FINAL REPORT:

A Comparison of Three Novel Fat Sources to Yellow Grease in Cattle

Prepared by T.A. Wickersham and J.R. Baber

Objectives

1. Determine the effect of fat source on intake and digestion in cattle consuming a finishing ration.
    a. *Intake was not impacted.*
    b. *Digestion was not impacted with the exception of IP, which improved.*
2. Determine the effect of fat source on ruminal biohydrogenation and fatty acid profile reaching the duodenum relative to the diet.
    a. *Biohydrogenation was not impacted; however, IP was numerically lower.*
    b. *Only minor differences in fatty acid profile reaching duodenum.*

Data Summary

1. In contrast to the previous attempt to complete this project, diets were effectively mixed and sampled close to formulated values (Table 1).
2. No differences in intake were observed (Table 2).
3. There were no differences in fecal excretion, except IP which excreted less in the feces than VOP.
4. Measures of ruminal digestion for OM, NDF, ADF, and starch seem reasonable for AF, VOP, and PHOS (Table 3). Values for IP are higher than expected and should not be used to draw conclusions. Additionally, there is no mechanism for EE and AH to be digested in the rumen. In fact, with low fat diets negative digestibilities are expected because of microbial synthesis of lipids. Therefore, these data should not be used to draw conclusions. Acceptable digestibilities for the other nutrients suggests our sampling protocol prevented accurate collection of duodenal samples for determination of both EE and AH. Suggestions to improve this are welcomed.
5. Measures of total tract digestion seem reasonable; however, IP maybe higher than expected. Digestibilities of OM for the three steers completing this treatment were 82, 83, and 70%. These maybe attributed to a marker problem, especially given the aforementioned observations of ruminal digestion. Significant differences were detected between IP and VOP for OM, ADF, starch, and AH.
6. There were numerous differences in fatty acid intake between the treatments (Table 4). These differences should be attributed to differences in the fatty acid profile of the treatments as intake did not differ between treatments.
7. Fatty acid profile at the duodenum differed between AF and the other three treatments for 14:0, 16:0, 17:0, 20:0, C:20:2, and C 20:4 (Table 5).
8. Biohydrogenation of 18 carbon fatty acids ranged from 78 to 92%.
9. Fecal excretion of individual fatty acids did not differ between treatments (Table 6).
10. Treatments did not significantly impact ruminal fermentation data, with the exception of minor and biologically insignificant changes in the percentage of acetate (Table 7).

11. One period of ruminal ammonia concentrations were compromised preventing us from drawing meaningful conclusions.

Materials & Methods

Animal Work: The experimental protocol was approved by the Institutional Animal Care and Use Committee at Texas A&M University.

Four Angus steers fitted with ruminal and duodenal cannulas were used in a 4 × 4 Latin square design experiment. Steers were housed in an enclosed barn in individual pens and had ad libitum access to water and commercial trace mineral blocks. Four treatments were compared: 1) animal fat and CCDS, 2) VOP and CCDS, 3) Interphase/Kappa, and 4) Phos. Diets consisted of 37.5% dry-rolled corn, 15% alfalfa, 15% cottonseed hulls, 15% of the test fat CCDS mixture, 15% dried distillers grains, 1% limestone, 1% 12/12 mineral mix and 0.25% urea. All ingredients except alfalfa and cottonseed hulls were mixed prior to starting each period and alfalfa/cottonseed hull mixture was added on the day of feeding to improve diet uniformity, based on our observations in a previous experiment. Four experimental 12 d periods were used, each consisting of 6 d for adaptation, 5 d for intake and digestion measurements, and 1 d for sampling rumen fluid for ruminal pH, VFA, and NH_3 measurements. Diets were fed daily at 0730 and were offered ad libitum consumption. On d 7 through 10 diet samples were obtained before feeding. Feed refusals were collected and sub-sampled before feeding on d 7 through 10. Feed and feed refusals were dried at 55°C for 96 h then weighed for partial dry matter (PDM) and frozen at -20°C.

On d 8 through 11, duodenal and fecal samples were collected 3 times daily and immediately frozen at -20°C. Duodenal and fecal samples were collected every 8 h with sample time advancing 2 h each day thus samples were obtained at 2 h intervals in a 24 h period over a 4 d collection period. Approximately 500 g of whole ruminal contents was collected once daily on d 8 through 11 for rumen bacteria. Ruminal contents were immediately blended for 5 minutes in a Waring blender with 500 mL of 0.9% saline solution. Blended ruminal contents were strained through 2 layers of cheesecloth and the strained liquid was frozen at -20°C. Collection times advanced 6 h each day thus samples were obtained at 6 h intervals in a 24 h period over a 4 d collection period. On d 12, a suction strainer (Raun and Burroughs, 1962; 19 mm diameter, 1.5 mm mesh) was used to collect rumen fluid samples prior to feeding (0 h) and 3, 6, 9, 12, and 18 h after feeding. A portable pH meter was used to measure the pH of each sample immediately after each sampling time. Subsamples were prepared for later determination of VFA and NH_3 and frozen at -20°C. Before freezing, 8 mL of rumen fluid was combined with 2 mL of 25% *m*-phosphoric acid for VFA analysis, and 9 mL of rumen fluid was combined with 1 mL of 1 *N* HCl for NH_3 analysis.

Laboratory analysis: Feed, orts, and fecal samples were dried at 55°C in a forced-air oven for 96 h, air-equilibrated, then weighed to determine partial DM. Duodenal samples were lyophilized. Feed, orts, duodenal, and fecal samples were ground in a Wiley mill to pass a 1-mm screen. Feed, orts, and fecal samples were composited by steers across days within period. Acid detergent insoluble ash (ADIA) concentrations of feed, orts, duodenal, and fecal samples were determined. Feed, orts, duodenal, and fecal samples were dried at 105°C in a forced-air oven for 24 h to determine DM then ashed for 8 h at 450°C to determine OM. Nitrogen was measured using the Elementar rapid N cube (Elementar, Hanua, Germany) and CP was calculated as N × 6.25. Feed, orts, duodenal, and fecal samples will be analyzed for NDF and ADF using an Ankom Fiber Analyzer with sodium sulfite and amylase omitted and without correction for residual ash (Ankom Technology Corp., Macedon, NY).

Rumen fluid samples were thawed and centrifuged at 20,000 × *g* for 20 minutes. Volatile fatty acid concentrations were measured using a gas chromatograph with methods described by Vanzant and

Cochran (1994). Ammonia N concentrations were measured using a UV-vis with colorimetric procedures described by Broderick and Kang (1980).

Calculations: Acid detergent insoluble ash was used as a digestion marker to estimate digestibility. Duodenal and fecal output was calculated as amount of ADIA (g/d) consumed divided by the concentration of ADIA in the duodenal digesta and feces (g/g of DM). Nutrient digestibilities were calculated by the following formula: [1-(output of nutrient/intake of nutrient)] × 100.

Statistical Analysis: Intake and digestion were analyzed using the MIXED procedure of SAS (SAS Inst. Inc., Cary, NC). Terms in the model were treatment and period with steer included as the random effect. Fermentation profile variables were analyzed using the MIXED procedure of SAS. Terms in the model were treatment, period, hour and hour by treatment with steer and treatment by period by steer include as random terms. The repeated term was hour with treatment by steer serving as the subject. Compound symmetry was used as the covariance structure. The LSMEANS option was used to calculate treatment means. Treatment means were separated using the PDIFF option of SAS.

Table 1. Nutrient composition of experimental diets fed to steers

Item	AF	VOP	IP	PHOS
OM, %	94.1	93.5	93.2	93.6
CP, %	12.8	12.7	14.0	12.8
NDF, %	35.6	36.1	36.6	36.0
ADF, %	22.5	22.1	22.8	22.3
Starch, %	28.8	28.7	26.4	27.3
Ether Extract, (**EE**) %	6.3	6.0	5.7	6.3
Acid Hydrolysis, (**AH**) %	7.3	6.7	7.0	7.1