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Daily kiwifruit consumption did not improve blood pressure and markers of cardiovascular function in men with hypercholesterolemia

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ABSTRACT

Increasing fruit and vegetable consumption is a key lifestyle modification in the prevention and treatment of hypertension. Kiwifruit has previously been shown to have favorable effects on blood pressure (BP), likely through inhibiting angiotensin I–converting enzyme activity. We hypothesized that the replacement of 2 fruit servings in a healthy diet with 2 green kiwifruit a day would significantly improve BP and other markers of cardiovascular function, including heart rate, stroke volume, cardiac output, and total peripheral resistance, in a group of hypercholesterolemic men. Using a controlled cross-over study design, 85 subjects completed a 4-week healthy diet run-in period before randomization to one of two 4-week intervention sequences in which they either consumed 2 green kiwifruit a day plus a healthy diet (intervention) or consumed a healthy diet alone (control). Blood pressure and other measures of cardiovascular function (using a Finometer MIDI [Finapres Medical Systems B.V, Amsterdam, The Netherlands] and standard oscillometric device) and anthropometric measurements were taken before and at the end of the treatment periods. A physical activity questionnaire was completed during the last visit. Subjects were found to be predominantly normotensive (43.5%) or prehypertensive (50.6%) and quite physically active (>30 minutes of moderate to vigorous physical activity/day in >80% subjects). No significant differences were seen for BP or any of the other markers, including heart rate, stroke volume, cardiac output, and total peripheral resistance. In conclusion, in this hypercholesterolemic, nonhypertensive group, no beneficial effects on BP or other markers of cardiovascular function were seen when consuming 2 kiwifruit a day against the background of a healthy diet.

Abbreviations: ACE, angiotensin I–converting enzyme; BP, blood pressure; CI, confidence interval; CO, cardiac output; CVD, cardiovascular disease; DBP, diastolic blood pressure; LDL-C, low-density lipoprotein cholesterol; NO, nitric oxide; SBP, systolic blood pressure; SV, stroke volume; TPR, total peripheral resistance.

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1. Introduction

In terms of attributable deaths worldwide, raised blood pressure (BP) or hypertension is the leading risk factor for cardiovascular disease (CVD) [1]. It is also one of the most modifiable risk factors, with changes in lifestyle factors having central roles in both its prevention and management [2,3]. Important lifestyle modifications for BP control include weight loss, regular aerobic exercise, and the adoption of a healthy dietary pattern. After reduction of dietary sodium, the next key component of a healthy diet is increasing the consumption of fruits and vegetables [2]. Strategies that decrease BP by even modest amounts can result in significant reductions in CVD risk [2]. The role of lifestyle strategies is potentially even greater in prehypertensives, a group that has been shown to be at increased CVD risk, but where, for most individuals, pharmacological therapy is not indicated [4].

There is strong evidence for the antihypertensive effects of fruit and vegetables and specific dietary patterns rich in fruits and vegetables, such as the Dietary Approaches to Stop Hypertension diet [5]. Fruits contain a range of nutrients and nonnutrient components that may contribute independently or synergistically to lowering BP, including fiber, potassium, vitamin C, and polyphenols [6-9].

Compared with most other commonly consumed fruit, kiwifruit are particularly good sources of vitamin C, potassium, polyphenols, and fiber [10,11]. Both aqueous and 70% ethanol kiwifruit extracts at 10 and 50 mg/mL concentrations have been shown in vitro to inhibit angiotensin I–converting enzyme (ACE), a key regulator of BP through the renin-angiotensin system [12]. Karlsen et al [13] conducted an 8-week randomized, parallel intervention, in which male smokers consumed 3 green kiwifruit daily; significant reductions were observed in diastolic BP (DBP) and systolic BP (SBP) compared with control treatment (habitual diet), with the greatest effects (–15 mm Hg SBP, –13 mm Hg DBP) seen among hypertensive subjects. They also observed an 11% reduction in serum ACE activity in subjects in the kiwifruit group [13].

The present study describes a predefined secondary objective of our randomized kiwifruit trial [14]. Using a Finometer MIDI, the hypothesis that consuming 2 green kiwifruit daily in conjunction with a healthy diet would significantly improve BP and cardiovascular function in hypercholesterolemic men was investigated by measuring finger pulse pressure, stroke volume (SV), cardiac output (CO), and total peripheral resistance (TPR). Our study design allowed us to investigate the specific effects of kiwifruit, independent of the effects of a healthy diet containing fruit.

2. Methods and materials

2.1. *Subjects and study design*

The study protocol for this randomized controlled cross-over trial was approved by the Massey University Human Ethics Committee: Southern A 09/76, in accordance with the principles outlined by the Declaration of Helsinki. Written informed consent was obtained from all subjects. Details of the protocol, subject recruitment, and exclusion criteria for subjects were previously described [14]. In brief, 87 hypercholesterolemic men with a low-density lipoprotein cholesterol (LDL-C) concentration greater than 3.0 mmol/L and a plasma triglyceride concentration less than 3.0 mmol/L, but otherwise healthy nonsmokers not taking any cholesterol-lowering medication, were recruited from the Auckland region in New Zealand. The trial was conducted between May and September 2010 and was registered with the Australian New Zealand Clinical Trials Registry (no. ACTRN12610000213044).

Subjects made 5 visits to the Massey University Human Nutrition Research Unit. Anthropometric measures (height, weight, waist circumference, and percent body fat) and a blood sample for lipids were taken during visit 1 (baseline 1). Subjects were then asked to complete a 3-day food record, before attending a nutrition consultation with a nutritionist to outline the healthy diet they were requested to follow for the 12-week study. The healthy diet was based on the Heart Foundation of New Zealand's "9 steps to Eating for a Healthy Heart" [14]. The 9 steps consist of a series of guidelines to encourage individuals to make healthier choices focused on heart health, such as incorporating fruit and/or vegetables at every meal; reducing salt, saturated fat, and alcohol intakes; and choosing wholegrain breads and cereals instead of white and low-fiber varieties. As the study was a fruit intervention, the focus was to increase fruit intake to the minimum guideline of at least 2 servings a day. During the run-in period, kiwifruit were excluded from fruit intake.

After completing their 4-week healthy diet run-in period, subjects returned (visit 3) and were randomly assigned, using computer-generated random numbers (http://www.randomization.com), to one of two 4-week intervention sequences. These were either a healthy diet alone that contained at least 2 servings of fruit per day excluding kiwifruit (control) or a healthy diet and replacement of 2 usual fruit servings with 2 Zespri Green kiwifruit (*Actinidia deliciosa* var Hayward) per day (average weight, without skin 176 g/d) (intervention). Subjects who normally consumed more than 2 fruit servings per day could consume any other fruit to make up their regular number of servings. Follow-up anthropometric measures were taken at visit 3 (baseline 2) and at the end of each intervention period (visits 4 and 5). Participants also completed a 24-hour food record, which was checked for fruit intake compliance and discussed with participants by a nutritionist, and an online fruit questionnaire, which assessed fruit intake over the previous week.

Full details in regards to sample collection and the biochemical analysis of lipids and measurement of anthropometric variables are described by Gammon et al [14]. In addition, at these visits, BP measurements (using an Omron HEM-907 Digital Automatic Blood Pressure Monitor) and finger pulse recordings (using the Finometer MIDI, Model 2, without return-to-flow calibration) (Finapres Medical Systems B.V, Amsterdam, The Netherlands) were taken. The Finometer provides a noninvasive, continuous measurement of BP and tracks changes in other markers of cardiovascular function, including SV, CO, and TPR, compared with automated oscillometric devices, which only provide a momentary value of BP [15]. The device is shown to be sensitive in recording relatively small changes in cardiovascular function