

Effect of Replacing Barley Grain by Wheat-based Dried Distillers' Grains with Solubles in the Diet on Nutritional Profiles, Energy Values, Rumen Degradation Kinetics, and Protein Supply

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Abstract

The objectives of this study were to determine the effect of replacing barley grain portion of the diet by wheat-based dried distillers' grains with solubles (wDDGS) on feeding value for ruminants. This study revealed that increasing wDDGS inclusion level increased most of nutritional composition linearly, except for starch which linearly decreased. With increasing wDDGS inclusion, the rumen degradation rate of all measured parameters decreased linearly, extent of degradability of organic matter (OM) was not affected. Extent of CP degradability, degraded protein balance in rumen and calculated metabolizable protein supply in small intestine increased linearly with increasing levels of wDDGS. The inclusion of wDDGS in barley based diets up to 50% did not alter energy values of the diet. Furthermore, the optimum N to energy balance of the feed mixture for microbial growth in the rumen was reached by replacing 25% of barley by wDDGS. Thus, the nutritive value of the barley-based diets can be manipulated by including wDDGS in the diet to overcome shortcomings of barley dominated diets for cattle.

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). However, barley has extremely high ruminal rate and extent of starch degradation (>80%; Yu et al. 2003) which results in digestive disorders such as bloat and acidosis with serious economic impacts on the feeding program. Hence, there is a need to develop strategies to optimize barley utilization and reduce the risk of metabolic disorders for cattle industry. Due to expansion of bioethanol production in North America, a large supply of bio-ethanol co-products like wDDGS is available in western Canada. We hypothesized that feeding barley 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 barley 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

Barley grains from two cultivars (CDC Lophy-1 and CDC Cowboy) were used for this experiment. One barley cultivars was mixed with one batch wDDGS and the other barley cultivar with the other wDDGS batch in ratios of 100:0, 75:25, 50:50, and 25:75 (DM weight

basis; denoted as B0, B25, B50, and B75, respectively). The parameters assessed included (i) nutrient profile, (ii) energy values, (iii) rumen degradation kinetics, and (iv) protein supply. Rumen degradation kinetics of OM, starch and CP were determined according to Ørskov and McDonald (1997) and metabolizable protein supply was 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 ($P < 0.05$). Specifically, protein was 138, 201.8, 263.3, and 340.3 g/kg DM for the B0, B25, B50, and B75, respectively. Soluble, slowly degradable, and undegradable CNCPS (Cornel Net Carbohydrate and Protein System) protein and carbohydrate fractions linearly ($P < 0.05$) increased with increasing wDDGS inclusion level, while their rapidly and intermediately degradable fractions decreased. Energy values were negatively correlated ($r = -0.68$ to -0.74 ; $P < 0.05$) with inclusion of wDDGS in the barley- wDDGS mixture which is a reflection of the lower energy value of wDDGS than of barley (digestible energy was 3.48 and 3.24 Mcal/kg for barley and wDDGS, respectively). However, the study indicated that inclusion of wheat DDGS up to 50% of DM in barley based diets will not have a major effect on energy values in dairy and beef cattle diets.

Rumen Degradation Kinetics: As wDDGS increased in the mixture, the soluble fraction of OM increased ($P < 0.05$), while the potentially degradable fraction of OM linearly declined ($P < 0.05$). The rate of degradation of OM tended to decrease linearly ($P = 0.07$) when wDDGS increased in the mixture. However, undegraded OM (422.9 g/kg DM), as well as the extent of degradability (542.5 g/kg DM) were similar 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 barley (401.5 vs. 138 g/kg DM). The rate of starch degradability linearly declined ($P < 0.05$) as wDDGS inclusion increased, ranging from 0.12 to 0.08/h for B0 to B75. This suggested that replacing portion of barley by wDDGS might help to prevent digestive disorders caused by feeding large amounts of barley grain. As expected, both the extent of rumen degradability and rumen bypass starch decreased ($P < 0.05$) as the wDDGS inclusion increased in the mixture. The optimal ratio between the effective degradability of N and energy in order to achieve maximum microbial synthesis and minimize N loss is 32 g N/ kg CHO truly digested in rumen (Sinclair et al. 1991) or 0 for rumen degraded protein balance (NRC 2001). In current study, the ruminal N/CHO ratio was 26, 48, 72, and 124 for B0, B25, B50, and B75 respectively.

Rumen degraded protein balance was -42.3, 1.4, 47.7, and 110.6 g/kg DM for the B0, B25, B50, and B75, respectively. The metabolizable protein (from 94.5 to 161.1 g/kg DM) increased as wDDGS increased in mixture.

In conclusion, the study suggested that the nutrient and energy profiles of wDDGS make it a good source of protein and energy for ruminants. The inclusion of wheat DDGS up to 50% of DM in barley based diets will not affect energy values of the overall diet. Furthermore, the inclusion of wDDGS up to 25% of DM in the feed mixture created desirable nitrogen to energy balances for microbial growth in the rumen. Overall, through replacing barley by 25-50% wheat DDGS, the nutritive value of diets can be manipulated to more efficiently utilize barley for the beef industry.

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