Soy protein may affect plasma cholesterol through copper

Dear Sir:

Potter et al (1) found that individuals with mildly elevated blood cholesterol concentrations benefitted from incorporating 50 g soy protein into daily diets as a partial replacement of dietary protein. This replacement decreased total cholesterol and low-density-lipoprotein (LDL) cholesterol concentrations in plasma. According to the authors, the mechanism is not known. Perhaps an increase in dietary copper contributed to the success of this experiment.

The first man to experience experimental copper depletion (2) responded with hypercholesterolemia, increased plasma LDL, and a short run of ventricular tachycardia. A depletion experiment involving more than 20 men produced an increase in LDL cholesterol and a decrease in high-density-lipoprotein (HDL) cholesterol (3) and was aborted because of a myocardial infarction, two tachycardias, and a second-degree heart block (4).

The Western diet seems to be low in copper. Klevay et al (5) found 32% of 849 daily diets contained < 1.01 mg Cu and 61% contained < 1.51 mg. These frequencies, which are based on pooled data from 10 dietary surveys in which copper was measured by chemical analysis, are in good agreement with earlier estimates (6). The daily recommended safe and adequate range is 1.5–3 mg according to the Food and Nutrition Board (7).

Soybeans are high in copper, exceeding in concentration 216 of the 235 foods evaluated by Lurie et al (8). If soybeans resemble ready-to-eat cereals, the copper is more closely associated with the fiber (9) than with the oil (8). Soy flour is high in copper, 40–50 µg/g, particularly when it is low in fat (10). The isolated soy protein had the highest protein content of the several products fed (1); it is lower in copper than soy flour at 16 µg/g (10).

Using the copper concentration given above, addition of isolated soy protein to the diet would have provided a daily copper supplement of 0.88 mg. The copper supplement from soy flour would have been greater because it is higher in copper and because more of it would have been fed because it is lower in protein. Nonfat dry milk is not likely to be high in copper because the classical copper-deficiency experiments were done with milk diets (11–14).

The copper supplements provided by soy products (1) are large in comparison with the amount of dietary copper proved insufficient for the men in the depletion experiments (0.83–1.02 mg Cu/d) (2–4). The supplements may have increased the daily copper intake of the subjects to the recommended safe and adequate range (7).

The mechanism by which an increase in dietary copper may have benefitted lipid metabolism is being elucidated. When dietary copper is adequate, hepatic glutathione is low, as is the activity of 3-hydroxy-3-methylglutaryl coenzyme A reductase. Copper deficiency increases the activity of this enzyme (15–17) only if glutathione is not allowed to increase (17, 18). Copper deficiency also decreases the activity of lecithin: cholesterol acyl-transferase (19, 20) and lipoprotein lipase (21). Changes in these three enzymes in copper deficiency promote hypercholesterolemia.

Hypercholesterolemic men (1) are more likely to be low in copper than those with low plasma cholesterol (6, 22, 23). The mechanism outlined here may complement those cited (1). Measurement of copper in the materials and diets in question may help to define the effective dose. Dietary copper probably was a more powerful determinant (24) of plasma lipid than dietary lipid in this experiment because the changes in lipid concentrations did not follow changes in dietary fat and cholesterol (1).

Leslie M Klevay
Northern Plains Area
Grand Forks Human Nutrition Research Center
University Station
Grand Forks, ND 58202-9034

References


Reply to LM Klevay

Dear Sir:

It was suggested that an increase in copper upon addition of soy protein to the diet contributed to the reduction in plasma total the low-density-lipoprotein (LDL) cholesterol we observed. This hypothesis is based on the observation that copper depletion in humans leads to increased total and LDL cholesterol, and decreased high-density-lipoprotein (HDL) cholesterol, and that addition of soy products to the diet would increase ingestion of copper. Although we did not monitor copper intake of our subjects, we do not have any reason to believe that aberrant copper status existed.

Our data indicated that isolated soy protein was more effective than soy flour in lowering total and LDL cholesterol. According to Klevay’s letter, the copper content of soy flour is two- to threefold higher than that of isolated soy protein (ISP). Therefore, if copper repletion was the causative factor associated with the cholesterol-lowering effect of soy protein, one would expect that when subjects consumed soy flour, greater reductions in total and LDL cholesterol would be observed. This was not the case, in fact ISP resulted in the lowest total and LDL cholesterol concentrations whereas consumption of soy flour resulted in a significant reduction in total cholesterol but not LDL cholesterol.

Klevay also states that with adequate copper intake, decreased concentrations of hepatic glutathione and decreased activity of HMG CoA reductase are observed. We have found that feeding gerbils intact ISP resulted in lower hepatic concentrations of GSH (as well as the lowest total and LDL cholesterol) compared with animals fed casein, amino acids corresponding to ISP, or amino acids corresponding to casein. HMG CoA reductase activity was highest in ISP-fed animals compared with casein (1). Thus, it appears that the animals in this study responded to some other factor in ISP besides copper.

Others have shown in rats and rabbits that the cholesterol-lowering effect of soy protein is present even when amino acids representative of soy are fed, albeit the response is not equivalent (2–4). This indicates that amino acid composition may be important in certain species but not in others. Moreover, components of soy other than the amino acid composition may lend to the effect. A copper effect cannot be completely ruled out, but it appears that other constituents of soy such as the amino acids, a peptide, or possibly phytochemicals associated with soy protein are more likely candidates.

Susan M Potter
John W Erdman Jr

Division of Foods and Nutrition
University of Illinois at Urbana-Champaign
445 Beavier Hall
905 South Goodwin Avenue
Urbana, IL 61801

References


Nutrition education for primary-care physicians

Dear Sir:

Last year this Journal focused much attention on nutrition education in medical schools (1, 2), and on the effect of an education program provided by a physician nutrition specialist on nutrition knowledge and practices of physicians in a family-practice residency program (3). Levine et al (4) also reported on their national survey of attitudes and practices of primary-care physicians relating to nutrition (4). Levine et al state that "we need to learn why this gap exists between interest and performance."

We are studying the barriers that primary-care physicians experience for nutrition interventions during medical practice. We carried out an extensive nationwide mail survey with the aim of mapping the daily practices of general practitioners (GPs) in nutritional matters in general and to define the factors that influence attitudes, knowledge, and behavior of GPs in the field of nutrition and nutrition education. The questionnaire used was the result of previous qualitative research (focus-group discussions and in-depth interviews). The sample consisted of 1,000 GPs, in practice 5–15 y. The net response rate was 64%. A further 7% completed the nonresponse questionnaire by telephone (25% gave reasons for refusal to complete the questionnaire, but refused to complete the nonresponse questionnaire). Treatment and prevention of overweight