

Effects of Alfalfa Flavonoids on Growth Performance, Organ Development, and Serum Biochemical Indices in 28- to 70-Day-Old Yangzhou Geese (Postprint)

Authors: Chen Yinyin, Gong Xiaoxiao, Li Guodong, Lin Miao, Huo Yongjiu, Li Shengli, Zhao Guoqi

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Abstract

This study aimed to investigate the effects of dietary supplementation with different levels of alfalfa flavonoids on growth performance, organ development, and serum biochemical indices of Yangzhou geese from 28 to 70 days of age. A total of 240 healthy 21-day-old male Yangzhou geese with similar body weight were randomly allocated into 4 groups, with 6 replicates per group and 10 geese per replicate. The control group was fed a basal diet, while the experimental groups (Groups I, II, and III) were fed experimental diets supplemented with 150, 300, and 450 mg/kg alfalfa flavonoids, respectively. The pre-trial period lasted 7 days, and the formal trial period lasted 42 days. The results showed that: 1) The final body weight and average daily feed intake of Group II were significantly higher than those of the other three groups ($P < 0.05$); the average daily gain of Group II was significantly higher than that of the control group and Group I ($P < 0.05$); there was no significant difference in feed-to-gain ratio among all groups ($P > 0.05$). 2) There were no significant differences in live weight before slaughter, carcass weight, dressing percentage, semi-eviscerated weight, semi-eviscerated percentage, eviscerated weight, eviscerated percentage, leg muscle weight, and leg muscle percentage between the control group and each experimental group ($P > 0.05$); the breast muscle weight and breast muscle percentage of each experimental group were significantly higher than those of the control group ($P < 0.05$); the abdominal fat weight and abdominal fat percentage of Group I were significantly higher than those of the control group and Group III ($P < 0.05$); the tibia weight of Group II was significantly higher than that of the control group and Group I ($P < 0.05$). 3) There were no significant differences in heart weight, liver weight, and glandular stomach weight between each experimental group and the control group ($P > 0.05$); the spleen weight of

each experimental group was significantly higher than that of the control group ($P < 0.05$); the bursa of Fabricius weight of Group II was significantly higher than that of the control group and Group I ($P < 0.05$); the muscular stomach weight of Groups II and III was significantly higher than that of the control group and Group I ($P < 0.05$). 4) The serum contents of total cholesterol (TC), triglycerides (TG), low-density lipoprotein (LDL), and urea nitrogen (UN) in Group II were significantly lower than those in the control group ($P < 0.05$); the serum high-density lipoprotein (HDL) content of Groups I and II was significantly higher than that of the control group and Group III ($P < 0.05$); there were no significant differences in serum total protein (TP), albumin (ALB), globulin (GLB) contents, and albumin/globulin ratio (A/G) among all groups ($P > 0.05$); the serum activities of alanine aminotransferase (ALT) and aspartate aminotransferase (AST) in Groups II and III were higher than those in Group I and the control group, but the differences were not significant ($P > 0.05$); the serum alkaline phosphatase (ALP) activity of Groups I and II was higher than that of the control group and Group III, but the difference was not significant ($P > 0.05$). In conclusion, dietary supplementation of alfalfa flavonoids can improve the growth performance, organ development, and serum biochemical indices of Yangzhou geese, with supplementation at 300 mg/kg showing the best effect.

Full Text

Effects of Alfalfa Flavonoids on Growth Performance, Organ Development and Serum Biochemical Indexes of Yangzhou Geese Aged from 28 to 70 Days

CHEN Yinyin¹, GONG Xiaoxiao¹, LI Guodong¹, LIN Miao¹, HUO Yongjiu¹, LI Shengli², ZHAO Guoqi^{1*}

¹College of Animal Science and Technology, Yangzhou University, Yangzhou 225009, China

²College of Animal Science and Technology, China Agricultural University, Beijing 100193, China

Abstract

This experiment was conducted to investigate the effects of dietary supplementation with different levels of alfalfa flavonoids on growth performance, organ development, and serum biochemical indexes of Yangzhou geese aged 28 to 70 days. A total of 240 healthy 21-day-old male Yangzhou geese with similar body weight were randomly allocated into four groups, with six replicates per group and ten geese per replicate. The control group was fed a basal diet, while the experimental groups (Groups I, II, and III) were fed experimental diets supplemented with 150, 300, and 450 mg/kg alfalfa flavonoids, respectively. The pre-trial period lasted 7 days, followed by a 42-day formal experimental period.

The results showed: (1) The final body weight and average daily feed intake of

Group II were significantly higher than those of the other three groups ($P < 0.05$). The average daily gain of Group II was significantly higher than that of the control group and Group I ($P < 0.05$). No significant difference in feed-to-gain ratio was observed among all groups ($P > 0.05$). (2) No significant differences were found in slaughter live weight, carcass weight, dressing percentage, semi-eviscerated weight, semi-eviscerated percentage, eviscerated weight, eviscerated percentage, leg muscle weight, or leg muscle ratio between the control and experimental groups ($P > 0.05$). However, the breast muscle weight and breast muscle ratio of all experimental groups were significantly higher than those of the control group ($P < 0.05$). The abdominal fat weight and abdominal fat ratio of Group I were significantly higher than those of the control group and Group III ($P < 0.05$). The tibia weight of Group II was significantly higher than that of the control group and Group I ($P < 0.05$). (3) No significant differences were observed in heart weight, liver weight, or glandular stomach weight among the control and experimental groups ($P > 0.05$). The spleen weight of all experimental groups was significantly higher than that of the control group ($P < 0.05$). The bursa of Fabricius weight of Group II was significantly higher than that of the control group and Group I ($P < 0.05$). The muscular stomach weight of Groups II and III was significantly higher than that of the control group and Group I ($P < 0.05$). (4) The serum contents of total cholesterol (TC), triglycerides (TG), low-density lipoprotein (LDL), and urea nitrogen (UN) in Group II were significantly lower than those in the control group ($P < 0.05$). The serum high-density lipoprotein (HDL) content of Groups I and II was significantly higher than that of the control group and Group III ($P < 0.05$). No significant differences were found in serum total protein (TP), albumin (ALB), globulin (GLB) contents, or albumin-to-globulin ratio (A/G) among all groups ($P > 0.05$). The serum alanine aminotransferase (ALT) and aspartate aminotransferase (AST) activities in Groups II and III were higher than those in Group I and the control group, but the differences were not significant ($P > 0.05$). The serum alkaline phosphatase (ALP) activity in Groups I and II was higher than that in the control group and Group III, but the differences were not significant ($P > 0.05$).

In conclusion, dietary supplementation with alfalfa flavonoids can improve the growth performance, organ development, and serum biochemical indexes of Yangzhou geese, with the optimal supplementation level being 300 mg/kg.

Keywords: alfalfa flavonoids; Yangzhou geese; growth performance; organ development; serum biochemical indexes

Introduction

Alfalfa (*Medicago sativa* L.) is a high-yielding, high-quality perennial legume known as the “king of forages,” widely cultivated and introduced worldwide. Rich in nutritional value and various active substances, alfalfa has become a promising project in forage resource development in China, attracting increasing atten-

tion and research focus both domestically and internationally [1]. Flavonoids, as one of the bioactive components of alfalfa, have been shown to promote growth, improve carcass quality, and enhance immunity in livestock and poultry within a certain dosage range [2-3]. Xia et al. [4] reported that adding alfalfa meal to laying hen diets could improve egg quality and yolk color. Zhu et al. [5] found that supplementing mouse diets with alfalfa isoflavones significantly improved growth performance in male mice and enhanced both specific and non-specific immune functions. While flavonoids have been studied in pigs, rodents, ruminants, and chickens [6-11], their effects on Yangzhou geese have not been reported. Yangzhou geese, a new breed developed using local Chinese goose breeds and modern genetic breeding techniques, exhibit advantages including rapid early growth, strong adaptability, tolerance to roughage, and delicious meat quality. This study investigated the effects of different dietary levels of alfalfa flavonoids on growth performance, organ development, and serum biochemical indexes of Yangzhou geese to provide a scientific basis for the rational application of alfalfa flavonoids in goose production and effective development of alfalfa resources.

1. Materials and Methods

1.1 Experimental Animals and Materials One-day-old male Yangzhou geese (purchased from Gaoyou Chaotiangge Agriculture and Animal Husbandry Co., Ltd., Yangzhou) were conventionally raised until 21 days of age for the experiment. Alfalfa flavonoids were extracted using supercritical CO₂ extraction, purified by high-speed countercurrent chromatography, and determined by ultraviolet spectrophotometry, with a flavonoid content of 81%. The determination method for alfalfa flavonoids used in the experiment followed reference [12].

1.2 Experimental Design and Management The experiment was conducted from April to June 2015 at the Yangzhou Ruinong Technology Co., Ltd. goose farm, a teaching and practice base of Yangzhou University. A total of 240 healthy 21-day-old male Yangzhou geese with similar body weight were selected and randomly assigned to four groups using a single-factor experimental design, with six replicates per group and ten geese per replicate. The control group was fed a basal diet, while the experimental groups (Groups I, II, and III) were fed experimental diets supplemented with 150, 300, and 450 mg/kg alfalfa flavonoids, respectively. In the experimental groups, alfalfa flavonoids were first mixed into the prepared premix at the appropriate ratio, then incorporated into the diet. Geese were raised on net floors indoors with manual feeding, ad libitum access to feed and water, natural lighting, and routine immunization. The pre-trial period lasted 7 days: days 1-2 with basal diet, days 3-5 with 1/3 experimental diet and 2/3 basal diet, and days 6-7 with 2/3 experimental diet and 1/3 basal diet. The formal experimental period lasted 42 days.

The basal diet was formulated using corn and soybean meal as primary ingredi-

ents, with nutrient levels designed to meet or approach NRC (1994) standards. The composition and nutrient levels are shown in Table 1 .

Table 1 Composition and Nutrient Levels of the Basal Diet (Air-Dry Basis)

Ingredients	Content	Nutrient Levels ²⁾	Content
Corn		Metabolic Energy (ME)/(MJ/kg)	
Soybean meal		Crude Protein (CP)	
Wheat bran		Crude Fiber (CF)	
Oat grass		Crude Fat (EE)	
Limestone		Calcium (Ca)	
CaHPO ₄		Total Phosphorus (TP)	
Premix ¹⁾		Methionine (Met)	
Total		Lysine (Lys)	

¹⁾ The premix provided the following per kg of diet: VA 1,500 IU, VD₃ 200 IU, VE 12.5 IU, VB₁ 2.4 mg, VB₂ 5.0 mg, VB₆ 2 mg, VB₁₂ 0.01 mg, nicotinic acid 65 mg, D-pantothenic acid 15 mg, folic acid 0.5 mg, biotin 0.2 mg, choline 15 mg, Fe (as ferrous sulfate) 90 mg, Cu (as copper sulfate) 5 mg, Mn (as manganese sulfate) 95 mg, Zn (as zinc sulfate) 90 mg, I (as potassium iodide) 0.5 mg, Se (as sodium selenite) 0.3 mg.

²⁾ ME was a calculated value, while the others were measured values.

1.3 Measurement Indicators

1.3.1 Growth Performance Indicators During the experimental period, Yangzhou geese were individually weighed after fasting for 6 hours at 08:00 on days 28, 35, 42, 49, 56, 63, and 70. Daily feed intake and weight gain of each group were recorded to calculate average daily feed intake (ADFI), average daily gain (ADG), and feed-to-gain ratio (F/G).

1.3.2 Slaughter Performance Indicators At the end of the experiment on day 70, 12 geese from each group (2 per replicate) were selected for slaughter to determine carcass weight, eviscerated weight, semi-eviscerated weight, breast muscle weight, leg muscle weight, abdominal fat weight, tibia weight, and other indicators. Dressing percentage, eviscerated percentage, semi-eviscerated percentage, breast muscle ratio, leg muscle ratio, and abdominal fat ratio were calculated using the following formulas:

- Dressing percentage (%) = (carcass weight / slaughter live weight) × 100
- Semi-eviscerated percentage (%) = (semi-eviscerated weight / slaughter live weight) × 100
- Eviscerated percentage (%) = (eviscerated weight / slaughter live weight) × 100

- Breast muscle ratio (%) = (weight of both breast muscles / eviscerated weight) × 100
- Leg muscle ratio (%) = (weight of both leg muscles / eviscerated weight) × 100
- Abdominal fat ratio (%) = [abdominal fat weight / (eviscerated weight + abdominal fat weight)] × 100

1.3.3 Organ Indices The glandular stomach, muscular stomach (with contents removed), heart, liver, spleen, and bursa of Fabricius were quickly weighed after removing surrounding fat, and organ indices were calculated using the formula:

$$\text{Organ index (\%)} = (\text{fresh weight of visceral organ} / \text{live weight}) \times 100$$

1.3.4 Serum Biochemical Indicators On day 70 of the experiment, 12 Yangzhou geese from each group were selected for blood sampling (10 mL) from wing veins. Serum was prepared by centrifugation at 3,500 r/min for 15 minutes and stored at -20°C. Serum samples were tested at Yangzhou Center for Disease Control and Prevention for the following indicators: total protein (TP), albumin (ALB), globulin (GLB), albumin-to-globulin ratio (A/G), alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), urea nitrogen (UN), total cholesterol (TC), triglycerides (TG), high-density lipoprotein (HDL), and low-density lipoprotein (LDL).

1.4 Statistical Analysis Experimental data were initially processed using Excel 2007 and then subjected to one-way ANOVA using SPSS 21.0 statistical software. Duncan's multiple comparison test was used, and data were expressed as mean ± standard deviation. P<0.05 was considered statistically significant.

2. Results and Analysis

2.1 Effects of Alfalfa Flavonoids on Growth Performance of Yangzhou Geese Aged 28-70 Days As shown in Table 2, the final body weight and average daily feed intake of Group II were significantly higher than those of the other three groups (P<0.05). The average daily gain of Group II was significantly higher than that of the control group and Group I (P<0.05). No significant difference in feed-to-gain ratio was observed among all groups (P>0.05), though Group II had the lowest ratio.

These results indicate that alfalfa flavonoid supplementation can improve the growth performance of Yangzhou geese, with Group II showing the best effects.

Table 2 Effects of Alfalfa Flavonoids on Growth Performance of Yangzhou Geese at the Age of 28 to 70 Days

Items	Control	Group I	Group II	Group III
Initial body weight (IBW)/kg	1.21 \pm 0.04 ^a	1.22 \pm 0.05 ^a	1.22 \pm 0.06 ^a	1.23 \pm 0.06 ^a
<i>Finalbodyweight(FBW)/kg</i>	3.18 \pm 0.14 ^b	3.20 \pm 0.26 ^b	3.20 \pm 0.26 ^b	3.20 \pm 0.26 ^b
<i>to – gainratio(F/G)</i>	5.22 \pm 0.98 ^a	5.24 \pm 1.65 ^a	4.94 \pm 0.62 ^a	5.18 \pm 0.58 ^a

In the same row, values with different small letter superscripts indicate significant difference ($P < 0.05$), while values with the same or no letter superscripts indicate no significant difference ($P > 0.05$). The same applies below.

2.2 Effects of Alfalfa Flavonoids on Slaughter Performance of Yangzhou Geese Aged 28-70 Days As shown in Table 3, no significant differences were observed in slaughter live weight, carcass weight, dressing percentage, semi-eviscerated weight, semi-eviscerated percentage, eviscerated weight, eviscerated percentage, leg muscle weight, or leg muscle ratio between the control and experimental groups ($P > 0.05$). However, the breast muscle weight and breast muscle ratio of all experimental groups were significantly higher than those of the control group ($P < 0.05$), with Group II showing the highest values. The abdominal fat weight and abdominal fat ratio of Group I were significantly higher than those of the control group and Group III ($P < 0.05$). The tibia weight of Group II was significantly higher than that of the control group and Group I ($P < 0.05$), but did not differ significantly from Group III ($P > 0.05$).

These results demonstrate that alfalfa flavonoid supplementation improved most slaughter performance indicators in Yangzhou geese, with Group II showing the best effects.

Table 3 Effects of Alfalfa Flavonoids on Slaughter Performance of Yangzhou Geese at the Age of 28 to 70 Days

Items	Control	Group I	Group II	Group III
Slaughter live weight/kg	3.21 \pm 0.36 ^a	3.22 \pm 0.51 ^a	3.29 \pm 0.40 ^a	3.23 \pm 0.48 ^a
<i>Carcassweight/kg</i>	2.78 \pm 0.31 ^a	2.85 \pm 0.47 ^a	2.78 \pm 0.34 ^a	2.78 \pm 0.34 ^a
<i>Semi-evisceratedweight/kg</i>	2.23 \pm 0.48 ^a	2.24 \pm 0.29 ^a	2.28 \pm 0.34 ^a	2.18 \pm 0.40 ^a
<i>Semi-evisceratedpercentage/±0.03</i>	0.69 \pm 0.03 ^a	0.69 \pm 0.03 ^a	0.69 \pm 0.03 ^a	0.68 \pm 0.04 ^a
<i>Evisceratedweight/kg</i>	2.01 \pm 0.27 ^a	2.01 \pm 0.27 ^a	2.01 \pm 0.27 ^a	2.01 \pm 0.27 ^a

2.3 Effects of Alfalfa Flavonoids on Organ Development of Yangzhou Geese Aged 28-70 Days As shown in Table 4, no significant differences were observed in heart weight, liver weight, or glandular stomach weight between the control and experimental groups ($P > 0.05$), though Groups I-III were higher than the control, with Group II showing the highest values. The spleen weight of all experimental groups was significantly higher than that of the control group ($P < 0.05$). The bursa of Fabricius weight of Group II was significantly

higher than that of the control group and Group I ($P < 0.05$), but did not differ significantly from Group III ($P > 0.05$). The muscular stomach weight of Groups II and III was significantly higher than that of the control group and Group I ($P < 0.05$), with no significant difference between Groups II and III ($P > 0.05$).

These results indicate that alfalfa flavonoid supplementation increased the weight of visceral organs in Yangzhou geese, suggesting a promoting effect on the growth and development of internal organs, with Group II showing the best effects.

Table 4 Effects of Alfalfa Flavonoids on Organ Weight of Yangzhou Geese at the Age of 28 to 70 Days

Items	Control	Group I	Group II	Group III
Heart weight	21.89 \pm 3.21	22.21 \pm 3.86	22.46 \pm 2.49	22.14 \pm 3.48
Liverweight	74.25 \pm 8.57	76.06 \pm 12.28	77.13 \pm 6.93	76.06 \pm 12.28

2.4 Effects of Alfalfa Flavonoids on Serum Biochemical Indexes of Yangzhou Geese Aged 28-70 Days

As shown in Table 5, compared with the control group, Group II showed significantly reduced serum TC, TG, and LDL contents ($P < 0.05$). The serum HDL content of Groups I and II was significantly higher than that of the control group and Group III ($P < 0.05$). The serum UN content of Groups II and III was significantly lower than that of the control group and Group I ($P < 0.05$). No significant differences were observed in serum TP, ALB, GLB contents, or A/G among all groups ($P > 0.05$), though all experimental groups were higher than the control. The serum ALT and AST activities in Groups II and III were higher than those in Group I and the control group, but the differences were not significant ($P > 0.05$). The serum ALP activity in Groups I and II was higher than that in the control group and Group III, but the differences were not significant ($P > 0.05$).

These results demonstrate that alfalfa flavonoid supplementation improved serum biochemical indexes in Yangzhou geese, with Group II showing the best effects.

Table 5 Effects of Alfalfa Flavonoids on Serum Biochemical Indexes of Yangzhou Geese at the Age of 28 to 70 Days

Items	Control	Group I	Group II	Group III
TC/(mmol/L)	3.92 \pm 0.57 ^a	3.63 \pm 0.43 ^{ab}	3.20 \pm 0.62 ^b	3.18 \pm 0.47 ^b
TG/(mmol/L)	1.07 \pm 0.27 ^a	0.89 \pm 0.35 ^{ab}	0.73 \pm 0.35 ^b	0.73 \pm 0.35 ^b

3. Discussion

3.1 Effects of Alfalfa Flavonoids on Growth Performance of Yangzhou Geese Aged 28-70 Days

Flavonoids are plant secondary metabolites, a

class of yellow pigments derived from flavone (2-phenylchromone) as the parent nucleus. Numerous studies have shown that flavonoids extracted from alfalfa exhibit mild estrogenic effects, can improve growth performance in livestock and poultry, scavenge free radicals, and enhance antioxidant capacity and stress resistance [13-14]. Flavonoids can promote animal growth by acting on the hypothalamic-pituitary-target organ growth axis. Zhou [15] added alfalfa flavonoid extract to broiler diets and found that, compared with the control group, the extract promoted feed intake in female broiler chicks, increased body weight and daily gain, with greater effects in the later growth stage than in the early stage. Li et al. [16] reported that adding 0.2% sea buckthorn flavonoids to basal diets significantly improved the dressing percentage of Arbor Acres (AA) broilers. Sea buckthorn leaf flavonoids can improve the utilization rate of calcium and phosphorus in feed, facilitate tibial calcium and phosphorus deposition, and promote tibial development and bone strength [17]. The results of this experiment are similar to these findings: supplementation with 300 mg/kg alfalfa flavonoids significantly increased average daily feed intake, average daily gain, and final body weight of geese, while reducing abdominal fat ratio. Breast muscle and tibia indicators in all experimental groups were higher than those in the control group. This may be because this dosage of alfalfa flavonoids exerted estrogen-like effects to some extent, promoting goose growth, improving dressing percentage, enhancing feed conversion efficiency without increasing abdominal fat deposition, and thereby improving growth performance. These results are consistent with the conclusions of Zhao et al. [18]. The above findings indicate that an appropriate dosage of alfalfa flavonoids is safe and effective in Yangzhou goose diets.

3.2 Effects of Alfalfa Flavonoids on Organ Development of Yangzhou Geese Aged 28-70 Days

The growth and development status of visceral organs in geese can indirectly reflect nutrient digestion and absorption in the body. The heart and liver are important organs for metabolism, while the spleen and bursa of Fabricius are important immune organs. As early as 1985, Rivas et al. [19] suggested that the weight of the bursa of Fabricius and spleen could be used to evaluate the immune status of chicks. The bursa of Fabricius is the site where B lymphocytes develop and mature in poultry. Pluripotent stem cells from the bone marrow enter the bursa of Fabricius, where they differentiate into mature B lymphocytes under the influence of bursin, playing an important role in humoral immunity. The duration of the bursa's presence has a significant impact on the immune function of chickens, particularly humoral immunity [20]. Increased bursa weight can promote the induction, differentiation, and maturation of B cells, thereby enhancing humoral immunity [21]. The stomach is the main digestive organ in geese; the muscular stomach has well-developed muscular walls lined with a cuticle that can grind food [22]. In this experiment, dietary alfalfa flavonoid supplementation increased organ indices in geese. The weights of the liver, spleen, and bursa of Fabricius showed a trend of increasing then decreasing with increasing supplementation levels, possibly because alfalfa

flavonoids promoted glycogen storage in the liver, increased synthesis of secreted proteins, and facilitated the full functionality of the immune mechanisms of the spleen and bursa. The weights of the muscular and glandular stomachs increased within a certain range but decreased with excessive supplementation, likely because excessive alfalfa flavonoids affected diet palatability.

3.3 Effects of Alfalfa Flavonoids on Serum Biochemical Indexes of Yangzhou Geese Aged 28-70 Days

TG and TC are components of fat, and their levels reflect lipid absorption, metabolism, and utilization. Lower levels indicate higher fat utilization efficiency. The main physiological function of HDL is to transport cholesterol to cells throughout the body and to the liver for bile acid synthesis [23-24]. LDL is rich in cholesterol, and high levels can lead to atherosclerosis [25]. The results of this experiment show that alfalfa flavonoid supplementation reduced serum TG, TC, and LDL contents while increasing serum HDL content in Yangzhou geese, indicating that alfalfa flavonoids promoted cholesterol metabolism to some extent, slowed cholesterol deposition in the body, and thereby improved meat quality. Zhou [15] reported that dietary supplementation with 150-450 mg/kg alfalfa flavonoids increased serum TP, ALB, and GLB contents in broilers, which is consistent with the results of this experiment, indicating that alfalfa flavonoids within a certain dosage range have no adverse effects on protein metabolism and liver function in geese and are beneficial for protein synthesis. Serum UN is the main end product of amino acid metabolism in poultry, and protein metabolism can be reflected by serum UN content. Elevated serum UN content indicates enhanced protein catabolism, while decreased content indicates increased protein synthesis and deposition, improving nitrogen utilization efficiency [26]. In this experiment, all experimental groups showed a trend of reduced serum UN content compared with the control group while remaining within the normal range, which is consistent with the results of Zhou [15], indicating that dietary alfalfa flavonoid supplementation improved nitrogen utilization and increased protein deposition in Yangzhou geese. Serum ALT and AST are important transaminases in animals, playing a crucial intermediary role in the synthesis of non-essential amino acids and protein catabolism. Their levels reflect the status of protein synthesis and catabolism [27]. In this experiment, serum ALT and AST activities in experimental groups were higher than those in the control group, but the differences were not significant, possibly because the added alfalfa flavonoids accelerated the utilization of these two transaminases while improving protein and amino acid utilization, without causing adverse effects on the body. This is consistent with the findings of Wang et al. [28]. Under normal growth conditions, serum ALP activity in livestock and poultry typically increases, only decreasing when intestinal absorption is impaired. ALP is a pyrophosphatase that catalyzes the decomposition of pyrophosphate and promotes bone salt deposition [29]. The results of this experiment showed that serum ALP activity in Groups I and II was higher than that in the control group, indicating that alfalfa flavonoids can increase serum ALP activity without causing intestinal absorption impairment

and can promote bone growth in Yangzhou geese to some extent, which is basically consistent with the tibia measurement results. However, alfalfa flavonoids contain other substances that may affect serum biochemical indicators, and the specific mechanisms require further research.

In conclusion, dietary supplementation with alfalfa flavonoids in 28-70-day-old Yangzhou geese can increase average daily feed intake, reduce feed-to-gain ratio, and improve slaughter performance, organ indices, and serum biochemical indicators without adverse effects. The optimal supplementation level is 300 mg/kg.

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