Rice Bran and Rice Bran Oil Lower Human Heart Disease by Decreasing Cholesterol Synthesis

Hegsted and Kousik demonstrated that a breakfast meal containing rice bran or trice bran oil caused a decrease in the activity of HMG-CoA reductase, the key enzyme in cholesterol synthesis.

Rice bran and rice bran oil may lower heart disease risk by decreasing cholesterol synthesis in the body

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> A breakfast meal containing either rice bran or rice bran oil caused a decrease in the activity of HMG-CoA reductase, the key enzyme in cholesterol synthesis.

Elevated total and LDL cholesterol levels are associated with increased risk for developing heart disease. With the U.S. population becoming more health conscious, researchers and industries are expending considerable effort on developing and testing the effects of different dietary products on lowering the cholesterol levels of people at risk of heart disease due to high blood cholesterol. Recent research in the LSU Agricultural Center and elsewhere has shown that rice bran can lower cholesterol in humans. Research in India and the U.S. has shown that rice bran oil can lower cholesterol in laboratory animals and in humans. Animal studies suggest that the cholesterol lowering active ingredients in rice bran are in the nontriglyceride lipids present in rice bran oil.

The nontriglyceride fraction of rice bran oil is rich in compounds such as tocotrienols and gamma oryzanol. The synthesis of these compounds in plants starts out with the same identical steps used in the human body to synthesize cholesterol. As a result, it has been suggested that these compounds can act as regulatory agents to modify cholesterol synthesis. The human body normally regulates cholesterol synthesis by decreasing production of cholesterol when dietary cholesterol raises blood cholesterol levels. These plant products in rice bran oil may act by the same pathway to decrease cholesterol synthesis in the body, by inhibiting the key regulatory enzyme for cholesterol synthesis. This process is known as end-product inhibition, where an increase in the end-product of an enzyme decreases the activity of the enzyme so less end-product will be made. The cholesterol synthesis regulating enzyme is Hydroxy-Methyl-Glutaryl-Coenzyme A reductase, better known as HMG-CoA reductase. The cholesterol lowering drug, lovastatin (brand name Mevacor), functions by decreasing HMG-CoA reductase activity. However, lovastatin is expensive and has side effects for some patients. Thus, a dietary change that can lower cholesterol synthesis by decreasing HMG-CoA reductase without serious side effects would be beneficial.

Two studies were conducted in the School of Human Ecology to examine the effects of rice bran and rice bran oil on HMG-CoA reductase activity.

Methods and Results

Study I. Human Pilot Study

Four subjects participated in a pilot study to examine the postprandial (after eating) response to a meal containing rice bran, rice bran oil, wheat bran

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(negative control), or wheat bran + cholesterol (positive control). Meals were identical except for specific dietary treatments. Subjects fasted overnight and came to the Human Ecology building for an initial blood sample to be taken at 7:30 am. They were then fed a breakfast meal containing one of the four different dietary treatments. Blood samples were taken again at 9:30 am, at 11:30 am, at 1:30 pm, and at 3:30 pm. A lowfat lunch meal was served immediately after the noon blood sampling. Subjects returned at two-week intervals for a total of four study days until each subject had received each of the four treatments in a random order.

Blood samples were analyzed for total cholesterol, HDL, LDL, and VLDL cholesterol, triglycerides, apolipoprotein A1, and apolipoprotein B. Leukocytes were isolated from the whole blood and analyzed for HMG-CoA reductase activity.

HMG-CoA reductase activity increased after the control breakfast meal containing wheat bran. This is the expected morning response to a breakfast meal for HMG-CoA reductase activity. However, the rice bran, rice bran oil, and wheat bran + cholesterol diets all showed a decrease in HMG-CoA reductase activity within two hours of the breakfast meal. This difference decreased gradually until there were no differences between the four diet treatments by 2:00 in the afternoon.

There were no differences in total, LDL, VLDL, or HDL cholesterol responses to the meal treatments. There were no treatment effects on either apolipoprotein A1 or apolipoprotein B. Plasma triglycerides rose after the meal as expected. There were no significant differences in triglyceride responses among the diet treatments.

Study II. Rat Study

Sixty adult male rats were randomly assigned to one of four dietary treatments. The rats were fed one of the following cholesterol containing diets for two weeks: control; 38 percent rice bran; 8 percent rice bran oil, chemically refined; and 8 percent rice bran oil, physically refined.

At the end of the two-week feeding period the rats fasted overnight and one-third of each diet group (five rats per diet) were sacrificed (time 0). The remaining rats were fed for three hours, all the food was removed, and the second one-third were sacrificed (time three hours). The last one-third of the rats were sacrificed three hours later (time six hours). Total cholesterol and triglycerides were analyzed in blood samples. Liver samples were analyzed for HMG-CoA reductase activity.

Overall, rice bran and physically refined rice bran oil diets lowered HMG-CoA reductase activity in comparison to the control diet.

Rice bran signficantly lowered total cholesterol in comparison to the control diet and tended to decrease triglycerides. Neither rice bran oil signficantly affected cholesterol or triglyceride levels.

Discussion

The human study confirms that rice bran and rice bran oil can mimic the effect of dietary cholesterol in decreasing the activity of the key regulatory enzyme for cholesterol synthesis. The decrease in activity of HMG-CoA reductase lasted about four hours, suggesting a need for the presence of rice bran or oil in each meal daily, not as a single dose. In a previous human study, where rice bran was incorporated into breakfast, lunch, and dinner meals, an overall 7 percent decrease in cholesterol was found. Rats fed the rice bran diet consistently had lower plasma cholesterol levels than the control fed rats and tended to have lower triglyceride levels. Neither rice bran oil had an overall effect on plasma cholesterol or on triglycerides. All three rice bran products tended to have a lower fasting level of HMG-CoA reductase activity, but only rice bran and physically refined rice bran oil had a significant effect in lowering overall HMG-CoA reductase activity.

Based on the rat fasting lipid values, it appears that rice bran itself is more effective than either rice bran oil in lowering cholesterol levels. However, previous work with rats as an animal model for cholesterol metabolism have not shown a consistent effect of rice bran in lowering cholesterol. The cholesterol reducing activity of rice bran is supported by the decreased activity of HMG-CoA reductase activity seen with the rice bran diet. However, physically refined rice bran oil also decreased overall HMG-CoA reductase activity, but showed no corresponding decrease in total cholesterol level in the rat. This suggests that there may be other constituents present in rice bran besides lipid fractions that may alter cholesterol levels.

The physically refined rice bran oil had a greater effect on HMG-CoA reductase activity then chemically refined rice bran oil, supporting the hypothesis that nontriglyceride components in the oil may be responsible for lowering the enzymes activity. The chemical or caustic refining of oil removes most of the nontriglyceride fraction from the oil, thus removing what is believed to be the active components of the rice bran oil. The rice bran oil used in the human study was physically refined oil which should have maximal cholesterol-lowering capacity.

Overall, the two studies indicate that there are active components in rice bran and physically refined rice bran oil which can inhibit HMG-CoA reductase activity in vivo in both humans and rats, thus decreasing cholesterol synthesis. Further work is necessary to examine the long-term effects of feeding rice bran or rice bran oil to people with elevated cholesterol levels. ■

Rice bran: as a viable source of high value chemicals

Development of by-products of the rice industry has been hampered by the likelihood of limited economical potential. Rice production in this country is not widespread, and thus reduces the likely quantity of raw material available for by-product production. The large costs normally associated with product development, coupled with the limited potential supply of raw materials, has precluded efforts to utilize by-products. Therefore, it is generally believed that by-product development in the rice industry is only feasible when production costs are low relative to the value of the resulting product.

Rice bran has a unique composition of microconstituents that have been suggested to have economic potential as high value additives to food, pharmaceuticals, and cosmetics. We have been interested in the antioxidant compounds present in rice bran as they relate to sensory quality. However, these compounds may have even greater importance relative to their value as by-products.

The principal antioxidant compounds present in rice bran are tocopherols, tocotrienols and oryzanols. The first two include eight different isomers, commonly referred to as vitamin E. Oryzanols are a complex group of chemical compounds that are esters of the phenolic compound ferrulic acid.

Vitamin E and other antioxidant nutrients are receiving considerable attention for their perceived health benefits. Tocotrienols have been suggested to have potent serum lowering potential. Oryzanols have also been suggested to lower serum cholesterol and are important additives to cosmetics, especially skin lotions, because of their ability to absorb ultraviolet light. The Japanese have recognized the value of oryzanols and have developed techniques to extract these compounds from rice oil as a valuable by-product.

We have developed an analytical scale liquid chromatography procedure to quantitate these compounds in rice bran because of our interest in maximizing stability relative to oxidative degradation. The Audubon Sugar Institute has had an ongoing interest in chromatographic separation of sugars from molasses and has assembled extensive commercial and pilot scale liquid chromatographic capabilities. These facilities could be employed in an effort to scale-up the analytical chromatographic procedures to commercial scale applications utilizing the chromatographic capabilities of the Audubon Sugar Institute. Optimization of the extraction and separation procedures needed to accomplish this goal have been proposed.

It is our belief that the importance of the targeted chemical compounds as valuable by-products of the rice industry will increase tremendously in the current marketplace that demands "natural" components of food and cosmetics. Our proposed program for the extraction and concentration of the target compounds will generated patentable technology with great economic and licensing potential. ■

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