Effects of sour cherry juice on blood glucose and some cardiovascular risk factors improvements in diabetic women

A pilot study

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Abstract

Purpose – Some studies on anthocyanins have revealed their antioxidant activity and beneficial effects for diabetes control and reducing the risk of coronary heart diseases. It has been found that sour cherries contain high levels of anthocyanins that possess insulin-releasing stimulatory properties on pancreatic β-cells in vitro. The purpose of this paper is to investigate whether concentrated sour cherry juice (CSCJ) beneficially alters serum glucose and some cardiovascular risk factors in diabetes type 2 subjects.

Design/methodology/approach – In this quasi-experimental study, 19 diabetic women with FBS $\geq$ 110 mg/dl were recruited from patients referred to the Diabetes Clinic of Shariati Hospital. Subjects were asked to consume 40 g of CSCJ daily for 6 weeks. Before the onset of the study (week 0) and after 6 weeks, weight and blood pressure measurements were done and fasting blood samples were drawn. FBS, hemoglobin A1c (HbA1c) and blood lipid profiles were measured. In addition, a 24-hour food record was taken from all of the individuals in both stages. The Wilcoxon signed test was used for statistical analysis.

Findings – After six weeks' consumption of CSCJ, significant reductions in body weight ($p < 0.01$), blood pressure and HbA1c ($p < 0.05$) was seen. Total cholesterol and LDL-C decreased significantly in a sub-group of patients ($n = 12$) with LDL-C $\geq$ 100 mg/dl as well.

Originality/value – Based on the results of this study, consuming 40 g/day of CSCJ decreases body weight, blood pressure and HbA1c in diabetes type 2 women after 6 weeks and improves blood lipids in diabetic patients with hyperlipidemia.

Keywords Fruits, Diabetes, Blood pressure

Paper type Research paper

Introduction

Today, there are approximately 200 million people with diabetes worldwide. This number is predicted to rise to almost 333 million by the year 2025. The largest proportional and absolute increase will occur in developing countries. The prevalence of diabetes is increasing in Iran, like other developing countries (Tabari and Larijani, 2005). In diabetes type 2, we are encountered with different degrees of impaired ß-cells function to secrete sufficient amounts of insulin to overcome insulin resistance (Fauci and Jameson, 2005). Some oral hypoglycemic agents directly stimulate insulin release from ß-cells. Some components in the diet, for example anthocyanins can cause the pancreatic β-cells to produce insulin.

Anthocyanins are polyphenol components and the largest group of water-soluble plant pigments responsible for the color of many fruits including cherries. They also are potent antioxidants, highly active chemicals that have been increasingly associated

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with a variety of health benefits, including protection against atheroscelerosis, cardiovascular disease, cancer and diabetes (Jayaprakasam *et al.*, 2004).

Beneficial effects of different anthocyanins in controlling blood glucose or insulin resistance have been shown in diabetic samples (Tsuda *et al.*, 2003; Jankowski *et al.*, 2000; Matsui *et al.*, 2001). Jayaprakasam and co-workers studied the stimulatory effects of different kinds of anthocyanins and anthocyanidins isolated from Cornus fruits (berries and cherries) on insulin secretion from rodent pancreatic β-cells in vitro. Some of these anthocyanins increased insulin production by 50 per cent (Jayaprakasam *et al.*, 2005). The mechanism of this effect is not clear yet. They are currently feeding anthocyanins to a group of obese, diabetic mice to determine how the chemicals influence insulin levels in live subjects. Results of these tests are not yet available.

Beneficial effects of fruits and vegetables in reducing the risk of coronary heart diseases are well known. This property may be related to minor components, especially flavonoids, which are proposed to exert their action by inhibiting low-density lipoprotein (LDL) oxidation and platelet aggregation (Cook and Samman, 1996). It is also suggested that increasing intake of flavonoid rich foods is associated with a lower risk of hypertension (Moline *et al.*, 2000).

Anthocyanins are found in many kinds of fruits. However, the biggest insulin effects seem to come from the anthocyanins found in cherries. The potential cardioprotective effects of sour cherry juice have not been investigated in humans as well. Sour cherry is native to Iran and it is a rich source of several anthocyanins, especially cyanidine-3-glucoside (Blando *et al.*, 2004). This study investigated whether concentrated sour cherry juice (CSCJ) beneficially alters serum glucose, lipids and blood pressure in diabetes type 2 subjects.

Methods

This quasi-experimental study was conducted on 20 diabetic type 2 women recruited from the Diabetes Clinic, Shariati Hospital, Tehran. A fasting blood sugar (FBS) $\geq$ 110 mg/dl, being free of any other chronic diseases, and not using insulin for diabetes control were the inclusion criteria. Patients' type and dose of drugs and diets were required to be constant from 2 weeks before the study. Informed consent was taken and then subjects were asked to consume 40 g of CSCJ daily for 6 weeks. This project was approved by the ethics committee of the Endocrinology and Metabolism Research Center of Tehran University of Medical Sciences. Before the onset of the study (week 0) and after 6 weeks, weight and blood pressure measurements were done and fasting blood samples were drawn. Fasting blood sugar, hemoglobin A1c (HbA1c), total cholesterol, high-density lipoprotein (HDL)-cholesterol, low-density lipoprotein (LDL)-cholesterol and triacylglycerol were measured. In addition, a 24-hour food record was taken from all of the individuals in both stages.

They were advised to keep their usual diet and physical activity stable in the duration of the trial. Participants were excluded in the case of drug dosage alterations.

To make sure of regular intake of the CSCJ, the team made regular contacts with the volunteers by phone call and personal visits in EMRC. Total daily energy and nutrient consumption of the subjects were estimated by Nutribase IV diet analysis software.

The CSCJs were supplied by Takdaneh Company (Tehran). The total anthocyanin concentration of SCJ, which was determined spectrophotometrically, was 1800 mg/100 g.

HbA1c levels in the whole blood samples were measured by ionic exchange chromatography on DS5 Analyser. Serum glucose, total cholesterol, LDL-C, HDL-C and triglyceride were measured enzymatically on a HITACHI-902 autoanalyzer using Pars-Azmoon test kits (Tehran, Iran). Statistical data analysis was performed using the Wilcoxon signed test to compare the changes from baseline after consumption of CSCJ. A value of $p < 0.05$ was considered significant.

Results

One patient was excluded from the study because of inadequate consumption of CSCJ and 19 subjects completed the study. Subjects' mean $\pm$ S.D. age and duration of diabetes were 53.6 ± 8.8 and 8.3 ± 7.1 years, respectively. The kind and dosage of medications and physical activity level were constant during the research. There was no change in the daily intake of energy, nutrients and contribution of macronutrients to energy before and after the study (data not shown).

Table I shows alterations of body weight and BMI, blood pressure, FBS, HbA1c and blood lipid levels before and after consumption of the juices. After 6 weeks consumption of CSCJ, all of the variables decreased and HDL-C increased. These changes were significant in the case of body weight ($p < 0.01$), blood pressure and HbA1c ($p < 0.05$).

Since according to current guidelines, the primary lipid target in diabetes is an LDL-C < 100 mg/dl, we re-analysed the results of blood lipids in a subgroup of our subjects with LDL-C ≥ 100 mg/dl. There were 12 subjects in this sub-group. Six weeks consumption of CSCJ resulted in a significant reduction of total cholesterol and LDL-C ($p < 0.05$) in diabetic patients with hyperlipidemia (Table II).

Variable	Week 0	Week 6
Body weight (kg)	72.8 ± 14.9	69.9 ± 13.6*
BMI (kg/m^2)	29.6 ± 4.3	28.7 ± 3.9*
FBS (mg/dl)	158.3 ± 43.4	145.3 ± 38.0
HbA1c (%)	7.9 ± 1.6	7.5 ± 1.2*
Systolic blood pressure (mmHg)	129.1 ± 15.7	123.1 ± 12.8**
Diastolic blood pressure (mmHg)	81.7 ± 8.1	76.3 ± 8.7**
Total cholesterol (mg/dl)	196.4 ± 29.7	184.9 ± 22.0
LDL-cholesterol (mg/dl)	105.2 ± 19.6	96.9 ± 15.0
HDL-cholesterol (mg/dl)	47.6 ± 7.1	48.2 ± 7.9
Triacylglycerol (mg/dl)	158.5 ± 43.2	145.5 ± 49.1

Notes: Significantly different from baseline (Wilcoxon signed test): *$p < 0.01$; **$p < 0.05$

Table I. Body weight, blood pressure, FBS, HbA1c and blood lipid concentrations at baseline and after CSCJ consumption ($n = 19$)

Variable (mg/dl)	Week 0	Week 6
Total cholesterol	213.9 ± 27.0	193.2 ± 20.2^a
LDL-cholesterol	118.4 ± 14.7	103.6 ± 13.5^a
HDL-cholesterol	47.1 ± 5.1	46.3 ± 8.6
Triacylglycerol	161.4 ± 37.3	157.3 ± 48.9

Notes: [a]Significantly different from baseline, $p < 0.05$ (Wilcoxon signed test)

Table II. Blood lipid concentrations in hyperlipidemic sub-group at baseline and after CSCJ consumption ($n = 12$)

Discussion

The results of this study indicate that the consumption of 40 g/day of CSCJ decreases body weight, blood pressure and HbA1c after 6 weeks in diabetes type 2 women and improves blood lipids in diabetic patients with hyperlipidemia.

In this study, FBS levels decreased not significantly. However, HbA1c, which is the long-term representative of blood glucose, reduced after 6 weeks intake of CSCJ. HbA1c measurement is the most effective method for monitoring the effectiveness of diabetes treatment (Buse *et al.*, 2003). Beneficial effects of this fruit in glycemic control can be related to its anthocyanin content. These compounds are well-known free radical scavengers with antidiabetic activity. Besides, cyaniding-3-glucoside (the main anthocyanin in sour cherry), was shown to be one of the most stimulants of pancreatic β-cells to release insulin (Jayaprakasam *et al*, 2005).

Blood pressure reducing effects of bioflavonoids and anthocyanins have been proved in some studies. It is estimated that phytochemical and polyphenol content of the DASH (dietary approaches to stop hypertension) diet is higher than in the Control Study Diet (Most, 2004). Comparing the antihypertensive effect of juice of the so-called sweetie fruit (a hybrid between grapefruit and pummelo) with and without high flavonoid content in patients with stage I hypertension showed that high flavonoid sweetie juice have a significant beneficial effect in reducing diastolic blood pressure, compared with the effect observed with the other type (Reshef *et al.*, 2005).

Endothelial nitric oxide synthase (eNOS) plays an important role in maintaining blood pressure homeostasis and vascular integrity. The effect of cyanidin-3-glucoside (Cy3G), a typical anthocyanin pigment, on eNOS expression was examined and the results demonstrated that Cy3G induced eNOS expression and escalated NO production in vascular endothelial cells (Xu *et al.*, 2004). Bell and Gochenaur reported direct vasoactive and vasoprotective properties of anthocyanin-rich extracts, which suggest that such extracts could have significant beneficial effects in vascular disease. Blood pressure reducing effect of sour cherry in this study, can be related to it's main anthocyanin, cyanidin-3-glucoside (Bell and Gochenaur, 2006).

Body weights decreased after 6 weeks consumption of CSCJ. Diet and physical activity level did not change during the study compared to the week 0. A few studies have been conducted on the obesity preventive or weight controlling effects of anthocyanins in animals. Tsuda *et al.* studied the effect of 3-glucoside-rich purple corn color (PCC) on obesity and hyperglycemia in mice and showed that dietary PCC significantly suppressed the high fat diet-induced increase in body weight gain, and white and brown adipose tissue weights (Tsuda *et al.*, 2003). In another study, the most abundant bioactive compounds in Cornelian cherries, the anthocyanins and ursolic acid, were purified and their ability to ameliorate obesity and insulin resistance was evaluated in mice fed a high-fat diet. The high-fat diet induced glucose intolerance, and this was prevented by anthocyanins and ursolic acid. The anthocyanin-treated mice showed a 24 per cent decrease in weight gain and exhibited extremely elevated insulin levels (Jayaprakasam *et al.*, 2006).

These findings are in accordance with many similar studies on hypocholesterolemic effects of anthocyanin rich foods. Esmaillzadeh *et al.* found that 40 g/day of concentrated pomegranate juice resulted in a significant reduction in total cholesterol and LDL-C ($p < 0.006$) in diabetic type 2 patients with hyperlipidemia after 8 weeks (Esmaillzadeh *et al.*, 2004). In that study, baseline level of cholesterol $\geq$5.2 mmol/L or triglyceride $\geq$2.3 mmol/L were the inclusion criteria, which compared to our study, had a higher baseline lipid levels and probably this is the reason for it's greater effect.

However, consumption of orange juice by normocholesterolemic subjects (Harats *et al.*, 1998)) or pomegranate juice (Aviram *et al.*, 2000) or red wine (Lavy *et al.*, 1994) in healthy subjects had no effect on serum total cholesterol levels. Duthie *et al.* did not find any changes in blood lipids of healthy women who consumed 750 cc/day of cranberry juice for 2 weeks (Duthie *et al.*, 2006). That is probably because of the short duration of the study and normality of baseline lipid levels.

These observations altogether demonstrate the hypocholesterolemic effects of bioflavonoid and anthocyanin rich foods only in hypercholesterolemic subjects. The higher the baseline levels of total cholesterol or LDL-C, the more effectiveness of these foods. The kind of anthocyanin is another factor in its cholesterol reducing effects. Consumption of 100 mg bid grape seed proanthocyanidin extract had no significant effect on blood lipids of subjects with total cholesterol of 210-300 mg/dl (Preuss *et al.*, 2000). In this study, the baseline levels of cholesterol was near the lowest limit of that range (213.9 ± 27 mg/dl). However, sour cherry juice inserted significant reduction on blood cholesterol.

This is the first study on beneficial effects of sour cherry in diabetic subjects. We didn't consider a control group in this study. However, it was well controlled by frequent contacts with patients. We found that the CSCJ, as an anthocyanin-rich food, produces significant improvements in weight, glycemia and blood pressure in diabetic type 2 patients. It also improves blood lipids in diabetic patients with hyperlipidemia. So, this juice or the fruit could be suitable in diabetic diet.

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