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Barley protein meal for lactating dairy cows: Effects on production, intake, and nutrient excretion[1]

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ABSTRACT

The objectives of this study were to quantify production performance and nutrient excretion of lactating dairy cows fed barley protein meal (BPM) and to assess its potential as a source of ruminal bypass protein and ruminally protected lysine. Forty-two lactating cows were fed diets formulated to meet NRC nutrient requirements, containing either BPM at 15% of diet DM, corn distillers grains (CDG), or soybean meal (SBM) to supply equal dietary N. Dietary treatment had no effect on milk production or BW. Milk fat content and yield were greater for cows fed BPM compared with cows fed SBM. Dry matter intake was less in cows fed CDG compared with cows fed BPM and SBM. Apparent digestibility of N and P were less (and fecal P excretion was greater) in cows fed BPM than in cows fed SBM. Ruminal degradation rates of CP and DM were similar for BPM and SBM and greater than CDG. Loss of BPM DM and CP from the Dacron bags at zero-time was much greater than for SBM or CDG, resulting in much lower estimates of ruminal escape. However, half of the zero-time loss was apparently due to small particle loss, which would bias estimates of ruminal escape. Degradation rates of the insoluble DM and CP were similar for BPM and SBM and lower for CDG. Undegraded barley protein was a better source of arginine, leucine, and methionine than was SBM and a better source of arginine, lysine, methionine, threonine, and valine than was CDG.

Key words: barley protein meal, corn distillers grains, lactating cow, nutrient excretion

INTRODUCTION

Increases in petroleum prices and concerns about energy security and climate change have led to dramatic growth in ethanol production. Barley may be an attractive alternative to corn for production of ethanol because it is a widely adaptable crop and may be grown via double cropping in many regions of the world. Also, barley is used less for livestock feed in the United States than is corn, minimizing the food versus fuel challenge associated with the use of corn for ethanol production. Barley production in the United States is approximately 5 million metric tons (US Grain Council, 2008). In the United States, 66% of the barley produced is for food and industrial uses, 22% is used for animal feed, and 12% is exported. In contrast, of the 282 million metric tons of corn produced in the United States, 34% is used for food and industrial uses, 47% is used for animal feed, and 19% is exported.

Barley protein meal (**BPM**) is a coproduct of the production of ethanol from barley, analogous to distillers grains from corn. Whereas significant research has documented the utility of corn-based distillers grains (**CDG**) in livestock rations, little is known of the feed value of BPM. Weiss et al. (1989) reported similar milk production, fat-corrected milk, and milk fat yield in cows fed distillers grains produced from a blend of 65% barley and 35% corn as compared with soybean meal (**SBM**), CDG, or a mix of these sources; milk protein content and palatability decreased.

The concentration of P in coproducts of many processing systems is greater than that in the original

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feedstuff because fermentable carbohydrates and fats are removed, concentrating the remaining nutrients. Feeds such as cottonseed meal, brewers grains, and CDG contain ~0.6 to 1% P or more, elevating dietary P beyond the requirements of lactating cows (~0.35 to 0.38% P; NRC, 2001). Intake and excretion of P are tightly linked in ruminants (e.g., Morse et al., 1992; Wu et al., 2000; Knowlton and Herbein, 2002), so use of these high-P by-product feeds exacerbates nutrient imbalances on dairy and livestock farms.

Use of by-product feeds also has implications for protein nutrition. Diets based primarily on corn products are considered deficient in Lys, and many US dairy diets are marginal with respect to Met and Lys. Protected sources of Met and Lys are commercially available but expensive. Barley protein meal has high Lys content relative to corn, but the effect of fermentation (ethanol production) and processing on the ruminal availability of Lys is unknown. Therefore, the objectives of this study were to determine production performance and nutrient excretion of lactating dairy cows fed BPM and to assess its potential as a source of ruminal bypass protein and ruminally protected Lys.

MATERIALS AND METHODS

Exp. 1

All animal care and use procedures were approved by the Virginia Tech Institutional Animal Care and Use Committee. Forty-two lactating cows (11 Holsteins, 7 Jerseys, and 24 Holstein × Jersey crossbreds) were fed diets formulated to meet NRC nutrient requirements, containing BPM, CDG, or SBM (control). Barley protein meal was included at 15% of the diet DM; CDG and SBM were included in amounts to supply equal amounts of dietary N. Experimental diets were fed for 39 d. Treatment groups were balanced for BW [average 567 ± 77 (±SD) kg of BW], DIM (156 ± 57), and parity (1.6 ± 1.1). Animals were group housed and fed experimental diets once daily at 1200 h via Calan doors at 5 to 10% excess of the previous day's intake (wet basis). Feed and water were available ad libitum except during milking. Cows were milked twice daily at 12-h intervals.

Samples of experimental TMR were obtained weekly. Dry matter intake was measured daily, and BW and milk yield were measured at each milking. Milk samples were obtained twice daily on d 35 to 39 and analyzed for fat, protein, solids non-fat, lactose, milk urea N, and somatic cells (DHIA, Blacksburg, VA).

Feces samples were collected manually per rectum on d 35 to 39 at 12-h intervals. Sampling times advanced by 3 h each day to yield 8 samples from around the clock to account for diurnal variation in digestion and passage. Samples were frozen immediately after collection and then thawed and composited by cow on an equal wet weight basis from each sampling time.

Exp. 2

Three ruminally cannulated, lactating Holstein cows (parities 2, 3, and 4; 321, 164, and 111 DIM) were used to assess the ruminal DM and N degradation characteristics of SBM, CDG, and BPM. Cows were housed in individual stalls and fed the control diet from Exp. 1. Dry matter intake averaged 22 kg/d for the days when the Dacron bags were resident. Cows weighed 639 ± 42 kg and were producing 31.4 ± 6.8 kg of milk per day. The experiment consisted of a 2-wk diet-adaptation period followed by 3 d when the in sacco evaluation of feedstuffs was conducted. The in sacco experiment was conducted and

Table 1. Ingredient composition of diets[1]

Item	SBM	CDG	BPM
Ingredient, % of diet DM			
Corn silage	35.9	35.9	35.9
Alfalfa silage	9.24	9.24	9.24
Grain mix	54.8	54.8	54.8
Composition of grain mix, % of grain mix DM			
Corn	60.3	46.6	46.3
Distillers dried grains	—	27.09	—
Barley protein meal	—	—	27.5
Soybean meal	28.0	14.3	14.2
Tallow	4.33	4.36	4.33
Soybean hulls	3.66	3.69	3.67
Limestone	1.67	1.68	1.67
Sodium bicarbonate	1.00	1.01	1.00
Salt	0.33	0.34	0.33
Urea	0.33	0.64	0.63
Potassium magnesium sulfate[2]	0.17	0.17	0.17
Monoammonium phosphate	0.13	—	—
Selenium (0.06%)	0.04	0.04	0.04
Mineral premix[3]	0.03	0.03	0.03
Vitamin A-D_3-E[4]	0.03	0.03	0.03
Vitamin E[5]	0.01	0.01	0.01

[1]SBM = soybean meal; CDG = corn distillers grains; BPM = barley protein meal.

[2]Contained 18.5% K, 11.4% Mg, and 22% S.

[3]Contained 40,080 mg of Cu, 160,032 mg of Zn, 150,030 mg of Mn, 1,603 mg of Co per kilogram.

[4]Contained 26,453 KIU of vitamin A, 8,818 KIU of vitamin D, and 44,088 IU of vitamin E per kilogram.

[5]Contained 132,264 IU of vitamin E per kilogram.