DIETARY FAT AND SEX CLASS EFFECTS ON SERUM CHOLESTEROL AND CARCASS TRAITS IN GROWING PIGS SELECTED FOR HIGH OR LOW SERUM CHOLESTEROL

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SUMMARY

At approximately 8 weeks of age, four-way cross (Chester White x Landrace x Large White x Yorkshire) pigs (n = 24) were selected based on genetically high (H) or low (L) serum cholesterol levels — 12 from each genetic group — to determine the relationship between genetics, diet and sex class on serum cholesterol and carcass characteristics. Boars and gilts, six each from the two genetic groups, were assigned randomly to one of three dietary treatments for 46 days. A standard grower diet was modified to include either beef tallow (T), corn oil (CR) or coconut oil (CC), and the pigs were given ad libitum access to feed. Cholesterol was added to each diet to ensure that the measured changes were due to fat sources and not cholesterol differences between the diets. There were no differences between boars and gilts at the initial evaluation or at the end of the treatment; therefore, means were pooled for statistical analyses. No differences were found for live weights taken on day 1, 18, 29 and 46. Blood samples were taken on day 1, 29, and 46 via the jugular vein. The total serum cholesterol concentration was different between the two genetic groups at the start of the study (H = 129±6, L = 104±5; $P < .01$), and the genetic influence remained throughout the experiment (ending values: H = 151±10, L = 130±7; $P < .10$). Differences ($P < .01$) were found between dietary treatments for total cholesterol on day 29 (T = 178±11, CR = 129±10, CC = 151±8), but by day 46, differences were resolved. Pigs were slaughtered on day 46, and carcass data were collected. There were no differences in fat deposition at the first rib, 10th rib, last rib, or last lumbar vertebra, but differences were found between genetic groups for longissimus muscle area (H = 21.0±.8, L = 18.1±1.0; $P < .05$) and USDA muscle score (H = 2.1±.1, L = 1.7±.1; $P < .05$).

Introduction

Data have shown that high levels of total fat in the diet increase serum cholesterol levels and are correlated with increased risk of coronary heart disease. Therefore, reducing the total fat intake in a person's diet should help reduce their risk for heart disease. Several studies have addressed the effects of dietary fat source on lipoprotein and cholesterol concentrations using both animal and human models.

Baldner-Shank et al. (1987) fed young growing pigs diets with different protein sources (soy protein isolate or ground beef) and different fat sources (soybean oil or beef tallow). They determined that plasma cholesterol, LDL cholesterol and HDL cholesterol values were not affected by type of dietary protein; however, the pigs fed soybean oil had lower levels of plasma cholesterol, LDL cholesterol and HDL cholesterol than those fed beef tallow. Conversely, Faidley et al. (1990) fed young growing pigs diets that contained soy oil, beef tallow, or a blend of beef tallow and soy oil, and discovered that concentration of plasma cholesterol was not affected by changes in dietary fat. Fernandez and McNamara (1990) evaluated guinea pigs fed diets containing corn oil, olive oil and lard at two levels (7.5 and 15%). The animals fed corn oil had a significantly lower plasma cholesterol level than the animal fed olive oil or lard for both fat levels, and the plasma cholesterol level was higher for all animals fed the 15% fat diet compared to the 7.5% fat diet. Scott et al. (1991) investigated the source of dietary fat using human subjects and found similar changes in lipoprotein profiles for subjects on a lean beef diet versus a chicken and fish diet. Lin et al. (1992) studied the interaction between dietary fat and quantity of dietary cholesterol by feeding guinea pigs diets with fat from lard, olive oil or corn oil with varying levels of added cholesterol. The results revealed that increasing dietary cholesterol increased plasma cholesterol and LDL cholesterol concentrations. Lin et al. (1992) also noted changes in hepatic cholesterol accumulation with the lard-fed animals having the lowest accumulation of cholesterol.

Materials and Methods

At approximately eight weeks of age, twenty-four, four-way-cross (Chester White X Landrace X Large White X Yorkshire) pigs were selected based on genetically high or low cholesterol levels — twelve from each genetic group. The pigs were obtained from swine bred by USDA/ARS that had been selected for seven generations for their genetic propensity toward high or low serum cholesterol (Young et al., 1993).

Boars and gilts were selected and assigned randomly to one of three dietary (Table 1) treatments. Each group of pigs were placed on the appropriate dietary treatment for six weeks. The dietary treatments provided fat in the form of beef tallow (Merrick's, Inc., Union Center, WI), corn oil (J.M. Swank Co., North Liberty, IA), or coconut oil (Merrick's Inc., Union Center, WI). Cholesterol (ICN Biochem., Cleveland, OH) was added to each of the diets to ensure that the measured changes in serum cholesterol were due to fat sources and not cholesterol differences between the diets. The feed was mixed at Prairie View A&M University (Prairie View, TX). The feed intake was monitored daily, and the body weight was recorded every 2 weeks during the treatment phase.

Blood was analyzed during weeks 1, 3 and 6 of the study. Samples were taken from the anterior vena cava for all 24 pigs to determine total serum cholesterol. The pigs were fasted for 12-16 hours before blood was collected.

At the end of the feeding period, the pigs were anesthetized by electrical stunning followed by exsanguination and commercial processing procedures. The following carcass characteristics were measured: hot carcass weight; fat thickness at the first rib, 10th rib, last rib and last lumbar vertebra; longissimus muscle area; USDA muscle score and carcass length.

Data were analyzed as a 2 (genetic group: high or low cholesterol) X 3 (fat source: tallow, corn oil, or coconut oil) design. Analysis of variance procedures were performed on these data using SAS (1988). When significant differences were found, means were separated using Student-Newman-Keuls procedures using SAS (1988).

Results

There were no differences between boars and gilts at the initial evaluation or at the end of the treatment; therefore, means were pooled for statistical analyses. No differences were found for live weights taken on day 1, 18, 29 and 46. This disagrees with Pond et al. (1992) which reported the body weight of pigs selected for high serum cholesterol to be greater than those selected for low serum cholesterol. However, these differences could relate to dietary treatment differences between the studies rather than genetic influence.

As anticipated, the total serum cholesterol concentration was different between the two genetic groups at the start of the study (H = 129±6, L = 104±5; $P < .01$). This is consistent with the difference in cholesterol values in the larger population of high and low cholesterol pigs from which these were sampled, as well as those used by Pond et al. (1992). The genetic influence remained throughout the experiment (ending values: H = 151±10, L = 130±7; $P < .10$); however, the level of significance decreased probably due to the variation seen within the high cholesterol genetic group.

Differences ($P < .01$) were found between dietary treatments for total cholesterol on day 29 (T = 178±11, CR = 129±10, CC = 151±8), but by day 46 differences were resolved and the cholesterol was declining. The rise in serum cholesterol between day 1 and day 29 indicates a response to the diets, and the decline betwee day 29 and day 46 indicates the animals adjusted to the dietary treatment over time. This differs from Pond et al. (1992) which demonstrated an increase in serum cholesterol over time when pigs bred for high or low serum cholesterol were fed high-fat, high-cholesterol or low-fat, low-cholesterol diets.

There were no differences in fat deposition at the first rib, 10th rib, last rib, or last lumbar vertebra, but differences were found between genetic groups for longissimus muscle area (H = 21.0±.8, L = 18.1±1.0; $P < .05$) and USDA muscle score (H = 2.1±.1, L = 1.7±.1; $P < .05$). Pond et al. (1992) evaluated the effect of dietary fat and cholesterol in pigs selected for high or low serum cholesterol, and they found the pigs with high serum cholesterol to have less fat thickness at the 1st rib, last rib, and last lumbar vertebra than those with low serum cholesterol. However, Miller et al. (1990) fed swine different levels of monounsaturated fats and noted no differences in first rib fat thickness, longissimus muscle area, but differences were found for the last-rib fatness.

Conclusions

This study indicates that genetic influence had a greater impact on serum cholesterol concentration and muscle growth than did dietary fat source or sex class in growing pigs selected for high or low serum cholesterol. Additional research is needed to determine the relationship between fat source and tissue accretion of cholesterol between the high and low cholesterol groups.

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List of Tables

Table 1: Composition of corn oil, coconut oil, and tallow diets.

Table 2: Effects of diet (corn oil, coconut oil, and tallow) and genetic selection (high or low cholesterol) on body weight, serum cholesterol, and carcass characteristics of growing swine.