

# Ruminant Nutrition Symposium: Advancements in Enhancing Cell Wall Digestibility and its Contribution to Improve Ruminant Production

**113 Improving cell wall digestion and animal performance with fibrolytic enzymes.** A. T. Adesogan\*, J. J. Romero, and Z. X. Ma, *Department of Animal Sciences, IFAS, University of Florida, Gainesville.*

The objective of this paper is to summarize published responses to treatment of cattle diets with exogenous fibrolytic enzymes (EFE), to discuss reasons for variable EFE efficacy in animal trials and to recommend strategies for improving enzyme testing and enzyme efficacy in ruminant diets. A review of 24 dairy cow studies with 69 treatments revealed that dietary addition of exogenous fibrolytic enzymes (EFE) increased milk production and feed efficiency 20 and 23% of the time by 2.45 kg/d (7.6% increase) and 0.13 (9% increase) on average, respectively. This variability is attributable to several enzyme, feed, animal, and management factors that will be discussed in this paper. The variability reflects our limited understanding of the synergistic and sequential interactions between exogenous glycosyl hydrolases, autochthonous ruminal microbes and endogenous fibrolytic enzymes that are necessary to optimize ruminal fiber digestion. An added complication is that many of the standard methods of assaying EFE activities may over or underestimate their potential effects if they are based on pure substrate saccharification or if they do not simulate ruminal conditions. Our recent evaluation of 18 commercial EFE showed that 78 and 83% of them exhibited optimal endoglucanase and xylanase activities at 50°C and 77 and 61% had optimal activity at pH 4–5, respectively. Hence, most would not be optimally active under ruminal conditions. Of the many fibrolytic activities that act synergistically to degrade forage fiber, only a few are typically assayed, and of the latter endoglucanase and xylanase typically account for most the variability in fiber digestion. Yet, neither of these can hydrolyze the recalcitrant phenolic acid–lignin linkages that are the main constraints to ruminal fiber degradation. These factors highlight the futility of random addition of EFE to diets. This paper will discuss animal responses to fibrolytic enzymes, advance explanations for the variability in the response and suggest strategies to improve enzyme testing and enzyme efficacy in ruminant diets.

**Key Words:** fibrolytic enzyme, cow, digestion

**114 Effects of neutral detergent fiber concentration and digestion characteristics on energy intake and partitioning of lactating cows.** M. S. Allen\*, *Michigan State University, East Lansing.*

Neutral detergent fiber (NDF) comprises from less than 28% to more than 40% of dietary dry matter for lactating cows. The concentration and digestion characteristics of NDF in diets affect dry matter intake, digestibility, and energy partitioning and can greatly affect productive performance of lactating cows. Ruminal turnover rate of NDF varies depending upon initial particle size, digestion kinetics and particle fragility. Longer retention time increases digestibility as well as digesta mass and volume. Increased digesta mass in the rumen can reduce risk of ruminal acidosis and abomasal displacement but can also limit feed intake. Signals to brain feeding centers from ruminal distension control feed intake when the drive to eat is high and metabolic control of feed intake is diminished (e.g., cows at peak lactation) while signals derived from metabolism of fuels dominate the control of feed intake when signals from distension decrease (e.g., cows in late lactation). Therefore, NDF turnover rate is an important consideration for diet

formulation; a higher turnover rate is desirable when feed intake is limited by ruminal distention. Over half of the ruminal mass of NDF is in particles that are below the threshold size for passage. Ruminal retention of small particles is from entrapment by the pool of large particles in the rumen and passage rate is positively related to particle density. Forage family (e.g., legumes, grasses) and maturity at harvest affect digestion characteristics and ruminal retention time and therefore the filling effect of forages. Non-forage fiber sources (NFFS) contribute little to the filter bed of large particles but function to displace dietary starch. Substitution of fermentable fiber for starch can maintain milk yield while decreasing gain in body condition for cows with lower requirement for glucose. This presentation will discuss the effects of dietary NDF concentration and digestion characteristics on energy intake and partitioning of cows and how they change throughout the lactation cycle.

**Key Words:** physiological state, digestion kinetics, fiber fragility

**115 Nutritional strategies to optimize feeding brown midrib corn silage to dairy and beef cattle.** J.-S. Eun\*, M. S. Holt, A. J. Young, and D. R. ZoBell, *Department of Animal, Dairy, and Veterinary Sciences, Utah State University, Logan.*

Digestibility of forage fiber affects many aspects of dairy and beef cattle production. In addition, providing adequate concentrations of digestible fiber in cattle ration is essential for animal health, as it is required to support an appropriate rumen function. Brown midrib corn silage (BMRCS) is characterized by its lower lignin concentration and higher fiber digestibility than conventional corn silage (CCS). Several, but not all experiments feeding BMRCS, have reported improved lactational performance of dairy cows. Inconsistent effects of BMRCS have been caused by various factors, including cows differing in physiological state and duration of experiment. Our recent study indicated that feeding BMRCS in high-forage diets can have beneficial effects to lessen body fat mobilization in fresh cows without limiting DMI around peak lactation, resulting in longer peak milk production. Similarly, another lactation study reported that feeding BMRCS during the transition period resulted in increased feed intake for the last 2 wk of gestation as well as the first 3 wk postpartum, leading to an increase in milk yield during the 3-wk postpartum period. When all cows were fed a CCS-based diet, a carryover effect occurred from the feeding of BMRCS during the transition period, resulting in increases in the yields of protein, lactose, and solids in these cows from wk 4 to 15 of lactation. Feeding BMRCS in growth-phase diets of beef steers resulted in increased DMI and improved digestibility of DM and fiber, whereas it did not result in improved ADG compared with those fed CCS. Feeding BMRCS at 24% of diet DM by replacing corn did not negatively affect growth rates in finishing beef cattle, implying that feeding BMRCS in a relatively higher dietary concentration can be a cost-effective alternative method to raising beef. Understanding interactive effects of dietary sources of fiber with BMRCS at various dietary proportions, physiological conditions of animals, and control of feed intake is needed to optimize potential benefits of feeding BMRCS in cattle diets.

**Key Words:** brown midrib corn silage, growth performance, lactational performance

**116 The utility of lipid extracted algae as a protein source in forage or starch-based ruminant diets.** S. L. Ivey\* and L. N. Tracey, *New Mexico State University, Las Cruces.*

Microalgae are unicellular organisms that live and reproduce in many forms of water and use sunlight, CO<sub>2</sub> and added nutrients to produce carbohydrates, proteins and lipids. Algal biomass has shown many different advantages as a feedstock for the biofuel industry, including: (1) high biomass yield per unit cultivation; (2) minimal competition for land used for traditional agriculture; (3) uses various water sources such as waste, saline, and produced water; and (4) biomass from algae could potentially produce both fuel and valuable co-products. Co-products resulting from the algal biofuel industry may be a source of protein for ruminant livestock. It is widely recommended that the algal biofuel industry not trivialize co-product value but consider it an additional source of revenue in an effort to gain industry sustainability and food security in the US by using geographic areas and resources not used for traditional food production. The cattle industry consumes approximately

40 million tons of protein feeds annually; therefore, the potential exists for the ruminant feeding industry to be a consistent, large-volume outlet for high protein algal co-product. In addition to proteins and lipids microalgae utilize photosynthesis to produce carbohydrates. Carbohydrates are used for energy storage and structure by the algal cell and the types of carbohydrates present are species-dependent but may include cellulose, glycogen, starch and other monosaccharides. The algal biofuel industry will potentially use a variety of algal strains, growth conditions, and harvesting and oil extraction methods. All of these factors may influence the utility of the final co-product. This presentation will address ongoing research to evaluate LEA produced from various algal strains, cultivation methods, and harvesting and extraction protocols. Currently, oil extraction protocols coupled with multiple algal strains have yielded inconsistent coproduct that ranges in protein from 15 to 50%, 3 to 47% ash and an uncharacterized carbohydrate fraction.

**Key Words:** ruminant, algae, biofuel