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ANIMAL

Effect of GABA on the growth performance, nutrient digestibility, and backfat thickness in growing-finishing pigs

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Abstract

A total of 100 growing pigs (25.66 ± 1.55 kg) were used in a 16-week feeding trial. Pigs were randomly distributed into two treatment groups on the basis of body weight and sex. There were ten replicate pens per treatment, with five pigs (three barrows and two gilts) per pen. The dietary treatments for this trial were as follows: 1) Basal diet (CON) and 2) T1 (γ-aminobutyric acid, GABA), CON + 100 $mg \cdot kg^{-1}$ GABA. During weeks 0 to 6, the feed efficiency (G : F) in the T1 group was higher ($p < 0.05$) than that in the CON group, but no improvements in the average daily feed intake (ADFI) and average daily gain (ADG) were noted ($p > 0.05$). During the experimental period, the final body weight (BW) was improved ($p < 0.05$). However, no differences ($p > 0.05$) were noted in the apparent total tract digestibility (ATTD) of dry matter (DM) nitrogen (N). Meanwhile, there were no significant differences ($p > 0.05$) observed in the backfat thickness among the treatment groups. These results therefore indicate that supplementation with GABA may improve the overall growth performance but may not lead to differences in the nutrient digestibility and backfat thickness in growing-finishing pigs.

Keywords: backfat thickness, growing-finishing pigs, growth performance, nutrient digestibility, γ-aminobutyric acid

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Introduction

γ-Aminobutyric acid (GABA) is an inhibitory neurotransmitter, and it is biosynthesized from the α-decarboxylation which is a kind of glutamic acid. The reaction is catalyzed by glutamate decarboxylase (Chung et al., 2009). GABA not only plays a principal role in inhibitory neurotransmitter, but also serves nutritional and pharmacological functions in the central nervous system (CNS), such as the induction of diuresis, blood pressure-lowering effects, promotion of the absorption of metal ions, protecting liver against alcohol damage, and immunomodulatory effects (Omori et al., 1987; Oh and Choi 2000; Adeghate and Ponery, 2002; Kimura et al., 2002; Jin et al., 2013).

GABA could be using as feed additive for animals. The livestock sector demonstrates that GABA can improve the growing pigs and weanling pigs feed intake and weight and ease sow losing weight during the lactation (Fan et al., 2007; Liang et al., 2009; Yang et al., 2009). Wang et al. (2013) reported that GABA had several positive impacts to livestock, such as increasing feed intake, improving lactation performance, and keeping dairy cows health during early lactation. Dai et al. (2011) demonstrated that feed GABA to broilers exerting stress-relaxation function and helping prevent heat stress-related symptom in growth performance and carcass traits. Although there are some phenomena prove that GABA using as a dietary supplement has positive effects, but few data are available, especially in the field of biological properties of GABA in growing-finishing pigs.

Our research was collecting information which was based on using GABA (provided by AD Biotech Co., Chuncheon, Korea) as a feed ingredient and observing the growing-finishing pigs growth performance, nutrition digestibility and backfat thickness.

Materials and methods

The experimental protocol used in this study was approved by the Animal Care and Use Committee of Dankook University, which is comparable to those laid down by the Canadian Council on Animal Care.

Experimental design, animals, housing

A total of 100 growing pigs ([Yorkshire × Landrace] × Duroc) with an average body weight (BW) of 25.66 ± 1.55 kg were used in this 16-wk experiment. Pigs were randomly allotted to 2 experimental diets according to their initial BW and sex (2 gilts and 3 barrows·pen^{-1}; 10 pens·$treatment^{-1}$). Dietary treatments were as follows: (1) control (no GABA, basal diet), (2) 0.01% GABA (control + 100 mg·kg^{-1} GABA), The GABA was provided by a commercial company (AD Biotech Co., Chuncheon, Korea). Feed additive was mixed in the ground maize for the basal diet, and all diets were provided as meals that were formulated to meet or exceed NRC (2012) requirements (Table 1). Pigs were housed in an environmentally controlled facility with slatted plastic floor. The target room temperature and humidity were 25℃ and 60%, respectively. Each pen was equipped with a self-feeder and nipple drinker to allow *ad libitum* access to feed and water throughout the experimental period.

Sampling and measurement

Individual pig's BW was checked at the beginning and at the end of the 6th, 12th, and 16th weeks, and the feed consumption was recorded per pen during the experiment to calculate the average daily gain (ADG), average daily feed intake (ADFI), and gain/feed (G/F) ratio.

Backfat thickness (BFT) was measured at weeks 6, 12, and 16 using Pig-log 105 (Carometec food technology, New York, USA) at P2 position (6.5 cm area on the right and left end frames).

Table 1. Formula and chemical composition of experimental diet (as-fed basis).

Ingredients	(%)
Corn	65.32
Wheat hard	3.00
DDGS	3.00
Soybean meal	15.33
Rapeseed meal	3.00
Animal fat	4.00
Molasses	3.50
Lysine-sulfate	0.44
DL-methionine (99%)	0.04
L-threonine (100%)	0.06
Limestone	0.48
Dicalcium phosphate	1.23
Salt	0.3
Vitamin-premix[y]	0.2
Mineral-premix[z]	0.1
Calculated nutrition compositions (%)	
Metabolic energy ($Kcal \cdot kg^{-1}$)	3,226
Crude protein	14.5
Lysine	0.95
Methionine	0.28
Calcium	0.65
Phosphorus	0.55

DDGS, distillers dried grains with solubles.

[y] Provided per kg of complete diet: 4,000 IU of vitamin A; 800 IU of vitamin D_3; 17 IU of vitamin E; 2 mg of vitamin K; 4 mg of vitamin B_2; 1 mg of vitamin B_6; 16 microgramme of vitamin B_{12}; 11 mg of pantothenic acid; 20 mg of niacin; 0.02 mg of biotin.

[z] Provided per Kg of complete diet: 220 mg of Cu (as $CuSO_4 \cdot 5H_2O$); 175 mg of Fe ($FeSo_4 \cdot H_2O$); 191 mg of Zn (as $ZnSO_4 \cdot H_2O$); 89 mg of Mn (as MnO_2); 0.3 mg of I (as CaI); 0.5 mg of Co ($CoSo_4 \cdot 7H_2O$); 0.3 mg of Se (as $Na_2SeO_3 \cdot 5H_2O$).

Chromium oxide (Cr_2O_3) was added to the diet at 0.2% of the diet as an indigestible marker for 7 days prior to fecal collection on week 6, week 12, and week 16 to calculate dry matter (DM), nitrogen (N) and energy. Fecal grab samples were collected randomly from at least two pigs in each pen (1 gilt and 1 barrow) at weeks 6, 12, and 16 of the experiment. All feed and fecal samples were immediately stored at - 20℃ until analysis. Feces samples was dried 72 hours in the dryer at 60℃ and finely ground to allow for passage through a 1 mm screen for analyzing apparent total tract digestibility of dry matter (DM) (AOAC method 930.15), nitrogen (AOAC method 990.03) and energy (using a bomb colorimeter, Parr 61.00; Parr Instruments Co., Moline, IL, USA), following the procedures outlined by AOAC (2000). Chromium was analyzed via UV absorption spectrophotometry (Shimadzu, UV-1201, Kyoto, Japan), following the method described by (Williams et al., 1962). Gross energy in the feces was also determined using a calorimeter (Mode 1241, Parr Instrument Co., Illinois, USA). The production of manure on dry matter basis per pig per day was calculated using the formula:

$$\text{Digestibility (\%)} = \{1 - [(Nf \times Cd)/(Nd \times Cf)]\} \times 100 \quad (1)$$

where Nf is the nutrient concentration in faeces (% DM), Nd the nutrient concentration in diet (% DM), Cd the chromium concentration in diets, and Cf the chromium concentration in faeces.

Statistical analyses

All experimental data were analyzed using the general linear model (GLM) procedure of SAS (2001) as a randomized complete block design (SAS Inst. Inc., Cary, NC, USA). Data on growth performance, nutrient digestibility and backfat thickness were based on a pen basis. Mean values and standard error of means (SEM) are reported. Statements of statistical significance are based on $p < 0.05$.

Results and Discussion

As shown in Table 2, pigs fed T1 diet had the higher body weight (BW) than the CON diet ($p < 0.05$), meanwhile the G : F ratio had significant difference in growing phase ($p < 0.05$), and there have an increasing trend ($0.1 > p > 0.05$) of ADFI and ADG. There are some of scientific studies assessing the effects of use GABA as an additive to feed livestock. (Zhang et al., 2018; Ding and Kim, 2019). Xu et al. (2009) showed that, compared with control diet, finishing pigs treated with GABA (10, 30 and 50 $mg \cdot kg^{-1}$ GABA supplementation in diet) exhibited significantly improved ADFI and ADG. In our study, although ADG and ADFI was not affected significantly by the addition of 100 $mg \cdot kg^{-1}$ GABA to the diets fed to growing-finishing pigs, there have an increasing trend ($0.1 > p > 0.05$) of ADFI and ADG of pigs fed GABA, compared with the control group, lead to an increase of final BW ($p < 0.05$). Furthermore, differences in feed intake may be attributed to the differences in breed, GABA supplemental level, environment temperature, and the experimental diet. In present study, dietary supplement of GABA could improve the gain feed radio (G : F) during growing phase. It is possible that GABA is a modulator of peristaltic activity via the regulation of acetylcholine release from cholinergic neurons through interaction with γ-Aminobutyric acid type A (GABAA) or γ-Aminobutyric acid type B (GABAB) receptors (Auteri et al., 2014). In addition, GABA could cause transient relaxations of the longitudinal and circular muscle of the colon and transient constrictions followed by relaxation of the muscle of the ileum (Krantis et al., 1980).

Table 2. Effect of dietary supplementations of γ-aminobutyric acid (GABA) on growth performance in growing-finishing pigs[z].

Items	Dietary treatment		SEM
	CON	GABA	
Body weight (kg)			
Initial BW	25.58	25.83	0.13
Final BW	111.20b	114.51a	0.50
Growing phase (week 0 - 6)			
ADG (g)	722	735	6.55
ADFI (g)	1,748	1,781	16.22
G : F	0.405b	0.421a	0.005
Finishing phase (week 6 - 16)			
ADG (g)	790	809	6.95
ADFI (g)	2,478	2,507	26.43
G : F	0.319	0.323	0.002
Overall (week 0 - 16)			
ADG (g)	764.5	781.3	10.30
ADFI (g)	2201.8	2225.8	22.64
G : F	0.345	0.352	0.004

BW, body weight; ADFI, average daily feed intake; ADG, average daily gain; G : F, gain : feed ratio; SEM, standard error of means.

[z] CON, basal diet; GABA, basal + 0.01% GABA.

a, b: Means in the same row with different superscript differ significantly ($p < 0.05$).

Nutrient digestibility and backfat thickness are shown in Table 3. Compared with the CON dietary treatment, inclusion of 100 $mg \cdot kg^{-1}$ GABA did not influence backfat thickness, and the ATTD of DM, GE, and N, The present results showed that there was no difference between two diets in apparent total tract digestibility, which agrees with the previous reported results of Cheng et al. (2014), who observed when feeding treatments consisted of 0 (control), 40, 80, or 120 mg of true $GABA \cdot kg^{-1}$ of dry matter (DM) was not influence the content and the coefficient of apparent total tract digestibility (CATTD) in cows. Given the age and the trial period, there might be a more pronounced effect by reducing the trial period. Dietary supplementation with GABA in growing-finishing pigs needs further study to better understand the underlying mechanisms and determine the appropriate concentration of supplementation in growing-finishing pigs.

Table 3. Effect of dietary supplementations of γ-aminobutyric acid (GABA) on nutrient digestibility, backfat thickness in growing-finishing pigs[z].

Items	Dietary treatment		SEM
	CON	GABA	
Apparent total tract nutrient digestibility			
week 6			
Dry matter	76.96	77.80	0.76
Nitrogen	76.11	77.40	0.81
Energy	76.97	78.57	0.86
week 16			
Dry matter	72.65	73.95	0.89
Nitrogen	72.42	72.90	0.81
Energy	73.97	74.59	0.97
Backfat Thickness (mm)			
Initial	9.44	9.63	0.20
week 6	13.28	13.40	0.20
week 12	16.66	16.20	0.35
week 16	20.96	20.68	0.36

SEM, standard error of means.

[z] CON, basal diet; GABA, basal + 0.01% GABA.

Conclusion

It is concluded that a dietary supplement of 0.01% GABA could improve growth performance in growing-finishing pigs. We are suggesting the dietary supplementation of GABA may be beneficial to growing-finishing pigs.

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