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Effects of Chinese Herbal Medicines on the Muscle Growth and Meat Quality of Broiler Chickens

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ABSTRACT

Background: Chinese herbal medicine are rich in nutrients and active ingredients, with advantages such as immune function, antioxidant capacity, stress reduction, tumor inhibition and improved meat quality. The effects of Chinese herbal medicines on the muscle microstructure and meat quality of broiler chickens were investigated by feeding with compound Chinese herbal medicines composed of stir-fried Atractylodes macrocephala, licorice, astragalus, hawthorn fruit, poria cocos, isatis root, dried tangerine peel and common yam rhizome.

Methods: The 800, 1-day-old, chickens were allocated to 4 treatments with 5 replicates, each replicate containing 40 birds. Birds were fed diets supplemented with 0.5%, 1.0% and 1.5% compound Chinese herbal medicines for a period of 7 weeks *ad libitum*. At 21 and 42 days old, the birds were slaughtered and the breast and thigh muscles were sampled from 4 birds per replicate to determine meat quality and microstructure of muscle.

Result: The results revealed that 1.0% compound Chinese herbal medicines significantly increased water holding capacity of the thigh muscle and decreased drip loss, cooking loss and water loss rate of 21-day-old broiler chickens. Moreover, 1.0% compound Chinese herbal medicine significantly decreased the muscle fibers diameters of breast and thigh muscle. Microscopic observation showed that 0.5% and 1.0% compound Chinese herbal medicines decreased the fibers diameters of muscle fibers. The results indicated that the addition of 0.5% and 1.0% compound Chinese herbal medicines in the diets could promote muscle growth and improve the meat quality of broiler chickens.

Key words: Broiler chickens, Meat quality, Muscle fiber diameter, Muscle microstructure.

INTRODUCTION

Chicken is one of the high-quality animal protein sources for humans. Since it is rich in proteins, low in cholesterol and high in unsaturated fatty acids and other bioactive substances, chicken is also called a “functional food”. Proper intake of chicken will benefit human health (Petracci and Cavani, 2012; Barroeta, 2007). With the improvement of living standards, people’s demand for high-quality chicken meat has significantly increased.

Chinese herbal medicines are unique medicinal resources found in countries such as China and India. Many Chinese herbal medicines are rich in nutrients and active ingredients, with great advantages of lower side effects, rare drug resistance and no residuals. Due to these, they have been widely applied in human health care and animal industries (Chen *et al.,* 2024; Chandra *et al.,* 2017). Reports showed that addition of 2.5 mg/mL of astragalus polysaccharides significantly increased the concentration of superoxide dismutase (SOD) in EA.hy 926 cells (immortalized human umbilical vein endothelial cells), decreased the concentrations of malondialdehyde (MDA) and reactive oxygen (ROS), inhibited the expressions of proinflammatory cytokine (IL-8), intercellular adhesion molecule 1 (ICAM-1) and nuclear factor p65, thereby enhanced the antioxidant and anti-inflammatory activity of cells (Huang *et al.,* 2013). The addition of 1.0% compound Chinese herbal medicines including poria cocos, Atractylodes, hawthorn fruit and dried tangerine peel in the diets of Hetian chickens significantly increased their slaughter rate, eviscerated weight and thigh muscle rate and decreased the concentrations of plasma triglyceride and unsaturated fatty acids and then increased slaughter performance and improved fat metabolism in the liver (Xie *et al.,* 2017). Furthermore, Tu *et al.* (2014) reported that the addition of 20 g/ton compound Chinese herbal medicines composed of licorice, rosemary and sage dramatically increased the fat content in the meat of Holstein’s calf, decreased the shearing force and cooking loss and improved the beef quality.

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These previous studies indicated that many compound Chinese herbal medicines and their active ingredients could improve many biological functions in humans and animals, as well as meat quality. However, there are fewer reports about the effects of Chinese herbal medicines on chicken meat quality. So, we investigated the effects of compound Chinese herbal medicines containing stir-fried Atractylodes macrocephala, licorice, astragalus astragalus, hawthorn fruit, poria cocos, isatis root, dried tangerine peel and common yam rhizome on the muscle microstructure and meat quality of broiler chickens, to provide a scientific basis for the promotion of Chinese herbal medicines on chicken production.

MATERIALS AND METHODS

The experiment was carried out at Animal Experiment Center in the Anhui Province Key Laboratory of Animal Nutritional Regulation and Health, College of Animal Science, Anhui Science and Technology University during 2019-09 and 2022-05.

Animal grouping and experimental design

A total of 800 healthy one-day-old AA (Arbor Acres) broiler chickens (half male and half female) were purchased from a local commercial poultry company (Anhui, China). The broiler chickens were randomly divided into 4 groups including the control group (Con) and experimental groups I-III (Exp. I-III). Every group included 5 replicates of chickens each. The Con was fed a basic corn-soybean diet. According to relevant reports and our previous research results, the 0.5%, 1.0% and 1.5% compound Chinese herbal medicines were added to the basic corn-soybean diet of chickens in the Exp. I, II and III, respectively. The experimental period was 42 days. All broiler chickens were raised on plastic meshes in a controlled environment and the poultry house was disinfected before experiment. The environmental humidity was maintained at about 65% with 24-hour light. All broilers received feed and water ad libitum until the end of the experiment. Daily administration and immune work were carried out according to the common procedures. The temperature and relative humidity were recorded daily as well as the body weight of chickens and the consumption of feed. This experiment was undertaken according to the directions of the Regional Animal Ethics Committee and was approved by the Institutional Animal Care and Use Committee of Anhui Science and Technology University.

Preparation of the compound Chinese herbal medicine and its main ingredients

The compound Chinese herbal medicines used in this study was composed of 10% stir-fried Atractylodes macrocephala, 10% licorice, 15% astragalus, 15% hawthorn fruit, 15% poria cocos, 10% isatis root, 15% dried tangerine peel and 10% common yam rhizome. All the Chinese herbal medicines were purchased from the traditional Chinese medicinal material market in Bozhou City, Anhui province. After removing the impurities, the Chinese herbal medicines were completely crushed and sieved with an 80-mesh sieve. Then the powders were mixed in proper proportion and packed in sealed bags. The main ingredients of the compound Chinese herbal medicines were identified using spectrophotometry and HPLC, as 6.12% of polysaccharides (spectrophotometry), 0.488% of saponins (spectrophotometry), 0.047% of flavonoids (spectrophotometry), 3.67 mg/kg of atractylenolide (HPLC), 82.44 mg/kg of liquiritin (HPLC), 3.70 mg/kg of indigo (HPLC), 2150.86 mg/kg of oxalic acid (HPLC), 17.24 g/kg of tartaric acid (HPLC), 51.98 mg/kg of malic acid (HPLC) and 2.27 mg/kg of ascorbic acid (HPLC) by the Qingdao Science Standard Testing Institute.

Diet preparation

The diet was prepared as a corn-soybean meal according to the nutrition requirement for broiler chickens in Dale (1994).

Sample collection and processing

At 21 and 42 days of age, 20 broiler chickens (4 broiler chickens in each replicate) were randomly selected from each group respectively. The selected broiler chickens were made to fast for 12 hours with free access to water. Each chicken was sacrificed by bloodletting from the jugular vein. The breast and thigh muscle were carefully separated and cut into a size of 1 cm × 0.5 cm × 0.5 cm and fixed using 4% paraformaldehyde phosphate buffer. The remaining breast and thigh muscle were used to determine the muscle fiber diameter and meat quality.

Determination of meat quality

The quality (pH value, water holding capacity, drip loss, cooking loss, shearing force) of the breast and the thigh muscle were analyzed according to previous studies (Pelicano *et al.,* 2003).

Muscle fiber diameter measurement

The breast muscle was cut into a size of 2 mm × 1 mm × 1 mm along the direction of the muscle fibers. After ripening at 4°C for 24 h and then soaking in 20% nitric acid for another 24 h, the muscle was placed on a glass slide and 70% glycerin was added. The muscle fibers were evenly dispersed using a dissecting needle and then were covered with a coverslip. 50 fibers in each muscle sample were randomly selected and the diameter of each fiber was measured using a CX23 microscope with a micrometer (OLYMPUS OPTICAL CO., LTD. Japan).

Paraffin section and HE (hematoxylin and eosin) staining

After fixation using 4% paraformaldehyde phosphate buffer, the breast and thigh muscle were dehydrated by gradient ethanol treatment and rendered transparent in xylene. After paraffin embedding, the muscle was transversely sliced by RM2235 Paraffin rotary slicer (Leica, Germany) to 6ìm thickness and stained by HE staining. Then, a BX51 light microscope (Olympus, Japan) was used for observation and photo shoot.

Statistical analysis

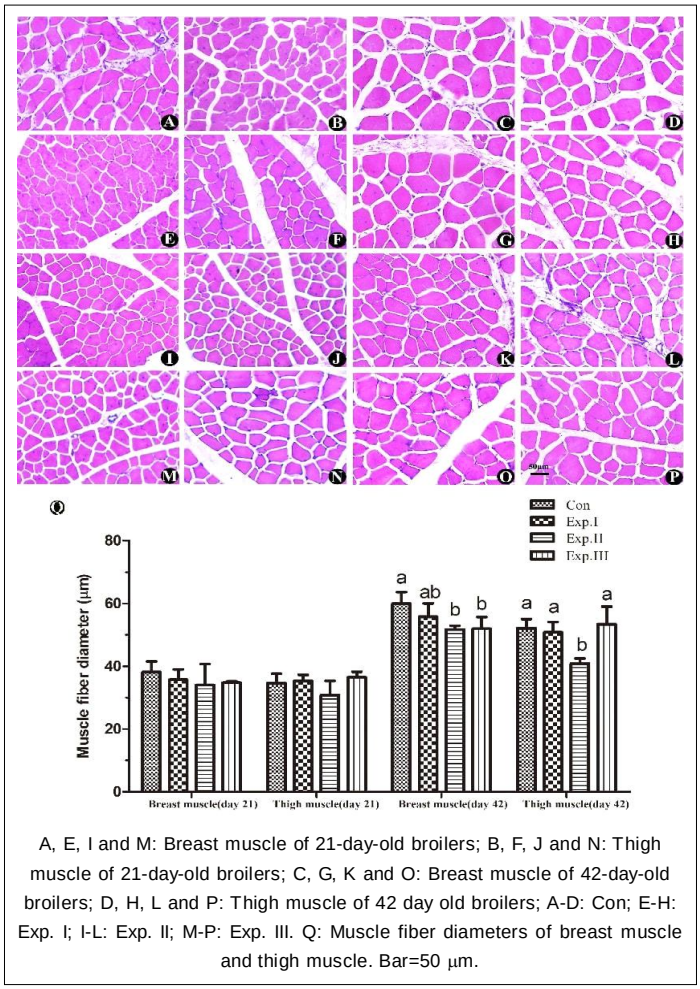
Experimental data were analyzed by SPSS 20.0 software (Chicago, Illinois). Levene's test and Kolmogorov-Smirnov test were used to determine the homogeneity of variance and normality of distribution, respectively. Post-hoc tests were performed at a significance level of $P<0.05$ using LSD multiple comparisons of one-way analysis of variance. The ns stands for non-significant differences. $P<0.05$ indicates significant differences. Correlations were assessed using Pearson correlation analysis of the Euclidean distance. A p-value less than 0.05 was considered as statistically significant. The heatmap for correlations was created using GraphPad Prism (version 9.0 Graph Pad Software Inc., San Diego, CA, USA).

RESULTS AND DISCUSSION

The microstructure and muscle fiber diameters of breast muscle and thigh muscle

As shown in Fig 1, at the age of 21 days, Compared with the Con, the muscle fibers of breast and thigh muscle were thinner with smaller cross-section area, tighter arrangement and less connective tissues between muscle bundles in the Exp. I and Exp. II (Fig 1E, 1F, 1I and 1J). The microstructure of the breast muscle and thigh muscle in Exp. III had no significant change (Fig 1M and 1N). At the age of 42 days, compared with the Con, the microstructure of breast and thigh muscle in Exp. I was not significantly different (Fig 1G and 1H). The microstructure of breast muscle in the Exp. II and Exp. III presented a tighter arrangement, lesser cross-sectional area and connective tissue between the muscle bundles (Fig 1K and 1O). The thigh muscle fibers in the Exp. II were also obviously thinner and tighter in arrangement (Fig 1L). In the Exp. III, the arrangement of thigh muscle fiber became tighter and connective tissues became less between muscle bundles (Fig 1P).

When the broiler chickens were 21-day-old (Fig 1Q), no significant difference was observed in the fiber diameters of breast and thigh muscle among the 4 groups (breast muscle: 38.15±3.39, 35.71±3.31, 34.06±6.68, 34.78±3.46; thigh muscle: 34.68±2.99, 35.35±1.98,



A, E, I and M: Breast muscle of 21-day-old broilers; B, F, J and N: Thigh muscle of 21-day-old broilers; C, G, K and O: Breast muscle of 42-day-old broilers; D, H, L and P: Thigh muscle of 42 day old broilers; A-D: Con; E-H: Exp. I; I-L: Exp. II; M-P: Exp. III. Q: Muscle fiber diameters of breast muscle and thigh muscle. Bar=50 μm.

Fig 1: The effect of compound Chinese herbal preparations on microstructure and muscle fiber diameter of breast muscle and thigh muscle in broilers (200 ×, H and E staining, n=20).

30.90±4.51, 36.46±1.82). When the chickens were 42-day-old (Fig 1Q), the fiber diameters of breast muscle in the Exp. II and Exp. III were decreased by 13.75% and 13.30% compared with the Con ($P<0.05$). Compared with the Con, the Exp. I, Exp. III, the fiber diameters of breast muscle were decreased by 21.62%, 19.50% and 23.41% in the Exp. II ($P<0.05$).

Muscle is composed of many muscle fibers, the quantity and diameter of the muscle fibers will directly impact the growth of muscle and meat quality. Under the same conditions, more muscle fibers indicate a larger potential for muscle growth, while smaller muscle diameters with higher density suggest higher meat quality (Felício *et al.,* 2013). The morphological structure changes in quantity, diameter and density of muscle fibers are closely related to the composition of feed, the rising environment and the health situation of animals (Mehri *et al.,* 2016). In the current study, by adding 0.5% and 1.0% compound Chinese herbal medicines into the diet, the microstructure of breast muscle and thigh muscle of 21-day-old and 42-day-old broiler chickens were improved in pace with more muscle fibers and higher fiber density. This was mainly due to the active ingredients such as polysaccharides, saponin and others contained in the compound Chinese herbal medicines not only could improve the local immunity of the gastrointestinal tract, but also enhance the immune function and antioxidant capacity of the whole body (Choi *et al.,* 2014; Wu *et al.,* 2016). This would, in turn, potentially provide a favorable environment for the proliferation of skeleton satellite cells (stem cells to produce muscle fibers) and inhibit the expression of genes correlated with cell apoptosis (Liu *et al.,* 2010) and then promote the growth of muscle fibers.

Meat quality of breast muscle and thigh muscle

The meat quality is mainly evaluated by indicators including pH value, water holding capacity, drip loss and cooking loss. Any change in the above indicators would directly impact the quality of chicken meat. The pH value of muscle is closely related to acidic substance contents and the water-holding capacity of muscle. An increase in pH value suggests less acidification degree of muscle and stronger water-holding capacity. In our study (Table 1), when the broiler chickens were 21-day-old, the pH_{45min} value of breast muscle in the Exp. I and Exp. II were increased by 4.01% and 3.84% compared with the Con ($P<0.05$). When the broiler chickens were 42-day-old, the pH_{45min} value of breast muscle was not significantly different among the 4 groups ($P>0.05$). The pH_{45min} value of thigh muscle in the Exp. I was increased by 4.27 % compared with the Con ($P<0.05$), but no significant difference was found when compared with the Exp. II and Exp. III ($P>0.05$).

Water holding capacity, drip loss and cooking loss are closely related to the protein amount in the muscle (Kapase *et al.,* 2021). An increase in these indicators indicates stronger water retention capacity and higher protein amounts in the muscle, which means more nutrients. As shown in Table 1, when the broiler chickens were 21-day-old, the water-holding capacity of the thigh muscle in the Exp. II was increased by 9.06% and 23.87% compared with the Con and the Exp. III, respectively ($P<0.05$). When the broiler chickens were 42-day-old, the water-holding capacity of thigh muscle in the Exp. I and Exp. II were increased by 23.03% and 16.31% compared with the Con, respectively ($P<0.05$). When the broiler chickens were 21-day-old, the drip loss of breast muscle in the Exp. II was not different compared with the Con ($P>0.05$), while had a decrease of 28.92% and 27.86% compared with the Exp. I and Exp. III ($P<0.05$). The drip loss of thigh muscle in the Exp. I and Exp. II were decreased by 23.37% and 21.20 compared with the Con ($P<0.05$) and decreased by 27.32% and 25.26 % compared with the Exp. III ($P<0.05$). When the broiler chickens were 42-day-old, the drip loss of breast muscle in the Exp. I decreased by 25.10% compared with the Con ($P<0.05$). The drip loss of thigh muscle showed no significant difference among the 4 groups ($P>0.05$). When the broiler chickens were 21-day-old, there was no significant difference in the cooking loss of breast muscle among the 4 groups ($P>0.05$). The cooking loss of thigh muscle in the Exp. II was decreased by 15.88% and 13.16% compared with the Con and Exp. III, respectively ($P<0.05$). When the broiler chickens were 42-day-old, there was no significant difference in the cooking loss of breast muscle among the 4 groups ($P>0.05$). The cooking loss of thigh muscle in the Exp. I and II were decreased by 14.11% and 13.06%, compared with the Con, respectively ($P<0.05$). When the broiler chickens were 21-day-old, the water loss rate of breast muscle in the Exp. I and Exp. II were decreased by 11.35% and 17.56% compared with the Con ($P<0.05$). The water loss rate of thigh muscle in the Exp. I and Exp. II were decreased by 16.35% and 25.47% compared with the Con ($P<0.05$). When the broiler chickens were 42-day-old, the water loss rate of breast muscle in the Exp. II was decreased by 17.05%, 17.52% and 21.22% compared with the Con, Exp. I and Exp. III ($P<0.05$). The water loss rate of thigh muscle in the Exp. II was decreased by 18.41% and 11.56% compared with the Con and Exp. I ($P<0.05$). The water loss rate of thigh muscle in the Exp. III was decreased by 12.42% compared with the Con ($P<0.05$).

Shearing force is a reflection of muscle tenderness. Higher shearing force means lower muscle tenderness and weaker water retention capacity (Li *et al.,* 2010). As shown in Table 1, when the broiler chickens were 21-day-old, the shearing force of breast muscle had no significant difference among the 4 groups ($P>0.05$). The shearing force of thigh muscle in the Exp. I was decreased by 26.54% and 32.77% compared with the Con and Exp. II, respectively ($P<0.05$). When the broiler chickens were 42-day-old, the shearing force of breast muscle in the Exp. I was decreased by 46.61% compared with the Con ($P<0.05$). The shearing force of thigh muscle showed no significant difference among the 4 groups ($P>0.05$).

Many studies have reported that the addition of the compound Chinese herbal medicines in the diet improved

the meat quality as well as increased the growth performance of animals. The research of Zhang *et al.*(2012) on pigs showed that the addition of 0.2% Ligustrum lucidum extracts in the diet significantly decreased the drip loss, cooking loss and shearing force of longissimus dorsi muscle, thus improved the meat quality. The study of Ma *et al.* (2016) on Hetian chickens indicated that the addition of 1.0% compound Chinese herbal medicines composed of astragalus and Atractylodes in the diet significantly increased the muscle rate and pH_{45min} value of thigh muscle and decreased drip loss and shearing force, which resulted in the improvement of meat quality. Our research results indicated that the addition of 0.5% and 1.0% compound Chinese herbal medicines improved the meat quality of broiler chickens. The main reason may be that the active ingredients such as polysaccharides, saponin and others in the compound Chinese herbal medicines increased the activities of antioxidants and other enzymes in the energy metabolism pathways in the muscle fiber (Sun and Wang, 2010), enhanced the antioxidant activities of myocytes, regulated energy metabolism and some biochemical processes of the cell and then reduced cellular proteolysis, thereby affected the pH value, water holding capacity and shearing force of muscle (Kadam and Ambadkar, 2022). In addition, astragalus and Poria cocos in the compound Chinese herbal medicines increased the amount of proteins and essential fatty acids in muscle by regulated the fat metabolism in the liver and amino acid metabolism in the muscle of the chickens (Meng *et al.,* 2016), thereby contributed to the nutritional quality of muscle.

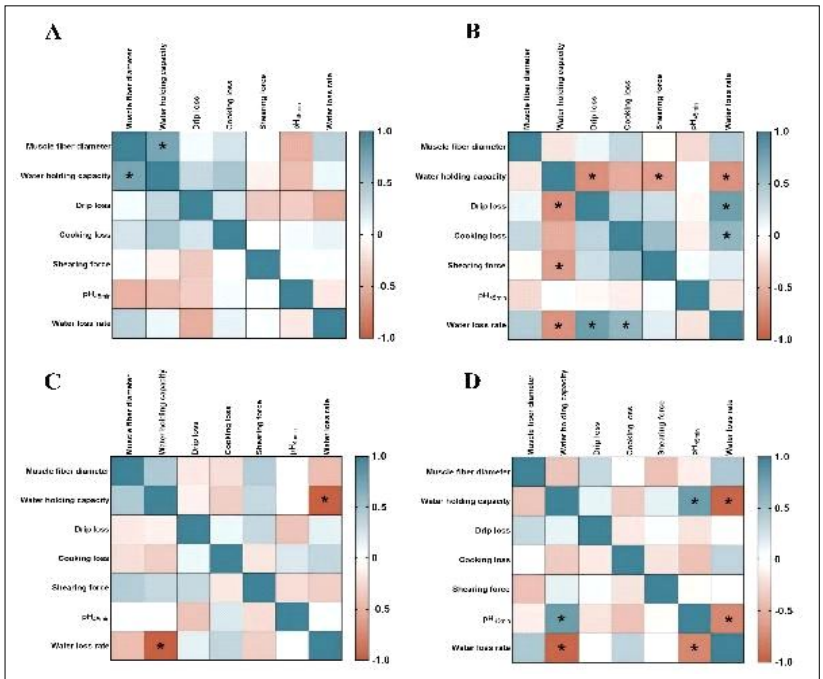
Correlation analysis

According to our research on the correlation between muscle fiber diameter and muscle water holding capacity, drip loss, cooking loss, shearing force, pH_{45min} value and water loss rate, it was found that the muscle fiber diameter

Table 1: The effect of compound Chinese herbal preparations on meat quality of breast muscle and thigh muscle of broilers.

Item	AA (Arbor acres) broiler chickens				Significance
	Con	Exp. I	Exp. II	Exp. III	
21 day old					
Breast muscle					
pH_{45min} value	5.99^{b}±0.04	6.23^{a}±0.12	6.22^{a}±0.03	6.14^{ab}±0.07	*
Water holding capability (%)	43.37±3.60	43.39±3.05	43.91±1.91	43.13±5.30	NS
Drip loss (%)	1.85^{ab}±0.22	2.04^{a}±0.20	1.45^{b}±0.27	2.01^{a}±0.15	*
Cooking loss (%)	32.32±1.59	31.11±1.94	33.33±1.75	32.23±0.45	NS
Water loss rate (%)	44.58^{a}±2.26	39.52^{b}±4.30	36.75^{b}±4.35	44.40^{a}±1.76	*
Shearing force (kgf)	0.77±0.16	0.70±0.09	0.82±0.12	0.94±0.13	NS
Thigh muscle					
pH_{45min} value	6.61±0.17	6.64±0.17	6.53±0.08	6.58±0.21	NS
Water holding capability (%)	49.87^{b}±2.02	51.69^{ab}±2.11	54.39^{a}±0.30	43.91^{c}±0.75	*
Drip loss (%)	1.84^{a}±0.23	1.41^{b}±0.17	1.45^{b}±0.18	1.94^{a}±0.05	*
Cooking loss (%)	36.71^{a}±0.74	32.62^{ab}±1.07	30.88^{b}±1.71	35.56^{a}±2.96	*
Water loss rate (%)	43.19^{a}±2.77	36.13^{b}±1.99	32.19^{b}±3.99	42.36^{a}±0.88	*
Shearing force (kgf)	1.62^{a}±0.18	1.19^{b}±0.10	1.36^{ab}±0.26	1.77^{a}±0.09	*
42 day old					
Breast muscle					
pH_{45min} value	6.01±0.12	6.07±0.19	5.95±0.15	5.81±0.17	NS
Water holding capability (%)	42.43±2.17	44.44±8.17	42.76±0.34	48.75±7.21	NS
Drip loss (%)	2.43^{a}±0.29	1.82^{b}±0.17	1.93^{ab}±0.19	2.10^{ab}±0.24	*
Cooking loss (%)	32.69±2.86	31.91±2.52	30.63±2.24	31.52±5.45	NS
Water loss rate (%)	42.57^{a}±3.55	42.81^{a}±0.47	35.31^{b}±3.49	44.82^{a}±3.12	*
Shearing force (kgf)	1.18^{a}±0.02	0.63^{b}±0.11	1.08^{ab}±0.25	1.05^{ab}±0.26	*
Thigh muscle					
pH_{45min} value	6.32^{b}±0.03	6.59^{a}±0.06	6.51^{ab}±0.04	6.45^{ab}±0.18	*
Water holding capability (%)	40.03^{b}±2.15	49.25^{a}±0.65	46.56^{a}±2.83	45.45^{ab}±2.71	*
Drip loss (%)	2.04±0.19	1.92±0.01	1.83±0.34	2.16±0.02	NS
Cooking loss (%)	37.43^{a}±1.27	32.15^{b}±1.99	32.54^{b}±2.44	35.68^{ab}±1.33	*
Water loss rate (%)	46.78^{a}±1.63	43.16^{a}±0.33	38.17^{b}±1.09	40.97^{ab}±2.21	*
Shearing force (kgf)	1.39±0.11	1.55±0.21	1.61±0.20	1.25±0.27	NS

Values are mean ± SEM of 20 broilers. Values with different lowercase superscripts on the same line represent significant differences. The asterisk (*) represents significant (P<0.05). NS: Not significant.



A and C: Breast muscle; B and D: Thigh muscle; A and B: 21-day-old broiler; C and D: 42-day-old broiler; Data represent mean ± SEM values of 20 broilers at each time point.

Fig 2: Correlation between muscle fiber diameter and muscle water holding capacity, drip loss, cooking loss, shearing force, pH_{45min} value and water loss rate (Pearson coefficient).

of the breast muscle in 21-day-old broiler showed a significant positive correlation with muscle water holding capacity (P<0.05), while the muscle water holding capacity of the thigh muscle showed a significant negative correlation with drip loss, shearing force and water loss rate (P<0.05), the water loss rate of thigh muscle showed a significant positive correlation with drip loss and cooking loss (P<0.05) (Fig 2A and 2B). For the breast muscle of 42-day-old broiler, the correlation between the water holding capacity showed a significant negative correlation with water loss rate (P<0.05); the water holding capacity of thigh muscle showed a significant negative correlation with water loss rate (P<0.05) and showed a significant positive correlation with pH_{45min} value (p<0.05). The correlation between muscle pH_{45min} value showed a significant negative correlation with water loss rate (P<0.05) (Fig 2C and 2D).

Many studies have found a significant correlation between muscle fiber diameter or cross-sectional area and muscle quality. Smaller muscle fiber diameter or cross-sectional area can increase muscle water holding capacity, decrease muscle drip loss, cooking loss and shearing force, improve muscle tenderness and enhance muscle palatability, which mainly determined by the number of fiber types IIA and IIB (Mehmood and Zhang, 2020). Current study found, at 21-day-old, the diameter of muscle fibers breast muscle was significantly positively correlated with water holding capacity, while the water holding capacity of thigh muscle was significantly negatively correlated with drip loss, shearing force and water loss rate. At 42-day-old, the water holding capacity of thigh muscle is positively correlated with pH_{45min} value and negatively correlated with water loss rate and pH_{45min} value is also negatively correlated with water loss rate. This indicates that the smaller the diameter of muscle fibers and the higher the density, accompanied by stronger water holding capacity and an appropriate increase in pH_{45min} value and the smaller the shearing force, drip loss and water loss rate, resulting in better muscle quality. Our results are consistent with previous research reports and the main reason may be related to muscle fiber type and protein content (Huo *et al.,* 2022; Zhang *et al.,* 2020).

Our research shows that adding an appropriate amount of Chinese herbal medicine can affect muscle development and improve muscle quality, but the composition of Chinese herbal medicine is complex and it is not clear which ingredient produces the improvement effect. More importantly, there are many types of Chinese herbal medicine and it is unclear which Chinese herbal medicine formula can effectively improve muscle quality. Therefore, more research is needed on the application of Chinese herbal medicine in animal husbandry.

CONCLUSION

The addition of 0.5% and 0.1% compound Chinese herbal medicine to the diet improved muscle microstructures and qualities of breast and thigh muscle and can improved muscle shearing force, well as promoting the growth of

muscle in broiler chickens. Moreover, there was a significantly positively between the diameter of muscle fibers of breast muscle and water holding capacity.

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Disclaimers

The views and conclusions expressed in this article are solely those of the authors and do not necessarily represent the views of their affiliated institutions. The authors are responsible for the accuracy and completeness of the information provided, but do not accept any liability for any direct or indirect losses resulting from the use of this content.

Informed consent

All animal procedures for experiments were approved by the Committee of Experimental Animal care and handling techniques were approved by the University of Animal Care Committee.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this article. No funding or sponsorship influenced the design of the study, data collection, analysis, decision to publish or preparation of the manuscript.

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