Effects of Mulberry Leaf Extract on Growth Performance, Slaughter Performance, and Meat Quality of Dwarf Yellow Chickens (Postprint)

Authors: Song Qiongli, Zhou Quanyong, Qipeng Wei, Liu Linxiu, Zou Zhiheng, Chen Xiaolian

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Abstract

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Full Text

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Song Qiongli, Zhou Quanyong, Wei Qipeng, Liu Linxiu, Zou Zhiheng, *Chen Xiaolian* *Institute of Animal Husbandry and Veterinary Science, Jiangxi Academy of Agricultural Sciences, Nanchang 330200, China*

Abstract

This experiment investigated the effects of dietary mulberry leaf extract supplementation on growth performance, slaughter performance, and meat quality in yellow dwarf chickens. Three hundred 21-day-old yellow dwarf hens with similar initial body weight were randomly allocated to four groups (five replicates per group, 15 birds per replicate). The four dietary treatments were: Group I (control) fed a basal diet, Group II fed the basal diet supplemented with 0.2% mulberry leaf extract, Group III fed the basal diet supplemented with 0.5% mulberry leaf extract, and Group IV fed the basal diet supplemented with 0.8% mulberry leaf extract. The 53-day feeding trial yielded several key findings. First, compared with the control group, supplementation with 0.2%, 0.5%, and 0.8% mulberry leaf extract significantly increased average daily gain and average daily feed intake ($P<0.05$), while showing a tendency to decrease feed-to-gain

ratio, though this difference was not statistically significant (P>0.05). Second, dietary mulberry leaf extract had no significant effect on slaughter performance (P>0.05), though it slightly improved dressing percentage and half-eviscerated yield percentage. Third, as the supplementation level increased, lightness (L*), redness (a*)*, and yellowness (b*) values of both breast and leg muscles showed an upward trend. The pH at 24 hours postmortem (pH24 h) in both muscle types was significantly higher in all supplemented groups compared with the control (P<0.05). Muscle tenderness improved with increasing supplementation levels, with Group IV showing significantly greater leg muscle tenderness than the control (P<0.05). Fourth, crude protein and crude fat contents in breast and leg muscles increased to varying degrees in supplemented groups, though differences were not significant (P>0.05). Fifth, except for significant changes in arginine, isoleucine, leucine, and lysine contents in certain supplemented groups (P<0.05), most amino acid contents remained unchanged (P>0.05), and the essential to non-essential amino acid ratio showed no significant differences between groups (P>0.05). Sixth, as supplementation levels increased, saturated fatty acid (SFA) and monounsaturated fatty acid (MUFA) contents gradually increased, while unsaturated fatty acid (UFA), polyunsaturated fatty acid (PUFA), essential fatty acid (EFA), ω-6, ω-3 contents, and the UFA/SFA ratio gradually decreased. These results demonstrate that dietary mulberry leaf extract supplementation can effectively improve growth performance and meat quality in yellow dwarf chickens.

Keywords: mulberry leaf extract; yellow dwarf chickens; growth performance; slaughter performance; meat quality

Introduction

China is a traditional major sericulture country, with mulberry trees widely distributed throughout the nation. Mulberry leaf cultivation covers approximately 1 million hectares in China, representing an abundant resource. Mulberry leaves are rich in protein, carbohydrates, vitamins, mineral elements, and various natural bioactive substances that play important roles in enhancing immune function and production performance in animals. Current research on mulberry leaf application in livestock and poultry diets primarily involves direct addition of mulberry leaf powder, which has been shown to improve product quality, enhance meat flavor, and promote animal health. However, mulberry leaves contain anti-nutritional factors such as tannins and lectins that can reduce growth performance when added in large quantities. The primary bioactive substances in mulberry leaves include polysaccharides, flavonoids, and superoxide dismutase. Plant polysaccharides can promote animal growth and immune function while improving carcass performance and meat quality. Flavonoids and superoxide dismutase possess strong antioxidant properties that scavenge free radicals and improve meat quality. While mulberry leaf extract has demonstrated hypolipidemic, hypoglycemic, and antibacterial effects in experimental animals, its impact on livestock production performance and meat quality remains poorly

documented. This study examined the effects of different dietary levels of mulberry leaf extract on growth performance, slaughter performance, and meat quality in yellow dwarf chickens to provide a scientific basis for its application in broiler diets.

1. Materials and Methods

1.1 Experimental Materials Mulberry leaf powder was purchased commercially and contained 12.63% moisture, 15.40% crude protein, 3.72% crude fat, 16.00% crude ash, 2.50% calcium, and 0.25% total phosphorus. The mulberry leaf extract used in this experiment was a hot water extract of the commercial mulberry leaf powder, with an extraction yield of approximately 10%.

1.2 Experimental Animals and Diets Three hundred 21-day-old yellow dwarf hens with similar initial body weight were selected as experimental animals. The basal diet was a corn-soybean meal-based diet formulated as powdered complete feed according to the Chinese "Feeding Standard of Chickens" (NY/T 33-2004). The diet was provided in two phases: 21-42 days and 43-73 days. The composition and nutrient levels are presented in Table 1 .

1.3 Experimental Design The experimental chickens were randomly divided into four groups with five replicates each containing 15 birds. Initial body weight did not differ significantly among groups ($P>0.05$). The four dietary treatments were: Group I (control) fed the basal diet, Group II fed the basal diet supplemented with 0.2% mulberry leaf extract, Group III fed the basal diet supplemented with 0.5% mulberry leaf extract, and Group IV fed the basal diet supplemented with 0.8% mulberry leaf extract. The experimental period lasted 53 days.

1.4 Management Practices The experiment was conducted at the experimental chicken farm of the Institute of Animal Husbandry and Veterinary Science, Jiangxi Academy of Agricultural Sciences. Throughout the trial, birds were raised in partitioned floor pens with free access to feed and water.

1.5 Measurement Indicators 1.5.1 Growth Performance
Feed intake, residual feed, initial body weight, and final body weight were recorded by replicate to calculate average daily gain (ADG), average daily feed intake (ADFI), and feed-to-gain ratio (F/G).

1.5.2 Slaughter Performance
At the end of the experiment, two birds per replicate with normal development, healthy condition, and body weight close to the group average were randomly selected for slaughter after a 12-hour feed withdrawal with water provided. After recording live weight, birds were slaughtered, bled, scalded, defeathered, washed, and drained before measuring slaughter performance indicators. Dressing percentage, half-eviscerated yield percentage, and eviscerated yield percent-

age were calculated using pre-slaughter live weight as the denominator, while breast muscle percentage, leg muscle percentage, and abdominal fat percentage were calculated using eviscerated carcass weight as the denominator.

1.5.3 Meat Quality Indicators

Meat color was measured using an automatic colorimeter to determine lightness (L*), redness (a*), and yellowness (b*) values in breast and leg muscles within 2 hours postmortem. Muscle pH at 24 hours (pH24 h) was measured using a pH meter. Drip loss percentage was determined by weighing meat samples at 2 hours postmortem, suspending them with wire and metal hooks in sealed plastic bags at 0-4°C for 24 hours, then reweighing after blotting surface moisture. Tenderness was assessed after 48 hours of postmortem aging; samples were heated in an 80°C water bath until reaching an internal temperature of 70°C, cooled to approximately 20°C, then trimmed into 1.27 cm diameter strips for shear force measurement using a C-LM tenderness meter. Crude protein content was determined according to GB/T 5009.5-2010, and crude fat content according to GB/T 9695.7-2008. Amino acid content was analyzed using an automatic amino acid analyzer following GB/T 5009.124-2003. Fatty acid composition was determined by gas chromatography according to GB/T 17377-2008.

1.6 Data Processing and Statistical Analysis Data were processed using SPSS 16.0 software for one-way ANOVA and Duncan' s multiple comparison tests. All data are expressed as means with significance set at $P<0.05$.

2. Results

2.1 Effects of Mulberry Leaf Extract on Growth Performance As shown in Table 2 , initial body weight did not differ significantly among groups ($P>0.05$). After the 52-day feeding trial, final body weight in Groups II, III, and IV was significantly higher than in the control group ($P<0.05$). Average daily gain in Groups II, III, and IV increased significantly by 4.50%, 4.00%, and 3.96%, respectively ($P<0.05$). Average daily feed intake in Groups II and III increased significantly by 3.06% and 3.45%, respectively ($P<0.05$). Dietary supplementation with 0.2%, 0.5%, and 0.8% mulberry leaf extract showed no significant effect on feed-to-gain ratio ($P>0.05$), though a decreasing trend was observed.

2.2 Effects of Mulberry Leaf Extract on Slaughter Performance Table 3 shows that dietary mulberry leaf extract supplementation had no significant effect on dressing percentage, half-eviscerated yield percentage, eviscerated yield percentage, breast muscle percentage, or leg muscle percentage ($P>0.05$). Abdominal fat percentage showed an upward trend with increasing supplementation levels, though differences among groups were not significant ($P>0.05$).

2.3 Effects of Mulberry Leaf Extract on Crude Protein and Crude Fat Contents in Muscle As presented in Table 4 , crude protein and crude

fat contents in breast and leg muscles increased to varying degrees in all supplemented groups compared with the control, though these differences were not statistically significant (P>0.05).

2.4 Effects of Mulberry Leaf Extract on Meat Quality Table 5 demonstrates that L*, a*, and b* values of both leg and breast muscles increased with higher supplementation levels. Specifically, leg muscle L* values in Groups II, III, and IV increased by 6.39%, 7.52%, and 11.50% compared with the control (P<0.05). Leg muscle a* values increased by 6.64% in Group II (P>0.05) and by 38.33% and 65.42% in Groups III and IV, respectively (P<0.05). Leg muscle b* values in Groups II, III, and IV increased by 108.57%, 117.14%, and 261.71%, respectively (P<0.05). Breast muscle L* values increased by 2.35%, 3.38%, and 6.76% in Groups II, III, and IV, respectively (P>0.05). Breast muscle a* values increased by 29.78% in Group II (P>0.05) and by 44.67% and 68.00% in Groups III and IV, respectively (P<0.05). Breast muscle b* values increased by 14.41%, 25.18%, and 18.98% in Groups II, III, and IV, respectively, with only Group III showing a significant difference from the control (P<0.05).

The pH24 h of both leg and breast muscles increased with mulberry leaf extract supplementation. Leg muscle pH24 h in Groups II, III, and IV increased by 1.84%, 1.55%, and 1.55%, respectively (P<0.05). Breast muscle pH24 h showed slight increases in Groups II and IV (P>0.05) and a significant 1.59% increase in Group III (P<0.05). Muscle tenderness tended to improve with increasing supplementation levels, with only Group IV showing significantly greater leg muscle tenderness compared with the control (P<0.05).

2.5 Effects of Mulberry Leaf Extract on Amino Acid Contents in Muscle As shown in Table 6 , in leg muscle, Group III had significantly lower arginine content than the control (P<0.05), Groups III and IV had significantly lower isoleucine content (P<0.05), Group II had significantly higher leucine content (P<0.05), and Group IV had significantly lower lysine content (P<0.05). Other amino acids showed no significant differences among groups (P>0.05). The essential to non-essential amino acid ratio did not differ significantly between supplemented groups and the control (P>0.05), though Groups II and III showed upward trends in total amino acids, essential amino acids, and flavor amino acids, while Group IV showed a downward trend.

Table 7 presents the results for breast muscle. Except for a significantly higher essential to non-essential amino acid ratio in Group IV compared with the control (P<0.05), no significant differences were observed in individual amino acid contents among groups (P>0.05).

2.6 Effects of Mulberry Leaf Extract on Fatty Acid Contents in Muscle Tables 8 and 9 reveal consistent trends in fatty acid composition of leg and breast muscles. As mulberry leaf extract supplementation increased, saturated fatty acid (SFA) and monounsaturated fatty acid (MUFA) contents

gradually increased, while unsaturated fatty acid (UFA), polyunsaturated fatty acid (PUFA), essential fatty acid (EFA), ω-6, and ω-3 contents, as well as the UFA/SFA ratio, gradually decreased. The ω-6/ω-3 ratio decreased slightly in Group II but increased in Groups III and IV, though these changes were not significant ($P>0.05$).

3. Discussion

3.1 Effects on Growth Performance Mulberry leaves contain anti-nutritional factors such as tannins and lectins that can reduce growth performance when included at high levels. Previous studies by Chang Wenhuan, Zhang Lei et al., and Fan Jinghui et al. have demonstrated that excessive mulberry leaf powder significantly reduces broiler body weight, with greater effects at higher inclusion levels. Mulberry leaf extract concentrates and purifies the active components, maximizing their efficacy. In this study, dietary supplementation with 0.2%, 0.5%, and 0.8% mulberry leaf extract significantly improved average daily gain and average daily feed intake compared with the control, while showing a non-significant decreasing trend in feed-to-gain ratio. These results align with Fan Jinghui et al.' s report that 0.3% mulberry leaf powder extract improved growth performance in broilers.

3.2 Effects on Slaughter Performance Dietary mulberry leaf extract supplementation slightly improved dressing percentage and half-eviscerated yield percentage in yellow dwarf chickens, while eviscerated yield percentage, breast muscle percentage, and leg muscle percentage remained largely unchanged, indicating modest improvements in slaughter performance. These findings are similar to Wu Ping et al.' s research showing that mulberry leaf powder improved broiler slaughter performance. However, this study found that abdominal fat percentage tended to increase with mulberry leaf extract supplementation, which contradicts reports by Fan Jinghui et al., Wu Ping et al., and Lan Cuiying et al. that mulberry leaf powder reduced abdominal fat percentage. The reasons for this discrepancy require further investigation.

3.3 Effects on Muscle Protein and Fat Content Protein is the primary component of muscle, and higher protein content indicates greater nutritional value. Fat content is closely related to meat quality, directly affecting juiciness and tenderness, while fatty acid composition partially determines meat flavor. In this study, mulberry leaf extract supplementation increased crude protein and crude fat contents in breast and leg muscles to varying degrees, though differences were not significant. This suggests that mulberry leaf extract does not significantly alter muscle chemical composition but may enhance nutritional value and quality to some extent.

3.4 Effects on Meat Quality Meat color is an important quality indicator reflecting physiological, biochemical, and microbiological changes in muscle,

primarily influenced by pigment content (myoglobin and hemoglobin) and its chemical state. This study demonstrated that mulberry leaf extract supplementation improved meat color in yellow dwarf chickens, with L, *a*, and b* values increasing at higher supplementation levels, consistent with Wu Dong et al.' s findings. The improved meat color may be related to the antioxidant capacity of functional compounds in mulberry leaf extract. All supplemented groups showed significantly higher pH24 h in both muscle types compared with the control, and muscle tenderness tended to improve with increasing supplementation, with Group IV showing significantly greater leg muscle tenderness. These results differ from Wu Ping et al., Lan Cuiying et al., and Wu Dong et al., who found no significant effects of mulberry leaf powder on pH24 h and tenderness, warranting further investigation.

3.5 Effects on Amino Acid and Fatty Acid Contents Flavor amino acids such as aspartic acid, glutamic acid, alanine, and glycine play crucial roles in meat flavor development, while sulfur-containing amino acids (cystine, cysteine, and methionine) are important precursors for many volatile flavor compounds. In this study, except for significant changes in arginine, isoleucine, leucine, and lysine contents in certain supplemented groups, most amino acids in breast and leg muscles showed no significant differences from the control. The essential to non-essential amino acid ratio also remained unchanged, indicating that mulberry leaf extract does not enhance chicken flavor by altering flavor amino acid content, consistent with Wu Dong et al.' s findings with mulberry leaf powder.

The effects of mulberry leaf extract on fatty acid composition were consistent between leg and breast muscles: increasing supplementation levels gradually increased SFA and MUFA contents while decreasing UFA, PUFA, EFA, ω-6, ω-3 contents, and the UFA/SFA ratio. These results partially contradict Lan Cuiying et al.' s findings that increasing mulberry leaf powder levels increased UFA, MUFA, PUFA, EFA, ω-6, and ω-3 contents and the UFA/SFA ratio while decreasing SFA content and the ω-6/ω-3 ratio. The reasons for these inconsistencies require further study.

4. Conclusions

1. Dietary mulberry leaf extract supplementation significantly improved average daily gain and average daily feed intake in yellow dwarf chickens but had no significant effect on feed-to-gain ratio.
2. Mulberry leaf extract had no significant effect on slaughter performance but slightly improved dressing percentage and half-eviscerated yield percentage.
3. Mulberry leaf extract supplementation had no significant effect on crude protein and crude fat contents in muscle but improved nutritional value and quality to some extent.
4. Mulberry leaf extract improved meat color, significantly increased muscle pH24 h, and enhanced muscle tenderness.

5. Mulberry leaf extract had no significant effect on most amino acid contents or the essential to non-essential amino acid ratio in muscle.
6. Increasing mulberry leaf extract supplementation levels gradually increased SFA and MUFA contents while decreasing UFA, PUFA, EFA, ω-6, and ω-3 contents and the UFA/SFA ratio.

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