Effects of Xylooligosaccharides on Growth Performance, Carcass Traits, and Meat Quality in Growing-Finishing Pigs: Postprint

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Date: 2017-10-23T00:00:00+00:00

Abstract

To investigate the effects of xylo-oligosaccharide (XOS) on growth performance, carcass traits, and meat quality of growing-finishing pigs, 80 three-way crossbred pigs with an average body weight of approximately 30 kg were selected and randomly allocated into 8 groups with 10 pigs per group, half barrows and half gilts, and individually housed. The experiment consisted of a control group, an antibiotic group, 100, 250, and 500 g/t XOS groups for the 30–65 kg stage, and 100, 250, and 500 g/t XOS groups for the 30–100 kg stage. The fasting body weight and feed intake of each pig were recorded at the beginning and end of the experiment to calculate average daily feed intake (ADFI), average daily gain (ADG), and feed/gain ratio (F/G). When the average body weight of the experimental pigs reached 100 kg, they were slaughtered for sampling to determine carcass traits, meat quality, and muscle chemical composition. The results showed that, compared with the control or antibiotic group, dietary supplementation with different doses of XOS had no significant effects on ADFI, ADG, F/G, carcass traits, or meat quality of growing-finishing pigs ($P > 0.05$). Supplementation with 250 g/t XOS during the 30–65 kg stage significantly increased the spleen index and crude protein content in the longissimus dorsi muscle ($P < 0.05$). Supplementation with 500 g/t XOS during the 30–100 kg stage significantly increased the spleen index and crude protein content in the longissimus dorsi muscle ($P < 0.05$). In conclusion, although dietary supplementation with different doses of XOS had no significant effects on ADFI, ADG, F/G, carcass traits, meat quality, and other indicators of growing-finishing pigs, it could improve the nutritional value of pork by increasing the crude protein content of muscle, with supplementation of 500 g/t XOS during the 30–100 kg stage showing the best effect.

Full Text

Effects of Dietary Supplementation of Xylo-Oligosaccharide on Growth Performance, Carcass Traits and Meat Quality in Growing-Finishing Pigs

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Abstract

This study investigated the effects of dietary xylo-oligosaccharide (XOS) supplementation on growth performance, carcass traits, and meat quality in growing-finishing pigs. Eighty crossbred pigs with an average initial body weight of approximately 30 kg were randomly allocated to eight groups (n = 10 per group, half male and half female) and housed individually. The experimental groups consisted of a control group, an antibiotic group, and groups receiving 100, 250, or 500 g/t XOS during the 30–65 kg stage, or 100, 250, or 500 g/t XOS during the 30–100 kg stage. Initial and final fasting body weights and feed intake were recorded to calculate average daily feed intake (ADFI), average daily gain (ADG), and feed-to-gain ratio (F/G). When the average body weight reached approximately 100 kg, pigs were slaughtered to determine carcass traits, meat quality, and muscle chemical composition. The results showed that compared with the control or antibiotic groups, dietary XOS supplementation at various doses did not significantly affect ADFI, ADG, F/G, carcass traits, or meat quality ($P > 0.05$). However, supplementation with 250 g/t XOS during the 30–65 kg stage significantly increased the spleen index and crude protein content in the longissimus dorsi muscle ($P < 0.05$). Similarly, 500 g/t XOS during the 30–100 kg stage significantly increased the spleen index and muscle crude protein content ($P < 0.05$). In conclusion, although dietary XOS supplementation did not significantly affect growth performance, carcass traits, or meat quality, it improved pork nutritional value by increasing muscle crude protein content, with the most effective regimen being 500 g/t XOS during the 30–100 kg stage.

Keywords: xylo-oligosaccharide; growing-finishing pigs; growth performance; carcass traits; meat quality

Introduction

With rising living standards, antibiotic-free pig production has become a major focus of public attention. However, conventional swine operations often rely on

feed antibiotics to enhance growth rate and feed conversion efficiency, which concurrently suppresses immune function, promotes microbial resistance, and compromises pork quality and flavor while leaving antibiotic residues in meat products. Consequently, developing safe and effective green feed additives to replace dietary antibiotics is urgently needed.

Xylo-oligosaccharide (XOS) is a functional oligosaccharide composed of 2–7 xylose units linked by β-1,4-glycosidic bonds, characterized by acid resistance, thermal stability, and resistance to host digestive enzymes, making it one of the most promising oligosaccharides. Research demonstrates that XOS selectively stimulates beneficial bacteria such as *Bifidobacterium* while inhibiting pathogenic *Escherichia coli*, enhances intestinal digestive function and immunity, promotes animal growth, and improves product quality. For instance, dietary supplementation with 100 or 200 g/t XOS increased ADG and reduced F/G in growing-finishing pigs, while 150–200 g/t XOS significantly improved ADG or ADFI. Additionally, 300 g/t XOS increased lean meat percentage and bone ratio, reduced carcass fat content, and improved meat color. Despite numerous reports on XOS effects, results remain inconsistent, and few studies have examined supplementation strategies across different growth phases. Therefore, this experiment aimed to evaluate the effects of varying XOS doses on growth performance, carcass traits, and meat quality in different growth stages of finishing pigs to provide a basis for producing high-quality pork.

1.1 Experimental Animals, Groups, and Management

Eighty Duroc × Large White × Landrace crossbred pigs weighing approximately 30 kg were randomly assigned to eight groups (n = 10 per group, equal sex ratio) and housed individually in 0.6 m × 1.1 m pens. The experimental design included a control group, an antibiotic group (0.04 kg/t virginiamycin and 0.2 kg/t colistin sulfate), three XOS groups receiving 100, 250, or 500 g/t XOS during the 30–65 kg stage, and three XOS groups receiving 100, 250, or 500 g/t XOS during the 30–100 kg stage. All pigs were slaughtered at approximately 100 kg body weight. XOS was provided by Shandong Longli Biotechnology Co., Ltd. (containing $ $35% XOS, primarily xylobiose, xylotriose, and xylotetraose). Supplementation levels were based on previous studies and manufacturer recommendations. The basal diet was a commercial grower-finisher feed formulated to exceed NRC (2012) nutrient requirements without antibiotics. Diet composition and nutrient levels are presented in Table 1 . The feeding trial was conducted at the Yongan Animal Experimental Base of the Institute of Subtropical Agriculture, Chinese Academy of Sciences from June to September 2015, following commercial pig farm management practices.

1.2 Growth Performance Measurement

Initial and final fasting body weights were recorded individually, and daily feed intake was monitored throughout the trial to calculate ADFI, ADG, and F/G.

1.3 Carcass Trait Measurement

At trial completion, eight pigs per group were selected and slaughtered by exsanguination according to the national standard "Technical Regulations for Performance Testing of Lean Meat Breeding Pigs." After removing the head, feet, tail, and viscera while retaining leaf fat and kidneys, carcasses were chilled at 4 °C for 2 hours and weighed. Backfat thickness at the 6th–7th rib interface and loin-eye area were measured using vernier calipers. After dissection, fat, lean, bone, liver, and spleen weights were recorded to calculate slaughter yield, fat percentage, lean meat percentage, bone percentage, and liver and spleen indices.

1.4 Meat Quality and Muscle Chemical Composition Measurement

Longissimus dorsi muscle samples were collected from the 6th–7th rib region of the right carcass side. Two-centimeter-thick slices were cut along muscle fibers, trimmed into 5 cm × 3 cm strips, weighed, bagged, and suspended at 4 °C for 24 hours to determine drip loss. Meat color was measured within 2 hours postmortem using a Minolta Chroma Meter II, and pH was recorded at 45 minutes and 24 hours (4 °C storage) as pH_{45} and pH_{24}, respectively. Freeze-dried and pulverized muscle samples were analyzed for dry matter, crude protein, and intramuscular fat content using conventional methods.

1.5 Statistical Analysis

Data were initially processed using Excel 2010 and subsequently analyzed by one-way ANOVA and LSD multiple comparisons using SAS 9.2. Results are expressed as least-squares means, with $P < 0.05$ considered statistically significant.

2.1 Effects of XOS on Growth Performance

As shown in Table 2 , no significant differences were observed in initial or final body weight among groups ($P > 0.05$). Similarly, ADFI, ADG, and F/G did not differ significantly ($P > 0.05$). However, numerically, the 100 g/t XOS group during the 30–65 kg stage exhibited higher ADG and lower F/G than the control group, while the 500 g/t XOS group during the 30–100 kg stage showed higher ADFI than both control and antibiotic groups.

2.2 Effects of XOS on Carcass Traits and Organ Indices

Table 3 shows that dietary XOS supplementation did not significantly affect slaughter yield, lean meat percentage, total fat percentage, bone percentage, backfat thickness, or loin-eye area compared with control or antibiotic groups ($P > 0.05$). Numerically, backfat thickness was reduced in the 100 and 250 g/t XOS groups during the 30–65 kg stage and in the 500 g/t XOS group during the 30–100 kg stage. All XOS groups had lower lean meat percentage and higher fat percentage than the control group. During the 30–65 kg stage, 250 g/t XOS

significantly increased the spleen index ($P < 0.05$), while during the 30–100 kg stage, 500 g/t XOS significantly elevated the spleen index ($P < 0.05$).

2.3 Effects of XOS on Meat Quality and Muscle Nutrient Content

Table 4 indicates that pH_{45} , pH_{24} , meat color, and drip loss did not differ significantly among groups ($P > 0.05$). Compared with the control group, 250 g/t XOS during the 30–65 kg stage and 500 g/t XOS during the 30–100 kg stage significantly increased crude protein content in the longissimus dorsi muscle ($P < 0.05$). No significant changes in intramuscular fat content were observed among XOS groups compared with control or antibiotic groups ($P > 0.05$).

Discussion

Previous studies indicate that XOS improves intestinal microecological balance and structure, enhances nutrient utilization, increases feed intake, boosts immune function and antioxidant capacity, and ultimately promotes growth and meat quality. In this trial, although XOS supplementation did not significantly affect ADG or F/G, the 500 g/t XOS group during the 30–100 kg stage showed a trend toward increased ADFI compared with the control group, whereas no such effect was observed during the 30–65 kg stage. This suggests that XOS supplementation can effectively increase feed intake in finishing pigs (65–100 kg), consistent with previous reports. Research also demonstrates that XOS supplementation produces more pronounced growth-promoting effects in low-performance pigs than in high-performance animals. However, other studies have shown that XOS significantly reduces F/G in piglets without affecting ADFI or ADG. These discrepancies may be attributed to differences in housing conditions, slaughter age, and dietary composition. The current trial was conducted during hot summer months with individually housed pigs, and heat stress or limited space in later stages may have compromised growth performance, warranting further investigation.

Carcass traits are reflected by slaughter yield, lean meat percentage, fat percentage, and backfat thickness. In this study, 100 or 250 g/t XOS during the 30–65 kg stage reduced backfat thickness, while 500 g/t XOS during the 30–100 kg stage decreased backfat thickness and increased slaughter yield without significant differences from the antibiotic group, suggesting that XOS can improve carcass traits comparably to antibiotics. Other studies have reported that XOS significantly increases lean meat and bone percentages while reducing carcass fat percentage, with variations possibly related to breed, nutritional level, and slaughter age.

Visceral organ weight serves as an important health indicator, with organ weights correlating linearly with body weight. The spleen, the largest immune organ, reflects cellular immune function through its index. In this trial, the 250 g/t XOS group during the 30–65 kg stage showed a higher spleen index than the 500 g/t group, indicating better immune enhancement at this dosage.

During the 30–100 kg stage, the 500 g/t XOS group exhibited a significantly higher spleen index than the corresponding 30–65 kg stage group, suggesting that XOS effectively improves immune function in finishing pigs (65–100 kg). Compared with control and antibiotic groups, 250 g/t XOS during the 30–65 kg stage or 500 g/t XOS during the 30–100 kg stage significantly increased the spleen index, indicating that XOS may moderately outperform antibiotics in modulating immune function, consistent with previous findings and likely attributable to its immune-enhancing properties.

Meat quality is evaluated primarily through color, pH, and drip loss, which directly affect tenderness, water-holding capacity, and shelf life. In this study, 500 g/t XOS during the 30–65 kg stage and 250 or 500 g/t XOS during the 30–100 kg stage numerically reduced yellowness (b*), lightness (L*), and drip loss while increasing redness (a*) in the longissimus dorsi muscle, suggesting that XOS can improve meat quality, which aligns with previous research. Muscle chemical composition is a major determinant of meat quality; lower moisture content corresponds to higher dry matter and protein content, thereby increasing nutritional value. The 250 g/t XOS group during the 30–65 kg stage showed higher muscle crude protein content than the 500 g/t group, indicating superior improvement in nutritional value at this dosage. During the 30–100 kg stage, the 500 g/t XOS group exhibited significantly higher crude protein content than the corresponding 30–65 kg stage group, suggesting that XOS effectively enhances the nutritional value of pork in finishing pigs. Compared with control and antibiotic groups, 500 g/t XOS during the 30–100 kg stage increased dry matter and crude protein content in the longissimus dorsi muscle, indicating that XOS moderately outperforms antibiotics in improving pork nutritional value, with 500 g/t XOS during the 30–100 kg stage being optimal.

In conclusion, although dietary XOS supplementation did not significantly affect ADFI, ADG, F/G, carcass traits, or meat quality in growing-finishing pigs, it increased immune organ indices and improved pork nutritional value by elevating muscle crude protein content, with the most effective regimen being 500 g/t XOS during the 30–100 kg stage.

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Note: Figure translations are in progress. See original paper for figures.