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Effects of Dietary Supplemental Megazone® on Growth Performance, Nutrients Digestibility, Blood Characteristics, Meat Quality and Carcass Traits in Weaning-to-Finishing Pigs

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Abstract

This study was conducted to investigate the effects of Megazone® (a mineral mix) supplementation on growth performance, nutrients digestibility, blood characteristics, meat quality and carcass traits in weaning-to-finishing pigs. A total of 48 crossbred (Landrace×Yorkshire×Duroc) pigs with initial body weight (BW) of 4.46±0.18 kg were used in a 21 wks trial. Pigs were blocked by weight and allotted to two dietary treatments in a completly randomized design. There were 6 pens per treatment. Dietary treatments included: 1) Control (CON: basal diet) and 2) MT (basal diet+0.8% Megazone®). Through the entire experimental period, there were no effects of dietary Megazone® supplementation on growth performance, nutrients digestibility, blood characteristics and meat quality traits (p>0.05). Market weight and backfat thickness also had no differences between the two treatments (p>0.05). However, carcass weight and carcass ratio in MT treatment were improved significantly compared with CON treatment (p<0.05). In conclusion, supplmentation of Megazone® can increase carcass weight and carcass ratio in weaning-to-finishing pigs, however, it has no effects on growth performance, nutrients digestibility, blood characteristics and meat quality traits.

Key words : megazone®, mineral mix, carcass traits, blood characteristics, growth performance

INTRODUCTON

The alumninosilicate compounds have been used as adsorbent in pigs for many years. It's suggested that these compounds are effective in trapping certain molecules, such as ammonia (Mumton and Fishman, 1977). The mechainisms of these compounds are mainly related to their porosity properties which is called three-dimensional structures and highly ion selectivity and exchange capacity. A series of alumninosilicate clay additives experiments including bentonite, zeolite, biotite and clinoptilolite (Castro and Iglesias, 1989; Ward *et al.*, 1991; Kwon *et al.*, 2002; Malagutti *et al.*, 2002) had been studied to determine their potential capability of promoting growth performance and improving feed efficiency of pigs. However, limited information exists on the effects of supplementing diets with alumninosilicate clays on blood characteristics, as well as meat quality of pigs. Also, the effects of alumninosilicate clays on carcass traits have not been elucidated much. Our study was, therefore, undertaken to evaluate the effects of an alumninosilicate minerals product which named Megazone® (Anicx Co., Korea) on growth performance, nutrients digestibility, blood characteristics, meat quality and carcass traits in weaning-to-finishing pigs.

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MATERIALS AND METHODS

Source and Composition of Megazone®

The compositions of Megazone® include 30% quartz, 30% feldspar, 30% ceramic MAMS (Mystery Activaed Material Series) and 10% biotite (Manufacturers specifications). This product was manufactured by Anicx Co. (Korea). The primary effective composition of this product is alumninosilicate clays.

Experimental Design, Animals, Housing and Diets

A total of 48 crossbred (Landrace×Yorkshire×Duroc) pigs weaned at 17 d of age with an average initial BW 4.46±0.18 kg were used in the current experiment. The experimental period lasted 21 wks. Pigs were fed on a 3-phase dietary regimen: nursery diet, growing diet and finishing diet. At the beginning of experiment, pigs were allotted on the basis of initial BW according to a completly randomized design. There were 6 replication pens per treatment and 4 pigs per pen during each phase, resepectively. Dietary treatments include: 1) CON (basal diet) and 2) MT (basal diet add 0.8% Megazone®). The 3-phase diets (Table 1) were fed in meal form and formulated to meet or exceed of NRC (1998) recommendations for all nutrients.

Nursery house (wk 1 to 5), growing house (wk 5 to 11) and finishing house (wk 11 to 21) were environmentally controlled building with slatted floors. Nursery house temperature was maintained at 32℃ and decreased 2℃ weekly, the other two houses maintained approximately 25±2℃ and 22±2℃, respectively. The dimensions of the pen (length×width) were 1.6×0.8 m, 1.6×1.2 m and 1.8×1.8 m, respectively. Each pen was equipped with a one-sided self-feeder and a nipple waterer to allow *ad libitum* access to feed and water throughout all the experimental period.

Sampling and Measurements

Body weight and feed intake were measured at the end of wk 5, 11 and 21 to determine average daily gain (ADG), average daily feed intake (ADFI) and gain/feed (G/F). Chromic oxide (Cr_2O_3) was added (0.2%) as an indigestible marker on d 30 to 35, d 72 to 77 and d 142 to 147. Feed and fresh fecal samples were collected on d 35, d 77 and d 147. Feed and feces samples were analyzed for dry matter (DM) and nitrogen (N) digestibilities (AOAC, 1994). Chromium was determined by UV absorption spectrophotometry (UV-1201, Shimadzu, Japan) and apparent digestibilities of DM and N were calculated using the indirect method.

Blood samples were collected at cervical vein into both K_3EDTA vacuum tubes and clot activator vacuum tubes (Becton Dickinson Vacutainer Systems, Franklin Lakes, NJ, USA) from 2 pigs in each pen at the end of wk 5, 8, 11, 16 and 21. Both the concentrations of red blood cell (RBC) count, white blood cell (WBC) count and lymphocytes count in whole blood and IgG, albumin and total protein in serum were measured. All the blood parameters (RBC, WBC and lymphocytes) and serum parameters (total protein, albumin and IgG) were measured using the automatic blood analyzer (ADVIA 120, Bayer, USA).

Market weight and backfat thickness were measured at the end of the test, using PigLog 105 (SFK-Technology, Denmark) ultrasonically apparatus. Backfat thickness were measured on left side 7 cm from the middle of the back at the 5th, 10th, 15th and last ribs according to the methed of PigLog 105-User's Guide.

Pigs were slaughtered at a local commercial slaughterhouse.

Table 1. Formula and chemical composition of 3-phase basal dietary

Ingredients (%)	Nursery	Growing	Finishing
Corn	55.26	59.94	64.48
Soybean meal	33.43	23.74	19.74
Rice bran	-	5.00	5.00
Molasses	2.50	4.00	4.00
Animal fat	5.33	2.61	2.10
Rapeseed meal	-	2.00	2.00
Difluorinated phosphate	1.93	1.16	1.19
Limestone	0.78	0.44	0.46
L-lysine-HCl	0.17	0.34	0.37
Trace mineral premix[1)]	0.10	0.25	0.25
Vitamin premix[2)]	0.12	0.10	0.10
Salt	0.20	0.15	0.15
DL-methionine	0.03	0.10	0.06
L-threonine	-	0.09	0.07
Choline chloride	0.05	0.08	0.03
Chemical composition[3)]			
ME (kcal/kg)	3,360	3,450	3,415
Crude protein (%)	20.00	17.70	16.20
Lysine (%)	1.30	1.00	0.95
Calcium (%)	0.90	0.70	0.70
Phosphorus (%)	0.80	0.60	0.60

1) Provided per kg of complete diet: 12.5 mg Mn, 179 mg Zn, 5 mg Cu, 0.5 mg I and 0.4 mg Se.

2) Provided per kg of complete diet: 4,800 IU vitamin A, 960 IU vitamin D_3, 20 IU vitamin E, 2.4 mg vitamin K_3, 4.6 mg vitamin B_2, 1.2 mg vitamin B_6, 13 mg pantothenic acid, 23.5 mg niacin and 0.02 mg biotin.

3) Calculated values.

Slaughter grade was evaluated by careermen at Animal Product Grading Service. Carcass weight and carcass ratio were measured after a 44 h chill at 3℃.

The 10th-rib chop samples were vacuum-sealed subsequent analysed for water holding capacity (WHC), cook loss and shear force as the method previously described by Matthews *et al.* (2001).

Surface meat color, CIE L* (lightness), a* (red-green component), b* (blue-yellow component), were measured in triplicate on a freshly-cut surface after a 30 min bloom time at 0℃ using a Minolta Chromameter (Minolta CR-301, Tokyo, Japan). Ultimate pH values were measured directly using a combined pH electrode (NWKbinar pH, K-21, Landsberg, Germany).

Statistical Analyses

In this experiment, all the data were analyzed as a completly randomized design using GLM procedure of SAS (1996). The model included the effects of block (replication) and treatment. Pen served as the experimental unit.

RESULTS

The results of inclusion Megazone® in weanling-to-finishing diets at 0.8% had no effects on ADG, ADFI and G/F during the nursery (wk 0 to 5), grower (wk 5 to 11) and finisher (wk 11 to 21) phases, or entire trial (p>0.05) (Table 2).

The effects of Megazone® on nutrients digestibility in weaning-to-finishing pigs are presented in Table 3. During the three periods, there were no effects (p>0.05) on the apparent digestibility of DM or N between the treatments.

Table 4 and Table 5 show the effects of Megazone® on blood characteristics in weaning-to-finishing pigs. Determined serum parameters including total protein, albumin and IgG (Table 4) were not affected by the dietary treatments (p>0.05). Also, blood cell count parameters inculding WBC, RBC and lymphocyte (Table 5) could not find statistical differences between dietary treatments (p>0.05).

Slaughter grade of meat in pigs fed dietary addition of Megazone® are presented in Table 6. There was no difference (p>0.05) in slaughter grade of pork between the treatments (p>0.05).

Table 7 shows the results of CIE L*/a*/b*, shear force, cook loss, WHC and total carcass fat. There were no significant differences between CON and MT treatments on any measured meat quality traits.

Table 2. Effects of dietary supplemental Megazone® on growth performance in pigs

Items	CON[1)]	MT[1)]	SE[2)]
Wk 0 to 5			
ADG (kg)	0.416	0.393	0.020
ADFI (kg)	0.646	0.653	0.045
G/F	0.709	0.668	0.040
Wk 5 to 11			
ADG (kg)	0.745	0.766	0.032
ADFI (kg)	1.614	1.632	0.023
G/F	0.464	0.481	0.020
Wk 11 to 21			
ADG (kg)	0.810	0.829	0.018
ADFI (kg)	2.708	2.658	0.016
G/F	0.297	0.311	0.011
Wk 0 to 21			
ADG (kg)	0.708	0.716	0.008
ADFI (kg)	1.656	1.648	0.007
G/F	0.490	0.487	0.008

1) Abbreviated CON, basal diet; MT, Con diet added 0.8% Megazone®.
2) Pooled standard error.

Table 3. Effects of dietary complex Megazone® on nutrients digestibility in pigs

Items (%)	CON[1)]	MT[1)]	SE[2)]
Wk 0 to 5			
DM	84.12	83.81	3.93
N	81.64	82.43	4.44
Wk 5 to 11			
DM	70.60	70.39	2.19
N	65.81	65.20	2.63
Wk 11 to 21			
DM	72.39	70.47	2.01
N	72.69	68.24	1.92

1) Abbreviated CON, basal diet; MT, Con diet added 0.8% Megazone®.
2) Pooled standard error.

Table 4. Effects of dietary supplemental Megazone® on serum characteristics in pigs

Items	CON[1)]	MT[1)]	SE[2)]
Total protein (g/dL)			
5 Wks	5.18	5.18	0.16
8 Wks	5.12	5.12	0.29
11 Wks	5.38	6.42	0.35
16 Wks	6.52	7.06	0.29
21 Wks	7.22	7.44	0.26
Difference (Wks 8~Wks 5)	−0.06	−0.06	0.21
Difference (Wks 11~Wks 8)	0.26	1.30	0.62
Difference (Wks 16~Wks 11)	1.14	0.64	0.56
Difference (Wks 21~Wks 16)	0.70	0.38	0.84
Difference (Wks 21~Wks 5)	2.05	2.26	0.23
Albumin (g/dL)			
5 Wks	3.48	3.40	0.15
8 Wks	3.12	3.06	0.29
11 Wks	3.48	3.98	0.29
16 Wks	3.94	4.12	0.12
21 Wks	3.48	3.82	0.13
Difference (Wks 8~Wks 5)	−0.36	−0.34	0.22
Difference (Wks 11~Wks 8)	0.36	0.92	0.58
Difference (Wks 16~Wks 11)	0.46	0.14	0.39
Difference (Wks 21~Wks 16)	−0.46	−0.30	0.20
Difference (Wks 21~Wks 5)	0.00	0.42	0.33
IgG (g/dL)			
5 Wks	326.25	386.50	13.48
8 Wks	431.40	358.60	56.64
11 Wks	443.20	655.60	78.07
16 Wks	711.40	905.80	209.18
21 Wks	1,185.40	1,057.00	108.80
Difference (Wks 8~Wks 5)	105.15	−27.90	32.10
Difference (Wks 11~Wks 8)	11.60	297.00	127.24
Difference (Wks 16~Wks 11)	268.25	250.20	255.79
Difference (Wks 21~Wks 16)	474.05	151.20	223.23
Difference (Wks 21~Wks 5)	859.15	670.50	184.91

1) Abbreviated CON, basal diet; MT, Con diet added 0.8% Megazone®.
2) Pooled standard error.

Table 5. Effects of dietary supplemental Megazone® on whole blood characteristics in pigs

Items	CON[1)]	MT[1)]	SE[2)]
WBC ($\times 10^4/mm^3$)			
5 Wks	11.46	11.49	0.18
8 Wks	11.67	11.85	0.27
11 Wks	18.18	18.02	2.38
16 Wks	15.50	18.12	1.64
21 Wks	15.11	14.54	0.87
Difference (wk 8~wk 5)	0.21	0.36	0.09
Difference (wk 11~wk 8)	6.51	6.17	0.12
Difference (wk 16~wk 11)	−2.68	0.10	2.91
Difference (wk 21~wk 16)	−0.39	−3.58	1.03
Difference (wk 21~wk 5)	3.65	3.05	0.64
RBC ($\times 10^6/mm^3$)			
5 Wks	6.38	6.29	0.20
8 Wks	6.55	6.73	0.12
11 Wks	6.08	5.49	0.34
16 Wks	6.20	6.25	0.26
21 Wks	6.24	6.30	0.15
Difference (wk 8~wk 5)	0.17	0.44	0.21
Difference (wk 11~wk 8)	−0.47	−1.24	0.30
Difference (wk 16~wk 11)	0.12	0.76	0.26
Difference (wk 21~wk 16)	0.04	0.05	0.26
Difference (wk 21~wk 5)	−0.14	0.01	0.31
Lymphocyte (%)			
5 Wks	51.16	54.25	4.07
8 Wks	43.32	47.14	2.38
11 Wks	37.60	43.40	4.88
16 Wks	47.40	54.20	6.24
21 Wks	49.00	43.80	7.05
Difference (wk 8~wk 5)	−7.84	−7.11	3.28
Difference (wk 11~wk 8)	−5.72	−3.74	2.43
Difference (wk 16~wk 11)	9.80	10.80	8.01
Difference (wk 21~wk 16)	1.6	−10.40	7.32
Difference (wk 21~wk 5)	−2.16	−10.45	6.22

1) Abbreviated CON, basal diet; MT, Con diet added 0.8% Megazone®.
2) Pooled standard error.

Dietary addition of Megazone® had no effects (p>0.05) on market weight and backfat thickness (Table 8) in MT treatment compared with CON treatment. However, carcass weight and carcass ratio in MT treatment significantly increased (p <0.05) compared with CON treatment.

DISCUSSION

Several experiments were conducted to evaluate the effects of different alumninosilicate minerals, such as biotite, zeolite and bentonite on growth performance of pigs. Chen *et al.*

Table 6. Effects of dietary supplemental Megazone® on slaughter grade of pork in pigs

Items	CON[1)]	MT[1)]
Slaughter Grade (%)		
A	33.3	33.3
B	33.3	33.3
C	33.3	33.3
D	0.0	0.0
A+B	66.6	66.6

[1)] Abbreviated CON, basal diet; MT, CON diet added 0.8% Megazone®.

Table 7. Effects of dietary supplemental Megazone® on meat quality characterstics in pigs

Items	CON[1)]	MT[1)]	SE[2)]
CIE L*	49.938	53.215	1.024
CIE a*	6.687	7.372	0.363
CIE b*	2.012	3.238	0.378
Shear force (kg)	3.522	3.120	0.161
Cook loss (%)	33.037	34.095	1.148
pH	5.708	5.572	0.021
WHC (%)	60.043	61.032	0.632
Total carcass fat (%)	1.752	1.372	0.143

[1)] Abbreviated CON, basal diet; MT, CON diet added 0.8% Megazone®.
[2)] Pooled standard error.

(2005a) using 1.0% and 2.0% biotite (an aluminosilicate mineral product) and Mathews *et al.* (1999) using 0.5% hydrated sodium calcium alumninosilicate (HSCAS) observed no significant improvements on pig performance. Our experiment seemed to approve above results. In contrast, Kwon *et al.* (2003) using 0.3% biotite suggested significant improvements were observed on pigs performance from their growth trials. Similarly, Castro and Iglesias (1989) observed significant improvments in weight gain and feed conversion when pigs were fed 3.0% and 6.0% zeolite (primary composition is HSCAS).

Digestibility coefficients for DM and N were unaffected by Megazone® inclusion in the present experiment. Similar reuslt have been reported by Kwon *et al.* (2002) when feeding biotite and Collings *et al.* (1980) with sodium betonite.

Table 8. Effects of dietary supplemental Megazone® on carcass traits in pigs

Items	CON[1)]	MT[1)]	SE[2)]
Market weight (kg)	112.02	112.58	0.336
Carcass weight (kg)	93.60[b]	96.27[a]	0.329
Carcass ratio	83.53[b]	85.50[a]	0.155
Backfat thickness (mm)	20.62	21.80	0.950

[1)] Abbreviated CON, basal diet; MT, Con diet added 0.8% Megazone®.
[2)] Pooled standard error.
[a,b] Mean values with no common superscript are significantly different in the same row (p<0.05).

However, Thacker (2003) found that DM digestibility was decreased linerly with increasing levels of biotite. Chen *et al.* (2005a) also demonstrated significant improvement in DM and N digestibilities by addition of biotite.

None of the blood cell count parameters and serum parameters determined in the current expriment were affected by Megazone® inclusion. Previous reports were various, Chen *et al.* (2005b) found that RBC and Lymphocyte were increased, and WBC was lower compared with or without biotite treatment, but there were no statistical differences. Yuan *et al.* (2004) reported that lymphocyte proliferation was improved by addition of biotite in nursery pig diets. Limited studies were conducted to evaluate the effects of HSCAS clays on serum parameters of pigs. However, other study found improvements on serum total protein and albumin when pigs fed aflatoxin-contaminated diets with HSCAS clays vs aflatoxin-contaminated diets (Schell *et al.* 1993). The discrepancy between Schell's report and our study may be explained by the aflatoxin reduced indicators of protein synthesis such as serum albumin and total protein, moreover, HSCAS has a ability to correct the aberrations in serum profiles.

Megazone® supplementation had no effects on all the meat quality traits measured (Table 7) in our experiments. However, improvements in carcass weight and carcass ratio were evident in meat from pigs fed diets supplemented with Megazone® (Table 8). On the contrary, Thacker (2003) reported there was no effect on carcass weight when pigs fed diets with biotite inclusion. The backfat level observed in our study is consistent with the results of Mathews *et al.* (1999) when feeding HSCAS and Pearson *et al.* (1985) feeding zeolite in growing-finishing pigs. However, the contrast results were found by Taverner *et al.* (1984) reported higher backfat levels in pigs fed sodium bentonite while Ward *et al.* (1991) reported a leaner carcass in pigs fed sodium zeolite. More studies should be conducted to evaluated the effects on carcass traits.

IMPLICATION

Current results indicate that Megazone® can improve carcass weight and carcass ratio, however, growth performance, nutrients digestibility, blood characteristics and meat quality are not affected. As several aspects or factors can lead to similar result, the exact mechanisms of this mineral additive can not be explained clearly by current study. Further research is also needed to determine the optimum addition level of the Megazone® used in this study.

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