Effects of Dietary Supplementation of Flammulina velutipes Mushroom Residue on Growth Performance, Meat Quality, and Muscle Nutrient Composition of Yellow-Feathered Broilers (Postprint)

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Abstract

This experiment was conducted to investigate the effects of dietary supplementation with Flammulina velutipes residue on growth performance, meat quality, and muscle nutritional composition in yellow-feathered broilers. A total of 192 healthy 28-day-old yellow-feathered broilers were selected and randomly allocated into 2 groups according to the principle of similar body weight, with 6 replicates per group and 16 chickens per replicate. The control group was fed a basal diet, while the experimental group was fed a test diet in which 2% Flammulina velutipes residue was used to equivalently replace corn and soybean meal in the basal diet. The experimental period lasted 28 days. The results showed that: compared with the control group, the experimental group exhibited no significant differences in average daily feed intake (ADFI), average daily gain (ADG), and feed/gain ratio (F/G) ($P > 0.05$); the experimental group showed no significant differences in lightness (L*) and yellowness (b*) values of breast and thigh muscles ($P > 0.05$), but the redness (a*) value was significantly decreased ($P < 0.05$); the crude fat content in breast and thigh muscles of the experimental group was significantly decreased ($P < 0.05$), while the crude protein and total amino acid contents were significantly increased ($P < 0.05$), and the essential amino acid and flavor amino acid contents were extremely significantly increased ($P < 0.01$). It can be concluded that dietary supplementation with Flammulina velutipes residue had no significant effect on growth performance of yellow-feathered broilers, but could improve meat quality and nutritional value.

Full Text

Effects of Dietary Enoki Mushroom Residues on Growth Performance, Meat Quality, and Muscle Nutrient Composition of Yellow-Feathered Broilers

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Abstract

This experiment was conducted to investigate the effects of dietary Enoki mushroom residues on growth performance, meat quality, and muscle nutrient composition in yellow-feathered broilers. A total of 192 healthy 28-day-old broilers were randomly allocated into 2 groups according to similar body weight principles, with 6 replicates per group and 16 broilers per replicate. The control group received a basal diet, while the experimental group received a test diet in which 2% Enoki mushroom residues replaced equivalent amounts of corn and soybean meal in the basal diet. The 28-day trial period revealed no significant differences in average daily feed intake (ADFI), average daily gain (ADG), or feed-to-gain ratio (F/G) between groups ($P > 0.05$). While brightness (L*) and yellowness (b*) values of breast and thigh muscle were unaffected ($P > 0.05$), redness (a*) values were significantly reduced ($P < 0.05$). The experimental group exhibited significantly decreased crude fat content ($P < 0.05$) and increased crude protein and total amino acid contents ($P < 0.05$) in both breast and thigh muscle, with essential amino acid and flavor amino acid contents showing extremely significant increases ($P < 0.01$). These results demonstrate that dietary supplementation with Enoki mushroom residues does not significantly affect growth performance but improves meat quality and nutritional value in yellow-feathered broilers.

Keywords: Enoki mushroom residues; yellow-feathered broilers; growth performance; meat quality

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Introduction

Following industrialized Enoki mushroom production, the spent cultivation substrate remaining after mushroom harvest is referred to as Enoki mushroom residue. Research indicates that this residue contains diverse nutrients, including substantial amounts of underutilized cellulose, inorganic salts, protein, and fat. China ranks among the world' s leading producers of edible mushrooms, yet improper utilization practices—such as burning for fuel or indiscriminate disposal—have caused severe environmental pollution and resource waste. In practical production, using mushroom residue as feed can reduce feed costs.

Rational development and utilization of this resource not only contributes to environmental improvement but also promotes sustainable development in animal husbandry and mushroom cultivation industries while fostering beneficial commercial cycles. Currently, Enoki mushroom residue is classified as an unconventional feed due to its limited application in animal production. To develop this feed resource, the present study investigated the effects of dietary Enoki mushroom residues on growth performance, meat quality, and muscle nutrient composition in yellow-feathered broilers, aiming to standardize usage protocols and comprehensively evaluate its feeding value.

1. Materials and Methods

1.1 Experimental Materials Air-dried Enoki mushroom residue was collected from a mushroom production company in Guangdong Province. Analysis revealed the following composition: metabolic energy 12.87 MJ/kg, dry matter 94.09%, crude protein 10.55%, crude fiber 28.80%, ash 12.98%, calcium 0.45%, and phosphorus 2.40%.

1.2 Experimental Animals and Design The trial utilized 192 healthy 28-day-old yellow-feathered broilers (equal sex distribution) randomly divided into 2 groups based on similar body weight, with 6 replicates per group and 16 broilers per replicate. The control group received the basal diet, while the experimental group received a test diet in which 2% Enoki mushroom residues replaced equivalent amounts of corn and soybean meal. The experimental period lasted 28 days.

1.3 Experimental Diets The basal diet was a corn-soybean meal formulation designed according to China's "Nutrient Requirements of Yellow-Feathered Broilers" standard (NY/T 33-2004). The test diet incorporated 2% Enoki mushroom residues to replace 1.75% corn and 0.25% soybean meal, ensuring nutritional consistency between groups. Diet composition and nutrient levels are presented in Table 1 .

1.4 Management Practices Broilers were raised in net-floor pens at a stocking density of 10 birds/m² with ad libitum access to feed and water. Lighting consisted of 24-hour illumination combining natural and artificial light. Temperature was maintained at 20–25°C throughout the trial, with ambient humidity under natural conditions. Excreta were regularly removed to maintain dry, clean, and sanitary pen conditions.

1.5 Measurement Indicators 1.5.1 Growth Performance

Feed intake was recorded by replicate. Body weight was measured at 28 and 56 days of age before morning feeding after overnight fasting to calculate average daily feed intake, average daily gain, and feed-to-gain ratio.

1.5.2 Meat Quality

At trial conclusion (56 days), live weight was recorded and one male broiler per replicate was selected for slaughter after 12-hour fasting. Following bleeding and feather removal, the entire pectoralis major and thigh muscles were excised from one side. Meat quality parameters were measured according to recommended procedures for yellow-feathered broiler meat quality evaluation.

Meat color was measured using a colorimeter (Optp-Star, Matthaus, Germany) at three points along the muscle longitudinal axis from thick to thin end, recording L, *a*, and b* values and calculating means. pH was determined at three points along the muscle longitudinal axis using a pH meter (PHS-2F, Shanghai Leici Company). Water loss rate was measured by placing meat samples between two layers of medical gauze with 18 layers of filter paper above and below, compressing at 35 kg for 1 minute, then reweighing. Drip loss was assessed by suspending weighed meat samples from wire hooks in inverted plastic cups within sealed plastic bags at 4°C for 24 hours before reweighing. Cooking loss was determined after refrigerating samples in sealed bags for 24 hours, bringing to room temperature for 30 minutes, weighing, then heating in sealed bags in an 80°C water bath until reaching 70°C core temperature, cooling for 24 hours, and reweighing. Shear force was measured on cooked samples trimmed into three pieces, shearing each twice perpendicular to fiber direction using a shear meter (C-LM, Northeast Agricultural University Engineering College), and averaging the six measurements.

1.5.3 Muscle Nutrient Composition and Amino Acid Content

Moisture content was determined by oven drying, crude ash by hydrochloric acid (2 mol/L) boiling, crude protein by semi-micro Kjeldahl method, and crude fat by Soxhlet extraction. For amino acid analysis, samples were hydrolyzed with hydrochloric acid at 110°C for 24 hours and analyzed using an automatic amino acid analyzer (835-50, Hitachi, Japan) for 17 amino acids. Tryptophan was determined after 5 mol/L NaOH hydrolysis using a fluorescence spectrophotometer (RF-540, Shimadzu, Japan).

1.6 Statistical Analysis Data were initially processed using Excel 2010 and analyzed by one-way ANOVA using SPSS 19.0 software. Duncan' s multiple range test was applied for post-hoc comparisons. Results are expressed as mean ± standard deviation, with $P < 0.05$ considered significant and $P < 0.01$ considered extremely significant.

2. Results

2.1 Effects on Growth Performance As shown in Table 2 , dietary Enoki mushroom residues had no significant effects on average daily feed intake, average daily gain, or feed-to-gain ratio in yellow-feathered broilers ($P > 0.05$).

2.2 Effects on Meat Quality For breast muscle, dietary Enoki mushroom residues significantly decreased redness value, water loss rate, and drip loss ($P < 0.05$) while significantly increasing shear force ($P < 0.05$), with no significant differences in brightness, yellowness, pH, or cooking loss ($P > 0.05$). For thigh muscle, supplementation significantly decreased redness value, shear force, and drip loss ($P < 0.05$), while brightness, yellowness, water loss rate, pH, and cooking loss remained unaffected ($P > 0.05$). These results are presented in Table 3 .

2.3 Effects on Muscle Nutrient Composition In breast muscle, dietary Enoki mushroom residues significantly increased crude protein content ($P < 0.05$) and decreased crude fat content ($P < 0.05$), with no significant effects on moisture or ash content ($P > 0.05$). Similar results were observed in thigh muscle, where supplementation significantly increased crude protein content ($P < 0.05$) and decreased crude fat content ($P < 0.05$) without affecting moisture or ash content ($P > 0.05$). Data are shown in Table 4 .

2.4 Effects on Muscle Amino Acid Composition As shown in Table 5 , dietary Enoki mushroom residues significantly increased total amino acid content ($P < 0.05$) and extremely significantly increased essential amino acid and flavor amino acid contents ($P < 0.01$) in both breast and thigh muscle, though individual amino acid contents showed no significant differences ($P > 0.05$).

3. Discussion

3.1 Effects on Growth Performance and Meat Quality Mushroom residues are rich in nutrients and contain substantial mycelial biomass from fungal growth, providing protein and various amino acids. Non-protein nitrogen in feed materials is synthesized into mycelial protein, enhancing feed protein content, while degradation of cellulose and hemicellulose improves digestibility. The distinctive fungal aroma may also enhance palatability and feed intake. Previous studies have reported positive effects of mushroom residue supplementation on weight gain and egg production in broilers and laying hens. Salmonella is a major pathogenic bacterium causing intestinal diseases in poultry and contaminating animal products, reducing growth performance and posing food safety risks. Lee et al. found that dietary supplementation with Enoki mushroom mycelium inhibited cecal Salmonella populations and reduced excreta gas emissions in broilers, promoting overall health. In the present study, Enoki mushroom residue supplementation showed increasing trends in average daily feed intake and average daily gain while reducing feed costs, thereby improving economic efficiency.

Meat tenderness is reflected by shear force, moisture content, and drip loss. Shear force is a critical indicator of tenderness, with lower values indicating more tender meat. High moisture content improves mouthfeel, while muscle fiber diameter and density affect tenderness and water loss rate. Water loss

rate, representing the percentage of water lost under pressure, is an important meat quality parameter, with lower values resulting in more succulent cooked meat. The current results demonstrate that dietary Enoki mushroom residues significantly reduced redness values, water loss rate, and drip loss in breast muscle while increasing shear force. In thigh muscle, supplementation significantly reduced redness values, shear force, and drip loss. These improvements in water-holding capacity and reduced shear force in thigh muscle indicate enhanced meat quality. Previous research has shown that dietary protein levels can affect multiple meat quality parameters. Since protein levels were consistent between diets in this study, the observed improvements in breast and thigh meat quality suggest that Enoki mushroom residues may influence protein and lipid metabolism in yellow-feathered broilers, though the underlying mechanisms require further investigation.

3.2 Effects on Muscle Nutrient Composition and Amino Acid Composition Meat nutritional value depends on protein content and quality. Previous research demonstrated that mushroom residue supplementation increased crude protein content in broiler muscle. The present study confirmed that dietary Enoki mushroom residues significantly increased crude protein content while decreasing crude fat content in both breast and thigh muscle, without affecting moisture or ash content, indicating improved muscle nutrient composition.

Amino acid content and composition are important indicators of meat quality. Mushroom residues contain complete amino acid profiles, with essential amino acids comprising approximately 39% of total amino acids, showing strong similarity to standard egg protein. Although protein and amino acid contents are lower than in mushroom fruiting bodies, the residue remains highly valuable. The amino acid profile is a key indicator of meat quality, with higher contents generally indicating superior nutritional value. Flavor amino acids—including aspartic acid, glutamic acid, glycine, alanine, and arginine—are closely associated with meat flavor. Glutamic acid, a primary component of monosodium glutamate, contributes to umami taste, with higher contents producing more flavorful meat. The current results showed increasing trends in glutamic acid content in both muscle types following supplementation. Furthermore, dietary Enoki mushroom residues significantly increased total amino acid, flavor amino acid, and essential amino acid contents, thereby enhancing chicken flavor.

4. Conclusion

Dietary supplementation with Enoki mushroom residues improves muscle nutrient composition and meat quality in yellow-feathered broilers, significantly increases flavor and essential amino acid contents, and does not significantly affect growth performance.

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