

Effects of Mulberry Leaf Powder on Growth Performance, Meat Quality and Serum Biochemical Indices of Finishing Pigs Postprint

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Abstract

This experiment aimed to investigate the effects of dietary mulberry leaf powder supplementation on growth performance, meat quality, and serum biochemical indices of fattening pigs. One hundred and sixty healthy three-way crossbred (Duroc × Large White × Landrace) fattening pigs with relatively uniform initial body weight [(87.10±5.33) kg] were selected and randomly divided into 4 groups (4 replicates per group, 10 pigs per replicate): the control group was fed a basal diet, while the experimental groups were fed diets containing 5%, 10%, and 15% mulberry leaf powder, respectively, for a trial period of 50 days. The results showed that, compared with the control group: 1) dietary supplementation with 5% and 10% mulberry leaf powder had no significant effect on average daily gain of fattening pigs ($P>0.05$); supplementation with 15% mulberry leaf powder significantly decreased average daily gain and significantly increased feed conversion ratio ($P<0.05$). 2) supplementation with 5% and 10% mulberry leaf powder had no significant effect on muscle shear force and pH at 45 min and 24 h post-slaughter ($P>0.05$), and could increase muscle marbling score, but the difference was not significant ($P>0.05$); when mulberry leaf powder was supplemented at 15%, average backfat thickness and total cholesterol content were significantly decreased ($P<0.05$). 3) supplementation with 5%, 10%, and 15% mulberry leaf powder significantly increased muscle superoxide dismutase activity ($P<0.05$), decreased muscle malondialdehyde content ($P>0.05$), and effectively improved muscle antioxidant capacity. 4) supplementation with 5%, 10%, and 15% mulberry leaf powder significantly increased serum urea nitrogen content ($P<0.05$), decreased lipase activity, but the difference was not significant ($P>0.05$), and dietary supplementation with 15% mulberry leaf powder significantly decreased serum triglyceride content ($P<0.05$). Based on comprehensive analysis of all indices, dietary supplementation with 10% mulberry leaf

powder had minimal impact on growth rate of fattening pigs, but could effectively improve meat quality.

Full Text

Effects of Mulberry Leaf Powder on Growth Performance, Meat Quality and Serum Biochemical Indexes in Finishing Pigs

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Abstract

This study investigated the effects of dietary mulberry leaf powder on growth performance, meat quality, and serum biochemical indexes in finishing pigs. One hundred sixty healthy “Duroc × Large White × Landrace” crossbred finishing pigs with consistent initial body weight [(87.10±5.33) kg] were randomly allocated to four groups (four replicates per group, ten pigs per replicate). The control group received a basal diet, while the experimental groups received diets supplemented with 5%, 10%, and 15% mulberry leaf powder, respectively. The trial lasted for 50 days.

The results showed that, compared with the control group: (1) Supplementation with 5% and 10% mulberry leaf powder did not significantly affect average daily gain (ADG) ($P>0.05$), whereas 15% mulberry leaf powder significantly reduced ADG and increased feed-to-gain ratio ($P<0.05$). (2) Dietary inclusion of 5% and 10% mulberry leaf powder had no significant effects on muscle shear force or pH at 45 min and 24 h post-slaughter ($P>0.05$), though marbling score showed a non-significant increase. At the 15% supplementation level, average backfat thickness and total cholesterol content were significantly reduced ($P<0.05$). (3) Supplementation with 5%, 10%, and 15% mulberry leaf powder significantly increased superoxide dismutase (SOD) activity in muscle ($P<0.05$) and decreased malondialdehyde (MDA) content ($P>0.05$), effectively enhancing muscle antioxidant capacity. (4) Serum urea nitrogen content was significantly elevated at all supplementation levels ($P<0.05$), while lipase activity decreased non-significantly ($P>0.05$). The 15% mulberry leaf powder diet significantly reduced serum triglyceride content ($P<0.05$).

Based on comprehensive evaluation of all parameters, dietary inclusion of 10% mulberry leaf powder minimally impacted growth rate while effectively improving meat quality in finishing pigs.

Keywords: mulberry leaf powder; finishing pig; growth performance; meat quality; serum biochemical index

Introduction

China is a traditional major producer of mulberry cultivation for sericulture. Mulberry trees are widely distributed throughout the country, with approximately 1 million hectares of mulberry cultivation area [1], representing abundant mulberry leaf resources. Mulberry leaves are rich in protein, carbohydrates, vitamins, mineral elements, and natural bioactive substances [2-3]. The amino acid composition of mulberry leaves is generally consistent with that of defatted soybean meal. Although the amino acid content is far lower than that of defatted soybean meal, the proportion of each amino acid to total amino acids shows a consistent trend, making mulberry leaf protein an excellent protein resource [3]. As an unconventional feed for animals, mulberry leaves possess tremendous development potential and utilization value, attracting significant attention from the Food and Agriculture Organization (FAO) of the United Nations [2].

In recent years, the application of mulberry leaves in diets for chickens, pigs, and ruminants has been reported, though most studies have focused on adjusting mulberry supplementation levels to improve livestock growth performance. The natural bioactive substances in mulberry leaves primarily include flavonoids, polysaccharides, and superoxide dismutase (SOD) [3]. Flavonoids exhibit antioxidant and cholesterol-lowering effects, polysaccharides have blood glucose-reducing properties, and SOD can scavenge free radicals and prevent aging. Therefore, while utilizing mulberry leaves as an excellent protein source, the regulatory functions of its unique flavonoids, polysaccharides, and other natural bioactive substances can be harnessed to improve meat quality in livestock and poultry. This experiment aimed to investigate the effects of mulberry leaf powder supplementation in finishing pig diets on growth performance, meat quality, and serum biochemical indexes, providing a scientific basis for the application of mulberry leaf powder in finishing pig diets.

Materials and Methods

1.1 Experimental Materials Mulberry leaf powder was purchased from the market. Nutritional composition analysis revealed: moisture 12.63%, crude protein 15.40%, total 17 amino acids 11.33%, crude fat 3.72%, crude fiber 8.68%, crude ash 16.00%, calcium 2.50%, and phosphorus 0.25%.

1.2 Experimental Animals and Diets One hundred sixty healthy “Duroc × Landrace × Large White” crossbred finishing pigs with consistent parity, initial body weight [(87.10±5.33) kg], and age were randomly divided into four groups. Each group received one of four experimental diets containing different mulberry leaf powder levels. The basal diet was a corn-soybean meal type formulated

according to NRC (1998) nutrient requirements as a powdered complete feed. Diet composition and nutrient levels are presented in Table 1 .

1.3 Experimental Design Experimental pigs were randomly allocated to four groups with four replicates per group and ten pigs per replicate (half barrows and half gilts). Initial body weight did not differ significantly among groups ($P>0.05$). The four groups received different diets: Group (control) received the basal diet, Group received the basal diet with 5% mulberry leaf powder, Group received the basal diet with 10% mulberry leaf powder, and Group received the basal diet with 15% mulberry leaf powder. The trial lasted 50 days with ad libitum feeding in separate pens.

1.4 Feeding Management and Slaughter The experiment was conducted at Jingtangshan Huafu Animal Husbandry Co., Ltd. Conventional feeding and immunization practices were implemented throughout the trial period with ad libitum access to feed and water. At the end of the experiment, two pigs were randomly selected from each replicate for slaughter. The left carcass *longissimus dorsi* muscle (loin eye) at the last rib was collected for meat quality and biochemical index determination.

1.5 Measurement Indicators 1.5.1 Growth Performance

Pigs were weighed on days 1 and 50 after 16 h of fasting. Feed consumption was recorded for each replicate during the trial to calculate average daily gain (ADG), average daily feed intake (ADFI), and feed-to-gain ratio (F/G).

1.5.2 Meat Quality Indicators

At the end of the feeding trial, all pigs had free access to water, were fasted for 16 h, and weighed before slaughter. After slaughter, the left carcass *longissimus dorsi* muscle at the last rib was collected for meat quality and biochemical analysis. Average backfat thickness was measured first. Muscle pH and shear force were determined at 45 min and 24 h post-slaughter. Marbling score and total cholesterol (TCH) content were also measured. Muscle total cholesterol content was determined using assay kits from Nanjing Jiancheng Bioengineering Institute following the manufacturer' s instructions.

1.5.3 Muscle Antioxidant Capacity

Eye muscle samples were stored at 4 °C, and malondialdehyde (MDA) content and SOD activity were measured at 45 min and 24 h post-slaughter using assay kits from Nanjing Jiancheng Bioengineering Institute according to the manufacturer' s protocols.

1.5.4 Serum Biochemical Indicators

Serum samples were collected from 12 pigs of medium body weight selected from each group at trial conclusion via anterior vena cava puncture. Serum urea nitrogen (UN) content, triglyceride (TG) content, and lipase activity were

determined using assay kits from Nanjing Jiancheng Bioengineering Institute following the manufacturer' s instructions.

1.6 Data Processing and Statistical Analysis Data were processed and analyzed using Excel 2007 and SPSS 16.0 software for variance analysis and multiple comparisons. All results are expressed as mean \pm standard deviation.

Results

2.1 Effects of Different Mulberry Leaf Powder Levels on Growth Performance As shown in Table 2 , initial body weight did not differ significantly among groups ($P>0.05$). After 50 days, final body weight showed no significant differences among Groups , , , and ($P>0.05$). Average daily gain decreased gradually with increasing dietary mulberry leaf powder levels. ADG in Groups and did not differ significantly from Group ($P>0.05$), while Group showed significantly lower ADG than Group ($P<0.05$). Compared with Group , feed-to-gain ratio in Group showed no significant change ($P>0.05$), but was significantly higher in Groups and ($P<0.05$). Average daily feed intake did not differ significantly among groups after mulberry leaf powder supplementation ($P>0.05$).

2.2 Effects of Different Mulberry Leaf Powder Levels on Meat Quality Table 3 shows that average backfat thickness decreased gradually with increasing mulberry leaf powder levels, with reductions of 8.04% and 13.64% in Groups and compared with Group , though these differences were not significant ($P>0.05$). Group showed a significant 28.67% reduction compared with Group ($P<0.05$). Muscle pH did not differ significantly among groups ($P>0.05$). Marbling score increased with higher mulberry leaf powder levels ($P>0.05$). Dietary mulberry leaf powder levels had no significant effect on muscle shear force at 45 min or 24 h ($P>0.05$). Compared with Group , muscle total cholesterol content decreased by 11.52%, 13.80%, and 18.72% in Groups , , and , respectively, with a significant reduction observed at the 15% supplementation level ($P<0.05$).

2.3 Effects of Different Mulberry Leaf Powder Levels on Muscle Antioxidant Capacity As shown in Table 4 , after 72 h storage at 4 °C, muscle SOD activity in Groups , , and increased by 34.43%, 68.44%, and 79.12%, respectively, compared with Group , with all differences being significant ($P<0.05$). Muscle MDA content decreased by 14.50%, 33.73%, and 41.72% in Groups , , and , respectively, though differences among groups were not significant ($P>0.05$).

2.4 Effects of Different Mulberry Leaf Powder Levels on Serum Biochemical Indexes Table 5 shows that serum urea nitrogen content increased by 21.78%, 36.69%, and 42.25% in Groups , , and , respectively, compared

with Group , with all differences being significant ($P < 0.05$). Serum triglyceride content decreased by 5.02%, 17.85%, and 25.01% in Groups , , and , respectively, with Group showing a significant difference from Group ($P < 0.05$). Lipase activity did not differ significantly among groups ($P > 0.05$).

Discussion

3.1 Effects of Dietary Mulberry Leaf Powder on Growth Performance

Mulberry leaves are rich in nutrients and unique natural bioactive substances, making them excellent livestock feed. Liu et al. [4] reported that adding 2.5 kg of fresh mulberry leaves to pig diets increased ADG from 0.34 kg to 0.58 kg. Guo et al. [5] found that supplementing finishing pig diets with fresh mulberry leaves altered intestinal microbiota and increased beneficial bacteria, thereby improving feed efficiency and ADG. The present study showed that ADG in finishing pigs decreased gradually with increasing dietary mulberry leaf powder levels, while average backfat thickness also decreased progressively. These effects may be related to anti-nutritional factors and toxic substances in mulberry leaves that affect animal performance, representing the primary reason why mulberry leaves cannot be added in large quantities to animal diets. In this experiment, 10% mulberry leaf powder supplementation did not significantly affect growth rate.

3.2 Effects of Dietary Mulberry Leaf Powder on Meat Quality

Muscle pH is a direct indicator of muscle acidity, an important index of glycolysis rate, and one of the key parameters for meat quality evaluation [6]. Post-slaughter, muscle glycogen and fat undergo anaerobic glycolysis under hypoxic conditions, producing large amounts of lactic acid that cause a sharp decline in muscle pH and protein denaturation until glycolytic enzyme activity is inhibited [6]. Therefore, slowing the post-slaughter pH decline can help reduce the incidence of low-quality pork such as PSE and DFD meat. Yang et al. [7] demonstrated that dietary mulberry leaf powder could slow the post-slaughter pH decline in porcine muscle, improving meat quality and flavor. Marbling depth is positively correlated with intramuscular fat content, and marbling score can be used to estimate intramuscular fat content [8]. Within an appropriate range, marbling score increases with higher intramuscular fat content [9]. Liu et al. [10] reported that adding 10% mulberry branch and leaf powder to basal diets fed to 60 kg pigs for 50 days improved muscle quality and flavor, increased intramuscular fat content and marbling score, without significantly affecting production performance. Guo et al. [5] found that dietary fresh mulberry leaves increased high-density lipoprotein, cholesterol, creatinine, vitamin E, linoleic acid, total amino acids, and lysine content in *longissimus dorsi* muscle while decreasing total cholesterol and stearic acid content. The present results indicate that mulberry leaf powder supplementation increased marbling score and reduced muscle total cholesterol content, thereby improving meat quality.

3.3 Effects of Dietary Mulberry Leaf Powder on Muscle Antioxidant Capacity Post-slaughter muscle SOD activity and MDA content are significantly correlated with important meat quality traits including water-holding capacity, meat color, and tenderness, confirming that higher SOD activity and lower MDA content are associated with greater water-holding capacity, brighter meat color, and more tender meat [11]. The low-molecular-weight flavonoid compounds and polysaccharides in mulberry leaves are natural potent antioxidants that can scavenge superoxide radicals, oxygen radicals, hydrogen peroxide, lipid peroxides, and hydroxyl radicals, thereby inhibiting oxidative damage induced by free radicals and promoting animal health [12]. Cheong et al. [13] reported that supplementing 10% silaged mulberry leaves in Hanwoo steer total mixed rations increased activities of antioxidant enzymes including glutathione peroxidase, SOD, catalase, and glutathione-S-transferase in beef *longissimus dorsi* muscle. The present findings demonstrate that dietary mulberry leaf powder significantly increased muscle SOD activity and reduced MDA content, effectively enhancing muscle antioxidant capacity, which may be attributed to the abundant mulberry leaf polysaccharides and flavonoids present.

3.4 Effects of Dietary Mulberry Leaf Powder on Serum Urea Nitrogen Content Serum urea nitrogen content reflects the efficiency of dietary protein utilization [14]. The present results showed that mulberry leaf powder supplementation significantly increased serum urea nitrogen content in finishing pigs, with a progressive increase as supplementation levels rose. This may be related to the anti-nutritional and toxic effects of certain bioactive substances in mulberry leaf powder. Reports indicate that tannins are the primary anti-nutritional factors in mulberry leaves, capable of binding with proteins and other biological macromolecules to form indigestible complexes [12]. However, these findings contradict those of Chang et al. [15], who reported reduced serum nitrogen content in chickens fed mulberry diets. The specific reasons require further investigation.

3.5 Effects of Dietary Mulberry Leaf Powder on Serum Triglyceride Content and Lipase Activity High intake of animal fat seriously affects human health, particularly increasing the incidence of cardiovascular diseases [16]. Flavonoids are one of the main active components in mulberry leaves, with Korean scholar Kim et al. isolating nine flavonoids from mulberry leaves [17]. Numerous studies have demonstrated that flavonoid compounds regulate animal fat deposition and metabolism, promote vasodilation, increase coronary blood flow, and exert lipid-lowering, blood pressure-lowering, blood glucose-lowering, and cardioprotective effects, while also improving cardiac function, stimulating central nervous system activity, and providing antioxidant benefits [18]. In this experiment, mulberry leaf powder supplementation reduced serum triglyceride content in finishing pigs, consistent with research results on mulberry leaf flavonoids in hyperlipidemic model mice [19-22], likely attributable to the lipid-lowering effects of total flavonoids present in mulberry leaves.

Conclusion

Based on the comprehensive results, the following conclusions can be drawn: (1) Dietary supplementation with 10% mulberry leaf powder did not significantly affect growth rate in finishing pigs but improved marbling score while reducing average backfat thickness and muscle total cholesterol content. (2) Adding 10% mulberry leaf powder to diets significantly increased muscle SOD activity and enhanced muscle antioxidant capacity. (3) Dietary inclusion of 10% mulberry leaf powder reduced serum triglyceride content and regulated lipid metabolism in finishing pigs.

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