2001 MAFMA Final Report

Project Title: **Cholesterol-lowering properties of ground beef enriched with phytosterols**

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1. Objective Summary

Our objective was to improve the nutritional quality of ground beef by incorporating cholesterol-lowering phytosterols. We used a hamster model in order to gather metabolic data that is not directly accessible in healthy human subjects, including liver cholesterol composition and concentration.

2. Objective Accomplishments

The objectives of this project were fully met, and the results have met our expectations. In previous studies, we reported that phytosterol-enriched ground beef could be used as a functional food to safely and effectively lower plasma cholesterol levels in a manner similar to the phytosterol-containing margarines available to consumers. The current project focused on whether the type of fatty acid used to make the phytosterol esters could enhance the cholesterol lowering effect. Because stearic acid is known to lower cholesterol, we addressed the question: Do phytosterol esters made with stearic acid lower plasma cholesterol more effectively than phytosterol esters currently used in the food industry?

An abundant source of stearic acid is beef tallow. Therefore, phytosterol esters were made using beef tallow fatty acids (27% stearic acid) or soybean oil fatty acids (3% stearic acid). Soybean oil, canola oil, and safflower oil are used in the commercial preparation of phytosterol esters, although these vegetable oils contain less than 5% stearic acid. Phytosterol esters were also made with purified stearic acid to verify that any metabolic effect observed with beef tallow was due to stearic acid. The phytosterol esters were incorporated into beef-based diets and fed to hamsters for 4 weeks.

Hamsters fed phytosterol esters made with purified stearic acid or beef tallow fatty acids had significantly reduced plasma total and LDL cholesterol levels compared to hamsters fed phytosterol esters made with soybean oil fatty acids. Similar reductions in intestinal cholesterol absorption were observed in hamsters phytosterol esters made with purified stearic acid or beef tallow fatty acids. Parallel reductions in liver cholesterol was also observed in hamsters fed phytosterol esters made with purified stearic acid or beef tallow fatty acids. Taken together, these data indicate that: (i) phytosterol esters can be successfully incorporated into ground beef-containing diets, (ii) consumption of ground beef enriched with phytosterol esters significantly

lowers both plasma and liver cholesterol concentration, (iii) phytosterol-induced reductions in plasma and liver cholesterol is due to reduced cholesterol absorption, and (iv) phytosterol esters made with beef tallow fatty acids reduce plasma cholesterol, liver cholesterol, and cholesterol absorption to a significantly greater extent than phytosterol esters made with soybean oil fatty acids.

3. Unexpected findings, if any

Although we expected phytosterol esters made with beef tallow fatty acids to be more effective at lowering plasma cholesterol compared to phytosterol esters made with soybean oil fatty acids, we did not expect the difference to be so dramatic. The average LDL cholesterol concentration in hamsters fed phytosterol esters made with soybean oil fatty acids was 108 mg/dL, whereas the LDL cholesterol concentration in hamsters fed phytosterol esters made with beef tallow fatty acids was only 30 mg/dL. (Current recommendations in the U.S. for reducing the risk of heart disease are to maintain LDL cholesterol levels of <130 mg/dL.) This finding is particularly noteworthy because the cholesterol-lowering margarines currently available to consumers contain phytosterols made with vegetable oils that have negligible amounts of stearic acid.

4. Practical impacts of research efforts.

a. Short Term Impacts

The immediate impact of this research is that commercial producers of phytosterol esters could easily switch from using vegetable oils to beef tallow, thus significantly enhancing the cholesterol-lowering ability of the phytosterol esters. Moreover, the data clearly demonstrate that phytosterol esters made with beef tallow can be successfully incorporated into a low-fat food, unlike currently available phytosterol esters made with vegetable oils that require a significant amount of fat be present in the food (e.g., margarine or salad dressing). Our industry partner is currently developing a line of low-fat beef products that contain phytosterol esters, and our data firmly establish the utility of phytosterol esters made with tallow as an ingredient in low-fat foods.

The improved functionality and application of phytosterol esters made with tallow is likely due to its physical state as a dry powder. Phytosterol esters made with vegetable oils yields a soft sticky mass that is not easily dispersed, thus limiting their use to foods high in fat. Phytosterol esters made with tallow could have much broader application to other food products in the short term.

b. Long Term Impacts

The long term impact of our research is three-fold. First, foods containing phytosterol esters made with beef tallow could be an effective cholesterol-lowering tool for consumers. Because the cholesterol-lowering ability of these phytosterol esters is so effective, they could easily be considered an alternative to drug therapy, thus reducing consumer costs and side effects that

many experience with prescription drugs. The broad application of phytosterol esters made with tallow would also give consumers a greater number of food choices. Providing more healthful food choices for consumers is important for those looking to optimize their diets while maintaining busy lifestyles.

The second long term benefit would be to the food industry. In 2000, sales of nutraceuticals and functional foods, fortified foods, and other “healthy” foods were over $50 billion. Developing food products that fall into these categories has been greatly enhanced by this research because of the broader application of phytosterol esters made with tallow. Current public perception regarding phytochemicals is already very positive, and the recent FDA approval of health claims for phytosterol-containing products will likely boost sales. Moreover, our industry partner will continue to focus on developing beef-based products that further promote the positive image of beef as a healthful food rich in high quality protein, iron, zinc, and several B vitamins.

The third long term benefit would be to the beef and soybean industries. Combining phytosterols with beef tallow fatty acids demonstrates a “healthful” application for beef tallow, thus greatly adding value to the tallow surplus. The soybean industry would benefit because the majority of phytosterols produced in the United States are extracted from soybeans. The method of isolating phytosterols does not disrupt the processing and application of other soy products, such as soy protein. Therefore, increasing the use and application of soy phytosterols will add value to a currently under-utilized component of soy.

5. Publications

A manuscript is currently being written and will be submitted for publication shortly.