579 Feeding two corn milling co-products to dairy cattle: Intake and milk production. A. M. Gehman* and P. J. Kononoff, *University of Nebraska*, *Lincoln*.

The objectives of this experiment were to examine the effects of feeding dairy cattle different types of corn milling co-products, modified wet distillers grains plus solubles (WDGS) and wet corn gluten feed (WCGF). Multiparious (n = 20) and primiparious (n = 20) cows averaging 93 ± 29 DIM were used in a replicated 5 × 5 Latin square in which cows were blocked by parity and milk production. During each 20–d period, cows were offered one of 5 rations: 1) CONT, 0% co-products; 2) 15WDGS, 15% DM WDGS; 3) 15WCGF, 15% DM WCGF; 4) 15MIX, 7.5% WDGS and 7.5% WCGF; and 5) 30MIX, 15% WDGS and 15% WCGF. Rations were formulated to be similar in crude protein and metabolizable energy and protein allowable milk. Milk production and DMI were averaged for d 14 – 20 of each period for each cow, and milk components were measured on d 19 – 20 of each period. Dry matter intake was greatest ($P < 0.01$) for cows consuming 30MIX (25.5 kg/d) and lowest for CONT and 15 WCGF (22.7 and 23.2 kg/d). Milk production tended ($P = 0.08$) to be higher for 15MIX and 30MIX as compared to CONT (41.9 and 41.8 vs. 39.9 kg/d). 4% fat corrected milk (40.6 kg/d), fat percent and yield (3.92% and 1.59 kg/d), and milk urea N (14.5 mg/dL) were not different among treatments. Milk protein percent was increased ($P < 0.01$) for all rations containing co-products as compared to CONT (3.03 vs. 2.95 %). Protein yield also tended ($P = 0.07$) to be higher for co-products rations as compared to CONT (1.26 vs. 1.20 kg/d). Cows consuming 30MIX were ($P = 0.02$) the least efficient in producing milk from feed consumed (1.64 kg milk/ kg DMI) while 15MIX was the most efficient (1.83). This research demonstrates that WDGS and WCGF can be fed in combination up to 30% DM with an improvement in DMI, milk production, and protein percent and yield and no negative effect on milk fat.

Key Words: Corn Milling Co-Product, Milk, Intake

580 Endosperm type of dry ground corn grain affects ruminal and total tract digestion of starch in lactating dairy cows. M. S. Allen*, R. A. Longuski, and Y. Ying, *Michigan State University*, *East Lansing*.

Our objective was to determine effects of dry corn grain varying in endosperm type and particle size on ruminal digestion kinetics and ruminal and total tract digestibility of starch in lactating cows. Eight ruminally and duodenally cannulated Holstein cows (132 ± 42 DIM; mean ± SD) were used in a duplicated 4 × 4 Latin square design with a 2 × 2 factorial arrangement of treatments. Main effects were corn grain vitreousness (floury or vitreous) and particle size (medium or fine). Endosperm was 25% vitreous for floury treatment and 66% vitreous for vitreous treatment. The fraction of ground corn passing through a 1.18 mm sieve was 43% for medium, vitreous; 42% for medium, floury; 57% for fine, vitreous; and 62% for fine, floury. Diets included alfalfa silage, corn treatments, protein supplement, minerals and vitamins and contained 29.2% starch, 27.6% neutral detergent fiber and 18.3% crude protein. Corn grain treatments supplied 86.2% of dietary starch. No interactions were detected for any measure of starch digestion. Floury treatment increased rate of starch digestion (19.2 vs. 9.9 %/h, $P < 0.01$) and decreased rate of starch passage (16.1 vs. 25.7 %/h, $P < 0.001$), increasing apparent ruminal starch digestibility (53.7 vs. 24.6 %, $P < 0.001$). Total tract starch digestibility was increased by floury treatment (92.2 vs. 85.1 %, $P < 0.0001$) despite greater post-ruminal starch digestion (% of starch intake) for the vitreous treatment (60.7 vs. 38.4 %, $P < 0.01$). Fine grinding increased rate of starch digestion (19.5 vs. 9.51 %/h, $P < 0.01$), which increased apparent ruminal digestibility (47.2 vs. 31.1 %/h, $P = 0.03$) compared to medium treatment. However, total tract starch digestibility was not affected by fineness of grind (mean = 22.2 %/h) because of greater post-ruminal starch digestibility (% of starch intake) for medium compared to fine treatment (57.2 vs. 41.9 %, $P = 0.02$). Endosperm type greatly affects ruminal and total tract starch digestibility independent of corn grain grind size.

Key Words: Vitreous, Digestion Kinetics, Particle Size

581 Effects of two dietary non-fiber carbohydrate levels on ruminal fermentation and animal metabolism of lactating cows. M. Blanch*[1], S. Calsamiglia[1], M. Devant[2], and A. Bach[2,3], [1]*UAB*, *Spain*, [2]*IRTA*, *Spain*, [3]*ICREA*, *Spain*.

Sixty-two lactating Holstein cows (BW = 654 ± 14 kg, DIM = 186 ± 6.8, 40 multiparous and 22 primiparous), fitted with rumen cannulas (5 multiparous and 3 primiparous) were used to study the effects of two dietary NFC levels on ruminal fermentation and animal metabolism following a cross-over design with 2 periods of 30 d. Treatments were: a traditional ration (**TR**, 16.5% CP, 33.8% NDF, and 41.8% NFC, on a DM basis), and a high-NFC ration (**HC**, 17.6% CP, 27.1% NDF, and 47.9% NFC, on a DM basis). Milk yield and feed intake were recorded daily and milk composition biweekly. Animals were blood sampled to determine blood glucose, insulin, and urea concentrations within the first hour after the morning feeding in 2 separate days in each treatment. Fecal samples were taken 1 d in each treatment within the first hour after the morning feeding to determine total tract starch digestibility using lignin as an internal marker. Samples of ruminal contents were collected during 3 d in each treatment at 0, 4 and 8 h post-feeding to determine VFA and ammonia-N concentrations. Rumen pH was recorded electronically at 22-min intervals during 6 d in each treatment. Milk yield was greater (34.4 and 31.9 kg/d), milk fat % was lesser (3.03 and 3.64), and concentrate intake at the milking unit was lesser (2.63 and 3.72 kg/d) in HC compared with TR, respectively. Blood glucose concentration was lesser in TR compared with HC (61.8 and 67.2 mg/dL, respectively), and HC resulted in a lesser total tract starch digestibility (94.7 and 95.9% for HC and TR, respectively) and a greater blood urea level (33.3 and 30.1 mg/dL for HC and TR, respectively). Rumen pH of HC primiparous cows fell below 5.6 for longer periods of time than that of TR cows (6.76 and 0.812 h/d, respectively), but no changes in mean pH were observed (5.93 and 6.26 for HC and TR, respectively). These results indicate that feeding high NFC diets for short periods of time may increase milk yield without incurring in strong negative repercussions to the animal.

Key Words: Dairy Cows, Non-Fiber Carbohydrates

582 Effects of feeding three types of corn milling co-products on ruminal fermentation and digestibility in lactating Holstein dairy cattle. J. M. Kelzer*[1], P. J. Kononoff[1], A. M. Gehman[1], K. Karges[2], and M. L. Gibson[2], [1]*University of Nebraska*, *Lincoln*, [2]*Dakota Gold Research Association*, *Sioux Falls, SD*.

Replacing traditional feed ingredients with corn milling co-products in total mixed rations may alter ruminal environments in dairy cattle. Three co-products were fed at 15% inclusion to 4 ruminally fistulated Holstein cows averaging (± SD) 677 ± 41 kg BW and 124 ± 5 DIM to determine effects on ruminal fermentation and total tract digestibility. Cows and treatments were randomly assigned in a 4 × 4 Latin square over four, 21-d periods. Treatments were formulated by replacing portions of forage and concentrate feeds with 15% co-product and included: 1) 0% co-product (**Control**), 2) dried distillers grains + solubles (**DDGS**), 3) dehydrated corn germ meal (**Germ**), and 4) high protein dried distillers grains (**HPDDG**). Diets were formulated to be isonitrogenous and similar in metabolizable energy and protein. Neutral detergent fiber (NDF) content was 34.4, 36.9, 37.0, and 38.8 %, and starch was 26.1, 21.9, 22.0, and 22.8 % for Control, DDGS, Germ, and HPDDG, respectively. On d 21, rumen fluid was collected at 10 time points over 24 h post-feeding. Dry matter intake and milk production were not different across treatments and averaged (± SEM) 26.1 ± 2.3 and 28.3 ± 3.9 kg/d. Ruminal pH (6.26 ± 0.08), rumen ammonia (14.1 ± 1.0 mg/dL), and total concentration of volatile fatty acids (125.3 ± 4.2 mM) were similar. Acetate concentration for Control was higher ($P < 0.05$) than DDGS, Germ, and HPDDG (81.7 vs. 75.8, 75.0, and 78.4 mM). Concentrations of propionate (27.8 ± 1.2 mM) and butyrate (14.3 ± 0.9 mM) were not different. The acetate:propionate ratios for Control, Germ, and HPDDG were higher ($P < 0.05$) than DDGS (3.02, 2.88, 2.91 vs. 2.62). Dry matter, organic matter, and NDF digestibilities were similar and averaged 63.5 ± 2.7, 67.3 ± 2.2, and 43.5 ± 4.2 %. Feeding corn milling co-products to dairy cows decreased acetate concentration in the rumen; however, total tract digestibility was not affected.

Key Words: Co-Product, Ruminal Fermentation, Digestibility

583 Evaluation of low starch diets for lactating Holstein dairy cattle. H. M. Dann*[1], K. W. Cotanch[1], P. D. Krawczel[1], C. S. Mooney[1], R. J. Grant[1], and T. Eguchi[2], [1]*William H. Miner Agricultural Research Institute*, *Chazy, NY*, [2]*Zen-Noh National Federation of Agricultural Cooperative Associations*, *Tokyo, Japan*.

Proliferation of ethanol production in the US has increased price of corn grain and consequently feeding diets containing less than 20% starch may be economically advantageous. The objective of this experiment was to measure the ruminal and lactational responses of Holstein dairy cattle when fed diets containing 17.7 (LS), 21.0 (MS), or 24.6% (HS) starch (dry basis). Twelve multiparous cows (3 ruminally fistulated) were assigned randomly to these diets in a replicated 3×3 Latin square design with 3-wk periods (14-d adaptation, 7-d collection). Diets were fed as total mixed rations and contained approximately 30.2% corn silage, 18.5% grass silage, and 5.0% alfalfa hay (dry basis). Dietary starch was manipulated by reducing the amount of corn grain (16.9%, HS; 10.1%, MS; 3.4%, LS; dry basis) and increasing the amount of beet pulp (0%, HS; 3.4%, MS; 6.7%, LS), wheat midds (6.8%, HS; 10.1%, MS; 13.4%, LS) and distillers grains (7.8%, HS; 8.7%, MS; 9.7%, LS). In vitro 6-h starch digestibility of the diet increased as byproducts replaced corn grain (73.6%, HS; 77.3%, MS; 82.5%, LS). Data were analyzed as a replicated Latin square design using the MIXED procedure of SAS. Dry matter intake (26.5 kg/d), solids-corrected milk (SCM) yield (40.8 kg/d), and efficiency of SCM production (1.54) were unaffected ($P > 0.05$) by diet. Diet also had no effect ($P > 0.05$) on total chewing (815 min/d), ruminal pH averaged over 24 h (6.06), or acetate to propionate ratio (2.4). Total tract organic matter digestibility was higher ($P \leq 0.05$) for HS (69.2%) compared with MS (67.3%) and LS (67.0%) diets, but crude protein, neutral detergent fiber, and starch digestibilities were unaffected ($P > 0.05$) by diet. Microbial N synthesized in the rumen (584 g/d) estimated using urinary excretion of purine derivatives was unaffected ($P > 0.05$) by diet. As dietary starch decreased in this study, ruminal fermentability increased and consequently the range between HS and LS in rumen fermentable starch (3.5%-units) was less than the range in starch content (6.9%-units). Under these conditions, dietary starch content had no measurable effect on ruminal microbial production or lactation performance.

Key Words: Starch, Lactation Performance, Dairy Cattle

584 Ground vs steam-rolled barley grain for lactating cows: A clarification into conventional beliefs. A. Soltani[1], G. R. Ghorbani[1], M. Alikhani[1], and A. Nikkhah*[2], [1]*Isfahan University of Technology*, *Isfahan, Iran*, [2]*University of Illinois*, *Urbana*.

An optimum processing method of barley grain that controls its rumen degradation rate, synchronizes starch and protein fermentation, and avoids strach overflow into the small intestine and hindgut is one of priorities in managing lactating cows. Grinding is an easy-to-access technique traditionally believed to be a potensial risk to feed intake and rumen health. Steam-rolling is thought to overcome such concerns, but it is expensive. Our main objective was to determine if ground barley grain (GB) is as effective in promoting feed intake and maintaining milk production as steam-rolled barley (SB). Eight multiparous Holstein cows (85 ± 9 days in milk) were used in a replicated Latin square design experiment with four 21-d periods. Each period had 14-d of adaptation and 7-d of sampling. Treatments included feeding GB or SB barley grains at either 35% or 30% of dietary dry matter. Diets were prepared as a totally mixed ration and fed twice daily at 0700 and 1600 h. Neither processing method nor barley grain inclusion rate affected dry matter intake, daily eating, ruminating and chewing times, total tract digestibility of dry matter, organic matter, and neutral and acid detergent fibers, milk yield, and milk percents and yields of fat, protein, and total solids. When barley grain was ground, increasing its inclusion from 30% to 35% of diet dry matter tended to reduce milk fat percent (3.7 vs. 3.3%, $P<0.10$) and reduced milk fat yield (1.38 vs. 1.24 kg/d, $P<0.05$). Changing dietary level of SB did not change these criteria. Dietary use of 35% instead of 30% barley grain increased percents but not yields of milk lactose and solids-non-fat. Feed efficiency was improved by feeding SB instead of GB (1.57 vs. 1.50, $P<0.05$) but was unaffected by dietary levels of barley grain. Therefore, GB was as effective as SB in stimulating feed intake and maintaining rumen fermentation and milk production.

Key Words: Barley Grain, Processing, Lactating Cow

585 Replacement of starch from corn with non-forage fiber from distillers grains in diets of lactating dairy cows. S. D. Ranathunga*, K. F. Kalscheur, A. R. Hippen, and D. J. Schingoethe, *South Dakota State University*, *Brookings*.

Availability of larger quantities of dried distillers grains with solubles (DG) and its greater energy content indicate that one can replace high-priced corn with DG, in dairy cow diets, to lower feed costs. Therefore, this research was to evaluate the partial replacement of starch from corn in dairy cow diets with different amounts of a non-forage fiber source, DG, on lactation performance. Forty Holstein cows were used in completely randomized design with a 2-wk covariate period followed by a 6-wk treatment period. Four diets were formulated: 1) high starch (28% starch, 0% DG), 2) medium starch (24.5% starch, 7% DG), 3) low starch (21% starch, 14% DG), and 4) very low starch (17.5% starch, 21% DG). Diets contained 17% CP, 4.5% fat, a constant forage to concentrate ratio (49:51), and 21% forage NDF. As starch was replaced with DG, DMI linearly decreased ($P < 0.01$; Table 1). Milk production during the study (38.2 kg/d) was not affected by diets. There were no treatment effects on milk fat and protein percentages nor milk fat and protein yields. Other parameters including 4% fat-corrected milk (FCM), total solids (TS), and MUN were unaffected by dietary treatments. There was a linear tendency to increase feed efficiency as starch was replaced by non-forage fiber ($P < 0.10$). Results from this research suggest that non-forage fiber from DG can partially substitute for starch from corn in dairy cow diets without affecting milk production and milk composition.

Table 1.

Item	High Starch	Medium Starch	Low Starch	Very low Starch	SEM	P[a]
DMI, kg/d	25.6	25.0	23.4	22.9	0.70	L
Milk, kg/d	39.4	37.4	37.7	38.3	1.03	NS
Fat, %	3.14	3.23	3.29	3.24	0.11	NS
Protein, %	2.97	2.96	3.01	2.94	0.04	NS
TS, kg/d	4.73	4.54	4.55	4.58	0.13	NS
MUN, mg/dL	11.7	12.2	11.6	12.2	0.38	NS
4% FCM, kg/d	34.3	33.6	33.6	33.4	1.04	NS
Feed eff. (FCM/DMI)	1.46	1.35	1.41	1.50	0.05	LT

[a] L=linear effect ($P<0.05$); LT=linear tendency ($P<0.10$); and NS=non significant

Key Words: Distillers Grains, Starch, Non-Forage Fiber