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Short communication: Effects of processing methods of barley grain in starter diets on feed intake and performance of dairy calves

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ABSTRACT

The present study was conducted to evaluate the effects of different processing methods of barley grain in starter rations on feed intake, average daily gain, feed efficiency, skeletal growth, fecal score, and rumen pH of dairy calves. Thirty-two Holstein dairy calves (16 female and 16 male) were randomly allocated to 1 of 4 treatments consisting of coarse ground, whole, steam-rolled, or roasted barley from d 4 to 56 of birth in a completely randomized design. Starter diets were formulated to have similar ingredients and composition. All calves had free access to water and feed throughout the study period and received 4 L of milk/d from a bottle from d 4 to 41, 2 L/d from d 41 to 45, and weaning occurred on d 45. Feed intake and fecal score were recorded daily. Body weight and skeletal growth measures were recorded on d 4 (beginning of the study), 45, and 56. Rumen fluid and blood samples were collected on d 35, 45, and 56. Data were analyzed using PROC MIXED of SAS (SAS Institute Inc., Cary, NC). The results indicate that different methods of processing barley had no detectable effect on dry matter intake, average daily gain, and feed efficiency and that skeletal growth, health, and rumen pH were not affected by dietary treatments. In conclusion, the results show that different processing methods of barley included in starter diets had no detectable effect on the performance of dairy calves under our experimental conditions. Therefore, feeding whole or coarsely ground barley would be a more economical method compared with steam rolled or roasted barley.
Key words: dairy calf, starter diet, processed barley

Short Communication

Early transition from monogastric digestion to a functional rumen microbial degradation in dairy calves is important for economic reasons (Khan et al., 2007). Consumption of solid feed, especially concentrate or high-carbohydrate diets, stimulates rumen microbial proliferation and VFA production, and subsequently initiates rumen development in neonatal calves (Harrison et al., 1960). Cereal grains are the primary source of starch in ruminant diets; corn, rice, barley, wheat, oats, and sorghum are commonly used worldwide as starch sources in animal feeds including calf starters (Huntington, 1997). Mechanical and chemical alterations during processing increase surface area exposure and improve ruminal, intestinal, and total-tract starch digestibility of seed grains (Huntington, 1997; Owens et al., 1997). Grain processing methods and degree of processing influence DMI and digestibility. Reis and Combs (2000) reported that starch digestibility was the highest for steam-flaked grains, followed by finely ground and dry-rolled grains, and was the lowest for whole grains. In contrast, feeding raw, roasted or conglomerated sorghum grain resulted in no effects on calf performance or rumen and blood metabolites (Abdelgadir and Morrill, 1995). Limited data are available regarding the effects of processing method of barley on feed intake and performance measures in dairy calves. Therefore, the objective of the present study was to determine the effects of 4 different processing methods of barley on feed intake, growth performance, blood metabolites, and rumen pH in Holstein calves.

Thirty-two 4-d-old Holstein dairy calves (16 female and 16 male) were used in a completely randomized design from May to August 2011. Calves were randomly allocated to 1 of the 4 treatments consisting of coarse ground (**CGB**), whole (**WB**), steam-rolled (**SRB**), or roasted barley (**RB**) from d 4 to 56. Calves were separated from their dams shortly after birth and randomly assigned to individual pens (1.5 × 2.8 m) bedded with wood shavings that were renewed, as required (every 24–48 h). Physical contact among calves was minimized by pen arrangement. All calves received 6 L of colostrum within 12 h of birth and then 4 L of fresh milk/d from a bottle from d 4 to 41, and 2 L/d from d 41 to 45; weaning occurred on d 45. Free access to fresh water was provided every day. Calf starter was offered ad libitum, and intake was recorded daily, beginning

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Table 1. Ingredients of calf starter (batch records) with different forms of processed barley: whole (WB), coarse ground (CGB), steam-rolled (SRB), and roasted (RB) barley

	Calf starter			
Ingredient[1] (% of starter DM)	WB	CGB	SRB	RB
Whole barley	66.1	—	—	—
Coarse ground barley	—	66.1	—	—
Steam-rolled barley	—	—	66.1	—
Roasted barley	—	—	—	66.1
Soybean meal	24.0	24.0	24.0	24.0
Soybeans	4	4	4	4
Wheat bran	3	3	3	3
Calcium carbonate	1.9	1.9	1.9	1.9
Monocalcium phosphate	0.3	0.3	0.3	0.3
Premix (vitamins and minerals)[2]	0.5	0.5	0.5	0.5
Salt	0.3	0.3	0.3	0.3

[1]All values are reported on a DM basis.

[2]Premix contained (mg/kg) calcium (800), phosphorus (80), magnesium (100), copper (10), manganese (18), zinc (35.2), cobalt (0.12), iodine (0.28), selenium (0.17) as well as vitamin A (3,000 IU/kg), vitamin D (800 IU/kg) and vitamin E (6 IU/kg) on a DM basis.

on d 4. Starter diets were formulated to contain the same ingredients and have similar composition (Table 1). Calf starters contained 66.1% (DM basis) barley from different processing methods, including WB, CGB [processing index (**PI**; as defined by Wang et al., 2003) = 90.07], SRB (PI = 59.96), and RB (PI = 84.97). The other components of the diet were in meal form. Barley grain (*Hordeum* spp.; 2,000 kg) was purchased from a vendor (Poshtibani Omour Dam; Isfahan, Iran) and divided into four 500-kg batches to be processed. Barley grain was ground using a conventional hammer mill (model 5543 GEN; Isfahan Dasht, Isfahan, Iran) with a standard screen size of 1 mm. Barley grains were screened during 2 separate steps and steamed for a minimum of 5 min at 102°C within a 4-m-high stainless steel chamber directly above the rollers. Steamed grains had a moisture content of 18 to 20% as they were rolled between preheated corrugated rollers (46 × 90 cm; Harris Co., Coalinga, CA). Rolled grains were passed through a channel under air pressure and were allowed to dry before storage and subsequent use in the diet. The barley grain fed in this trial was either unroasted or roasted using a mobile system consisting of a propane-fired roaster with a throughput rate of 8 t/h. The barley kernels passed directly through the propane flame for 30 min (approximate flame temperature of 450°C) and were heated to a temperature of 135°C when exiting the roaster. The starter diets were sampled for DM (oven drying at 60°C for 48 h), NDF (Van Soest et al., 1991; using heat-stable α-amylase and sodium sulfate), and ADF (method 973.18; AOAC 1990), ether extract (AOAC, 1990; using a Tecator Soxtec System HT 1043 extraction unit by Tecator, Foss North America, Eden Prairie, MN), and CP (1030 micro-Kjeldahl autoanalyzer; Tecator, Foss North America) analyses (Table 2). All procedures involving animals were conducted under protocols approved by the Animal Care Advisory Committee of Isfahan University of Technology (Isfahan, Iran).

To monitor calf health, fecal scoring (Larson et al., 1977) was used on a daily basis. Scoring was as follows: 1 = hard, 2 = normal, 3 = soft to loose and watery, 4 = watery mucous, and 5 = watery mucous and bloody. No measurement was performed regarding the presence of grain in feces. The BW was measured at 3 different time points, including at d 4, 45, and 56. The skeletal growth indices (body length, body barrel, hearth girth, hip height, and hip width; Khan et al., 2011) were measured on d 4, 45, and 56. Blood samples (7 mL) were collected 3 h after the morning feeding via jugular vein on d 35, 45, and 56. Blood samples were placed on ice immediately after collection and centrifuged at 4,500 × *g* for 15 min at 4°C to harvest serum. The serum was then stored at −20°C until analyzed for blood metabolites. Blood urea nitrogen and glucose were measured using Pars Azmoon kits according to the manufacturer's procedures (Pars Azmoon Co., Tehran, Iran). The concentration of BHBA was measured using commercial kit (Randox Laboratories Ltd., London, UK) with a Technicon-RA 1000 Autoanalyzer (DRG Co., Marburg, Germany). Ruminal fluid (8 mL) was obtained via stomach tube on d 35, 45, and 56, approximately 4 h after morning feeding, which was done at 0800 h. Rumen fluid pH was immediately determined (pH meter model M90; Corning Inc., Corning, NY). Ruminal fluid (8 mL) was then placed into bottles containing 2 mL of 25% metaphosphoric acid and stored at −20°C until VFA and NH_3 analyses were conducted.

Data for intake, ADG, feed efficiency (**FE**), skeletal growth, pH of rumen fluid, and blood metabolites (glu-