

## Study: High-energy diets have a negative impact on the health of cattle

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When cattle are fed starchy, low-fiber, grain-based diets, acid and gas accumulation in their digestive tracts can lead to liver abscesses and proliferation of detrimental bacteria. Cattle evolved as grazing herbivores and their complex digestive tract still needs fiber to function properly, according to U.S. Department of Agriculture and Cornell microbiologists, who summarize the consequences of grain feeding in the May 11 issue of the journal *Science*.

Graduate student Jennifer Rychlik, left, and professor and USDA-Agricultural Research Service microbiologist James Russell feed hay to a cow -- named Lucy -- outside the Veterinary College's Large Animal Research and Teaching Unit. They have researched the effects of switching from high-fiber grazing diets to low-fiber grain diets on the digestive tracts of cattle. Matthew Fondeur/University Photography



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"The use of grain-based diets has increased animal productivity and improved the economics of animal agriculture," James B. Russell and Jennifer L. Rychlik acknowledge in their review article, "Factors That Alter Rumen Microbial Ecology." However, they report, switching the animals from high-fiber grazing diets to lower-fiber grain disrupts the digestive process, increases acidity and creates a variety of bovine disorders that cattle producers often counteract with additives, such as ionophores, buffers and antibiotics.

Some scientists have expressed concern over the use of antibiotics in animal feed. For example, avoparcin, a vancomycin analog, was once used as a feed additive for livestock in Europe, until an increase in antibiotic resistance led to its withdrawal. Ionophores are not used to treat human infections, but some therapeutic antibiotics prescribed by physicians and veterinarians are used to prevent liver abscesses in grain-fed cattle.

Because cattle evolved as grazing animals that consumed little grain, they do not digest starch as well as pigs, chickens and humans, Russell explains. If starch from grain escapes fermentation in the first cattle stomach (the rumen) and passes into the colon, the bacterial count of *Escherichia coli* increases and the *E. coli* become highly acid resistant. In humans, most *E. coli* are killed by acids of the gastric stomach, he said, but highly acid-resistant bacteria can survive and grow in the intestines. While most *E. coli* are harmless, many cattle carry *E. coli* O157:H7, and this potentially deadly bacterium can be transmitted from cattle to humans via contaminated meat.

Russell is a USDA-Agricultural Research Service microbiologist stationed at the U.S. Plant, Soil and Nutritional Laboratory on the Cornell campus, who has spent more than 25 years studying rumen microbiology and cattle nutrition. Rychlik is a graduate student and Ph.D. candidate in the laboratory of Russell, who also serves as an adjunct professor of microbiology in the College of Agriculture and Life Sciences at Cornell. Together they reviewed dozens of laboratory studies, including some arising from their own laboratory at Cornell.

Their *Science* article concludes that over-consumption of grain causes a variety of metabolic and infectious diseases:

- Bloat is caused by the slime of starch-fermenting bacteria that entraps fermentation gases. If cattle cannot burp and expel the gas, the rumen can compress the lungs and the animal suffocates. Some ionophores are highly effective in preventing bloat.
- Acute rumen acidosis is caused by a sudden switch from forage to grain and the overgrowth of starch-fermenting, lactate-producing bacteria. When lactate accumulates, pH decreases (that is, acidity increases) drastically and the animal can die as water rushes from blood into the rumen.
- Chronic acidosis is caused by an accumulation of normal fermentation acids (acetic, propionic and butyric acids). The animal does not die but stops eating until the pH increases. Cattle feeders counteract chronic acidosis by adding buffers to the rations. Up to half the soda bicarbonate produced in the United States is used in cattle feed. Lime also can be added to the ration.
- Rumen ulcers occur because the rumen is not protected by mucous. Ulcers arise if the rumen pH remains low for more than a few hours. Bacteria such as *Fusobacterium necrophorum* can grow on the lactate and migrate through the ulcers into the blood.
- Liver abscesses are caused by *F. necrophorum* that travel from rumen ulcers to the liver. Some 13 percent of livers from grain-fed beef have abscesses and are declared unfit for human consumption.
- Lameness is caused by metalloproteinases that are released by inflamed rumen walls and travel via the blood to the hooves.
- Sudden death can be caused by excess starch in the intestines and an overgrowth of *Clostridium perfringens*, a bacterium that produces a powerful enterotoxin.
- Overall, only three out of 1000 cattle die from grain-related diseases, but grain-related disorders are a serious problem to the cattle industry.

According to Russell, the USDA and several universities currently are conducting research to decrease the negative aspects of grain on cattle. For example, USDA research in 1998 and 1999 indicated cattle could be switched to hay for a brief period before slaughter to counteract *E. coli* acid resistance and the prevalence of O157:H7 in cattle. Hay can be difficult to feed in a feedlot, and supplies of hay currently are limited. However, it is also conceivable that less starchy, higher-fiber byproducts from the human food and ethanol industries could be substituted for grain to counteract rumen acidosis.