UDK 636.59:546.15

EFFECTS OF ASTRAGALUS EXTRACT AND GLYCYRRHIZA EXTRACT ON BROILER PERFORMANCE, APPARENT NUTRIENT METABOLISM RATE AND MEAT QUALITY

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This experiment aims to study the effects of Astragalus extract and Glycyrrhiza extract on broiler performance, nutrient metabolism rate, organ index and meat quality. The experiment was carried out in Yunnan Academy of Animal Science, for determine the quality of meat used the laboratories of Henan Institute of Science and Technology. A total of experiment use 360 healthy 1-day-old Avian broiler chickens were randomly divided into three groups, each with 6 replicates, and each replicate with 20 chickens. The study showed that adding Astragalus polysaccharides to poultry diets can significantly increase ADFI and improve FCR (P<0.05). Nutrient metabolism rate is an important indicator to measure the digestion and absorption of nutrients by animals. Its level directly affects the growth performance of animals and also reflects the nutritional value of diets. This study showed that adding Astragalus extract and Glycyrrhiza extract to the diet increased the metabolic rate of crude protein (P <0.05), but had no effect on the apparent metabolic rate of energy, crude fat, calcium and phosphorus. The relative weight of the thymus, spleen and bursal Index can reflect the overall immune function of the body to some extent. It is generally believed that a large immune organ index indicates that the immune organs are well developed, and the body's immunity is high. The study found that adding 0.2% or 0.3% of Astragalus extract significantly increased the Thymus index and Bursa index of broilers (P <0.05), and the spleen index had a tendency to increase. Muscle pH, shear force and drip loss are indicators to evaluate the physical and chemical properties of meat quality. The content of fatty acids in muscle is an index to evaluate the nutritional value of meat quality. This study found that the addition of Astragalus extract and Glycyrrhiza extract to the diet increased the pH of chicken significantly (P<0.05). Compared with the antibiotic group, pH was significantly increased (P<0.05) and pH was significantly decreased (P<0.05) for combination group, and there were no differences for other indicators (P>0.05). Indicating that feeding Astragalus extract and Glycyrrhiza extract can effectively alleviate the glycogen caused by the stress of broilers after slaughter Glycolysis. Fatty acid is an important chemical substance that constitutes fat, and it is also an important factor that affects the flavor of meat. This study showed that the addition of Astragalus Extract and Glycyrrhiza Extract to the diet increased the SFA, USFA, MUFA, PUFA, and EFA in muscles, but there was no significant change, indicating that the addition of Astragalus and Glycyrrhiza extract under this test condition Does not affect the flavor of the meat. In summary, Adding 300 mg/kg Astragalus extract and 150 mg/kg Glycyrrhiza extract to the diet can improve the performance and immune function of broilers and the freshness of chicken meat, and can be used as a substitute for antibiotics in the poultry industry.

Keywords: *production performance, nutrient metabolism rate, organ index, meat quality, growing, technology, chicken, broiler, poultry*

DOI: https://doi.org/10.32845/bsnau.lvst.2021.3.5

Introduction. In the past few decades, the application of antibiotics has improved the growth rate and feed conversion efficiency of poultry (Sugiharto.,2016). However, the increasing use of antibiotics in livestock and poultry production has caused widespread concern about the prevalence of antibiotic-resistant bacteria. In particular, the accumulation of antibiotic residues in chickens leads to the contamination of meat and eggs (Suresh et al., 2017). Consumers' increasing awareness of food safety and biosafety issues has prompted the poultry industry to look for alternatives to antibiotics (Yitbarek et al., 2015). Studies have shown that Chinese herbal feed additives can improve the growth performance of livestock and poultry, improve immune function, and have antibacterial, antiviral and antioxidant effects (Wang et al., 2014, Hu et al., 2011). Astragalus and Glycyrrhiza are traditional Chinese herbal medicines. Astragalus contains polysaccharides, proteins, alkaloids, amino acids, flavonoids, trace elements and other active substances. Among them, the immunological activity of polysaccharides is the most prominent and has the functions of enhancing animal immunity and promoting animal growth (Chen et al., 2009). Glycyrrhiza is also

rich in chemical substances with biological activity, mainly triterpene saponins (mainly glycyrrhizic acid), flavonoids, coumarins, alkaloids, volatile oils, organic acids, sugars, etc. Glycyrrhiza has antioxidant, antibacterial and antiviral properties, anti-cancer, anti-inflammation and immune regulation, blood sugar lowering and regulating various drugs and other biologically active functions (Xiang et al., 2018). A number of studies have shown that adding plant extracts to poultry diets can improve the immunity of poultry, prevent the occurrence of diseases, and promote poultry growth (Wallace R J et al., 2010, Diaz-Sanchez S et al., 2015). Studies have shown that adding 1.0g/kg of Astragalus polysaccharides to the diet can improve the growth performance and immune function of broilers (Shen et al., 2015). Adding 800mg/kg of Astragalus extract to the diet can increase the body weight of broilers at 42 days and the weight gain of broilers at 15-42 days (Bai S et al., 2020). The addition of Glycyrrhiza to the diet of broilers improves the spleen and bursa of Fabricius which improves the immune function, improves the survival rate and health status (Kalantar M et al., 2017). Glycyrrhiza extract can reduce the negative effects of aflatoxin B1 on broiler performance and immunity (Rashidi N et al., 2020). Drinking water containing Glycyrrhiza extract can improve the average body weight, average daily feed intake (ADFI), average daily gain (ADG) and feed conversion rate (FCR) (El-Hack M et al., 2019), adding 10, 15, 20 and 25ml/l Glycyrrhiza root water extract to the diet has a good effect on the growth and carcass yield of broilers (Iqbal, HF et al., 2020). According to TCM theory, Glycyrrhiza is often used as a "drug pair" in prescriptions to enhance curative effects or reduce toxic side effects. Glycyrrhiza is often compatible with aconite, ginseng, donkey-hide gelatin, dandelion, ginger, jujube, hemp seed, etc., to enhance its efficacy. However, there are few reports on the compatibility of Astragalus extract and Glycyrrhiza extract. In this experiment, Astragalus extract and Glycyrrhiza extract were added to broiler diets to explore the effects on broiler performance, nutrient metabolism, organ index and meat quality and provide both a theoretical basis and a new feeding technology for the use of Astragalus extract and Glycyrrhiza extract in poultry industry.

1. Materials and research methods.

1.1 Preparation of Astragalus Extract and Glycyrrhiza Extract

Astragalus extract and Glycyrrhiza extract are provided by Inner Mongolia Hengguangda Pharmaceutical Co., Ltd. The extraction process is: water extraction at 90°C, double-effect concentration at 70°C, vacuum drying at 70°C, Astragalus extract contains 62.86% of Astragalus polysaccharides, Glycyrrhiza extract Contains 53% of Glycyrrhiza polysaccharides.

1.2 Experimental animals and experimental design

The experiment selected 360 1-day-old AA broilers and randomly divided them into three groups with 6 replicates in each group and 20 chickens in each replicate. The experiment adopts corn-soybean meal type diet, and its formula refers to the NRC (1994) nutritional requirements standard. It is divided into two stages: 0-21 day and 22-42 day. The composition and nutritional level of the basic diet are shown in Table 1. The control group (CON) was fed the basal diet, the antibiotic group (ANT) was fed basal diet adding oxytetracycline calcium 500 mg/kg, the Astragalus extract (AE) and Glycyrrhiza extract (GE) combination group (AE+GE) was fed the basal diet adding Astragalus extract 300 mg/kg and Glycyrrhiza extract 150 mg/kg. The feeding test lasted for 42 days. It is raised in a 3-layer vertical cage with free intake of food and water, the immunization program is to be vaccinated against Newcastle disease at the age of 7 and 21, and the infectious bursal vaccine at the age of 14 days. Feeding management is carried out in accordance with routine procedures.

Table 1

Composition and nutrient levels of basal diets (air-dry basis) %

Items	1 to 21 days of age	22 to 42 days of age
Ingredients		
Corn	54.50	55.42
Soybean meal	29.70	25.30
Corn gluten meal	8.00	8.00
$CaHPO_4$	1.30	1.20
Limestone	1.40	1.40
NaCl	0.30	0.30
Soybean oil	2.80	6.50
Soda	0.15	0.15
L-Lys•HCl	0.87	0.80
DL-Met	0.25	0.21
Threonine	0.13	0.12
Premix[1)]	0.60	0.60
Total	100.00	100.00
Nutrient levels[2)]		
ME/（MJ/kg）	12.61	13.59
CP	23.39	21.19
Ca	0.77	0.72
TP	0.56	0.54

1) Premix is provided per kilogram of diet: 1-21 days: VA, 12000 IU; VD3, 4500 IU; VE, 30 IU; VK3, 4.5 mg; VB1, 2.8 mg; VB2, 9.6 mg; VB6, 3.75 mg; VB12, 30μg; niacin, 49.5 mg; calcium pantothenate, 20 mg; folic acid, 1.5 mg; biotin, 0.18 mg; choline, 500 mg; Zn, 100 mg; Fe, 110 mg; Cu, 20 mg; ; Mn, 120 mg; I, 0.7 mg; Se, 0.3 mg. 22-42 days: VA, 10000 IU; VD3, 3750 IU; VE, 25 IU; VK3, 3.75 mg; VB1, 2.3 mg; VB2, 8 mg; VB6, 3.1 mg; VB12, 25 μg; Niacin, 41.2 mg ; Calcium pantothenate, 20 mg; folic acid, 1.25 mg; biotin, 0.12 mg; choline, 400 mg; Zn, 100 mg; Fe, 110 mg; Cu, 20 mg;; Mn, 120 mg; I, 0.7 mg; Se, 0.3 mg.

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

1.3 Index measurement

1.3.1 Growth performance

Fasting at 20:00 in the evening on the 21st and 42nd day and drinking water freely. The broilers were weighed in repetitions at 8:00 on the 22nd and 43rd days, respectively, and the body weight and the consumption of the broilers were accurately recorded.

Actual consumption: actual consumption = total consumption-total consumption × dead chicken weight / (live chicken weight + dead chicken weight)

Average daily gain (ADG): average daily gain = (average weight of each chicken in each repetition at the end of the experiment-average weight of each chicken in each repetition at the beginning of the experiment)/test days.

Average daily feed intake (ADFI): Average daily feed intake = actual feed consumption/ (test days × number of chickens on hand at the end of the test).

Feed conversion rate（FCR）: average daily feed intake/average daily gain.

1.3.2 Nutrient metabolism rate

At the end of the feeding experiment, two broilers were randomly selected for each repetition to carry out the total fecal collection metabolism test. The collected feces were dried at 60~65℃ to a constant weight, and the moisture regained for 24 hours in the natural state. The weight was recorded after grinding time passed. The mesh size 40 mm is reserved. The content of crude protein in diets and feces samples was determined by Kjeldahl method, the content of crude fat was determined by ether extraction, the content of calcium was determined by complexometric titration with disodium edetate, and the content of phosphorus was determined by molybdenum yellow method.

Determination. The total energy in the diet and manure is measured using an automatic oxygen bomb calorimeter (IKA-C2000, IKA, Germany).

Apparent nutrient metabolism rate (%) = (diet intake × diet nutrient content-excrement amount × excrement nutrient content)/(diet intake × diet nutrient content) × 100

1.3.3 Organ Index

After the end of the experiment, a repetition was used as a unit. From each repetition, a broiler that was close to the average weight was selected by jugular vein bloodletting and sacrificed, and the weight of the thymus, spleen, and bursa were weighed by autopsy. Calculate the organ index, the calculation formula is: organ index = [organ weight (g) / live weight before slaughter (g)] × 100%.

1.3.4 Meat quality

After slaughter, samples of the pectoral muscles on the same side were taken, and the following meat quality indicators were determined.

Muscle pH: Testo 205 pH meter (Testo AG, Lenzkirch, Germany) was directly inserted into the pectoral muscle at 45 min and 24 h after slaughter. The pH meter was calibrated with standard buffers of pH 4.01 and pH 6.86 before use.

Muscle flesh color: 45 minutes after slaughter, use a colorimeter (CH-400, Konica Minolta Holdings, Inc., Japan) to cut 3 pieces of breast muscle samples (5cm×5cm×0.5cm) vertically, and measure the colorimeter of the meat samples. L* value, a* value and b* value. Each meat sample was measured repeatedly 3 times, and the average value was taken as the final color value.

Muscle drip loss rate: After slaughter, from the each chicken takes about 2 g of pectoral muscle and weighs it (W1), puts it in a sealed plastic bag, inflates the plastic bag to prevent the muscle mass from sticking to the wall, hangs in the refrigerator at 4℃ for 24 hours. Dry the surface water of the muscle with filter paper and weigh it (W2) to calculate the drip loss: drip loss=(W1-W2)/W1×100%

Muscle shearing force: The pectoral muscle samples after slaughter are packaged in plastic bags and placed in a constant temperature water bath at 80°C for heating. When the core temperature of the meat reaches 70°C, it is taken out and cooled to room temperature. Then trim the length 3 cm and width1 cm, the strips along the direction of the muscle fibers, and cut them perpendicular to the direction of the muscle fibers with a digital meat tenderness meter (model C-LM3B, Northeast Agricultural University). Shear force.

Fatty acid content determination: Gas chromatography (GB/5009.168-2016). Determination principle: After the sample is hydrolyzed, the fat in the sample is extracted with a solution of ether + petroleum ether (1:1), and then saponified and methyl esterified under alkaline conditions. Fatty acid methyl esters were analyzed by capillary column gas chromatography and the content of fatty acids was quantitatively determined by external standard method.

2. Data processing

All data were analyzed by SPSS18.0, one-way ANOVA (One-way ANOVA), and Ducan's method were used for multiple comparisons, $P < 0.05$ indicates significant difference. The test data is expressed as "mean ± standard deviation".

3. Research results.

3.1 The effect of Astragalus extract and Glycyrrhiza extract on broiler performance

The effects of Astragalus extract and Glycyrrhiza extract on broiler performance are shown in Table 3. In the early stage of broiler feeding (1-21d), the 21day weight, ADFI, ADG and FCR of the three group were not significantly different ($P>0.05$). However, compared with the CON group, the 21 day weight and ADG of the AE+GE group tended to increase, and the FCR tended to decrease, compared with the ANT group, the FCR of the AC+GE group tended to decrease. In the late feeding period (22~42 day), the ADFI, ADG and FCR of the three group were not significantly different ($P>0.005$). But compared with the CON group, the 42 day weight and ADG of the AE+GE group have a tendency to increase, and the FCR has a tendency to decrease, compared with the ANT group, the 42day weight, ADFI and ADG of the AE+GE group have a tendency to increase. During the whole period (1~42d), compared with the CON group, the FCR of the AE+GE group was significantly reduced ($P>0.005$), and the difference between ADFI and ADG was not significant ($P>0.005$), compared with the ANT group, the AE+GE group. The differences in ADFI, ADG and FCR were not significant ($P>0.005$).

Table 2

Effects of AE and GE on broiler performance

Items	CON	ANT	AE+GE	*P*-value
Day1-21				
Initial weight(g)	46.18±0.57	46.27±1.13	46.20±0.56	0.982
21day weight(g)	841.67±23.17	866.27±19.58	870.14±20.39	0.069
ADFI (g/d)	48.10±1.95	50.19±4.68	46.56±3.74	0.254
ADG (g/d)	37.88±1.11	39.05±0.89	39.23±0.98	0.067
FCR (g·g)	1.27±0.08	1.29±0.14	1.19±0.09	0.252
Day22-42				
42day weight(g)	2488.77±51.93	2578.15±55.66	2585.83±97.37	0.059
ADFI (g/d)	142.08±5.40	138.68±6.71	142.55±5.52	0.482
ADG (g/d)	78.43±2.07	81.52±2.91	81.70±4.40	0.186
FCR (g·g)	1.81±0.03	1.70±0.08	1.75±0.09	0.050
Day1-42				
ADFI (g/d)	95.09±3.18	94.43±2.80	94.55±2.36	0.911
ADG (g/d)	58.16±1.25	60.28±1.32	60.47±2.31	0.059
FCR (g·g)	1.64±0.04^{a}	1.57±0.03^{b}	1.56±0.05^{b}	0.011

(Note: The data in the same column marked with different lowercase letters indicates significant differences, p<0.05; marked with the same lowercase letters or not marked indicates that the differences are not significant, P<0.05, the same in the table below.)

The effects of Astragalus extract and Glycyrrhiza extract on the apparent metabolic rate of nutrients in broilers are shown in Table 3. Compared with the CON group, the apparent metabolic rate of crude protein in the AE+GE group was significantly increased (P<0.05). The apparent metabolic rate, the crude fat apparent metabolic rate, the calcium apparent metabolic rate and the phosphorus apparent metabolic rate were not significantly different (P<0.05), compared with the ANT group, the crude protein apparent metabolic rate of the AE+GE group. There were no significant differences in the apparent metabolic rate of energy, crude fat, calcium and phosphorus (P＞0.05).

Table 3

Effects of AE and GE on nutrient metabolic rate of broilers

Items	CON	ANT	AE+GE	*P*-value
Energy apparent metabolic rate/%	64.15±4.65	74.05±2.05	69.02±4.39	0.055
CP apparent metabolic rate/%	46.20±1.48^{b}	49.98±3.23^{a}	50.33±2.32^{a}	0.019
EE apparent metabolic rate/%	70.95±4.26	75.97±4.51	72.18±2.52	0.322
Ca apparent metabolic rate/%	40.20±2.94	47.03±5.58	43.32±1.64	0.164
P apparent metabolic rate/%	42.74±4.33	45.31±2.38	45.05±3.24	0.622

The effects of Astragalus extract and Glycyrrhiza extract on the organ index of broilers are shown in Table 4. Compared with the CON group, the thymus index of the AE+GE group was significantly increased (P<0.05), the spleen index and the bursa index, the difference was not significant (P<0.05). Compared with the ANT group, the thymus index, spleen index and bursa index of the AE+GE group were not significantly different (P<0.05).

Table 4

The effect of AE and GE on the organ index of broilers

Items	CON	ANT	AE+GE	*P*-value
thymus	0.16±0.02^{c}	0.16±0.02^{bc}	0.20±0.03^{a}	0.004
spleen	0.13±0.04^{c}	0.18±0.06^{ab}	0.15±0.03^{bc}	0.088
bursal	0.06±0.01	0.06±0.01	0.05±0.02	0.557

The effects of Astragalus extract and Glycyrrhiza extract on meat quality are shown in Table 5. Compared with the CON group, the pH_{45min} and L* value of the AE+GE group increased significantly (P<0.05), and the b* value decreased significantly (P<0,05), the difference of pH_{24h}, a* value, shear force and drip loss was not significant (P>0.05). Compared with the ANT group, the pH_{45min} of the AE+GE group increased significantly (P<0,05), and the pH_{24h} decreased significantly (P<0.05). There was no significant difference in L*, a*, b* values, shear and force and drip loss (P<0,05).

Table 5

Effects of AE and GE on Meat Quality

Items	CON	ANT	AE+GE	*P*-value
pH_{45min}	6.22±0.17^{b}	6.22±0.13^{b}	6.49±0.17^{a}	0.012
pH_{24h}	5.81±0.05^{ab}	5.90±0.11^{a}	5.74±0.06^{b}	0.010
L*	46.34±4.94^{b}	52.60±2.89^{a}	51.81±2.86^{a}	0.001
a*	6.81±0.42	6.30±0.24	5.68±0.21	0.233
b*	8.53±0.9^{a}	6.34±0.15^{b}	4.33±0.37^{b}	0.002
shear force	27.13±1.24	26.64±2.45	26.38±1.72	0.114
drip loss	1.61±0.43	1.07±0.35	1.38±0.47	0.781

The effect of Astragalus extract and Glycyrrhiza extract on the fatty acid content of breast muscle of broilers is shown in Table 6. Compared with the CON group, the C16:1 of the AE+GE group was significantly increased (P<0.05), and the difference in other fatty acids was not significant (P>0.05) but SFA, USFA, MUFA, PUFA, EFA all have a rising trend. Compared with the ANT group, the fatty acids in the AE+GE group were not significantly different (P>0.05).

Table 6

Effects of AE and GE on Fatty Acid Content in Breast Muscle of Broilers

Items	CON	ANT	AE+GE	*P*-value
C16:0	18.92±0.26	19.08±0.50	19.77±0.78	0.127
C16:1	1.28±0.06b	1.43±0.08a	1.41±0.04a	0.015
C18:0	9.53±0.93	8.82±1.21	10.11±0.83	0.245
C18:1n9c	22.25±0.86	23.51±0.14	23.00±0.79	0.073
C18:2n6	33.52±1.21	35.74±1.94	34.77±1.66	0.210
C18:3n3	2.09±0.09	2.50±0.40	2.27±0.23	0.158
C20:2	0.86±0.21	0.73±0.01	1.12±0.30	0.070
C22:0	0.64±0.15	0.55±0.13	0.58±0.03	0.584
C20:3n6	034±0.09	0.31±0.05	0.30±0.02	0.614
C22:1n9	5.86±1.02	5.08±1.78	6.18±1.95	0.638
C24:1	1.30±0.36	1.19±0.16	1.56±0.49	0.370
C22:6n3	0.77±0.24	0.63±0.24	1.05±0.51	0.283
SFA	29.09±0.80	28.45±1.81	30.45±1.04	0.137
UFA	68.24±0.42	71.12±0.80	71.64±3.26	0.075
MUFA	30.68±0.73	31.21±1.82	32.14±1.67	0.410
PUFA	37.57±0.87	39.91±2.07	39.50±1.94	0.175
EFA	35.61±1.29	38.24±2.28	37.04±1.62	0.168

Discussion. Chicken is a good source of protein. However, intensive poultry farming reduced the growth performance and immune function of broilers, increased the spread of diseases, and caused huge losses to the poultry industry. Historically, antibiotics have been used in the poultry industry to reduce diseases, improve growth performance and feed efficiency, but due to the development of bacterial resistance and potential consequences for human health, the use of antibiotics has been controversial. Therefore, it is necessary to seek effective alternatives to antibiotics. In the past few decades, many plant polysaccharides have been used in animal feeding to improve production performance (Xu D et al., 2015; Wang X et al., 2015).

Yang et al. (2019a). reported that both Astragalus polysaccharides and ginseng polysaccharides can increase the daily weight gain and feed conversion rate of piglets, and reduce the rate of diarrhea in piglets. In poultry, polysaccharides have been shown to have a positive effect on growth performance (Yusuf A A et al., 2016, Ao X et al., 2020, Wang Q et al., 2021). The study showed that adding 600 or 900 mg/kg Astragalus polysaccharides to poultry diets can significantly increase ADFI and reduce FCR (P<0.05). Astragalus polysaccharides can also alleviate the effects of cyclophosphamide treatment on meat. The growth performance of broilers is reduced (Shan L et al., 2018). Adding 800 mg/kg of Astragalus Extract to the diet can increase the body weight of 42-day broilers and the weight gain of 15-42-day broilers (Bai S et al., 2020). The study of Yue Y et al. (2010) found that the growth-promoting effect of Astragalus Polysaccharides on broiler chickens is different between sexes, and the growth-promoting effect of hens is better than that of roosters. When Astragalus Polysaccharides 1 000 mg/kgh and 2 000 mg/kg are added respectively. The growth-promoting effect on hens is significant (P <0.05), and Astragalus polysaccharide can improve the uniformity of broiler weight. The study of Wu H et al. (2010) showed that adding 3% glycerin residues to broiler diets can significantly increase the ADG of broilers and reduce FCR (P <0.05). Glycyrrhiza extract can reduce the negative effects of aflatoxin B1 on broiler performance and immunity (Rashidi N et al., 2020). The addition of 10, 15, 20 and 25ml/L Glycyrrhiza root water extract to the diet has a good effect on the growth and carcass yield of broilers. Compared with the control group, with the increase of the Glycyrrhiza extract addition level, both ADG and ADFI. There is a significant increase trend, and FCR has a decreasing trend (P <0.05) (Iqbal, HF et al., 2020). This study shows that adding Astragalus extract and Glycyrrhiza extract to the diet can significantly reduce the FCR of 42-day-old broilers, and ADG and ADFI tend to increase, indicating that Astragalus extract and Glycyrrhiza extract can improve the performance of broilers, and can achieve the feeding effect of antibiotics.

Nutrient metabolism rate is an important indicator to measure the digestion and absorption of nutrients by animals. Its level directly affects the growth performance of animals and also reflects the nutritional value of diets. Studies have shown that adding Glycyrrhiza extract to the diet can improve the growth performance of broilers, which may be related to the reduction of FCR by Glycyrrhiza extract, and the increase in growth performance may be related to the increase in nutrient metabolism (Zhang C et al., 2020). Some studies have found that adding traditional Chinese medicine polysaccharides to diets can increase the rate of dry matter and nitrogen metabolism of broilers (Park J H et al., 2020). The study of Wu H et al. (2010) showed that adding 3% Glycyrrhiza residue in broiler diets can significantly increase the nutrient metabolism rate of crude protein (P <0.05) and reduce the nutrient metabolism rate of crude fat (P <0.05). Adding mugwort polysaccharides to broiler diets can significantly increase the nutrient metabolism rate of crude protein, crude fat and calcium (Niu Z et al., 2019). This study showed that adding Astragalus extract and Glycyrrhiza extract to the diet increased the metabolic rate of crude protein (P <0.05), but had no effect on the apparent metabolic rate of energy, crude fat, calcium and phosphorus.

Thymus, spleen, and bursal index are the main immune

organs of birds. The relative weight of the thymus, spleen and bursal index can reflect the overall immune function of the body to some extent. It is generally believed that a large immune organ index indicates that the immune organs are well developed, and the body's immunity is high. A small immune organ index indicates that the immune organs are not well developed. The body's immunity is low. Studies have shown that adding 100, 200, and 300 mg/kg of Astragalus extract to the diet can increase the weight of the immune organs of broilers (Farag M R et al., 2018). Adding Astragalus polysaccharides to the diet can effectively increase the quality of immune organs, improve organ index, and promote the development of some organs (Li S et al., 2014, Wang J et al., 2010, Wang Z et al., 2006). The study found that adding 0.2% or 0.3% of Astragalus extract significantly increased the thymus index and bursa index of broilers (P <0.05), and the spleen index had a tendency to increase. This shows that Astragalus extract can promote the development of immune organs in broilers Gao X et al., (2010). Study the effect of different concentrations of Astragalus polysaccharides on the immune function of mice, and found that with the increase of the concentration of Astragalus polysaccharides, the weight of the mouse thymus and spleen increased significantly, confirming that Astragalus polysaccharides can increase immunity organ quality to improve the body's immunity Wang J et al., (2010). The study found that the effect of Astragalus polysaccharides on organs is affected by gender and growth stage Zhang B et al., (2014). Studies have shown that different doses of Astragalus polysaccharides are used to treat chicks stimulated by cyclophosphamide. It is found that the addition of Astragalus polysaccharides to the diet of early chicks can effectively antagonize the inhibitory effect of cyclophosphamide on the immune function of the spleen. Can promote the development of the spleen Zhang X et al., (2018). Studies have shown that broiler chickens drink fermented Astragalus-Glycyrrhiza water extract, the spleen index is significantly increased by 50.82%, and the bursa index is increased by 38.13% (P <0.05), Fu D et al., (2018). The study found that administering different doses of Glycyrrhiza polysaccharide to mice can significantly increase the spleen index of mice (P<0.05). This study is the same as the above results, indicating that the addition of Astragalus extract and Glycyrrhiza extract to the diet can significantly increase the thymus index of broilers at 42 days and improve the immune function of broilers.

Muscle pH, shear force and drip loss are indicators to evaluate the physical and chemical properties of meat quality. The content of fatty acids in muscle is an index to evaluate the nutritional value of meat quality. The acceptability of meat to consumers depends on the physical and chemical properties of the meat, and the chemical composition of the meat is closely related to its nutritional value. The decrease in pH value after animal slaughter is related to the fermentation of muscle glycogen. Stress accelerates glycogenolysis in the body and rapidly lowers muscle pH. Studies have shown that adding 0.4% Jerusalem artichoke extract to broiler diets can significantly reduce muscle drip loss and leg muscle water rate (P <0.05), but has no significant effect on pH (Wang Yakai et al., 2013). This study found that the addition of Astragalus extract and Glycyrrhiza extract to the diet increased the pH_{45min} of chicken significantly (P<0.05), indicating that feeding Astragalus extract and Glycyrrhiza extract can effectively alleviate the glycogen caused by the stress of broilers after slaughter Glycolysis.

The color of meat is the most intuitive external performance that consumers evaluate the freshness of meat. It is usually expressed by L*, a*, and b* values. L* represents the brightness of the meat. The normal range is 46-53, which is in this range. The larger the value inside, the better the gloss, the a* value represents the redness of the sample, the higher the value, the better and the fresher the meat, the b* value represents the yellowness of the meat, the higher the value is, it means the less fresh the meat (Wang M et al., 2015, Zhang X et al., 2018). Studies have shown that drinking fermented Astragalus-Glycyrrhiza water extract for broilers can significantly increase the a* value of the flesh color, and significantly reduce the b* value and drip loss (P <0.05). Studies have shown that adding 3000mg/kg ~ 4000mg/kg Glycyrrhiza extract to sheep diet can improve the physical quality of fresh meat (Yuwei Zhang et al., 2013). The result of this test is that the L* value is within the normal range, and L* is significantly increased, and b* is significantly decreased. The results show that adding Astragalus extract and Glycyrrhiza extract to the diet can help improve the freshness of chicken.

Fatty acid is an important chemical substance that constitutes fat, and it is also an important factor that affects the flavor of meat. Among them, the content of Unsaturated Fatty Acid (USFA) plays a key role in the formation of flavor substances. The higher the proportion of Unsaturated Fatty Acids in the whole fat structure, the larger the proportion of soft fat in meat, and the more flavor substances produced during the cooking process, the better the palatability. Unsaturated Fatty Acids (USFA) can be divided into Monounsaturated Fatty Acids (MUFA) and Polyunsaturated Fatty Acids (PUFA). Among them, PUFA is an important precursor of meat flavor and an indispensable nutrient for the human body. Studies have shown that adding Astragalus Extract to pig diets can significantly increase marble score and unsaturated fatty acid content (P <0.05), (Hao Z et al., 2021). The addition of different proportions of Astragalus by-products in the diet has a certain promotion effect on the meat quality and flavor of sheep (Yin D et al., 2021). Wang Y et al., (2021) research shows that adding 1.74% compound Astragalus granules to broiler diets can significantly improve meat quality. Adding 900mg/kg of Glycyrrhiza extract to the diet of finishing pigs can increase the content of unsaturated fatty acids in the muscles, thereby improving pork quality (Luo Z et al., 2019). This study showed that the addition of Astragalus extract and Glycyrrhiza extract to the diet increased the SFA, USFA, MUFA, PUFA, and EFA in muscles, but there was no significant change, indicating that the addition of Astragalus and Glycyrrhiza extract under this test condition does not affect the flavor of the meat.

Conclusion*:*

1.Adding 300 mg/kg of Astragalus extract and 150 mg/kg of Glycyrrhiza extract to the diet can increase the feed conversion efficiency of broilers and increase the apparent metabolic rate of feed protein, thereby improving the performance of broilers.

2. The supplementation of 300 mg/kg Astragalus extract and 150 mg/kg Glycyrrhiza extract can improve the immune function of broilers.

3. Adding 300 mg/kg of Astragalus Extract and 150 mg/kg of Glycyrrhiza extract to the diet can help improve the freshness of chicken.

4. Adding 300 mg/kg of Astragalus extract and 150 mg/kg of Glycyrrhiza extract to the diet can achieve the feeding

effect of adding 500 mg/kg of oxytetracycline calcium.

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Дослідження вплив екстракту Astragalus та екстракту Glycyrrhiza на продуктивність бройлерів, рівень метаболізму поживних речовин та якість м'яса

Метою наших досліджень було вивчити вплив екстракту astragalus та екстракту glycyrrhiza на продуктивність бройлерів, швидкість метаболізму поживних речовин, індекс внутрішніх органів та якість м'яса. Експеримент був проведений в Юньнаньській академії тваринництва, для визначення якості м'яса використовували лабораторії науково-технічного інституту у місті Хенань. Всього в експерименті було використано 360 здорових 1-денних курчат-бройлерів, які були випадковим чином поділені на три групи, кожна з яких мала 6 повторів, і кожна по 20 курчат у групі. Дослідження показало, що додавання полісахаридів astragalus до раціону птиці може значно збільшити ADFI (середньодобове споживання корму) та покращити FCR (коефіцієнт конверсії корму) (P <0,05). Швидкість метаболізму поживних речовин є важливим показником для вимірювання травлення та засвоєння поживних речовин тваринами. Його рівень безпосередньо впливає на показники росту тварин, а також відображає харчову цінність раціону. Це дослідження показало, що додавання до раціону екстракту astragalus та екстракту glycyrrhiza збільшує швидкість метаболізму сирого білку (P <0,05), але має низку ефективність на швидкість метаболізму енергії, сирого жиру, кальцію та фосфору. Відносна вага таких органів як тимус, селезінки та показник бурсального індексу може певною мірою відображати загальну імунну функцію організму. Вважається, що великий індекс імунних органів вказує на те, що імунні органи добре розвинені, а імунітет організму високий. Дослідження показало, що додавання 0,2% або 0,3% екстракту astragalus значно збільшило індекс тимусу та індекс бурси бройлерів (P <0,05), а індекс селезінки мав тенденцію до зростання. Показник РН м'язів, сила заклякання та вологоутримуюча здатність є показниками для оцінки фізичних та хімічних властивостей якості м'яса. Це дослідження показало, що додавання до раціону екстракту astragalus та екстракту glycyrrhiza суттєво впливає на показник pH курки. У порівнянні з групою антибіотиків показник pH значно збільшився (P <0,05), при цьому pH комбінованої групи значно знизився (P <0,05), для інших показників відмінностей не було (P> 0,05). Вміст жирних кислот у м'язах є показником для оцінки харчової цінності якості м'яса. Жирна кислота є важливою хімічною речовиною, що входить до складу жиру, а також є важливим фактором, що впливає на смак м'яса. Це дослідження показало, що додавання до раціону екстракту

astragalus та екстракту glycyrrhiza збільшувало вміст SFA, USFA, MUFA, PUFA та EFA у м'язах, що свідчить про те, що додавання екстракту astragalus та glycyrrhiza за цих умови досліджень суттєво покращує показники свіжості м'яса, але при цьому не вплинули на смак м'яса. Таким чином, додавання до раціону 300 мг/кг екстракту astragalus та 150 мг/кг екстракту glycyrrhiza може покращити продуктивність та імунну функцію бройлерів та свіжість курячого м'яса, а також може використовуватися як замінник антибіотиків у птахівництві.

Ключові слова: *продуктивність, швидкість обміну поживних речовин, індекс органів, якість м'яса, вирощування, технології, курча, бройлери, птахівництво*

Дата надходження до редакції: 13.07.2021 р.