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Study on Meat Yield and Quality Characteristics of Hac Phong Chicken

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Abstract

The study aimed to evaluate meat yield and meat quality of Hac Phong chickens. A total of 100 birds (50 males and 50 females)from 1 days of agewas raised at the experimental station of Faculty of Animal Science, Vietnam National University of Agriculture . The chickens were fed *ad libitum* with a complete compound feed. Twenty chickens (10 males and 10 females) were slaughtered at 20 weeks of age with an average live weight of 1303.70 kg. The results found the carcass, breast, and thigh meat percentages were 70.36%, 16.16%, and 22.42%, respectively. The pH value at 15 min and 24 h post-mortem were in the normal range. The color of the meat was dark. The L* (lightness) value was low. The drip loss and cooking loss percentages were low while the tenderness was high. Hac Phong chicken meat contained a high crude protein content (27.71%) and low cholesterol content (25.45%).

Keywords

Hac Phong chicken, meat yield, meat quality

Introduction

In parallel with the development of high-yield and high-quality poultry breeds such as those for specialized meat and chicken eggs, research on the selection and breeding of rare and special poultry has also been strongly developing in recent years. Broiler chickens exhibit a high growth performance, reach market weight at early stages of development, and have high meat yields because of genetic selection, improved nutrition, and regular veterinary attention. However, selection for fast growth and high yield may have negatively impacted the sensory and functional qualities of the meat (Fanatico *et al*., 2007). Broiler carcasses contain high fat, less protein, and higher cholesterol than other breeds (Mendes *et al*., 1994). In recent years, consumers tend to prefer products that are naturally produced, high in nutrition, have no contaminants with chemicals, and have good meat quality. Native chickens are generally raised without using antibiotics or chemicals, and thus render their safety with no negative impacts on human health (Funaro *et al*., 2014). The

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meat of native chicken strains has lower contents of fat and cholesterol (Jaturasitha *et al*., 2008), and is considered a rich source of protein and iron (Haunshi *et al*., 2011).

Currently, in Vietnam, some specialty chicken breeds are called black chickens (Ac; H'mong chickens). These chickens are well known for their characteristics of sweet tasting meat, thick and crispy skin, high nutrient content, low-fat meat, and eggs with a high percentage of yolk, and their meat is considered a health-promoting medicine for humans. Ac chickens also have a significantly higher proportion of iron and amino acids (Nguyen Thi Mai *et al*., 2009), and crude protein (Phung Duc Tien *et al*., 2010) than other chicken breeds. H'mong chickens have a similar meat quality to other domestic chicken breeds, however, they have a higher iron content and all eight essential amino acids (Nguyen Thi Phuong *et al*., 2017).

Besides the two chicken breeds mentioned above, Hac Phong is also a black chicken breed appearing in Vietnam. Previously, Hac Phong chickens were raised in Quang Ninh province, but in 2006 this breed was raised at the Dai Xuyen Duck Research Center for conservation. According to Pham Cong Thieu (2018), the body weight at 8 weeks of age of Hac Phong chickens was 666.47g; at 19 weeks this trait was 1468.9g for cocks and 1212.9g for hens; the egg production in the period of 148-154 days was 5%; peak egg production occurred in weeks 33-36; the number of eggs produced/hen/72 weeks was 148.69 eggs; and hatchability was 76.64%. However, until now there have not been many studies evaluating the carcass performance and meat quality of this breed. Therefore, with the objective of adding more scientific information on the meat characteristics of Hac Phong chickens, this study was conducted.

Materials and Methods

Animals, experimental design, and management

A total of 100 Hac Phong chickens (50 males and 50 females) were raised from 1 day of age to 20 weeks of age at the Experimental Area of the Faculty of Animal Science, Vietnam National University of Agriculture. The chickens were obtained from the Dai Xuyen Duck Breeding and Research Center in Dai Xuyen commune, Phu Xuyen district, Hanoi city. The research was carried out from February to September 2021. Chickens were identified individually using a numbered plastic ring on a leg in the period of 1 to 4 weeks of age, and using metallic ones on a wing in the period of 9 weeks of age until the end of the experiment.

Animals were held in a ventilated building with rice husk litter on the floor. The animals under 4 weeks of age were put under a heating lamp; and after 4 weeks of age, they were raised under room conditions. The males and females were not kept separate until slaughter. The chickens were free fed with a complete compound feed with a diet according to TCVN 2265:2007. Metabolism energy (ME) and crude protein (CP) were provided based on the requirements of each developmental stage of the animals. Particularly, 3000Kcal of ME/kg and 22% CP for the period from 0 to 3 weeks of age; 3000 Kcal of ME/kg and 18% CP for 4 to 8 weeks of age; and 3030 Kcal of ME/kg for 9 to 20 weeks of age. Feed was provided for chickens twice a day (8 am and 2 pm). Drinking water was freely provided.

Measurements

At 20 weeks of age, the animals were fasted for 1 day and slaughtered. Twenty chickens (10 males and 10 females) were used to evaluate the live weight, killing out weight, carcass weight, heart and liver weights, and thigh and breast weights according to the methods of Bui Huu Doan *et al*. (2011).

Muscle pH: At 15min and 24h post-mortem, the breast and thigh muscle pH values were respectively determined at a depth of 2.5cm below the surface using a Testo 230 (Germany).

Color measurement: The surface color of the chicken rolls was measured in package using a Minolta CR-410 (Japan) colorimeter and expressed as color L* (lightness), a* (redness), and b* (yellowness) values.

The drip loss was determined based on the difference in the weights of the samples before

and after processing. After 24h of storage, the samples were steamed in a water bath at 75ºC for 60 minutes to determine the cooking loss.

Tenderness: Twenty-four hours after slaughter, the thigh and breast muscles were collected to evaluate tenderness using a Warner-Bratzler 2000D machine (U.S.A.).

Cholesterol content: At the end of the treatment (20 weeks of age), six chickens were fasted for 12 hours and slaughtered. Two ml of blood was taken from the jugular vein and centrifuged for analysis of total cholesterol. The blood plasma was stored at -30°C until the cholesterol content analysis. For the analysis of cholesterol concentration in the carcass, 5g mixtures of thigh and breast meat were used using NIFC. 04. M. 009 (GC-MS). Both blood and carcass contents were analyzed at the National Institute for Food Control of Vietnam.

Meat chemical composition: Four samples of male chicken breast meat were used for analysis. The parameters of dry matter (DM), crude protein (CP), and lipids were determined according to the TCVN 8135: 2009, TCVN 8134: 2009, and TCVN 8136: 2009 standard methods of Vietnam, respectively.

Statistical analysis

Descriptive statistical parameters included the number of samples, mean, and standard deviation. To compare between sexes data analyses were performed in SAS 9.4 to evaluate the variance components, using Duncan's Multiple Range Test at $P < 0.05$.

Results and Discussion

Meat yield

The carcass yield of 20 week-old Hac Phong chickens is shown in **Table 1**. The carcass, breast, and thigh percentages were 70.36%, 16.16%, and 22.42%, respectively. The ratio between the thigh and breast meat was 1.38%. These parameters were higher for males than for females ($P < 0.05$). The results of this study are similar to the results of other studies on meat yield for indigenous chicken breeds in Vietnam. Vu Quang Ninh (2002) found that Ac chickens at 13, 17, and 21 weeks of age had carcass proportions of 65.12%, 66.41%, and 69.00%, respectively. Nguyen Thi Phuong *et al*. (2017) reported that H'mong chickens had carcass, breast, and thigh meat percentages of 72.4%, 16.1%, and 21.1%, respectively. Le Thi Thuy *et al.* (2011) found that Ri and H'Mong chickens at 14 weeks of age had similar proportions of thigh (23.19% and 16.69%) and breast meats (16.69% and 14.86%), respectively. Ho Xuan Tung & Phan Xuan Hao (2010) found that Ri chickens at 11 weeks of age had percentages of 67.77%, 20.38%, and 14.72% for carcass, thigh, and breast meats, respectively. A study on Long Cam indigenous chickens by Nguyen Ba Mui *et al.* (2012) found that the proportions of carcass, thigh, and breast meats were 69.9%, 22.25%, and 14.39%, respectively. Compared with the carcass yields of indigenous chicken breeds around the world, Hac Phong chicken has the same (Li *et al*., 2003) or even higher values (Choo *et al*., 2014; Farzana *et al*., 2017). According to Li *et al*. (2003), Taihe silky fowls had carcass yields in the range of 69.51% to 75.16% from 1 to 12 weeks of age. When studying four indigenous Korean locally bred chickens (white-mini broiler, Hanhyup-3-ho, Woorimatdag, and a breed of silky fowl), Choo *et al*. (2014) reported the carcass yields were 67.4%, 65.4%, 65.8%, and 64.3%, respectively. The ratio of thigh and breast meat was 1.38% proving that Hac Phong chickens belong to the chicken group that likes to move. Nielsen *et al*. (2003) reported that slow-growing chickens were characterized by a significantly lower breast yield, but a higher yield of thigh meat than fast-growing chickens.

Meat quality

The parameters of meat quality, namely weights at pre-mortem, post-mortem, and post-cooking, and drip loss and cooking loss of the thigh and breast meats, are presented in **Table 2**. The sex of the bird had an effect on the weight at post-cooking, drip loss, a* value, and tenderness of the thigh meat; and on almost all the parameters of breast meat quality except the pH, L*, and tenderness values ($P < 0.05$). The drip loss of Hac Phong chicken meat in this study was quite low as compared with other indigenous chicken breeds. Ho Xuan Tung & Phan Xuan

Table 1. The parameters of meat yield of Hac Phong chickens at 20 weeks of age

Item	Common		Males		Females	
	n	Mean ± SD	n	Mean ± SD	n	Mean ± SD
Live weight (g)	20	1303.70 ± 221.82	10	1449.00^{a} ± 183.87	10	1158.40^{b} ± 152.16
Dressing weight (g)	19	1020.53 ± 195.69	10	1151.00^{a} ± 137.63	9	875.56^{b} ± 141.17
Carcass weight (g)	19	917.34 ± 287.38	10	1028.00^{a} ± 389.10	9	806.67^{b} ± 123.19
Heart (g)	20	6.47 ± 2.32	10	8.55^{a} ± 1.03	10	4.38^{b} ± 0.79
Liver (g)	20	22.03 ± 4.93	10	21.16 ± 4.83	10	22.90 ± 5.14
Spleen (g)	20	2.59 ± 1.20	10	2.88 ± 1.32	10	2.30 ± 1.06
Breast (g)	20	148.20 ± 24.21	10	166.62^{a} ± 19.06	10	129.78^{b} ± 10.98
Thigh (g)	20	205.61 ± 55.03	10	249.84^{a} ± 36.48	10	161.38^{b} ± 26.76

Note: Within a row, means of males and females followed by different letters are significantly different (P <0.05).

Hao (2010) found this parameter was 3.65% in Ri chickens raised in household conditions. Nguyen Thi Phuong *et al*. (2017) found this parameter was 4.3 to 4.5 for H'mong males and females, respectively, raised industrially. Tuoi *et al*. (2020) reported the drip loss of Noi chicken meat was 2.08% and 2.16% for males and females, respectively. According to Lengerken & Pfeiffer (1987), a drip loss value of less than 5% at 24h post-mortem reflects the good quality of the meat. So with the values of 1.13-1.33% for drip loss, Hac phong chickens seem to have good meat quality. For the cooking loss, the results were parallel with the results of previous studies on the meat quality of native chickens (Ho Xuan Tung & Phan Xuan Hao, 2010; Le Thi Thuy *et al*., 2010; Le Thi Tham *et al*., 2016; Nguyen Thi Phuong *et al*., 2017) with the range from 17% to 23.5%.

For the pH values at 15 min and 24 h post-mortem, no significant differences were found between the sexes (P >0.05). After 15 min of storage, the pH value was higher and then decreased after 24 h. Compared with other Vietnamese native chicken breeds (Le Thi Thuy *et al*., 2010; Nguyen Thi Phuong *et al*., 2017; Nguyen Hoang Thinh *et al*., 2020), the pH value of Hac Phong chicken meat after storage is comparable. When studying the pH values of 480 Korean local chickens (white-mini broiler, Hanhyup-3-ho, Worimatdag, and silky fowl), Choo *et al*. (2014) found the pH value at 24h post-mortem was in the range of 5.59 to 5.72. According to Marcinkowska Lesiak *et al*. (2016), the decline in pH values was probably due to the changes in glycogen content according to the preservation time. If the pH of the meat drops faster, the meat is usually of poor quality. In poultry, meat with a pH lower than 5.6 is PSE (pale, soft, and exudate) meat (Medic *et al*. (2009); and meat with a pH higher than 6.4 is DFD (dark, firm, and dry) meat (Ristic, 1977). The pH value has been associated with numerous other meat quality attributes including tenderness, cooking loss, and juiciness (Allen *et al*., 1998). Husak *et al*. (2008) reported that a higher meat pH is more effective for retaining desirable color and moisture absorption properties.

The L* value of Hac Phong meat was lower when compared with other Vietnamese native chicken breeds (Ho Xuan Tung & Phan Xuan Hao, 2010; Le Thi Thuy, 2010; Le Thi Tham, 2016), Korean native chickens (Choo *et al*., 2014), or even Chinese Taihe chicken or black-boned chickens (Jaturasitha *et al*., 2008). Quiao *et al*. (2001) classified chicken breast meat into three groups by color: bright (L* > 53), normal (48 < L* > 53), and dark (L* < 48). The Hac Phong meat had a darker color than the meat of other chicken breeds, reflecting its true name, black bone and meat chicken. Meat and skin colors are influenced by various factors including heme pigments, genetics, and feeding (Fletcher, 1999; Xiong *et al*., 1999). Between the thigh meat and breast meat of Hac Phong chickens, thigh meat was much darker (L*) and redder (a*) than the breast meat. One of the factors affecting

Table 2. Meat quality of Hac Phong chickens at 20 weeks of age (Mean ± SD)

	Item	Common (n = 20)	Males (n = 10)	Females (n = 10)
Thigh	Weight at pre-mortem (g)	103.31 ± 27.80	125.92^{a} ± 17.77	80.69^{b} ± 13.38
	Weight at post-mortem (g)	102.16 ± 27.52	124.65^{a} ± 17.27	79.66^{b} ± 13.27
	Weight at post-cooking (g)	80.07 ± 21.74	97.63^{a} ± 14.14	62.51^{b} ± 10.63
	Drip loss (%)	1.13 ± 0.46	0.98^{b} ± 0.54	1.29^{a} ± 0.31
	Cooking loss (%)	21.60 ± 2.25	21.70 ± 1.60	21.51 ± 2.85
	pH15	6.15 ± 0.24	6.08 ± 0.18	6.24 ± 0.25
	pH24	5.76 ± 0.57	5.89 ± 0.78	5.64 ± 0.15
	L*	37.40 ± 3.93	37.58 ± 4.37	37.22 ± 3.50
	a*	9.85 ± 3.55	11.58^{a} ± 3.80	8.12^{b} ± 2.23
	b*	8.35 ± 3.79	10.12^{a} ± 4.08	6.59^{b} ± 2.46
	Tenderness	36.04 ± 7.82	38.10^{a} ± 6.98	34.45^{b} ± 8.13
Breast	Weight at pre-mortem (g)	73.90 ± 12.33	83.31^{a} ± 9.53	64.48^{b} ± 5.76
	Weight at post-mortem (g)	72.94 ± 12.32	82.32^{a} ± 9.53	63.55^{b} ± 5.81
	Weight at post-cooking (g)	61.12 ± 10.94	69.66^{a} ± 8.33	52.58^{b} ± 4.60
	Drip loss (%)	1.33 ± 0.64	1.20^{b} ± 0.73	1.46^{a} ± 0.54
	Cooking loss (%)	16.30 ± 2.37	15.40^{b} ± 2.05	17.21^{a} ± 2.42
	pH15	6.01 ± 0.20	5.93 ± 0.17	6.08 ± 0.20
	pH24	5.61 ± 0.10	5.66 ± 0.08	5.57 ± 0.11
	L*	43.34 ± 4.19	42.89 ± 4.10	43.79 ± 4.30
	a*	1.57 ± 1.54	2.12^{a} ± 1.63	1.02^{b} ± 1.25
	b*	9.05 ± 3.45	9.53^{a}± 3.88	8.57^{b} ± 2.50
	Tenderness	29.46 ± 6.04	29.83 ± 7.16	29.12 ± 5.67

Note: Within a row, means of males and females followed by different letters are significantly different (P <0.05). pH15 = the pH value at 15 min post-mortem; pH24 = the pH value at 24 h post-mortem; L = Lightness, a* = Redness, b* = Yellowness*

meat color is the amount of heme-containing compounds such as myoglobin, haemoglobin, and cytochrome c. The breast muscle is almost entirely composed of white fibers which are low in myoglobin as compared to the red fibers of the thigh/leg muscles. Therefore, chicken breast fillets generally appear to have a pink color, which is a desirable characteristic for the consumer (Wideman *et al*., 2016).

The tenderness of the thigh and breast meats of Hac Phong chickens was quite high (**Table 2**). Nguyen Hoang Thinh *et al*. (2020) found the tenderness of Ri chicken was 2.54kg and 2.70kg for thigh and breast meats, respectively. Nguyen Thi Phuong *et al*. (2017) reported this parameter in thigh and breast meats was 2.5kg and 2.4kg, respectively. When studying the meat quality of Dong Tao chickens, Le Thi Tham *et al*. (2016) indicated that the tenderness of thigh and breast meats were 37.43N and 29.23N. Thus, the tenderness of Hac Phong chicken meat in this study was much higher than several of the native chickens mentioned above but seems to be similar to Dong Tao chicken. The tenderness of the meat is one of the important meat quality parameters as it is related to the taste preferences of consumers. In Vietnam, almost all consumers prefer to eat less tender chicken meat while the majority of Europeans and Americans prefer to eat more tender meat.

Nutrition values in terms of dry matter, protein, fat, and cholesterol of Hac Phong chicken meat are shown in **Table 3**. The breast meat of Hac Phong chickens had a high content

of protein and fat when compared with other native chickens in Vietnam and several native chickens from around the world. The CP and fat contents in the breast meat of Long Cam chickens were 23.35% and 23.53% in males and 0.91% and 0.54% in females (Nguyen Ba Mui *et al*., 2012). These parameters were 23.86% and 0.87% in Ac chickens (Phung Duc Tien *et al*., 2010); and were 20.4% and 0.6% in H'mong chickens (Nguyen Thi Phuong *et al*., 2017). For Thai native chickens and black-bone chickens from China, the CP content was 20.4% and 21.7%, respectively; and the fat content was 0.53% and 0.51%, respectively (Jaturasitha *et al*., 2008). However, the fat content in the breast meat of Hac Phong chickens was much lower compared to commercial chickens. Farzana *et al*. (2017) found the fat content was 1.5% in commercial chicken breast meat. The fat content in meat may be affected by factors such as bird feeding, strain, age, gender, and slaughter processing (Rodrigues *et al*., 2007). Some studies have reported that broilers of fast-growing strains tend to have a higher concentration of fat in the breast meat than chickens from slow-growing or crossbred strains (Lonergan *et al*., 2003; Castellini *et al*., 2006).

The total cholesterol content in the blood and meat are shown in **Table 3** and the value was rather low. Cholesterol is an important molecule of the cell membrane's structure and is a precursor of steroid hormones, vitamin D, and bile acids. It can be obtained directly from the diet or synthesized by biosynthesis de novo, allowing cholesterol production to meet the needs of the large variety of biological processes in which it is involved (Ponte *et al.* 2008). The total cholesterol levels in meat play an important biological role because they are closely related to cardiac diseases (Salma *et al*., 2007), such as obstruction of the coronary veins caused by fatty material accumulation (cholesterol, calcium, blood cells, and the cells from the arterial wall), and may evolve over time, reducing blood flow and also making the individual more susceptible to thrombus or clots (Chou & Friedman, 2016). Compromising normal heart functioning can affect consumer acceptance of some kinds of meat and, therefore, there has been increasing interest in recent years in modulating the cholesterol concentration and fatty acid composition in chicken meat products (Sacks, 2002; Salma *et al*., 2007). In this study, the cholesterol content in the breast meat of Hac Phong chickens was much lower than other native chickens. Ac chicken meat contained 54.65 mg/100 g of cholesterol (Phung Duc Tien *et al*., 2010); while Thai native chicken and black-bone chicken meat had 30.5 mg/100 g and 27.9 mg/100 g, respectively (Jaturasitha *et al*., 2008). The cholesterol concentration in chicken meat may be influenced by the diet composition, the bird's age, and the bird's gender (Wang *et al*., 2005).

Conclusions

Hac Phong chicken meat had carcass, breast, and thigh percentages with the respective values of 70.36%, 16.16%, and 22.42%. The meat colors were as follows: L*: 37.40 and a*: 9.85 for

Table 3. Meat chemical composition and cholesterol content in the meat and blood of Hac Phong chickens

Item	n	Mean ± SD
Meat chemical composition (%)		
DM	4	24.51 ± 0.26
CP	4	27.71 ± 0.47
Fat	4	1.11 ± 0.17
Cholesterol in blood (mmol/L)		
Total	15	3.55 ± 0.64
HDL-Cholesterol	15	1.57 ± 0.51
LDL-Cholesterol	15	1.32 ± 0.50
Cholesterol in meat (mg/100g)	4	25.45 ± 9.16

thigh meat; and L*: 43.34 and a*: 1.57 for breast meat. For meat quality, Hac Phong chickens had several outstanding characteristics including low percentages of drip loss (1.13-1.33%) and cooking loss (16.30-21.60%), high tenderness (29.46-36.04 N), a high percentage of crude protein (27.71%), and a low content of cholesterol in the meat (25.45mg/100g).

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