

►ADM researchers conclude from a Nebraska feedlot trial that including crude glycerin in a high-grain diet can improve feed efficiency.



# Glycerin: Beef Industry's New Corn?

Thanks to innovative thinking on the part of German animal nutritionists, U.S. beef producers could have ready access to a cost-effective replacement for high-priced corn.

Story & photo by Ed Haag

If a growing body of evidence is correct, glycerin could be your cattle's next source of digestible starch.

Feeding glycerin to cattle is not a new concept. Its role, and that of the closely related derivative propylene glycol, as a food-based tonic for ruminant disorders dates back more than 50 years to when R.B. Johnson published "The treatment of ketosis with glycerol and propylene glycol" in the periodical, *The Cornell Veterinarian*, in 1955.

Since then it has been used as a popular drench for high-performing ruminants suffering from ketosis. Metabolic benefits aside, today's incentives to feed glycerin to cattle are mostly economic.

Terry Klopfenstein has spent the last three decades studying the role of ethanol byproducts in livestock feeding. The University of Nebraska animal scientist says one of the greatest challenges facing the beef industry in the new bioenergy economy is how to adjust to a totally new feed-price structure.

"We are moving out of a feeding situation where energy — especially in the form of corn — has been cheap, and protein in the form of soybean meal has been more expensive," he says. "Historically, we are talking two to two-and-a-half times the price per ton."

In the near future that paradigm is going to flip, Klopfenstein says. "Instead of cheap

energy and expensive protein, we are going to see cheap protein in the form of distillers' grains and expensive energy in the form of feeder corn."

The imbalance will only be exacerbated by the increased availability of high-protein oilseed meal and soybean meal produced by a rapidly growing biodiesel industry.

One alternative to corn is glycerin, which is, ironically, a byproduct of biodiesel production. Researchers have confirmed that crude glycerin provides close to the same dietary energy as feed corn, and for every 10 gallons (gal.) of biodiesel produced, 1 gal. of glycerin is available as a marketable byproduct.

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While the availability of crude glycerin stocks from biodiesel production looks favorable well into the future, some questions must still be answered before the cattle feed industry pulls out all the stops.

Low-purity glycerin contains methanol, a form of alcohol known to cause blindness and kidney failure in humans and lab animals. Before the universal green light is given to feeding glycerin that contains more than 150 parts per million (ppm) — the Food and Drug Administration's (FDA's) current limit for methanol in feed products — more feed studies must be conducted to determine the precise feeding levels at which methanol becomes toxic to cattle.

### German study shows promise

Angela Schröder and Karl-Heinz Südekum of the Institute of Animal Nutrition, Physiology and Metabolism, at the University of Kiel in Kiel, Germany, conducted a study in 2001 that has managed to answer some significant questions.

The objective of the study was to determine how cattle responded to three purities of glycerol commonly available as byproducts of biodiesel production. A second component of the study looked at ruminant response to varying percentages of glycerol in the diets, and a third evaluated the feeding of a palletized concentrate that included various purities of glycerol.

The researchers fed four ruminally cannulated steers in a 4 × 4 Latin square design on mixed diets [40:60 forage-to-concentrate, dry-matter (DM) basis] using three different purities of the product in both high-starch and high-forage diets.

Glycerols were mixed with forage (wilted grass silage) and a high-starch concentrate. The mixed diets were formulated to contain 40% forage, 50% concentrate and 10% pure glycerol (DM basis) irrespective of the purity of the glycerol-containing product.

A 100% forage diet and a glycerol-free forage:concentrate (40:60) diet served as controls.

To evaluate the performance of various percentages of glycerol in the ration, high-purity glycerol was included in diets containing 40% forage and 5%, 10%, 15% or 20% glycerol. The high-starch concentrate or a low-starch concentrate made up the balance of these diets.

Estimated energy concentrations for glycerol derived from diets containing the low-starch concentrate and 10%, 15% or 20% glycerol in the DM were similar.

Four separate concentrate pellets were used in the study. These included pellets that contained no glycerol as well as three others that contained 15% glycerol. The last three pellets were differentiated by low, medium and high purities of glycerol.

During the course of the study, the researchers observed that total tract digestibilities of organic matter, cell-wall [neutral detergent fiber (NDF)] and starch were similar for all dietary treatments (mean value, 72.1%, 65.1% and 98.3%, respectively).

Researchers did observe an elevation in butyric acid concentrations in the ruminal fluid, peaking at 3 hours postfeeding, in all diets containing glycerol. Butyric acid concentrations in the control diet remained constant.

Researchers viewed this phenomenon as positive, noting that earlier studies equated elevated butyric acid concentrations in the ruminal fluid with improved energy conversion and aided in detoxification.

The German research team concluded from their study that glycerol derived from biodiesel production could be used in diets for cattle at up to 10%, that it provided more energy in the high-forage diets when compared with the high-

concentrate diets, and that there was no difference due to purity in up to 10% of the diet DM even though the lowest-purity product contained up to 27% methanol.

They also noted that although methanol concentration of the glycerol of low purity (crude) was marked, only negligible quantities of methanol were detected in the pelleted concentrates. Researchers also observed that the addition of glycerol increased the pellet quality of the prepared feeds.

### U.S. research shows similar results

In December 2006, Shawn Donkin and his research team at Purdue University completed a 56-day feeding trial involving 60 dairy cows being fed various rates of glycerol in their rations. "The objective of the study was to determine the potential for replacing corn with glycerol in the diet of lactating cows," Donkin says. "We started with a TMR (total mixed ration) that contained 18% corn grain."

Donkin then replaced the corn with glycerol in incremental steps of 5%, 10% and 15% of the total ration. "At the 15% level we were replacing the total corn ration with glycerol," he says, adding that at all levels of glycerol as well as the non-glycerol control group production averaged approximately 80 pounds (lb.) of milk per day.

Milk components remained the same, and feed intake was the same once those animals that had 15% glycerol in their diet were able to adjust to a new taste in their

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— Terry Klopfenstein

**Table 1: Chemical composition of glycerol as related to purity**

	Purity of glycerol		
	Low	Medium	High
Water, %	26.8	1.1	2.5
Composition of the dry matter <sup>1</sup> , %			
Glycerol	63.3	85.3	99.8
Ether extract	0.71	0.44	n.a. <sup>2</sup>
P	1.05	2.36	n.a.
K	2.20	2.33	n.a.
Na	0.11	0.09	n.a.
Pb	0.0003	0.0002	n.a.
Methanol	26.7	0.04	n.a.

<sup>1</sup> Concentrations of cadmium, mercury and arsenic were below the detection limit.  
<sup>2</sup> Not analyzed.

**Source:** Angela Schröder and Karl-Heinz Südekum of the Institute of Animal Nutrition, Physiology and Metabolism, University of Kiel, Kiel, Germany.

ration. "This study demonstrated that glycerol can be a valuable macroingredient in a ruminant's diet," Donkin says. "Up to this point in time people were looking at it as a feed additive."

One observation in the study that could be particularly relevant to the beef industry is while Donkin's calculations confirmed that all animals in the study were fed diets that were identical in energy content, weight gain among those fed high levels of glycerol was approximately 60 lb. higher than those fed the conventional corn diet.

While Donkin cautions it is risky to draw assumptions about finishing beef calves and feed efficiency in the feedlot from a dairy study that involves Holsteins and focuses on milk production, he believes the discrepancy does raise some interesting questions.

### **Better feed efficiency documented**

Those questions might have already been partially answered in a recent feedlot study led by Nathan Pyatt of the ADM Nutrition Research Center, Decatur, Ind. His colleague Mike Cecava presented a

summary of the research at the American Dairy Science Association (ADSA)/American Society of Animal Science (ASAS) Joint Annual Meeting in San Antonio, Texas, in July.

In the study, 158 Angus-cross steers were separated into two initial feeding groups. One group received a grain diet consisting of 70% cracked corn, 15% corn silage, 10% distillers' dried grains with solubles (DDGS) and 5% supplement (DM basis); the other group received a coproduct diet consisting of 35% cracked corn, 30% DDGS, 15% soyhulls, 15% corn silage and 5% supplement.

Each group was then split into two subgroups. One subgroup was fed the diet outlined for its particular grouping; the other subgroup had 10% of its corn replaced with an energy equivalent amount of crude glycerin.

Cattle were blocked by weight (four pens per treatment) and were weighed at 28-day intervals. Animals were harvested at a constant backfat end point, which required 116-153 days on feed.

Researchers determined from the data

that the cumulative average daily gain (ADG) was 11.4% greater in cattle fed grain diets with glycerin and 2.5% better for steers fed coproduct diets with glycerin.

Dry-matter intake (DMI) was greater — 9.7% higher — in the coproduct-fed animals than in grain-fed ones, but cattle whose diets also included glycerin had decreased DMI with a reduction of 8.1% for the grain diet and 11.8% for the coproduct diet.

While DMI dropped with the addition of glycerin in the rations, feed efficiency improved, with a 21.9% improvement for the grain diet and a 16.4% improvement for the coproduct diet. Glycerin improved overall feed efficiency for the two diets by an average of 19.2%.

Pyatt concluded from his research data that feeding crude glycerin can improve efficiency of cattle fed high-grain diets. Additionally, feeding crude glycerin in combination with coproducts like DDGS and soyhulls may diminish feed intake but improve feed efficiency.

