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Review: Lipid Addition to Corn Finishing Diets

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Summary

The fat content of distillers grains with solubles (DGS) partially accounts for DGS feeding value being greater than corn. Finishing diets containing DGS to supply up to 8% of diet DM as fat may be fed without depressing cattle performance. However, feeding diets containing 8% diet fat with corn oil depresses cattle performance. The difference in rumen metabolism of these two fats is due to physical protection of DGS fat from interaction with rumen microbes. Due to an unknown mechanism, condensed corn distillers solubles, a liquid fat source, does not limit ruminal metabolism like corn oil. Optimum dietary fat level is dependent on the sources of fat in the diet.

Introduction

Based on greater caloric density of fat versus starch and protein, it makes sense to replace a portion of lesser energy starch or protein from feedlot diets with fat. However, there are upper limits to the level of dietary fat that cattle in a feedlot can ingest without affecting rumen function and depressing feeding performance. These upper limits may be lipid source dependant based on the degree of fatty acid saturation and physical structure. Therefore, University of Nebraska–Lincoln feedlot research evaluating fat addition to dry-rolled (DRC) and high-moisture corn (HMC) diets was summarized to evaluate feeding traditional and byproduct fat sources.

Procedure

A series of six feedlot and metabolism studies evaluating different fat sources compared to distillers grains with solubles (DGS) were reviewed to better understand fat metabolism of different feedstuffs. Evaluated was the addition of fat to corn diets from corn oil, tallow, condensed corn distillers soluble (CCDS), or DGS, in addition to the impact of decreasing lipid content of DGS on cattle feeding performance (*2004 Nebraska Beef Cattle Report*, pp. 45-48; *2007 Nebraska Beef Cattle Report*, pp. 39-42; 2009 *Nebraska Beef Cattle Report*, pp. 64-66; 2010 *Nebraska Beef Cattle Report*, pp. 74-76; *2011 Nebraska Beef Cattle Report,* pp. 44-45).

Review

CCDS and DGS Products

Both CCDS and DGS fats are from the dry milling ethanol industry. These fats both have been subjected to a low pH environment during the fermentation process of producing ethanol and heating to distill ethanol. Once the ethanol is removed, the remaining stillage is centrifuged to separate the liquid distillers solubles fraction from the remaining fermentation solids. Water is removed from the soluble stream (95% moisture) to form CCDS (65% moisture). Often times, the CCDS are combined back with the grains fraction to make wet DGS (WDGS; 65% moisture). The WDGS may have additional heat energy applied to produce dry DGS (DDGS; 10% moisture). The CCDS accounts for about 20% of DGS DM. Some ethanol plants also sell CCDS as a separate feed ingredient.

Different Forms of Fat

Corn oil, CCDS, and DGS fat all originate from corn. However, these fats are not equal in feeding value. Differences are partially due to physical form. Fat in vegetable oils is mainly in the form of unsaturated fatty acids. Unsaturated fats differ from saturated fats in the bonding structure of the carbons in the fatty acid molecules. Saturated fats are "saturated" when they have as many hydrogen atoms attached to the carbons as possible. Unsaturated fats have fatty acids that contain stronger bonds between carbons that can accept additional hydrogens and alter the shape of the fatty acids. Corn oil is a liquid at room temperature, and thus, unsaturated and is readily available for rumen microbial interaction. The CCDS also is a liquid. The fat of CCDS is slightly more saturated than the fat in corn oil due to the fermentation and heat used to produce ethanol. However, CCDS not only contains fat (10-35% of CCDS DM) but also protein from yeast cells and corn, in addition to other nutrients. The fat in the grains fraction of DGS is trapped in the ground corn germ particles. This fat is protected from interaction with rumen microbes due to the germ particles physically inhibiting interaction of lipid with microbes. The ratio of CCDS to grains at the ethanol plant and CCDS % fat impacts the final fat profile of DGS. The corn fiber and protein also are concentrated in grains fraction of DGS.

Beef tallow is an example of how ruminants can modify dietary unsaturated fatty acids to a more saturated fatty acid profile. The tallow is from cattle fed unsaturated corn fatty acids, but the ruminal microbes have altered the corn oil fat before the fat was incorporated into carcass tissues. The more saturated fatty acids of tallow are not as detrimental to microbial function in the rumen as corn oil.

Fat and Rumen Function

The ruminant has the unique ability to modify dietary unsaturated fatty acids to saturated fatty acids with rumen microbes. This process is known as biohydrogenation. Fatty acid biohydrogenation is what causes beef to have harder fat than pork. One of the explanations of why the microbes biohydrogenate the fatty acids is to combat the inhibition of fermentation that can occur with unsaturated fatty acids. Another explanation is that the unsaturated fatty acids serve as a sink for free hydrogen ions in the rumen.

Results

Cattle Performance When Fed Different Fat Sources

Replacing a blend of DRC and HMC to create diets with 6.4% total diet ether extract, with either 2.5% corn oil or 20% of diet DM with WDGS, resulted in similar or improved feeding performance relative to the corn diet for individually fed heifers. When total diet ether extract was increased to 8.8%, with either 5% corn oil or 40% WDGS, feed conversion was greater for the 40% WDGS diet relative to 20% WDGS. The 5% corn oil diet resulted in depressed performance relative to the corn diet. This trial indicated that 8.8% diet fat from 5% corn oil was detrimental to rumen function.

In a second trial, HMC was replaced by 1.3% or 2.6% tallow or 20% or 40% DDGS in diets containing 20% wet corn gluten feed (WCGF; Sweet Bran®). Feeding performance was similar for all treatments. Maximum dietary ether extract was 6.0% and 5.0% for tallow and DDGS, respectively. This trial indicates that 2.6% tallow was not enough saturated fat to depress cattle performance with 20% WCGF diets.

A third finishing trial evaluated replacing HMC in 35% WCGF diets with either CCDS or WDGS. Inclusion of 20% of diet DM as CCDS or 40% WDGS resulted in diets containing 6.2% and 6.9% diet fat, respectively. The CCDS diets resulted in similar performance as the WDGS diets. The combined interpretation of the first and third studies shows that CCDS does not depress feeding performance like corn oil. These data substantiate that the form of fat in DGS and CCDS have a different effect on rumen function relative to corn oil.

Two metabolism trials evaluated fat digestion of corn, WDGS, and corn with corn oil diets. Both studies found less ruminal biohydrogenation of WDGS fatty acids, compared to corn and corn with corn oil diets. Steaks from steers consuming WDGS had increased proportion of unsaturated fatty acids relative to saturated fatty acids compared to steaks from corn fed cattle. One of the metabolism studies also evaluated CCDS lipid biohydrogenation and noted that omasal contents from CCDS fed steers were biohydrogenated to a similar level of saturation as omasal content from corn, corn oil, and tallow diets and omasal contents of WDGS fed steers were less satuated than the other treatments. These trials indicate that CCDS diet fat is not protected from biohydrogenation like the grains fraction of WDGS.

A finishing trial evaluated feeding 35% of diet DM as wet distillers grains without CCDS (6.7% fat; DM basis), 35% normal WDGS (13.0% fat; DM basis), and a corn diet. Dry matter intake was similar for all three treatments. However, ADG of the lower fat WDGS was similar to the corn diet and the ADG of the normal WDGS fed steers was superior to the other two diets. The feeding values of the lower fat distillers grains and normal WDGS were 102% and 127 % of corn, respectively. This trial indicates the importance of the lipid component of DGS on the feeding value of DGS products.

High fat DGS finishing diets (8% dietary fat) may be fed to feedlot cattle with improved performance relative to cattle fed corn. Feeding 8% fat diets containing corn and corn oil depresses feeding performance compared to corn fed cattle. The difference in ruminant biological processing of corn oil and DGS diets is partially due to the physical form of the fat in DGS being protected from interaction with ruminal microbes. Although CCDS fatty acids are not protected from ruminal biohydrogenation, CCDS fat does not appear to limit ruminal fermentation like diets with corn oil. The CCDS fat in WDGS partially accounts for WDGS feeding value being greater than corn.

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