount of tea during the study and their medications and diet were kept unchanged. The sour tea, which was imported from Saudi Arabia, was obtained from a local market. The black tea was imported from Sri Lanka. Both types of tea were purchased as bulks of loose tea and packaged in 2-g sachets. Patients' compliance was measured by counting the empty sachets retrieved from them on the 15th and 30th day of the study.

Measures and Biochemical Analyses

Overnight fasting blood samples were obtained before and after intervention. Serum was separated from the clot after complete coagulation (1 hour in room temperature) by low-speed centrifugation (15 minutes at 2000 g), and the concentrations of lipids, lipoproteins, and apolipoproteins were evaluated. Total cholesterol (TC) and TG concentrations were determined by enzymatic methods, cholesterol oxidase and glycerol oxidase, respectively. HDLc concentration was determined with dextran-sulfate-magnesium chloride precipitation of betalipoproteins, followed by the same enzymatic method for TC. LDLc was calculated using the Friedewald formula when the TG levels were less than 400 mg/dL.[15] Apolipoprotein-A1 (Apo-A1) and apolipoprotein-B100 (Apo-B100) were determined by the immunoturbidimetry method.[16] Lipoprotein (a) [Lp(a)] was determined by the method of electroimmunoassay.[17] Specific anti-Lp(a), anti-apo-B100, anti-apo-A1 antibodies, primary standards, and controls were from DAKO (DK-2600 Glostrup, Denmark).

Data Analysis

All values are reported as mean $\pm$ standard deviation. Differences between the ST and BT groups were assessed by Student's *t*-test and paired *t*-test. The *p*-values ≤ 0.05 were considered significant. All *p*-values were two-tailed. All the tests were performed by the SPSS package Version 11 (SPSS Inc., Chicago, IL).

Ethical Considerations

An informed consent was obtained from each patient. They could quit the study freely, whenever they liked. All the patients were continuing their medical treatment and no interruptions were made. The sour tea, as described in this study, did not have any adverse affect on the patients; hence, it was thought to be useful for them. The Research Ethics Committee of the Shahid Sadoughi University of Medical Sciences approved the research proposal of the study.

Results

Sixty (60) patients were recruited in two groups at the beginning of the study. Three (3) patients from the ST group and 4 patients from the BT group withdrew the study due to going on trips, illness, or other personal reasons. The remaining 53 patients included 45 female (84.9%) and 8 male (15.1%). Despite the majority of female gender among the patients, the sex distributions in these two groups did not show a statistically significant difference, as in the ST group there were 22.2% male and 77.8% female patients and in the BT group there were 7.7% male and 92.3% female patients.

Twenty and eight tenths percent (20.8%) of the patients were only on diet whereas the rest were either on insulin or oral hypoglycemic agents as their treatment plans. Regarding the treatment method, there was no statistically significant difference among the two groups. Compliance to tea consuming in both groups was around 93%.

The mean of quantitative variables of the study including weight, age, diabetes duration, BMI, TC, LDLc, HDLc, TG, Apo-A1, Apo-B100, and Lp(a) before starting the intervention are shown in Table 1. Mean of lipids, lipoprotein and

Table 1. Quantitative Variables of the Sour Tea Group and Black Tea Group at the Beginning of the Study

Variable	*Sour tea group* (n = 27) *Mean ± SD*	*Black tea group* (n = 26) *Mean ± SD*	*Student's* t-*test* p-*value*
Weight (kg)	70.44 ± 11.31	69.90 ± 10.11	0.8
Age (years)	55.37 ± 8.6	50.42 ± 8.56	0.04
Duration (years)	9.81 ± 5.81	10.7 ± 5.1	0.05
BMI (kg/m^2)	28.28 ± 3.8	28.35 ± 4.8	0.09
TC (mg/dL)	237.2 ± 58.1	221.8 ± 52.2	0.2
LDLc (mg/dL)	137.5 ± 53.1	123.9 ± 55.4	0.2
HDLc(mg/dL)	48.2 ± 10.1	46.03 ± 15.01	0.6
TG (mg/dL)	246.1 ± 84.9	247.5 ± 84.7	0.9
Apo-A1 (mg/dL)	150.6 ± 28	148.6 ± 20.8	0.7
Apo-B100 (mg/dL)	80.0 ± 28.7	81.6 ± 21.8	0.9
Lp(a) (mg/dL)	26.8 ± 35.2	27.7 ± 32.5	0.9

SD, standard deviation; BMI, body–mass index; TC, total cholesterol; LDLc, low-density lipoprotein-cholesterol; HDLc, high-density lipoprotein-cholesterol; TG, triglycerides; Apo-A1, apolipoprotein A1; Apo-B100, apolipoprotein B100; Lp(a), lipoprotein (a).

apoproteins before and after the intervention in the ST group are shown in Table 2. According to these data, except for Apo-A1, Lp(a), LDLc, and TC, the mean of other measures have significantly changed at the end of the study, as TC, LDLc, TG, and Apo-B100 decreased 7.6%, 8.0%, 14.9%, and 3.4%, respectively, but HDLc increased 16.7%.

Mean of lipids, lipoproteins, and apoproteins in the BT group before and after the intervention are shown in Table 3. In this group, only HDLc has changed significantly after the intervention. It increased from 46.2 ± 15 at the beginning to 52.0 ± 17 at the end of study, which shows an increase of 13%. At the end of the study, lipids, lipoproteins, and apoproteins were compared in two groups (Table 4). The only significant change is seen in LDLc. The mean of LDLc in the BT and ST groups were 130.1 ± 45.2 and 128.5 ± 41.2 mg/dL, respectively (p-value = 0.003).

Discussion

Of 60 patients who entered the study, 53 people (88.4%) finished it. Compliance to tea consumption was 95% in the BT group and 92% in the ST group, which shows satisfactory co-operation. Distribution of sex and treatment plan of the patients in the two groups did not show significant difference. At the beginning of the study, mean of BMI, TC, LDLc, HDLc, TG, Apo-A1, Apo-B100, and Lp(a) were not significantly different in the two groups (Table 1). At the beginning of the study the two groups were significantly different in mean of diabetes duration (about 1 year) and mean of age (about 5 years). These data show that the random allocation of patients into two groups was acceptable, especially when mean of lipids and lipoproteins were not significantly different in the two groups at the beginning of the study.

By comparing mean lipids and lipoproteins, it was revealed that except for Lp(a) and Apo-A1, the other measures in the ST group had changed significantly after the intervention (Table 2). In the BT group, the only statistically significant change was seen in HDLc, which increased after the intervention (Table 3). Comparing lipids, lipoproteins, and apoproteins after the intervention in the two groups revealed significant change in LDLc, so that in the ST group, LDLc was reduced more than that of the BT group (Table 4), whereas the other measures did not change significantly after the intervention. According to these results, sour tea consumption had reduced most of the lipids and lipoproteins and increased HDLc, but black tea consumption had reduced only LDLc.

In the ST group, the intervention caused a 7.6% decrease in TC, an 8.0% decrease in LDLc, a 14.9% decrease in TG, a 3.4% decrease in Apo-B100, a 16.7% increase in HDLc, and a 4.2% increase in Apo-A1. Meanwhile, in the BT group, HDLc increased 13% and the other measures did not change significantly (Tables 2 and 3).

Table 2. Mean of Lipids and Lipoproteins in Sour Tea Group Before and After the Intervention

Variable	*Before* (n = 27) *Mean ± SD*	*After* (n = 27) *Mean ± SD*	*Change (%)*[a]	*Paired* t-*test* p-*value*
TC (mg/dL)	236.2 ± 58.1	218.6 ± 38.4	−7.6	0.01
LDLc (mg/dL)	137.5 ± 53.4	128.5 ± 41.2	−8.0	<0.001
HDLc (mg/dL)	48.2 ± 10.6	56.1 ± 11.3	+16.7	0.002
TG (mg/dL)	246.1 ± 84.9	209.2 ± 57.2	−14.9	0.003
Apo-A1 (mg/dL)	150.6 ± 28	157.0 ± 26.6	+4.2	0.06
Apo-B100 (mg/dL)	80.0 ± 28.7	77.3 ± 27.6	−3.4	0.05
Lp(a) (mg/dL)	26.8 ± 35.2	26.0 ± 32.5	0	0.5

[a]Increased +, decreased −.

SD, standard deviation; TC, total cholesterol; LDLc, low-density lipoprotein-cholesterol; HDLc, high-density lipoprotein-cholesterol; TG, triglycerides; Apo-A1, apolipoprotein A1; Apo-B100, apolipoprotein B100; Lp(a), lipoprotein (a).

Table 3. Mean of Lipids and Lipoproteins in Black Tea Group Before and After the Intervention

Variable	*Before* (n = 26) Mean ± SD	*After* (n = 26) Mean ± SD	Change (%)[a]	*Paired* t-*test* p-*value*
TC (mg/dL)	221.8 ± 52.2	228.5 ± 47.1	+3.0	0.4
LDLc (mg/dL)	124.9 ± 55.4	130.1 ± 45.2	+4	0.3
HDLc (mg/dL)	46.2 ± 15.01	52.01 ± 17.1	+13	0.002
TG (mg/dL)	247.5 ± 84.7	247.8 ± 103.4	0	0.9
Apo-A1 (mg/dL)	148.6 ± 20.8	150.3 ± 22.0	+1.1	0.4
Apo-B100 (mg/dL)	81.6 ± 21.8	81.0 ± 19.8	0	0.6
Lp(a) (mg/dL)	27.7 ± 32.5	26.4 ± 26.7	−4.6	0.5

[a]Increased +, decreased −.
SD, standard deviation; TC, total cholesterol; LDLc, low-density lipoprotein-cholesterol; HDLc, high-density lipoprotein-cholesterol; TG, triglycerides; Apo-A1, apolipoprotein A1; Apo-B100, apolipoprotein B100; Lp(a), lipoprotein (a).

Table 4. Mean of Lipids and Lipoproteins of Sour Tea Group and Black Tea Group at the End of Study

Variable	*Sour tea group* (n = 27) Mean ± SD	*Black tea group* (n = 26) Mean ± SD	*Student's* t-*test* p-*value*
TC (mg/dL)	218.6 ± 38.4	228.5 ± 47.1	0.4
LDLc (mg/dL)	128.5 ± 41.2	130.1 ± 45.2	0.003
HDLc (mg/dL)	56.1 ± 11.3	52.01 ± 17.1	0.6
TG (mg/dL)	209.2 ± 57.2	247.8 ± 103.4	0.09
Apo-A1 (mg/dL)	157.0 ± 26.6	150.3 ± 22.0	0.3
Apo-B100 (mg/dL)	77.3 ± 27.6	81.0 ± 19.8	0.5
Lp(a) (mg/dL)	26.0 ± 32.5	26.4 ± 26.7	0.9

SD, standard deviation; TC, total cholesterol; LDLc, low-density lipoprotein-cholesterol; HDLc, high-density lipoprotein-cholesterol; TG, triglycerides; Apo-A1, apolipoprotein A1; Apo-B100, apolipoprotein B100; Lp(a), lipoprotein (a).

Various studies, either in humans or animals, have shown similar results.[12–14,18–21] Lin et al. showed that drinking sour tea for 4 weeks reduced cholesterol levels by 8.3–14.4%.[13] In 2003, Chen et al. in Taiwan showed that adding 0.5%–1% of sour tea extract to a high cholesterol diet (1.3%) and pig fat (3%) for 10 weeks in New Zealand white rabbits reduced TG, cholesterol, and LDLc more effectively in the group with higher content of sour tea extract than that of the group with less. Also, histological studies showed that acute atherosclerosis of the aorta was less frequent in this group. The final result of this study was that sour tea may have antiatherosclerotic effects by lowering serum lipid levels.[12]

El-Saadany et al. in Egypt showed that administration of 5% and 10% sour tea to hyper-cholesterolemic rats for 9 weeks reduced cholesterol and TG, but increased phospholipids.[19] In another study, administering 500 and 1000 mg/kg of sour tea calyces extract to hyper-cholesterolemic rats reduced total cholesterol by 22% and 26%, TG by 33% and 28% and LDLc by 22% and 32%, respectively, meanwhile these two concentrations had no significant difference on lowering cholesterol level.[22] Most of the studies suggest antioxidant effect and water-soluble fibers as the main reasons for these effects.[22,23]

Recently, researchers have paid more attention to the effects of glucose digestion blocker enzymes of herbs for control of diabetes. Many studies have identified these blockers in herbal drugs and their effect on blood glucose and lipids.[4,7,8,24,25] Compounds such as hibiscus acid and hydroxycitric acid, which exist in sour tea, have strong inhibition effects on pancreatic α-amylase.[12] Comparing antioxidative and antihyperglycemic effects of sour tea with lovastatine in rats with diabetes showed that sour tea has a noticeable effect on blood glucose and lipids, and patients with diabetes are recommended to consume it for preventing diabetes complications.[20]

Conclusions

In conclusion, sour tea infusions can improve lipid profiles of patients with diabetes. Conducting more studies on this herb and its use is recommended. For instance, long-term effects of sour tea on diabetic complications and also its possible adverse effects on other organs should be studied.

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laboratory analysis. Dr. F. Fatehi facilitated data analysis and writing the manuscript. All of authors are employed by SSUMS and all critically reviewed the manuscript and approved the final version submitted for publication.

Disclosure Statement

The authors declare that they have no conflicts of interest.

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