The Effects of Dietary Biotite V Supplementation as an Alternative Substance to Antibiotics in Growing Pigs

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ABSTRACT : This study was conducted to investigate the effects of Biotite V supplementation on growth performance, nutrients digestibility and blood constituents and to evaluate whether Biotite V could replace an antibiotics in growing pigs diet. One hundred twenty pigs with initial body weight of 18.35±0.15 kg were used in a 28 days growth trial. Pigs were allotted to four treatments by sex and body weight in a randomized complete block design. There were six replicate pens per treatment and five pigs per pen. Four dietary treatments were: 1) NC (basal diet without antibiotics), 2) PC (basal diet+0.1% CTC), 3) NCBV (NC diet+0.5% 200 mesh Biotite V) and 4) PCBV (PC diet+0.5% 200 mesh Biotite V). Through the entire experimental period, ADG tented to increase in NCBV and PCBV treatments compared to NC and PC treatments respectively, but no significant differences were observed ($p>0.05$). ADFI was slightly lower in NCBV and PCBV treatments than that in NC and PC treatments without significant differences ($p>0.05$). Gain/feed in PC and PCBV treatments was improved significantly compared to NC treatment ($p<0.05$). N and Ca digestibilities were higher in PCBV treatments than those in PC treatment ($p<0.05$). DM and P digestibilities were not affected by the addition of Biotite V ($p>0.05$). RBC, HCT, Hb, lymphocyte and monocyte were increased numerically in NCBV and PCBV treatments compared to NC and PC treatments ($p>0.05$). WBC was lower in treatment groups than that in NC treatment, but no significant differences were observed ($p>0.05$). In conclusion, dietary supplementation of Biotite V can better the gain/feed and some of the nutrients digestibilities in growing pigs. It has a possibility to replace antibiotics in swine diet. ***(Asian-Aust. J. Anim. Sci. 2005. Vol 18, No. 11 : 1642-1645)***

Key Words : Biotite V, Antibiotics, Digestibility, Blood Constituents, Growing Pigs

INTRODUCTION

Antibiotics has been wildly used for many years and played an important role due to the therapeutic effect against disease and improved performance of animals (Kiser, 1976; Corpet, 2000). Livestocks fed subtherapeutic levels of antibiotics have been documented to increase weight gain and improve feed efficiency (Hays, 1981). However, the over-use of antibiotics also leads to several problems, the most important one is the antibiotics resistance which has the possibility of resistant bacteria or genes transferred from animals to human through the food chain (Taylor, 1997; Barton, 2000).

As the reasons described above, the restriction of antibiotics becomes a worldwide trend. The European Union has started to restrict the use of antibiotics since last decade. Several other countries or areas also tend to limit the use of antibiotics recently. This trend made people search for other ways or substances to replace antibiotics as a growth promoter. Many investigations have focused on the alternative feed additives or supplements, such as probiotics, enzymes, minerals, organic acids and herbs etc. Currently, some alumninosilicate minerals (zeolite, kaolinite and bentonite etc.) have received considerable interest by researchers. It is suggested that those kinds of minerals are effective in adsorption and binding cations such as ammonia (NH_4^+) ions (Mumpton and Fishman, 1977). However, the effects of these minerals have not been rigorously evaluated now. Our study was concerned about one of the alumninosilicate mineral product which named Biotite V (Seobong Biobestech Co., Ltd, Seoul, Korea). The objective of this experiment was to determine the effects of this product on growth performance, nutrients digestibility and blood constituents in growing pigs, so that we can evaluate the possibility of Biotite V as a substitute of antibiotics.

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MATERIALS AND METHODS

Source and compositions of Biotite V

Biotite V used in this experiment was provided by Seobong Biobestech Co., Ltd (Seoul, Korea). The main compositions of this product were 61.90% SiO_2, 23.19% Al_2O_3, 3.97% Fe_2O_3 and 3.36% Na_2O (Manufacturers specifications).

Experimental design, animals and diets

A total of 120 [(Landrace×Yorkshire) ×Duroc] pigs with the initial body weight of 18.35±0.15 kg were used in this 28 days experiment. Pigs were assigned to four dietary treatments by sex and weight in a randomized complete block design. There were five pigs per pen and six replicates per treatment. Basal diets were formulated to meet or exceed NRC (1998) nutrient requirements and

Table 1. Formula and chemical composition of diets for growing pigs (as-fed basis)

Ingredients (%)	NC	PC	NCBV	PCBV
Corn	64.25	64.15	63.75	63.65
Soybean meal (CP 44%)	25.63	25.63	25.63	25.63
Molasses	2.50	2.50	2.50	2.50
Biotite V	-	-	0.50	0.50
Animal fat	4.67	4.67	4.67	4.67
DCP	1.55	1.55	1.55	1.55
Limestone	0.81	0.81	0.81	0.81
Salt	0.20	0.20	0.20	0.20
Vitamin premix /trace mineral premix[1]	0.22	0.22	0.22	0.22
Antibiotics (CTC)	-	0.10	-	0.10
Antioxidant (Ethoxyquin 25%)	0.05	0.05	0.05	0.05
L-lysine·HCl	0.12	0.12	0.12	0.12
Chemical composition[2]				
ME (kcal/kg)	3,320	3,320	3,320	3,320
Crude protein (%)	18.00	18.00	18.00	18.00
Lysine (%)	1.00	1.00	1.00	1.00
Methionine (%)	0.28	0.28	0.28	0.28
Calcium (%)	0.70	0.70	0.70	0.70
Phosphorus (%)	0.60	0.60	0.60	0.60

[1] Provided per kg of complete diet: 20,000 IU vitamin A, 4,000 IU vitamin D_3, 80 IU vitamin E, 16 mg vitamin K_3, 4 mg thiamin, 20 mg riboflavin, 6 mg pyridoxine, 0.08 mg vitamin B_{12}, 120 mg niacin, 50 mg Ca-pantothenate, 2 mg folic acid, 0.08 mg biotin, 140 mg Cu, 179 mg Zn, 12.5 mg Mn, 0.5 mg I, 0.25 mg Co and 0.4 mg Se.
[2] Calculated values.

dietary treatments were: 1) NC (basal diet without antibiotics), 2) PC (basal diet+0.1% CTC), 3) NCBV (NC diet+0.5% 200 mesh Biotite V) and 4) PCBV (PC diet+0.5% 200 mesh Biotite V) (Table 1). All diets were provided by meal form. Feed and water were offered *ad libitum* to all pigs throughout the experiment.

Sampling and measurements

Body weight and feed intake were measured at the end of experiment to determine ADG, ADFI and gain/feed. Prior to the termination of experiment, chromic oxide (Cr_2O_3) was added at 0.20% of the diets as an indigestible marker and fecal grab samples were collected at the end of the experiment. Fecal samples were dried and finely ground before chemical analyses. Diet and fecal samples were analyzed for DM, N, Ca and P according to the AOAC procedures (AOAC, 1995). Chromium was analyzed by UV absorption spectrophotometry (Shimadzu, UV-1201, Japan). Apparent digestibilities of nutrients (DM, N, Ca and P) were measured using the indirect-ratio method.

Blood sample was collected from pigs by jugular venipuncture at the end of experiment. Blood was centrifuged at 2,000×g at 4°C for 30 min. Following centrifugation of the blood, the serum was separated. The blood constituents were measured using the automatic blood analyzer (ADVIA 120, Bayer, USA).

Statistical analyses

The experiment was analyzed as a randomized complete block design with the pen of pigs considered as the experimental unit. Data for each response criterion were analyzed using the GLM procedure of SAS (1996). Orthogonal contrasts were used to separate treatment means and consisted of 1) NC vs. PC, 2) NC vs. NCBV and 3) PC vs. PCBV.

RESULTS

Table 2 shows the effects of Biotite V supplementation on growth performance in growing pigs. ADG tended to increase in NCBV and PCBV treatments compared to NC and PC treatments respectively, but there was no significant difference ($p>0.05$). ADFI was lower in NCBV and PCBV treatments than that in NC and PC treatments without significant difference ($p>0.05$). Gain/feed in PC and PCBV treatments were significant higher than that in NC treatment ($p<0.05$).

The effects of Biotite V supplementation on nutrients digestibility in growing pigs are show in Table 3. DM and P digestibilities tended to increase in NCBV and PCBV treatments compared to NC and PC treatments, but there were no statistical differences ($p>0.05$). N digestibility was increased significantly in PCBV and NCBV treatments compared to NC and PC treatments ($p<0.05$). Digestibility of Ca was also higher in PCBV treatment than that in PC treatment ($p<0.05$).

RBC, HCT, Hb, lymphocyte and monocyte were increased in NCBV and PCBV treatments compared to NC and PC treatments (Table 4), but there were no statistical

Table 2. Effects of Biotite V supplementation on growth performance in growing pigs[1]

Items	NC[2]	PC[2]	NCBV[2]	PCBV[2]	SE[3]	Contrast[4]		
						1	2	3
ADG (g)	644	677	662	707	24	0.11	0.32	0.77
ADFI (g)	1,301	1,279	1,281	1,271	26	0.55	0.60	0.81
Gain/feed	0.495	0.529	0.517	0.556	0.017	0.05	0.17	0.91

[1] Pigs with an average initial body weight of 18.35±0.15 kg.
[2] Abbreviations: NC, basal diet; PC, basal diet with 0.1% CTC; NCBV, NC diet with 0.5% Biotite V and PCBV, PC diet with 0.5% Biotite V.
[3] Standard error.
[4] Contrast: 1) NC vs. PC; 2) NC vs. NCBV; 3) PC vs. PCBV.

Table 3. Effects of Biotite V supplementation on nutrients digestibility in growing pigs[1]

Items (%)	NC[2]	PC[2]	NCBV[2]	PCBV[2]	SE[3]	Contrast[4]		
						1	2	3
DM	75.11	77.42	75.83	77.74	0.35	0.32	0.25	0.24
N	67.20	70.64	69.59	71.70	0.23	0.56	0.05	0.04
Ca	51.39	52.38	51.29	53.27	1.59	0.08	0.05	0.04
P	45.61	47.88	46.51	47.38	1.79	0.11	0.27	0.22

[1] Pigs with an average initial body weight of 18.35±0.15 kg.
[2] NC: Basal diet; PC: Basal diet with 0.1% CTC; NCBV: NC diet with 0.5% Biotite V; PCBV: PC diet with 0.5% Biotite V.
[3] Standard error.
[4] Ccontrast : 1) NC vs. PC; 2) NC vs. NCBV; 3) PC vs. PCBV.

Table 4. Effects of Biotite V supplementation on blood constituents in growing pigs[1]

Items	NC[2]	PC[2]	NCBV[2]	PCBV[2]	SE[3]	Contrast[4]		
						1	2	3
RBC ($\times 10^6$/ml)	6.35	6.49	6.55	6.85	0.25	0.09	0.07	0.07
WBC ($\times 10^3$/ml)	22.36	21.58	19.32	18.42	3.32	0.14	0.19	0.17
HCT (%)	34.26	34.00	36.75	39.67	2.03	0.14	0.12	0.15
Hb (g/dl)	10.23	10.44	10.87	11.13	1.46	0.13	0.16	0.16
Lymphocyte (%)	50.92	52.41	53.59	54.24	3.27	0.08	0.10	0.12
Monocyte (%)	5.01	5.27	5.52	6.32	0.85	0.09	0.11	0.08

[1] Pigs with an average initial body weight of 18.35±0.15 kg.
[2] NC: Basal diet; PC: Basal diet with 0.1% CTC; NCBV: NC diet with 0.5% Biotite V; PCBV: PC diet with 0.5% Biotite V.
[3] Standard error.
[4] Contrast: 1) NC vs. PC; 2) NC vs. NCBV; 3) PC vs. PCBV.

differences ($p>0.05$). WBC was lower in NCBV and PCBV treatments than that in NC and PC treatments without significant difference ($p>0.05$).

DISCUSSION

Several experiments were conducted to evaluate the effects of different alumninosilicate clay products such as biotite, zeolite and bentonite on growth performance of pigs. Castro and Iglesias (1989) using 3% and 6% zeolite respectively and Kwon et al. (2003) using 3% Biotite V suggested significant improvements were observed on pigs performance from their growth trials. Our experiment seemed to approve above results. In our experiment, obtained data (Table 2) showed that ADG in PCBV treatment was highest compared to other treatments and ADFI had a reverse trend ($p>0.05$). As the result of increased ADG with less feed intake, gain/feed was improved significantly (12.3%) when pigs fed diet added Biotite V and antibiotics (PCBV) compared to those of pigs fed NC diet. On the contrary, different results were observed by Shurson et al. (1984), Pearson et al. (1985) and Thacker (2003).

As data shown in our digestibility study (Table 3), N and Ca digestibilities were improved by addition of Biotite V ($p<0.05$), however, DM and P digestibilities were not affected ($p>0.05$). Previous reports were various, Thacker (2003) found that N and P digestibilities were unaffected by addition of Biotite V. Dry matter digestibility decreased linearly with increasing levels of Biotite V. However, Poulsen and Oksbjerg (1995) suggested that N metabolism and retention were affected by clinoptilolite. Chen et al. (2005) also observed significant improvement in DM and N digestibilities by addition of Biotite V. The reason for clay minerals influence on N digestibility was not fully clear now. Therefore, more experiment should be conducted to further investigate this item.

Previous studies of alumninosilicate clay products were more concern about its ion exchange capacity and the ability of absorbing ammonium. Recently studies also suggested that nature and synthetic clay products have the ability of absorbing metal ions because of its three-dimensional structure and ion-exchange capacity. It has been widely documented that minerals such as Cu and Zn have beneficial effects on animals (Stahly et al., 1980; Roof and Mahan, 1982), also some researchers suggested that they have antibacterial and antimycotic activity (Dupont et al., 1994; Hill et al., 2000). Previous studies indicated that dietary supplementation of zeolites could alter tissue mineral concentrations in poultry and pigs (Pond and Yen, 1983; Watkins et al., 1989). Therefore, the antibiotics properties of activated Biotite V might be due to its affection of the metabolism or interaction with those metal ions.

Limited studies were conducted to evaluate the effects of alumninosilicate clay series on immune system of pigs. Lymphocytes are both precursor cells of immunologic function as well as regulators and effectors of immunity so

that they played an important role in animal immune system. Proliferation of lymphocytes is essential for the generation of a normal immune response. In our experiment, the percentage of lymphocyte and monocyte were numerically higher (6.5% and 26.1%) in pigs fed diets containing Biotite V and antibiotics (PCBV) than those of pigs fed basal diet. Although no significant effect was observed from current data, there is some evidence that the immune system may be affected by supplementation of Biotite V. Yuan et al. (2004) reported that lymphocyte proliferation was improved by addition of Biotite V in nursery pig diets.

IMPLICATIONS

The overall data seems suggested that addition of either antibiotics or biotite V has a beneficial trend. Also, this trend was more obviously when diets added both antibiotics and Biotite V. Therefore, the product of Biotite V may serve as an alternative substance of antibiotics in swine diets. The addition of Biotite V to growing pigs diet resulted in alterations of some of the growth performance and nutrients digestibility aspects measured in our study. Further research is needed to better discern those mechanisms by which Biotite V alter systemic and enteric immune function when supplementation to swine diets.

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