Effects of Corn- and Wheat-Based Diets on Growth Performance, Meat Quality, Plasma Biochemical Indices, and Lipid Metabolism in Broiler Chickens: Postprint

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Date: 2017-10-11T00:00:00+00:00

Abstract

This experiment was conducted to investigate the effects of corn-based diet and wheat-based diet on growth performance, meat quality, plasma biochemical indices, and lipid metabolism in broiler chickens. A total of 180 healthy 1-day-old male Arbor Acres broiler chicks were randomly allocated to 2 groups, which were fed corn-based diet and wheat-based diet, respectively, with 6 replicates per group and 15 birds per replicate. The experimental period lasted 42 days. The results showed that, compared with the corn-based diet, broiler chickens fed the wheat-based diet had: 1) significantly increased average daily gain (ADG) during the early growth stage (1-21 days of age) and the entire period (1-42 days of age) ($P<0.05$), and significantly decreased mortality during the early growth stage ($P<0.05$); 2) significantly decreased abdominal fat percentage at 42 days of age ($P<0.05$); 3) significantly decreased a* values of breast muscle at 45 min and 24 h at 42 days of age ($P<0.05$), and increased L* value at 45 min ($P=0.096$); 4) significantly decreased plasma total bilirubin content at 21 and 42 days of age ($P<0.05$); significantly increased plasma total protein and albumin contents at 21 days of age ($P<0.05$), significantly decreased plasma glutamate aminotransferase activity at 21 days of age ($P<0.05$); significantly increased plasma uric acid content at 42 days of age ($P<0.05$); 5) significantly decreased plasma triglyceride content at 21 and 42 days of age ($P<0.05$); significantly decreased plasma total cholesterol content at 42 days of age ($P<0.05$). In conclusion, under the conditions of this experiment, compared with the corn-based diet, the wheat-based diet improved growth performance, lipid metabolism, and health status, and reduced abdominal fat percentage in broiler chickens.

Full Text

Effects of Corn-Type Diet and Wheat-Type Diet on Growth Performance, Meat Quality, Plasma Biochemical Parameters, and Lipid Metabolism of Broilers

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Abstract

This study investigated the effects of corn-type and wheat-type diets on growth performance, meat quality, plasma biochemical parameters, and lipid metabolism in broiler chickens. A total of 180 healthy one-day-old male Arbor Acres broilers (initial weight approximately 44.03 g) were randomly allocated to two groups fed either a corn-type or wheat-type diet, with six replicates per group and 15 birds per replicate. The experiment lasted 42 days. The results showed that, compared with the corn-type diet, the wheat-type diet significantly increased average daily gain (ADG) during the starter phase (1–21 days) and the entire experimental period (1–42 days) ($P<0.05$), and significantly reduced mortality during the starter phase ($P<0.05$). At 42 days of age, the wheat-type diet significantly decreased abdominal fat percentage ($P<0.05$). Breast muscle redness (a*) values at 45 min and 24 h post-slaughter were significantly lower ($P<0.05$), while lightness (L*) values at 45 min showed an increasing trend ($P=0.096$). Plasma total bilirubin content was significantly reduced at both 21 and 42 days of age ($P<0.05$). At 21 days, plasma total protein and albumin contents were significantly increased ($P<0.05$), while plasma alanine aminotransferase activity was significantly decreased ($P<0.05$). At 42 days, plasma uric acid content was significantly increased ($P<0.05$). Plasma triglyceride content was significantly reduced at both 21 and 42 days ($P<0.05$), and plasma total cholesterol content was significantly decreased at 42 days ($P<0.05$). These findings indicate that, under the conditions of this experiment, wheat-type diets improved growth performance, lipid metabolism, and health status while reducing abdominal fat percentage compared to corn-type diets.

Keywords: corn; wheat; broilers; growth performance; meat quality; plasma parameters

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Introduction

Corn is widely used as the primary energy source in animal production due to its favorable palatability, nutritional value, and economic benefits. However,

fluctuations in corn prices in China—driven by increasing feed demand, import restrictions, reduced planting area, and mold contamination—have created challenges for the poultry industry. Since feed costs account for over 60% of broiler production expenses, utilizing alternative feed resources can help balance feed formulations and reduce costs. Wheat, which has high starch content, is extensively used in animal feed in Europe, Canada, and Australia. In recent years, Chinese feed mills in major wheat-producing regions have also adopted wheat as an energy feedstuff. Compared with corn, wheat has lower energy value but higher contents of crude protein, amino acids, phytate phosphorus, and non-starch polysaccharides (NSP). Consequently, research has focused on enzyme supplementation in wheat-based diets, with studies demonstrating that enzymes can improve feed conversion efficiency, promote intestinal development, modulate gut microbiota, reduce intestinal digesta viscosity, and enhance growth performance. As a result, enzyme supplementation in wheat-based diets has become common practice. However, few studies have directly compared the effects of corn- and wheat-based diets on meat quality, plasma biochemical parameters, and lipid metabolism in broilers. Since wheat contains lower levels of crude fat and pigments than corn, it may affect meat quality and plasma biochemical indices. Therefore, this experiment was conducted to evaluate the effects of corn- and wheat-type diets on growth performance, meat quality, plasma biochemical parameters, and lipid metabolism in broilers, providing a theoretical basis for the feasibility of replacing corn with wheat.

Materials and Methods

Experimental Design and Diets A single-factor experimental design was employed. One hundred eighty healthy one-day-old male Arbor Acres broilers with an average initial weight of 44.03 g were randomly divided into two groups fed either a corn-type or wheat-type diet. Each group consisted of six replicates with 15 birds per replicate. During diet preparation, corn, wheat, and soybean meal were first ground using a hammer mill, then mixed individually before being combined in proportion to produce uniform compound powder feed, which was subsequently cold-pelleted and fed in pellet form. Birds were raised in a four-tier cage system. Experimental diets were formulated according to NRC (1994), the Chinese Feeding Standard of Chickens (NY/T 33—2004), and the AA Broiler Management Handbook. The experimental period lasted 42 days.

Management Practices Birds had ad libitum access to feed and water throughout the experiment. Lighting consisted of natural light supplemented with artificial light at an intensity of 30 lx: 24 h of light during days 1–7, and 23 h of light daily thereafter. Room temperature was maintained at 33 °C for the first three days, then reduced by 2 °C weekly until reaching 24 °C, which was maintained for the remainder of the experiment. Management followed the AA Broiler Management Handbook, with routine vaccination and disinfection.

The house was well-ventilated. Temperature (23.5–24.5 °C) and humidity (50–60%) were recorded continuously, and mortality was documented daily.

Sample Collection and Preparation At 21 and 42 days of age, one bird per replicate with body weight close to the replicate average was selected after a 12-hour fast. Blood (4 mL) was collected from the wing vein into anticoagulant tubes, centrifuged at 3,000 rpm for 10 min at 4 °C, and the plasma was stored in 0.5 mL Eppendorf tubes at -20 °C for subsequent analysis of biochemical and lipid metabolism parameters.

Measurements **Growth Performance:** At 1, 21, and 42 days of age, birds and residual feed were weighed by replicate to calculate average body weight (BW), average daily gain (ADG), average daily feed intake (ADFI), feed-to-gain ratio (F/G), and mortality.

Slaughter Performance: At 42 days, one bird per replicate with body weight close to the average was selected, slaughtered by jugular bleeding, and eviscerated. Carcass, breast muscle, thigh muscle, and abdominal fat were weighed to calculate dressing percentage, breast muscle percentage, thigh muscle percentage, and abdominal fat percentage according to the National Poultry Breeding Commission' s methods.

Meat Quality: At 42 days, the right breast muscle was excised and weighed to measure pH, meat color, drip loss, cooking loss, and shear force according to the method of Zhang et al. [6]. pH was measured at 45 min and 24 h post-slaughter (stored at 4 °C) using a pH meter (CyberScan pH310, EUTECH, Singapore) by inserting the probe approximately 1 cm deep into the muscle. Each sample was measured three times and averaged. Meat color was assessed using the CIE-Lab system with a WSC-S colorimeter (Shanghai Precision Scientific Instrument Co., Shanghai) to determine lightness (L*), redness (a*)*, and yellowness (b*) values at 45 min and 24 h post-slaughter, with three measurements per sample. Drip loss was determined by weighing approximately 30 g of uniform breast muscle (W1) within 45 min post-slaughter, placing it in a sealed bag inflated with nitrogen to minimize contact with the bag interior, suspending it at 4 °C for 24 h, then blotting and reweighing (W2). Drip loss (%) = [(W1-W2)/W1] × 100. Cooking loss was measured on the same samples after drip loss determination. Samples were placed in new sealed bags and heated in an 80 °C water bath until the core temperature reached 75 °C, then cooled to room temperature under running water, blotted, and weighed (W3). Cooking loss (%) = [(W2-W3)/W2] × 100. Shear force was measured on two rectangular strips (2 cm × 2 cm × 1 cm) cut parallel to the muscle fiber orientation. Using a TMS-Pro texture analyzer (Food Technology Corporation, Virginia, USA) with a 100 N load cell, 150 mm/min crosshead speed, and 6 mm gap, each sample was tested three times perpendicular to the fiber direction, and the average of six measurements was reported.

Plasma Biochemical and Lipid Metabolism Parameters: Plasma alanine

aminotransferase (ALT), aspartate aminotransferase (AST) activities, and total bilirubin (TBIL), total protein (TP), albumin (ALB), uric acid (UA), glucose (GLU), creatinine (CRE), triglyceride (TG), total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C) concentrations were measured using commercial kits (Shanghai Kehua Bio-engineering Co., Ltd.) on a CHEM-5 semi-automatic biochemical analyzer.

Statistical Analysis Data are presented as means ± standard deviation. Differences between the two groups were analyzed using t-tests in SPSS 16.0 software, with $P<0.05$ considered statistically significant.

Results

Effects of Corn- and Wheat-Type Diets on Growth Performance As shown in , broilers fed the wheat-type diet had higher body weights at 21 and 42 days of age compared to those fed the corn-type diet ($P=0.105$ and $P=0.065$, respectively). During the starter phase (1–21 days), ADG was significantly increased ($P<0.05$) and mortality was significantly decreased ($P<0.05$) in wheat-fed broilers, while ADFI showed an increasing trend ($P=0.090$). During the grower phase (22–42 days), although ADG and ADFI were numerically higher in the wheat group, no significant differences were observed ($P>0.05$). Over the entire experimental period (1–42 days), wheat-fed broilers exhibited significantly greater ADG ($P<0.05$) with no significant differences in other performance parameters ($P>0.05$). These results suggest that wheat-type diets improved ADG in broilers while maintaining other growth performance parameters comparable to corn-type diets.

Effects of Corn- and Wheat-Type Diets on Slaughter Performance shows that no significant differences were observed between dietary treatments for dressing percentage, breast muscle percentage, or thigh muscle percentage ($P>0.05$). However, wheat-fed broilers exhibited numerical increases of 1.67% in dressing percentage and 8.64% in breast muscle percentage at 42 days, and a 4.93% increase in thigh muscle percentage at 21 days. Abdominal fat percentage was reduced in wheat-fed broilers, showing a decreasing trend at 21 days ($P=0.104$) and a significant reduction at 42 days ($P<0.05$). These findings indicate that wheat-type diets reduced abdominal fat deposition and tended to improve carcass yield in broilers.

Effects of Corn- and Wheat-Type Diets on Meat Quality As presented in , no significant differences were observed between dietary treatments for drip loss, cooking loss, or shear force of breast muscle at 42 days ($P>0.05$). However, compared with the corn-type diet, wheat-fed broilers showed significantly lower a^* values at 45 min and 24 h post-slaughter ($P<0.05$), and a trend toward increased L^* values at 45 min ($P=0.096$). No significant differences were detected

for pH or b* values at 24 h (P>0.05). These results suggest that wheat-type diets reduced meat color intensity in broilers without significantly affecting other meat quality attributes.

Effects of Corn- and Wheat-Type Diets on Plasma Biochemical Parameters demonstrates that wheat-fed broilers had significantly lower plasma TBIL content at both 21 and 42 days (P<0.05). At 21 days, plasma TP and ALB contents were significantly increased (P<0.05), while ALT activity was significantly decreased (P<0.05). Plasma UA content was significantly increased at 42 days (P<0.05). No significant differences were observed for plasma AST activity or GLU and CRE contents at either age (P>0.05). These findings indicate that wheat-type diets improved plasma biochemical profiles, reduced TBIL content and ALT activity, and increased TP, ALB, and UA contents, suggesting enhanced health status in broilers.

Effects of Corn- and Wheat-Type Diets on Plasma Lipid Metabolism As shown in , wheat-fed broilers exhibited significantly lower plasma TC content at 42 days (P<0.05) and significantly reduced TG content at both 21 and 42 days (P<0.05) compared to corn-fed broilers. No significant differences were observed for HDL-C content at either age (P>0.05), though LDL-C content was numerically lower in wheat-fed broilers. These results suggest that wheat-type diets improved lipid metabolism in broilers.

Discussion

Effects on Growth Performance The wheat-type diet improved body weight and ADG in broilers, likely due to increased feed intake and enhanced intestinal health promoting nutrient digestion and absorption. Research indicates that whole wheat diets stimulate gizzard development, which improves feed grinding and increases contact between nutrients and digestive enzymes, thereby enhancing nutrient utilization and energy efficiency. Wheat-based diets also promote intestinal tract development (duodenum, jejunum, ileum), contributing to improved growth. Additionally, the reduced mortality during the starter phase reflects better health status, as this period is critical for organ development and immune system maturation. The plasma biochemical results support this, showing significantly increased TP and ALB and decreased ALT at 21 days, indicating enhanced immunity and liver metabolic function. While whole wheat feeding significantly affects upper digestive tract development, the wheat-type diet in this study did not improve feed conversion efficiency, possibly due to processing methods. Increased viscosity during pelleting may reduce digestibility if not properly processed, and previous research suggests that feeding method significantly influences the effects of wheat-based diets on intestinal development and growth, with ad libitum feeding potentially not being optimal.

Effects on Slaughter Performance Although dressing percentage, breast muscle percentage, and thigh muscle percentage were not significantly improved by the wheat-type diet, the increased body weight resulted in greater absolute yields. Wheat-based diets enhanced nutrient digestion and absorption, promoting the growth of digestive organs, breast muscle, thigh muscle, and bone. The significant reduction in abdominal fat percentage is attributed to wheat' s lower fat content. Wheat has been shown to decrease muscle fat and cholesterol content, and reduced cholesterol can inhibit abdominal fat deposition, which rapidly accumulates between 21–35 days of age. Furthermore, wheat contains higher mineral levels, particularly manganese and zinc, which act as cofactors in carbohydrate and lipid metabolism. Research indicates that dietary manganese supplementation can reduce abdominal fat deposition in broilers under thermoneutral conditions.

Effects on Meat Quality Previous studies have shown that wheat-type diets can improve water-holding capacity and shear force, depending on water-soluble arabinoxylan (WSAX) content. In this experiment, wheat-fed broilers showed numerically lower drip loss and cooking loss and higher shear force, though differences were not significant, possibly due to lower WSAX content in the wheat used. When WSAX content is low, wheat may promote growth with minimal effects on meat quality; conversely, high WSAX content can reduce growth performance and affect meat quality and expression of key genes such as fatty acid synthase and lipoprotein lipase. Wheat lacks carotenoids and contains significantly less pigment than corn, resulting in lower a* values and higher L* values in breast muscle, consistent with previous research.

Effects on Plasma Biochemical Parameters Plasma biochemical parameters reflect physiological function and metabolic status. Albumin and uric acid are key indicators of liver function, and together with AST and ALT activities, reflect hepatic lipid deposition. Elevated AST and ALT activities indicate liver cell damage, while TP reflects protein metabolism and overall nutritional status. TBIL is involved in liver metabolism, and increased plasma TBIL suggests enhanced erythrocyte breakdown and impaired liver function. In this study, increased plasma TP and ALB in wheat-fed broilers indicated improved immunity. Decreased TBIL content and ALT activity suggested enhanced liver metabolic function. Increased plasma UA content indicates higher protein catabolism, which may reflect lower amino acid utilization from wheat protein compared to corn. Overall, the plasma biochemical profile of wheat-fed broilers indicated better liver function and health status.

Effects on Plasma Lipid Metabolism Plasma TG and TC are important indicators of lipid metabolism, and their reduction suggests decreased fat accumulation. The lower plasma TG and TC contents in wheat-fed broilers corresponded with reduced abdominal fat percentage. Poultry fat deposition depends on plasma TC content, indicating that wheat reduces fat deposition by lower-

ing cholesterol and modulating lipid metabolism. This is primarily attributed to wheat' s lower fat content, as dietary fat level is closely related to TC content. However, the underlying mechanisms of wheat' s effects on lipid metabolism require further investigation.

Conclusion

Under the conditions of this experiment, wheat-type diets improved ADG, reduced abdominal fat percentage, tended to increase carcass yield, modified meat color, and improved plasma biochemical and lipid metabolism parameters, thereby enhancing the overall health status of broilers compared to corn-type diets.

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