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Effects of Anti-diarrhoeal Herbs on Growth Performance, Nutrient Digestibility, and Meat Quality in Pigs

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ABSTRACT: Two studies were conducted to investigate the effects of anti-diarrhoeal herbs on growth performance, nutrient digestibility, and meat quality in pigs. In Exp 1, 150 weanling-growing piglets (average BW = 7.5±0.24 kg, average age = 27±1 d) were allotted into one of the five dietary treatments, including: i) CON, basal diet, ii) DP, basal diet+1 g/kg date pits, iii) JH, basal diet+0.5 g/kg Japanese-honeysuckle, iv) HCT, basal diet+1 g/kg houttuynia cordata thunb, and v) LE, basal diet+1 g/kg laquer tree extract. From wk 0 to 5, the JH, HCT and LE groups presented higher ($p<0.05$) ADFI, ADG and gain/feed ratio (G/F) than CON and DP groups. During wk 5 to 10, Pigs fed JH, HCT and LE diets indicated higher ($p<0.05$) ADG and ADFI than the pigs fed CON and DP diets. During the entire experimental period, a significant increase of ADG appeared in JH, HCT and LE ($p<0.05$). Pigs fed JH, HCT and LE diets got a higher ($p<0.05$) ADFI than the pigs fed CON and DP diets. Pigs fed diets with supplementations of herb additives revealled lower ($p<0.05$) score of diarrhea pigs during d 2 to d 6 compared with pigs fed CON diet. In Exp 2, 60 growing-finishing barrows and gilts (average BW = 54.10±1.20 kg, average age = 54±3 d) were allotted to three treatments: i) CON, basal diet; ii) YG, basal diet+1 g/kg yellow ginger and iii) HR, basal dietary+1 g/kg hoantchy root, respectively. From wk 0 to 5, Dietary supplementation of YG and HR enhanced ($p<0.05$) ADG. No difference was found between YG and HR treatments. During, wk 5 to 10, ADG also was observed higher in YG and HR treatments than CON group ($p<0.05$). Additional, YG had the highest ADG ($p<0.05$) among treatments. There was always an increase of ADG in YG and HR ($p<0.05$) through all periods. HR treatment showed a lower ($p<0.05$) score of diarrhoeal pigs on d 1and d 2 compared with CON treatment. Pigs fed YG and HR diets had a higher ($p<0.05$) *longissimus muscle area* (LMA) than pigs fed CON diet. In conclusion, anti-diarrhoeal herbs can improve growth performance, and prevent diarrhea incidence in pigs, it can also increase LMA in finishing pigs. (**Key Words:** Anti-diarrhoeal Herbs, Blood Characteristics, Growth Performance, Meat Quality, Pigs)

INTRODUCTION

Diarrhea is a big challenge for pork productions, especially at post-weanling phase resulted from the stress of weaning and movement to another environment increases the potential for disease, poor feed intake, and nutritional disorders (Kohler and Moon., 1984). Weanling piglets are associated with growth retardation as well as an increase in both morbidity and mortality in pigs (Wilson et al., 1989), due to an increase in the susceptibility to gram-negative bacterial infections (Nabuurs et al., 1995). Regarding the fact that weaning greatly affects general health condition of piglets, thereby it is necessary to supplement antibiotics in diets for alleviating the impacts of diarrhea. Indeed, after supplemented antibiotics, there is a substantial increase in performance by enhancing immunity and decreasing the occurrence of diarrhea. However, as the growth of scientific research, exposure problems during production process, we came to realize the adverse influences, especially the development of resistant pathogenic bacterial strains and residual contamination of the food chain. In view of low residual contamination, low environmental pollution of natural raw materials, a increasing number of studies are focusing on phylogenic products that comprise a wide variety of herbs, spices, and essential oils (Windisch et al., 2008).

Some herbs additives are excellent anti-diarrhoeal drug which were demonstrated to be antioxidant (Nakatani, 2000; Wei and Shibamoto, 2007), antimicrobial (Si et al., 2006), and growth-promotor (Basmacioglu et al., 2004; Mao et al., 2005) in pigs. Those effects are partially associated with enhancing immunity, promoting anti-stress ability and increasing digestibility (Yen and Pond, 1993;

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Platel and Srinivasan, 1996; Hoshi et al., 1999). However, it's because of a mass of species of herbs, the complicated ingredients and uncertain specific mechanism, that the utilization of herbs is not well known.

Date pits, Japanese-honeysuckle (*Lonicera Japanica*), Houttuynia cordate thunb (*H. cordate*), Laquer tree (*Rhus verniciflua Stokes*), Yellow ginger (*Dioscorea* zingiberensis), Hoantchy root (*Leguminosae*) and *Acanthopanax senticosus* extract are used for anti-diarrhoeal, anti-inflammatory, increasing appetite, antibacterial on human and livestock. (Jung., 1998; Hong et al., 1999; Mohamed and Chang., 2007; Yin et al., 2008) Enough reasons make us to evaluate the impacts of the traditional prescription which used as additives in pigs (Huo et al., 2004). We can hypothesis anti–diarrhoeal herbs are able to improve nutrient digestibility, growth performance and meat quality.

Therefore, the objective of the current study was to determine the effects of anti-diarrhoeal herbs on growth performance, nutrient digestibility, and meat quality in pigs.

MATERIALS AND METHODS

Herbs substances

As follow, the process of herbs additives in current experiment exhibited: while the herbs were taken into machine, the condition were controlled at moisture 15% to 17%, 70 to 90°C, and the pressure of water vapor at 220 to 500 kPa, temperature at 115 to 125°C. At least, herbs were in an attrition mill to a size of 0.15 to 0.25 mm. Main composition of the herbs used in the current experiment, were determined in accordance with the methods recommended by AOAC (1995).

In Exp 1, the compositions of data pits (DP) included 5.0 to 6.3% protein; 9.9 to 13.5% fat; 65 to 69% neutral detergent fibre and 1.0 to 1.8% ash. Mainly bioactive ingredients comprised dietary fibre, minerals, phytic acid, a–amylase inhibitors and tannins; The ingredients of Japanese–honeysuckle (JH) were 1.6 to 2.1% proteins, 1.5 to 2.3% lipids, 6.4 to 7.2% saccharides, 61 to 73% neutral detergent fibre, and 0.5 to 1.1% ash. Mainly bioactive ingredients included green orthoacid, glycoside, flavonoid, volatile oils. Houttuynia cordata thumb (HCT) compromised 2.3 to 21% proteins, 1.1 to 2.3% lipids, 74 to 80% neutral detergent fibre, and 1.6 to 2.1% ash. Mainly bioactive compositions consist of lauric aldehyde, a-pinene, linlool, quercitrin, isoquercitrin. Laquer tree extracts (LE) included 3.7 to 4.2% proteins, 5.1 to 6.3% fat, 63 to 79% neutral detergent fibre and 1.3 to 2.1% ash, mainly bioactive components involved flavones, fisetin, arachidic acid, butein.

In Exp 2, Yellow ginger (YG) compromised 1.3 to 2.4% proteins, 2.1 to 2.6% lipids, 61 to 75% neutral detergent fibre, and 1.2 to 1.6% ash. Bioactive component consisted of curcumin, flavonoid glycoside. Hoantchy root (HR) included 3.2 to 4.3% proteins, 1.9 to 2.6% lipids, 57 to 72% neutral detergent fibre, and 1.4 to 1.9% ash. The mainly bioactive substance composed flavones, astragalus polysaccharides, ehilme and betaine.

Experimental design, animals and diets

The animal care and use protocol was approved by the Animal Care and Use Committee of Dankook University. In experiments (Landrace×Yorkshire×Duroc) crossbred pigs were allotted to treatments in randomized complete block designs according to the initial BW. Pigs were housed in an environmentally controlled nursery room with pens and plastic completely slotted flooring. Each pen was equipped with a self-feeder and a nipple drinker to allow *ad libitum* access to feed and water throughout the experimental period. All diets based on corn and soybean meal were provided in mash form and formulated to meet or exceed the NRC (1998) recommendations for all nutrient requirements (Tables 1, 2 and 3). Treatment additive was included in the diet by replacing the same amount of corn.

Experiment 1

A total of 150 weanling pigs (average BW = 7.5±0.36 kg, average age = 27±1 d) were allotted into one of five

Table 1. The diet composition of weanling pigs (as-fed basis)

Ingredient (%)	
Corn	55.55
Soybean meal (44% CP)	24.96
Whey powder	6.00
Fish meal (64% CP)	5.00
Soybean oil	2.08
Spray-dried poroine plasma (78% CP)	3.00
Dicalcium phosphate	0.65
Limestone	1.00
Salt	0.25
L-lysine HCl	0.15
DL-methionine	0.04
Vitamin and mineral premix[a]	1.00
L-threonine	0.02
Chemical composition[b]	
ME (kcal/kg)	3,450
CP (g/kg)	21.1
Methionine	0.4
Lys (g/kg)	1.45
Ca (g/kg)	0.82
P (g/kg)	0.66

[a] Provided the following per kilogram of complete diet: vitamin A, 12,000 IU; vitamin D_3, 2,500 IU; vitamin E, 30 IU; vitamin K_3, 3 mg; vitamin B_{12}, 0.012 mg; riboflavin, 4 mg; niacin, 40 mg; pantothenic acid, 15 mg; choline chloride, 400 mg; folic acid, 0.7 mg; thiamin,1.5 mg; pyridoxine, 3 mg; biotin, 0.1 mg; Zn, 105 mg; Mn, 22 mg; Fe, 84 mg; Cu, 225 mg; I, 0.50 mg; and Se, 0.35 mg.

[b] All calculated values are based on NRC (1998) tabular values.

Table 2. The diet composition of growing pigs (as-fed basis)

Ingredient (%)	
Corn	64.25
Soybean meal (CP 44%)	26.63
Rice bran	5.00
Molasses	5.00
Animal fat	4.67
Defluorinated phosphate	1.55
Calcium carbonate	0.68
L-lysine·HCl	0.12
Salt	0.20
Vitamin and mineral premix[a]	0.06
Choline chloride	0.04
L-threonine	0.02
Chemical composition[b]	
ME (kcal/kg)	3,320
CP (%)	18.00
Lys (%)	1.00
Methionine (%)	0.28
Ca (%)	0.70
P (%)	0.60

[a] 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.
[b] All calculated values are based on NRC (1998) tabular values.

Table 3. The diet composition of finishing pigs (as-fed basis)

Ingredient (%)	
Corn	67.45
Soybean meal (CP 44%)	18.14
Rice bran	5.00
Molasses	5.00
Animal fat	2.00
Defluorinated phosphate	1.12
Calcium carbonate	0.68
L-lysine·HCl	0.20
Salt	0.15
Vitamin premix[a]	0.05
Mineral premix[b]	0.15
Choline chloride	0.04
L-threonine	0.02
Chemical composition[c]	
ME (kcal/kg)	3,350
CP (g/kg)	14.80
Lys (g/kg)	0. 89
Ca (g/kg)	0.74
P (g/kg)	0.54

[a] 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 μg of vitamin B_{12}; 11 mg of pantothenic acid; 20 mg of niacin and 0.02 mg of biotin.
[b] Provided per kg of complete diet: 220 mg of Cu; 175 mg of Fe; 191 mg of Zn; 89 mg of Mn; 0.3 mg of I; 0.5 mg of Co and 0.15 mg of Se.
[c] All calculated values are based on NRC (1998) tabular values.

dietary treatments, including: i) CON, basal diet; ii) DP, basal diet+1 g/kg date pits and iii) JH, basal diet+0.5 g/kg Japanese-honeysuckle; iv) HCT, basal diet+1 g/kg houttuynia cordata thunb and v) LE, basal diet+1 g/kg laquer tree extract. There were 6 pigs per pen, 5 replications per treatment. Each pen size was 0.6×1.2 m. The experiment lasted for 10 wks. The pigs were housed in a complete temperature and humidity controlled room and the initial room temperature was maintained at 30°C and decreased by 1°C each week of the experiment.

Experiment 2

Sixty growing-finishing pigs (average BW = 54.10±1.20 kg, average age = 54±3 d) were allotted into 1 of the 3 treatments: i) CON, basal diet; ii) YG basal diet+1 g/kg yellow ginger and iii) HR basal dietary+1 g/kg hoantchy root. There were 4 pigs per pen, 5 replications per treatment. The experiment lasted for 10 wks. Pigs were housed in a complete temperature and humidity controlled room. During the growing phase, pigs were housed by pens (1.2×1.6 m), and the temperature was kept at 26°C. when the finishing phase, Pen size were 1.8×1.8 m. And the room temperature was maintained at 22°C.

Sampling and measurements

Experiment 1 : During the experimental periods, individual body weight and feed consumption per pen were measured at the end of 5th and 10th week to monitor ADG, ADFI and gain:feed ratio (G/F).

For each piglet showing scours, diarrhoea was assessed visually and characterised, by the same person, according to the following scale as: 0 = normal faeces, 1 = pasty, 2 = liquid, 3 = with mucus and 4 = with blood. The daily diarrhoea score for each pen was calculated by multiplying each piglet by the previous characterization scale of diarrhoea, and the results for all piglets within a pen were then added together. Diarrhoea scores were calculated by day. The maximum theoretical diarrhoea score was 24 (6 pigs×scale 4 = 24).

Experiment 2 : The pigs and feeders were weighed at the beginning, the 5th wk and at 10th wk of the growth assay to allow calculation of ADG, ADFI and G/F.

For each pigs showing diarrhoea, the severity was assessed visually and characterized, by the same person, according to the following scale as: 0 = normal faeces, 1 = pasty, 2 = liquid, 3 = with mucus and 4 = with blood (Kyriakis et al., 1999). The total diarrhoea score on a pen basis was calculated as the sum of the number of piglets in the pen with diarrhoea multiplied by the days of observations and multiplied by the diarrhoea scale observed

in the majority of the pigs in the pen. Diarrhoea scores were calculated by day. The maximum theoretical diarrhoea score was 16 (4 pigs×scale 4 = 24).

Chromium oxide (Cr_2O_3) was added to each of the diet as an inert indicator (0.20%) to calculate the apparent total tract digestibility (ATTD) for dry matter (DM), nitrogen (N) and energy during each dietary phase. After the pigs were fed diet containing the indicator for 5 d, fresh fecal grab samples were obtained from 2 pigs (one barrow and one gilt) per pen. All fecal and feed samples from one pen were then pooled and mixed, after which a representative sample was stored in a freezer at -20°C until analysis. Prior to chemical analysis, the fecal samples were thawed and dried at 70°C for 72 h, after which they were finely ground to a size that could pass through a 1 mm sieve. All of the feed and fecal samples were then analyzed for DM and N following the procedures outlined by the AOAC (AOAC, 1995). Chromium was analyzed using UV absorption spectrophotometry (Shimadzu, UV-1201, Kyoto, Japan) and nitrogen was determined using a Kjeltec 2300 Analyzer (Foss Tecator AB, Hoeganaes, Sweden). Gross energy was determined by measuring the heat of combustion in the samples using a Parr 6100 oxygen bomb calorimeter (Parr instrument Co., Moline, IL, USA).

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 on 35 d, and the same pigs were sampled again on the final day of the experiment. White blood cell (WBC), red blood cell (RBC), and lymphocytes counts were analyzed using an automatic blood analyzer (ADVIA 120, Bayer Corp). The IgG was analyzed using nephelometry (Dade Behring, Marburg, Germany).

At the end of the trial, all of the pigs were transferred to the slaughterhouse and were treated with conventional procedures. Carcasses were chilled at 2°C for 24 h and a piece of the right loin was taken through a perpendicular cut between 10th and 11th ribs. Before the meat quality evaluation was performed, meat samples were thawed at ambient temperature. The color measurement of lightness (L*), redness (a*) and yellowness (b*) values were determined by Minolta CR410 chroma meter (Konica Minolta Sensing, Inc., Osaka, Japan). S he proportion of LM acceptable for Pork Composition and Quality Assessment Procedures (NPPC, 2000) was determined via the selection of LM with acceptable color, firmness, and marbling (all measures 3 or greater, based on a scale of 1 to 5, NPPC, 2000). At the same time, duplicate pH values of each sample were measured by pH meter (Pittsburgh, PA, USA). The water holding capacity (WHC) was measured according to the methods of Kauffman et al. (1986). In brief, 0.2 g sample was pressed at 3,000 psi for 3 min on 125-mm-diameter filter paper. The areas of the pressed sample and expressed moisture were delineated and then determined with a digitizing arealine sensor (MT-10S; M.T. Precision Co. Ltd., Tokyo, Japan). A ratio of water: meat areas was calculated, giving a measure of WHC (the smaller ratio indicate the higher the WHC). Longissimus muscle area (LMA) was measured by tracing the longissimus muscle surface at 10th rib, which also used the above-mentioned digitizing arealine sensor. Drip loss was measured using approximately 2 g of meat sample according to the plastic bag method, which was described by Honikel et al. (1998). The weight of each sample was taken before and after cooking to determine cooking loss, which was defined as the cooked weight divided by uncooked weight multiplied by 100.

Statistical analyses

All data were subjected to the GLM procedures of SAS (1996) as a randomized complete block design, with pen as the experimental unit. Differences among all treatments were separated by Duncan's multiple range test. The variability in the data was expressed as standard error (SE) Probability values less than 0.05 were considered significant.

RESULTS

Experiment 1

Growth performance : Effects of herbs on growth performance in weanling-growing pigs were shown in Table 4. Pigs fed JH, HCT and LE diets revealled a higher ($p< 0.05$) BW on wk 5 and wk 10 than pigs fed CON and JH diets. The ADG in JH, HCT and LE treatments was enhanced ($p<0.05$) compared with that in CON and DP treatments during weaning and growing period. On wk 5, pigs had a higher ($p<0.05$) ADFI in LE treatment compared with CON and DP treatments, besides pigs fed JH, HCT and LE diets had a higher ($p<0.05$) G/F ratio than pigs fed CON and DP diets. Furthermore, form wk 5 to 10, JH, HCT and LE treatment groups had a higher ($p<0.05$) ADFI compared with CON and DP treatment groups.

Appearance of diarrhea : Pigs fed diets with supplementations of herb additives had lower ($p<0.05$) score of diarrhea pigs during d 2 to d 6 compared with pigs fed CON diet (Table 5). On d 2 and 3, HCT and LE exhibited lower diarrhea score than DP and JH ($p<0.05$). No difference was found among herb additives groups on d 5 and 6 ($p>0.05$).

Experiment 2

Growth performance and Apparent total tract nutriment digestibility : Effects of herbs on growth performance in growing–finishing pigs were shown in Table 6. From wk 0

Table 4. Effect of anti-diarrhoeal herbs on growth performance, in weanling-growing pigs[1]

Items	CON	DP	JH	HCT	LE	SE[2]
Initial BW (kg)	7.17	7.34	7.21	7.33	7.19	0.13
5 w (kg)	24.26[b]	24.82[b]	28.29[a]	28.10[a]	29.20[a]	1.65
10 w (kg)	46.94[b]	47.25[b]	53.25[a]	52.36[a]	54.33[a]	2.14
0 to 5 w						
ADG (g)	488[b]	499[b]	602[a]	593[a]	629[a]	17
ADFI (g)	613[b]	658[b]	681[ab]	673[ab]	731[a]	53
G;F	0.796[b]	0.758[b]	0.884[a]	0.881[a]	0.861[a]	0.06
5 to 10 w						
ADG (g)	648[b]	641[b]	713[a]	693[a]	718[a]	38
ADFI (g)	1,436[b]	1,424[b]	1,562[a]	1,602[a]	1,549[a]	56
G:F	0.451	0.450	0.457	0.433	0.464	0.03
Overall						
ADG (g)	568[b]	570[b]	658[a]	643[a]	673[a]	25
ADFI (g)	1,025	1,041	1,122	1,138	1.140	51
G:F	0.554	0.548	0.587	0.565	0.590	0.07

[1] CON = Basal diet; DP = Nasal diet+1 g/kg date pit; JH = Basal diet+0.5 g/kg Japanese-honeysuckle; HCT = Basal diet+1 g/kg Houttuynia cordata thumb; LE = Basal diet+1 g/kg laquer tree extract.
[2] Standard error. [a,b] Means in the same row with different superscripts differ (p<0.05).

to 5, Dietary supplementation of YG and HR enhanced (p<0.05) ADG. Beside, no difference was found, between YG and HR treatments. During, wk 5 to 10, higher ADG also was observed in YG and HR treatments (p<0.05). Additional, YG had the highest ADG (p<0.05). There was always an increase on ADG in YG and HR (p<0.05) though all periods. There were no differences (p>0.05) observed on DM, N and energy digestibility among all treatments (Table 8).

Appearance of diarrhea : Effects of herbs on appearance of diarrhea in growing-finishing pigs were shown in Table 7. From d 0 to d 4, CON treatment had higher diarrhoeal score compared to others (p<0.05). The lowest diarrhea score were presented in HR treatment on d 1.

Blood characteristic : During all the experiment periods, there were no differences (p>0.05) observed on RBC, WBC, lymphocyte and IgG concentrations among all treatments (Table 9).

Meat quality : No differences were observed on meat color, sensory evaluation (color, firmness, marbling), drip loss, cooking loss, pH, water holding capacity (WHC) among all treatment groups (Table 10). However, pigs fed YG and HR diets had a higher (p<0.05) longissimusdorsi muscle area (LMA) than pigs fed CON diet.

Table 5. Effect of anti-diarrhoeal herbs on appearance of diarrhea in weanling-growing pigs[1]

Items	CON	DP	JH	HCT	LE	SE[2]
1 d	17.9	16.6	18.3	16.1	16.4	1.45
2 d	17.9[a]	8.5[b]	8.4[b]	4.1[c]	4.3[c]	0.87
3 d	11.2[a]	4.0[b]	4.1[b]	0.7[c]	0.6[c]	0.82
4 d	6.1[a]	0.8[b]	1.0[b]	0.6[b]	0[b]	0.60
5 d	1.3[a]	0.3[b]	0.2[b]	0.2[b]	0[b]	0.30
6 d	0.8[a]	0.2[b]	0[b]	0[b]	0[b]	0.37

[1] CON = Basal diet; DP = Basal diet+1 g/kg date pit; JH = Basal diet+0.5 g/kg Japanese-honeysuckle; HCT = Basal diet+1 g/kg Houttuynia cordata thumb; LE = Basal diet+1 g/kg laquer tree extract.
[2] Standard error.
[a,b,c] Means in the same row with different superscripts differ (p<0.05).

DISCUSSION

Growth performance and apparent total tract digestibility

Recently, some researchers have conducted to

Table 6. Effect of anti-diarrhoeal herbs on growth performance in growing-finishing pigs[1]

Items	CON	YG	HR	SE[2]
0 to 5 w				
ADG (g)	751[b]	837[a]	819[a]	12
ADFI (g)	1,972	2,107	2,075	58
G:F	0.381	0.397	0.395	0.01
5 to 10 w				
ADG (g)	858[b]	933[a]	914[ab]	22
ADFI (g)	2,372	2,564	2,531	79
G:F	0.362	0.365	0.361	0.01
Overall				
ADG (g)	805[b]	885[a]	867[a]	12
ADFI (g)	2,172	2,336	2,303	54
G:F	0.371	0.379	0.377	0.01

[1] CON = Basal diet; YG = Basal diet+1 g/kg yellow ginger; HR = Basal diet+1 g/kg hoantchy root.
[2] Standard error.
[a,b] Means in the same row with different superscripts differ (p<0.05).

Table 7. Effect of anti-diarrhoeal herbs on appearance of diarrhea in growing-finishing pigs[1]

Items	CON	YG	HR	SE[2]
1 d	8.6[a]	4.7[b]	0.7[c]	0.42
2 d	5.4[a]	2.1[b]	0.5[b]	0.77
3 d	1.7[a]	1.6[a]	0.3[b]	0.28
4 d	0.2[a]	0[b]	0[b]	0.12
5 d	0	0	0	0
6 d	0	0	0	0

[1] CON = Basal diet; YG = Basal diet+1 g/kg yellow ginger; HR = Basal diet+1 g/kg hoantchy root.
[2] Standard error.
[a,b,c] Means in the same row with different superscripts differ (p<0.05).

investigate the effect of the supplementation herbs (Young et al., 2003; Basmacioglu et al., 2004; Govaris et al., 2004; Giannenas et al., 2005; Kong et al., 2007). However, the results were inconsistent, even the same species herb appeared the distinct results. Such as, Al-Yousef and Lyons (1995) observed date pits in broiler starting diets at levels ranging from 5 to 27%, improved feed conversion. However, this study showed different results, no difference was observed through experimental period. Those different results may be due to the animal species. Relatively, the influence of different herbs on growth performance also presented different results. For instance, Janz et al. (2007) found that pigs preferred the feed supplemented with garlic or rosemary over the feed supplemented with oregano or ginger. Several experiments also showed the inconsistent impacts of the same anti-diarrhoeal herbs. For example, the study conducted by Chang et al. (2010) reported that inclusion of lacquer meal had no influences on growth performance of growing-finishing pigs at 20 and 40 g/kg diet which was different from our results. During post weanling phase, incomplete development of intestinal tracts caused it easier to be invaded by pathogens than finishing pigs. There was another possibility. Basal dietary ingredients comprised different substance that interacted with supplementation herbs.

As the development of anti-diarrhoeal herbs added in diets, we pay more attention on major bioactive compounds of herbs. For example, saponin that was one of major bioactive compounds of Japanese honeysuckle (Suh et al., 2005). In addition, Tong et al. (2004) reported that a natural extract known as saponins promoted growth performance in broiler chickens and weaning pigs, and the conclusion is in agreement with current results. Houttuynia cordata is a traditional medicinal plant that is used in herbal preparations in Asian countries to relieve inflammatory conditions (Jee et al., 2010). Flavonoid which exist Houttuynia cordata, exhibit a wide range of biological effects, such as anti-inflammatory, anti-allergic, anti-virus, anti-bacteriaand anti-oxidation (Jian et al., 1986). Flavonoid in soy genistein, at dietary concentrations of 200 to 400 ppm is an orally active immune modulator that enhances systemic serum virus elimination and body growth in

Table 8. Effect of anti-diarrhoeal herbs on digestibility nutriment in growing-finishing pigs[1]

Items (%)	CON	YG	HR	SE[2]
5 w				
DM	77.27	80.77	78.72	1.11
N	79.54	82.59	79.41	1.10
GE	76.56	76.22	77.35	1.08
10 w				
DM	74.54	75.79	76.06	1.33
N	75.33	77.96	73.49	1.71
GE	72.94	74.96	75.01	1.54

[1] CON = Basal diet; YG = Basal diet+1 g/kg yellow ginger; HR = Basal diet+1 g/kg hoantchy root.
[2] Standard error.

Table 9. Effect of anti-diarrhoeal herbs on blood characteristic in growing-finishing pigs[1]

Items	CON	YG	HR	SE[2]
5 w				
RBC (10^6/μl)	6.77	6.83	6.97	0.11
WBC (10^3/μl)	15.78	17.06	16.16	0.59
Lymphocyte (%)	64.65	62.33	65.17	1.64
IgG (g/dl)	969.7	988.2	984.2	43.98
10 w				
RBC (10^6/μl)	7.23	7.32	7.46	0.07
WBC (10^3/μl)	17.81	17.19	17.68	0.43
Lymphocyte (%)	66.49	65.20	64.03	1.24
IgG (g/dl)	1,003.3	1,051.3	1,014.7	15.66

[1] CON = Basal diet; YG = Basal diet+1 g/kg yellow ginger; HR = Basal diet+1 g/kg hoantchy root.
[2] Standard error.

Table 10. Effect of anti-diarrhoeal herbs on meat quality in growing-finishing pigs[1]

Items	CON	YG	HR	SE[2]
CIE				
L*	57.71	58.44	57.33	0.811
a*	17.35	17.49	17.78	0.337
b*	8.22	8.29	8.35	0.390
Sensory evaluation				
Color	3.25	3.31	3.25	0.108
Firmness	3.06	3.13	3.19	0.096
Marbling	3.13	3.25	3.19	0.130
Drip loss (%)	7.27	7.20	7.33	0.442
Cooking loss (%)	27.17	26.72	27.30	0.973
pH	6.05	6.04	6.07	0.017
Water holding capacity (%)	54.81	55.90	54.56	1.349
LMA (cm^2)	48.06[b]	49.81[a]	49.65[a]	0.384

[1] CON = Basal diet; YG = Basal diet+1 g/kg yellow ginger; HR = Basal diet+1 g/kg hoantchy root.
[2] Standard error.
[a,b] Means in the same row with different superscripts differ (p<0.05).

virally challenged pigs (Greine et al., 2001). In this study, houttuynia cordata thumb was beneficial for growth performance, especially during 0 to 5 wks. It indicated flavonoid was able to promoted growth performance by ensuring a well ecosystem of gastrointestinal microbitota. Those trials also illuminated bioactive ingredient determinated herbs' property. However, the interaction of different bioactive ingredients leaded to diverse influences generally. To our knowledge specific mechanisms were unclean, further experiments were always requisite.

Compare the influence of the four kinds of herbs in current experiment on growth performance in weanling-growing pigs, no difference was found except DP. This finding was suggested that JH, HCT, LE might be growth promotor. Additionally, it confirmed previous conclusion that herbs had an ability to enhance growth performance (Guo et al., 2004; Namkung et al., 2004; Kong et al., 2007). However, the appropriate quantity and functional mechanism of those herbs were indistinct. Thereby, our study laid a foundation for the further experiments to utilize anti-diarrhoeal herbs supplementation in pigs.

Although both of yellow ginger and hoantchy root are regarded as Chinese traditional medicine to anti-inflammatory, increasing appetite for a long time, there has been little research on them as a feed additive to growing-finishing pigs. Janz et al. (2007) reported that the essential oils (500 mg/kg) from ginger had no effect on growth performance and dressing percentage of finisher pigs. In contrast, the current study presented different results. It's indicated unpurified extracts contain a number of different molecules extracted with certain solvent, which can affect the action of each other. In current observation, hoantchy root affected growth performance. It probably resulted from that hoantchy root were against gram-positive bacteria (Joseph, 1956). It guaranteed healthy gastrointestinal tracts to accelerate a well growth performance. Unclear specific mechanism, and no more study to be compared, further studies are needed to determine the effects.

In additions, herbs enhanced the intestinal tract health which could lead to the improving nutriment digestibility, Wang et al. (2007) found that supplemental herb mainly included *Zizyphi spinosae* (Spina Date Seed) 10%, pollen pini 5% treatments on pigs yielded better digestibility of DM and N at 4 wks. However, the current study appeared results, that herbs not affected apparent digestibility of DM, N. Manzanilla et al. (2006) got a similar result with us. Avilamycin improved feed efficiency in spite of a lower total tract digestibility of DM. Indeed, some experiments had revealed the effects of herbs on digestibility were not significant (Ao et al., 2011). It is probably a consequence that herbs accelerate the digestion and shorten the time of feed passage through the digestive tract (Platel et al., 2001; Suresh and srinivasan, 2007). Many results are inconsistent and controversial, further experiments are in requirement.

Appearance of diarrhea

In current study, except date pits, no difference was found on the effects of anti-diarrhoeal. The other herbs included Japanese-honeysuckle, houttuynia cordata Thumb, laquer tree extract, yellow ginger and hoantchy root which were documented owning the antioxidant, antimicrobial or anti-diarrhoeal property (Chen et al., 2003; Joshua et al, 2005; Irena et al., 2008; Zhang et al., 2009; Kim et al., 2010). Besides, antioxidant, prevent the villus cells shedding to keep villus height, in order to protecting intestinal integrality, enhancing resistance, reducing appearance of diarrhea (Sies, 1991). As we known, *Escherichia coli*, which adhere to the small intestinal microvilli and produce enterotoxins that act locally on enterocytes (Mackinnon, 1998) play an important role against diarrhea. Nevertheless, antimicrobial ability limited the proliferation of *E. coli* (Cutter et al., 2000). Pasqua et al. (2006) found a change in long chain fatty acid profile in the membranes of *E. coli* grown in the presence of limonene or cinnamaldehyde. It was consistent with current study that supplementation of herbs decreased the appearance of diarrhea significant. As for date pits, it may be caused by dietary fibre, which regulate intestinal peristalsis, promote comfortable digestion. Or functional components selenium that presented in date pits can be used as antidiarrhea (thus antic-arcinogenic) in human therapeutics (Pszczola et al., 1998).

Blood characteristic

The study of Kazeem et al. (2011) found the basal diet added ginger at the levels 2.5%, 5%, 10% respectively, were inability to influence WBC, RBC, and lymphocyte in rats. The current study was agreement with this result. No difference in WBC, RBC and lymphocyte were observed in YG and HR treatments compared with control treatment. In contrast, Kong et al. (2007) reported that dietary supplementation with Chinese herbal ultra-fine powder enhanced serum concentrations of IL-2, IL-6, TNF-α, IgG, IgM and lymphocytes in early-weaned piglets. Anna et al. (2009) reported herbs can increase the amounts of RBC and lymphocyte, and decrease WBC's amounts. It implicated a better metabolization and immunity. Leea et al. (2007) confirmed this consequence, whose study displayed methanol extracts of dandelion root was able to increase the amounts of lymphocyte in chicken. However, basal diet with YG (yellow ginger), HR (hoantchy root) didn't differ in the WBC, RBC and lymphocyte with control group. Flavones that were bioactive substance of YG and HR had been documented that were unable to affect the amounts of WBC and lymphocyte in rats supplemented at 2.5, 5, 10 levels (Kazeem et al., 2011). However, the study have been

conducted by Greiner (2001), which revealed flavones in soy genistein could improve the biological response of animals to pathogens and vaccines. It may be related to capacity to affect intercellular signaling of immune cells and the ability to arrest the virus to replicate or attach. However, to the best of our knowledge, limited scientific information is available to justify reputed utilization of yellow ginger and hoantchy in swine diet.

Meat quality

Organic farming systems, which have been invested by The European Union, use no chemical products both on the crop or phytogenic feed on the animals. The one of all reasons was that phytogenic feed or additives could improve meat quality (Morbidini et al., 2001). Such as, the experiment was conducted by Ao et al. (2011) indicated that red ginseng can increase LMA, enhance WHC, decrease drip loss at supplementation at the level 1, 2, 4 g/kg fermented red ginseng. Similarly, yellow ginger was capable of affecting meat quality by different ways. Such as ginger at level of 0.5% which was used for improving meat quality by post-slaughter handling appeared to be the optimum level to achieve the best tenderization effect (Naveena, 2004). However, Janz et al. (2007) didn't believe that it improved meat quality by adding ginger into diets barely. In current study, there is no difference between the treatment group of FH1, FH2 and control group, except LMA. LMA can reflect the ratio of lean meat indirectly. The influence of herbs on fat metabolism that had been demonstrated it could depress the hepatic activities of lipogenic and cholesterogenic enzyme (Stephen et al., 1993). As to bioactive ingredients, the both of yellow ginger and hoantchy root comprised flavones, the property of which can increase the concentration of HDL (high-density lipoprotein) (Wei et al., 2008). Additionally, there was a negative relationship between triglycerides and HDL in plasma. Consequently, flavones decreased triglycerides in according to influence lipid's metabolism.

In conclusion, supplementation of anti- diarrhoeal herbs in pig diets can prevent diarrhea of pigs, improve growth performance in pigs and increased LMA of finishing pigs.

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