Effects of valine and isoleucine supplementation in the antibiotic-free diet on piglets

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Abstract

This study investigated the effects of valine (Val) and isoleucine (Ile) supplementation in the antibiotic-free diet on piglets. One hundred and eighty 40-day-old piglets were randomly assigned to 3 groups with 6 replicates of 10 heads each. Piglets were fed three different diets: high protein diet with antibiotics (Val:Lys=52% and Ile:Lys=42%), low protein diet without antibiotics (Val:Lys=52% and Ile:Lys=42%), and low protein diet without antibiotics (Val:Lys=70% and Ile:Lys=55%) for 21 days. The results showed that supplementation of valine and isoleucine in the antibiotic-free low-protein diet was more effective, which increased feed intake while reducing diarrhea rate.

Key words: valine, isoleucine, antibiotic-free, piglets

Introduction

On July 1, 2020, China officially implemented the policy on banning the use of antibiotic growth-promoting (AGP) additives in feed. The swine industry immediately searched for alternatives to antibiotics (Shao, 2020; Zhang, 2019). This paper documented the experiment conducted by a commercial swine farm in China, where an alternative approach to remove the in-feed antibiotics and establish an antibiotic-free feed formulation was designed. The diets used in this study include a combination of acidulants, essential oils, and probiotics to replace in-feed antibiotics with simultaneous crude protein reduction in the diet while maintaining the recommended ratios of amino acids to reduce diarrhea incidence and improve the growth performance of piglets.

Materials and methods

Experimental Design, Diets, and Husbandry

A total of one hundred and eighty (180) 40-day old weaning piglets of Duroc × Landrace × Yorkshire breeds with uniform body conditions, similar birth dates, and an average weight of 10.75 kg were selected and divided into three treatments: Group A, Group B, and Group C. Each treatment was replicated 6 times with a pen of 10 piglets per replicate. The feeding period lasted for 21 days. Piglets in Group C were fed the basal diet with antibiotics and with 52% and 42% SID Val:Lys and SID Ile:Lys, respectively. On the other hand, the piglets in Group A , were fed with the basal diet supplemented with acidulants, probiotics, and essential oils and no antibiotic was added. The crude protein content was also reduced by 1% as compared to Group C while the ratios of lysine, methionine, threonine, and tryptophan were balanced. The diet composition of Group B was almost the same as Group A except with the added supplementation of valine and isoleucine yielding a ratio of 70% and 55% SID Val:Lys and SID Ile:Lys, respectively. The summary of treatment diets was shown in Table 1.

Table 1. Composition and nutrient content of the experimental diets (as-fed basis)

Component, g/kg	Group A	Group B	Group C
Corn	431.08	425.54	450
Extruded corn	150	150	150
Soybean meal	114	110	156.2
Extruded soybean	125	131	50
Fermented soybean meal	35	35	50
Whey powder	25	25	25
Fish meal			20
Fish meal substitute	20	20	
Essential oil	0.15	0.15	
Probiotics	0.03	0.03	
Composite antibiotics			5
Benzoic acid	5	5	
Citric acid	2	2	
L-Lysine·HCl	4.5	4.5	5.2
DL-Methionine	2	2	1
L-Threonine hydrochloride	1.9	1.9	1.35
L-Tryptophan	0.64	0.65	0.6
L-Valine		2	
L- Isoleucine		1.53	
Antioxidant	0.3	0.3	0.35
Antiseptic	0.8	0.8	0.8
Choline chloride	0.7	0.7	1.4
Zinc oxide	2	2	2
Limestone	7.5	7.5	7.5
Dicalcium phosphate	8.8	8.8	10
Sodium chloride	3.3	3.3	3.3
Glucose	5	5	
Fat powder	25	25	25
Granulated sugar	20	20	25
Phytase	0.3	0.3	0.3
Premix	10	10	10
Total	1000	1000	1000
Nutrient composition, %	**Group A**	**Group B**	**Group C**
Net energy, MJ/kg	10.66	10.66	10.31
CP	17.5	17.5	18.5
EE	6.2	6.2	5
Ca	0.65	0.65	0.68
Total P	0.52	0.52	0.54
Available P	0.31	0.31	0.33
Total Lys	1.25	1.25	1.25
Total Met+Cys	0.72	0.72	0.72
Total Thr	0.81	0.81	0.81
Total Trp	0.25	0.25	0.25
Total Val	0.65	0.88	0.65
Total Ile	0.52	0.69	0.52
Val/Lys	52	70	52
Ile/Lys	42	55	42

Growth Performance Determination

The piglets were weighed at d 1 and 21 d of the experiment, and consumed feed was recorded daily to determine the average daily feed intake (ADFI), average daily gain (ADG), and feed conversion ratio (FCR; feed: gain, g: g). Diarrhea rate was recorded daily.

Results

The ADFI of piglets in Group B was the highest at 663.41 g/head, which is 59.3g higher than that of Group A, corresponding to an increase of 9.81% as shown in the summary of results in Table 2. The diarrhea rate of Group A was the highest at 10.79%, while the piglets in Group B had the lowest diarrhea rate at 5.4%, and the antibiotic Group C had a diarrhea rate at 7.05%. In terms of daily weight gain, the piglets in Group C had performed the most with an ADG of 428g, and Group A was the lowest at 374g, corresponding to a difference of 54g/d. However, the ADG of Group B whose diet was supplemented with valine and isoleucine recovered, showing the importance of supplementing the branched-chain amino acids for growth performance when piglets are fed with low-protein antibiotic-free diets.

Table 2. Effects of different diets on growth performance of piglets

Indices	Group A	Group B	Group C
40 d BW (kg)	10.74	10.79	10.67
61 d BW (kg)	18.6	19.43	19.66
ADFI (g), 40 - 52 d	511.94	538.61	558.06
ADFI (g), 53 - 61 d	727.04	829.81	759.13
ADFI (g), 40 - 61 d	**604.13**	**663.41**	**644.23**
ADG (g) , 40 - 61 d	**374**	**412**	**428**
FCR (g feed/g gain) , 40 - 61 d	**1.62**	**1.61**	**1.55**
Diarrhea rate (%), 40 - 52 d	7.92	4.44	5.56
Diarrhea rate (%), 53 - 61 d	14.63	6.67	9.04
Diarrhea rate (%), 40 - 61 d	**10.79**	**5.4**	**7.05**

Discussion

The ADFI of Group B was higher than that of Group C at the later stage of the trial, while the difference in the ADFI between Group A and Group C was also narrowing. The overall reason may be that the gastric acid secretion of piglets was insufficient in the early post-weaning period, which became normal only 4-5 weeks after weaning. As such, the feed intake of weaned piglets could be increased by supplementing acidulant (Risley, 1992; Liu, 2019). In this trial, the total amount of acidulant (Benzoic acid + Citric acid) in both Group A and Group B was 7 kg, which was higher than the 5 kg of Group C. On the other hand, when piglets were fed the antibiotic-free diet, the intestinal microflora made certain changes to the antibiotic-free environment. The acidulants and essentials oils contributed to the effect positive effects of the treatment diets which help inhibit the pathogenic micro-organisms. The increase in population of beneficial microorganisms like Bifidobacterium and Lactobacillus and the decrease of Salmonella led to an overall improvement on the status of piglet's gut microflora (Leng, 2002). The vital activity of the intestinal flora requires energy, which can only be obtained from the feed ingested by the piglets, and endogenous consumption may be increased in this case. This may account for the increase in feed intake and overall FCR later in the trial. From the viewpoint of the entire trial period, Group C still performed the best among the other treatments but reducing CP with increased BCAA levels and supplementation of acids and essential oils is a good start to totally eliminate the use of antibiotics in feed without sacrificing animals' performance.

Conclusions

When reducing crude protein in piglets' diet to control diarrhea without antibiotic supplementation, attention needs to be given to valine and isoleucine ratios relative to lysine while maintaining the balance of other essential amino acids to prevent the negative effects on growth performance.

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