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Effects of beta-mannanase supplementation in combination with low and high energy dense diets for growing and finishing broilers

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ABSTRACT

A total of 540 and 1-d-old male Ross 308 broilers (BW=43±1 g) were randomly divided into 4 treatments (9 replicates/treatment, 15 chicks/replicate) by their BW. This experiment lasted for 28-d and there were 2 phases, starter (0 to 14 d) and finisher (15 to 28 d). The experiment was a 2 × 2 factorial arrangement with two levels of metabolizable energy [low energy=12.34 (starter) and 13.08 MJ ME/kg (finisher); high energy=12.66 (starter) and 13.39 MJ ME/kg (finisher), the differences in dietary energy were based on differences in the content of tallow and maize] and two levels of β-mannanase (MAN) (0 and 0.04%). During starter phase, the effect of MAN and high energy were observed to increase ($P<0.05$) BW gain and decrease ($P<0.05$) feed conversion ratio. Chicks consumed high energy and MAN diets improved ($P<0.05$) BWG, whereas only effect of MAN was found to improve feed efficiency in overall phase. There was a significant interaction between mannanase and dietary energy content with respect to BWG ($P=0.014$) and FCR ($P=0.042$). The apparent total tract digestibility of dry matter and energy were improved ($P<0.05$) by the high energy density and MAN alone at end of experiment. There was a significant ($P=0.045$) effect of MAN with respect to meat lightness. Feeding chicks with high energy and MAN supplementation alone were shown to have higher ($P<0.05$) relative breast meat weight. There was a significant interaction between mannanase and energy regarding the breast meat yield ($P=0.024$). The breast meat of chicks fed high energy diet had greater ($P<0.05$) concentration of C16:0 and C18:0 and total saturated fatty acids and lower ($P<0.05$) linoleic acid (18:2n-6), and total unsaturated fatty acids than in low energy diet. In conclusion, the results indicated that the β-mannanase supplementation in low and high energy diets can improve body weight gain, feed conversion ratio, nutrient digestibility, and relative breast meat weight and decrease the LDL-C in serum.

1. Introduction

β-Mannan, which is commonly found in soybean meal and soybean hull (Hsiao et al., 2006), is a polysaccharide and intensely anti-nutritional factor in poultry due to their lack of endogenous enzyme (Ward and Fodge, 1996). Therefore, several studies have been conducted to investigate the β-mannanase (MAN) supplementation in broiler, and suggested that there was an improvement in weight gain, feed efficiency, feed conversion as well as dietary ME (Lee et al., 2003; Daskiran et al., 2004; Zou et al., 2006). Other studies also demonstrated that the use of a carbohydrate enzymes improve the fat digestibility and ME contents of diets containing oilseed (Meng et al., 2006; Slominski et al., 2007; Jia et al., 2008).

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Energy is the major dietary element responsible for differential utilization of nutrients and result different gain of an animal. Previous studies also suggested that higher energy levels (addition of saturated lipid and unsaturated lipid source) could affect plasma low density lipoprotein cholesterol (LDL-C), high density lipoprotein cholesterol (HDL-C) concentration and carcass characteristics (Harris et al., 2003; Özdoğan and Akşit, 2003). Manilla et al. (1999) reported that carcass fatty acid composition was affected by diet fatty acid content, and the effect of dietary fat on the composition of breast meat was less pronounced than that for abdominal fat (Sanz et al., 1999).

Recently study demonstrated that MAN can improve growth performance and immunity of broilers (Zou et al., 2006). Since the supplementation of MAN can improve the ME, the lower ME diet were used in practice to save the feed cost. Therefore, it is necessary to investigate the effect of MAN in different energy dilution on broilers fed a corn–soybean diet. However, little research has been conducted to investigate the effect of β-mannanase supplementation on organ weights, serum metabolites and breast meat fatty acid composition of broilers fed a corn–soy diet. Collectively, the objective of this experiment is to investigate the effect of β-mannanase supplementation in different energy level on growth performance, nutrient digestibility, relative organ weight, serum metabolites, and breast meat fatty acid profiles in broilers.

2. Materials and methods

2.1. Preparation of the β-mannanase

The β-mannanase was provided by ChemGen Co., Ltd (Gaithersburg, MD) under a trademark Hemicell, it is a dried *bacillus lentus* fermentation soluble with the activity of β-mannanase greater than 1.09×10^5 units/kg

2.2. Experimental design, animals and housing

A total of five hundred and forty 1-d-old male Ross broiler chickens (BW=43±1 g) were used in a 28-d experiment. This experiment lasted for 28 d and there were 2 phases, starter (0 to 14 d) and finisher (15 to 28 d). Broiler chickens were allotted into 4 treatments and there were 9 replications per treatment with 15 birds per pen. The experiment was a 2×2 factorial arrangement with two levels of ME [low energy=12.34 (0 to 14 d) and 13.08 MJ ME/kg (15 to 28 d); high energy=12.66 (0 to 14 d) and 13.39 MJ ME/kg (15 to 28 d), the differences in dietary energy were based on differences in the content of tallow (starter: 0% vs. 2%; finisher: 0% vs. 3%) and maize (starter: 50.45% vs. 52.71%; finisher: 52.60% vs. 55.84%)] and two levels of β-mannanase (MAN: 0% and 0.04%). Broiler chickens were raised in a temperature-controlled room with stainless steel pens of identical size (1.75×1.55 m^2). Room temperature began at 33 °C from day 1 to 3 and was reduced gradually to 24 °C until the end of the experiment and the relative humidity was around 60%. Broiler chickens received diet and water ad libitum. Each pen had a pan feeder with a 35-cm diameter. Water was provided by evenly spaced nipple drinkers (5 nipples per pen) positioned along the side wall of the pen. Artificial light was provided 24 h/d by the use of fluorescent lights and intensity of light was about 10 lx. All broilers used in this trial were handled in accordance with the guidelines set forth by the Animal Care and Use Committee of Dankook University.

2.3. Sampling and measurements

2.3.1. Chemical analysis

All diets were formulated to allowance of each nutrient requirement according to the NRC (1994) (Table 1), and were provided in pellet forms. Diets were freeze-dried and ground through a 1-mm screen in a Wiley mill to determine dry matter (DM, 930.15), crude protein (CP, 990.03), phosphorous (P, 965.17), crude fat without acid hydrolysis (920.39), and calcium (Ca, 984.01) (AOAC, 1995). Gross

Table 1
Ingredients and analyzed chemical composition of the experimental diet (%, as-fed basis).

Ingredients	Starter		Finisher	
	High energy	Low energy	High energy	Low energy
Corn	50.45	52.71	52.60	55.84
Wheat	5.00	5.00	10.00	10.00
Rapeseed meal	2.00	2.00	3.00	3.00
Soybean meal	34.31	34.02	24.98	24.69
Soybean oil	2.00	2.00	3.00	3.00
Tallow	2.00	–	3.00	–
Limestone	1.16	1.16	0.96	0.97
Salt	0.25	0.25	0.25	0.25
β-mannanase	–	0.04	–	0.04
Choline chloride	0.12	0.12	0.09	0.09
Methionine	0.29	0.29	0.17	0.17
L-lysine-HCl	0.27	0.27	0.14	0.14
Dicalcium phosphate	1.82	1.81	1.56	1.56
Threonine	0.10	0.10	0.02	0.02
Mineral premix[a]	0.12	0.12	0.12	0.12
Vitamin premix[b]	0.11	0.11	0.11	0.11
Caculated value				
ME (MJ/kg)	12.66	12.34	13.39	13.08
Crude protein	22.00	22.00	19.00	19.00
Crude fat	6.04	5.10	6.69	5.92
Lysine (%)	1.27	1.27	0.97	0.97
Met+Cys	0.65	0.67	0.61	0.60
Ca	1.00	1.00	0.85	0.85
Available P	0.72	0.72	0.66	0.66
Analyzed composition				
Dry matter (%)	89	89	89	89
Crude protein	21.87	22.01	19.12	18.99
Crude fat	5.90	4.89	6.55	5.63
Lysine (%)	1.24	1.29	0.95	0.95
Methionine	0.62	0.63	0.46	0.47
Cysteine	0.35	0.35	0.30	0.30
Met+Cys	0.70	0.68	0.62	0.67
Ca	0.98	1.02	0.82	0.82
P	0.69	0.73	0.63	0.64

[a] Provided per kg of diet: 15,000 IU of vitamin A, 3750 IU of vitamin D_3, 37.5 mg of vitamin E, 2.55 mg of vitamin K_3, 3 mg of thiamin, 7.5 mg of riboflavin, 4.5 mg of vitamin B_6, 24 μg of vitamin B_{12}, 51 mg of niacin, 1.5 mg of folic acid, 0.2 mg of biotin and 13.5 mg of pantothenic acid.

[b] Provided per kg of diet: 37.5 mg of Zn, 37.5 mg of Mn, 37.5 mg of Fe, 3.75 mg of Cu, 0.83 mg of I, 62.5 mg of S and 0.23 mg of Se.