EFFECT OF PROTEIN SOURCE (SOYBEAN VERSUS WHEY) UPON SERUM CHOLESTEROL LEVELS OF THE PIG

S.A. Norton[1], C.G. Beames, Jr.[2] and C.V. Maxwell[3]

Story in Brief

Four Yorkshire barrows were used in a Latin square experiment to determine the effect of whey versus soybean protein on blood cholesterol in pigs. Diets were fed without or with .5% supplemental cholesterol. When soybean protein was replaced by whey with no supplemental cholesterol, there was a slight but nonsignificant increase in blood cholesterol. Added dietary cholesterol increased serum cholesterol, but when soybean protein was replaced by whey in diets containing .5% cholesterol, serum cholesterol was significantly reduced. A protein source by cholesterol interaction was noted. In swine fed a high cholesterol diet, whey is more hypocholesteremic than soy protein.

Key Words: (Serum Cholesterol, Dietary Cholesterol, Whey, Soy Protein)

Introduction

Previous biomedical investigations have demonstrated a correlation between the incidence of atherosclerosis, diet, and serum cholesterol levels. Researchers have shown that serum cholesterol levels can be elevated by adding high levels of chemically isolated cholesterol, and by varying the ratio of polyunsaturated to saturated fats.

Other dietary nutrients may also influence levels of serum cholesterol and the incidence of atherosclerosis. Specifically, milk and milk products have been suggested to exacerbate hypercholesteremic (increasing blood cholesterol) effects by increasing both fat and animal protein intake Dietschy, et al.,1978). Recently, however, several reports have indicated that certain components of whole, skim, fermented and unfermented milk products may be hypocholesteremic (decreasing blood cholesterol) (Kritchevsky et al., 1979; Mann, 1977; Richardson, 1978).

The hypocholesteremic effects of milk and milk products have not been monitored in swine extensively. Declines in both total and HDL-cholesterol have been observed in pigs fed large amounts of whey, but only slight depressions in serum triglyceride titers were apparent. The exact mechanism of this response in swine to whey feeding, and the nature of the interaction of whey with other dietary components remains unknown. A clearer understanding of the hypocholesteremic effect of whey is particularly important since it conflicts with the general attitude that animal proteins are hypercholesteremic relative to vegetable proteins. This study was conducted to further investigate the influence of dietary protein source (whey versus soybean meal) and dietary cholesterol on serum cholesterol levels in the pig.

---

[1]Graduate Assistant [2]Professor [3]Professor

Materials and Methods

Four Yorkshire barrows weighing approximately 60 kg were utilized in a 4 X 4 Latin square design with a 2 X 2 factorial arrangement of diets. Each pig was surgically fitted with an indwelling jugular catheter to accomodate daily blood collection and randomly assigned to one of four diets (Table 1). Diets consisted of 11.3% soybean meal + 0% cholesterol (Diet1), 11.3% soybean meal + .5% cholesterol (Diet 2), 40% dried whey + 0% cholesterol (Diet 3), and 40% whey and .5% cholesterol (Diet 4). Whey or soybean meal was provided as the supplemental protein source in corn-soy based diets formulated to supply .62% lysine. Each experimental period lasted 14-d followed by a 7-d interim during which a basal diet was fed to allow serum cholesterol levels to stabilize before the initiation of the next period. In addition, at the start of each period pigs were weighed to readjust feed intake to 2.8% of bodyweight. Water was available ad libitum.

At 0700 h each day a 10 ml whole blood sample was drawn and the cannulas immediately flushed with 10 ml of 2.8% sodium citrate in .9% saline. Blood samples were allowed to clot at approximately 4 C for 3 hours after which time the serum was extracted from the sample by centrifugation at 3000 x g for 20 min. Serum was stored at -20 C until total cholesterol analyses were performed.

Table 1. Percent composition of basal and experimental diets.

Item	Basal	Diet 1	Diet 2	Diet 3	Diet 4
Corn, ground	75.60	74.45	73.95	46.40	45.90
Whey, dried	0.00	0.00	0.00	40.00	40.00
Soybean Meal	21.15	11.30	11.30	0.00	0.00
Animal Fat	0.00	8.00	8.00	8.00	8.00
Meat and Bone Meal	0.00	5.00	5.00	5.00	5.00
Dicalcium Phosphate	1.50	.55	.55	0.00	0.00
Cholesterol[a]	0.00	0.00	.50	0.00	.50
Salt	.50	.35	.35	.35	.35
Vitamin-TM Premix	.50	.25	.25	.25	.25
Calcium Carbonate	.75	.10	.10	0.00	0.00
COMPOSITION					
Dry Matter	87.65	89.57	89.66	92.02	91.83
Crude Protein	15.96	14.04	14.00	11.40	11.36
Ether Extract	2.53	9.95	9.02	9.17	9.52
Lysine	.79	.62	.62	.62	.62
Calcium	.69	.71	.71	.90	.90
Phosphorus	.63	.63	.63	.68	.68

[a] Sigma Chemical Co., USP Grade

Results and Discussion

Mean serum cholesterol concentrations across all sampling days for four experimental diets are presented in Table 2. Serum cholesterol values were low but similar in pigs fed diets without supplemental

Table 2. Serum cholesterol concentrations as influenced by basal and experimental diets.

Diet Description	N	Serum Cholesterol [a,b]
Diet 1		
Control w/o Cholesterol	16	86.62[c]
Diet 2		
Control w/ Cholesterol	16	158.36[d]
Diet 3		
Whey w/o Cholesterol	16	89.70[c]
Diet 4		
Whey w/ Cholesterol	16	135.02[e]

[a] Values expressed as mg/dl.

[b] Standard error of mean for all values +/- 2.46.

[c,d,e] Means in the same column with different superscripts differ (P<.0001).

dietary cholesterol. Adding .5% cholesterol (diets 2 and 4) increased serum cholesterol levels (P<.0001). However, response to added cholesterol differed with protein source (P<.0001). Serum cholesterol was approximately 15% lower with whey than with soybean meal as a source of dietary protein (diet 4 versus diet 2). This response indicates that whey had a hypocholesteremic effect only when the diet contained .5% supplemental cholesterol.

The response of serum cholesterol over time on each test diet is presented in Figure 1. Serum cholesterol of pigs offered diet 1 and 3 increased slightly and linearly (P<.0001) from day 0 to 4 with only a small fluctuation between 85 and 95 mg/dl for the remainder of the 14-d period. The slight increases observed between days 0 and 4 may represent an adaptation to the switch from the lowfat basal ration (% ether extract = 2.8%) to the higher fat content of experimental diets (% ether extract = 9.28%).

Among pigs fed the soy with added cholesterol (diet 2), serum cholesterol exhibited a quadratic increase (P<.0001) to approximately 200 mg/dl at day 11 after which levels decreased and stabilized at 185 mg/dl for the duration of the period. A similar quadratic increase (P<.0001) in serum cholesterol was observed for pigs fed the whey protein diet with added cholesterol (diet 4), except that the increase was more gradual.

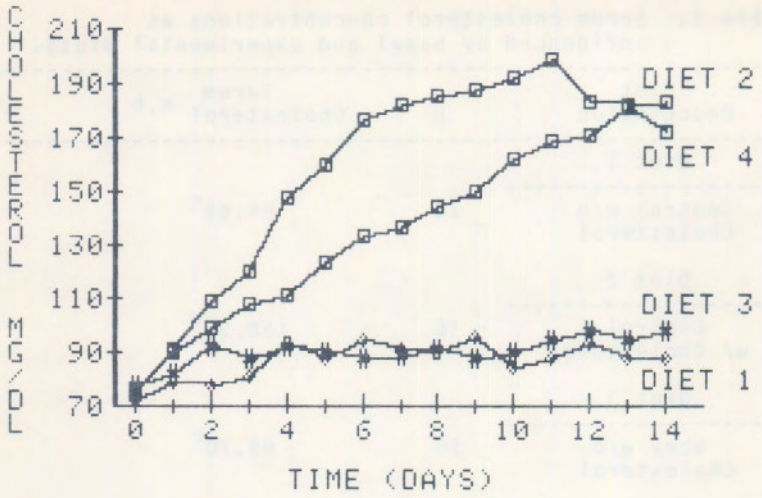

Figure 1. Response of serum cholesterol over time to experimental and basal diets.

The results of this trial indicate that dietary whey protein reduces the increase in serum cholesterol in pigs fed a high cholesterol diet. This supports the position that milk and milk products do contain a hypocholesteremic factor(s). Since blood levels had not fully stabilized by day 14, longer-term studies are needed to determine the effects under steady state conditions. The mechanism whereby this effect occurs still remains to be elucidated. Since the human diet varies in composition from day to day, and milk and milk products have hypocholesteremic effects with variable diets, past criticism of milk products should be reevaluated.

Literature Cited

Dietschy, J.M, et al. 1979. Disturbances in lipid and lipoprotein metabolism. American Physiological Society, Bethesda, MD.

Kritchevsky, D., et al. 1979. Influence of whole or skim milk on cholesterol metabolism in rats. J. Clin. Nutr. 32:597.

Mann, G.V. 1977. A factor in yogurt which lowers cholesteremia in man. Atheroschlerosis 26:335.

Richardson, T. 1978. The hypocholesteremic effect of milk--A review. J. Food Protect. 41:226.