Effects of citrus sinensis juice on blood pressure

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Original Article

Abstract

BACKGROUND: Citrus sinensis juice (CSJ) is a rich source of dietary flavonoids which reduce the risk of adverse cardiovascular events. This study aimed to examine the effects of four-week intake of natural and commercial orange (*Citrus sinensis*) juice on blood pressure in healthy volunteers.

METHODS: In this single-blind randomized crossover study, 22 healthy subjects (age: 18-59 years old) were included and randomly divided into two groups of 11. Group A consumed commercial CSJ during the first four-week period. After a two-week washout period, they consumed natural CSJ for another four weeks. The procedure was reversed in group B. The participants were asked to drink 500 ml/day of either natural or commercial CSJ twice a day with breakfast and dinner. The effects of orange juice on blood pressure were evaluated.

RESULTS: After drinking commercial CSJ, diastolic and systolic blood pressure were significantly decreased (5.13%; P = 0.03 and -5.91%; P = 0.003, respectively). However, consumption of natural CSJ did not have significant effects on either diastolic or systolic blood pressure.

CONCLUSION: Commercial CSJ significantly decreased blood pressure. Higher flavonoid, pectin, and essential oils content of concentrated products compared to natural juice might have been responsible for this finding. Nevertheless, further studies to focus on dose-response effects are recommended.

Keywords: Citrus Sinensis Juice, Hypertension, Blood Pressure

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Introduction

Hypertension is a major risk factor for cardiovascular diseases (CVD) whose global prevalence is predicted to be as high as 30% by 2025. Approximately 25% (6.6 million) 25-64 year-old have hypertension and 46% (12 million) have prehypertension.[1,2] A growing number of epidemiological studies have consistently shown the protective effect of polyphenol-rich foods (fruit, tea, wine, cocoa or chocolate, and special citrus fruits) against some intermediate risk factors for CVD including high low-density lipoprotein (LDL) cholesterol, high blood pressure, and endothelial dysfunction.[3-5] Orange *(Citrus sinensis)* juice is also considered a good source of essential nutrients such as vitamin C, folate, and potassium. Vitamin C has recently been found to protect endothelial cells and LDL from intra- and extracellular oxidative stress[6] and to reduce the risk of atherosclerosis.[7] In addition, folic acid can lower plasma homocysteine concentrations and to revert endothelial dysfunction in patients with cardiovascular diseases.[8] Potassium, on the other hand, may contribute to lower blood pressure.[6-9] Four-week consumption of orange juice in healthy middle-aged, normal-weight men has been suggested to reduce diastolic blood pressure (DBP). Since DBP is an indicator of peripheral vessel resistance, orange juice can have particular health benefits.[10]

Citrus sinensis juice (CSJ) consumption has become a worldwide dietary habit. As a result, the consumption of frozen concentrated juice has also increased steadily over years. Not surprisingly, the market share of this product is now much greater than that of natural fruit, especially in developed countries.[11] Furthermore, it was hypothesized that

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natural and commercial orange juice consumption have different effects on blood pressure in healthy volunteers. This study aimed to examine the effects of four-week intake of natural orange (*Citrus sinensis*) juice and commercial CSJ on blood pressure in healthy volunteers.

Materials and Methods

Subjects

This single-blind, randomized, crossover study was conducted on 22 healthy volunteers (age: 18-59 years old) with no evidence of chronic, metabolic, and endocrine diseases. The exclusion criteria were using medications, antioxidants, or vitamin supplements, intense physical activity (five hours a week), smoking, and vegetarian or other restrictive dietary habits.

Using a protocol approved by the ethics committee of Isfahan Cardiovascular Research Center (Isfahan, Iran), this study mainly aimed at comparing the effects of four-week consumption of natural and commercial orange juice on blood pressure in healthy volunteers. The subjects were hence allocated to two groups of 11 using computer-generated random numbers. Group A received commercial orange juice for four weeks, had a two-week washout period, and consumed natural orange juice for another four weeks. The reverse order was used in group B. Commercial orange juice without preservatives, extra vitamin C, or other additives was purchased. Natural fruits were also bought at the fruit market, crushed, and then squeezed. Both types of juice were stored in one-liter bottles at 20°C. The subjects were asked to drink 500 ml/day of orange juice twice a day with breakfast and dinner.

In order to measure blood pressure, the participants made four visits to the clinical research unit, i.e. before and 30 days after each experimental period. All measurements were performed in the morning and after a 20-minute rest using a stethoscope and a sphygmomanometer (Accutorr 1A, Datascope, Japan) and according to a standard protocol.[12]

The collected data was reported as means ± standard deviation (SD). A paired t-test was performed to analyze data obtained by the crossover design before and after juice supplementation and to determine possible significant differences in blood pressure between time points. A paired t-test between baseline values (before either natural or commercial orange juice supplementation) was used to establish the correct performance of the washout. A paired t-test was also used to compare the mean values obtained before and after the experiment period. Data was compared by repeated-measures analysis of variance with Dunnett's post-test for nonparametric data. In all cases, P values less than 0.05 were considered statistically significant. All statistical analyses were performed using SPSS for Windows 15.0 (SPSS Inc., Chicago, IL, USA).

Results

Overall, 22 subjects were included. The mean age of the participants was 34.36 ± 11.54 years old in group A and 35.91 ± 12.80 years old in group B (P = 0.769). The mean SBP in groups A and B was 112.00 ± 8.50 and 110.91 ± 7.01 mmHg, respectively (P = 0.555). The mean DBP was 78.0 ± 11.35 mmHg in group A and 72.73 ± 4.67 in group B (P = 0.130).

Blood pressure was measured at the beginning and at the end of each experimental period. There was a statistically significant difference in DBP between the two groups the first and second experimental periods. However, within group comparisons did not reveal statistically significant differences in DBP and SBP (Table 1).

Table 1. Comparison of the two groups before and after each experimental period

Characteristics	Group	T1	T2	P	T3	T4	P
Systolic blood pressure (mmHg)	Group A	112.00 ± 8.50	108.00 ± 7.89	0.020	112.55 ± 8.20	110.91 ± 11.36	0.271
	Group B	110.91 ± 7.01	106.36 ± 6.74	0.129	110.91 ± 7.01	104.55 ± 8.20	0.053
	P	0.555	0.917	0.860	0.630	0.119	0.840
Diastolic blood pressure (mmHg)	Group A	78.00 ± 11.35	72.00 ± 7.89	0.050	75.45 ± 11.28	76.36 ± 10.27	0.792
	Group B	72.73 ± 4.67	70.91 ± 7.01	0.317	72.91 ± 5.39	69.09 ± 5.39	0.050
	P	0.130	0.400	0.204	0.011	0.146	0.490

Group A consumed commercial Citrus sinensis juice during the first period and natural Citrus sinensis juice during the second. Group B consumed natural Citrus sinensis juice during the first period and commercial Citrus sinensis juice during the second.
T_1: Before the first period T_2: After the first period
T_3: Before the second period T_4: After the second period

Table 2. Changes in systolic and diastolic blood pressure (SBP and DBP) after the intervention compared to baseline

Characteristic	Commercial orange juice users (n = 22)	Natural orange juice users (n = 22)
SBP (mmHg)	-5.91%	-3.63%
DBP (mmHg)	-5.13%	-0.61%

SBP: Systolic blood pressure; DBO: diastolic blood pressure

In addition, DBP and SBP had significant reductions after commercial orange juice consumption (-5.13% and -5.91% respectively). Nevertheless, commercial orange juice resulted in a significantly lower DBP reduction compared to natural orange juice (Table 2).

Discussion

The main finding of this study is that four-week consumption of commercial CSJ significantly decreased DBP and SBP in healthy subjects. Morand et al. reported similar findings.[13] Hara showed that four-week consumption of orange juice reduced DBP in healthy middle-aged, normal-weight men.[14] Moreover, studies have shown consumption of flavanone-rich fruit juice to have a significant beneficial effect on blood pressure in hypertensive subjects.[10,14] Focus on flavanones is particularly relevant considering their high content in citrus and high consumption of citrus fruits, and particularly orange juice, worldwide.[15] Concentrated citrus products have a greater flavonoid (polymethoxylated flavones, hesperitin and naringin) content compared to natural juice.[16] This is due to the grinding process which uses the entire fruit to produce the juice. Pectin and essential oils contained in the peel are also found in greater amounts in the concentrated juice.[16] Naringin and hesperidin are mainly present in grapefruits and oranges. They have been reported to possess antioxidant, antihypertensive, and hypocholesterolemic effects and to offer some kind of protection against mutagenesis and lipid peroxidation.[17,18] In healthy, middle-aged, moderately overweight men, regular postprandial consumption of Citrus sinesis juice (CSJ) has been found to decrease DBP and increase endothelium-dependent microvascular reactivity. Hesperidin was suggested to cause the beneficial effect of orange juice.[13] Law et al. showed that a 3-4 mmHg reduction in DBP would reduce the incidence of coronary artery disease by 20%.[19]

The possible mechanisms by which these flavonoid-rich foods lowered blood pressure may involve a chronic increase in the production of nitrogen oxide (NO) by vascular endothelium. Other mechanisms such as an inhibitory effect on angiotensin-converting enzyme could also be responsible for the blood pressure-lowering effects of flavanones.[13,20,21] Endothelium dysfunction causes the endothelium to become permeable to plasma components such as LDL which are deposited in the subendothelial space. Consequently, endothelial dysfunction can be considered as the first step in atherogenesis and development of arteriosclerotic lesions.[22-24]

In general, association between flavonoid intake and blood pressure is a theory which requires more research.

Conclusion

Commercial orange juice has a significant effect on blood pressure. As concentrated products have greater contents of flavonoids, pectin, and essential oils compared to natural juice, they are more effective on blood pressure. Future studies to examine dose-response effects are recommended.

Conflict of Interests

Authors have no conflict of interests.

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