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Effects of replacing supplemental sucrose with beef during mid-to-late gestation on maternal health and fetal development using a sow biomedical model (#547)

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Introduction

An ongoing concern within the human population is the worldwide epidemics of obesity and diabetes associated with consumption of the modern western diet; a diet high in added and refined sugar, salt, and carbohydrates [1 – 3]. Between 2005 – 2010, American men and women 20+ years consumed an average of 13% of total daily calories from added sugar, 3% higher than the recommended intake [4, 5]. The objectives of this study were to investigate the influence of substituting supplemental sucrose with beef on maternal health and fetal development in sows used as a biomedical model. It was hypothesized that dietary treatment would have minimal influence on maternal health indicators while fetuses from sucrose supplemented sows would have greater body weights and would be more likely to be susceptible to metabolic diseases.

Methods

Pregnant multiparous crossbred sows (BW = 222 kg; n = 21; replicates = 3) were individually housed in gestation stalls from d 30 to 111 (± 0.58) of gestation. From d 30 to 39 of gestation, a complete sow ration (corn-soybean meal-based, CSM) was fed at 1% of d 30 gestational BW at 0700 h. On d 39, daily dietary ration was adjusted to 1% of d 39 gestational BW which was fed daily at 0700 h from d 40 to 110 (± 0.58) of gestation. Sows were randomly assigned to one of four isocaloric supplement treatments; 126 g CSM to serve as a control (CON, n = 5), 110 g cooked ground beef (BEEF, n = 6), 85.5 g sucrose (SUCR, n = 5), or 54.8 g BEEF and 42.7 g SUCR (B+S, n = 5). Dietary supplements were fed daily at 1100, 1500, and 1800 h from d 40 to 110 (± 0.58) of gestation. Blood was collected via jugular venipuncture from sows on d 29 and 111 (± 0.58) of gestation. Blood chemistry was immediately analyzed and serum samples were collected for total, HDL-, and LDL-cholesterol and insulin concentrations. Bodyweights were measured on d 30, 39, 54, 68, 82, 96, and 111 (± 0.58) of gestation. Tenth rib and last rib subcutaneous (SQ) fat depth were measured on d 35, 70, and 110 (± 0.58) of gestation. Sows were euthanized on d 111 (± 0.58). Reproductive tract, pancreas, kidney, liver, heart, heart fat, lung, semimembranosus and adductor (SM), and semitendinosus (ST) weights were recorded from each sow. Color scores were obtained for kidney and liver. Fetal growth measurements were recorded for all fetuses. Two median weight male and female fetuses were selected from each sow for tissue collections. Fetal pancreas, kidney, liver, heart, heart fat, lung, SM, ST, and testes weights were recorded. A repeated measures design, with sow as the repeated measure, was modeled using the MIXED procedure of SAS using compound symmetry variance covariance matrix. Sow data fixed effects were replicate and treatment. Fetal data fixed effects were replicate and fetal weight category. Fetal weight category was determined as overweight, normal, or underweight. Covariates were determined for each trait depending on goodness of fit. Treatment by day interaction was used for sow data. Fetal data were analyzed using treatment by sex interaction. Alpha level was 0.05.

Results

Dietary treatment did not influence gestational BW ($P \geq 0.99$), SQ fat depth ($P \geq 0.09$), blood chemistry ($P \geq 0.21$), or serum concentrations ($P \geq 0.07$). Dietary treatment did not influence sow tissue weight ($P \geq 0.42$). Compared to BEEF and SUCR, CON and B+S sows had a more yellow colored liver (greater b*; 4.41 ± 0.43, 5.58 ± 0.38, 2.89 ± 0.37, and 1.90 ± 0.47, respectively; $P = 0.01$). Compared to CON, BEEF fetuses had increased BW ($P = 0.01$), crown to rump length ($P = 0.01$), nose to crown length ($P < 0.01$), heart girth ($P = 0.02$), and abdominal girth ($P = 0.05$). Dietary treatment did not influence fetal growth characteristics of median weight male and female fetuses ($P \geq 0.23$). Compared to BEEF, fetuses from SUCS sows had heavier liver weights (31.43 ± 2.06 g and 40.13 ± 2.09 g, respectively; $P = 0.04$). There was a dietary treatment by sex interaction for fetal kidney weight with BEEF males having lighter kidney weights compared to all other interactions ($P = 0.03$). Dietary treatment did not influence any other fetal tissue weight ($P \geq 0.09$). As hypothesized, dietary treatment had minimal effects on maternal health parameters. It is not known how the observed differences in liver color and kidney weight may influence hepatic and renal function during development and adulthood. The increase in SUCR fetal liver weight could be due to increased amounts of hepatic triglyceride concentrations [6]. Further analysis is required to determine susceptibility of metabolic disorders due to fetal programming in both fetal liver and kidney.

Conclusion

Beef and/or sucrose supplementation during mid-to-late gestation has minimal effects on maternal health and fetal development.

Notes