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Effects of rearing systems on growth performance and meat quality of Wuding chickens

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Abstract

The study was conducted to investigate the different rearing systems on growth performance and meat quality of Wuding chickens (local native breeds in Yunnan Province of P. R. China). A total of 240, 70-day-old Wuding chickens with similar weight were divided into two groups of healthy Wuding chickens: (1) chickens caged-reared at the Poultry Unit of Yunnan Agricultural University, and fed a commercial feed and (2) chickens reared free-range in the gardens or meadows where there was no animal epidemic in Wuding county of Yunnan Province; free-range chickens were provided corn, wheat bran, and grass. The growth performance of caged Wuding chickens was substantially higher than that of free-range chickens. Crude protein content in the breast muscle of free-range cocks was substantially higher than that of caged cocks. The crude ash content of free-range chickens was substantially higher than that of caged chickens. Four essential amino acids (Thr, Leu, Phe and Lys), total essential amino acids and total amino acids in breast muscle of the free-range Wuding chickens were substantially higher than that in caged Wuding chickens. In the free-range mode, the C12:0, C18:l n-9t, C18:1, C18:2 n-6c, C20:0, C20:4, C20:5 n-3, C22:6; total, polyunsaturated, unsaturated, and essential fatty acids in breast muscle of the free-range Wuding chickens were substantially higher than that in caged Wuding chicken. The meat quality of the Wuding chickens was improved by free-range management.

Keywords: amino acid, cage-reared, fatty acid, free-range

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Introduction

After high selection pressure for approximately 50 years, broiler growth rates have increased by over 300%, but this selection has resulted in differences in phenotypic performance, particularly in phenotype and production performance. With improvements in people's living standards, the target of animal research has been expanded from the simple pursuit of economic indicators of animal production quantity to the pursuit of animal health, product quality, and other aspects (Sundrum, 2001; Fanatico *et al*., 2005a; Song *et al*., 2017; Ekizoğlu *et al*., 2020; Ülger & Fidan., 2021; Ay *et al*., 2023; Ülger *et al*., 2023; Ülger & Mahmood., 2023). The physical and chemical properties of chicken meat play an important role in meat quality. These physical and chemical properties can be described in terms of sensory attributes (pH value, colour, flavour, tenderness, juiciness) and physical attributes (muscle yield, water holding capacity, cooking loss) (Dou *et al*., 2009). Chemical composition (fat, protein and minerals) and carcass traits are important economic indicators for poultry in association with meat quality.

Rearing systems play an important role in growth and meat quality of chickens. In the past few decades, the rearing systems of native chickens has gradually turned to intensive caging in order to meet the increasing market demand for meat quantity. Free-range rearing systems have received more attention in recent years due to an increase in consumer interest in organic and natural poultry production (Wang *et al*., 2009; Jin *et al*., 2021). Chickens reared in a free-range environment are perceived as being natural, environmentally-, and welfare-friendly (Vaarst *et al*., 2005; Fanatico *et al*., 2005b, 2008; Husak *et al*., 2008). Native chickens are well-known to retain desirable features like resistance to some diseases, better taste, and meat flavour (Hashiguchi *et al*., 2008; Li *et al*., 2008; Zhu *et al*., 2012). Wuding chicken is a native chicken breed in Yunnan Province and is famous for its large body, attractive appearance, high disease resistance, and good meat quality (Liu *et al.*, 2016; Dou *et al.*, 2017), but there are few studies on differences of meat quality in Wuding chickens under free-range and caged feeding systems.

The differences in meat quality of Wuding chicken from different rearing systems could elucidate the characteristics of Wuding chicken and provide a scientific basis for protection and utilization of a system, while providing a theoretical basis for consumers to choose high quality poultry meat.

Materials And Methods

All procedures conducted with the chickens had been pre-approved by the Yunnan Agricultural University Animal Care and Use Committee (Yunnan Agricultural University Animal Care and Use Committee approval. ID: YNAU#0016.). One-day-old Wuding chickens (local native breeds in Yunnan Province of P. R. China) were purchased from the Poultry Unit of Yunnan Agricultural University. Chicks were fed a grain feed produced by Kunming Yunling Fowl Breeding Poultry Feed Co., Ltd. A total of 120 randomly-selected, 70-day-old healthy Wuding chickens were allowed to free-range in pastures with no animal epidemic area in Wuding county of Yunnan Province. Free-range chickens were provided a corn-, wheat bran-, and grass-fed diet. A total of 120, 70-day-old healthy Wuding chickens were randomly selected to be caged at the Poultry Farm of Yunnan Agricultural University. Caged chickens were fed a compound feed. The composition of the corn and soybean meal basal diet is shown in Table 1. Feed and water were freely supplied in these two rearing systems.

Table 1 Dietary composition and nutrient levels of compound feeds in caged chickens

	Items	A	B	C	D	E	F
Diet composition (%)	Corn	64.66	67.92	65.00	61.84	61.81	67.47
	Wheat bran	0.00	10.00	6.00	3.50	5.00	8.00
	Soybean meal	30.20	18.10	20.90	22.20	21.00	20.40
	Soybean oil	1.10	0.00	0.60	1.90	1.90	0.00
	Dicalcium phosphate	1.50	1.50	1.60	1.50	1.50	1.50
	Fine stone powder	0.70	0.60	2.00	4.00	4.00	0.70
	Coarse stone powder	0.41	0.46	2.35	3.50	3.34	0.50
	Sault	0.35	0.35	0.35	0.35	0.35	0.35
	Lysine hydrochloride	0.00	0.00	0.05	0.05	0.00	0.00
	Methionine	0.08	0.07	0.15	0.16	0.10	0.08
	1% premix	1.00	1.00	1.00	1.00	1.00	1.00
Formulated nutrient level	ME (MJ/kg)	12.13	11.63	11.51	11.55	11.51	11.72
	Crude protein (%)	19.30	15.50	16.00	16.00	15.60	16.20
	Calcium (%)	0.85	0.80	2.00	3.07	3.00	0.85
	Total P (%)	0.61	0.64	0.65	0.66	0.60	0.64
	Available P (%)	0.37	0.37	0.37	0.37	0.38	0.37
	Lys (%)	0.98	0.75	0.80	0.82	0.76	0.77
	Met (%)	0.39	0.32	0.40	0.42	0.35	0.34
	Met+Cys (%)	0.73	0.60	0.69	0.70	0.63	0.63

Note: A, 0–6 w of age; B, 7–18 w; C, 19–24 w; D, 24–36 w, hen; E, 36–43 w, hen; F, 24–43 w, cock.
The premix contained: VitA, 8,000 IU/kg; $VitB_1$, 5 mg/kg; $VitB_2$, 8 mg/kg; $VitB_3$, 25 mg/kg; $VitB_5$, 25 mg/kg; $VitB_6$, 5 mg/kg; $VitB_7$, 0.15 mg/kg; $VitB_{11}$, 0.60 mg/kg; $VitB_{12}$, 0.012 mg/kg; $VitD_3$, 2000 IU/kg; VitE, 30 IU/kg; $VitK_3$, 1.8 mg/kg; Mn, 80 mg/kg; Cu, 8 mg/kg; Fe, 80 mg/kg; Zn, 90 mg/kg; Se, 0.15 mg/kg; iodine, 0.25 mg/kg

Chickens were sacrificed according to the National Experimental Animal Slaughter Standard of China. At the age of 300 d, 60 chickens from each group (30 cocks and 30 hens) were selected, and feed was withdrawn 16 h and water was withdrawn 12 h before slaughter. Chickens were weighed then sacrificed by cervical dislocation; breast muscle was dissected out and weighed (Jia *et al.*, 2018).

Breast muscle was ground up with a meat grinder and freeze-dried with a freeze-drying machine. The powder sample was made by a high-speed pulverizer and stored after using a 60-mesh screen. The chemical composition of breast muscle (crude protein, crude fat, and crude ash) were determined using standard methods (AOAC, 2011). The moisture content was determined using freeze-drying. Amino acids content were detected using high performance liquid chromatography (LC-20A, Shimazu). Fatty acid contents were detected using gas chromatography (GC-2014, Shimazu).

The experimental data were organized using Excel 2016 and analysed using IBM SPSS 22.0

for the different rearing systems. Variability of all experimental data was expressed as the standard deviation of the mean. Independent sample *t*-tests were used to test the data for each group, with significance determined at P <0.05.

Results and Discussion

The body weight and breast muscle weight of caged cocks and caged hens were higher than those of free-range cocks and hens (P <0.05) (Table 2).

Table 2 Comparative analysis of growth performance in different feeding modes (g)

Weight	Cock		Hen	
	Free-range	Caged	Free-range	Caged
Body	2401.18 ± 356.84^{a}	3928.65 ± 583.80^{b}	1708.35 ± 289.89^{a}	2446.20 ± 243.42^{b}
Breast	224.23 ± 38.40^{a}	377.02 ± 74.01^{b}	166.10 ± 30.55^{a}	215.60 ± 39.54^{b}

Note: values are mean ± SD in each group; values not sharing a common superscript differ significantly at P <0.05

Fat is very important since it is a source of many aromatic substances affecting meat taste. Fat is the source of some fat-soluble vitamins and essential fatty acids and is also the main part where many aromatic substances are deposited. The content of fat in meat depends on many factors, such as animal species, breed, sex, and anatomical origin of muscles (Klíma, 1996; Kumar &Rani, 2014). Protein plays a very important physiological role in metabolism, growth, and development. The higher the content of protein in meat, the richer the nutritional value. Protein provides amino acids and the crude protein content determines the kind and content of amino acids. Amino acids have an important role in immune resistance, feed intake, and stress. Crude ash is the main material providing minerals and the content of crude ash directly affects the body's supply of mineral. Mineral matter contains all necessary elements for constituting the tissue and maintaining normal physiological function, but cannot be produced or synthesized by the body and must be supplied. The requirement for different minerals per day varies according to species, environment, and age.

The crude protein and crude ash in breast muscle of free-range cocks were higher than that in caged cocks (P <0.05). There was no difference in moisture and crude fat in different feeding modes (P >0.05). The crude ash content of free-range hens was higher than that in caged hens (P <0.05) and there was no difference in the content of moisture, crude protein, and crude fat in free-range and caged hens (P >0.05). The fat content in breast muscle of caged Wuding chickens was higher than that in free-range Wuding chickens. The reason may be that caged Wuding chickens do less exercise than free-range chickens (Castellini *et al*., 2002). Fat is the main energy material and a greater amount of exercise requires the body to provide energy. It is therefore easier to deposit fat in a caged chicken. In the caged system, the room temperature was relatively constant, whereas in the free-range system, the outdoor temperature varied substantially between day and night, such that chickens in the free-range system needed to consume more energy than in the caged system to maintain the normal operation of life, which is also an important reason for the higher fat content in the caged chickens. This result was consistent with previous studies showing a reduced muscle fat content in free-range chicken (Fanatico *et al*., 2007; Bogosavljevic-Boskovic *et al*., 2010).

In this study, crude protein content was ~25% in Wuding chicken breast and the crude protein and crude ash content in the free-range chickens was higher than that in caged chickens. This difference may be caused by the differences in nutrient uptake and metabolism in the different feeding systems.

Table 3 Comparison of routine nutritional components in breast muscles of Wuding chickens (fresh samples, %)

	Cock		**Hen**	
	Free-range	**Caged**	**Free-range**	**Caged**
Moisture	72.37 ± 0.47	72.91 ± 1.16	72.08 ± 1.27	72.40 ± 1.82
Crude protein	25.35 ± 0.46^{a}	24.61 ± 1.02^{b}	25.11 ± 1.21	24.37 ± 1.35
Crude fat	0.96 ± 0.42	1.14 ± 0.32	1.50 ± 0.86	1.85 ± 0.92
Crude ash	1.20 ± 0.07^{a}	1.15 ± 0.06^{b}	1.23 ± 0.14^{a}	1.09 ± 0.10^{b}

Note: values are mean ± standard deviation in each group; values not sharing a common superscript differ significantly at P <0.05

Table 4 showed that 17 amino acids were detected in Wuding chicken breast muscle, including seven essential amino acids (EAA) and 10 non-essential amino acids (NAA). EAA/TAA values were greater than 40% in different feeding modes. In different rearing systems, the highest content of amino acids in breast muscle was of glutamic acid, followed by lysine, aspartic acid, leucine, arginine and alanine, and the lowest was cystine. The content of EAA and TAA in free-range Wuding chicken breast muscle was higher than that in caged chickens (P <0.05). There was no difference in the content of the flavour amino acids in chickens under the different rearing systems (P >0.05). The content of EAA (Thr, Ile, Leu, Phe, Lys) in the breast muscle of cocks was higher than that in caged cocks (P <0.05). There were five essential amino acids (Thr, Val, Leu, Phe and Lys) in the breast muscle of free-range hens that were higher than those in caged hens (P <0.05).

Amino acids are the basic units of proteins (Eylar, 1970). The various important flavours of the chicken are based on the Maillard reaction of various free amino acids (Steinhart, 2005; Jayasena *et al*., 2013). The type and content of amino acid in chicken meat are important factors in the nutritional value of chicken (Pasantes-Morales *et al*., 1972). Chicken protein is rich in flavourful amino acids, such as glutamic acid, aspartate, glycine, arginine, and alanine. Flavourful amino acids can improve the flavour of chicken and keep the muscle fresh and tender (Jayasena *et al*., 2013). The higher the content of flavourful amino acids in muscle, the higher the meat quality and the more popular it is with the consumer.

Table 4 Comparison of amino acid content in breast muscle of Wuding chicken (fresh samples, %)

Animo acids	Cock		Hen	
	Free-range	Caged	Free-range	Caged
Asp	2.18 ± 0.14	2.15 ± 0.11	2.12 ± 0.18	2.12 ± 0.17
Glu	3.30 ± 0.38	3.26 ± 0.13	3.24 ± 0.39	3.20 ± 0.25
Ser	0.81 ± 0.13	0.79 ± 0.03	0.77 ± 0.11	0.76 ± 0.06
Gly	0.83 ± 0.25[a]	0.68 ± 0.03[b]	0.63 ± 0.20	0.61 ± 0.07
His	1.26 ± 0.14	1.20 ± 0.19	1.23 ± 0.15	1.18 ± 0.19
Arg	1.52 ± 0.21	1.45 ± 0.06	1.44 ± 0.20	1.46 ± 0.11
Thr	1.02 ± 0.08[a]	0.96 ± 0.06[b]	1.04 ± 0.08[a]	0.95 ± 0.08[b]
Ala	1.37 ± 0.07	1.39 ± 0.08	1.32 ± 0.08	1.31 ± 0.10
Pro	0.98 ± 0.24[a]	0.87 ± 0.06[b]	0.95 ± 0.16[a]	0.83 ± 0.06[b]
Tyr	0.71 ± 0.03	0.70 ± 0.03	0.69 ± 0.03	0.67 ± 0.06
Val	1.07 ± 0.09	1.07 ± 0.05	1.05 ± 0.08[a]	0.96 ± 0.09[b]
Met	0.51 ± 0.06[a]	0.58 ± 0.03[b]	0.57 ± 0.06	0.58 ± 0.05
Cys	0.03 ± 0.01[a]	0.01 ± 0.01[b]	0.04 ± 0.02[a]	0.02 ± 0.02[b]
Ile	1.06 ± 0.06[a]	1.02 ± 0.05[b]	1.04 ± 0.06	1.01 ± 0.08
Leu	1.76 ± 0.12[a]	1.64 ± 0.07[b]	1.71 ± 0.11[a]	1.62 ± 0.13[b]
Phe	0.81 ± 0.04[a]	0.74 ± 0.04[b]	0.78 ± 0.04[a]	0.72 ± 0.07[b]
Lys	2.62 ± 0.49[a]	2.32 ± 0.08[b]	2.50 ± 0.13[a]	2.29 ± 0.15[b]
EAA	8.84 ± 0.75[a]	8.33 ± 0.31[b]	8.74 ± 0.88[a]	8.12 ± 0.66[b]
TAA	21.83 ± 1.23[a]	20.82 ± 0.80[b]	21.12 ± 1.12[a]	20.29 ± 0.84[b]
FAA	9.19 ± 1.05	8.92 ± 0.32	8.74 ± 0.88	8.70 ± 0.35
EAA/TAA	40.50	40.00	41.22	40.01
EAA/NEAA	68.05	66.69	70.60	66.72

Note: values are mean ± standard deviation in each group; values not sharing a common superscript differ significantly at P <0.05; no significant difference at P >0.05. Asp (aspartic acid), Glu (glutamic acid), Ser (serine), Gly (glycine), His (histidine), Arg (arginine), Thr (threonine), Ala (alanine), Pro (proline), Tyr (tyrosine), Val (valine), Met (methionine), Cys (cystine), Ile (isoleucine), Leu (leucine), norleucine internal standard, Phe (phenylalanine), Lys (lysine); EAA (essential amino acid), TAA (total amino acid), FAA (flavour amino acid); TAA does not include tryptophan

Table 5 Comparison of 18 fatty acids in breast muscles of Wuding chickens (fresh samples, mg/100 g)

Fatty acid	Cock		Hen	
	Free-range	**Caged**	**Free-range**	**Caged**
C12:0	0.39 ± 0.07[a]	0.30 ± 0.18[b]	0.58 ± 0.17[a]	0.35 ± 0.21[b]
C14:0	2.41 ± 0.97	2.24 ± 1.23	6.11 ± 1.96	5.49 ± 1.51
C16:0	131.37 ± 32.37[a]	101.97 ± 43.01[b]	211.78 ± 41.89	195.93 ± 46.89
C16:1	0.76 ± 0.31	0.58 ± 0.39	0.73 ± 0.53	0.51 ± 0.21
C18:0	91.08 ± 15.01[a]	68.31 ± 18.11[b]	93.5 ± 21.25	82.00 ± 19.31
C18:l n-9t	6.34 ± 0.51[a]	4.81 ± 2.37[b]	6.63 ± 0.85[a]	5.47 ± 2.38[b]
C18:l n-9c	123.25 ± 40.21	121.69 ± 47.12	294.73 ± 45.32[a]	257.37 ± 64.23[b]
C18:1	18.79 ± 4.14[a]	11.43 ± 4.19[b]	23.51 ± 8.83[a]	13.55 ± 3.97[b]
C18:2 n-6t	0.32 ± 0.10	0.32 ± 0.17	0.38 ± 0.09	0.36 ± 0.18
C18:2 n-6c	94.54 ± 21.42[a]	77.01 ± 20.99[b]	151.82 ± 51.94[a]	117.73 ± 34.29[b]
C18:3 n-3	3.55 ± 0.60	3.21 ± 1.54	5.08 ± 1.74[a]	3.95 ± 1.12[b]
C18:3 n-6	0.83 ± 0.20[a]	0.52 ± 0.19[b]	1.09 ± 0.29	1.07 ± 0.31
C20:0	0.92 ± 0.20[a]	0.59 ± 0.25[b]	0.99 ± 0.34[a]	0.68 ± 0.24[b]
C20:1	2.13 ± 0.78	2.02 ± 0.64	3.73 ± 1.70[a]	2.69 ± 0.81[b]
C20:2	2.41 ± 0.60	2.13 ± 0.84	2.99 ± 1.06	2.74 ± 1.06
C20:4	83.75 ± 16.30[a]	68.03 ± 13.66[b]	85.79 ± 13.49[a]	73.42 ± 14.51[b]
C20:5 n-3	0.69 ± 0.13[a]	0.49 ± 0.27[b]	0.79 ± 0.14[a]	0.52 ± 0.16[b]
C22:6	10.00 ± 1.88[a]	4.09 ± 1.86[b]	12.68 ± 3.19[a]	7.17 ± 1.91[b]
TFA	573.52 ± 103.22[a]	469.74 ± 109.50[b]	902.94 ± 137.68[a]	770.99 ± 124.02[b]
SFA	226.16 ± 46.11[a]	173.40 ± 48.72[b]	312.97 ± 57.61	284.46 ± 56.76
MUFA	151.26 ± 42.61	140.53 ± 49.75	329.33 ± 45.18[a]	279.59 ± 66.16[b]
PUFA	196.10 ± 24.74[a]	155.81 ± 24.11[b]	260.63 ± 63.66[a]	206.95 ± 45.65[b]
USFA	347.36 ± 61.50[a]	296.34 ± 64.94[b]	589.96 ± 88.90[a]	486.53 ± 75.39[b]
EFA	98.09 ± 21.77[a]	80.22 ± 21.79[b]	156.91 ± 53.32[a]	121.68 ± 34.56[b]

Note: values are mean ± standard deviation in each group; values not sharing a common superscript differ significantly at P <0.05; no significant difference at P >0.05.

C12:0 (Lauric acid), C14:0 (Myristic acid), C16:0 (Palmitic acid), C16:1 (Palmitoleic acid), C18:0 (Stearic acid), C18:l n-9t (Elaidic acid), C18:l n-9c (Cis different oleic acid), C18:1 (Oleicacid), C18:2 n-6t (Linolelaidic acid), C18:2 n-6c (Cis different oleic acid), C18:3 n-3 (α-linolenic acid), C18:3 n-6 (γ-linolenic acid), C20:0 (Arachidic acid), C20:1 (Eicosenoicacid), C20:2 (Eicosadienoic acid), C20:4 (Arachidonicacid), C20:5n-3 (Eicosapentaenoic acid), C22:6 (Docosahexaenoic acid). TFA (total fatty acids), SFA (saturated fatty acid), MUFA (monounsaturated fatty acids), PUFA (polyunsaturated fatty acids), USFA (unsaturated fatty acid), EFA (essential fatty acid)

Lysine is one of the essential amino acids in body and plays an important role in growth and development. It plays an important role in absorbing and utilizing grain protein (Volpi *et al.*, 2003; Murton, 2015). Therefore, it is said that lysine is the first essential amino acid in body. The lysine content in livestock and poultry can be used as an important basis for evaluating the nutritional value of meat. In this study, it was found that the lysine content in Wuding chickens was higher than commercial broiler, and it could be inferred that Wuding chicken has a higher nutritional value.

Modern nutrition believes that the closer the proportion of essential amino acids in a food protein is to the composition of human protein, the higher its nutritional value. According to the FAO/WHO model (FAO/WHO *Ad Hoc* Expert Committee, 1973), the EAA/TAA ratio should be ~40% in the higher quality protein amino acid composition, and the EAA/NEAA ratio should be >60%. In this study, the ratio of EAA/TAA was >40% and the ratio of EAA/NEAA was >60% in different rearing systems, indicating a better nutritional value in Wuding chicken.

In this study, the flavour amino acid content (including aspartic acid, glutamic acid, serine, glycine, arginine, threonine, proline and lysine) in breast muscle of free-range Wuding cocks was higher than that in caged Wuding cocks. The content of glutamic acid, serine, glycine, threonine, proline, and lysine in breast muscle of free-range Wuding hens was higher than that in caged Wuding hens, indicating that free-range Wuding chickens had better flavour than caged Wuding chickens.

The main content of fatty acid in breast muscle of Wuding chickens was USFA (Table 5), which was much higher than that of SFA. The content of TFA, SFA, MUFA, PUFA, USFA, and EFA in the free-range system was higher than that in the caged system. The content of C12:0, C16:0, C18:l n-9t, C18:1, C18:2 n-6c, C18:3 n-6, C20:0, C20:4, C20:5 n-3, C22:6, TFA, SFA, PUFA, USFA, and EFA in free-range Wuding cock breast meat was higher than that in caged Wuding cocks ($P < 0.05$). The content of C12:0, C18:l n-9t, C18:l n-9c, C18:1, C18:2 n-6c, C18:3 n-3, C20:0, C20:1, C20:4, C20:5 n-3, C22:6, TFA, MUFA, PUFA, USFA, and EFA in free-range Wuding hen breast meat was higher than that in caged Wuding hens ($P < 0.05$).

Fatty acids show important effects on body. There are some disagreements on saturated fatty acids, which are thought to increase cholesterol levels in blood lipoprotein to some extent (Nagy & Tiuca, 2017). Unsaturated fatty acids have many biological functions, such as constituting cell membranes, inducing gene expression, preventing and controlling cardiovascular diseases, and promoting growth and development (Caliceti, 1962). MUFA is important for reducing cardiovascular disease. In MUFA, oleic acid is typical. It has the effect of lowering low-density lipoprotein cholesterol, which can prevent arteriosclerosis. The n-3 family of PUFA is representative of fatty acids, including linolenic acid (C18:3 n-3), linoleic acid, EPA and DHA, and is related to the process of immunity, age, the growth of the embryo, and the gene regulatory process (Baojie, 1996).

Fat deposition is an important aspect of modern chicken breeding for its relation with meat quality. Besides the total amount of fat, the fatty acid composition of muscle and fat tissue determines the flavour and nutrition of meat and affects consumers' perception of meat. Studies have shown that the distribution of fatty acids in the muscle has a direct impact on the flavour of meat. The breed, age, and nutritional status of animals are important factors in affecting the distribution of fatty acids in muscle (Ertas *et al.*, 2005). In the current study, the content of saturated fatty acids (SFA), unsaturated fatty acids (USFA), single unsaturated fatty acid (MUFA), polyunsaturated fatty acids (PUFA), essential fatty acids (EFA), and total fatty acids in free-range Wuding chickens was higher than that in caged Wuding chickens. This result is consistent with previous studies that show that free-range chicken can have higher PUFA content, which is generally beneficial for meat flavour and human health (Wood *et al*., 2004; Chen *et al*., 2013).

Some studies have been carried out on chicken meat quality under free-range and caged feeding. Cheng *et al*. (2023) reported that the free-range system could improve the pH, tenderness, and reducing the hardness of the thigh muscle, and the free-range system could improve muscle quality by promoting the formation of slow-twitch fibres and intramuscular fat in thigh muscle in Lueyang black-bone chicken. Yang *et al*. (2022) indicated that the leg muscle aroma, juiciness, and flavor intensity improved substantially with cage-free rearing; cage-free hens had substantially lower body weight, abdominal fat percentage, and meat fat content, but higher meat moisture content. The results of different rearing systems on Lueyang black-bone chickens indicated that the pH, shear force, inosine monophosphate (IMP), palmitic acid, and linoleic acid in the free-range group were higher than those in the caged group (P <0.05); fat content in the free-range group was lower than in the caged and flat-net groups (P <0.05); and glutamate (Glu) levels, the amino acid crucial for the umami taste, was higher in the free-range group than in the caged group (P <0.05). The content of unsaturated fatty acids in the breast muscle of Wuding chicken was much higher than that of saturated fatty acids under different rearing systems and the results were similar to Chen *et al*. (2013). The reason for differences in growth and meat quality in free-range and caged feeding may be that the cage-free rearing changed biosynthesis pathways associated with glycogen metabolism, lipid and fatty acid biosynthesis and transport, and altered levels of intramuscular fat content and other flavor substances, which are related to meat quality (Yang *et al*., 2022; Zhang *et al*., 2022).

Conclusions

Although the growth performance of the caged Wuding chickens was higher than that of the free-range birds, the meat quality of the Wuding chickens was improved by being free-range. Free-range Wuding chickens can meet people's demand for better meat quality. Further research is needed to study the biological mechanisms of the differences in meat quality in different rearing systems.

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Author contributions

WH and YLD collected the data for this study, conducted the statistical analysis, collaborated in interpretation of the results, and wrote the initial draft of this manuscript; XJY developed the original hypotheses, designed the experiments, collaborated in interpreting the results, and finalized the manuscript; JSR, JL participated in the experiment. All authors have read and approved the finalized manuscript.

Conflict of interest declaration

Authors declare no conflict of interest.

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