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THE EFFECT OF HIGH-TEMPERATURE MEAT PROCESSING TECHNOLOGY ON THE FLESH QUALITY OF BROILERS FED WITH ASTRAGALUS EXTRACT AND GLYCYRRHIZA EXTRACT

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This experiment was conducted to investigate the effects of high-temperature processing of meat raw materials technology on the flesh quality of broilers fed with Astragalus extract and Glycyrrhiza extract and their combination. Also at the same time, was investigated the effect of feeding, extracts of plant Astragalus extract and Glycyrrhiza extract were used to improve the quality and taste of meat of broiler chickens. Analysing influence of high-temperature processing of meat raw materials technology on the content of nutrients in chicken flesh it is necessary to note, that Compared with CON group, CP in AE group, GE group, AE+GE Ⅰ group and AE+GE Ⅱ group was significantly increased (P < 0.05). There were no significant differences in EE, Ash, Ca and P among all groups (P > 0.05). By this study, it was found that, compared with the control group, the crude protein content in the meat treated with Astragalus extract and Glycyrrhiza extract was significantly increased after high temperature treatment, indicating that Astragalus extract and Glycyrrhiza extract could improve the nutritional value of meat after high temperature treatment, and the effect was better than use the antibiotics.Also, high-temperature technology processing of meat raw materials had an effect on such an indicator as fatty acid content in chicken. Compared with CON group, PUFA content in AE group, GE group, AE+GE Ⅰ group and AE+GE Ⅱ group and MUFA content in AE+GE Ⅰ group and AE+GEⅡ group were significantly increased (P < 0.05). There was no significant difference in SFA content among all groups. It is also necessary to note the influence of technology high-temperature processing on processing of meat raw materials on such an indicator as flesh colour and shear force. Compared with CON group, a in AE group, GE group, AE+GE Ⅰ group and AE+GE Ⅱ group was significantly increased, while b* and shear force were significantly decreased (P < 0.05). There was no significant difference in L value among all groups (P > 0.05). By this study, the L value of meat color in each group did not change significantly after high-temperature technology processing, but the a* value of meat color in the groups treated with Astragalus and Glycyrrhiza was significantly increased, and the b* value was significantly decreased, indicating that the consumption of Astragalus extract and Glycyrrhiza extract of high temperature treatment could improve the meat color after after such treatment. In summary, the following can be noted adding Astragalus extract and Glycyrrhiza extract, and their combination, can improve the meat quality and flavour of broilers.*

Key words: *Astragalus extract, Glycyrrhiza extract, high temperature boiling technology, broiler, meat quality*

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Plant extract is a mixture of bioactive chemical components extracted from plants, with antibacterial, anti-inflammatory, antioxidant, immune regulation and other effects. In poultry production, plant extracts can be added to improve the nutritional level and safety of feed, promote animal growth, resist disease and improve product quality (Cui, Y., et al., 2019).

Astragalus extract and Glycyrrhiza extract are two common Chinese medicinal materials with many bioactive components. Astragalus extract is widely used in various health products and drugs, because of its obvious immune regulation, anti-inflammatory, antioxidant, antibacterial, antiviral effects. In addition, Astragalus can also promote metabolism, enhance body immunity, and prevent and treat symptoms such as weakness (Zheng, Y.,et al., 2020). And Glycyrrhiza extract has antioxidant, antibacterial, antiviral, anti-cancer, anti-inflammatory, immune regulation, hypoglycemic, harmonizing drugs and other biological activities, and is also

widely used in the manufacture of drugs and health products. Experiments have shown that adding Astragalus extract and Glycyrrhiza extract can improve meat quality of broilers, including improving meat tenderness, increasing water content and reducing fat content (Pastorino, G.,et al.,2018). These findings provide a reference for developing more types and functions of plant extracts to help improve broiler meat quality.

Most meat needs to be processed before eating, to get the desired taste and flavour, to get rid of the odour and blood taste of meat itself, more conducive to human digestion and absorption of more nutrients. Traditional processing methods commonly used include salting, steaming, boiling, frying, roasting, drying, etc., but the quality of meat will change after processing, and different processing methods have different effects on the quality of meat. Studies have shown that the high-temperature boiling of meat can not only kill harmful microorganisms in the meat, improve the taste, but also retain the nutritional components of meat in a more comprehensive way (Beriain, M. J., et al.,2011).

High temperature boiling technology is a processing method with water as the heat transfer medium. The raw materials and ingredients are put into a large amount of boiling water, and the food is cooked by fire first and then by gentle fire. After heating for a certain period of time, the food is ready to be eaten. After cooking, the food taste light, delicious, and good retention of nutrients. The control of cooking time and temperature is the key to the cooking process, and the time and temperature of different raw materials should be controlled reasonably, so as to avoid too long processing time and too high processing temperature, which will make the food too soft and rotten, taste bad, and excessive loss of nutrients, which is not conducive to the absorption of nutrients by human body. However, too short processing time, too low temperature, insufficient food processing, and difficult inactivation of microorganisms and bacteria are potentially harmful to human body (Beriain, M. J., et al., 2011).

The nutritional quality of meat is one of the four qualities of meat evaluation, which has an important impact on human nutrition balance and health. The nutritional quality changes vary with different processing methods. In order to find suitable processing conditions and obtain high-quality food, many studies have been done by predecessors. The group of researchers (Wang Ruihua, et al., 2017) made a comparative analysis of the impact of boiling processing methods on the nutritional quality of pork, and found that boiling can improve the nutritional value of meat. The group of researchers (Gao Tianli, et al., 2017) studied the changes of fatty acids of mutton using boiling, microwave and ultrasonic treatment methods and mutton as raw materials, and the results showed that the nutritional value of fatty acids of mutton after boiling treatment was significantly improved. Through the analysis of relevant literature reports, it was found that there were many studies on the nutritional quality of livestock and poultry meat with high-temperature boiling technology, but there was no report on the influence of the comprehensive cooking process of adding Astragalus extract and Glycyrrhiza extract in the diet of broilers on meat production. Therefore, this study mainly studied the effect of high temperature boiling technology on the meat quality of broilers fed with Astragalus extract and Glycyrrhiza extract, providing theoretical basis for the application of Astragalus extract and Glycyrrhiza extract in poultry breeding and the development and utilization of high temperature «boiling technology».

Materials and research methods.

The experiment selected of 600 one-day-old AA broilers were randomly divided into 5 groups with 6 replicates per group and 20 broilers per replicate. Corn-soybean meal diet was adopted in this experiment, and its formula was divided into two stages of 0 to 21 days and 22 to 42 days according to the nutritional requirement standard of AA broilers. The basic diet composition and nutritional level were shown in Table 1. Control group (CON) was fed a basal diet, Astragalus extract group (AE) was fed a basal diet supplemented with 300 mg/kg Astragalus extract, and Glycyrrhiza extract group (GE) was fed a basal diet supplemented with 150 mg/kg. Astragalus extract + Glycyrrhiza extract Ⅰ group (AE+GE Ⅰ) added 150 mg/kg Astragalus extract and 75 mg/kg Glycyrrhiza extract in the basal diet, and Astragalus extract + Glycyrrhiza extract Ⅱ group (AE+GE Ⅱ) added 300 mg/kg Astragalus extract and 150 mg/kg Glycyrrhiza extract in the basal diet. The experiment lasted for 42d. Adopt three-layer vertical cage, free to eat and drink; According to the immunization schedule, Newcastle disease vaccine was given on 7 and 21 days, and infectious bursal of Fabryssa vaccine was given on 14 days. Feeding management is carried out according to routine procedures. Preparation of AE and GE were provided by Inner Mongolia Everbright Pharmaceutical Co., LTD., and the extraction process was as follows: water extraction at 90℃, double concentration at 70℃, vacuum drying at 70℃. AE contained 62.8% of Astragalus polysaccharide, and GE contained 53.0% of Glycyrrhiza polysaccharide.

1) Premix is provided per kilogram of feed : 1-21d : VA, 12000 IU ; VD3, 4500 IU ; VE, 30 IU ; VK3, 4.5mg ; VB1, 2.8mg ; VB2, 9.6mg ; VB6, 3.75mg ; 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, 0.7mg ; Se, 0.3 mg。22-42d : 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, 0.7mg ; Se, 0.3 mg. .

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

After slaughter, skin, fascia and connective tissue were removed, 200g of meat sample was washed and dried, boiled in 800ml water for 60 min, cooled to room temperature, and set aside.

Meat colour: a colorimeter (CR-400, Konica Minolta Holdings, Inc., Japan) was used 45 min after slaughter. Three pieces of breast muscle sample (5cm×5cm×0.5cm) were cut vertically, and L*, a* and b* values of the meat sample were determined by colorimeter. The determination of each meat sample was repeated 3 times and the average value was taken as the final chroma value.

Table 1

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

Items Ingredients	1 to 21 days of age	22 to 42 days of age
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
Lys	1.50	1.34
Met	0.62	0.55
Thr	0.97	0.88

Shear force: Slaughtered breast muscle samples were packaged in plastic bags and heated in a thermostatic water bath at 80℃. When the central temperature of meat reached 70℃, they were taken out and cooled to room temperature. Then, the length, width and height of 3 cm, 1 cm and 1 cm were trimmed along the direction of muscle fibers, and the digital meat tenderness instrument (Model C-LM3B, Northeast Agricultural University) was used to cut perpendicular to the direction of muscle fibers, and the shear force was measured.

Crude protein content was determined by Kjeldahl nitrogen determination method.

Crude fat content was determined by ether extraction method.

Ash content: determined by Muffle furnace method.

Calcium content was determined by ethylenediamine tetraacetic acid disodium complexometric titration.

Phosphorus content: determination with ammonium vanadomolybdate color method.

Determination of fatty acid content: Gas chromatography (GB/5009.168-2016) : The sample was hydrolyzed and extracted with ethyl ether + petroleum ether (1:1) solution. After saponification and methyl ester under alkaline conditions, fatty acid methyl ester was generated. The content of fatty acid was quantitatively determined by external standard method through capillary column gas chromatography.

Data processing and analysis

SPSS 20.0 software was used for one-way ANOVA and Duncan's method was used for multiple comparisons. The results were expressed by mean value and standard error, P < 0.05 was used as the criterion to judge the significance of difference.

Research results.

As shown in Table 2, the effect of high temperature boiling technology on flesh color and shear force. Compared with CON group, a* in AE group, GE group, AE+GE Ⅰ group and AE+GE Ⅱ group was significantly increased, while b* and shear force were significantly decreased (P < 0.05). There was no significant difference in L value among all groups (P > 0.05).

As shown in Table 3, the influence of high-temperature boiling technology on the content of nutrients in chicken. Compared with CON group, CP in AE group, GE group, AE+GE Ⅰ group and AE+GE Ⅱ group was significantly increased (P < 0.05). There were no significant differences in EE, Ash, Ca and P among all groups (P > 0.05).

As shown in Table 4, the effect of high-temperature boiling technology on fatty acid content in chicken. Compared with CON group, PUFA content in AE group, GE group, AE+GE Ⅰ group and AE+GE Ⅱ group and MUFA content in AE+GE Ⅰ group and AE+GE Ⅱ group were significantly increased (P < 0.05). There was no significant difference in SFA content among all groups.

Table 2

Influence of high temperature boiling technology on flesh color and shear force

Items	CON	AE	GE	AE+GE Ⅰ	AE+GE Ⅱ	SEM	*P*-value
L	55.57	52.91	56.77	56.34	54.50	0.53	0.22
a*	1.78[b]	2.92[a]	2.75[a]	2.69[a]	2.92[a]	0.15	0.04*
b*	14.62[a]	11.71[b]	11.35[b]	10.43[b]	9.87[b]	0.24	0.03*
Shear force	27.06[a]	21.77[b]	23.19[b]	22.38[b]	22.33[b]	0.27	0.02*

Table 3

Effects of high temperature boiling technology on the content of nutrients in chicken

Items	CON	AE	GE	AE+GE Ⅰ	AE+GE Ⅱ	SEM	*P*-value
CP	24.15[b]	26.78[a]	26.84[a]	27.87[a]	27.03[a]	0.57	0.03*
EE	1.54	1.58	1.51	1.56	1.56	0.08	0.13
Ash	2.23	2.46	2.25	2.19	2.32	0.22	0.12
Ca	0.78	0.79	0.84	0.81	0.78	0.04	0.09
P	3.44	3.48	3.51	3.49	3.58	0.15	0.15

Table 4

Effects of high temperature boiling technology on fatty acid content of chicken

Items	CON	AE	GE	AE+GE I	AE+GE II	SEM	P-value
C16:0	20.13	20.64	20.89	20.87	21.32	0.22	0.07*
C16:1	2.26^{b}	2.89^{a}	2.78^{a}	2.96^{a}	2.85^{a}	0.03	0.04*
C18:0	10.43	10.45	10.64	10.11	10.87	0.16	0.06*
C18:1n9c	24.26	25.01	24.98	24.09	24.98	0.19	0.08*
C18:2n6	35.43^{c}	38.68^{ab}	40.14^{a}	36.89^{bc}	37.79^{abc}	0.19	0.02*
C18:3n3	2.10^{c}	2.85^{a}	2.79^{ab}	2.38^{bc}	2.36^{bc}	0.06	0.03*
C20:2	0.86	0.82	0.83	0.87	0.84	0.05	0.12*
C22:0	0.74	0.75	0.81	0.79	0.78	0.04	0.14*
C20:3n6	0.36	0.38	0.37	0.37	0.40	0.01	0.16
C22:1n9	5.67	4.66	4.45	6.34	6.54	0.23	0.17
C24:1	1.38	1.43	1.42	1.39	1.44	0.05	0.09
C22:6n3	0.47^{b}	0.54^{b}	0.78^{ab}	1.05^{a}	1.12^{a}	0.06	0.03*
SFA	31.3	31.84	32.34	31.77	33.03	0.31	0.07*
MUFA	33.57^{b}	33.99^{b}	33.63^{b}	34.78^{a}	35.81^{a}	0.23	0.02*
PUFA	39.22^{b}	43.27^{a}	44.91^{a}	41.56^{a}	42.51^{a}	0.25	0.02*

Discuss

When selecting meat products, most consumers mainly look at the color. Under the condition of non-contact, flesh color may be the only standard to judge the quality, playing a more important role than other factors. It is generally believed that the flesh color of stale or unsanitary meat is darker (Li Linqiang, et al.,2016). In this study, the L value of meat color in each group did not change significantly after high temperature treatment, but the a* value of meat color in the groups treated with Astragalus and Glycyrrhiza was significantly increased, and the b* value was significantly decreased, indicating that the consumption of Astragalus extract and Glycyrrhiza extract of broilers could improve the meat color after boiling at high temperature. This is consistent with the results of studying the color change of mutton meat under high-temperature processing (Li Linqiang, et al.,2016). Researchers (Jiang Xiuli, et al.,2017) studied the influence of different drying time on the color of meat breast as raw material, and the same results were obtained. The reason for this result may be that during the processing, meat is heated and oxidized in full contact with oxygen, which promotes the production of high ferrimyoglobin and gradually darkens the color of meat (Song Jie, et al.,2017).

Protein is one of the nutrients that human body can not lack, meat is an important source of protein, but the protein in meat is affected by various factors and different. In this study, it was found that, compared with the control group, the crude protein content in the meat treated with Astragalus extract and Glycyrrhiza extract was significantly increased after high temperature treatment, indicating that Astragalus extract and Glycyrrhiza extract could improve the nutritional value of meat after high temperature treatment, and the effect was better than antibiotics. Tenderness reflects the texture of meat, and the structure and state of myofibrillar fibers are the key factors leading to the difference in meat tenderness, which is also influenced by calpsin and connective tissue (Zhou Guanghong, et al.,2007). In this study, it was found that chicken tenderness was greatly affected by high temperature treatment, which was consistent with the previous report that high temperature treatment had a significant effect on poultry shear force (BaÉza M., et al.,2011; Zhang LAN, et al.,2016). The shear force increases gradually with the extension of processing time and the increase of processing temperature. During high-temperature processing, some proteins in meat are denatured due to heat, resulting in changes in protein structure and meat tenderness (Zhang LAN, et al.,2016). In this study, the shear force value of chickens fed with Astragalus extract and Glycyrrhiza extract decreased after high temperature treatment and heating treatment, indicating that the consumption of Astragalus extract and Glycyrrhiza extract would affect the process of meat collagen dissolution into gel, improve the tenderness and thus improve the palatability of meat.

Fatty acids are important nutritional indexes for evaluating meat and meat products, and the changes of FA after processing directly affect the nutritional quality of meat (Liu Xiaozhan, et al.,2017). Researchers (Sun Chengfeng, et al.,2016) studied the changes of FA in the process of high temperature treatment of pork and found that the FA content increased after high temperature treatment. In addition, most of the contents of SFA, MUFA and PUFA in meat increased significantly after different hot processing, which may be related to the decrease of water content during processing (Aubry L, et al.,2012). It was previously reported that the high temperature treatment processing method had different effects on FA of rabbit meat, and the loss rate of cooking was greater than that of baking (Wang Xiangxiang, et al.,2017). Researcher Janiszewski took pork and mutton as raw materials to study the influence of heat treatment on FA content and composition, and found that the influence on FA content of pork was significant, and the higher the temperature, the greater the influence. Researchers (Liu Meng, et al.,2017) took beef products as the research object to study the effects of different heating methods on their antioxidant properties, and found that

when heating at 100℃, the antioxidant properties were the best and FA retention was the highest. In this experiment, the contents of MUFA and PUFA were increased in chickens fed with Astragalus extract and Glycyrrhiza extract after high temperature treatment and heating, which further indicated that the consumption of Astragalus extract and Glycyrrhiza extract could improve meat flavor and meat quality of broilers.

Conclusion

High temperature boiling technology can improve the meat quality of broilers fed with Astragalus extract and Glycyrrhiza extract.

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Вплив технології високотемпературної обробки м'ясної сировини на якість м'яса бройлерів, яких годували екстрактом Astragalus та екстрактом Glycyrrhiza

Даний експеримент проводився з метою вивчення впливу технології високотемпературної обробки сирої м'ясної сировини на якість м'яса бройлерів, яких годували екстрактом Astragalus та екстратом Glycyrrhiza та їх комбінацією. Також паралельно досліджували вплив згодовування рослинного екстракту Astragalus та екстракту Glycyrrhiza для покращення якості та смаку м'яса курчат-бройлерів. Аналізуючи вплив технології високотемпературної обробки м'ясної сировини на вміст поживних речовин у м'ясі курятини, необхідно зазначити, що порівняно з групою CON, CP у групі AE, групі GE, групі AE+GEI та групі AE+GEII значно збільшився показник (P <0,05). Також не було суттєвих відмінностей у показниках EE, Ash, Ca та P серед усіх груп (P> 0,05). Дослідженнями було встановлено, що порівняно з контрольною групою вміст сирого протеїну в м'ясі, обробленому екстрактом Astragalus та екстрактом Glycyrrhiza, значно збільшився після високотемпературної обробки, що вказує на те, що екстракт Astragalus та екстракт Glycyrrhiza можуть підвищувати поживну цінність м'яса після високотемпературної обробки, при цьому ефект був кращим, ніж при використанні антибіотиків. Також, високотемпературна технологія обробки м'ясної сировини вплинула на такий показник, як вміст жирних кислот у курячому м'ясі. Порівняно з групою CON вміст PUFA у групі AE, групі GE, групі AE+GEI та групі AE+GE II

вміст MUFA у групі AE+GE I та групі AE+GE II були значно збільшені (P <0,05). При цьому не виявлено істотної різниці у вмісті SFA між усіма групами. Слід також відзначити вплив технології високотемпературної обробки м'ясної сировини за таким показником як колір м'якоті та зсувне зусилля. Порівняно з групою CON, a у групі AE, групі GE, групі AE+GEI та групі AE+GE II було значно збільшене, тоді як b* і сила зсуву значно зменшилися (P <0,05). Також не виявлено достовірної різниці у значенні L серед усіх груп (P > 0,05). Згідно наших досліджень, значення L кольору м'яса в кожній групі суттєво не змінилося після високотемпературної обробки, але значення a* кольору м'яса в групах, які отримували екстракт Astragalus і Glycyrrhiza, значно збільшилося, а значення b* суттєво зменшилося, що вказує на те, що додавання до раціону екстракту Astragalus та екстракту Glycyrrhiza, та використання високотемпературної обробки мяса, може суттєво покращити колір м'яса після такої обробки. Підводячи підсумок, можна відзначити наступне: додавання екстракту Astragalus та екстракту Glycyrrhiza та їх поєднання може покращити якість м'яса та смакові якості бройлерів.*

Ключові слова: *екстракт астрагалу, екстракт солодки, високотемпературна технологія варіння, бройлер, якість м'яса.*