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Does Beef Inclusion in a Modern Diet Influence Risk Factors for Obesity-Related Metabolic Disorders in a Swine Biomedical Model

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Objectives

Using swine as a model for humans, the objectives of this project were to determine if replacing sugar with beef in a total western diet (TWD) would alter body composition and risk factors for obesity-related disorders.

Materials and Methods

Twenty-four Berkshire gilts were obtained at weaning and transported 1,480 km to the NDSU Animal Nutrition and Physiology Center (Fargo, ND). Upon reaching 18 kg, gilts were sorted, blocked by litter and weight, and penned individually. Gilts were assigned a treatment (TWD vs. GB) and provided feed at 3.7% of body weight (BW; 12 gilts/treatment) for 91 d. A TWD was developed for swine using the 2007 to 2008 National Health and Nutrition Examination Survey with micronutrients corresponding to American intakes at the 50th percentile when adjusted for nutrient density (mass of nutrient/calorie). For GB, cooked ground beef (70:30 lean:fat) replaced sugar in TWD on a kcal for kcal basis. Blood samples were collected on d0 at start of treatment and then every 28 d. Weekly BW were taken and subcutaneous fat depth (FD) and longissimus muscle area (LMA) were measured at the 10th rib on d 42, 56, 70, and 91. Fat-free lean as a percentage of BW (FFL%) was calculated using FD, LMA, and live BW. Data were analyzed as repeated measures using the mixed procedure of SAS (SAS Inst. Inc., Cary, NC) with fixed effects of treatment, day, and treatment by day with pig as the repeated variable.

Results

The GB gilts had superior BW, LMA, and FFL% gain over time ($P < 0.01$). Actual anatomical measures at completion found GB had larger LMA (33.1 cm^2 vs. 14.3 cm^2; $P < 0.01$), less FD (2.0 cm vs. 3.1 cm; $P < 0.01$), and greater FFL% (51.6 vs. 32.0%; $P < 0.01$) than TWD, respectively. Blood chemistry treatment differences were observed for blood sodium, hematocrit, and hemoglobin reading higher for GB vs. TWD ($P < 0.01$). Stunting of growth, attenuation of muscle deposition, and increased adiposity were partly alleviated in GB vs. TWD. Total, low-density lipoprotein, and high-density lipoprotein cholesterol levels were lower in GB ($P < 0.05$) on d 17 and d 45. The TWD gilts developed porcine acne and thinning of hair compared to GB gilts. A GB gilt became non-ambulatory and was removed from test. A modified necropsy revealed a diagnosis of rickets, resulting in termination of the project at d 91. During final processing, it was discovered that both treatments possessed uncharacteristically brittle bones.

Conclusion

Ground beef gilts exhibited significantly more muscle mass and less body fat. Subjective evaluation of surface area of skin acne lesions and hair thinning was less in GB gilts. Compared to conventional swine diets, TWD was much lower in several minerals. Both treatments exhibited brittle bones and the heavier GB were less ambulatory by d 91. The nutritional shortfalls of the diets are obvious to swine nutritionists because of extensive production research which is absent in human nutrition. This study holds relevance to American dietary patterns because swine, being the best dietary model for humans, cannot thrive consuming what the average American eats. Further analysis is necessary to determine the physiological relationship to human nutrition.