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THE EFFECTS OF NEONATAL DIETARY CHOLESTEROL ON TISSUE CHOLESTEROL AND CARCASS CHARACTERISTICS OF GROWING PIGS SELECTED FOR HIGH OR LOW SERUM CHOLESTEROL

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INTRODUCTION

Coronary heart disease is a topic that in recent years has attracted much attention from researchers, the media, and the general public. Coronary heart disease stemming from atherosclerosis is caused by a variety of factors. Diet was first linked to coronary heart disease during the Depression in the United States and during World War II in Western Europe. In those times, consumption of animal products such as milk, eggs, butter, and cheese declined along with the mortality rate from coronary heart disease. With the successful selection of pigs with high and low serum cholesterol, several aspects of animal production and cholesterol metabolism can be investigated. Utilizing these genetic strains, data were collected and analyzed to determine differences in carcass traits due to the effects of high and low cholesterol diets, and to evaluate differences in cholesterol distribution in various tissues.

MATERIALS AND METHODS

Female pigs, genetically selected for either high (n = 12) or low (n = 12) serum cholesterol, were used to determine the effects of either high (.5%) or low (0%) cholesterol levels in the neonatal diet on tissue cholesterol content and carcass measurements at 6 mo of age. Pigs were removed from their dams at 1 day of age and assigned within litter to either low or high cholesterol diets so as to form 4 groups: genetically low plasma cholesterol pigs fed low cholesterol diets (n = 6) or high cholesterol diets (n = 6) and genetically high plasma cholesterol pigs fed low cholesterol diets (n = 6) or high cholesterol diets (n = 6). All pigs were kept in individual cages and fed their respective diets *ad libitum* from 1 to 28 days of age. From 4 to 8 weeks of age, all pigs were kept in pairs and fed the low cholesterol diet, after which all were kept in groups of 4 in concrete floor pens and full-fed a high (.5%) cholesterol diet until 6 months of age. Animals were converted to carcasses, and carcass measurements and organ weights were collected. Lipid extraction, and cholesterol assays were performed on each collected sample. Statistical analysis was performed using the General Linear Models procedure on SAS (SAS, 1986). No interactions were found to be significant. Significance level was assigned at $P < .05$.

RESULTS AND DISCUSSION

Brain cholesterol concentration was affected by diet ($P < .02$), but not by genetics. The concentration of the high cholesterol diet groups was more than that of the low cholesterol diet groups (2,793.8 mg/100 g and 2,391.5 mg/100 g, respectively). Zhang et al. (1994) showed that, in genetically selected lean and obese pigs, cholesterol feeding had little effect on cerebrum cholesterol concentration. Their theory states that cholesterol synthesis in the brain is constant and is not controlled by the same mechanisms of synthesis in other tissues. Included in this postulate is the idea that regardless of serum cholesterol concentration, cerebrum cholesterol level remains unchanged, possibly because the brain synthesizes almost all the sterol it requires. In contrast, Schoknecht et al. (1994) found in pigs genetically selected for high or low serum cholesterol and fed varying amounts of cholesterol in the neonatal diet that total cholesterol in the cerebrum was greater in the cholesterol-fed pigs. This finding, as well as the present study, contradict the commonly accepted fact that cholesterol does not cross the blood-brain barrier. This variance from the accepted theory may be explained because newborn piglets may not have the ability to produce endogenous cholesterol in the amounts necessary to supply their growth needs. Schoknecht et al. (1994) showed that cholesterol supplementation caused an increased growth rate in both groups of pigs, but especially in the low serum cholesterol group where genetic selection may have decreased the ability to produce enough cholesterol endogenously.

Means for liver cholesterol concentration of 403.3 mg/100 g for the high diet groups were higher than the 345.7 mg/100 g of the low diet groups ($P < .03$). These findings are supported by other researchers (Zhang et al., 1994). A clear-cut mechanism for this event is unknown, but it has been shown that the liver is the site of cholesterol storage in times of high cholesterol intake.

Mean cholesterol concentrations in the muscle and fat samples were not significantly different. Mean cholesterol concentrations were slightly higher for the high diet groups than the low diet groups in the longissimus dorsi (74.9 mg/100 g and 72.9 mg/100, respectively) and semitendinosus (97.1 mg/100 g and 95.6 mg/100 g, respectively). Although not significantly different, subcutaneous fat mean cholesterol concentration for the low diet groups, 151.2 mg/100 g, was slightly higher than the high diet groups, 148.6 mg/100 g. These findings indicate that serum cholesterol concentration has no effect on the cholesterol content of tissue cholesterol.

Brain weight was affected by diet ($P < .03$) but not by genetics. Weight of brain was heavier in the high cholesterol diet group than in the low cholesterol group. Pond et al. (1992) found similar results. When brain weight was examined as a percentage of body weight, the brain of the low cholesterol diet group was a higher percentage of body weight than was the brain of the high cholesterol diet groups. Liver weight also was affected by diet ($P < .01$), but again, no effect of genetics was seen. The liver of the high diet groups weighed more than the liver of the low diet groups. Live weight was affected by both diet ($P < .01$) and genetics ($P < .05$). Live weight was heavier for the high diet group than for the low diet group. Backfat thickness at the first rib, last rib, last lumbar vertebra, and fat thickness at the 10-11th rib interface, showed no significant differences when the actual measurements were examined. Analyzing these measures as a percentage of body weight showed that a difference existed as an effect of diet at the first rib, last lumbar vertebra, and at the 10-11th rib interface (Table 1). The low cholesterol diet group had backfat measurements that were a larger percentage of body weight than the high cholesterol diet groups. These finding concur with those of Pond et al. (1992). Data on the four lean cuts showed that all were affected by diet (Table 2). When these same data were analyzed as a percentage of body weight, only the trimmed ham was affected by diet. This finding might suggest that animals have similar proportions even though they differ in body weights.

Table 1. Effect of genetics and diet (high serum cholesterol-high cholesterol diet, HH; high serum-low cholesterol diet, HL; low serum cholesterol-high cholesterol diet, HL; low serum cholesterol-low cholesterol diet, LL) on carcass traits as a percentage of body weight.

	Group				Probability	
Item	HH	HL	LH	LL	Diet	Genetic
Hot carcass weight, %	71.1	69.6	72.5	72.9	.05	.63
Backfat first rib, %	1.9	2.0	2.2	2.3	.01	.29
Backfat last rib, %	1.0	1.2	1.3	1.3	.07	.53
Backfat last lumbar vertebra, %	1.7	1.4	1.8	1.9	.05	.34
Fat depth, 10th-11th rib interface, %	1.5	1.1	1.5	1.1	.01	.60

Table 2. Effect of genetics and diet (high serum cholesterol-high cholesterol diet, HH; high serum-low cholesterol diet, HL; low serum cholesterol-high cholesterol diet, HL; low serum cholesterol-low cholesterol diet, LL) on four lean cuts in kg.

	Group				Probability	
Item	HH	HL	LH	LL	Diet	Genetic
Rough ham, kg	7.5	6.7	7.1	5.8	.01	.10
Trimmed ham, kg	6.5	5.6	6.2	4.9	.01	.11
Rough loin, kg	8.6	8.1	8.0	6.6	.05	.04
Trimmed loin, kg	6.2	5.6	6.1	4.7	.01	.12
Rough shoulder, kg	7.4	6.7	6.9	5.5	.01	.04
Boston butt, kg	1.9	1.8	2.0	1.5	.02	.12
Picnic shoulder, kg	2.7	2.5	2.2	1.9	.03	.17

CONCLUSION

High or low cholesterol diet during the suckling period affected brain and liver cholesterol concentration, but not muscle cholesterol concentration. Brain, liver, and live weights also were affected by high or low cholesterol diet. Only live weight was affected by genetically determined high or low serum cholesterol. These data suggest that cholesterol concentration in the neonatal diet of swine affected later development.

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