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Short communication

Effects of levan supplementation on growth performance, nutrient digestibility and fecal dry matter content in comparison to apramycin (antibacterial growth promoter) in weanling pigs

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ABSTRACT

A total of 144 weanling pigs (18 ± 1 d of age) with an average BW of 5.48 ± 0.65 kg were used in a 28-d trial to evaluate the effects of dietary levan supplementation on growth performance, nutrient digestibility and fecal dry matter content in comparison to apramycin (antibacterial growth promoter) in weanling pigs. Pigs were randomly allocated into four treatments with two levels of apramycin (0 or 165 mg/kg) and two levels of levan (0 or 1 g/kg). There were six replications per treatment with six pigs per pen (three barrows and three gilts). Diets were fed in two phases: phase 1 (from d 0 to 14) and phase 2 (from d 15 to 28). Administration of either levan or apramycin improved ($P < 0.05$) average daily gain (ADG) during phase 1 and overall. Pigs fed apramycin had greater ($P < 0.05$) ADG and gain:feed ratio than pigs fed other diets in phase 2. In addition, the apparent total tract digestibility of dry matter, nitrogen and gross energy was increased ($P < 0.05$) in response to either levan or apramycin treatments during phase 1. Apramycin administration decreased ($P < 0.05$) fecal DM content from d 0 to 14, whereas levan decreased ($P < 0.05$) fecal DM content from d 15 to 28. The results of the current study indicated that levan had some growth promoting effects similar to antibiotics in weanling pigs.

1. Introduction

Due to the ban on the in-feed use of antibiotics in European and other parts of the world, several studies have demonstrated the beneficial effects of oligosaccharides on growth performance and intestinal bacteria balance in weanling pigs (Lemieux and Bidner, 2003; Rozeboom et al., 2005). However, the growth promoting effects of oligosaccharides are inconsistent in some studies (Houdijk et al., 1998; Mikkelsen et al., 2003).

Fructans are widely used as prebiotics to modulate the intestinal microbial balance and immunity in humans (Rhee et al., 2002). As one form of fructan, levan represents a mixture of oligosaccharides, which has a greater molecular weight (700–10,000 kDa) than that of inulin (4–20 kDa). Kang et al. (2005) reported that levan might have greater water solubility and modulatory activity on the lumen microbiota than inulin. Dietary supplementation of levan resulted in improved performance and nutrient digestition in broilers and growing-finishing pigs (Li and Kim, 2013; Zhao et al., 2013a; Zhao et al., 2013b) However, there is scarce information on the effect of levan on performance in weanling pigs.

Therefore, this study was conducted to determine the effects of levan supplementation on growth performance, nutrient digestibility and fecal dry matter (DM) content in comparison to apramycin in weanling pigs.

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2. Materials and methods

2.1. Preparation of levan

Levan was provided by RealBioTech Co. (Daejeon, South Korea). In brief, the sucrose medium was treated via enzyme reactions using levan–sucrase from *Zymomonas mobilis*. 5% Levan solution was mixed with 0.4 M sulfuric acid for 3 min at 95 °C, and the high-molecular weight levan was precipitated via the addition of five volumes of ethanol followed by a centrifugation step (7500*g*, 10 min). The supernatants were extracted, concentrated with a rotary evaporator at 60 °C, then applied to a glass column (3×50 cm^2) containing silica gel. The levanoligosaccharides were eluted using chloroformethanol–water (3/3/2, v/v/v). The levan samples were then collected, freeze-dried, and stored at −70 °C. The molecular weight of levan was an average of 700 kDa.

2.2. Experimental design, animals and diets

A total of 144 weanling pigs (weaned at 18 ± 1 d of age) [(Yorkshire × Landrace) × (Hampshire × Duroc)] with an average body weight (BW) of 5.48 ± 0.65 kg were randomly assigned into 24 pens (three barrows and three gilts) in a 28-d experiment. There were four dietary treatments with two levels of levan (0 or 1 g/kg) and two levels of apramycin (0 or 165 mg/kg). Diets (phase 1 from d 0 to 14 and phase 2 from d 15 to 28) were formulated to provide nutrients to meet or exceed NRC (1998) requirements (Table 1). Pigs had free access to mashed feed and water throughout the trial. The Animal Welfare Committee of Dankook University approved the animal care protocol used for this study.

2.3. Sampling and measurements

Individual BW and feed consumption per pen were monitored on d 14 and 28 to determine ADG, average daily feed intake (ADFI) and gain:feed ratio (*G*:*F*). From d 8 to 14 and d 22 to 28, chromic oxide (2 g/kg) was added to the diets as an indigestible marker for the determination of the apparent total tract digestibility (ATTD) of DM, nitrogen (N) and gross energy. On d 14 and 28, fecal samples were collected from at least two pigs in each pen in the afternoon (six samples per treatment) via rectal massage and pooled within pen. For chemical analysis, fecal samples and feed samples were thawed, sub-samples were collected, freeze-dried and ground to pass through a 1-mm screen. Dietary DM, N, calcium, phosphorus, crude protein, crude fiber, lysine and methionine were analyzed according to the procedures described by the AOAC (1995). The ATTD of DM, N and gross energy were calculated using indirect methods as described by Zhao et al. (2012).

Fresh fecal samples were collected from 12 piglets of each experimental group (one barrow and one gilt per pen) daily in the afternoon throughout the experiment. Fecal moisture was determined by air-drying the collected subsamples at 60 °C, followed by equilibration at 105 °C (Harris, 1970).

Table 1
Composition of the basal diets (as-fed basis).

Item	Phase 1 (d 0–14)	Phase 2 (d 15–28)
Ingredients, g/kg		
Expanded maize	66.5	357.2
Expanded oat	100.0	–
Biscuit meal[a]	–	50.0
Soybean meal, 440 g CP/kg	80.0	200.0
Fermented soybean meal, 540 g CP/kg	78.0	82.0
Fish meal, 620 g CP/kg	50.0	40.0
Soy oil	41.5	48.0
Lactose	100.0	60.0
Dried whey	165.0	100.0
Milk product	130.0	20.0
Lecithin	5.0	–
Monocalcium phosphate	12.5	10.0
Glucose	50.0	–
Sucrose	40.0	20.0
Plasma powder	65.0	–
L-Lys-HCl, 780 g/kg	1.2	2.5
DL-Met, 500 g/kg	2.6	1.5
L-Thr, 890 g/kg	7.7	0.8
Choline chloride, 250 g/kg	2.0	1.0
Vitamin premix[b]	1.0	1.0
Mineral premix[c]	2.0	2.0
Limestone	–	2.0
Salt	–	2.0
Calculated composition		
ME, MJ/kg	14.8	14.8
Analyzed composition, g/kg		
CP	226.3	226.7
Crude fiber	32.1	33.4
Lys	16.5	16.3
Met	6.2	6.2
Ca	8.1	8.1
P	7.8	7.9

[a] Contained 210 g fat/kg and 220 g protein/kg.
[b] Provided per kg of complete diet: vitamin A, 11,025 IU; vitamin D_3, 1103 IU; vitamin E, 44 IU; vitamin K, 4.4 mg; riboflavin, 8.3 mg; niacin, 50 mg; thiamine, D-pantothenic acid, 29 mg; choline, 166 mg; and vitamin B_{12}, 33 μg.
[c] Provided per kg of complete diet: Fe (as $FeSO_4 \cdot 7H_2O$), 80 mg; Cu (as $CuSO_4 \cdot 5H_2O$),12 mg; Zn (as $ZnSO_4$), 100 mg; Mn (as MnO_2), 8 mg; I (as KI), 0.28 mg; Se (as $Na_2SeO_3 \cdot 5H_2O$), 0.15 mg.

2.4. Statistical analyses

All data were analyzed by ANOVA (SAS Inst. Inc., Cary, NC, US) using a 2×2 factorial arrangement of treatments with the pen being considered as the experimental unit. The main effects of the apramycin, levan, as well as their interaction were included in the model. Variability in the data is expressed as the standard error means (SEM) and alpha level used for determination of significance was 0.05.

3. Results and discussion

Mortality was zero during the experiment (data not shown). No interactive effects between levan and apramycin were observed. Therefore, only the main effects of levan and apramycin are presented in the tables.

From d 0 to 14, pigs fed the diets supplemented with levan and apramycin had greater ADG ($P < 0.05$) than those fed the diets with no supplementations (Table 2).