Poultry, Fisheries & Wildlife Sciences
ISSN: 2375-446X

Yi-ping et al., Poult Fish Wildl Sci 2016, 4:2
DOI: 10.4172/2375-446X.1000162

Review Article Open Access

Analysis of the Chinese Indigenous Chicken's Meat Quality in Different day for Optimum Slaughter Time

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Abstract

Indigenous chicken breeds were an important contributor to the human food and on the other hand which were an important source of valuable genes. Especially, in Asia and Africa lots of different local chicken breeds exist, but few is known about their quality. The present paper reports on an experiment to research the effect of slaughter time on slaughter and meat quality characteristics at 4 ages (90, 120, 150, 180 d) for Chinese Caoke chicken though measure the carcass characteristic and meat quality index. Overall assessment the results shown that the optimum meat quality age for roosters and hens were on 120 d 150 d, respectively. The results of this study will be beneficial for the breeders and consumers.

Keywords: Slaughter age; Indigenous chicken; Meat quality; Carcass characteristic; Eviscerated weight; Volatile flavor compounds

Introduction

Recently, more and more people were high on eating indigenous chicken. Indigenous chicken breeds are on the one hand an important source of valuable genes and on the other hand an important contributor to the human food. Especially the aged indigenous chicken was more accepted by customers. In China, indigenous chickens making up 20% of the poultry market, and the indigenous chicken market is rapidly developing by a rate of 5 to 10% per year [1]. Caoke chicken is one of the famous Chinese indigenous chickens in Sichuan province, and it has a large number of breeders in Ya'an city. Recently, the caoke chicken breeders stock reached 3 millions, and it was the major income source for farmers in Ya'an city, especially in Shimian county of Ya'an [2,3].

Though a lot of different local chicken breeds exist in China, few are known about their quality. Meat quality is a generic term used to describe properties and perceptions of meat, which includes attributes such as carcass composition and conformation, the eating quality of the meat, health issues associated with meat and production-related issues including animal welfare and environmental impact [4]. These factors combine to give an overall assessment of meat quality by the consumer, the ultimate arbiter who determines the decision to repurchase [5].

Many times indigenous chicken breeds deemed to be more delicious than commercial breeds due to their meat quality by Chinese consumers [6]. However, the problem is that the day for slaughter is different between different farmers, so that the meat quality has large differences, which directly affected the eating qualities and price [7,8]. On the other hand, famers think their product sell the sooner the better. But the younger maybe not have the best meat quality which also affected the price and consumers' attitude; this was also a contradiction issue. In order to find the optimum slaughter age or best meat quality of Caoke chicken, this research analyzed the meat quality and carcass characteristics at four different ages. Slaughter and meat quality criteria like eviscerated weight, the rate of thigh and breast weight, subcutaneous fat layer thickness on back, muscle moisture, intramuscular fat content (IMF), crude protein, density and diameter of muscle fiber, inosine monophosphate (IMP) and the volatile flavor compounds in breast muscle.

Materials and Methods

Birds and management

Total of 120 male and female (1:1) Caoke chickens were employed for the experiment at 4 ages (90, 120, 150 and 180 d). They were divided into 8 groups, each containing 15 animals.

All birds were reared under the same conditions of being cage free (density of <35 chicken/100 m^2) under standard conditions of temperature, humidity, and ventilation. A temperature of 20 to 22°C with an RH of 55 to 60% was maintained. The chickens were fed the same professional broiler diet and had free access to feed and water during the entire rearing period. Birds were managed with full consideration of bird welfare. All procedures involving animals were approved by the Institutional Animal Care and Use Committee of the Sichuan agriculture university.

Measurements

Traits and indexes: The measured traits and indexes include eviscerated weight, thigh muscle weight, breast muscle weight, subcutaneous fat layer thickness on back, muscle moisture, intramuscular fat (IMF), crude protein, and diameter of muscle fiber, density of muscle fiber, inosine monophosphate (IMP) and the volatile flavor compounds in breast muscle.

Methods for measure: The methods for measure those traits and indexes followed the AOAC method [9]. The method for the eviscerated weight was weighed the carcass remove all of the viscera. Breast and thigh muscle weight were measured by weigh the breast and thigh muscle, and the rate of breast and leg muscle was measured as followed:

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Received June 03, 2016; **Accepted** August 02, 2016; **Published** August 09, 2016

Citation: Yi-ping L, Dan L, Yao-dong H, Chao-wu Y, Xiao-song J (2016) Analysis of the Chinese Indigenous Chicken's Meat Quality in Different day for Optimum Slaughter Time. Poult Fish Wildl Sci 4: 162. doi:10.4172/2375-446X.1000162

The rate of breast muscle=the total breast muscle weight/eviscerated weight * 100%

The rate of leg muscle=the total leg muscle weight/eviscerated weight * 100%

Subcutaneous fat layer thickness on back was measured by using vernier caliper.

The method for the measurement of muscle moisture used oven drying and the procedure was that chest muscles (about 4 g) may be dried in a about 125°C for 2-4 hours. Using a vacuum oven (≤100 mm Hg) at 95-100°C for about 5 hours after that weight the residue.

The method for the measurement of the total fat content of meat has been through the use of several solvent-based procedures. These procedures include ether extraction followed by gravimetric measurement, tetrachloroethylene extraction followed by specific gravity measurements [9], and methylene chloride extraction followed by gravimetric measurements.

The protein was analyzed by the Kjeldahl method. Two phases were included in this method:

i. A catalysed mineralization of nitrogen by heating in concentrated sulphuric acid;

ii. An alkaline treatment followed by a distillation and dosage of the produced free NH_3.

Density and diameter of muscle fiber were measured by section. Pieces (0.2 cm × 0.2 cm × 0.5 cm) were excised from the central part of the breast muscle. They were immersed in formalin solution for 24 h, and then approximately 1 mm × 1 mm × 1 mm sections were sampled. These sections were placed onto a glass slide in which two drops of glycerin were added before placing, and then they were separated by hand using a dissecting needle to make the fibers separate and be distributed uniformly. Fibers were coated with a cover glass slide. An electron microscope was used to examine the fiber diameters, and imaging program and Image-Pro-Plus (IPP) software (Eastman Kodak Company, New Haven, CT, USA) were used for muscle fiber diameter measurement. One-hundred-fiber diameters of each sample were recorded, and the mean values of them were used to present the fiber diameter. The density of muscle fiber was the number of fiber divide by area.

Samples for IMP and volatile flavor compounds analysis are collected immediately after killing and are transferred to liquid nitrogen to keep the cellular homeostasis. The IMP was measured by high performance liquid chromatography (HPLC). The volatile flavor compounds in chicken breast samples were determined by headspace solid-phase micro extraction-Gas Chromatograph-Mass Spectrometer analysis (HS-SPME-GC-MS).

Statistical analysis

The statistical analyses were done using the program SAS [10]. The model used was a factorial ANOVA with interaction between slaughter age and sex. Means were compared using the Student-Newman-Keuls test. For all evaluations, differences between means were considered significant at $p<0.05$.

Results

Slaughter traits results

Eviscerated weight: The eviscerated weight had raise trend in roosters and hens (Figure 1), though the growth rate is slow as the age increased. The weigh rose from 1708 g, 1488 g to 2067 g, 1877 g, respectively for roosters and hens. The difference of eviscerated weight is not significant at four ages ($p>0.05$), while it was significant between rooster and hen group ($p<0.05$) at same age. And the eviscerated weight of males was heavier than females at all ages.

The rate of breast and leg muscle: The difference of the rate of breast and leg muscle between each group was not significant. The rate of breast muscle is always lower than rate of leg muscle at 4 ages (Figure 2). The rate of breast muscle had "rise-down" trend in roosters, as the highest was 14.41% (120 d), and down to 12.75% (180 d), but the difference was not significant ($p>0.05$). The % of breast muscle had significant difference between roosters and hens ($p<0.05$), as the roosters less than hens. On the contrary, the % of leg muscle was roosters higher than hens at same ages.

Subcutaneous fat layer thickness on back: The subcutaneous fat layer thickness on back had "rise" trend (Figure 3), and it was rose from 0.37 cm, 0.47 cm to 0.69 cm, 0.82 cm, respectively in roosters and hens group. The thickness of roosters always less than it on hens, but the differences were not significant at any age.

Meat quality results

IMP and volatile flavor compounds in breast muscle: IMP content had no variation trend at those 4 ages in roosters (Table 1). As for hens, it was lowest (2.1280 ± 1.12 mg/g) in 120 d, while had no significant difference in other ages. At the same age, difference sex had no significant difference.

The volatile flavor compounds results shown that roosters had

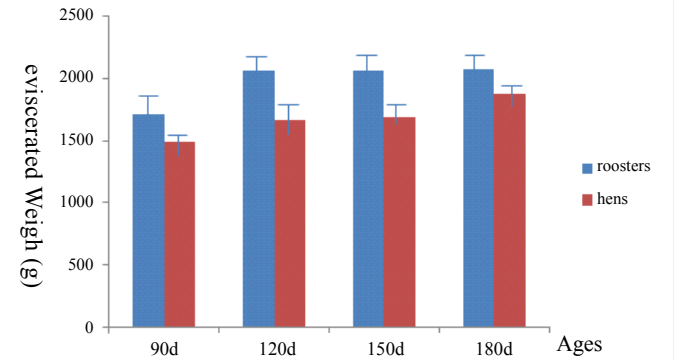

Figure 1: Eviscerated weight in difference groups.

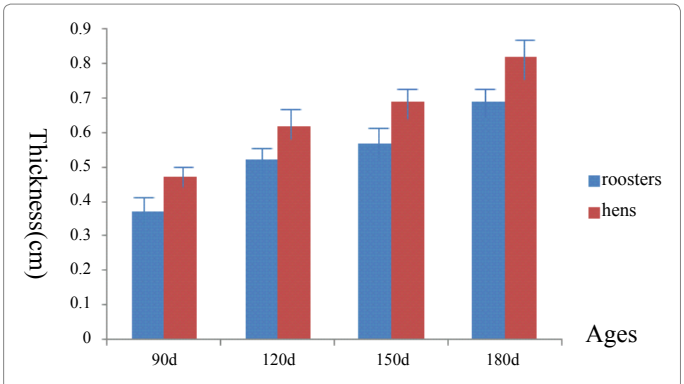

Figure 2 The rate of breast and leg muscle results in each group.

49 flavor compounds, and hens had 45 contents. Those compounds main divided into 8 types (hydrocarbon, aldehydes, alcohol, esters, acids, lactone, heterocycle, ketone). Composes was shown in Figure 4. As the results were that roosters had 4 hydrocarbon types, hens just had 3 types; alcohol contents had 9, 8 types, esters had 5 and 3 types respectively in roosters and hens; aldehydes, acids, lactone, heterocycle and ketone had same types (22, 1, 1, 3, 4) in roosters and hens.

The concentration of the flavor component had difference as the age increased and the data was not shown. The concentration of six flavor component had increased trend with the age growth.

Diameter and density of muscle fiber: Diameter of muscle fiber was increased while density was decreased as the age growth (Figure 5). The diameter of roosters was always smaller than hens at same age. The diameter of muscle fiber was increased from 27.94 ± 1.20 μm to 33.078 ± 1.53 μm in roosters, while it was increased from 29.41 ± 2.64 μm to 40.84 ± 5.26 μm in hens. And the density of muscle fiber was decreased from 774.92 ± 65.03 N/mm^2 to 517.44 ± 33.25 N/mm^2 in roosters, and decreased from 632.58 ± 29.182 N/mm^2 to 421.1 ± 46.55 N/mm^2 in hens groups. At the same age, the difference in density of muscle fibbers was significant ($p<0.05$) between roosters and hens, while it was not significant ($p>0.05$) for the diameter.

Muscle moisture, IMF and protein: Muscle moisture had "decrease" trend as the age growth (Table 2), which was down from 70.26 ± 1.72% (90 d) to 66.61 ± 2.30% (180 d) in roosters, and down from 71.46 ± 0.98% (90 d) to 66.28 ± 1.98% (180 d) in hens. But all of them had no significant difference ($p>0.05$) in sex and difference ages.

IMF and protein content had "increase" trend (Table 2). The difference was not significant at each group. And there was no difference between roosters and hens at same age.

Discussion

Slaughter traits

Slaughter trait especially the eviscerated weight is related to price. As the results shown, the weight was increased more and more slow as the age growth which implied the feed conversion ratio was declined. This result also can explain why the farmers want to sell their product

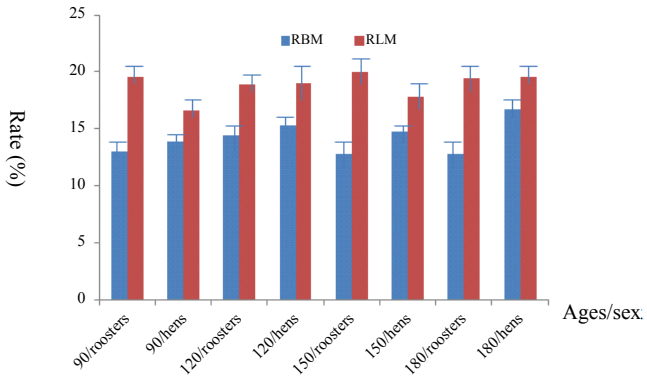

Figure 3: The results of subcutaneous fat layer thickness on back in each group.

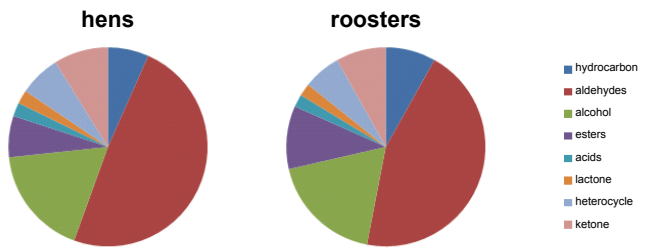

Figure 4: The composes of flavor compounds in hens and roosters.

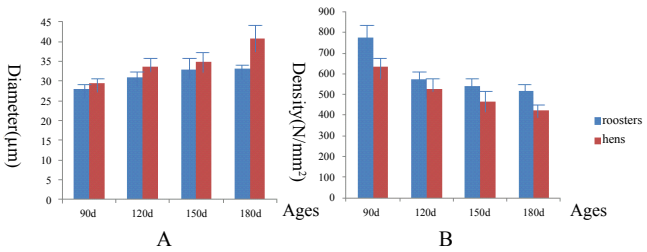

Figure 5: Diameter (A) and density (B) of muscle fiber results.

IMP(mg/g)	90 d	120 d	150 d	180 d
Roosters	3.2141 ± 0.076^{A}	3.0581 ± 0.27^{A}	2.9229 ± 0.33^{AB}	3.1589 ± 0.04^{A}
Hens	3.1209 ± 0.19^{A}	2.1280 ± 1.12^{B}	2.9432 ± 0.20^{AB}	3.1926 ± 0.22^{A}
^{AB}Values in a column having a common superscript are not significantly different (P ≤ 0.01)				

Table 1: The results of IMP in breast muscle.

Group	Moisture (100%)	IMF (100%)	Pro (100%)
90/roosters	70.26 ± 1.72^{ABC}	2.81 ± 0.48^{bc}	23.49 ± 1.88a
90/hens	71.46 ± 0.98^{A}	2.49 ± 0.23^{c}	23.04 ± 0.63^{a}
120/roosters	70.62 ± 1.20^{AB}	3.17 ± 0.42^{abc}	24.65 ± 0.9135^{ab}
120/hens	67.96 ± 3.73^{ABC}	3.86 ± 0.52^{ab}	24.94 ± 3.21^{ab}
150/roosters	68.25 ± 1.24^{ABC}	3.58 ± 0.91^{abc}	25.71 ± 1.89^{b}
150/hens	68.08 ± 1.50^{ABC}	3.89 ± 0.54^{ab}	24.09 ± 1.47^{ab}
180/roosters	66.61 ± 2.30^{BC}	4.47 ± 0.88^{a}	26.66 ± 1.93^{b}
180/hens	66.28 ± 1.98^{BC}	3.94 ± 0.81^{ab}	25.90 ± 0.73^{B}
Note: the IMF was the abbreviation of intramuscular fat (IMF), pro was the abbreviation of crude protein. $^{a-d}$Values in a column having a common superscript are not significantly different (P ≤ 0.05) $^{A-D}$Values in a column having a common superscript are not significantly different (P ≤ 0.01)			

Table 2: Muscle moisture, IMF and protein content.

the sooner the better. The rate of breast and leg muscle was agreed with the studies by previous researchers [3,11]. Lipids and fats in poultry are unique and combine with odor to account for the characteristic "poultry" flavor, not the sugar or amino acid interactions [12]. As the results shown, the aged chicken had more subcutaneous fat layer thickness on back, this result consistent with the consumers' attitude with the aged chicken.

Meat quality

IMP and volatile flavor compounds had important contribution to meat flavor. IMP can affect the meat umami, some study have reported it had association with animal sax, age and muscle type [13,14]. Previous study had reported that those six increased compounds had association with special flavors. The ethyl alcohol and (E, E)- 2, 2-decenal ,4 - heptyl diene aldehyde had effected on the poultry characteristic aroma; while d-limonene , hexanal and 2 - amyl furan can affect the poultry total flavor [15-18]. The results shown those compounds can accumulate as the growth. Even so hexanal is not the more the better, Melton have reported that the higher concentrations hexanal and 2,4-decadienal may produce undesirable flavors in beef [19]. Roosters had more four types than hens, those four types were 2-heptanone, butyrolactone, heptanal, Vinyl stearate. Which can produce fruit flavor [20,21]? As the results shown, though the roosters had those four compounds, the concentration was very low, and individual difference was bigger. That can speculate those compounds had little effect for poultry flavor.

Muscle moisture, IMF, diameter and density of muscle fiber can direct affect the meat eating quality as the tenderness, succulence. Higher or lower of those indexes will decline the quality, just when all of them had an optimum contents; the meat was the best time for quality. Previous research had imply that those index change with the sex, age and other factors [22,23]. The aged chicken had lower muscle moisture and bigger diameter of muscle fiber, all of them is disadvantage for meat quality.

Conclusion

As the seller consider how well the product sells and how much people are willing to pay for it, while the consumer consider more of meat quality. Overall assessment the results shown that the optimum meat quality age for roosters and hens were on 120 d 150 d, respectively.

Acknowledgments

We thank Sun Jing for measure the volatile flavor compounds data. This study was supported by the project of Twelfth Five-Year Province Crops and Livestock and Poultry Breeding Research (2011NZ0099-6), the program for the key project from education department of Sichuan Province (14ZA0021), the project of the application basis project from the science and technology department of Sichuan province (2014JY0163), and the project of national natural science foundation of china (31402068).

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