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RESEARCH ARTICLE

Effects of conditioners (single-layer, double-layer and retention-conditioner) on the growth performance, meat quality and intestinal morphology of growing and finishing pigs

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Abstract

This experiment was conducted to investigate the effects of feed conditioners (single-layer, double-layer and retention-conditioner) on the growth performance, meat quality and intestinal morphology of pigs throughout the growing to finishing phase. A total of 96 growing pigs ((28.70±3.20) kg) were selected and randomized into three treatment groups with four replicates per group. Eight pigs were used per replicate for the 17-week feeding trial. The grower diet was given at 0 to 6 weeks and a finisher diet was given at 6 to 17 weeks. The treatments were as follows: SC diet (control; single-layer conditioning), DC diet (double-layer conditioning), and RC diet (retention-conditioning). Starch gelatinization was significantly higher (P<0.05) in the RC treatment than in the SC treatment, however, there was no significant difference in the starch gelatinization between the DC group and the RC group. In the growing phase, the feed to gain index (F:G) was significantly lower (P<0.05) in the RC group than in the SC and DC groups. Between growing and finishing, the F:G was the lowest (P<0.05) in the SC group compared to the RC or DC group. Drip loss, a measurement of meat quality, was significantly lower (P<0.05) in *longissimus dorsi* tissue collected from pigs fed the RC diet than in tissues collected from pigs fed the SC diet. The intestinal quality of the duodenum and jejunum tissues showed a significant increase (P<0.05) in the crypt depth and villus height in the RC group compared to the SC- or DC-treated pigs. These results demonstrated that the retention-conditioner treatment decreased the F:G in growing pigs, improved intestinal morphology and enhanced the meat quality in the finishing pigs. However, the retention-conditioner treatment had a negative impact on growth performance in the finishing pigs.

Keywords: pigs, conditioner, feed quality, meat quality, intestinal morphology

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1. Introduction

Livestock diet preparation has evolved from a simple "grind and mix" feed to more advanced hydro-thermal processes, such as pelleting, expanding, and even extruding feeds prior to animal consumption (Lundblad *et al*. 2011b). Traditional feed processing technology includes receiving, grinding, batching, mixing, conditioning, pelleting, and packaging procedures. These practices are most commonly used for diet preparation in farrow-to-finish pig operations (Boroojeni *et al*. 2016). Of these measures, the conditioning step is crucial to the feed grade value as it provides time for steam or liquids to be absorbed in the pellets as well as promotes uniformity of the feed. The manner in which the materials are conditioned plays a large role in determining the durability of the feed pellets (Zimonja and Svihus 2009). High temperature conditioning or long-term conditioning has been shown to greatly improve pellet quality (Lundblad *et al*. 2009). A recent study investigated the effects of various feed processing techniques on pig growth performance and nutritional digestibility. It found that heat processing of the cereal improved digestibility and growth rate only during the first 10 days post-weaning while pelleting the diet improved digestibility and feed conversion but not growth rate (Medel *et al*. 2004). Another study indicated that efficient extrusion processing, utilizing larger particles from milled grains and recombining with finer ground grains, improved energy utilization in monogastric feeds (Al-Rabadi *et al*. 2011). Furthermore, numerous research studies have explored the effect of hydro-thermal processing on feed quality or growth performance of young piglets (Vanschoubroek *et al*. 1971; van der Poel *et al*. 1990; Vranjes *et al*. 1994; Lundblad *et al*. 2009; Zimonja and Svihus 2009). However, studies are seldom to take concern to the effects of various hydro-thermal conditioner preparations on meat quality of finishing pigs.

In this study, feed underwent hydro-thermal conditioning with different conditioners prior to pig consumption. We hypothesized that the pigs fed diets that endured longer retention-conditioner processing will have a greater growth performance than pigs fed traditionally processed feed with a single-layer conditioner treatment. To test our hypothesis, feeds were created using different hydro-thermal methods and fed to pigs throughout the growing phase (0 to 6 weeks) and into the finishing phase (6 to 17 weeks). The different feed effects on growth performance, meat quality, and intestinal morphology were investigated.

2. Materials and methods

This study was approved by the Animal Welfare and Animal Experimental Ethical Inspection Committee of Feed Research Institute, Chinese Academy of Agricultural Sciences (Beijing, China).

2.1. Diets and hydro-thermal conditioning treatments

Two diets both based on corn, soybean meal, cottonseed meal, and wheat bran were formulated to meet or exceed NRC (2012) requirements for pigs (grower and finisher). Grower diet was used during the growing phase (0 to 6 weeks) and finisher diet was used during the finishing phase (6 to 17 weeks). Although diets were comprised of the same constituents, the diets differed in final ingredient and chemical composition percentages (Table 1).

Macro materials, including corn, soybean meal, cottonseed meal, and wheat bran, were ground to a mean particle size of 535 μm through a 2.0-mm screen and mixed with vitamins as well as other ingredients in three separate batches prior to further processing. The treatments were: (1) single-layer conditioner (85°C for 12 s before pelleting,

Table 1 Experimental diet ingredients and chemical compositions (air-dry basis)

Item	Grower diet (0 to 6 weeks)	Finisher diet (6 to 17 weeks)
Ingredients (%, as-fed basis)		
Corn	63.30	59.30
Soybean meal	20.10	11.00
Cottonseed meal	1.00	2.30
Wheat bran	6.00	15.77
Maize germ meal	6.00	–
DDGS[1)]	–	7.50
Soybean oil	0.50	1.00
Calcium hydrophosphate	0.40	0.20
Mountain flour	1.00	1.20
Calcium bicarbonate	–	0.10
Salt	0.30	0.30
1% compound premix[2)]	1.00	1.00
L-Lys	0.20	0.26
DL-Met	0.07	–
L-Thr	0.13	0.07
Chemical composition (%, as-fed basis)[3)]		
Digestible energy (kcal kg^{-1})	3 542	3 442
Crude protein	17.90	15.90
Calcium	0.73	0.73
Total phosphorus	0.55	0.45
Lys	0.90	0.89
Met+Cys	0.64	0.58

[1)] DDGS, distillers dried grains with solubles.
[2)] Premix provides the following per kg of diet: For grower, vitamin A (retinyl acetate) 6 312 IU; vitamin D_3 (cholecalciferol) 2 600 IU, vitamin E (DL-a-tocopheryl acetate) 35 IU; vitamin K_3 (menadione sodium bisulphite) 4 mg; vitamin B_1 (thiamin mononitrate) 2.8 mg; vitamin B_2 (riboflavin) 5 mg; vitamin B_6 (pyridoxine hydrochloride) 4 mg; vitamin B_{12} (cyanocobalamin) 28.1 μg; nicotinic acid 40 mg; folacin 1.1 mg; D-pantothenic acid 14 mg; biotin 44 μg; choline 400 mg; Cu ($CuSO_4 \cdot 5H_2O$) 100 mg; Fe ($FeSO_4 \cdot H_2O$) 80 mg; Zn (ZnO) 75 mg; Mn (MnO) 40 mg; I (CaI_2) 0.3 mg; Se (Na_2SeO_3) 0.3 mg. For finisher, vitamin A (retinyl acetate) 5 612 IU; vitamin D_3 (cholecalciferol) 2 250 IU; vitamin E (DL-a-tocopheryl acetate) 21 IU; vitamin K_3 (menadione sodium bisulphite) 4 mg; vitamin B_1 2.8 mg; vitamin B_2 5 mg; vitamin B_6 (pyridoxine hydrochloride) 3 mg; vitamin B_{12} (cyanocobalamin) 21 μg; nicotinic acid 40 mg; folacin 1.1 mg; D-pantothenic acid 14 mg; biotin 62 μg; choline 360 mg; Cu ($CuSO_4 \cdot 5H_2O$) 76 mg; Fe ($FeSO_4 \cdot H_2O$) 60 mg; Zn (ZnO) 50 mg; Mn (MnO) 20 mg; I (CaI_2) 0.3 mg; Se (Na_2SeO_3) 0.3 mg.
[3)] Crude protein is a measured value while the other values were calculated.
–, the raw material was not added in this recipe.