# Effect of Wheat Supplementation on Lactation Performance in Dairy Cows

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Wheat grain is seldom fed to dairy cows because of the concern that it will contribute to the development of sub-acute rumen acidosis, with subsequent negative effects on cow productivity. However, wheat is readily available in Western Canada, and if priced competitively, may be an alternative to barley in dairy cow diets.

The objective of this experiment was to examine the effect of increasing levels of dietary wheat supplementation on rumen pH and lactation performance. Twelve 2nd lactation Holstein cows were used in a replicated 3 x 3 Latin square design. Cows were fed a TMR twice daily consisting of barley silage (35%), alfalfa hay (15%) and concentrate (50%) containing 0, 20, and 40% rolled hard red spring wheat, so that the final diets contained 0, 10, and 20% wheat on a DM basis. All diets contained sodium bicarbonate at 0.5% of diet DM. In the two wheat diets, wheat directly replaced rolled barley.

Dry matter intake (average of 20.9 kg/d) and milk yield (35.9, 36.0, and 36.4 kg/d for 0, 10, and 20% wheat, respectively) were not different between the treatments. Milk protein content was lower in the wheat-fed cows (2.98% and 3.06% for 10 and 20% wheat) than in the barley-fed cows (3.09%). Milk fat content (3.46%) and yield (1246 g/d) were unaffected by treatment. Rumen pH, measured in 6 cows, was reduced by wheat inclusion in the diet (6.44, 6.34, and 6.37 for 0, 10, and 20% wheat, respectively), but not to levels that would indicate sub-acute rumen acidosis.

**Implications:** Our results indicate that replacing rolled barley with readily fermentable carbohydrate in the form of rolled wheat has minimal effects on lactation performance and that up to 20% wheat can be included in the diet without causing milk fat depression.

# Effect of Dietary Wheat Supplementation on Dairy Cow Performance Is Not Influenced By the Addition of Rumen Buffers

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In a previous study, we had demonstrated that wheat grain fed to lactating dairy cows at up to 20% of diet DM in conjunction with sodium bicarbonate at 0.5% of diet DM had no adverse effects on rumen pH or milk and milk component yields compared to those obtained when barley was fed.

The current study was conducted to determine if a diet containing 20% wheat could safely be fed to dairy cows without the addition of rumen buffers. Twelve 2nd lactation Holstein cows were used in a replicated crossover with 21 day periods. Cows were fed a total mixed ration twice daily consisting of 35% barley silage, 15% alfalfa hay and 50% concentrate on a DM basis. The concentrate contained 40% rolled hard red spring wheat with (SB) or without (Ctl) sodium bicarbonate at 0.5% of total diet DM.

Dry matter intake (21.3 and 20.7 kg/d for Ctl and SB, respectively), and milk yield (31.4 and 30.2 kg/d) were unaffected by treatment. Milk fat content (3.77%) and fat yield (1155 g/d) were not different between treatments. Similarly, milk protein content (3.31%) and yield (1007 g/d) were also not influenced by treatment. Treatment had no effect on rumen pH (6.26 and 6.22 for Ctl and SB, respectively).

**Implications:** These results suggest that up to 20% wheat can be included in the diet of lactating cows without a need for rumen buffers provided that the cows consume adequate fibre. If readily available and priced competitively, wheat should be considered a suitable feedstuff for lactating dairy cows.

# Harvesting the Health Promise of Conjugated Linoleic Acid (CLA)

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New research results are strengthening the case for conjugated linoleic acid (CLA) as one of the most promising food nutrients to aid in the battle against chronic disease. This unique fat, found naturally in dairy and beef products, is showing considerable potential for human health benefits related to cancer, heart disease, obesity, diabetes, kidney disease and bone density.

In Canada, a major effort to understand and harvest the health promise of CLA is the CLA Network. Founded in Alberta in 2001, the CLA Network is a collaborative team from academia, industry and government, including representatives from many areas of expertise such as research, food industry, health and communications.

Canadian dairy producers are well positioned to benefit. CLA progress has excellent potential to strengthen the health image and market value of dairy products, supporting the sustainability and profitability of dairy producers.

# Effect of Grain Source on the Requirements of Dairy Cows for Physically Effective Fibre

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Dairy cows require diets that contain adequate physically effective fibre (peNDF) to prevent ruminal acidosis. The peNDF stimulates chewing activity which increases saliva secretion and rumen pH. The amount of peNDF supplied by the diet depends on the particle length of the forages and the proportion of forage in the ration. We conducted two studies to determine if the amount of peNDF required by dairy cows depends upon the type of grain in the diet. We speculated that more peNDF might be required when diets contain barley grain rather than corn grain because barley is more rapidly fermented in the rumen.

Barley and corn grains were each used in separate feeding studies with lactating dairy cows. Alfalfa silage, chopped short (5/16") and long (3/4"), was the forage in both studies. In each study, four diets were formulated using the two cuts (short and long) of alfalfa silage combined with two ratios of forage to concentrate (35:65 or 60:40, dry matter basis, DM). The peNDF contents of the diets were determined by measuring particle length of the ration using the Penn State Particle Separator with two sieves and a pan, and by chemically analyzing the fibre (NDF) content of the ration. The peNDF contents ranged from 9.6 to 19.8% for barley diets, and from 10.7 to 17.5% for corn diets (DM basis). Chewing activity and rumen pH were continuously measured for 48 hours.

When diets contained barley grain, increasing the peNDF content of low forage diets increased the mean ruminal pH by 0.31 units and reduced the amount of time each day that cows experienced ruminal acidosis (i.e, pH below 5.5) from 7.8 to 5.9 hours. However, no effects of peNDF on ruminal pH were detected for high forage diets containing barley. With corn diets, increasing peNDF improved mean ruminal pH of cows fed low forage diets, but not when fed high forage diets. In addition, higher forage to concentrate ratio increased chewing activity and mean ruminal pH, and reduced ruminal acidosis.

**Implications**: For low forage diets, increasing the peNDF content of the ration by feeding longer chopped forages improves rumen pH, and helps avoid acidosis. The reduction in acidosis by increasing the peNDF content of the diet was greater for barley than for corn diets, because the incidence of acidosis is higher in barley diets. Once diets contain more than 60% forage (DM basis), there is no need to consider particle length of forages.

# Benefits of Managing Methane Emissions from Dairy Cows

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Methane produced by the cow represents a loss of energy from the feed. Up to 12% of the energy in feed is converted to methane gas in the rumen when it is digested by the cow. Because methane is not used by the cow for milk production, methane gas is a loss of feed energy that could increase feed costs. In addition to improving feed efficiency, reducing methane losses is also an environmentally sound practice. Methane gas in the atmosphere is a potent greenhouse gas that contributes to global warming.

Scientists at the Lethbridge Research Centre have been working together with the Dairy Farmers of Canada to find ways of measuring and curbing methane greenhouse gas emissions from dairy farms. As part of this project, measurements of methane emissions were made on dairy farms in Southern Alberta using sensors positioned downwind from the barn.

In this on-farm survey, methane emissions varied between 438 and 519 litres per day per animal. All cattle on the farm over three months of age contributed to this estimate. Because of their higher feed intake, lactating dairy cows contributed about 600 litres each day.

**Implications:** The daily methane produced by a dairy animal is equal to the greenhouse gas emitted from a car driven 25 km. Over the course of the year, these methane losses quickly add up. The goal of our research is to make whole measurements of methane emissions and develop mitigation options for dairy producers wanting to take advantage of methane reduction. Controlling the loss of feed energy as methane helps improve efficiency and is an environmentally sound goal for the dairy industry.

# Feed intake, Digestion, Milk Production, and Milk Composition in Dairy Cows Fed Natural Plant Extracts.

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There is increasing interest in using plant extracts as 'natural' feed additives to manipulate ruminal fermentation and improve feed efficiency in ruminants. Extracts of some plants, e.g., *Yucca schidigera*, have been evaluated for their anti-microbial effects and for their potential to modulate ruminal fermentation and improve nutrient utilization in ruminants. More recently, essential oils have attracted attention for their potential as alternatives to feed antibiotics and growth promoters in livestock. Essential oils are naturally occurring volatile components that can be distilled from plant tissues by distillation methods. Strong anti-microbial effects of essential oils have been demonstrated against a wide range of microorganisms, including ruminal bacteria. Few studies to date have focused on the effects of essential oils on dairy cow metabolism and performance, and none to our knowledge, has compared essential oils against other extracted plant compounds such as yucca saponins extracts or condensed tannins.

The objective of this study was to determine the effects different plant extracts on feed intake, digestion, and milk performance of dairy cows. Four lactating Holstein cows (87 days in milk) used in a 4 x 4 Latin square design were fed for ad libitum intake a TMR without supplementation (Control), or supplemented with cinnamon extract (1 g/day; cinnamaldehyde), yucca saponins (60 g/d; *Yucca Schidegera*), and condensed tannins (150 g/d; Quebracho).

Feed intake averaged 22.9 kg/d and was not influenced by plant extracts addition. Apparent digestibilities of crude protein and fibre were similar between cows fed plant extracts and those fed TMR without additive. Production of milk and milk concentrations of protein and fat were not affected by plant extracts addition and averaged 33.1 kg/d, 3.52%, and 4.31% respectively.

**Implications:** Although plant extracts have been shown to favourably alter ruminal fermentation in laboratory studies, it may be a challenge to achieve similar results in vivo.

# Effect Of Post-Ruminal Supply Of Amino Acids On Feed Intake And Milk Production Of Lactating Dairy Cows

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Amino acids (AA), or building blocks of protein, have been divided into two categories, essential (EAA) and non-essential (NEAA). Despite this categorization, both types of AA are required for the synthesis of milk protein, but the EAA cannot be synthesized by the cow and must be supplied, while the NEAA can be synthesized by the cow in several organs including the mammary gland. The objective of this experiment was to determine if NEAA synthesis is a limiting step for milk protein synthesis. Eight lactating cows, 4 primiparous and 4 multiparous, were used in a replicated 4x4 Latin square. The cows were fed a diet that met their energy requirements but only 75% of their metabolizable protein requirements. The four treatments were 14-d abomasal infusions of: 1) water (control), 2) EAA (290 g/d), 3) NEAA (330 g/d) and 4) EAA + NEAA (620 g/d), with the casein profile.

Dry matter intake (16.6 kg/d), milk fat content (2.88%) and milk fat yield (1.02 kg/d) were not different between treatments. In contrast, milk yield, and milk lactose and protein yield were affected by treatment. Milk yield was higher for the EAA (37.1 kg/d) and EAA+NEAA (37.9 kg/d) treatments than for the control (34.0 kg/d) and NEAA (34.4 kg/d) treatments. Similarly, milk protein content and protein yield were higher for the EAA (2.97%, 1.10 kg/d) and EAA+NEAA (3.03%, 1.15 kg/d) treatments than for the control (2.83%, 0.97 kg/d) and NEAA (2.81%, 0.97 kg/d) treatments. Milk lactose content was higher for the NEAA and control treatments than for the EAA+NEAA and EAA treatments (4.69, 4.65, 4.60 and 4.55%, respectively), but lactose yield was higher with the EAA and EAA+NEAA treatments than with the control and NEAA treatments.

**Take Home Message:** Yields of milk, protein and lactose were higher for cows receiving the EAA or EAA+NEAA than for cows receiving the control or NEAA treatments. These results indicate that NEAA supplementation is not beneficial, at least on a 14 d-period, suggesting that NEAA synthesis does not limit milk protein secretion.

# Effects of Timing of Feed Delivery on Daily Rhythms in Glucose and Insulin in Blood Plasma and Glucose Tolerance in Dairy Cows

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Traditional feeding time for dairy operations is in the early morning. Recent studies have shown beneficial effects of evening feeding in beef cattle and dairy cattle. Studies in humans have proven that a night-time insulin resistance resulting in poor glucose tolerance exists. Daily rhythms in glucose tolerance have not yet been confirmed in dairy cattle. Synchronizing timing of feed delivery with these rhythms may improve milk fat and energy balance in high producing dairy cows.

To examine this possibility, 8 Holstein cows were used in a replicated 4x4 Latin Square with four periods. Each period lasted 21 days (14 d adaptation + 7 d sampling). Fresh total mixed ration containing higher concentrate (HC) or lower concentrate (LC) was delivered either at 9 am (AM) or at 9 pm (PM). The HC diet contained 62% of dry matter as concentrate. The LC diets contained 51% of dry matter as concentrate. Treatments were 1) HC + AM, 2) HC + PM, 3) LC + AM, and 4) LC + PM. Each sampling week, blood samples were taken every 2 hr for 2 days via jugular catheters. A glucose tolerance test was performed at noon of the last day of periods 2, 3 and 4. Feeding time had a significant effect on daily glucose and insulin rhythms, but had no effect on glucose tolerance or insulin response to glucose injection at noon. The PM fed cows had a lower glucose and higher insulin level at 2 h post-feeding than the AM fed cows, but from 6-8 hrs post-feeding both glucose and insulin was higher in PM fed cows than in AM fed cows. These results suggest a possible night-time insulin resistance. We have, therefore, recently completed a more thorough glucose tolerance study, in which we compared the glucose tolerance of AM and PM fed cows at different times of the day.

**Implications:** Feeding dairy cows in the evening alters post-feeding glucose metabolism and this may improve dairy cattle productivity.

# Could Luteotropic Agents Prevent Or Delay The Effect Of Prostaglandin $F_{2\alpha}$ In Cattle?

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As an approved product for reproductive management, prostaglandin $F_{2\alpha}$ (PG) is used routinely in dairy herds. The inadvertent use of PG in pregnant cows could result in luteolysis (CL regression) and pregnancy loss. There are approved luteotropic (supporting CL function) agents that may counteract the luteolytic (destroying the CL) action of PG but information on their efficacy is lacking. The objective of this study was to determine if the luteolytic effects of PG could be prevented, minimized, or delayed by luteotropic agents, using a non-pregnant cow model. Eighteen lactating non pregnant Holstein cows with a history of normal reproductive cycles were assigned randomly but equally (n=6) to one of three treatment groups. Ovarian status of cows was synchronized using an ovsynch protocol, and ovulation confirmed by ultrasonography (d 0). Between d 8 and 10, PG [25 mg dinoprost tromethamine; Lutalyse ®, Pfizer Canada] was administered intramuscularly to all cows. Exactly five minutes after giving PG, treatments of pLH [25 mg porcine LH; Lutropin-V, Bioniche Animal Health], or GnRH [200 :g gonadorelin acetate; Fertiline®, Vetoquinol NA Inc] or sterile saline solution (2 ml, Control) were given (i.m.) to cows within each treatment group. The time interval of 5 min between PG and luteotropic treatments was chosen as a realistic time frame to take remedial action, i.e., if an accidental PG administration occurred. Blood samples were collected from the jugular vein from all cows 12 h before PG treatment [-12 h], immediately before PG [0 h], 1 h and 6 h after PG, then every 6 h until 48 h after PG, and thereafter twice daily for the next 36 h. Plasma concentrations of progesterone were measured by enzyme-immunoassay. The effects treatment, time (of sampling), and their interactions were determined using the MIXED procedure of SAS. The main effect of time was detected in all treatment groups as progesterone concentrations declined rapidly during the first 24 h following PGF treatment. Decline in progesterone concentrations did not differ between GnRH and control, but progesterone did not fall below 1 ng/mL in cows treated with pLH until after 72 h. Results suggest that pLH countered the effect of PGF and delayed luteolysis. Whether repeating the pLH treatment every 6-8 h for the first 24 h after PGF administration will prevent luteolysis is worth investigating.

**Implications:** We investigated if either gonadotropin releasing hormone (Fertiline) or porcine luteinizing hormone (Lutropin-V) will counter the effect of PG. Lutropin-V appeared to delay the effect of prostaglandin for several hours, but neither product was effective in preventing CL regression.

# Fertility Profile Determination in Bovine Spermatozoa: Marker Linked To NRR

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It has been believed for a long time that sperm cells are only a vehicle of the haploid genome but recent evidence shows that these cells not only reflect the quality of past events (i.e. spermatogenesis) but also ship a complex cargo of RNA and proteins that may be crucial for an embryo's early development.

One of the final steps in spermatogenesis is cytoplasmic reduction, which is described as a step in which the unnecessary cytoplasmic components of the cell are rejected. Because the majority of the sperm RNA is ejected from the spermatozoa during cytoplasmic reduction, the residual RNA present in the mature spermatozoa is considered to be a remnant of spermatogenesis. However, a growing number of studies, mainly in humans, suggest that this RNA could be useful, if not in the post-fertilization stages then at least as markers to indicate whether spermatogenesis went wrong or well. In other terms, bovine expressed sequences in spermatozoa are not only a useless relic of spermatogenesis but can reflect the quality of the semen.

Our laboratory is studying the RNA populations present in bovine spermatozoa with the goal of determining whether these molecules can be used as fertility markers, within the context of the selection of the best bulls for the artificial insemination industry. Using the Suppressive Subtractive Hybridization molecular technique (SSH) for creating transcripts repertory or library for reporting differences among fertile bulls, we have selected and sequenced the differently expressed messenger RNA (mRNA) in the sperm cells of bulls that have demonstrated good/poor reproductive potential (based on their non-return rate, i.e. NRR). The preliminary results suggest primarily the presence of mRNA in bovine spermatozoa having a role in spermatogenesis and some transcripts that could also play a role during the initial steps of embryogenesis.

**Implication:** Verification of the status of fertility markers in semen will both help the artificial insemination industry (indicator of bull fertility or quality of a production lot) and make it possible to identify the genes and alleles that must be retained to improve the genetics of Canadian dairy herds.

# Feed Stalls Affect the Social and Feeding Behaviour of Lactating Dairy Cows

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Increasing the amount of available feed bunk space for lactating dairy cows has been shown to reduce competition and improve access to feed. Despite this, we still see high levels of aggressive behaviour at the feed bunk with increased amounts of bunk space. Research in other domesticated species has indicated that the configuration of feeding spaces can have profound effects on competitive behaviour observed at the feed bunk.

The objective of this research was to determine if the addition of partitions (feed stalls – see photo) between adjacent cows reduces aggressive behaviour while feeding. Twenty-four lactating Holstein cows were subjected to each of 2 treatments. The treatments, each tested for 10 d, were: 1) 0.92 m of feed bunk space/cow, and 2) feed stalls (0.87 m of feed bunk space/cow with feed stall partitions separating adjacent cows).

Total daily feeding time increased while the time spent standing in the feeding area (when not feeding) and the frequency of aggressive interactions at the feed bunk decreased when feed stalls were added to the feed bunk. The feed stalls also forced cows to change the strategy by which they displaced others from the feed bunk. Cows were forced to initiate contact at the rear of the animal that they were displacing rather than from the front and side. Further, those cows ranked lower in the social hierarchy at the feed bunk had the greatest decreases in the number of times they were displaced per day when fed using the feed stalls.

**Implications:** Based on these results, we recommend the provision of feed stalls to improve comfort at the feed bunk, particularly for subordinate cows. This could help reduce the between-cow variation in the composition of ration consumed by preventing these cows from being forced to access the bunk only after dominant cows have sorted the feed.

# Use of a Local Anaesthetic to Validate Two Measures of Lameness in Dairy Cows.

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To validate two possible measures for detecting lameness in dairy cows, we gait scored lame and healthy lactating Holstein cows (n=12) while walking and measured the percent (and variability) of weight placed on each leg while standing, before and after injections of a local anaesthetic into the leg judged as most responsible for the lameness.

Before injection, healthy cows had lower gait scores and placed their weight more evenly among their four legs than did lame cows. Lame cows placed less weight on the injured leg and placed more weight on the contralateral leg than did healthy cows. Furthermore, the variability in weight applied to the injured and the contralateral leg was much higher for lame cows than for healthy cows, suggesting more frequent shifting of weight.

After lidocaine injections, gait scores of healthy cows remained more-or-less constant, while gait scores of lame cows were reduced over 15 min. Furthermore, the percent of weight applied to the injured leg and the variability in weight applied to the injured and contralateral legs was reduced.

**Implications:** The system of gait scoring and the measure of weight applied to each leg were both able to detect lame cows and were both sensitive to local anaesthetic, indicating some degree of validity. The responses of lame cows to the anaesthetic show that lameness is painful.