

RESEARCH PROJECTS

DAIRY NUTRITION & MICROBIOLOGY LAB

UNIVERSITY OF DELAWARE



RESEARCH ON FORAGE QUALITY



Corn silage is a major forage for lactating dairy cows. Recent emphasis has focused on corn silage hybrids and management techniques to improve digestion. For example, the brown mid rib mutant results in corn silage with lower lignin and thus, higher digestibility than normal hybrids. However, the cost of seed and lower yields are trade offs that must be considered. Whole plant processing, where the corn plant is crushed and rolled, improves starch and fiber digestibility. Another management technique that is being evaluated is high cutting of corn silage or leaving 18-20 inches of stalk in the field rather than the traditional 4 to 6 inches. The logic for this practice comes from the fact that the lower section of the plant stalk is the most highly lignified and thus poorly digested. However, effects on yield drag may offset improvements in digestibility. Studies are underway evaluating high cutting and interactions with processing and maturity.

Some key findings from our recent forage research:

- High cutting has resulted in small decreases in fiber, increases in starch content, and about a 10-12% yield drag but improvements in milk production have been marginal. No recommendations are being made at this time until more research has been completed.

- Processing brown midrib corn silage can increase its nutritive value over unprocessed brown midrib silage for cows.

RESEARCH ON SILAGE FERMENTATION



A significant amount of feed is ensiled before feeding to ruminants. This ensiling or fermentation process is largely uncontrolled often resulting in poor fermentations that lead to excessive losses of nutrients and/or silages that are unstable when exposed to air. One goal of our laboratory is to identify methods that improve silage fermentation and aerobic stability. Approaches include evaluating the effects of microbial inoculants and chemical additives. The interactions between silage additives and packing density are also being examined as excess air has detrimental effects on the fermentation process.

Some key findings from our recent silage research:

- We have recently conducted lab and farm scale studies where silages were inoculated with a heterolactic acid bacteria, *Lactobacillus buchneri* 40788, resulting in marked improvements in the aerobic stability. Unlike most heterolactic bacteria that convert glucose to lactic and acetic acids, *L. buchneri* 40788 anaerobically converts lactic to acetic acid, 1,2 propanediol, and ethanol via a novel pathway. Three animal studies showed that feeding silages treated with *L. buchneri* 40788 has no negative effects on dry matter intake.
- Completed studies have shown that liquid applied microbial inoculants are more efficacious than dry applied inoculants, especially when the dry matter of the forage is greater than about 40-45% DM because water activity (a_w) limits the growth of bacteria in dry silages.
- Studies have shown that low application rates (2-4 lb/ton of forage) of buffered propionic acid additives can improve the aerobic stability of silages. These application rates are markedly lower than traditional recommendations for application of propionic acid to silages but they appear to be efficacious because current formulations contain additional antifungal compounds (sorbate, benzoate, etc.)

Selected Publications in This Area:

Kleinschmit, D. H., R. J. Schmidt, and L. Kung, Jr. 2005. The effects of various antifungal additives on the fermentation and aerobic stability of corn silage. *J. Dairy Sci.* 88:2130-2139.

Ebling, T. L., and L. Kung, Jr. 2004. A comparison of processed conventional corn silage to unprocessed and processed brown midrib corn silage on intake, digestion, and milk production by dairy cows. *J. Dairy Sci.* 87:2519-2527.

Kung, L., Jr., C. L. Myers, J. M. Neylon, C. C. Taylor, J. A. Lazartie, J. A. Mills, and A. G. Whiter. 2004. The effects of buffered propionic acid-based additives alone or combined with microbial inoculation on the fermentation of high moisture corn and whole-crop barley. *J. Dairy Sci.* 87: 1310-1316.

Neylon, J. M., and L. Kung, Jr. 2003. Effects of cut height and maturity on the nutritive value of corn silage for lactating cows. *J. Dairy Sci.* 86:2163-2169.

Kung, L., Jr., K. A. Smith, A. M. Smagala, K. M. Endres, C. A. Bessett, N. K. Ranjit, and J. Yaissle. 2003. Effects of 9,10 anthraquinone on ruminal fermentation, total tract digestion and blood metabolite concentrations in sheep. *J. Anim. Sci.* 81:323-328.

Kung, L., Jr., C. C. Taylor, M. P. Lynch, and J. M. Neylon. 2003. The effect of treating alfalfa with *Lactobacillus buchneri* 40788 on silage fermentation, aerobic stability, and nutritive value for lactating dairy cows. *J. Dairy Sci.* 86:336-343.

Ranjit, N. K., C. C. Taylor, and L. Kung, Jr. 2002. Effect of *Lactobacillus buchneri* 40788 on the fermentation, aerobic stability, and nutritive value of maize silage. *Grass and Forage Sci.* 57:1-9.

Kung, L., Jr., M. A. Cohen, L. M. Rode, and R. J. Treacher. 2002. The effect of fibrolytic enzymes sprayed onto forages and fed in a total mixed ration to lactating dairy cows. *J. Dairy Sci.* 85:2396-2402.

J. A. Mills and L. Kung, Jr. 2002. The effect of delayed filling and application of a propionic acid-based additive on the fermentation of barley silage. *J. Dairy Sci.* 85:1969-1975.

Taylor, C. C., N. J. Ranjit, J. A. Mills, J. M. Neylon, and L. Kung, Jr. 2002. The effect of treating whole-plant barley with *Lactobacillus buchneri* 40788 on silage fermentation, aerobic stability, and nutritive value for dairy cows. *J. Dairy Sci.* 85:1793-1800.

Taylor, C. C., and L. Kung, Jr. 2002. The effect of *Lactobacillus buchneri* 40788 on the fermentation and aerobic stability of high moisture corn in laboratory silos. *J. Dairy Sci.* 85:1526-1532.

Whiter, A. G., and L. Kung, Jr. 2001. The effect of a dry or liquid application of *Lactobacillus plantarum* MTD1 on the fermentation of alfalfa silage. *J. Dairy Sci.* 84:2195-2202.

Kung, L., Jr., and N. K. Ranjit. 2001. The effect of *Lactobacillus buchneri* and other additives on the fermentation and aerobic stability of barley silage. *J. Dairy Sci.* 84:1149-1155.

RESEARCH ON IMPROVING FIBER DIGESTION WITH ENZYMES



Adding dry enzyme preparations (e.g. cellulases and xylanases) to the rumen is usually not recommended because the amount of added enzyme activity is small and they can be degraded by rumen bacteria before they can affect digestion. However, spraying enzymes on forages prior to feeding may cause binding between the enzymes and fiber (substrate) thus protecting the enzymes from rumen degradation. We are evaluating several enzyme formulations and combinations in order to improve milk production from lactating cows.

Some key findings from our recent enzyme research:

- Spraying fibrolytic enzymes onto forages just before feeding can improve milk production.
- Selection of cellulase and hemicellulase enzymes that have good enzyme activity over a broad range of pH that can be found in the rumen appears to be critical for production improvements.

Selected Publications in This Area:

Kung, L., Jr., R. J. Treacher, G. A. Nauman, A. M. Smagala, K. M. Endres, and M. A. Cohen. 2000. The effect of treating forages with fibrolytic enzymes on its nutritive value and lactation performance of dairy cows. *J. Dairy Sci.* 83:115-122.

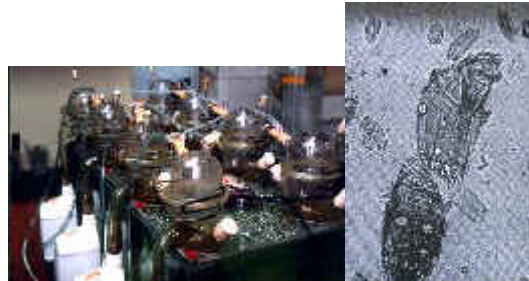
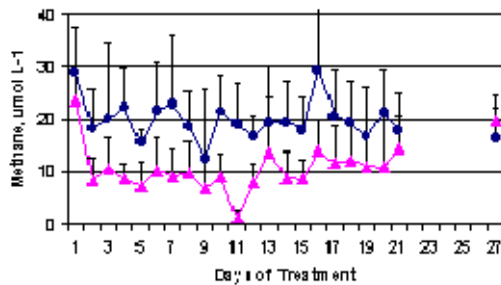
Kung, L., Jr., R. J. Treacher, and M. A. Cohen. 1998. Enzyme-treated forages for lactating cows. *J. Dairy Sci.* 81(Suppl.1): 196.

Sheperd, A.C., and L. Kung, Jr. 1996. An enzyme additive for corn silage: effects on silage composition and animal performance. *J. Dairy Sci.* 79:1760.

Sheperd, A.C., and L. Kung, Jr. 1996. Effects of an enzyme additive on composition of corn silage ensiled at various stages of maturity. *J. Dairy Sci.* 79:1767.

Sheperd, A. C., M. Maslanka, D. Quinn, and L. Kung, Jr. 1995. Additives containing bacteria and enzymes for alfalfa silage. *J. Dairy Sci.* 78:565.

RESEARCH ON ALTERING RUMEN FERMENTATION



A. Altering Rumen Fermentation with Novel Compounds

Microbial fermentation in the rumen is responsible for the digestion of fiber and production of microbial protein. Ruminal fermentation can be modified via the addition of various chemical compounds. Specifically, past research has been aimed at decreasing the production of methane, which represents a considerable loss of digestible energy. Various approaches have been taken to alter fermentation. For instance, ionophores such as monensin, inhibit the growth of hydrogen producing microbes in the rumen by disrupting proton motive force and thus, indirectly decreases methanogenesis. Other compounds appear to block specific steps in methanogenesis. Our lab has studied 9,10 anthraquinone, which disrupts electron transport in certain rumen bacteria.

Some key findings from our recent rumen research:

- 9,10 anthraquinone (AQ) can reduce methane production in in vitro and in vivo ruminal fermentations. High levels of AQ have no effect on liver function enzymes or other blood measurements. There was no rumen adaptation to the depression in methane through a 19 day feeding experiment with lambs.
- AQ can also inhibit sulfide production in in vitro rumen fermentations. This finding is

of interest because high levels of ruminal sulfide production have been associated with a disease in ruminants known as polioencephalomalacia (PEM). Several common antibiotics have been tested for their ability to reduce hydrogen sulfide production in the rumen with varying results. Interestingly, addition of monensin appears to stimulate, not reduce hydrogen sulfide production in ruminal fermentations.

Selected Publications in This Area:

Kung, L., Jr., J. P. Bracht, and J. Y. Tavares. 2000. Effects of various compounds on in vitro ruminal fermentation and production of sulfide. *Anim. Feed Sci. Tech.* 84:69-81.

Kung, L., Jr., A. O. Hession, and J. P. Bracht. 1998. Inhibition of sulfate reduction to sulfide by 9,10 anthraquinone in in vitro ruminal fermentations. *J. Dairy Sci.* 81:2251-2256.

Bracht, J. P. and L. Kung, Jr. 1997. Inhibition of sulfide production in in vitro ruminal fermentations. 24th Rumen Function Conference. Chicago, IL. 24:20.

Garcia, P. M., and L. Kung, Jr. 1996. In vitro inhibition of ruminal methane production by 9,10 anthraquinone. *J. Anim. Sci.* 74:2276.

Hession, A. O., L. Kung, Jr., and C. A. Bessett. 1995. Altering ruminal fermentation and inhibiting ruminal sulfide production with 9,10 Anthraquinone (AQ). 23rd Rumen Function Conference. Abstract # 12. Chicago, IL.

B. Altering Rumen Fermentation with Microorganisms

Addition of live microorganisms to dominate or fill niches in rumen fermentation has potential to improve the efficiency of production from ruminants. For example, the balance between lactate production and utilization in the rumen is key to the prevention of lactic acidosis in ruminant animals. Under normal conditions, accumulation of lactate is minimal because its use is as rapid as its production. However, in certain conditions, imbalances can lead to can accumulation of lactic acid that results in poor animal performance.

Some key findings from our recent rumen research with DFM:

- Studies in our lab have shown that inoculating ruminal cultures with *Megasphaera elsdenii* (the major lactate-utilizing organism in the rumen) prevented lactic acidosis.
- We have conducted studies showing that addition of live yeast to the diets of dairy cows improves milk production. Research continues in the area of direct-fed microbials for ruminants.

Selected Publications in This Area:

Kung, L., Jr., E. M. Kreck, R. S. Tung, A. O. Hession, A. C. Sheperd, M. A. Cohen, H. E. Swain, and J.A.Z. Leedle. 1997. Effects of a live yeast culture and enzymes on in vitro ruminal fermentation and production of dairy cows. *J. Dairy Sci.* 80:2045-2051.

Kung, L., Jr., and A. O. Hession. 1995. Altering rumen fermentation by microbial inoculation with lactate-utilizing microorganisms. *J. Anim. Sci.* 73:250.

Kung, L., Jr., A.O. Hession, J. E. O'Reilly, and G. A. Nauman. 1994. Effect of adding *Propionibacterium shermanii* on in vitro ruminal fermentations. *J. Anim. Sci* 72(Suppl. 2): 127.