Comparative Studies on Soy Protein and Rice Protein for Cholesterol Metabolism in Rats

Akira YOSHIDA, Hideo FUKUI, Yoritaka AOYAMA, and Hiroaki ODA

Department of Agricultural Chemistry, Nagoya University, Nagoya 464-01, Japan

Summary The serum level of cholesterol in rats fed a diet containing soy protein isolate was lower than that in rats fed either casein or rice protein at the level of 15% even after one day feeding, although fecal excretion of bile acids of rats fed soy protein isolate was almost equal with that of rats fed rice protein. Similar effect was also observed in the secretion rate of lipoproteins from the liver. Dietary proteins may affect the synthesis of apolipoproteins directly or through the hormonal system.

Key Words serum cholesterol, soy protein isolate, rice protein, lipoprotein secretion, fecal bile acids

The hypocholesterolemic effect of soy protein has been studied by many workers comparing it with casein, and it has been considered that this is the common effect of all plant proteins.

We previously reported that the serum level of cholesterol in rats fed a rice protein diet was as high as that in rats fed a casein diet. However, the fecal excretion of bile acids and neutral sterols were significantly higher as compared with the casein diet group. Excretion of bile acids by the rice protein diet group was comparable to that of the soy protein group. These results may suggest that the lower rate of cholesterol and bile acid absorption wouldn’t be the single main reason for the hypocholesterolemic effect of soy protein.

In the present experiments, the time course of serum level of cholesterol and fecal excretion of bile acids were investigated. The effects of dietary protein on the excretion of lipoprotein from the liver, cholesterol absorption, and lipoprotein lipase activity were also examined.

Animals and diets

Male rats of the Wistar strain were used throughout the experiments.

Experimental diets contained 15% of protein and appropriate amounts of vitamins and minerals. Dietary protein was casein, soy protein isolate or rice protein concentrate. Rice protein concentrate contained about 50% of proteins. Cholesterol was not included in the diets. Rats were fed diets ad libitum except the special cases.

Results and discussion

There were no difference in body weight gain among the 3 groups.

Time course changes in plasma cholesterol are shown in Fig. 1. Plasma levels of cholesterol of the casein group were almost constant for the first 10 days. In contrast to the casein group the plasma level of cholesterol significantly dropped after one day feeding of the soy protein diet, reaching its lowest level on the second day and keeping that level thereafter.

The cholesterol level of the rice diet group, dropped slightly for the first few days but returned to a similar level to that of casein. Thus we can see a clear difference between soy protein and rice protein.

In contrast to the plasma level of cholesterol, fecal weights were lowest for the casein diet group during the week, and highest for the rice protein group. Fecal weights of soy protein group were between the other 2 groups.

Fecal excretion of bile acids showed a similar figure (Fig. 2). The values of the casein diet group were lower than the other 2 groups through the experimental period. The rice group showed a high plasma level of cholesterol and high fecal excretion of bile acids. Therefore, the hypocholesterolemic effect of soy protein cannot be simply explained by higher excretion of fecal bile acids.

After only one day, liver weight (per 100 g BW)
Fig. 1. Effect of dietary casein, soy protein isolate (SPI) or rice protein concentrate on serum level of cholesterol in rat.

Fig. 2. Effect of dietary casein, soy protein isolate (SPI) or rice protein concentrate on fecal excretion of bile acids in rats.

Fig. 3. Effect of dietary casein, soy protein isolate (SPI) or rice protein concentrate on the plasma accumulation of cholesterol and triglyceride in rats after intravenous injection of Tyloxapol.

of the soy protein group was lower than the other 2 groups. Similarly, liver cholesterol and triglyceride of the soy protein group were also lower. These results indicate the low plasma level of cholesterol of the soy protein group is not due to the accumulation of lipids in the liver. Probably both synthesis and excretion of liver cholesterol would be lower for the soy protein group.

In the next experiment excretion of VLDL from the liver was measured by using an inhibitor of VLDL, Tyloxapol. As indicated in Fig. 3, the accumulation of cholesterol and triglyceride 3h after intravenous injection of Tyloxapol was lower in the soy protein group after one day on the experimental diet.

The effect of dietary protein on cholesterol absorption was determined by the dual isotope ratio method of Zilversmit in the absence and presence of experimental diet in the digestive tracts.

In the first experiment, animals were fed the respective experimental diets for 26 weeks. Eighteen h after fasting, 14C-cholesterol was injected intravenously and 3H-cholesterol was orally administered. Twenty-four, 48, 72, and 96 h after the administration of isotopic cholesterol, blood was taken and the ratio of 3H and 14C was determined. Six h after the administration of labeled cholesterol animal were fed the respective experimental diet ad libitum.

In the second experiment, all animals were kept on the casein diet, and fasted for 18 h and animals were fed the casein, soy protein or rice protein diet for 30 min, and then administered the isotopic cholesterol. Blood was collected 24, 48, 72, and 96 h after the administration of the labeled cholesterol.

Absorption of cholesterol were not different among the 3 groups when the experimental diets...
were not present in the digestive tracts.

Even when the experimental diets were present in the digestive tracts, the isotope ratio was not significantly affected by dietary proteins.

However, the absorption of cholesterol in rats fed a casein diet containing 4% cholestyramine, and in fasted rats, was significantly lower than in the other 3 groups 24 h after injection of isotopic cholesterol.

Both soy and rice protein diets stimulated fecal excretion of bile acids but they might not significantly affect cholesterol absorption even though the fecal bile acid excretion increased in SPI and rice protein diet groups.

Postheparin lipolytic activity was almost the same for the 3 groups. However, the hepatic triglyceride lipase activity of the casein diet group was higher than the other 2 groups, and the lipoprotein lipase activity of soy protein and rice protein groups were slightly higher than for the casein group. The results imply that lipoprotein lipase activity wouldn’t relate the serum level of cholesterol in these dietary conditions.

In conclusion, the hypocholesterolemic effect of soy protein appears in the early stage of feeding. The early difference in the secretion of lipoproteins from the liver may be at least one of the important factors involved in the hypocholesterolemic effect of soy protein. Dietary proteins may also affect the synthesis of apolipoproteins directly or through hormonal system. These points are now being studied.