Livestock Science 171 (2015) 20–27

Contents lists available at ScienceDirect

Livestock Science

journal homepage: www.elsevier.com/locate/livsci

Dietary supplementation with yeast product improves intestinal function, and serum and ileal amino acid contents in weaned piglets

Xia Xiong[a], Huansheng Yang*, Biao Li[b], Gang Liu[a], Ruilin Huang[a], Fengna Li[a], Peng Liao[a], Yuzhe Zhang*, Charles Martin Nyachoti[c], Dun Deng*

[a] Observation and Experiment Station of Animal Nutrition and Feed Science in South-Central China, Ministry of Agriculture, Changsha City, Hunan 410125, PR China

[b] Hunan Provincial Engineering Research Center for Healthy Livestock and Poultry Production, Changsha City, Hunan 410125, PR China

[c] Key Laboratory of Agro-ecological Processes in Subtropical Region, Institute of Subtropical Agriculture, Chinese Academy of Sciences, Changsha City, Hunan 410125, PR China

ARTICLE INFO

Article history:
Received 12 May 2014
Received in revised form
10 October 2014
Accepted 12 October 2014

Keywords:
Yeast product
Piglet
Weaning
Intestine
Amino acids

ABSTRACT

Weaning is associated with impairments in intestinal and immune function, and dietary supplementation with yeast products can improve the intestine mucosal structure and stimulate the immune system of weaned piglets. The present study was conducted to test the hypothesis that dietary supplementation with yeast product may regulate immunoglobulin production by improving intestinal function and nutrient levels in weaned piglets. Eighteen piglets weaned at 21 days of age were randomly assigned to receive 1 of 3 treatments consisting of a basal diet (control), the basal diet supplemented with 1.2 g/kg of yeast product (yeast product) or the basal diet supplemented with 20 mg/kg of colistin sulphate (antibiotic) for 14 days. Dietary yeast product or antibiotic supplementation enhanced ($P<0.05$) duodenal and ileal mucosal sIgA as well as serum total protein, IgG, and IgM contents in weaned piglets. Piglets that were fed a diet that contained yeast product had greater ($P<0.05$) serum Ile, Leu, Phe, and Pro contents than control piglets. The contents of Arg, His, Leu, Lys, Trp, Val, Ser, Glu, Gln, and Pro in the ileal mucosa of weaned piglets were also increased ($P<0.05$) when yeast products were included in the diet. Consistent with the increases in amino acid (AA) contents, the activity of alkaline phosphatase and the expression of AA transporters were both increased ($P<0.05$) in the ileum of piglets that were fed a diet that contained yeast product. These findings indicate that yeast product may enhance immunoglobulin production by improving intestinal function and the levels of nutrients in weaned piglets, which suggests that yeast product might be an alternative to the use of antibiotics in diets for weaning piglets.

1. Introduction

Weaning is a crucial stage for piglets because they must rapidly adapt to dramatic changes in their physical and social environments, including a change from milk to solid-based diet, separation from the sow and littermates, and relocation and commingling with unfamiliar piglets (Tang et al., 2005; Moeser et al., 2007; van Beers-Schreurs et al., 1998; Yin et al.,

* Corresponding authors: Tel.: +86 731 8461 9703; fax: +86 731 8461 2685.
E-mail addresses: yhs2121@126.com (H. Yang), zhangyuzhe_nm@163.com (Y. Zhang), Dengdun2005@163.com (D. Deng).

http://dx.doi.org/10.1016/j.livsci.2014.10.012
1871-1413/© 2014 Published by Elsevier B.V.

2013, 2014). These stressors are commonly associated with changes in the intestine mucosal structure and function, such as an increase in crypt depth, and decreases in villus height and digestive capability (Boudry et al., 2004; Pié et al., 2004). To solve postweaning problems, piglet diets have been supplemented with antibiotic growth promoters (Yin et al., 2001a). However, the use of antibiotics as growth promoters in swine production may pose a risk to public health through the transfer of bacterial resistance to humans (Van den Bogaard and Stobberingh, 2000). Therefore, many countries have imposed restrictions or prohibitions on the use of antibiotics in swine diets, and there is a growing demand to find safe alternatives to antibiotic usage (Gong et al., 2014; Si et al., 2006).

Dietary supplementation with yeast products, including yeast culture, yeast cell wall, and live yeast, has been reported to improve the growth performance of weaned piglets (Van Heugten et al., 2003; Shen et al., 2009; Gerritsen et al., 2012). Yeast culture is a dried product that contains live yeast cells and various metabolic by-products (i.e., enzymes, vitamins, and co-factors) produced during yeast fermentation, and the yeast cell wall contains several types of polysaccharides (e.g., β-glucan, and α-mannan) (Yin et al., 1993; Kogan and Kocher, 2007; Van der Peet-Schwering et al., 2007). Dietary supplementation with yeast culture or yeast cell wall stimulates the immune system, with an increase in serum immunoglobulin contents, and benefits the intestinal environment of weaned piglets (Li et al., 2006; Kogan and Kocher, 2007; Sauerwein et al., 2007; Shen et al., 2009; Gerritsen et al., 2012). The inclusion of yeast culture or cell wall extract in the diet has also been reported to improve intestine mucosal structure and nutrient digestibility (Hahn et al., 2006; Shen et al., 2009). In the present study, we hypothesized that dietary supplementation with a yeast product (a mixture of yeast culture and cell wall extract) would increase immunoglobulin production in weaned piglets by affecting intestinal function and the levels of nutrients in the body. Thus, the objective of the present study was to evaluate serum immunoglobulin contents, serum and tissue nutrient (amino acid (AA)) contents, alkaline phosphatase (ALP, a key marker enzyme of intestinal function) activity, and AA transporter expression in weaned piglets that were fed a yeast product- or antibiotic-supplemented diet.

Table 1
Chemical composition (%; as is basis) of a yeast product.

Item	Yeast product	
Nutrients	Moisture	10.13
	Crude protein	22.84
	Crude fat	2.31
	Crude fiber	7.27
	Ash	3.88
Amino acids	Arg	1.49
	His	0.73
	Ile	0.86
	Leu	1.86
	Lys	1.19
	Met	0.44
	Phe	1.22
	Thr	1.56
	Trp	0.25
	Val	1.39
	Gly	1.50
	Ser	2.05
	Tyr	1.15
	Asp	2.17
	Glu	3.91
	Cys	0.66
	Ala	1.74
	Pro	1.28

2. Materials and methods

2.1. Animals and experimental treatments

A total of 18 Duroc × Landrace × Yorkshire piglets were weaned at 21 days of age and randomly assigned to receive 1 of 3 treatments consisting of a basal diet (control), the basal diet supplemented with 1.2 g/kg of yeast product (yeast product) or the basal diet supplemented with 20 mg/kg of colistin sulphate (antibiotic) for 14 days. The yeast product used in the present study was purchased from Shintsen Biological Technology Co., Ltd. (Hubei, China) and its commercial name in Chinese is Yiningyi. This yeast product consists of media fermented by *Saccharomyces cerevisiae* and hydrolyzed yeast cell walls of *S. cerevisiae*, which is different from the yeast products used in previous studies that only contain yeast culture, yeast cell wall products or yeast cells. The chemical composition of the

Table 2
Ingredient and chemical composition of the basal diet (as-fed basis).

Ingredient	Content, %
Wheat	24.5
Extruded corn	28.5
Spray-dried whey	10
Extruded soybean	13.8
Soybean meal	10.3
Fish meal	4.5
Limestone	0.6
Monocalcium phosphate	0.6
Salt	0.30
L-Lys · HCl	0.4
Soy oil	3
Vitamin and mineral premix [a]	3.5
Calculated analysis	
NE (kcal/kg)	2500
CP (%)	20
Total lysine (%)	1.40
Total methionine (%)	0.35
Total threonine (%)	0.87
Total tryptophan (%)	0.24
SID [b] lysine (%)	1.27
Ca (%)	0.70
Available P (%)	0.43

[a] The vitamin–mineral premix supplied per kilogram of feed: 10,000 IU of vitamin A (trans-retinyl acetate), 1000 IU of vitamin D3 (cholecalciferol), 80 IU of vitamin E (all-rac-tocopherol acetate), 2.0 mg of vitamin K3 (menadione dimethylpyrimidinol bisulfite), 0.03 mg of vitamin B_{12}, 12 mg of riboflavin, 40 mg of niacin, 25 mg of D-pantothenic acid (D-Ca pantothenate), 0.25 mg of biotin, 1.6 mg of folic acid, 3.0 mg of thiamine (thiamine mononitrate), 2.25 mg of pyridoxine (pyridoxine HCl), 300 mg of choline (choline chloride), 150 mg of Fe (ferrous sulfate), 100 mg of Zn (zinc oxide), 30 mg of Mn (manganese sulfate), 25 mg of Cu (copper sulfate), 0.5 mg of I (potassium iodate), 0.3 mg of Co (cobalt sulfate), 0.3 mg of Se (sodium selenite), and 4.0 mg of ethoxyquin.

[b] SID: Standardized ileal digestibility.