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Complete List of Authors:	Sampath, Vetriselvi; Dankook University, Department of Animal Resource & Science Han, Kyudong ; Dankook University - Cheonan Campus, Department of Microbiology SureshKumar, S; Dankook University Department of Animal Resources Science, Department of Animal Resource, and Science Kim, In Ho; Dankook University - Cheonan Campus, Department of Animal Resource and Science
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Impact of yeast hydrolysate (*Saccharomyces cerevisiae*) supplementation on the growth performance, nutrient digestibility, fecal microflora, noxious gas emission, blood profile, and meat quality of finishing pigs

Vetriselvi Sampath¹, Kyudong Han^{2,3}, Shanmugam Sureshkumar¹, and In Ho Kim^{1, *}

¹Department of Animal Resource and Science, Dankook University, Cheonan, 31116, Republic of Korea

²Department of Microbiology, College of Science & Technology, Dankook University, Cheonan 31116, Republic of Korea

³Center for Bio-Medical Engineering Core Facility, Dankook University, Cheonan 31116, Republic of Korea

*Correspondence:

In Ho Kim,

Department of Animal Resource and Science,

Dankook University, Cheonan, 31116, Republic of Korea

Tel: 82-41-550-3652; Fax: 82-41-550-3652;

E-mail: inhokim@dankook.ac.kr

Abstract

A total of 90 finishing pigs ($52 \pm 1.46\text{kg}$) were randomly assigned to 1 of 3 dietary treatments as: TRT1- (CON (basal diet)), TRT-2 (CON + 0.05% yeast hydrolysate (YH)), TRT3 – (CON + 0.1% YH) for 8 weeks trial. Each treatment had 6 replications and 5 (3 gilts and 2 barrow) pigs pen. In weeks 4 and 8, YH supplement linearly increased ($P < 0.05$) body weight. Moreover, average daily gain was also linearly increased ($P < 0.05$) with YH supplementation in week 4 and the overall trial period. At the end of the trial, apparent total tract digestibility of dry matter, nitrogen, and gross energy was linearly increased in pigs fed YH supplementation. In addition, fecal *lactobacillus* counts, IGF-1 concentration, and the lean meat percentage was linearly increased by YH supplementation. Also, YH supplementation elicited a linear reduction on drip loss during days 3, 5, and 7. In summary, dietary yeast hydrolysate supplement positively enhanced the growth performance, nutrient digestibility, *lactobacillus* count and reduce the drip loss traits of finishing pig. Thus, we infer that the application 0.1% *S. cerevisiae* yeast hydrolysate can enhance the growth efficiency of finishing pigs.

Key words: yeast hydrolysate, finishing pig, growth performance, nutrient digestibility.

Introduction

Research on strengthening livestock production is ongoing and the profits may enhance by the provision of vitamins, minerals, protein, and energy. Besides, the use of feed additives can also improve the performance of animals, thereby modulating their gut function (Berchielli and Bertipaglia 2010). However, some countries (including the EU and South Korea) are restricted from using certain antibiotics the livestock industry, due to their harmful bacterial resistance (Upadhaya et al. 2016). The mounting anxieties about the safety and quality of livestock products have provoked many researchers and manufacturers to hunt for novel feed additives that can boost the health and production of animals. Over the past 50 years, many researchers and farm owners have preferred to use prebiotics, probiotics, yeast hydrolysates, organic acids and phytogenic feed additives as antibiotic growth promoters (AGP) in monogastric animal (Liu et al. 2018). In addition, they have also explored the combination of multiple alternatives, such as complex enzymes, synbiotic and plant-extract mixtures (Lei et al. 2017).

Yeast products are extensively used as additives in livestock feed to improve their growth performance and intestinal health, especially in weaner piglets to mitigate the negative impact of weaning- stress and disease (Liu et al. 2013; Kiarie et al., 2011; Kiarie et al., 2012). Besides, yeast has a strong fermentation capacity, high nutritional value, and can reduce potential toxicity. Nowadays, biologically active yeast fermentation stimulation products (including yeast cells and yeast extract) are known to improve the palatability of the diet, produce antibacterial compounds that could thwart pathogen growth and modulate the immune system. Yeast products such as yeast extract, yeast culture, and yeast hydrolysate (YH) comprise a variety of active ingredients (Jung et al. 2012; Molist et al. 2014; Kiarie et al., 2020). YH is an end product of hydrolysis extraction and naturally comprises both yeast extracts and yeast cell walls (Bootiam et al. 2020). Moreover, it contains abundant nucleotides, B-vitamins, amino acids, and polysaccharides (β -glucan and mannan-oligosaccharides (MOS)). β -glucan and MOS are also commonly used as prebiotics to

regulate the immune response of animal (Sauerwein et al. 2007). Likewise, nucleotides are considered to be one of the most important components of YH, because it aids to improve growth performance, regulate immune function, and repair the gastrointestinal tract of animals (Superchi et al. 2012). The dietary nucleotides can satisfy the physiological function requirements in period of rapid growth, malnourishment, and immune challenge. Apart from this, the production cost of YH is very low compared to yeast extract (Zhang et al. 2019). Although cost effective, the administration of YH supplementation in the diet of finishing pigs has not been well implemented, thus in-depth investigation is required. Therefore, in this study we aimed to evaluate the effect of dietary YH supplementation on the growth performance, nutrient digestibility, fecal microflora, noxious gas emission, blood profile, and meat quality of finishing pigs.

Materials and Methods

Ethical endorsement

The protocol of this experiment was reviewed and approved by the Animal Care and Use Committee of Dankook University (Approval no: DK-2-1937), Cheonan, Republic of Korea, for animal experimentation.

Animal management

This experiment was carried out for 8 weeks at Dankook University “intensive pig farm” (Gongju, South Korea) with 90 crossbred [(Landrace Yorkshire) × Duroc] finishing pigs. At first, pigs were selected and divided on the basis of gender and body weight (BW) (initial 52.93 ± 1.46 kg), then they were housed in steel pens. Trial room temperature was initially maintained at 30°C and gradually reduced up to 24°C (60% humidity).

Feeds and feeding programs

Pigs were randomly allotted to one of three different experimental diets. Each treatment consisted of six replications with five pigs per pen (3 gilts and 2 barrows). The dietary treatments

were: TRT1- (CON (basal diet)), TRT2 – (CON + 0.05% YH), and TRT3 – (CON + 0.1%YH). The diets (mash form) were formulated according to the recommendations of NRC (2012). The ingredients and the chemical composition of illustrated in Table-1. The main supplement YH (*Saccharomyces cerevisiae*) was commercially prepared in the name of CALMORIN and obtained from Daeho Co., Ltd. (Hwaseong, Republic of Korea) and added to pigs' diet at prescribed level. The active ingredients of YH were 40% of crude protein, 3.5% of nucleotides, 23% of β -glucans, 4.9% glutamic acid, and 15% of MOS. Basal diet and YH supplements were mixed using feed mixer DDK-801 (Daedong Tech, Korea). Self-feeder and nipple drinker were fixed in the corner of all cages which allowed pigs to enjoy free access of feed and water throughout the trial.

Sampling and laboratory analysis

Growth performance

The body weight (BW) of finishing pigs was measured using GL-6000 portable scale at the beginning and the end of week 4 and week 8. The feed intake and scraps were calculated every day at 15:00 PM to determine the average daily feed intake (ADFI) and gain to feed ratio (G: F).

Nutrient digestibility

Seven days prior to fecal collection (day 56), 0.2% chromic oxide (Cr_2O_3) was mixed in pigs' diet to measure the nutrient digestibility. The representative feed samples were collected using the sterilized plastic bags from each treatment groups right after mixing the marker. At the end of the experiment (8th week), fresh fecal samples were randomly collected from 2 pigs/pen (1 barrow and 1 gilt) by rectal palpation. Within half an hour the collected samples were transported to laboratory and stored at -20°C to prevent changes in nutrients. Before starting the analysis, all feed and fecal samples were placed in WOF-L800 convection drying oven (Daehan Scientific Co. Ltd, Wonju, South Korea) for 2 days at 105°C . Later, samples were taken out from the dryer and

grounded well (Willey mill, USA) to pass through a 1-mm screen sieve. The contents of dry matter (DM), nitrogen (N), and gross energy (GE) were analyzed according to the guidelines of AOAC (2006). In brief: 2g sample (feed and fecal) was added in crucibles and placed in the drying oven at 80°C for 1 day. A day later, the representative samples were taken out and re-weighed to calculate the DM digestibly. For chromium analysis, 2g sample (feed and fecal) was added in crucibles and 2 ml (KOH and K₂HPO₄ mix with distilled water) solution was added to the dried sample and placed in muffle furnace for 3-4 h at once takeout from the furnace, samples were allowed to cool and filtered. 1ml of acetone solution and 2ml of H₂SO₄ were added (respectively) in the filtered solution. 0.35ml solution was poured into microcuvette then placed in UV spectrophotometry (Shimadzu, UV-1201, Kyoto, Japan). Finally, the readings were noted for statistical analysis. 2 gm of feed, and fecal sample was taken and placed in Parr 6400 (Parr instrument Co., Moline, IL) oxygen bomb calorimeter and the heat combustion in the sample was measured to determine GE. N (0.4gm sample) was determined by Foss Tecator™ Kjeltac8400 (Hoeganaes, Skane, Sweden) analyzer and the protein levels were noted for statistical analysis. The apparent total tract digestibility was calculated using the below equation:

$$ATTD = [1 - \{(Nf \times Cd)/(Nd \times Cf)\}] \times 100,$$

ATTD = apparent total tract digestibility, whereas, Nf = nutrient concentration in feces (% DM), Nd = nutrient concentration in diets (% DM), Cf = chromium concentration in feces (% DM); and Cd = chromium concentration in diets (% DM).

Microbial shedding

On day 56, fresh fecal samples were collected 2 pigs/pen (1 barrow and 1 gilt) using sterile microtubes and immediately transported to the laboratory for microbial analysis. To determine the number of *E. coli* and *Lactobacillus*, 1gm of fecal sample was taken, diluted with 9 mL of 1 % peptone broth and mixed well with a vortex mixer. The serial dilution (10-fold in 1 % peptone) was performed and 0.02% of the peptone solution was added to MacConkey agar plates and Lactobacilli

medium III agar plates, respectively. *E. coli* count was enumerated in MacConkey agar for 24 h at 37°C. *Lactobacillus* was isolated on Lactobacilli medium III agar plates with an overnight incubation (20-24 h). Typical colonies were enumerated and log-transformed for statistical analysis.

Noxious gas emission

At the end of the experiment, to measure the gas emission, fresh fecal samples were collected from 2 pigs/pen (1 barrow and 1 gilt), pooled well and stored in airtight plastic container (2.6 L) which has a small hole on the middle of one side, sealed tightly with adhesive tape and led to ferment for 7 days at 25°C. 100 ml sample was taken away from the headspace (approximately 2.0 cm) for the air circulation. The box was re-sealed, and shaken manually for 30 seconds to measure the crust formation on the surface. Finally, the Concentrations of NH₃, H₂S, CO₂, methyl mercaptan, and acetic acid were measured within the scopes of 5.0 to 100.0 ppm (No. 3La, detector tube; Gastec Corp. Kanagawa, Japan) and 2.0 to 20.0 ppm (4LK, detector tube; Gastec Corp).

Blood profile assay

On the final day of the experiment, 5 ml of the blood sample was collected (from the same pigs used for fecal collection) by puncturing jugular vein of 2 pigs per pen (1 gilt and 1 barrow) using a sterilized syringe and stored in both heparinized tubes and non-heparinized tubes containing K₃EDTA (Becton, Dickinson and Co., Franklin Lakes, NJ) vacuum tubes. Heparinized tubes were used for blood urea nitrogen (BUN) analysis as well non-heparinized tubes were used for serum creatinine analysis. Blood serum was separated by centrifugation at 3000 rpm for 10 minutes and stored at -4°C. Abbott Spectrum urea nitrogen test kit (Series II, Abbot Laboratories, Dallas, TX) was used to analyzed BUN whereas Astra-8 Analyzer kit (Beckman Instruments, Inc., Brea, CA 92621) was used to determine Creatinine concentration.

Back-fat thickness and lean meat area

At the end of the experiment, Back-fat thickness (BFT) and the lean meat (LM) area (cm²) were measured at the 10th and 12th ribs using real-time ultrasound instrument (Piglog 105; SFK Technology, Herlev, Denmark) and the mean value was noted for statistical analysis

Meat quality

All pigs were taken to the local commercial slaughterhouse and slaughtered by exsanguinations and evisceration. Then the samples were vacuum-packed and transported to the laboratory for further analysis. The carcasses were weighed individually and stored at 4 °C for 24 hrs to calculate pH, meat color, water-holding capacity, drip loss, cooking loss, fat thickness, the longissimus muscle (LM) area, and marbling. A portable digital pH meter was used to calculate the pH suspension with two buffers (pH 4.0 and 7.0) and the measurement process was repeated for 3 times. The color parameters such as lightness, redness, and yellowness values of each samples (surface) were measured at 3 locations using CR-410 colorimeter (Konica Minolta Sensing Inc., Osaka, Japan). Marbling, and firmness scores were calculated. according to the protocols of the National Pork Producers Council (NPPC 2000). A 0.2gm sample was placed in 125 mm (diameter) filter paper and pressed for 3 min. The moisture-exposure of the compressed areas were determined using a digitalized area-line sensor (MT-10S, M.T. Precision Co. Ltd., Tokyo, Japan). The ratio of water: meat area was then calculated (a smaller ratio indicates increased WHC) and recorded. 4gm of meat samples were sliced and weighed. Then sliced samples were placed in a Ziplock bag, stored at 4°C and weighed at days 1, 3, 5, and 7 respectively, from the date of sample collection. The initial and final weight of each sample were used to determine the drip loss level. To estimate cooking loss, 4gm of raw meat samples was taken, packed into zipper bags, placed in a water bath for 30 min at 100°C and the samples were let to cool down for 1 hr. Boiled samples were re-weighed. Finally, the Cooking loss was determined by calculating the difference between the raw and boiled sample and noted.

Statistical analysis

All data were examined statistically in a completely randomized design using mixed procedures of SAS (SAS Inst. Inc., Cary, NC, USA) with pen as the experimental unit. Orthogonal comparisons were conducted using polynomial regression to determine linear and quadratic effects on the graded level of 0%, 0.05%, and 0.1%, of YH supplement in pigs' diet. Variability in the data was expressed as the standard errors mean. The $P < 0.05$ was considered as significant and $P < 0.10$ was considered as trend.

Results

The impact of YH supplementation on growth performance of finishing pigs is presented in Table 2. The ADFI and G: F ratio of finishing pigs was unaffected by dietary YH supplement. However, compared to CON, BW was linearly increased in YH supplemented groups during weeks 4, and 8 ($P = 0.021$, and 0.043 , respectively). Linear improvements in ADG was observed with the graded level of YH supplementation during week 4 ($P = 0.029$) and the overall ($P = 0.024$) trial period compared to CON. As shown in Table 3, the digestibility of DM ($P = 0.028$), N ($P = 0.058$), and GE ($P = 0.046$) was linearly increased in pigs fed YH supplementation compared to CON. The effect of YH supplementation on fecal microflora of finishing pigs was shown in Table 4. Dietary inclusion of YH supplementation showed a beneficial effect on the fecal microbial population with linear increase in *Lactobacillus* ($P = 0.036$) counts compared to CON, while *E. coli* count were not affected ($P > 0.05$) by the dietary treatments. The graded level of YH supplementation did not affect the gas emission (Methyl mercaptans, NH_3 , H_2S , Acetic acid, and CO_2) throughout the experimental period (Table 5). Dietary supplementation of YH had a significant difference on IGF-1 during week 8 ($P = 0.037$). However, there were no effects observed on BUN, creatinine, and growth hormone during the entire experimental period (Table 6). At the end of the trial, BFT ($P = 0.062$) was tendency to increased and the LMP ($P = 0.042$) was linearly increased in pigs fed YH supplementation (Table 7). A linear ($P = 0.052$ and 0.051) and tendency to decrease (0.078) drip loss on days 3, 5 and 7 (respectively) was exerted by the inclusion of YH in the diet of finishing pigs compared to CON.

(Table 8).

Discussion

Recently, yeast cell wall and extract has become a trending supplement in monogastric animals and showed a positive effect on growth performance of pigs (Zhang et al. 2019). In this experiment, pigs fed YH supplements has linearly increased BW and ADG in the overall experiment compared to those fed control diet. These findings are consistent with that of Wang et al. (2009) who noted a significant increase on the growth performance of BW and ADG in growing-finishing pigs fed with dietary yeast supplementation. To support our results, Li et al. (2006) stated that *S. Cerevisiae* live yeast supplementation had significantly enhanced BW and ADG, and feed intake of weaner pigs during the overall experiment. In addition, Zhao et al. (2012) observed that the nursery pig diet containing yeast extract had improved ADG and ADFI. Also, Pancrazio et al. (2016) demonstrated that pigs fed graded levels of yeast supplementation had enhanced feed consumption. However, an apposed result was found in this study using YH supplementation has failed to induce ADFI during the overall experiment. The probable reason for increased ADFI in previous studies (Zhao et al. 2012) may be due to the enhanced palatability of dietary yeast supplement and the lack of our results may be due to the difference in YH dosage level or animal's age.

The total tract digestibility of DM, N, and GE was linearly improved in pigs fed YH supplementation and this finding was correlated with Zhang et al. (2019) who found a significant improvement in DM, N, and energy (at the end of the phase) with the increased level of YH supplementation. Previously, many researchers have reported that the pigs fed cellulose and/or enzyme mixture supplementation has improved the apparent digestibility of DM, energy, and crude protein, thereby enhancing the growth performance of pigs (Varel et al. 1987., Caine et al. 1997., Yin et al. 2001). Similarly, Keimer et al. (2018) reported that total track digestibility of energy and crude protein tended to improve with a 1% hydrolyzed yeast diet. Furthermore, Håkenåsen et al. (2017) also reported that graded level of yeast dietary supplementation improved fecal DM. Also,

Liu et al. (2018) demonstrated that effective nutrient absorption and better performance are usually associated with enhanced villus height and decreased crypt depth. However, the present study did not measure the intestinal morphology. Moreover, Due to the short digestive tract of mono-gastric animals, the residence time of feed components in the intestine is also short. (Sun and Kim. 2019). From this aspect, we assume that the probable reason for the increased nutrient digestibility in finishing pigs may be due its effective digestive tract or due to the presence of increased beneficial bacteria (*Lactobacillus*) in the intestine.

The digestive tract is a complex micro-ecosystem that consist of many bacterial species. Recently, Nguyen and Kim. (2020) stated that gut health is the main factors in regulating the pig's performance and improving economic status of swine production. Moreover, intestinal microflora profile plays an important role in gut health, the present study showed a higher effect on *lactobacillus* count with YH diet, thereby improving the gut of host animal. This finding agreed with the results of Boontiam et al. (2020) who found decreased *E. coli* counts and increased *lactobacillus* in weaner pigs fed hydrolyzed yeast supplementation. Similarly, Tuoi et al. (2016) noted that dietary inclusion of β -glucan and mannan-oligosaccharides combined supplementation significantly increased the fecal microbial of *Lactobacillus* populations. However, Sweeney et al. (2012) stated that weaning pigs fed *S. cerevisiae* related β -glucans supplementation had significantly reduced *E. coli* counts without affecting *Lactobacillus* counts. It is known that probiotics could enhance the intestinal health by reducing the number of harmful microorganisms and promote the growth of beneficial bacteria (*Lactobacillus*) which possess a potential bio-preservation strategies and antibacterial effect due to the bacteriocin (Lee et al. 2013). Thus, we considered that the positive effects on excreta microflora and improved intestinal health of finishing pigs may be the same reason as stated by lee et al.2013. Several studies have aimed to explore a dietary manipulation strategy to reduce environmental hazards caused by noxious gas emission such as NH_3 , H_2S and methyl mercaptant (Okli et al. 2007). The study of Yan and Kim (2011) stated that

there was a strong connection between fecal noxious gas emission and nutrient digestibility. They also stated that higher level digestibility allows the large intestine to reduce the microbial fermentation and that leads to reduce the gas emission. However, in the current study the increased level of YH supplementation failed to affect the noxious gas emission of methyl mercaptans, NH_3 , H_2S , acetic acid, and CO_2 . To our knowledge, there has been no information presented on the YH supplementation on gas emission of finishing pigs. Therefore, in-depth investigations are needed with different levels of YH to know the exact cause for the absence of substantial changes in the fecal gas emission.

Boontiam et al. (2020) reported that variations in serum protein levels affects the animals' productivity and immunity. Besides, circulating IgA and IgG plays a vital role in protecting against pathogenic invasion (Hedegaard et al. 2016). Previously, Lemmey et al. (1994) demonstrated that administration of IGF-1 peptides has improved gastrointestinal absorptive function by partial gut resection, that mostly reflects in an increase gut absorptive surface area. In this study, the levels of IGF-1 was increased with the graded level of YH supplementation, which is considered as a positive factor that enhances gastrointestinal activities. Kohn et al. (2005) described that urea excreted in urine is the primary nitrogenous end product produced by amino acid catabolism in pigs, and there was a strong relationship between BUN concentration and rate of nitrogen excretion. In the current study, finishing pigs fed graded level of YH supplement did not show any significant improvement on BUN concentration contrary to Boontiam et al. (2020) who reported that weaning pigs fed hydrolyzed yeast supplementation had a linear reduction in the BUN concentration. Moreover, the primary role of GH is to promote growth. Besides, normal aging is associated with a great decline in GH secretion which is accompanied by a decreased bone density and muscle mass and an increase in adipose tissue. A study by Kim et al. (2009) reported that 1% of yeast supplementation improved the GH in the rats. Though previous studies noted a positive effect, the existing literature on

finishing pig fed YH supplementation have not examined the blood concentrations of GH, BUN, and creatinine, thus further studies are needed to determine the lack of biological function and to find optimal level of YH that could improve blood profile of finishing pigs.

According to Offer et al. (1988) back-fat thickness (BFT) is one of the main predictors of carcass lean content and meat quality. The impact of BFT has a reflection on LMP and assist in evaluating the meat quality. Apart from BFT the WHC is also considered as an important trait to quantify meat quality. Previously, Lee et al. (2011) demonstrated that edible meats from broiler chicks fed a diet containing yeast supplementation had enhanced water holding capacity and meat tenderness. Drip loss is another important visual sign to assess the quality of meat. In the current study, drip loss was significantly reduced on days 3, 5 and 7 with YH supplementation which is in agreement with Li et al. (2011) who noted a significant reduction on drip loss on day 7 in pigs fed greater level of yeast supplementation. In contrast Sun and Kim (2019), showed that broilers fed yeast containing *S. cerevisiae* strain did not show changes in the pH, color, cooking loss, WHC, and drip loss. However, to date, the influence of YH supplement on finishing pigs, and its effects on BFT, LMP and meat quality have not been well elucidated. Thus, adequate comparisons could not be made with other studies.

CONCLUSIONS

In summary dietary inclusion of yeast hydrolysate had increased growth performance, apparent total tract digestibility, *Lactobacillus* bacterial counts, backfat thickness, and lean meat percentage in finishing pigs. Moreover, best results are observed with inclusion of 0.1% yeast hydrolysate. Thus, we infer that the application 0.1% *S. cerevisiae* yeast hydrolysate can enhance the growth efficiency of finishing pigs.

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Conflict of Interest: The corresponding author and all co-authors have certified that there is no potential conflict of interest with this research article.

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Table 1. Composition of the experimental finishing pig diets (as-fed basis).

Composition	Phase I	Phase II
corn	45.06	51.15
Wheat	13.00	13.00
Soybean meal	23.00	18.70
Rapeseed meal	2.20	
Dried distillers' grains with soluble, corn	5.00	6.00
Dicalcium phosphate	1.06	1.12
Limestone	1.00	0.95
Salt	0.30	0.30
L-Lysine·SO ₄ (51%)	0.24	0.32
DL-Methionine (50%)	0.12	0.18
L-Tryptophan (10%)	0.01	
L-Threonine (98.5%)	0.13	0.07
Animal fat	5.30	4.86
Molasses	3.20	3.00
Choline (50%)	0.08	0.05
Vitamin premix ^a	0.15	0.15
Mineral premix ^b	0.15	0.15
Calculated composition		
Metabolizable energy (kcal kg ⁻¹)	3400	3400
Lysine (%)	0.95	0.90
Methionine (%)	0.30	0.30
Calciuma (%)	0.76	0.73
Phosphorus (%)	0.28	0.28

^a Provided per kilogram of complete diet: vitamin A, 10 000 IU; vitamin D₃, 2000 IU; vitamin E, 48 IU; vitamin K₃, 1.5 mg; riboflavin, 6 mg; niacin, 40 mg; D-pantothenic acid, 17 mg; biotin, 0.2 mg; folic acid, 2 mg; choline, 166 mg; vitamin B₆, 2 mg; and vitamin B₁₂, 28 mg.

^b Provided per kilogram of complete diet: iron (as FeSO₄·7H₂O), 90 mg; copper (as CuSO₄·5H₂O), 15 mg; zinc (as ZnSO₄), 50 mg; manganese (as MnO₂), 54 mg; iodine (as KI), 0.99 mg; and selenium (as Na₂SeO₃·5H₂O), 0.25 mg.

Table 2. Effect of dietary inclusion of yeast hydrolysate supplementation on growth performance of finishing pigs¹

Items	TRT1	TRT2	TRT3	SEM ²	<i>P</i> - Value ³	
					Linear	Quadratic
Body weight, kg						
Initial	52.9	53.00	53.00	0.02	0.092	0.92
Week 4	76.1	76.5	77.4	0.34	0.021	0.62
Week 8	100.5	101.9	103.1	0.80	0.043	0.924
Week 0-4						
ADG, g	826	841	871	13	0.029	0.617
ADFI, g	2,313	2,320	2,345	20	0.282	0.736
G: F	0.357	0.363	0.371	0.006	0.126	0.834
Week 4-8						
ADG, g	873	907	919	17	0.079	0.510
ADFI, g	2,731	2,754	2,760	36	0.588	0.847
G: F	0.320	0.330	0.333	0.009	0.313	0.740
Overall						
ADG, g	847	875	897	13	0.024	0.852
ADFI, g	2,522	2,537	2,552	23	0.361	0.991
G: F	0.336	0.345	0.352	0.007	0.145	0.850

¹Abbreviation: TRT1- (CON (basal diet)), TRT-2 (CON + 0.05% YH), TRT3 – (CON + 0.1% YH)

²Standard error of means.

³Means in the same row with different superscript differ significantly ($P < 0.05$).

Table 3. Effect of dietary inclusion of yeast hydrolysate supplementation on nutrient digestibility of finishing pigs¹

Items, %	TRT1	TRT2	TRT3	SEM ²	<i>P</i> - Value ³	
					Linear	Quadratic
Week 8						
Dry matter	71.4	72.3	73.5	1.31	0.028	0.911
Nitrogen	70. 8	71.8	72.3	1.67	0.058	0.906
Energy	72.00	72.1	73.1	1.44	0.046	0.818

¹Abbreviation: TRT1- (CON (basal diet)), TRT-2 (CON + 0.05% YH), TRT3 – (CON + 0.1% YH)

²Standard error of means.

³Means in the same row with different superscript differ (P<0.05).

Table 4. Effect of dietary inclusion of yeast hydrolysate supplementation on fecal microbial of finishing pigs¹

Items, log ₁₀ cfu/g	TRT1	TRT2	TRT3	SEM ²	<i>P</i> - Value ³	
					Linear	Quadratic
Week 8						
<i>Lactobacillus</i>	9.21	9.28	9.26	0.04	0.036	0.395
<i>E. coli</i>	7.28	7.29	7.25	0.03	0.532	0.480

¹Abbreviation: TRT1- (CON (basal diet)), TRT-2 (CON + 0.05% YH), TRT3 – (CON + 0.1% YH)

²Standard error of means.

³Means in the same row with different superscript differ significantly (P<0.05).

Table 5. Effect of dietary inclusion of yeast hydrolysate supplementation on gas emission of finishing pigs¹

Items, ppm	TRT1	TRT2	TRT3	SEM ²	<i>P</i> - Value ³	
					Linear	Quadratic
Week 8						
Methyl mercaptans	4.1	4.9	4.6	0.31	0.300	0.238
NH ₃	3.5	3.0	3.0	0.33	0.330	0.563
H ₂ S	23.1	27.0	21.9	3.11	0.798	0.281
Acetic acid	13.8	16.5	17.5	1.41	0.109	0.631
CO ₂	15,725	18,600	16,125	1170	0.817	0.111

¹Abbreviation: TRT1- (CON (basal diet)), TRT-2 (CON + 0.05% YH), TRT3 – (CON + 0.1% YH)

²Standard error of means.

³Means in the same row with different superscript differ significantly (P<0.05).

Table 6. Dietary impact of yeast hydrolysate supplementation on blood profile of finishing pigs¹

Items	TRT1	TRT2	TRT3	SEM ²	<i>P</i> - Value ³	
					Linear	Quadratic
Week 8						
BUN, mg/dL	10.2	7.2	6.6	1.4	0.151	0.519
Creatinine, mg/dL	1.50	1.53	1.36	0.07	0.148	0.185
Growth Hormone, ng/mL	0.05	0.05	0.06	0.01	0.597	0.302
IGF-1, ng/mL	79.6	86.6	98.0	11.0	0.037	0.063

¹Abbreviation: TRT1- (CON (basal diet)), TRT-2 (CON + 0.05% YH), TRT3 – (CON + 0.1% YH)

²Standard error of means.

³Means in the same row with different superscript differ significantly ($P < 0.05$).

Table 7. Dietary impact of yeast hydrolysate supplementation on backfat thickness & lean meat percentage of finishing pigs¹

Items	TRT1	TRT2	TRT3	SEM ²	<i>P</i> - Value ³	
					Linear	Quadratic
Week 8						
Backfat thickness, mm	17.0	17.2	17.4	0.2	0.062	0.976
LMP, %	56.2	57.4	57.9	0.3	0.042	1.000

¹Abbreviation: TRT1- (CON (basal diet)), TRT-2 (CON + 0.05% YH), TRT3 – (CON + 0.1% YH)

²Standard error of means.

³Means in the same row with different superscript differ significantly (P<0.05).

Table 8. Dietary impact of yeast hydrolysate supplementation on meat quality of finishing pigs¹

Items	TRT1	TRT2	TRT3	SEM ²	<i>P</i> - Value ³	
					Linear	Quadratic
pH	5.50	5.52	5.53	0.04	0.623	0.962
Water holding capacity, %	52.07	52.95	52.94	2.51	0.815	0.890
Cooking loss, %	61.28	61.91	59.44	1.59	0.443	0.458
Longissimus muscle area, cm ²	31.79	32.39	31.47	0.42	0.606	0.190
Drip loss, %						
d1	9.65	8.96	8.86	0.29	0.10	0.434
d3	15.08	14.22	13.37	0.54	0.05	0.182
d5	19.92	18.49	18.24	0.21	0.05	0.728
d7	24.65	23.97	23.60	0.24	0.08	0.285
Meat color						
L*	46.57	47.16	46.81	0.67	0.809	0.590
a*	14.59	14.36	14.25	0.16	0.167	0.782
b*	4.17	4.27	4.23	0.11	0.756	0.640
Sensory evaluation						
Color	3.30	3.28	3.31	0.07	0.919	0.747
Firmness	3.19	3.22	3.16	0.14	1.000	0.599
Marbling	3.25	3.16	3.25	0.22	0.921	0.863

¹Abbreviation: TRT1- (CON (basal diet)), TRT-2 (CON + 0.05% YH), TRT3 – (CON + 0.1% YH)

²Standard error of means.

³Means in the same row with different superscript differ significantly ($P < 0.05$).