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The effect of fruit and vegetable powder mix on hypertensive subjects: a pilot study☆

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Abstract

Objective: This study was designed to evaluate the effects of a fruit and vegetable powder mix on cardiovascular health as determined by blood pressure and heart rate variability (HRV) in a chiropractic college faculty and student population.

Methods: Forty subjects were recruited in the study via a schoolwide e-mail notification and through personal contacts. NanoGreens (Biopharma Scientific, Inc, San Diego, CA) vegetable supplement drink was tested to document its effect on the blood pressure and HRV in relation to cardiovascular health.

Results: After taking the supplement for 90 days, both systolic and diastolic blood pressures decreased significantly in the treatment group. The systolic blood pressure decreased from 140.4 ± 17.7 to 128 ± 14.2 mm Hg, and the diastolic blood pressure decreased from 90.2 ± 7.7 to 83.1 ± 7.4 mm Hg. No significant blood pressure decrease was observed in the control group (systolic blood pressure from 130.8 ± 16.3 to 131 ± 16.1 mm Hg and diastolic blood pressure from 83.6 ± 9.6 to 83.1 ± 7.9 mm Hg). Subject's body weight in pounds did not change significantly in the experimental group: from 193.5 ± 31.1 to 194 ± 31.3. The body weight in the control group showed an increase from 175.9 ± 27.4 to 178 ± 29.9, but it was not significant. The heart rate did not show any statistically significant changes. Time domain analysis of HRV showed an increase in the standard deviation of the average R-R intervals root mean square of successive interbeat intervals, but it did not reach statistical significance. Frequency analysis of HRV found an increase in the total power, but it did not reach a significant level.

Conclusion: It was concluded that taking the nutritional supplement for 90 days reduced blood pressure but not body weight in this group of subjects. The HRV was not affected by

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the supplement over the 3-month period. Larger studies should be conducted to determine effects on other populations.

Introduction

Hypertension has been identified as a significant risk factor for cardiovascular diseases, stroke, and renal diseases in the United States.[1] Treatment of hypertension has been a challenging endeavor for the health care professionals because it is a common illness and yet difficult to treat simply because of the complex nature of the underlying pathophysiologic causes of hypertension.[2] Using nutritional supplements to control blood pressure (BP) is a method focused on patients' overall health with the potential of antihypertensive effect for the prevention of coronary heart disease (CHD).[3] It is not intended to be a direct treatment of hypertension or replacement treatment of hypertension. However, because nutritional supplement may be beneficial to many aspects of the body system with no known adverse effects, it is important to investigate if consumption of such nutritional supplement has any antihypertensive effects in patients with mild to moderate hypertension. The international guidelines for the prevention of CHD suggested that patients with manifest CHD should control their BP to less than 140/90 mm Hg and low-density lipoprotein cholesterol to less than 2.6 mmol/L.[4]

Recent studies on the effect of diet on reducing BP have found that the overall dietary pattern exerted the greatest influence on BP than any one particular nutritional component.[5] Significantly, BP-lowering effects have been found in all population groups with a nutritionally complete diet rich in fruits, vegetables, and low-fat dairy foods.[5,6] The diet known as the *Dietary Approaches to Stop Hypertension* diet has been tested in randomized controlled trials and documented to elicit the greatest beneficial effects in hypertensive Americans.[6,7] The diet clearly demonstrated the beneficial effect for cardiovascular patients. It was also suggested that the Dietary Approaches to Stop Hypertension diet may also reduce the risk of some cancers.[8,9] The calcium in the dairy products would help lower the risk of osteoporosis.[10] The diet consists of whole foods that are easily available at local grocery stores.[7,11]

It was interesting to note in a meta-analysis of 44 randomized controlled studies that the dietary effect was more significant than exercise in terms of lowering BP ($P < .02$) and that adding exercise to diet does not seem to further reduce BP.[12] The effect on BP was more pronounced in hypertensives than in normotensives. Clinical trials indicate that the consumption of recommended levels of dairy products, as part of a healthy diet, can contribute to lowering BP in individuals with normal and elevated BP.[13]

A meta-analysis to combine mean differences between end point BP in treatment and control groups in 105 trials randomizing 6805 participants using robust statistical analysis found significant effects for improved diet, aerobic exercise, alcohol and sodium restriction, and fish oil supplements: mean reductions in systolic BP of 5.0 mm Hg with corresponding reductions in diastolic BP.[14] Green leafy vegetables are a rich source of a number of micronutrients and other phytochemicals having antioxidant properties.[15] It has been reported that consumption of green leafy vegetables in the raw state had significantly higher values as an antioxidant than the cooked state ($P < .001$).[14] This may contribute to the widely accepted method of improving cardiovascular health by taking a green vegetable supplement. NanoGreens (Biopharma Scientific, Inc, San Diego, CA) supplement is one of the many products that can be found in the market of nutritional supplements. The particular mechanism of the beneficial effects of taking a green vegetable supplement is not well established. It was proposed that the green vegetable supplement might serve as antagonists on the aryl hydrocarbon receptor.[15,16]

The specific aims of this study were to understand the influence of the NanoGreens nutritional supplements on BP, heart rate variability (HRV), and body weight. The hypotheses were that these nutritional supplements could reduce BP and body weight and increase HRV.

Methods

Subjects

Forty students and faculty members were recruited in the study via a schoolwide e-mail notification and

through personal contacts. Subjects were assigned into control (n = 17) and treatment groups (n = 23) using a random table. Subjects were not blinded, and no placebo was used because of the difficulty of making a similar product without its effective components. All study procedures were approved by the institutional review board at the Logan chiropractic college and explained to each subject before testing. All subjects were required to sign a written informed consent before participating in the study.

Inclusion/exclusion criteria

Male or female students and faculty members of any age with elevated BP were qualified for the study. The range for systolic and diastolic BPs was 180 to 120 mm Hg and 110 to 80 mm Hg, respectively. Subjects were considered meeting the inclusion criteria if only systolic or diastolic BP was elevated. Individuals with diabetes, heart, kidney, thyroid disorders, neurologic diseases, pregnancy, and chronic disease were not recruited in the study. Female subjects who were pregnant or breastfeeding were excluded and those using drugs or medications were not permitted to participate in the study. Subjects already taking similar supplements or those who did not sign the informed consent form were not accepted in the study. Subjects with hypotension, systolic BP greater than 180 mm Hg, and diastolic BP greater than 110 mm Hg were excluded.

Role of subjects and treatment

All 23 subjects in the treatment group were given a 90-day supply of the nutritional supplement free of charge. The supplement was supplied by Biopharma Scientific, Inc (San Diego, CA). Subjects were instructed to first mix with 6 to 8 ounces of water and then consume twice a day 1 scoop (12 g) of NanoGreens10, a phytonutrient dense, powdered "green drink" consisting of green plant foods, fruits, vegetables, powders of all the colors, teas, herbs, spice, various phytonutrient concentrates, high PC lecithin, oat, and rice bran. NanoGreens10 incorporates a patented liposomal delivery system (NanoSorb) designed to enhance the bioavailability of the ingredients.

All subjects answered the prescreening questionnaire. This was to ensure that each subject met the inclusion and exclusion criteria. Every subject signed an informed consent before beginning the study. The study began with a baseline test of BP, HRV, and body weight. All tests were performed in a research laboratory. All tests were performed before initially taking the supplement, and all tests were repeated after the 90-day study period.

Instrumentation

A Biopac (Santa Barbara, CA) manual BP monitor was used for the BP measurements. Researchers were trained in the correct BP measurement technique and had at least 2 years of experiences in BP research. Blood pressure measurements were taken at sitting position after 5 minutes of resting. The manual sphygmomanometer cuff was placed on the left arm at the heart level. The BP reading was taken twice during data collection, and an average was used for data analysis. Body weight was measured with the 6-way weight scale made by Chirotron (Seattle, WA).

Biocom's Active ECG Scanner (Biocom, Seattle, WA) was used in the HRV data collection with digital signal processing software. The heart scanner records an electrocardiographic (ECG) signal, computing the instantaneous changes of HRV after each recording session. The scanner connects to the subjects through 3 small electrodes that attach to the left arm, right arm, and left leg. A baseline HRV was recorded before treatment was given. The HRV recording was taken in the sitting position for 5 minutes for all subjects. No additional gels were needed for the electrodes. Special care was given to clean the skin surface to improve skin conductance. Data cleaning techniques were used to remove noise in the ECG signals to improve the quality of HRV measurements. This includes checking each ECG tracing to make sure that accurate ECG R-R intervals are recorded for HRV analysis. The HRV waveform was represented by R-R interval tachogram. The spectral analysis of this signal was obtained from a successive discrete series of R-R duration values taken from the ECG signal sampled at 256 Hz and transformed by the fast Fourier technique. The power spectrum was divided into 3 major frequency ranges (very low frequency at 0.01-0.08 Hz, low frequency at 0.08-0.15 Hz, and high frequency at 0.15-0.5 Hz). The integral of the power spectrum within each region was calculated.

Data treatment and analysis

One-way repeated-measures analysis of variance was used to assess the differences of BP, body weight, and HRV changes before and after taking the supplement for 90 days. Significance was determined at $P \leq$

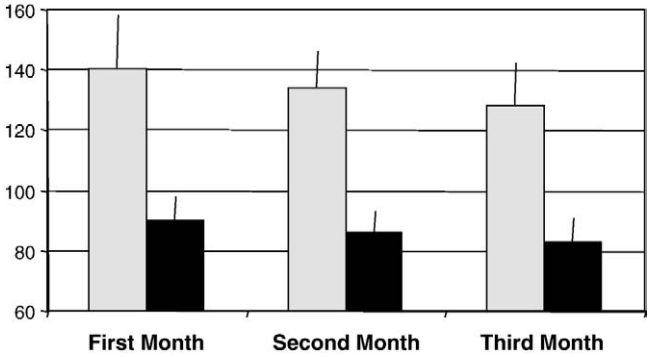

Fig 1. Both systolic (gray bars) and diastolic (black bars) BPs decreased significantly in the nutritional supplement group after taking the supplement for 3 months. Blood pressure was measured in millimeters of mercury.

.05. SPSS 11.5 (SPSS Inc, Chicago, IL) statistical software was used for the data analysis.

Results

A total of 125 subjects were screened for higher BP. Forty subjects (7 female) were recruited and completed the study. The average age of the subjects was 26 ± 6 years in the experimental group and 23 ± 3 years in the control group. Among the 40 subjects, there were 33 chiropractic students and 7 faculty members. All students came from trimester 1 and 2 classes. Subjects had no history of taking nutritional supplement and medications 30 days before the experiment.

After taking the supplement for 90 days, both the systolic and diastolic BPs decreased significantly in the experimental group (Figs 1 and 2, Tables 1 and 2). The systolic BP decreased from 140.4 ± 17.7 to 128 ± 14.2 mm Hg (F = 9.269, $P < .001$), and the diastolic BP decreased from 90.2 ± 7.7 to 83.1 ± 7.4 mm Hg (F = 17.044, $P < .001$). No significant BP decrease was observed in the control group (systolic BP from 130.8 ± 16.3 to 131 ± 16.1 mm Hg and diastolic BP from 83.6 ± 9.6 to 83.1 ± 7.9 mm Hg). The heart rate changed from 82.02 beats per minute in the nutritional supplement group to 82.28 beats per minute without reaching statistical significance. Time domain analysis of HRV showed a slight decrease in the standard deviation of the average R-R intervals and root mean square of successive interbeat intervals, but it did not reach statistical significance. Frequency analysis of HRV found increasing total power and high frequency, but both did not reach significant level. The very low frequency and low frequency did not change significantly. Subject's body weight did not change significantly in the experimental group: from 193.5 ± 31.1 to 194 ± 31.3. The body weight in pounds in the control group showed an increase from 175.9 ± 27.4 to 178 ± 29.9, but it was not significant.

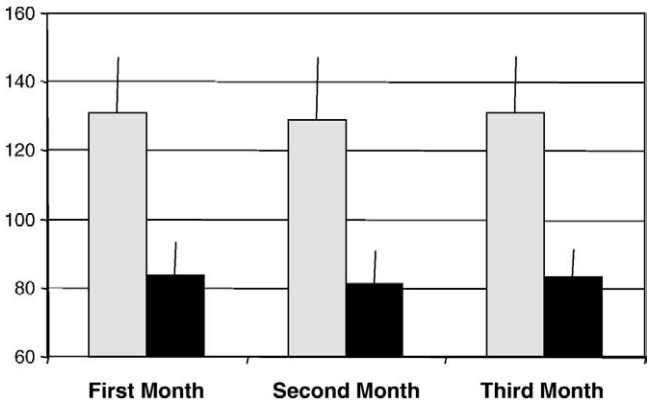

Fig 2. Systolic (gray bars) and diastolic (black bars) BPs did not show significant changes in the control group (no nutritional supplement was given to the subjects). Blood pressure was measured in millimeters of mercury.

Table 1 Control group descriptive statistics

Column	Size	Mean	SD	SE	CI of Mean
Baseline S	17	130.7	16.2	3.9	8.3
Baseline D	17	83.5	9.6	2.3	4.9
45-d S	17	129.0	18.0	4.3	9.2
45-d D	17	81.1	9.4	2.3	4.8
90-d S	17	130.9	16.0	3.8	8.2
90-d D	17	83.1	7.9	1.9	4.1

S, Systolic; *D*, diastolic.

Discussion

It has been noted in our previous study that nutritional supplement in the form of fruit and vegetable powder mix may reduce BP in subjects with normal BP but that no changes were found in blood chemistries.[17] Because the BP reduction was in healthy subjects, it is desirable to study subjects with

Table 2 Treatment group descriptive statistics

Column	Size	Mean	SD	SE	CI of Mean
Baseline S	23	140.4	17.7	3.6	7.6
Baseline D	23	90.2	7.7	1.6	3.3
45-d S	23	133.7	12.2	2.6	5.5
45-d D	23	86.3	6.7	1.4	3.0
90-d S	23	128.3	14.1	3.3	7.0
90-d D	23	83.1	7.4	1.7	3.6

S, Systolic; *D*, diastolic.

elevated BP. Another reason for this study was that we did not measure body weight for subjects in the first study. Without knowing the body weight changes, we could not determine if the lack of effect on blood chemistry was due to weight gains during the study period in school. If weight gain was found in the same study period, it would suggest that poor diet and lack of exercise played a role in the first study. Therefore, this new study was designed to address those unanswered questions.

Based on the reduction of systolic BP of our first study with normal BP, it was not surprising to find lower BP in the experiment group in the current study. The BP reduction was larger than that in the normal-BP subjects in the first study. As we noted in the first study, the BP was only decreased to a statistically significant level by an average of 4 mm Hg. In the current study with hypertensive subjects, the drop was much more pronounced at an average of 10 mm Hg. This was consistent with the literature.[18,19]

This study supported our first hypothesis that nutritional supplement (NanoGreens10) might result in lowering both systolic and diastolic BPs, but there was no support to the hypothesis on body weight and HRV. During the 3 months of treatment period, there was no adverse effect reported by the subjects. The only complain about the supplement was that it had a grassy taste because the supplement was made of green leafs and vegetable mix. On the other hand, most participants liked the taste of the supplements. The detailed contents of the supplement can be found in the NanoGreens bottle and the company Web site.

Limitations

There are many factors that could affect the outcome of the HRV, such as exercise, diet, and emotional states during the period in which the HRV was recorded. Another important factor in the HRV analysis is the duration of the study period. Longer-duration studies, such as greater than 6 months of treatment, might produce significant changes in HRV due to the set point of autonomic nervous system that requires longer treatment period to reset.[20] As well, no placebo was used; and this was not a blinded study. Thus, subjects in either group may have been influenced by these parameters.

As we have improved our study using hypertensive subjects, a control group, and a body weight measurement for a better insight of the hypertensive population with nutritional supplement, it is desirable to conduct a large-scale study to document the effect of the fruits and vegetable powder mix on hypertension. A limiting factor in the study was the fluctuations in the BP measurement that could affect the results of the study. We also noted the baseline differences of BP reading of the control and experimental groups. This difference was caused by the small sample size that was another limitation of the current study. Despite the limitations, fruits and vegetable powders seemed to cause no harm and might have potential cardiovascular benefits.[21,22]

Conclusion

After taking the NanoGreens10 supplement for 90 days, both the systolic and diastolic BPs were reduced in the study. There were no significant changes in body weight or HRV analysis after taking the supplement in either group.

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