Korean Journal Of Agricultural Science

pISSN : 2466-2402
eISSN : 2466-2410

ANIMAL

Effects of yeast culture (*Saccharomyces cerevisiae*) supplementation on growth performance, fecal score, and nutrient digestibility of weaning pigs

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Abstract

Weaning pigs often face post-weaning challenges such as diarrhea, low feed intake, and body weight (BW) loss which affects the health and economic value of weaning pigs. Interestingly, the use of yeast cultures (YCs) as feed supplements for pigs has increased markedly in recent years. This study evaluated the effects of yeast cultures (*Saccharomyces cerevisiae*) on the growth performance, fecal score, and nutrient digestibility of weaning pigs. A total of 50 crossed healthy weaning pigs [(Yorkshire × Landrace) × Duroc] with an average BW of 7.46 ± 1.60 kg (28 day of age) were used in a 6-week experiment. The experiment was divided into 3 phases (Phase 1, 1 - 2 weeks; Phase 2, 2 - 4 weeks; Phase 3, 4 - 6 weeks). Dietary treatments were as follows: 1) CON: basal diet and 2) CON + 0.50% YC. During phase 1, the average daily gain (ADG) and average daily feed intake (ADFI) were significantly increased ($p < 0.05$) in the weaning pigs fed YC supplementation diets compared with the weaning pigs fed the CON diet. During phase 3 as well as overall, the gain/feed ratio (G/F) was significantly increased ($p < 0.05$) in the YC supplementation group compared with the pigs fed the CON diet. In conclusion, the supplementation of YCs in the diet positively affected the growth performance of weaning pigs during the first two weeks after weaning.

Keywords: fecal score, growth performance, nutrient digestibility, *saccharomyces cerevisiae*, yeast culture

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Citation: Liu X, Li T, Kim IH. 2018. Effects of yeast culture (Saccharomyces cerevisiae) supplementation on growth performance, fecal score, and nutrient digestibility of weaning pigs. Korean Journal of Agricultural Science. https://doi.org/10.7744/kjoas.20180016

DOI: https://doi.org/10.7744/kjoas.20180016

Received: October 18, 2017

Revised: March 9, 2018

Accepted: March 15, 2018

Introduction

It is well known that weaning pigs often face post-weaning challenges, such as diarrhea, low feed intake, body weight (BW) loss (Pluske et al., 1996). These affect the health of weaning pigs, thereby affect the economic value of pigs. Interest in the use of yeast culture (YC) as feed supplements for pigs has been increased markedly in recent years. Fully fermented YC is a dried product containing yeast and various metabolites of yeast fermentation. Actually, YC has been used in feeding dairy cows to improve milk production (Robinson and Garrett, 1999). Recently, a report showed that feeding YC to gestating and lactating sows improved litter weight gain (Kim et al., 2008). Mathew et al. (1998) and Bontempo et al. (2006) showed that feeding YC to weaning pigs improve the average daily gain (ADG) and average daily feed intake (ADFI). A commonly used yeast culture is the *Saccharomyces cerevisiae* fermentation product. *Saccharomyces cerevisiae* is one kind of yeast which is used to ferment yeast culture (Minervini et al., 2012). A *Saccharomyces cerevisiae* fermentation product is produced during fermentation of an unmodified strain of *Saccharomyces cerevisiae*, including the products of fermentation, residual yeast cells, yeast cell wall fragments, and the media used during fermentation (Shen et al., 2011). Some research indicated that supplementation with YC enhanced the growth performance, nutrient digestion, reproductive performance of pigs, and so on (Vander Peet-Schwering et al., 2007; Kim et al., 2008; Kim et al., 2010). Yeast culture (*Saccharomyces cerevisiae*) has been shown to improve total tract nutrient digestibility of nursery pigs (Shen et al., 2009). However, another report showed that feeding yeast culture to animals had no significance in growth performance (Martin et al., 1992). Thus this study was conducted to determine the effects of YC (*Saccharomyces cerevisiae*) on growth performance, fecal score, and nutrient digestibility of weaning pigs.

Materials and Methods

All animals received human care as outlined in the guide for the care, and use of experimental animals (Animal Care Committee, Dankook University, Korea).

Animals and diets

A total of 50 crossed healthy weaning pigs [(Yorkshire × Landrace) × Duroc] with an average BW of 7.46 ± 1.60 kg (28 d of age) were used in a 6 weeks experiment that was divided into 3 phases of 2 week each. Pigs were randomly allotted to 1 of 2 experimental diets according to initial BW in a randomly complete block design. There were 5 replicated pens per treatment with 5 pigs per pen. Dietary treatments were 1) CON: basal diet, 2) CON + 0.50% YC. All diets were formulated to meet or exceed the recommendation of NRC (2012) for weaning pigs, and were fed in a mash form (Table 1). The product has been evaluated in this trial was yeast culture (XPC, Diamond V original XPC™ Yeast culture, Cedar Rapids, IA, USA). All pigs were housed in an environmentally controlled nursery room. The stainless steel pens were 0.5 m × 0.6 m × 2.0 m with a slatted plastic floor. Each pen was provided with a stainless steel feeder and a nipple waterer that allowed ad libitum access to feed and water throughout the experiment. Ventilation was provided by a mechanical system and lighting was automatically regulated to provide 12 h of artificial light per day. The ambient temperature within the room was approximately 30℃at the start of the experiment and decreased by 1℃ each week.

Chemical analysis

Feed and fecal samples were ground to pass through a 1mm screen, after which were analyzed for dry matter (DM) (method 934.01; AOAC, 2000), crude protein (CP, method 990.03; AOAC, 2000), crude fat (method 920.39; AOAC, 1995). Nitrogen (N) was determined by the machine (Kjeltec 2300 Nitrogen Analyzer; Foss Tecator AB, Hoeganaes Sweden), and CP was calculated as N × 6.25. Energy was analyzed by oxygen bomb calorimeter (Parr 1600 Instrument Co., Moline, IL, USA). Chromium was analyzed by UV absorption spectrophotometry (Shimadzu UV-1201; Shimadzu, Kyoto, Japan) following the method described by Williams et al. (1962). Digestibility was calculated using chrome oxide as an indigestible marker.

Sampling and measurements

Individual pig BW, and feed refusals were recorded on Wk 2, 4, and 6 to calculate ADG, ADFI, and growth efficiency (gain/feed ratio, G/F). On Wk 6, the experimental diets were supplemented with 0.2% chromium oxide (Cr_2O_3) as a non-digestible marker to calculate the apparent nutrient digestibility. After 7 d, fresh fecal samples were obtained from each pig by anal massage. Representative samples were stored at - 20℃ until analyzed. Before chemical analysis, the fecal samples were thawed, and dried at 60℃ for 72 h, after which they were finely ground to a size that could pass through a 1 mm screen.

Table 1. Compositions of basal weaning pig diets (as-fed basis).

Item	Phase 1 (wk1 - 2)	Phase 2 (wk2 - 4)	Phase 3 (wk4 - 6)
Ingredient (g/kg)			
Corn	34.24	49.38	35.91
Barley	5.00	2.50	-
Wheat-Flour	-	-	8.00
Soybean Meal 47%	4.70	16.50	24.90
Full fat Soybean	3.50	5.00	6.00
Wheat-bran	-	-	3.00
Biscuit meal	-	-	8.00
Sugar	5.50	5.00	3.00
Soy hull	2.50	-	3.00
Soybean Oil	3.00	3.35	3.83
Fish meal	4.50	3.00	-
Spray-dried porcine plasma	4.00	2.50	-
Cheese Powder	3.50	-	-
whey	20.50	6.00	-
Lactose	2.50	-	-
Whey permeate	-	-	2.50
Modified milk powder	5.00	5.00	-
Lys 78%	0.39	0.38	0.37
Met 99%	0.22	0.32	0.19
Tre 98%	0.17	0.14	0.15
Trp 10%	0.16	0.21	-
Limestone	-	-	0.70
Monocalcium phosphate 18%	-	0.17	-
Vitamin premix[y]	0.30	0.25	0.20
Mineral premix[z]	0.20	0.20	0.15
Choline 50%	0.12	0.10	0.10
Calculated composition (g/kg)			
Protein	20.34	19.18	18.44
Fiber	1.40	2.23	3.77
Ash	6.34	4.77	4.93
Ca	1.00	0.72	0.91
P	0.75	0.55	0.56
DE	3,968	3,913	3,562
Lysine	1.67	1.50	1.31
Lactose	19.37	5.90	1.95

[y]Provided per kg of complete diet: vitamin A, 11,025 IU; vitamin D3, 1103 IU; vitamin E, 44 IU; vitamin K, 4.4 mg; riboflavin, 8.3 mg; niacin, 50 mg; thiamine,4 mg; D-pantothenic, 29 mg; choline, 166 mg; and vitamin B 12 , 33 µg.
[z]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 $ZnSO_4$), 85 mg; Mn (as MnO_2), 8 mg; I (as KI), 0.28 mg; Se (as $Na_2SeO_3 \cdot 5H_2O$), 0.15 mg.

All feed and fecal samples were then analyzed for DM, N, and energy (E) as described before, and using the following formula: digestibility (%) = $[1 - \{(Nf \times Cd)/(Nd \times Cf)\}] \times 100$, where, Nf = nutrient concentration in feces (% DM), Nd = nutrient concentration in diet (% DM), Cd = chromium concentration in diet (% DM), and Cf = chromium concentration in feces (% DM) (Zhang et al., 2018).The incidence of diarrhea in weaning pigs was observed, and recorded 3 times per day throughout the study. In order to assess the severity of diarrhea, feces from each pen were scored according to the method of Zhou et al. (2012). In brief, the scores were as follows: 1 (hard, dry pellets in a small, hard mass); 2 (hard, formed stool that remains firm, and soft); 3 (soft, formed, and moist stool that retains its shape); 4 (soft, unformed stool that assumes the shape of the container); and 5 (watery, liquid stool that can be poured). A cumulative diarrhea score (DS) per diet, and day was then assessed (Smiricky et al., 2002).

Statistical Analysis

The data were analyzed using the General Linear Model (GLM) procedures of SAS (SAS, 1996), and significant differences among the means were determined using Duncan's Multiple Range Test method (Duncan, 1955), with $p < 0.05$ indicating significance. Probability values less than 0.10 were used as the criterion for a tendency.

Results

Growth performance

During phase 1, ADG, ADFI were significantly increased ($p < 0.05$) in weaning pigs fed yeast culture supplementation diets compared with weaning pigs fed CON diet (Table 2). During phase 3 and overall, G/F was significantly increased ($p < 0.05$) in pigs fed YC supplemented diets than CON diet. BW, ADG, and ADFI in phase 2, phase 3, and overall, G/F in phase 1 and phase 3 were not affected ($p > 0.05$) by dietary treatment during all phases of the experiment (Table 2). During the whole experiment, G/F in fed YC supplementation diets was increased compared with CON diet in numerical value.

Fecal score

During initial, Wk 2, 3, 4, 5, and 6, there was no significant effect ($p > 0.05$) with YC diet on fecal score compared with CON diet of weaning pigs (Table 3).

Nutrient Digestibility

There was no significant difference in nutrient digestibility ($p > 0.05$) between CON and YC treatments (Table 4), however the DW, nitrogen, and Edigestibility in pigs fed YC diet were higher in numerical value than pigs fed CON diet.

Table 2. Effect of yeast culture on growth performance in weaning pigs.

Items	Control	YC	SEM
BW (kg)			
Initial	7.47	7.47	0.03
wk2	11.69	12.06	0.19
wk4	18.82	19.16	0.42
wk6	26.51	26.64	0.47
wk2			
ADG (g)	302a	328b	6
ADFI (g)	391a	421b	12
G/F	0.776	0.786	0.011
wk4			
ADG (g)	509	507	12
ADFI (g)	755	733	18
G/F	0.675a	0.692b	0.004
wk6			
ADG (g)	549	534	14
ADFI (g)	901	870	27
G/F	0.611	0.617	0.017
Overall			
ADG (g)	453	456	11
ADFI (g)	682	675	26
G/F	0.665a	0.680b	0.006

YC, yeast culture; SEM, standard error of means; BW, body weight; ADFI, average daily feed intake; ADG, average daily gain; G/F, gain/feed ratio.
a, b: Means in a row with different letters are significantly different ($p < 0.05$).

Table 3. Effects of yeast culture on fecal score in weaning pig.

Fecal score	Control	YC	SEM
Initial	3.21	3.40	0.14
wk2	3.29	3.14	0.07
wk3	3.27	3.14	0.07
wk4	3.20	3.11	0.06
wk5	3.36	3.16	0.07
wk6	3.39	3.26	0.07

Fecal scores were determined using the following fecal scoring system: 1 hard, dry pellet; 2 firm, formed stool; 3 soft, moist stool that retains shape; 4 soft, unformed stool that assumes shape of container; 5 watery liquid that can be poured.
YC, yeast culture; SEM, standard error of means.

Table 4. Effect of yeast culture on nutrient digestibility in weaning pigs.

Items (%)	Control	YC	SEM
Dry matter	80.64	81.16	0.31
Nitrogen	79.79	80.54	0.32
Energy	79.91	80.27	0.38

YC, yeast culture; SEM, standard error of means.

Discussion

YC is rich in nutrients and growth factors. Many studies have shown that YC improved the growth performance of nursery pigs (Shen et al., 2009). Various yeast-related feed supplements were defined by the Association of American Feed Control Officials (2009). Active dry yeast could be considered as one kind of probiotics. Because it has been dried and contained at least 15 × 10^9 live yeast cells per gram. Yeast culture is the dried product of yeast and the media to preserve the fermenting activity of yeast, as well as the metabolites from yeast fermentation. It increased our attention to this interesting feed additive because of the growth-promoting and potential antibiotic alternative properties of yeast culture product (Price et al., 2010). Supplementing YC diets was contributed to growth of animals (Trckova et al., 2014). Some reports showed the positively increased growth performance with YC diet in weaning pigs (Mathew et al., 1998; Bontempo et al., 2006; Canibe et al, 2007). In previous studies, YC products increased ADFI and ADG (Van der Peet-Schwering et al., 2007; Shen et al., 2009), and improved the feed efficiency of pigs (Van der Peet-Schwering et al., 2007). Van Krimpen and Binnendijk (2001) showed that piglets fed diets supplemented with AGP (40 mg/kg of avilamycin) or live yeast cells (*Saccharomyces cerevisiae* CS47) performed better than piglets fed the negative control diet. Chen et al., (2017) reported that the YC (*Saccharomyces cerevisiae*) could positively affect BW and ADFI of broiler chickens. These results were in line with our study in the weaning pigs fed YC diets that had significant higher ADG, ADFI in phase 1 and G/F in phase 3 and overall than weaning pigs fed the basal diets. However, our findings were not exactly consistent with other people's research. Body weight, ADG, ADFI in phase 2, phase 3, and overall, G/F in phase 1 and phase 3 were not affected by dietary treatment during all phases of the experiment. In a study by Kornegay et al. (1995), the performance of piglets was not improved by supplementing the diet with YC, whereas in a study by Mathew et al. (1998), post-weaning performance did improve. Different possibilities might explain these discrepancies, such as the environment, the diet and so on. In our study, dry matter, nitrogen and energy in YC treatment though not significant had numerically higher value than control. In addition, the fecal score of weaning pigs during all phases of the experiment were not affected. It may possibility explains that YC stimulates the immune system. YC triggers the interaction between the intestinal immune response and the immune system. Energy flows in the direction of the immune function not only the growth performance. It is consistent with other authors. Stimulating the immune system, maintaining a beneficial intestinal environment (Van Heugten et al., 2003), and improving intestinal immunity (Jurgens et al., 1997) have all been suggested as potential modes of action of yeast products. Shen et al. (2009) showed that YC had a positive effect on gut health and immune system. We speculate it may possibility affect by the concentration of YC in diet. Shen et al. (2009) showed that it was increased significantly with 5 g/kg YC, but not significantly in a higher YC diet. It means that lower doses YC have a better effect than higher doses. Because the immune response need a higher dosages of YC are required to achieve beneficial effects. The result was similar to Gao et al. (2008). Thus, we need to use a more appropriate dose for the next step to study the mechanism of YC.

Conclusion

Weaning pigs fed YC supplementation diets significantly increased ADG, ADFI, and G/F during the first two weeks after weaning than those fed CON diet. In conclusion, supplement with YC in the diet positively affected the growth performance of weaning pigs.

Reference

AOAC (Association of Official Analytical Chemists). 1995. Official Method of Analysis. 16th ed. Association of Official Analytical Chemists, Gaithersburg, MD, USA.

AOAC (Association of Official Analytical Chemists). 2000. Official Method of Analysis. 17th ed. Association of Official Analytical Chemists, Gaithersburg, MD, USA.

Association of American Feed Control Officials. 2009. Official Publication. Association Of American Feed Control Offcials Inc., Atlanta, GA, USA.

Bontempo VA, Giancamillo DI, Savoini G, Dell'Orto V, Domeneghini C. 2006. Live yeast dietary supplementation acts upon intestinal morpho-functional aspects and growth in weanling piglets. Animal Feed Science Technology 129:224-236.

Chen CY, Chen SW, Wang HT. 2017. Effect of supplementation of yeast with bacteriocin and Lactobacillus culture on growth performance, cecal fermentation, microbiota composition, and blood characteristics in broiler chickens. Asian-Australasian Journal of Animal Sciences 30:211-220.

Canibe N, Hojberg O, Badsberg JH, Jensen BB. 2007. Effect of feeding fermented liquid feed and fermented grain on gastrointestinal ecology and growth performance in piglets. Journal of Animal Science 85:2959-2971.

Duncan DB. 1955. Multiple range and multiple F tests. Biometrics 11:1-42.

Gao J, Zhang HJ, Yu SH, Wu SG, Yoon I, Quigley J, Gao YP, Qi GH. 2008. Effects of yeast culture in broiler diets on performance and immunomodulatory functions. Poultry Science 87:1377-1384.

Jurgens MH, Rikabi RA, Zimmerman DR. 1997. The effect of dietary active dry yeast supplement on performance of sows during gestation-lactation and their pigs. Journal of Animal Science 75:593-597.

Kim SW, Brandherm M, Freeland M, Newton B, Cook D, Yoon I. 2008. Effects of yeast culture supplementation to gestation and lactation diets on growth of nursing piglets. Asian-Austral Journal of Animal Science 21:1011-1014.

Kim SW, Brandherm M, Newton B, Cook DR, Yoon I, Fitzner G. 2010. Effect of supplementing *Saccharomyces cerevisiae* fermentation product in sow diets on reproductive performance in a commercial environment. Canadian Journal of Animal Science 90:229-232.

Kornegay ET, Rhein-Welker D, Lindemann MD, Wood CM. 1995. Performance and nutrient digestibility in weanling pigs as influenced by yeast culture additions to starter diets containing dry whey or one of two fiber sources. Journal of Animal Science 73:1381-1389.

Martin SA, Nisbet DJ. 1992. Effect of direct-fed microbials on rumen microbial fermentation. Journal of Dairy Science 75:1736-1744.

Mathew AG, Chattin SE, Robbins CM, Golden DA. 1998. Effects of a direct-fed yeast culture on enteric microbial populations, fermentation acids, and performance of weanling pigs. Journal of Animal Science 76:2138 -2145.

Minervini F, Cagno RD, Lattanzi A, Angelis MD, Antonielli L, Cardinali G, Cappelle S, Gobbetti M. 2012.

The lactic acid bacteria and yeast microbiota of nineteen sourdoughs used for the manufacture of traditional/typical Italian breads: Interactions between ingredients and microbial species diversity. Appliedand Environmental Microbiology 78:1251-1264. doi:10.1128/AEM.07721-11.

NRC. 2012. Nutrient requirements of swine. 11th edn. National Academy Press, Washington DC, USA.

Pluske JR, Williams IH, Aherne FX. 1996. Nutrition of the neonatal pig. pp. 187-235. In the neonatal pig: Development and survival. Varley MA, ed. CAB Int., Wallingford, UK.

Price KL, Totty HR, Lee HB, Utt MD, Fitzner GE, Yoon I, Ponder MA, Escobar J. 2010. Use of *Saccharomyces cerevisiae* fermentation product on growth performance and microbiota of weaned pigs during Salmonella infection. Journal of Animal Science 88:3896-3908.

Robinson PH, Garrett JE. 1999. Effect of yeast culture (*Saccharomyces cerevisiae*) on adaptation of sows to post-partum diets and on lactational performance. Journal of Animal Science 77:988-999.

SAS (Statistical Analysis System). 1996. SAS User's Guide: Statistics. Version 7.0. SAS Institute, Cary, NC, USA.

Shen YB, Carroll JA, Yoon I, Mateo RD, Kim SW. 2011.Effects of supplementing *Saccharomyces cerevisiae* fermentation product in sow diets on performance of sows and nursing piglets. Journal of Animal Science 89:2462-71.

Shen YB, Pian XS, Kim SW, Wang L, Liu P, Yoon I, Zhen YG. 2009. Effects of yeast culture supplementation on growth performance, intestinal health, and immune response of nursery pigs. Journal of Animal Science 87:2614-2624.

Smiricky MR, Grieshop CM, Albin DM, Wubben JE, Gabert VM, Fahey GC. 2002. The influence of soy oligosaccharides on apparent and true ileal amino acid digestibilities and fecal consistency in growing pigs. Journal of Animal Science 80:2433-2441.

Trckova M, Faldyna M, Alexa P, Zajacova ZS, Gopfert E, Kumprechtova D, D'Inca R. 2014. The effects of live yeast on post weaning diarrhea, immune response, and growth performance in weaned piglets. Journal of Animal Science 92:767-774.

Van der Peet-Schwering CMC, Jansman AJM, Smidt H, Yoon I. 2007. Effects of yeast culture on performance, gut integrity, and blood cell composition of weaning pigs. Journal of Animal Science 85:3099-3109.

Van Heugten E, Funderburke DW, Dorton KL. 2003. Growth performance, nutrient digestibility and fecal microflorain weaning pigs fed live yeast. Journal of Animal Science 81:1004-1012.

Van Krimpen MM, Binnendijk GP. 2001. Biosaf as alternative for antimicrobial growth promoters in diets of weanling pigs. Animal Sciences Group, Lelystad, Netherlands.

Williams CH, David DJ, Iismaa O. 1962. The determination of chromic oxide in faeces samples by atomic absorption spectrophotometry. Journal of Agriculture Science 59:381-385.

Zhang JY, Hu J, Kim IH. 2018. Effects of γ-aminobutyric acid (GABA) on growth performance, nutrient digestibility, blood profiles, meat quality, and backfat in finishing pigs. Korean Journal of Agricultural Science 45:105-113.

Zhou TX, Cho JH, Kim IH. 2012. Effects of supplementation of chito-oligo-saccharide on the growth performance, nutrient digestibility, blood characteristics and appearance of diarrhea in weanling pigs. Livestock Science 144:263-268.