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Short communication

Enhancement of daily gain and feed efficiency of growing heifers by dietary supplementation of β-mannanase in Hanwoo (*Bos taurus coreanae*)

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ABSTRACT

β-mannanase is an enzyme that breaks down mannan which is complex biopolymers commonly found in plant cell walls. It has been reported that supplementation of β-mannanase in a diet that composed of high mannan containing feedstuffs (e.g. palm kernel meal, copra meal, soy hull; HMCF) improves digestibility and utilization of livestock feeds. In ruminants, β-mannanase supplementation also increased growth rate of goats and Holstein calves. No study, however, has been conducted to evaluate the effect of β-mannanase supplementation in growing heifers. Moreover, little is known whether β-mannanase supplementation will have beneficial effects in conventional corn-soy based diets (CS). The objective of this study was thus to investigate the effect of supplementation of β-mannanase in Hanwoo growing heifers fed a diet composed of either a CS or HMCF based concentrate mix. For this purpose, a feeding trial was conducted for 12 weeks using a total of 40 Hanwoo growing heifers (BW: 236.2 kg ± 1.1 kg, 11 month of age). Total mixed rations (250 g/kg of ryegrass and 750 g/kg of concentrate mix) were offered ad libitum. The experimental design was 2 × 2 factorial approach with two different concentrate mixes (CS or HMCF based) and with or without a commercial feed β-mannanase (800,000 U/kg DM) product (CTCZYME®, CTC Bio Inc., Seoul, Korea) at a level of 1 g/kg in concentrate mixes. In both diets, supplementation of β-mannanase significantly increased ADG of Hanwoo heifers by 95 g/d on average (111 g/d or 90 g/d for CS and HMCF, respectively). No significant difference was observed in DMI among treatments, but β-mannanase supplementation tended to decrease feed conversion ratio (DMI/ADG) by 1.3 on average. The ADG of CS (943 g/d) was significantly greater than that of HMCF (854 g/d). These results indicated that supplementation of β-mannanase enhanced growth rate and feed efficiency of Hanwoo heifers regardless of the basal diets. Therefore, we conclude that supplementation of β-mannanase can be beneficial to improve the feed utilization in Hanwoo growing heifers.

1. Introduction

To reduce feed costs and increase environmental sustainability, much research in animal feed has focused on the efficient use of agricultural by-products. Some of the by-products used to provide animals with dietary protein contain a high level of β-mannan; high mannan contained feedstuffs (HMCF; palm kernel meal, copra meal, soybean hull, etc.). The mannan in HMCF can increase the viscosity of digesta and thus compromising nutrient and water absorption in monogastric animals (Chauhan et al., 2012). These adverse effects due to high level of mannan can be reduced by supplementation of dietary β-mannanase, an enzyme that breaks down mannan.

Numerous studies have reported supplementation of β-mannanase in a diet composed of high level of HMCF improves digestibility and utilization in chickens (Jackson et al., 2004; Lee et al., 2003; Li et al., 2010; Wu et al., 2005) and pigs (Li et al., 2012; Lv et al., 2013; Pettey et al., 2002; Yoon et al., 2010). Dietary β-mannanase showed positive responses when added in soy-containing milk replacer (Nabté-Solís, 2009) and a concentrate starter (Lee et al., 2010) in calves. Our previous study demonstrated

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dietary supplementation of β-mannanase in a concentrate mix improved ADG, feed conversion ratio as well as nitrogen retention in growing goat fed high level of HMCF (Lee et al., 2014). No study, however, has been conducted to evaluate the effect of β-mannanase supplementation in growing heifers. Moreover, little is known whether β-mannanase supplementation also has beneficial effects in conventional corn-soy based diets.

The objective of this study was thus to investigate the effect of supplementation of β-mannanase in growing heifers fed a diet composed of either a conventional corn-soy based or HMCF based concentrate mix. A feeding trial using Hanwoo heifers, a dominant beef breed in Korea, was conducted, and growth performance (i.e., daily intake, body weight gain, feed conversion ratio) of the heifers was measured.

2. Materials and methods

This study was conducted at the Center for Animal Science Research, Chungnam National University, Korea. Animal use and the protocols for this experiment were reviewed and approved by the Chungnam National University Animal Research Ethics Committee (CNU-00521).

2.1. Experimental design, animals, and diets

In order to evaluate the effect of supplementation of β-mannanase on growth performance in Hawoo heifers, a 12-week feeding trial was performed. This study focused on growth performance (i.e., DMI, ADG, feed conversion ratio (FCR)). Although these parameters may not be sufficient enough to understand the physiological responses due to the treatments, differences in growth performance are of particular interest in the field application.

Since the effect of β-mannanase supplementation can differ by diets, a 2 × 2 factorial (diet and supplementation) design was used in this study, the diet treatment was either a corn-soy or a HMCF diet, and the supplementation was either with or without β-mannanase supplementation in a concentrate mix at a level of 1 g/kg on DM basis.

A total of 40 Hanwoo heifers (BW: 236 ± 1.1 kg, 11 months old) were randomly allocated to one of four dietary treatments: a corn-soy diet without (CS) or with β-mannanase supplementation (CS_ENZ) and a HMCF diet without (HMCF) or with (HMCF_ENZ) β-mannanase supplementation. A commercial feed β-mannanase (800,000 U/kg of DM) product (CTCZYME®, CTC Bio Inc., Seoul, Korea) was used in this study. The diets were prepared as total mixed ration (TMR), composed of 250 g/kg DM of ryegrass and 750 g/kg DM of each experimental concentrate mix. They were formulated to meet nutrient requirements for an ADG of 850 g/d (NRC, 2000). Diet formulation and chemical composition of the experimental diets are shown in Table 1. The TMR was fed ad libitum twice daily (0800 and 1700 h), and the heifers had free access to drinking water throughout the experiment.

2.2. Measurements

Daily feed intake of each animal was recorded automatically (Dawoon Co, Incheon, Korea). Every four weeks the experimental TMR were sampled, and BW of the animals was measured before morning feeding. The TMR samples were dried at 60 °C for 96 h and ground through a cyclone mill (Foss, Hillerød, Denmark) fitted with a 1 mm screen before chemical analysis. Contents of DM (#934.01), crude protein (CP; #976.05), ether extract (EE; #920.39), acid detergent fiber (ADF; #973.18) and ash (#942.05) were determined as described by AOAC (2005). Lignin (sa) and neutral detergent fiber (aNDF) analyzed using a heat stable amylase and expressed inclusive of residual ash was analyzed as described by Van Soest et al. (1991).

Table 1
Diet formulation and chemical composition (g/kg DM or as stated) of the experimental diets.

Item	Treatments[a]			
	Low mannan diet		High mannan diet	
	CS	CS_ENZ	HMCF	HMCF_ENZ
Ingredients				
Rye grass	250	250	250	250
Corn	276	276	150	149
Wheat	97	97	37	37
Wheat bran	37	37	37	37
Rice bran	23	23	45	45
Soy bean meal	25	25		
Soy hulls	25	25	110	110
Corn gluten feed	117	117	116	116
Rapeseed meal	23	23	13	13
Palm oil			17	17
Palm kernel meal	24	24	78	78
CMS			3	3
Copra meal	23	23	76	76
DDGS	23	23	6	6
Limestone	29	29	29	29
Vitamin and mineral mix[c]	2	2	2	2
NH_4Cl	4	4	4	4
Salt	7	7	8	8
Molasses	16	16	2	2
β-mannanase[b]		1		1
Chemical composition				
DM, g/kg as fed	889	889	895	895
CP	140	140	138	138
EE	30	30	53	53
Ash	84	83	94	94
aNDF	332	332	424	424
Lignin (sa), g/kg NDF	58	58	54	54
ME, MJ/kg DM	11.3	11.3	10.9	10.9
NE_m, MJ/kg DM	7.5	7.5	7.1	7.1
NE_g, MJ/kg DM	5.0	5.0	4.6	4.6

[a] CS; a corn-soy based diet without supplementation, CS_ENZ; a corn-soy based diet with supplementation of 1 g/kg β-mannanase in the concentrate mix, HMCF; a high mannan contained feeds based diet without supplementation, HMCF_ENZ; a high mannan contained feeds based diet with supplementation of 1 g/kg β-mannanase in the concentrate mix.
[b] A commercial feed β-mannanase (800,000 U/kg of DM) product (CTCZYME®, CTC Bio Inc., Seoul, Korea).
[c] 33,330,000 IU/kg vitamin A, 40,000,000 IU/kg vitamin D, 20.86 IU/kg vitamin E, 20 mg/kg Cu, 90 mg/kg Mn, 100 mg/kg Zn, 250 mg/kg Fe, 0.4 mg/kg I, and 0.4 mg/kg Se.

2.3. Statistical analysis

Data were analyzed with PROC MIXED (SAS Institute, Cary, NC). The linear model was as follows:

$$y_{ij} = \mu + \tau_i + e_{ij}$$

where, y_{ijk} is jth observation (j = 1–10) in ith treatment (i = 1–4), μ is the overall mean, τ_i is the fixed effect of ith treatment, and e_{ij} is the unexplained random effect on jth observation in ith treatment.

Three orthogonal contrasts were tested: the difference between diets (corn-soy versus HMCF), the effect of β-mannanase supplementation, and the interaction between diet and β-mannanase supplementation (i.e., the difference between CON_ENZ and CON versus the difference between HMCF_ENZ and HMCF). The effect of treatments on monthly BW changes throughout the experiment