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The Effect of Ration Particle Size on Dairy Cows in Early Lactation

A Thesis in

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by

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VITA

Paul James Kononoff was born on January 9, 1972 to Dr. Wallace and Edith Kononoff of Weyburn, SK, Canada. Paul graduated from Evan Hardy Colligate Institute (Saskatoon, SK) in 1990. In 1991 Paul Attended Canadian Bible College. He received is B.S.A. degree in Animal and Poultry Science in 1995, and an M.Sc. degree in Animal Science under D.A. Christensen from the University of Saskatchewan. Paul is a member of the American Dairy Science Association.

ABSTRACT

Three experiments were conducted to evaluate the Penn State Particle Separator **(PSPS)** as a method to measure ration particle size and determine the effects of feeding rations of different particle size to cows in early lactation. The overall objective of this thesis is to formulate ration physical recommendations that will strengthen current nutrient recommendations.

The objectives of the first experiment were to develop an additional sieve containing a smaller pore size to more accurately describe sample fineness, to further define sieving movements, and to investigate the effects of moisture content on results. An additional sieve was constructed out of wire cloth, consisting of nominal size aperture 1.18-mm. To test the effect of shaking frequency on particle size measurement, samples of alfalfa haylage, corn silage, and a TMR were analyzed using three different frequencies: 0.9, 1.1 and 1.6 Hz and a 17 cm stroke length. Reducing sieving frequency below 1.1 Hz to 0.9 Hz resulted in significantly more material being retained on the 19.0-mm sieve and less on the 8.0 and 1.18-mm sieves for all sample types. As a result we recommend a shaking frequency of 1.1 Hz or greater with a stroke length of 17 cm. To determine the effects of forage moisture level on particle size measurements, a samples of alfalfa haylage and corn silage were collected and partially dried at different times from 0 to 48 h to obtain samples of five different moisture contents. For alfalfa haylage samples, particle size measurements were not significantly different between 57.4 and 35.6 % moisture, indicating that small moisture loss in samples will not affect particle size measurements. In comparison, for corn silage the amount of particle mass < 1.18-mm was significantly different between 58.0 and 34.4 % moisture and resulted in a small but significant difference in geometric mean length. These results suggest that completely drying a sample may result in either further size reduction in dry samples or adhesion of particles in high moisture samples during the sieving process resulting in differences in particle size measurement.

In the second experiment effects of reducing alfalfa haylage particle size on cows in early lactation were evaluated. Eight cannulated, multiparous cows averaging 19 $\pm$ 4 DIM and 642 $\pm$ 45 kg BW were assigned to one of two 4X4 Latin Squares. During each of the 23 d periods animals were offered one of four diets which were chemically identical but included alfalfa haylage of

different particle size; short **(SH)**, mostly short **(MSH)**, mostly long **(MLG)**, and long **(LG)**. Physically effective NDF **(peNDF)** was determined by measuring the amount of NDF retained on a 1.18 mm screen and was similar across diets (27.2, 27.7, 27.9, 28.1) but the amount of particles >19.0 mm significantly decreased with decreasing particle size. Reducing haylage particle size increased DMI linearly (23.3, 22.0, 20.9, 20.8 kg for SH, MSH, MLG, LG, respectively). Milk production and percent fat did not differ across treatments averaging 35.5 kg milk and 3.32% fat, while a quadratic effect was observed for percent milk protein with lowest values being observed for LG. A quadratic effect was observed for mean rumen pH (6.04, 6.15, 6.13, 6.09) while A:P ratio decreased linearly (2.75, 2.86, 2.88, 2.92) with decreasing particle size. Total time ruminating increased quadratically (467, 498, 486, 468 min/d) while time eating decreased linearly (262, 253, 298, 287 min/d) with decreasing particle size. Both eating and ruminating time per unit of NDFI decreased with reducing particle size (35.8, 36.7, 44.9, 45.6 min/ kg; 19.9, 23.6, 23.5, 23.5 min/kg respectively). Although chewing activity was closely related to forage particle size, effects on rumen pH were small, indicating factors other than particle size are critical in regulation when recommended ration NDF levels are met. Feeding alfalfa haylage based rations resulted in animals consuming more feed, producing milk with 0.08% more milk protein and did not affect percent milk fat.

In the third and final experiment the effects of reducing corn silage particle length **(FPL)** and the inclusion of cottonseed hulls **(CSH)** on cows in early lactation were evaluated. Sixteen multiparous cows averaging 17 $\pm$ 3 DIM and 677 $\pm$ 58 kg BW were assigned to one of four 4X4 Latin Squares. One square contained rumen cannulated cows to evaluate effects of treatment on rumen fermentation and function. During each of the 23 d periods animals were offered one of four TMR's that differed in particle length (long or short corn silage) and CSH inclusion rate (0 or 8% DM). Dietary treatments were as follows: long no CSH **(LGNH)**, long with CSH **(LGH)**, short no CSH **(SHNH)**, and short with CSH **(SHH)**. Total physically effective NDF (peNDF), measured as percent of NDF greater than 1.18 mm, was similar across diets but mean particle length decreased with reducing FPL and inclusion of CSH. Dry matter intake was not significantly affected by FPL but was significantly increased with the inclusion of CSH. Decreasing FPL and

the inclusion of CSH significantly increased neutral detergent fiber intake **(NDFI)**. Total chewing activity expressed as minutes per day was unaffected by FPL and the inclusion of CSH. Both eating and ruminating efficiency expressed as minutes per kg of NDFI increased with increasing FPL and decreased with the inclusion of CSH. Milk production did not differ across treatments; but the inclusion of CSH significantly increased percent milk protein. Reducing forage FPL tended to reduce percent milk fat. Mean ruminal pH was not affected by FPL but was highest on diets containing CSH even though no treatment effects were observed on total VFA, acetate, or propionate concentration. These results indicate that corn silage FPL is a poor predictor of total chewing time and rumen pH but is useful in understanding factors affecting feeding behavior. Additionally, the inclusion of CSH, resulted in increased rumination and mean rumen pH even though effects of VFA concentration were not observed.

In summary, results of this work indicate that reduction in ration particle size through either rechopping of forage or the inclusion of a nonforage fiber source **(NFFS)** in rations containing a level of NDF meeting NRC requirements does not result in sever deleterious effects in rumen fermentation or milk production. In contrast, feeding rations of reduced particle size may be advantageous due to the positive effects on DMI observed in cows in early lactation and reducing the potential negative effects observed with bunk sorting.

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"What once was hurt, what once was friction, what left a mark, no longer stings, because Grace makes beauty out of ugly things."

– Bono, 2000. *Grace*