Effects of Dietary Flammulina velutipes Residue Supplementation 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 birds per replicate. The control group was fed the basal diet, while the experimental group was fed the experimental diet in which corn and soybean meal in the basal diet were replaced by 2% Flammulina velutipes residue. 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-to-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 highly significantly increased ($P < 0.01$). In conclusion, 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 to 2 groups according to similar body weight, 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 trial lasted for 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), or feed-to-gain ratio (F/G) ($P > 0.05$). No significant differences were observed in brightness (L*) or yellowness (b*) values of breast and thigh muscles ($P > 0.05$), but redness (a*) values were significantly decreased ($P < 0.05$). Crude fat content in both breast and thigh muscles was significantly reduced ($P < 0.05$), while crude protein and total amino acid contents were significantly increased ($P < 0.05$). Essential amino acid and flavor amino acid contents were extremely significantly elevated ($P < 0.01$). In conclusion, dietary supplementation with Enoki mushroom residues had no significant effect on growth performance but improved meat quality and nutritional value in yellow-feathered broilers.

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

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Following industrialized Enoki mushroom production, the spent cultivation substrate remaining after mushroom harvest is referred to as Enoki mushroom residues. Research indicates that these residues contain diverse nutrients, including substantial amounts of underutilized cellulose, inorganic salts, protein, and fat. China ranks among the world' s top producers of edible mushrooms, yet improper utilization by producers—such as burning for fuel or indiscriminate disposal—has caused severe environmental pollution and resource waste. In practical production, using mushroom residue feed can reduce feed costs. Rational development and utilization of these resources can not only contribute to environmental improvement but also promote sustainable development in animal

husbandry and mushroom cultivation industries while fostering a virtuous cycle in supporting business models. Enoki mushroom residues have been underutilized in animal production and are thus classified as unconventional feed. To develop this feed resource, this 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 methods and comprehensively evaluate feeding value.

1.1 Experimental Materials

Air-dried Enoki mushroom residues were purchased from an edible mushroom production company in Guangdong. Analysis revealed the following composition: metabolizable 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 (half male, half female), randomly divided into 2 groups based on similar body weight. Each group comprised 6 replicates with 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 type formulated according to China' s "Nutrient Requirements of Yellow-Feathered Broilers" standard (NY/T 33-2004). The experimental diet used 2% Enoki mushroom residues to replace corn and soybean meal at a ratio of 1.75% corn and 0.25% soybean meal to ensure consistent nutrient levels between groups. Diet composition and nutrient levels are presented in Table 1 .

1.4 Management Practices

Broilers were raised in battery cages at a stocking density of 10 birds/m². Feed and water were provided ad libitum throughout the 24-hour lighting period, which combined natural and artificial light. Temperature was maintained at 20–25°C until trial completion, with ambient humidity kept natural. Excreta were removed regularly to maintain dry, clean, and sanitary cage conditions.

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. Average daily feed intake, average daily gain, and feed-to-gain ratio were calculated.

1.5.2 Meat Quality

At trial conclusion (56 days of age), live weight was recorded and one male broiler per replicate was randomly selected for slaughter after 12-hour feed withdrawal. 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: Measured at three points along the muscle long axis from thick to thin end using a colorimeter (Opto-Star, Matthaus, Germany). Brightness (L*), redness (a*), and yellowness (b*) values were recorded and averaged.

pH: Measured at three points along the muscle long axis from anterior to posterior using a pH meter (PHS-2F, Shanghai Leici), with values averaged.

Water loss rate: Meat samples were placed between two layers of medical gauze with 18 layers of filter paper above and below, compressed between iron plates at 35 kg pressure for 1 minute, then reweighed to calculate water loss percentage.

Drip loss: Accurately weighed meat samples were suspended by wire hooks from the bottom of inverted disposable plastic cups inside sealed plastic bags and stored at 4°C for 24 hours before reweighing to calculate drip loss percentage.

Cooking loss: Meat samples were sealed in plastic bags, refrigerated at 4°C for 24 hours, equilibrated to room temperature for 30 minutes, weighed, then heated in sealed bags in an 80°C water bath until reaching 70°C internal temperature. After cooling for 24 hours, samples were reweighed to calculate cooking loss percentage.

Shear force: Following cooking loss measurement, samples were trimmed and cut into three pieces. Each piece was sheared twice perpendicular to fiber orientation using a shear meter (C-LM, Northeast Agricultural University Engineering College), with the six measurements averaged.

1.5.3 Muscle Nutrient and Amino Acid Analysis

Conventional nutrient analysis: Moisture by oven drying, crude ash by 2 mol/L HCl boiling, crude protein by semi-micro Kjeldahl method, and crude fat by Soxhlet extraction.

Amino acid analysis: Samples were hydrolyzed with HCl at 110°C for 24 hours and analyzed for 17 amino acids using an automatic amino acid analyzer (835-50, Hitachi, Japan). Tryptophan was determined separately 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 used for post-hoc comparisons. Results are expressed as means ± standard deviation, with $P < 0.05$ considered significant and $P < 0.01$ considered extremely significant.

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 quality (Table 3), dietary Enoki mushroom residues significantly decreased redness value, water loss rate, and drip loss ($P < 0.05$) while significantly increasing shear force ($P < 0.05$). No significant differences were observed in brightness, yellowness, pH, or cooking loss ($P > 0.05$). For thigh muscle quality, supplementation significantly decreased redness value, shear force, and drip loss ($P < 0.05$), with no significant effects on brightness, yellowness, water loss rate, pH, or cooking loss ($P > 0.05$).

2.3 Effects on Muscle Nutrient Composition

Table 4 shows that dietary Enoki mushroom residues significantly increased crude protein content ($P < 0.05$) and decreased crude fat content ($P < 0.05$) in both breast and thigh muscles, with no significant effects on moisture or ash content ($P > 0.05$).

2.4 Effects on Muscle Amino Acid Composition

As presented 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 muscles, though individual amino acid contents showed no significant differences ($P > 0.05$).

3.1 Effects on Growth Performance and Meat Quality

Mushroom residues are rich in nutrients and contain abundant mycelial biomass that provides protein and various amino acids. Non-protein nitrogen in feed materials is synthesized into microbial protein through mycelial action, thereby increasing feed protein content, while degradation of cellulose and hemicellulose improves feed digestibility. The distinctive fungal aroma may also enhance animal appetite and palatability. Dong et al. reported that using mushroom residue materials in broiler and layer diets produced favorable weight gain and egg production effects. *Salmonella* is a highly pathogenic bacterium that causes

intestinal diseases in poultry and other animals, contaminating eggs and meat products, reducing growth performance, and frequently causing human food poisoning. Lee et al. found that dietary supplementation with *Flammulina velutipes* mycelium inhibited cecal *Salmonella* counts and reduced excreta gas emissions, promoting overall animal health when intestinal health is maintained. In this trial, dietary Enoki mushroom residues showed increasing trends in average daily feed intake and average daily gain, and such residues are low-cost feed materials that can reduce production costs and improve profitability.

Meat tenderness is reflected by shear force, moisture content, and drip loss indicators. Shear force is a critical indicator—lower values indicate more tender meat. Higher muscle moisture content improves mouthfeel, while fiber diameter and density affect tenderness and water loss rate. Water loss rate, the percentage of moisture lost under pressure, is an important quality parameter; meat with low water loss rates remains more juicy after cooking. This trial demonstrated that dietary Enoki mushroom residues significantly reduced breast muscle redness, water loss rate, and drip loss while increasing shear force, and significantly reduced thigh muscle redness, shear force, and drip loss. The improved water-holding capacity and reduced thigh muscle shear force indicate enhanced meat quality. Previous studies have shown that dietary protein levels can affect multiple meat quality indicators. Since protein levels were consistent between diets in this trial, the observed improvements in breast and thigh meat quality suggest that Enoki mushroom residues may influence protein and fat metabolism in yellow-feathered broilers, though the underlying mechanism requires further investigation.

3.2 Effects on Muscle Nutrient Composition and Amino Acid Profile

Meat nutritional value depends on protein content and quality. Fan reported that mushroom residue feeding increased crude protein content in broiler muscle. This trial confirmed that dietary Enoki mushroom residues significantly increased crude protein while decreasing crude fat content in both breast and thigh muscles, without affecting moisture or ash content, demonstrating 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 fruiting bodies, residues remain highly valuable. The amino acid profile is a key quality indicator, 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; higher contents generally indicate better flavor. This trial showed increasing trends in glutamic acid content in both muscle types, with significant increases in total amino acids, flavor amino acids, and essential amino

acids, thereby enhancing chicken flavor.

4 Conclusion

Dietary supplementation with Enoki mushroom residues improved muscle nutrient composition and meat quality in yellow-feathered broilers, significantly increased flavor and essential amino acid contents, and showed no significant effects on growth performance.

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