Effects of Dietary Konjac Mannan Oligosaccharide Supplementation Levels on Growth Performance, Fur Quality, Slaughter Performance, and Meat Quality of Growing Rex Rabbits (Postprint)

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Abstract

This experiment aimed to investigate the effects of dietary konjac mannan oligosaccharide (KON-MOS) supplementation levels on growth performance, fur quality, slaughter performance, and meat quality of growing rex rabbits. One hundred twenty weaned rex rabbits with an average body weight of (0.84$±$0.07) kg were selected and randomly divided into 5 groups (24 replicates per group, 1 rabbit per replicate). Group served as the control group and was fed the basal diet, while groups - were experimental groups fed experimental diets with KON-MOS supplementation levels of 50, 100, 150, and 200 mg/kg, respectively. The pre-trial period lasted 7 days, and the formal trial period lasted 60 days. The results showed that: 1) Dietary KON-MOS supplementation level had significant effects on average daily gain and feed-to-gain ratio of growing rex rabbits (P<0.05). Group exhibited the highest average daily gain, which was significantly higher than that of the control group (P<0.05), and the lowest feed-to-gain ratio, which was significantly lower than that of the control group (P<0.05). Dietary KON-MOS supplementation level had no significant effect on diarrhea rate or mortality rate of growing rex rabbits (P>0.05), but both were lower in the experimental groups than in the control group. 2) Dietary KON-MOS supplementation level had no significant effects on hair density, hair length, or pelt weight of growing rex rabbits (P>0.05), but had a significant effect on pelt area (P<0.05). The pelt area of group was significantly larger than that of the control group (P<0.05), with no significant differences among the experimental groups (P>0.05). 3) Dietary KON-MOS supplementation level had no significant effects on eviscerated yield percentage or semi-eviscerated yield percentage of

growing rex rabbits (P>0.05), but both were higher in the experimental groups than in the control group. 4) Dietary KON-MOS supplementation level had no significant effects on pH, shear force, cooking loss, or lightness (L*), redness (a)*, and yellowness (b*) values at 45 min and 24 h post-slaughter in growing rex rabbits (P>0.05). Based on a comprehensive consideration of all measured indices in this experiment, the appropriate KON-MOS supplementation level in diets for growing rex rabbits is 100 mg/kg.

Full Text

Effects of Konjac Mannose Oligosaccharide Supplemental Level on Growth Performance, Fur Quality, Slaughter Performance and Meat Quality of Growing Rex Rabbits

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Abstract: This experiment investigated the effects of dietary konjac mannose oligosaccharide (KON-MOS) supplementation on growth performance, fur quality, slaughter performance, and meat quality in growing Rex rabbits. One hundred twenty weaned Rex rabbits with an average body weight of (0.84$±$0.07) kg were randomly allocated to five groups (24 replicates per group, one rabbit per replicate). Group I served as the control and received a basal diet, while groups II–V received experimental diets supplemented with 50, 100, 150, and 200 mg/kg KON-MOS, respectively. The study consisted of a 7-day pre-trial period followed by a 60-day formal experimental period.

The results showed: (1) Dietary KON-MOS supplementation significantly affected average daily gain (ADG) and feed-to-gain ratio (F/G) (P<0.05). Group III exhibited the highest ADG, which was significantly greater than that of the control group (P<0.05), and the lowest F/G, which was significantly lower than the control (P<0.05). While KON-MOS supplementation did not significantly influence diarrhea rate or mortality (P>0.05), both parameters were lower in all treatment groups compared to the control. (2) KON-MOS supplementation had no significant effect on wool density, wool length, or fur weight (P>0.05), but significantly influenced fur area (P<0.05). The fur area in group III was significantly larger than that of the control (P<0.05), though no significant differences were observed among the treatment groups (P>0.05). (3) Although not statistically significant (P>0.05), both eviscerated carcass yield and semi-eviscerated carcass yield were higher in all treatment groups compared to the control. (4)

KON-MOS supplementation did not significantly affect pH values at 45 min and 24 h post-slaughter, shear force, cooking loss, or L, *a*, and b* color values (P>0.05). Based on comprehensive evaluation of all measured parameters, the optimal dietary KON-MOS supplementation level for growing Rex rabbits is 100 mg/kg.

Keywords: konjac mannose oligosaccharide; Rex rabbits; growth performance; fur quality; slaughter performance; meat quality

Introduction

Amid growing concerns regarding livestock product safety and the progressive advancement of antibiotic-free animal production, the development of oligosaccharide additives has emerged as a prominent research focus. Konjac mannose oligosaccharide (KON-MOS), a functional oligosaccharide, offers advantages including environmental friendliness, safety, stability, and absence of residues and drug resistance. Its potential to promote animal growth and improve slaughter performance has gradually attracted scholarly attention. Previous studies have demonstrated beneficial effects of mannose oligosaccharides across species: Jian et al. [1] reported that dietary supplementation with 0.1% and 0.2% MOS improved feed utilization efficiency, growth performance, and intestinal environment in yellow-feathered broilers; Li et al. [2] found that *Pichia pastoris* MOS enhanced growth performance in weaned piglets by optimizing intestinal villus structure and strengthening immune function; and Torrecillas et al. [3] observed that MOS increased blood immunoglobulin levels while elevating T-cell receptor and major histocompatibility complex class II (MHCII) expression. China possesses abundant konjac resources, providing a strategic advantage for KON-MOS development and utilization. However, no studies have investigated KON-MOS application in Rex rabbit production. Therefore, this experiment examined the effects of varying dietary KON-MOS levels on growth performance, fur quality, slaughter performance, and meat quality in growing Rex rabbits to determine the optimal supplementation level and provide a scientific basis for KON-MOS application in rabbit production.

Materials and Methods

1.1 Experimental Material and Basal Diet The KON-MOS used in this study was a commercial product from Hebei Kena Biotechnology Co., Ltd., produced via enzymatic hydrolysis with $ $25% active content as a brownish-yellow powder. The basal diet was formulated according to NRC (1977) [4] recommendations for rabbit nutrient requirements and Gu Zilin [5] suggested nutrient allowances for Rex rabbits. Diet composition and nutrient levels are presented in . Experimental diets were prepared by supplementing the basal diet with 50, 100, 150, or 200 mg/kg KON-MOS. All diets were processed into pellets measuring 4–6 mm in diameter and 10 mm in length.

1.2 Experimental Animals and Design One hundred twenty weaned Rex rabbits with an average body weight of (0.84$±$0.07) kg (half male and half female) were randomly assigned to five groups based on sex and body weight. Each group comprised 24 replicates with one rabbit per replicate. Group I served as the control and received the basal diet, while groups II–V received experimental diets supplemented with 50, 100, 150, and 200 mg/kg KON-MOS, respectively. Prior to the experiment, all housing facilities and cages were thoroughly cleaned and disinfected. Rabbits were individually housed, fed twice daily at 08:00 and 18:00, and provided ad libitum access to feed and water under natural ventilation and lighting. The study consisted of a 7-day pre-trial period followed by a 60-day formal experimental period.

1.3 Measurement Parameters

1.3.1 Growth Performance Body weight was measured at the beginning and end of the experiment, with total feed consumption recorded throughout to calculate average daily gain (ADG), average daily feed intake (ADFI), and feed-to-gain ratio (F/G). Daily diarrhea incidence and mortality were recorded to calculate diarrhea rate and mortality percentage.

Diarrhea rate (%) = [Number of diarrheic rabbits/(Number of experimental days × Number of rabbits)] × 100
Mortality rate (%) = (Number of dead rabbits/Total number of experimental rabbits) × 100

1.3.2 Fur Quality Wool density was determined using the "five-point sampling method" described by Gu Zilin et al. [6]. Fur weight was measured after skinning via circular excision and removal of residual muscle and fat. Wool length was directly measured using vernier calipers. Fur area was calculated as the product of fur length (from the middle of the neck to the tail base) and fur width (distance between lateral edges at the waist).

1.3.3 Slaughter Performance At the conclusion of the experiment, four rabbits (two males and two females) were randomly selected from each group for slaughter following a 12-hour fasting period. Pre-slaughter live weight was recorded, and post-slaughter weights of carcasses and internal organs were measured. Eviscerated carcass weight was defined as the weight after removal of blood, head, fur, limbs, and all internal organs. Semi-eviscerated carcass weight included the eviscerated carcass plus liver, kidneys, and heart.

Eviscerated carcass yield (%) = (Eviscerated carcass weight/Pre-slaughter live weight) × 100
Semi-eviscerated carcass yield (%) = [(Eviscerated carcass weight + Heart weight + Liver weight + Kidney weight)/Pre-slaughter live weight] × 100

1.3.4 Meat Quality Post-slaughter, 3 cm × 4 cm samples of *longissimus dorsi* muscle were excised from both sides for determination of cooking loss, pH values at 45 min and 24 h post-slaughter, L*, a*, and b* color values, and shear force.

Cooking loss: Meat samples were weighed (m_1, g), vacuum-packaged in plastic bags, cooked in an 80°C water bath for 1 h, cooled under running water for 20–30 min, then reweighed after surface moisture removal (m_2, g). Cooking loss (%) = $[(m_1 - m_2)/m_1] \times 100$.

pH values: pH was measured at 45 min and 24 h post-slaughter using a testo-205 pH meter at three locations (upper, middle, lower) of each sample, with values averaged.

Color values: L*, a*, and b* values were measured using an i-wave WR-18 precision colorimeter at three locations per sample and averaged.

Shear force: Samples were bagged and heated in a 75–80°C water bath for 2 h, cooled under running water for 30 min, then cut into 1.5 cm × 1.0 cm × 0.5 cm sections parallel to muscle fiber orientation. Shear force was measured using a CLM-3B muscle tenderness meter.

1.4 Data Processing and Analysis Data were processed and analyzed using Excel 2007 and SPSS 17.0 software. One-way ANOVA was employed to test for significant differences among groups, with LSD post-hoc comparisons applied where appropriate. Significance was declared at $P<0.05$ and extreme significance at $P<0.01$. Except for diarrhea and mortality rates, all results are expressed as mean ± standard deviation.

Results

2.1 Effects of Dietary KON-MOS Supplementation on Growth Performance As shown in , dietary KON-MOS supplementation significantly affected ADG and F/G ($P<0.05$) but not ADFI ($P>0.05$). Group III exhibited the highest ADG at $(21.25\$\pm1.20)g/d, significantlyexceedingthecontrolgroup's(19.83\pm0.98)g/d(P < 0.05).GroupsII, IV, andVshowedADGincreasesof3.22\pm0.59), significantlylowerthanthecontrol's(5.33\pm0.51 0.05).NosignificantdifferencesinF/Gwereobservedamongtreatmentgroups(P > 0.05).GroupIIIalsoshowedthelowestADFIat(101.72\pm4.01)g/d, representinga4.13\pm\$2.97)$ g/d ($P>0.05$). Although diarrhea and mortality rates did not differ significantly among groups ($P>0.05$), both parameters were lower in all treatment groups compared to the control.

2.2 Effects of Dietary KON-MOS Supplementation on Fur Quality demonstrates that dietary KON-MOS supplementation had no significant effects on wool density, wool length, or fur weight ($P>0.05$), but significantly influenced fur area ($P<0.05$). All treatment groups exhibited larger fur areas than the control, with group III showing the greatest area of $(1132.33\$\pm29.05)cm^{\{2\}, significantlyexceedingthecontrol's(912.67\pm20.39)cm}\{2\}\$$

($P<0.05$). No significant differences were detected among treatment groups ($P>0.05$).

2.3 Effects of Dietary KON-MOS Supplementation on Slaughter Performance As presented in , despite no significant differences in pre-slaughter live weight among groups ($P>0.05$), both eviscerated and semi-eviscerated carcass yields in growing Rex rabbits showed a trend of increasing then decreasing with rising KON-MOS supplementation levels. Groups II, III, IV, and V exhibited eviscerated carcass yields 4.07%, 9.37%, 7.22%, and 3.72% higher than the control, respectively, and semi-eviscerated carcass yields 5.14%, 9.41%, 6.63%, and 4.94% higher, though these differences did not reach statistical significance ($P>0.05$).

2.4 Effects of Dietary KON-MOS Supplementation on Meat Quality reveals that dietary KON-MOS supplementation did not significantly affect shear force, cooking loss, meat color parameters (L*, a*, b* values), or pH values at 45 min and 24 h post-slaughter in *longissimus dorsi* muscle ($P>0.05$). However, the control group exhibited greater pH decline between 45 min and 24 h post-slaughter and higher a* values compared to all treatment groups.

Discussion

3.1 Effects on Growth Performance Numerous studies have documented MOS effects on livestock growth performance. Zhang et al. [7] reported that MOS significantly increased ADG and reduced F/G in weaned piglets while decreasing diarrhea rate and index. Kang et al. [8] demonstrated that MOS supplementation in calf diets significantly improved ADG and F/G while reducing diarrhea incidence. The present study' s significant improvements in ADG and F/G for growing Rex rabbits align with findings by Mourão et al. [9] in rabbits and Bovera et al. [10] in Ira rabbits. The growth-promoting mechanisms of KON-MOS likely involve: (1) modulation of intestinal microenvironment to promote beneficial bacteria proliferation and reduce pathogen colonization. Jahanian et al. [11] reported that MOS significantly increased intestinal *Lactobacillus* populations while markedly reducing *Salmonella* without affecting total bacterial counts. The interaction between nutrition and gut microbiota critically influences growth performance, and KON-MOS helps maintain microecological balance or establish beneficial bacterial dominance, thereby enhancing nutrient utilization. Additionally, KON-MOS mitigates nutrient absorption impairment and excessive nutrient consumption caused by microbial imbalance or pathogen predominance. (2) Optimization of intestinal morphology and function. Pinheiro et al. [12] found that MOS significantly increased intestinal villus length and absorptive surface area in rabbits. As the primary digestive organ in rabbits, intestinal function directly impacts nutrient digestion and utilization. KON-MOS promotes intestinal development, improves morphological structure and function, and enhances digestive and absorptive capacity, thereby improving growth performance. Furthermore, KON-MOS increases cecal volatile fatty

acid concentrations, reduces cecal pH, enhances disease resistance, antioxidant capacity, and stress tolerance, adsorbs mycotoxins, and improves feed quality —all contributing positively to rabbit growth performance. These mechanisms may also explain the reduced diarrhea and mortality rates observed in treatment groups, as decreased pathogen loads, maintained intestinal mucosal integrity, enhanced disease resistance, and improved feed quality collectively reduce digestive disorders and mortality.

In this study, 100 mg/kg KON-MOS supplementation produced the highest ADG and lowest F/G, with diminishing returns at higher inclusion levels. This may be attributed to weaning stress and dietary transitions affecting immune responses and intestinal homeostasis in young rabbits. While KON-MOS enhances disease resistance and maintains microecological balance, excessive supplementation may trigger overstimulation of the immune system, thereby compromising growth performance.

3.2 Effects on Fur Quality Rex rabbits are a fur-producing breed, with pelt quality directly determining economic value. Key quality indicators include wool density, wool length, fur area, and fur weight. The current study found no significant effects of KON-MOS supplementation on wool density, wool length, or fur weight. However, 100 mg/kg KON-MOS significantly increased fur area, likely due to the positive correlation between fur area and body weight. As Gu Zilin [13] reported, Rex rabbit fur area correlates positively with weight gain, and fur area changes influence fur weight. In this study, all treatment groups showed larger fur areas than the control, with group III significantly exceeding the control, while fur weight followed similar trends without reaching statistical significance—findings consistent with Gu Zilin [13].

3.3 Effects on Slaughter Performance As a fur-producing breed, research and production efforts have traditionally focused on improving Rex rabbit pelt quality and yield, with less emphasis on meat development and utilization. Rabbit meat, characterized by high protein, low fat, and low cholesterol content, is esteemed as "the essence among meats" and favored by consumers. Simultaneous improvement of both pelt and meat quality would enhance overall economic value. Slaughter yield is a crucial indicator of meat production efficiency. Although pre-slaughter live weights did not differ significantly among groups, both eviscerated and semi-eviscerated carcass yields were higher in all treatment groups compared to the control, albeit without statistical significance. This suggests that dietary KON-MOS supplementation tends to improve slaughter yields, possibly because slaughter yield correlates positively with body weight within the same breed or physiological stage.

3.4 Effects on Meat Quality Rising living standards have increased consumer demands for meat quality. Meat quality is a comprehensive trait evaluated through pH, tenderness, water-holding capacity, and color. pH is a critical parameter reflecting the rate and intensity of post-slaughter glycogen-to-lactic

acid conversion. pH decline causes protein denaturation, cytoskeletal contraction, and increased muscle rigor and drip loss, thereby affecting meat color, tenderness, and shelf life—higher pH generally correlates with longer storage duration [14]. Although no significant differences were observed in pH values at 45 min and 24 h post-slaughter among groups, the control group exhibited greater pH decline, suggesting that KON-MOS supplementation may delay glycolysis and extend storage life. Tenderness, a key consumer selection criterion, is typically represented by shear force and relates to myofibrillar and connective tissue content and structure. The absence of significant differences in shear force among groups indicates that KON-MOS did not significantly affect rabbit meat tenderness. Water-holding capacity, described by cooking loss, influences meat color, juiciness, and processing yield. The lack of significant differences in cooking loss suggests KON-MOS did not substantially affect water-holding capacity. Meat color, influenced by myoglobin content [15], serves as a direct sensory quality indicator affecting consumer behavior. The absence of significant differences in L*, a*, and b* values indicates that KON-MOS supplementation did not significantly impact meat color.

Conclusions

1. Dietary KON-MOS supplementation significantly improved ADG and F/G in growing Rex rabbits, showed no significant effects on fur quality or meat quality, but demonstrated improving trends in eviscerated carcass yield, semi-eviscerated carcass yield, and meat storage duration.
2. Based on comprehensive evaluation of all measured parameters, the optimal dietary KON-MOS supplementation level for growing Rex rabbits is 100 mg/kg.

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