

Molasses Supplementation of Grazing Dairy Cows

Summary of Case Study, Continuous Culture Fermenter Trials, and Controlled Research Farm Study

June 2011

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Overview

As milk prices fluctuate and input costs increase, grazing dairy operations seek lower-cost feed alternatives to maintain or improve milk production while reducing feed costs. This has been most evident within the organic dairy sector, as organic grain prices have been traditionally high relative to conventional grain. Thus, farmers have experimented with a variety of supplemental grains and other products.

Sugar cane molasses is a rich source of sugars, is available in organic form, and may be a viable supplementation option to corn. However, there is no literature available that evaluates molasses as the only supplement for grazing dairy cows. Anecdotal results, as reported by farmers, are mixed - some farms use molasses successfully while others report major milk production or body condition losses. Also, it has been proposed that molasses has three times more energy than corn, allowing for a lower feeding rate. However, there is no research data available to verify that molasses is higher in energy, as it is generally considered to be equivalent to corn.

It is not well understood which factors impact the success or failure of molasses. Therefore, to begin to understand the mechanisms by which molasses impacts grazing dairy cows, a multi-pronged research approach has been used involving an on-farm case study, continuous culture fermenters, and a controlled organic research farm study.

Two-Year Case Study

In 2008 and 2009, a central New York organic dairy farm was used for a case study on feeding molasses. The farm used was a seasonally calving, crossbred herd milking 56 cows the first year and 66 cows the second year. They fed a combination of 3 pounds of molasses and 1 pound of a corn/barley mix, with kelp and minerals offered free choice in 2008. The same grain mix was fed in 2009, but the relative proportions of molasses and grain varied through the grazing season from a 2 pound molasses and 3 pound grain ratio in early spring to a 2 pound molasses to 2 pound grain ratio by fall. Overall more molasses and grain were fed in 2009.

Pasture samples and body condition scores were collected monthly. At the end of the grazing season, the farm provided copies of all milk weight tank sheets and milk plant component and milk urea nitrogen (MUN) reports. Feed data was collected and summarized with milk production, components, MUN, and body condition score of the cows. Taking the project one step

further, the diets were evaluated with the Cornell Net Carbohydrate and Protein System model (CNCPS) for the potential milk production based on protein, energy, methionine, and lysine, as well as for predicted MUN, N excretion, and urea cost.

The key findings of this project

- In both years, the cows had a greater than normal drop in persistency for the first month after they reached their peak of 52 pounds per day at approximately 60 to 75 days in milk.
- Body condition dropped to a low of 2.1 on a scale of 1 (thin) to 5 (obese) in mid-summer of 2008, but recovered through September and October to over 2.5 by the end of the grazing season. In 2009 body condition was maintained slightly better through more of the grazing season with the lowest score at 2.3, likely due to slightly more energy being fed.
- The MUN levels were consistently greater than 14 mg/dl both years, suggesting that there was not enough energy in the rumen to recapture the excess ruminal ammonia as microbial protein - rather, it was excreted as urea. On average, MUN's were higher in 2008 than in 2009, suggesting that the higher supplementation level in 2009 helped recapture more of the ammonia into microbial protein. The recommended level for MUN is between 8 and 12 mg/dl.
- Milk protein levels in 2009 were higher than in 2008 (4.32% vs. 3.39%, respectively), also indicating that ruminal ammonia was converted to more microbial protein with the additional starch.
- When the diets were evaluated using CNCPS, energy was the most limiting factor for milk production. The recommended level of non-fiber carbohydrates is between 38 and 42%; these diets were only 19 to 33%. Starch levels were between 0.75 and 5.02%, whereas the recommended level is 25%. The sugar levels were at times higher than the recommended 4 to 7%, coming in between 3 and 15%.

It appears that in this herd, given their grazing management, herd genetics, and general management strategies, more milk could have been made in both years if more energy had been fed. Sources of starch would likely have improved production more than additional molasses. However, other factors such as economics, herd health, and farm goals and philosophy needs to be considered.

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Continuous Culture Fermenter Trials

Continuous culture fermenters are 'artificial rumens' that are inoculated with rumen fluid, fed various diets, and can be used to evaluate ruminal fermentation patterns, including pH, volatile fatty acid and ammonia concentrations, nutrient digestibility, and microbial protein synthesis. This low-cost screening tool can be used to evaluate diets before conducting a large-scale animal research trial. Two fermenter trials were conducted to evaluate the effects of molasses on ruminal fermentation.

The first fermenter trial evaluated the effects of supplementing a pasture diet with molasses (5% of total dry matter (DM) fed), corn meal (7% of total DM fed), or a combination of molasses (5%) and corn meal (7%), on ruminal fermentation. These supplementation levels were selected based on what is currently being fed to organic dairy herds, such as the case study farm.

For the second fermenter study, previous research suggests there may be a significant forage quality by molasses level interaction, however, this has not been evaluated with dairy cows grazing northeastern pastures. Therefore, we evaluated the interaction between forage quality and level of molasses supplementation on nutrient digestibility, ruminal fermentation and microbial protein synthesis of a pasture-based diet in continuous

culture. Experimental treatments were: 1) high-quality pasture with molasses supplemented at 5% of total DM fed; 2) high-quality pasture with molasses supplemented at 10% of total DM fed; 3) low-quality pasture with molasses supplemented at 5%; 4) low-quality pasture with molasses supplemented at 10%.

Key findings from these two studies showed

- Molasses responded similarly to corn in improving ruminal fermentation with both supplements showing only marginal benefits (at this low inclusion level) over a pasture-only diet.
- There were no significant interactions between forage quality and level of molasses supplementation.

In concert with the case study, these results suggest that there are many variables other than ruminal fermentation responses that must be considered by organic dairy farmers in supplementing dairy cows with molasses, including forage quality, cow production, cost, ease of feeding, and availability.

Research Farm Dairy Trial

The University of New Hampshire has a grazing-based, Organic Dairy Research Farm with a herd of Jersey cattle. This facility was used to evaluate cow performance fed either liquid molasses or corn meal during the grazing season.

Twenty lactating organic Jersey cows were grouped by lactation number and milk production, and assigned randomly to one of two energy sources: 1) liquid molasses (4.4 pounds of DM/day) or 2) corn meal (4.4 pounds of DM/day) which equated to approximately 13 and 15% of total DM intake, respectively. Cows grazed from early June to mid-September for a total of approximately 110 days. The energy sources were top-dressed on a grass-legume baleage (6.6 pounds of DM/day; approximately 19 and 22% of total DM intake for molasses and corn meal diets, respectively) and fed individually twice daily. Cows were split into two grazing groups with pasture intake estimated for the group using a calibrated rising plate meter to quantify pre- and post-grazing herbage biomass.

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Key findings from this study showed

- Intake of supplement (baleage plus molasses or corn meal) was significantly higher for cows fed molasses vs. corn meal possibly due to the enhanced palatability of molasses. Pasture and total DM intake were numerically higher for cows fed molasses than those fed corn meal.
- Despite enhanced total DM intake, no significant differences were observed for milk yield comparing these two energy sources. However, cows averaged 28.2 (molasses) and 26.0 (corn meal) pounds of milk per day during the experiment.
- Yields and concentrations of milk components did not differ between molasses and corn meal.
- Cows fed molasses had reduced MUN and other measures of nitrogen status compared to those fed corn meal, which may be partially explained by the higher crude protein of corn meal vs. molasses.
- Compared to corn meal, molasses had no detrimental effect on animal performance and improved nitrogen utilization in organic dairy cows.

The UNH study was partially funded by the Organic Farming Research Foundation and the Northeast Sustainable Agriculture Research and Education program.

Summary

When molasses is fed at the same rate as corn meal, or in combination, there does not appear to be a significant difference in rumen dynamics or cow performance. In the case study, it is hypothesized that a higher level of starch may be of some benefit to maintaining body condition and higher milk protein production. A higher level of milk production may have been achieved if additional starch was fed above the 2009 levels. However, there were no statistical differences found between the groups of cows in the research farm trial, indicating that other management factors may play a bigger role in production than the form of energy supplementation given.

In regards to molasses having three times more energy than corn, the fermenter and research farm trials do not indicate that to be true. This conclusion is based upon all the rumen fermentation measurements being similar, as well as cow performance when comparable amounts of molasses and corn meal were provided.

A simple way to compare the energy density of molasses vs. corn meal is through their hexose contents. Hexose is one of a number of sugars commonly found in carbohydrate sources such as molasses and corn meal. Large hexose polymers such as starch from corn meal have lost the weight of 1 water of hydration per sugar unit, and they are therefore more energy dense than sucrose from molasses. Thus, dietary energy is diluted when molasses replaces corn meal. However, comparisons have to be made on hexose basis. The divisor to go from DM to weight of hexose is: starch DM in pounds divided by 0.9 gives hexose in starch, and sucrose DM in pounds divided by 0.95 gives hexose in sucrose. One pound of molasses (74% DM) contains about 55% of sucrose while one pound of corn meal (86% DM) contains about 73% starch resulting in 0.37 lb and 0.70 lb of hexose, respectively. This indicates about half as much energy per pound when feeding molasses vs. corn meal.

The decision to feed molasses or corn meal as an energy supplement to grazing dairy cows should be based on the cost of each feed on a DM basis. Grazing management, genetics, environment, and other farm-specific characteristics are most likely to influence the success or failure of cow performance rather than energy source.

Authors

Karen Hoffman, Resource Conservationist – Animal Science, USDA-Natural Resources Conservation Service, Norwich, NY. E-mail karen.hoffman2@ny.usda.gov Phone: 607-334-4632 ext 116.

Kathy Soder, Research Animal Scientist, USDA-Agricultural Research Service, University Park, PA. Email: kathy.soder@ars.usda.gov Phone: 814-865-3158.

Andre Brito, Assistant Professor, University of New Hampshire, Durham, NH. Email andre.brito@unh.edu Phone: 603-862-1341.

