Effect of Replacing Corn Grain by Wheat-based Dried Distillers' Grains with Solubles Dietary Energy and Protein Value in Cattle

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Abstract
The objectives of this study were to determine the effect of replacing corn grain portion of the diet by wheat-based dried distillers' grains with solubles (wDDGS) on feeding value for ruminants by chemical fractionation, nylon bag rumen degradation and nutrient modeling approaches. This study revealed that increasing wDDGS inclusion level increased most of nutritional composition linearly, except for starch which linearly decreased. Metabolizable protein supply in small intestine increased linearly with increasing levels of wDDGS. The inclusion of wDDGS in corn based diets decreased energy values of the diet slightly. Optimum ruminal N to energy balance for microbial growth was reached by replacing 25-50% of corn by wDDGS. In summary, this study suggests that corn and wheat DDGS combinations are a viable alternative for replace feed barley grain for the beef industry in western Canada.

Introduction
Barley (*Hordeum vulgare* L.) is traditionally the mainstay of the western Canadian feedlot industry, with feedlot rations containing up to 90% barley grain (Beliveau and McKinnon, 2008). Corn grain (*Zea mays* L) is used by the western Canadian feedlot industry as an alternative feed source when the cost of barley grain is high. Corn contains more starch and is higher in metabolizable energy, but has less protein than barley which must be considered when formulating diets for feedlot cattle (NRC, 1996). Therefore, corn-based diets fed to finishing cattle in the United States are supplemented to ensure a dietary crude protein content (CP) of 12.5% of DM (Galyean, 1996). Due to expansion of bioethanol production in North America, a large supply of bio-ethanol co-products like wDDGS is available in western Canada. These co-products are typically high in CP. We hypothesized that feeding corn in combination with wDDGS will improve availability of nutrients to the animal (i.e., metabolizable protein) and synchronizes protein to energy fermentation in the rumen. The objectives of this study were to determine effects of replacing corn grain by wDDGS on nutritive value for ruminants in terms of detailed nutritional profiles, energy values, protein and carbohydrate sub-fractions, in situ rumen degradation kinetics, protein to energy degradation ratios, as well as protein supply to the intestine.

Materials and Methods
Corn grains from two sources were used for this experiment. One corn source was mixed with one batch wDDGS and the other corn source with the other wDDGS batch in ratios of 100:0, 75:25, 50:50, and 25:75 (DM weight basis; denoted as C0, C25, C50, and C75, respectively). The parameters assessed included (i) nutrient profile including CNCPS (Cornel Net

Carbohydrate and Protein System) protein and carbohydrate fractions, (ii) energy values according NRC (1996), (iii) *in situ* nylon bag rumen degradation kinetics according to Ørskov and McDonald (1979), and (iv) metabolizable protein supply to the animal determined according to NRC (2001).

Results and Discussion

Nutrient and Energy Profile: With increasing inclusion level of wDDGS, nutrient contents of protein and carbohydrate fractions increased linearly ($P < 0.05$) except for starch which decreased linearly ($P < 0.05$). Total CP increased from 89.0 to 331.8 g/kg DM from C0 to C75. Soluble, slowly degradable, and undegradable CNCPS protein and carbohydrate fractions linearly ($P < 0.05$) increased with increasing wDDGS inclusion level, while their rapidly and intermediately degradable fractions decreased ($P < 0.05$). Energy values were negatively correlated ($P < 0.05$) with inclusion of wDDGS in the corn - wDDGS mixture. This was a reflection of the lower metabolizable energy value of 2.9 Mcal/kg for wDDGS than 3.1 Mcal/kg for corn . However, inclusion of wheat DDGS in corn based diets had not a major effect on energy values in the diet for dairy and beef cattle.

Rumen Degradation Kinetics: The OM rate of degradation (5.6%/h), undegraded OM (467.9 g/kg DM), as well as the extent of rumen OM degradability (502.4 g/kg DM) were similar ($P > 0.05$) among treatments. Effective degradable CP and rumen bypass protein increased linearly ($P < 0.05$) with increasing inclusion of wDDGS in the mixture which is a reflection of the greater CP value of wDDGS than of corn (401.5 vs. 89.0 g/kg DM). As expected, both the extent of rumen degradability and rumen bypass starch decreased ($P < 0.05$) as the wDDGS inclusion increased in the mixture. To achieve optimal microbial synthesis and minimize N loss, 32 g N/ kg CHO truly digested in rumen (Sinclair et al. 1991) or 0 for rumen degraded protein balance (balance of microbial synthesis from protein – from energy; NRC 2001) is required. In current study, the ruminal N/CHO ratio was 10.6, 30.2, 64.6, and 105.9 g N/kg CHO and rumen degraded protein balance was -91.4, -37.2, 28.8, and 96.4 g/kg DM for C0, C25, C50, and C75, respectively. The metabolizable protein content increased as wDDGS increased in mixture from 67.4 to 159.3 g/kg DM for C0 to C75.

Conclusion

Replacing corn by wDDGS at graded levels had minimal reducing effect on energy values while increasing the metabolizable protein content of the diet. Inclusion of 25-50% of DM wDDGS in the feed mixture created optimal nitrogen to energy balances for microbial growth in the rumen. Overall, the nutritive value of diets can be manipulated to more efficiently utilize corn for the beef industry through the replacement of 25-50% corn by wheat DDGS.

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Literature Cited

Beliveau, R. M., McKinnon, J. J. 2008. Effect of graded levels of wheat-based dried distillers' grains with solubles on performance and carcass characteristics of feedlot steers. *Can. J. Anim. Sci. 88,* 677-684.

Galyean, M. L. 1996. Protein levels in beef cattle finishing diets: Industry application, university research, and systems results. *J Anim Sci 74*, 2860-2870.

National Research Council (NRC). 1996. Nutrient requirements of beef cattle. Update 2000. 7th edition. National Academy Press, Washington, DC.

National Research Council (NRC). 2001. Nutrient requirement of dairy cattle, 7th ed. rev. ed. Natl. Acad. Sci., Washington, DC.

Ørskov, E. R., McDonald, I. 1979. The estimation of protein degradability in the rumen from incubation measurements weighted according to the rate of passage. *J. Agric. Sci. Cambr*. *92*, 499-503.

Sinclair, L. A., Galbraith, H., Scaife, J. R. 1991. Effect of dietary protein concentration and cimaterol on growth and body composition of entire male lambs. *Anim. Feed Sci. Technol*. *34*, 181-192.