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Baked bean consumption reduces serum cholesterol in hypercholesterolemic adults☆

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Abstract

Baked bean consumption has been linked to reductions in total cholesterol (TC), and low-density lipoprotein cholesterol (LDL-C) in previous research with hypercholesterolemic adult men in controlled settings. The objective of the current research was to determine if daily intake of half a cup of vegetarian baked beans would reduce risk factors for coronary heart disease and type 2 diabetes in free-living hypercholesterolemic men and women over an 8-week period. The study was a randomized, crossover, 2 × 2 block design. Participants received each treatment for 8 weeks with a minimal 14-day washout in between. Fasting blood samples collected at the beginning and end of the study were analyzed for TC, LDL-C, high-density lipoprotein cholesterol, triacylglycerols (TAG), high-sensitivity C-reactive protein, insulin, glucose, homeostasis model assessment, and hemoglobin A_{1c}. A significant absolute decrease in TC concentrations after 8 weeks ($P = .01$) was observed with the vegetarian baked bean treatment in contrast to the control. Mean percentage change of serum TC for baked beans was −5.6% ± 1.5% SEM in contrast to 0.5% ± 1.8% SEM for the control ($P = .01$). Mean percentage change of serum LDL-C was −5.4% ± 2.3% SEM and 1.0% ± 2.7% SEM ($P = .08$, nonsignificant), respectively. No significant differences were found with the other blood concentrations. These findings indicate that vegetarian baked bean consumption can reduce serum TC in hypercholesterolemic adults.

Keywords: Legumes; Lipids; Coronary heart disease; Hypercholesterolemia; Insulin; Glucose; Humans

1. Introduction

The health benefits of beans or legume consumption have received increasing attention from researchers and the media. Similar to other vegetables and fruits, legumes are an excellent source of many essential nutrients, including vitamins, minerals, fiber, phytochemicals, and antioxidants, as well as being associated with health-promoting benefits, such as lowering risk for chronic diseases including coronary heart disease (CHD). The Dietary Guidelines for Americans recommends including half a cup (130 g) in the diet several times a week for good health. Total recommendations per week are 3 1/2 cups [1].

Large-scale epidemiological studies have observed that CHD risk is lower among adults who frequently consume legumes. Results from the National Health and Nutrition Examination Survey Epidemiologic Follow-up Study indicate that men and women who reported consuming legumes

Abbreviations: BMI, Body mass index; CHD, Coronary heart disease; HbA1c, Hemoglobin A1c; hs-CRP, High sensitivity C-reactive protein; LDL-C, Low density lipoprotein cholesterol; MUFA, Monounsaturated fatty acids; PUFA, Polyunsaturated fatty acids; SFA, Saturated fatty acids; TAG, Triacylglycerols; TC, Total cholesterol.

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4 or more times per week had a 22% reduction in CHD risk, compared with those who consumed legumes less than once a week. Higher legume intakes were associated with lower body mass index (BMI), blood pressure, serum total cholesterol (TC), and a lower incidence of diabetes mellitus, compared with lower legume intakes [2]. A recent Costa Rican study observed that myocardial infarction (MI) survivors and their matched controls had a 38% lower risk of MI if they reported consuming at least 1/3 cup of cooked beans per day. Consuming amounts greater than this amount provided the same risk reduction but did not provide additional protection against MI [3]. The health benefits from beans appear to be multidimensional. In a 5-country longitudinal study of food habits among the elderly, legume consumption was the best predictor of survival. Risk of death was reduced by 8% for each daily 20-g intake of legumes [4].

Per capita consumption of navy beans at 1.3 lb ranks second only to pinto beans at 3.6 lb in the United States [5]. Most canned baked beans are made from navy beans [6]. Although 71% of pinto beans are eaten at places such as restaurants, 86% of navy beans are consumed in the home. US populations in the South and Midwest use 62% of the navy beans marketed in the United States [6]. Baked beans are also popular in Britain, with a per-capita consumption of 4 times that in the United States. Recent British national survey data indicate that young adults 19 to 24 years of age have shown an increase in baked bean consumption since the mid 1980s [7]. Thus, although baked beans are a popular food, the market share could be increased.

Several clinical trials have investigated the effects of baked beans on serum lipoproteins. Positive effects on CHD biomarkers have been reported. However, variations in previous study designs have made it difficult to compare studies to each other or to consistently replicate results. Some of the distinctions between trials include participant selection criteria, the amount of beans consumed, study period length, and types of outcomes measured [8]. Most studies have only included hypercholesterolemic men, and few have been with free-living populations.

Anderson et al [9] conducted some of the classic work in this area during the 1980s. They demonstrated that consumption of 275 g (~1 cup) of navy beans for 3 weeks decreased serum cholesterol concentrations by 19% and low-density lipoprotein cholesterol (LDL-C) by 24% in hypercholesterolemic men. A second trial showed reductions of 23% in serum TC and LDL-C under metabolic ward conditions with a similar bean diet [10]. During a 2-week intervention, Shutler et al [11] also found that baked beans significantly reduced mean serum TC by 12% ($P < .02$) and mean serum high-density lipoprotein cholesterol (HDL-C) by 15% ($P < .001$). No changes in serum triacylglyerols (TAG) were observed, and LDL-C was not reported in this study. In a third trial, Anderson et al [12] observed the lipid responses of 24 hypercholesterolemic men fed baked beans in a metabolic ward clinical feeding trial after 3 weeks but using 3 diets that contained canned beans in tomato sauce at different dosages. Diets A and B contained 227 g of baked beans, and diet C contained 182 g. Diet A was consumed as a single dose, whereas diets B and C were consumed as divided doses. Changes in individual serum TC, LDL-C, and TAG values were combined for all 3 diets consumed and reported as mean percentage changes of −10.4% ($P < .001$), −8.4% ($P < .005$), and −10.8% ($P < .05$), respectively. The mean percentage change in HDL-C was −6.9% ($P < .05$). In contrast to these positive findings, Cobiac et al [13] fed equal amounts of baked beans and spaghetti in tomato sauce (440 g) for 4 weeks each to 20 hypercholesterolemic men. Compared with baseline values, mean serum TC, LDL-C, and HDL-C, as well as serum TAG values, were not different after consuming the baked beans. The aim of the current study was to determine if eating half a cup of vegetarian baked beans for 8 weeks would result in improved biochemical markers of CHD in adults with hypercholesterolemia in a free-living setting.

2. Methods and materials

2.1. Participants

Participants from the campus and local communities were recruited through newspaper advertisements, e-mail lists, contacts with previous study participants, and posted flyers. Men and women between 22 and 70 years of age with a fasting serum TC concentration 200 mg/dL or greater and 260 mg/dL or less were eligible to participate. Exclusion criteria included pregnancy; use of cholesterol-lowering medications or supplements; expressed desire to lose weight; weight loss or gain in excess of 5 kg in the past 6 months; cigarette smoking or other long-term tobacco uses; and diagnosed diabetes, heart disease, stroke, hypertension, or cancer. Participants on other medications such as oral contraceptives or hormone replacement therapy were allowed to participate but were counseled not to change medication dosages during the course of the study. The institutional review board of Arizona State University approved all aspects of the study protocol (Human Subjects no. 07858-04). Each participant gave written informed consent.

Potential participants who met eligibility requirements were scheduled for a screening appointment. At this appointment, participants provided consent and completed a self-administered medical history questionnaire. A fasting venous blood sample taken by a trained phlebotomist went to an outside laboratory for lipid analysis. Participants were notified of their eligibility status within 1 week of the blood draw. Fifty-nine potential participants had fasting blood samples analyzed. Of these, 23 did not qualify because their cholesterol concentrations were either too low (n = 19) or too high (n = 4). Individuals were notified to consult with their

physician for follow-up if their TC concentrations were in excess of 260 mg/dL. Seven eligible people declined to start the study. Twenty-nine participants began the study with 23 (79%; 10 men, 13 women) completing both 8-week dietary intervention phases. Six people dropped out after completing 1 to 5 weeks of the study. Two were asked to drop because of missing 2 biweekly appointments, and 4 stated they did not have time to participate any longer.

2.2. Study design

The study design was an unblinded, 2 × 2 randomized crossover with a vegetarian baked bean treatment and a control treatment. Each of the 2 interventions lasted for 8 weeks separated by a minimal 2-week washout period in between. Sample size calculations indicated that 14 participants would be sufficient to detect a difference in 20 mg/dL of TC concentration change with a 2-sided significance level of .05 and confidence interval of 0.80. After the screening blood draw, participants were randomly assigned to start the baked beans or control (canned carrots) treatment first. All participants completed both and thus served as their own controls. Bush Brothers & Company (Knoxville, Tenn) provided the canned vegetarian baked beans made with navy beans (*Phaseolus vulgarus*). These were the standard process product available to consumers at grocery stores. The canned sliced carrots were Valu-Time brand (Topco Associates, LLC, Skokie, Ill) purchased at a local supermarket.

Data were collected between June 2005 and July 2006. Participants were asked to consume a single 1/2 cup serving of vegetarian baked beans or carrots, as well as the brine or liquid the food was packaged in, daily for 8 weeks as part of their usual diet. Participants received $120 in gift cards to a major retailer after completion of each 8-week study phase ($240 total). At the end of the study, participants were provided copies of all blood analyses, a personal food intake analysis report, and a consultation with the staff registered dietitian.

2.3. Dietary assessment

Participants completed a 2-day baseline diet record before the start of each intervention phase for a total of 4 days of baseline intakes. During the two 8-week trials, participants completed 24-hour diet records at 2-week intervals and 2 days before exiting for a total of 5 records per intervention phase. Days for diet record completion were rotated so that both weekday and weekend eating habits were recorded. Participants received test foods, recipes and serving suggestions for the food products and instructions to avoid other legumes, soy foods, or carrots during the trial. Each participant received a food scale and a set of measuring cups to weigh and measure foods on the days they kept food logs. Food log data were entered into Food Processor nutrient analysis software (v 8.4, ESHA Research, Salem, Ore). Nutrient intake was averaged over days of baseline intakes and those of each intervention phase.

Participant compliance was monitored and reinforced by staff through frequent contact. Participants met with the dietitian every other week to pick up additional cans of food product and to review their 1-day food log. They received a follow-up telephone call by a staff member on the alternate week. During the telephone call or meeting, participants were asked how many times they had eaten the food product, if they had difficulty fitting the food product into their diet, and if they experienced any gastrointestinal discomfort or changes because of eating the study foods. Staff encouraged compliance and offered serving suggestions for foods as needed.

2.4. Clinical measurements

At the first meeting, height was measured according to a standard procedure using a stadiometer (GPM, Carlstadt, NJ) [14]. Participants were asked to pick from a list which US Census 2000 race and ethnicity categories best identified them. Waist and hip circumferences (Gulick nonstretch, consistent tension measuring tape; Sammons Preston, Chicago, Ill) were recorded at the start and end of each 8-week trial. A 12-hour fasting blood draw was performed by a trained phlebotomist at the beginning and end of each 8-week study period. The Stanford 7-day physical activity recall questionnaire was administered at the beginning (start, week 1), middle (week 5), and end (exit, week 8) of each treatment phase to obtain information regarding the duration and frequency of physical activity engaged in during the previous week by participants [15]. Weight (Seca scale, Hanover, Md) and blood pressure (Moore Medical, New Britain, Conn) were recorded at each biweekly visit over the course of the study. At these visits, participants were reminded to keep their weight stable, to not alter their physical activity and exercise patterns, and to not change their diet other than the inclusion of the intervention food.

2.5. Blood collection and analysis

At the beginning and end of each test period, a trained phlebotomist performed a fasting blood draw with the participant seated. Blood samples were analyzed by Sonora Quest Laboratories (Tempe, Ariz) using a Roche Modular Analytic System for TC, HDL-C, TAG, high-sensitivity C-reactive protein (hs-CRP) and hemoglobin A_{1c} (HbA_{1c}). TC and TAG were assessed photometrically, and HDL-C was measured by an enzyme immunoassay. LDL-C was calculated using a modified Friedewald equation. Because the reagent used is unblanked, TAG is divided by 6 instead of 5 (Sonora Quest Laboratories). The absolute change and the percentage change in outcome variables were calculated for each individual. Glucose and insulin were analyzed via the standard colorimetric glucose oxidase assay and a standard radioimmunoassay, respectively. Insulin sensitivity was calculated with the homeostasis model assessment {HOMA = [fasting insulin (μU/mL) × fasting glucose (mmol/L)]/22.5} [16].

2.6. Statistical methods

The Statistical Package for the Social Sciences (SPSS, version 13.0, SPSS Inc, Chicago, Ill), was used for all data analysis. Analysis of variance was applied to detect differences in the means of variables at baseline and the end of each 8-week food treatment intervention period. Paired *t* tests were used to examine differences in measurements and percentage changes over time for each of the biochemical markers [17]. Data are presented as the mean ± SEM. Statistical significance was indicated by $P \leq .05$.

3. Results

Research findings are based upon the results obtained from 23 participants after completion of both the intervention and control phases (10 men, 13 women), with the exception of hs-CRP. One participant was excluded from data analysis of hs-CRP because of outlier values greater than 2 SD from the mean during most phases of the study. Most participants self-reported their race/ethnicity as non–Hispanic white (n = 18), Hispanic (n = 2) African-American (n = 2), and Asian-American (n = 1). Participant characteristics at study entry are shown in Table 1.

Self-reported dietary intakes were analyzed for mean macronutrient and selected micronutrient content over the course of the 2 intervention periods and baseline. A statistically significant difference in mean fiber intake was observed during the baked bean intervention phase. Total energy, protein, carbohydrate, fat, and other micronutrient intakes were not appreciably different between baseline and intervention phases (Table 2). These findings suggest that participants did not markedly change their diets other than the inclusion of the intervention foods.

Blood sample results, including serum TC, LDL-C, HDL-C, TAG, hs-CRP, glucose, insulin and HbA_{1c} concentrations, and BMI for the vegetarian baked bean and control treatments are presented in Table 3. Analysis of variance or *t* tests were used to evaluate variables for potential confounding by age, ethnicity, sex, treatment order, seasonality, or average daily nutrient intakes. No significant differences were found in the variables, physical activity, blood pressure, or weight change over the 2 treatment periods (data not shown).

A statistically significant decrease in absolute TC concentrations after 8 weeks ($P = .01$) was observed with the baked bean treatment in contrast to the control. Mean percentage change of serum TC for baked beans was −5.6% ± 1.5% in contrast to 0.5% ± 1.8% for the control ($P = .01$). The mean percentage change of serum LDL-C showed a trend toward significance for the baked beans, compared with the control (−5.4% ± 2.3%; 1.0% ± 2.7%; $P = .08$). High-density lipoprotein cholesterol, TAG, hs-CRP, glucose, insulin, HOMA, and HbA_{1c} concentrations did not change appreciably and were also not significant. After 8 weeks of daily ingestion of the control, half a cup of canned carrots, serum parameters showed minimal changes, as expected.

Table 1
Baseline characteristics of hypercholesterolemic men and women participants at study entry (n = 23 [a])

Characteristic	Mean ± SEM [a]	Range
Age (y)	45.9 ± 2.2	24-67
Weight (kg)	78.2 ± 3.6	59.5-118.2
Height (cm)	168.6 ± 2.0	154.8-185.8
BMI (kg/m^2)	27.4 ± 0.9	22.4-43.1
Fasting insulin (μU/mL)	22.5 ± 2.5	6.2-48.1
Fasting glucose (mg/dL)	103.4 ± 2.7	77.4-131.8
TC (mg/dL)	218 ± 3.5	188-244
LDL-C (mg/dL)	138 ± 3.7	110-177
HDL-C (mg/dL)	58 ± 3.4	39-92
TAG (mg/dL)	133 ± 11.2	50-221
hs-CRP (mg/L)	2.3 ± 0.6	0.2-9.4
HbA_{1c} (%)	5.6 ± 0.07	5.0-6.4
HOMA	7.0 ± 1.6	1.5-38.4

[a] n = 22 for hs-CRP due to 1 participant having concentrations in excess of 2 SD throughout the study.

Table 2
Mean nutrient composition of participant's daily dietary intake during vegetarian baked bean and control treatment and baseline phases

Nutrients *	Diet + baked beans (n = 101)	Diet + control (n = 102)	Baseline (n = 67)
Energy (kj/d)	8733 ± 0.5	8878 ± 0.42	8088 ± 0.43
Protein (g/d)	88 ± 5	88 ± 6	83 ± 6
Carbohydrates (g/d)	263 ± 18	265 ± 19	246 ± 16
Dietary fiber (g/d)	25.5 ± 1.7 [a]	20.7 ± 1.6 [b]	19.6 ± 1.3 [b]
Total fat (g/d)	73 ± 6	79 ± 7	72 ± 6
Cholesterol (mg/d)	280 ± 36	276 ± 31	275 ± 36
SFA (g/d)	24 ± 2	27 ± 3	24 ± 2
MUFA (g/d)	18 ± 2	17 ± 2	16 ± 2
PUFA (g/d)	7.8 ± 1.0	7.6 ± 0.9	7.4 ± 0.7
Calcium (mg/d)	713 ± 79	798 ± 74	738 ± 67
Iron (mg/d)	13 ± 1	14 ± 1	14 ± 1
Sodium (mg/d)	2917 ± 262	3280 ± 266	3146 ± 259

Data are presented as means ± SEM. Means in a row with different superscript letters are significantly different, $P < .05$.
SFA indicates saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids.
* n = no. of food records.

4. Discussion

This research compared the effects of baked beans and a control dietary intervention in hypercholesterolemic adults on serum lipids. Serum TC and LDL-C concentrations were lowered by approximately 6% and 5%, respectively, after baked bean consumption. A 1% reduction in serum TC reduces risk for CHD by approximately 2%. Similarly, each 1% reduction in serum LDL-C reduces risk for CHD by about 1% [18]. Thus, the mean percentage reductions observed in our trial are physiologically significant as they correspond to a substantial lowering of CHD from 5% to 12% [18].

Table 3
Coronary heart disease and type 2 diabetes risk factor values at beginning and end of each treatment phase

	Diet + baked beans			Diet + placebo carrots			*P* (*t* Test) (% change)
	Week 0	Week 8	Mean % change	Week 0	Week 8	Mean % change	
TC (mg/dL)	216 ± 5	203 ± 5	−5.6 ± 1.5	213 ± 4	213 ± 5	−0.5 ± 1.8	.01
LDL-C (mg/dL)	135 ± 4	127 ± 4	−5.4 ± 2.3	134 ± 3	132 ± 5	1.0 ± 2.7	.08
HDL-C (mg/dL)	58 ± 3	56 ± 3	−0.9 ± 1.7	58 ± 3	56 ± 3	−2.2 ± 2.0	.63
TC/HDL-C ratio	4.0 ± 0.2	3.8 ± 0.2	−4.2 ± 1.9	3.8 ± 0.2	4.0 ± 0.2	2.7 ± 1.9	.01
TAG (mg/dL)	139 ± 15	122 ± 10	−5.6 ± 8	129 ± 10	150 ± 16	12.1 ± 7.5	.11
hs-CRP (mg/L)	2.3 ± 0.5	2.5 ± 0.5	50.0 ± 32	2.5 ± 0.6	2.5 ± 0.6	5.9 ± 8	.18
HbA_{1c} (%)	5.7 ± 0.08	5.6 ± 0.08	−2.2 ± 1.2	5.6 ± 0.07	5.5 ± 0.08	−1.1 ± 1	.48
Glucose (mg/dL)	101 ± 2	99 ± 2	−1.6 ± 2	104 ± 3	104 ± 2	−0.3 ± 2	.54
Insulin (μU/mL)	21 ± 2	20 ± 2	−13.2 ± 10	26 ± 5	21 ± 2	−1.9 ± 8	.41
HOMA	5.3 ± 0.6	5.1 ± 0.5	−0.2 ± 9	6.7 ± 1.6	5.4 ± 0.6	−15.3 ± 13	.36
BMI (kg/m^2)	27.4 ± 1.0	27.4 ± 1.0	−0.06 ± 0.3	27.3 ± 0.9	27.3 ± 1.0	−0.10 ± 0.4	.99

Data are presented as means ± SEM, n = 23 except for hs-CRP, for which n = 22. Percent change means were calculated as the mean of the percent changes of individual.

The mean percentage of reductions in serum TC and LDL-C of 6% and 5% observed in our trial are in accordance with the reductions observed in most other trials that investigated baked beans or navy beans as part of a component of mixed legumes. Anderson et al [12] observed an 8.7% drop in TC and a 7.3% decline in LDL-C among hypercholesterolemic men in a metabolic ward fed 120 g of canned pork and beans once per day. Somewhat larger reductions in TC (11.6%) and LDL-C (10%) were seen in this study when the participants received the same dosage of 120 g of pork and beans split more than 2 times during the day. In an earlier parallel arm trial, Anderson et al found reductions in serum TC of 18.6% and LDL-C of 23% with the consumption of a 115 g mixture of dried pinto and navy beans among hypercholesterolemic men in a metabolic ward setting. These large reductions in TC and LDL-C were confounded by the participants losing weight during the study in addition to the bean intervention [12]. Weight loss alone will decrease cholesterol concentrations.

Jenkins et al [19] observed similar mean percentage reductions of 7% and 5% in serum TC and LDL-C in a free-living, hypercholesterolemic population fed pinto beans as a component of mixed legumes. In contrast, Mackay and Ball [8] noted almost no change in serum TC and LDL-C when navy beans were fed with other legumes (80 g or ∼1/3 cup) to free-living, hypercholesterolemic participants. The lack of change reported by Mackay and Ball may be due to the small quantity of legumes consumed, the combination of legume types, and use of a free-living population. Because the navy beans were fed with other legumes in each of these other trials, it is impossible to determine if certain legume types may have impacted the results more than others. Although comparison of our results with other studies that have investigated navy beans or baked beans is important, direct comparisons are difficult because of these different methodologies.

The secondary hypothesis was that serum HDL-C, TAG, and hs-CRP would not be altered with consumption of baked beans. These 3 parameters did not change significantly with the dietary treatment. In other studies, HDL-C has either typically not affected legume consumption or was lowered in some cases by as much as 7% to 20% [10-12]. All studies in which HDL-C values decreased also demonstrated reductions in TC, which may help explain the decrease in serum HDL-C values. For example, Anderson et al [10] reported a significant 20% reduction in mean serum HDL-C in addition to a 23% reduction in mean serum TC. Other trials have found reductions in serum TAG, although larger amounts of legumes were fed and often legumes replaced carbohydrate sources that may have been composed of simple rather than complex carbohydrates. Jenkins et al [19] observed a significant reduction in mean serum TAG of 25% after feeding 335 g mixed legumes, including pinto beans that replaced 25% of energy from other carbohydrate sources in the diet. Anderson et al [12] also observed similar results, as mean serum TAG was reduced significantly by 20% after feeding 240 g (∼1 cup) of navy and pinto beans combined. The simple and complex carbohydrate sources were controlled for in this diet and were equivalent to amounts in a control diet.

Although legumes are frequently recommended as a low-glycemic-index food, baked bean consumption over 8 weeks did not produce changes in glucose or insulin concentrations in the current study population. It is possible that the half cup dose was insufficient to produce a change in glucose and insulin in nondiabetic individuals. Nestel et al [20] noted similar findings with chickpea consumption in a non–insulin-resistant population. Of the 23 participants, 7 (30%) were insulin-resistant, as defined by a fasting insulin of 25 μU/mL or greater [16]. However, these 7 individuals had not been diagnosed as diabetic. Differences in glucose, insulin, or HOMA responses were not observed among these individuals in contrast to the non–insulin-resistant participants.

Several factors distinguish this trial from previous studies that have examined the effects of baked bean intake on variables relating to CHD risk. The duration of the intervention at 8 weeks was substantially longer than that

of many previous trials with baked beans, which have typically been only 3 to 4 weeks in length [9-12]. Because the study population included both men and women, the results apply more to the general population. The free-living conditions used allow the study results to be applicable to other free-living individuals. Assessment of baseline dietary intake before each intervention allowed for determination of any major changes in dietary intakes. Many previous studies have not noted the usual intakes of participants before providing an intervention. Without preintervention dietary data, it is impossible to determine if dietary intakes changed with treatments.

The quantity of legumes fed to participants in this clinical trial, half a cup daily or 3.5 cups weekly, was consistent with the most recent recommendations for legume intake set forth by US governmental health agencies. Although attempts were made to control dietary intake in other trials, by feeding such large quantities of legumes, dietary fat may have been displaced from the diet. Should this have occurred, it may partially explain the larger reductions observed in serum TC and LDL-C over shorter periods of only 3 to 4 weeks in some instances. In our trial, it is unlikely that fat was displaced in the diet because of the reasonable quantity of legumes consumed and the fact that dietary fat intake was not significantly different between the baseline and 3 dietary treatment phases.

Although the current study was not designed to examine the mechanisms by which the vegetarian baked beans might reduce cholesterol concentrations, there are a few possible explanations. These include fat displacement from the diet, direct binding of dietary cholesterol by viscous fiber in the intestine, interruption of bile acid enterohepatic circulation, inhibition of endogenous cholesterol synthesis by short-chain fatty acids, and the fermentation of resistant starches by bacteria present in the human colon [21]. It is difficult to speculate as to which mechanism or combination of mechanisms were responsible for the substantial reduction in both serum TC and LDL-C after the vegetarian baked bean treatment phase from our research. However, from a practical standpoint, the mechanism may not be as important as the simple fact that individuals who consume the vegetarian baked beans are achieving these reductions and reducing their overall risk for CHD.

This research provides evidence that baked beans can decrease risk of coronary heart disease through a reduction in both total and LDL-C in a free-living population of men and women. In conjunction with results from past studies, increased baked bean consumption can be recommended to lower the risk for CHD via improvement in serum lipoprotein parameters. The mean percentage reductions observed in our trial are physiologically significant because they correspond to substantial lowering of CHD from 5% to 12% [18]. Rising health care costs and concern with pharmaceuticals have heightened the public's interest in functional foods to reduce disease risk [22,23]. Although consumers often view legumes as an alternate inexpensive protein source for them, few are aware of the potential health benefits from legume consumption or their role as a functional food. Implementation of dietary changes that include increased consumption of baked beans and other legumes known to reduce risk for CHD is realistic and cost-effective in comparison with other more traditional interventions, namely, drug therapy, especially for individuals in the borderline rather than high-risk categories [24].

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