

MORPHOLOGICAL CHARACTERISTICS OF INDIGENOUS CHICKEN HO AND DONG TAO IN VIETNAM

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Submitted Jan 14, 2019 - Accepted May 10, 2019

ABSTRACT

The objective of this study is to determine morphological characteristics and distinguish between Ho and Dong Tao chickens. Morpho-biometric characterization was based on measurement of 405 adult individuals, various body parameters were recorded including 165 Ho (123 males and 42 females) and 240 Dong Tao (40 males and 200 females). Moreover, 128 Ho (27 males and 101 females) and 240 Dong Tao (69 males and 171 females) were determined based on color characteristics of feather, tarsus and beak, and comb style. Ho chicken is a breed with large dimension, diversity in the colors (black with gold hackle, black copper, wheat, tan and tricolor), heavy body (3765.49 and 2642.56 g for males and females respectively). Dong Tao chickens have various phenotypes, as indicated in their diverse feather colors, tarsus colors and comb types. The body size of Dong Tao chickens is also large (3394.75 and 2815.20 g for males and females respectively). The body weight and all body measurements of the cocks were larger than those of hens. It is possible to distinguish Ho and Dong Tao chickens using morphological characteristics based on body size and visual observations. When using a combination of tarsus size, body weight and tarsus length, or a combination of tarsus color, beak color and feather color, Ho and Dong Tao breeds can be distinguished with less than 5% of errors. The results of this study can be used to separately select Ho and Dong Tao chickens using morphological characteristics.

Keywords: Ho, Dong Tao, indigenous chicken, morphological characteristics, Vietnam.

TÓM TẮT

Đặc điểm ngoại hình 2 giống gà Hồ và Đông Tảo của Việt Nam

Nghiên cứu này nhằm xác định các đặc điểm ngoại hình và phân biệt giống gà Hồ và Đông Tảo dựa trên chỉ số chiều đo cơ thể, màu lông, màu chân, màu mỏ và kiểu mỏ. Nghiên cứu đã xác định đặc điểm ngoại hình về các chiều đo cơ thể trên 165 gà Hồ (42 trống và 123 mái) và trên 240 gà Đông Tảo (20 trống, 40 mái). Trong đó xác định đặc điểm ngoại hình về màu lông, màu chân, kiểu mỏ trên 128 gà Hồ trưởng thành (27 trống và 101 mái). Gà Hồ có kích thước lớn và có sự đa dạng về màu lông (lông gà màu đen ánh xanh, màu đen ánh đồng, màu lúa mì, màu nâu sẫm và màu nâu sáng), khối lượng cơ thể của gà trưởng thành lần lượt là 3765,49kg gà trống và 2642,56kg gà mái. Gà Đông Tảo là giống gà có sự đa dạng về đặc điểm ngoại hình như màu lông, kiểu mỏ. Khối lượng gà Đông Tảo trưởng thành lần lượt là 3394,75kg gà trống và 2815,2kg gà mái. Khối lượng cơ thể và chiều đo cơ thể của gà trống luôn cao hơn gà mái ở cả hai giống. Có thể phân biệt hai giống gà Hồ và gà Đông Tảo dựa trên các đặc điểm ngoại hình là kích thước cơ thể và màu lông, màu mỏ, màu chân và kiểu mỏ. Khi sử dụng kết hợp các chỉ tiêu kích thước xương cổ chân, khối lượng cơ thể, chiều dài xương cổ chân chúng ta có thể phân biệt giống gà Hồ và gà Đông Tảo với độ tin cậy $P < 0,05$. Khi sử dụng kết hợp các chỉ tiêu màu lông, màu mỏ và màu chân có thể phân biệt giống gà Hồ và gà Đông Tảo với độ tin cậy $P < 0,05$. Kết quả của nghiên cứu này có thể được sử dụng trong chọn lọc giống gà Hồ và gà Đông Tảo dựa trên đặc điểm ngoại hình.

Từ khóa: Hồ, Đông Tảo, gà bản địa, đặc điểm ngoại hình, Việt Nam.

1. INTRODUCTION

Livestock production is an important and promising agricultural sector in the current context of increasing global demand for livestock products (Delgado et al., 2001). The use of indigenous breeds in livestock production contributes to biodiversity conservation and in-situ protection. The adaptation of indigenous poultry breeds to the local conditions and the fact that their products meet the expectations of local consumers is a factor adding value to these products from local breeds. The dramatic development of intensive livestock production systems is causing the decline of indigenous animal breeds. In particular, poultry production is also concerned in the general phenomenon of the reduction of animal genetic resources (Besbes, 2009).

Vietnamese human population is estimated at about 92 millions, with a density of 280 inhabitants per square km and the population in rural areas accounts 66% in 2016. Poultry production plays an important role in rural economic development and in providing food. In 2017, poultry meat production was 1031,9 thousand tons and ranked at the second position, after pork production, which was 3,733.3 thousand tons (GSO, 2018). Vietnam is ranked as one of the countries with the highest diversity of animal breeds in the world. More than 10% of the world's animal species have been found in Vietnam (Ly, 1993). The local poultry accounts for 84% of the

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total poultry (Desvaux *et al.*, 2008). MARD (2016) reported that 21 Vietnamese local chicken breeds have been identified, namely Ri, Ac (black meat, white or black feather), Te (or Lun, which means "short tarsus"), Mia, Ho, Dong Tao, H'mong, Tre, Tau Vang, Choi (fighting-cock), Oke, To, Mong, Lien Minh, Tien Yen, Hac Phong, Quy Phi, Xuoc, Nhieu Ngon, Kien, Lac Thuy. Among local chicken breeds, Ho and Dong Tao are famous for their massive body weights, thick tarsus and the good meat quality which are favored by consumers (Lan Phuong *et al.*, 2015). According to Cuc *et al.* (2011), a large number of local chicken breeds in Vietnam are in danger of extinction, making conservation of domestic animal genetic resources a major challenge in the future.

In Vietnam, indigenous chicken is kept in the household and the distinction between them usually is based on their morphological characteristics (Pham *et al.*, 2013). Nevertheless, the study of morphological characteristics of indigenous chickens in Vietnam is nowadays not complete. Consequently, the aim of this study is the determination of morphological characteristics of Ho and Dong Tao chicken and the development of a predictive model allowing to breeders to easily distinguish between these two breeds. It is also a foundation for a rehabilitation of Vietnamese local chicken breeds, which adapt well with less intensive farming conditions and play a paramount role on socioeconomic and cultural aspects.

2. MATERIAL AND METHODS

2.1. Study area

The study was carried out on households raising purebred Ho and Dong Tao chicken in Bac Ninh and Hung Yen provinces in northern Vietnam.

2.2. Morpho-biometric characterization

Morpho-biometric characterization was based on measurement of 405 adult individuals, including 165 Ho (123 males and 42 females) and 240 Dong Tao (40 males and females). Various body parameters were recorded in accordance with the FAO recommendations (FAO, 2012): a weighing scale (precision 10g) was used to measure chicken body weight; a tape measure and an electronic sliding caliper (precision 0.01mm) were used to measure body parameters. The collected data were the sex, the body weight and several body parameters including body length, neck length, back length, wing length, thoracic perimeter, breast length, thigh length, tarsus length, and tarsus diameter, beak length, comb length, comb height. Additionally, color characteristics of feather, tarsus and beak, and comb style were determined based on visual observations of 128 Ho (27 males and 101 females) and 240 Dong Tao (69 males and 171 females).

2.3. Statistical analysis

Comparisons of the measured morpho-biometric characteristics between genders were performed using ANOVA procedure of SAS software (1989). Least squares means (LSM) and their standard errors (SE) were obtained for each morpho-biometric parameter. A Bonferroni adjustment was applied for multiple tests. An alpha level of .05 was set for all statistical analyses.

Inferring breed using a decision tree were performed with R (version 3.3.2) with package rpart. This method shows how the value of a target variable can be predicted by using the values of a set of predictor variables. Two decision trees were built. For both, the target variable was the breed (Ho or Dong Tao) but predictor variables differed: one was based on morpho-biometric characteristics and the other on visual observations (sex, color of feather, tarsus and beak, comb style). The collected data are split into two subsets, training set (2/3 of the sample) and testing set (1/3 of the sample). The data are randomly drawn in keeping the ratio Dong Tao/Ho in each set. Therefore, 160 Dong Tao and 85 Ho was used to build the decision tree from morpho-biometric characteristics and 160 Dong Tao and 110 Ho was also randomly drawn to build the decision tree from visual observations. To build the two decision trees, 10 cross-validations was applied and the minimum number of observations that must exist in a node in order for a split to be attempted was 5. The splitting criteria is the Gini index. The accuracy of obtained decision trees is evaluated by making predictions against the test data. The accuracy of decision trees is measured by comparing the predicted target values and true target values of the testing data with a confusion matrix.

3. RESULTS

3.1. Morphometric traits

The body weight and body sizes of Ho and Dong Tao chickens are shown in Table 1. The males of Ho were heavier than females ($P < 0.001$) and body sizes were larger for all morphometric parameters ($P < 0.001$). The body weight, body length, neck length, wing length, thoracic perimeter, beak length, thigh length, tarsus diameter of Dong Tao on males were larger than those on females ($P < 0.001$). While the back length, tarsus length, comb length, comb height of Dong Tao on males were not no different significantly those on females ($P > 0.05$).

3.2. Feather color and aspect

The feathers, tarsus and beaks colors and comb type distributions of Ho and Dong Tao chickens are given in Table 2. These animals are characterized by 5 basic feather colors (2 for males and 3 for females). Two main types of feather colors were observed for the males in both breeds, with similar distributions: the black with gold hackle is predominant over the black copper. The situation is different for females, where the wheat color is the most frequently observed color in Ho chickens, followed by the tan and the tri colors, while the tan color is largely dominant in Dong Tao, followed by the tri and wheat colors. The differences are also marked for the tarsus colors: while red tarsus is only and very predominantly present in Dong Tao animals, Ho chickens show three different colors including yellow-red toe, yellow and ivory white, with more variations in females than in males. Finally, while comb types and beak colors are similar in both breeds, large differences in the distributions can be observed between breeds and between genders. For example, more than 90% of the Ho females had a yellow beak, while almost 73% of the Dong Tao females showed a dark horn one.

3.3. Inferring breed using a decision tree

The observed differences in the measured characteristics for the two breeds suggest using these traits to infer the breed of the animals. Figure 1 shows the decision tree built on the basis of 16 morpho-biometric characteristics. It can be seen that this tree includes a total of three decision nodes (i.e. criteria) and four leaf nodes (i.e. classification). Confusion matrix is reported in table 3. 3.75% of Dong Tao chickens are misclassified whereas 7.27% of Ho chickens are misclassified. The general accuracy is about 94.81%. Based on a decision tree, decision rules can be easily generated by traversing a path from the root node to a leaf node. For example, a decision rule can be generate in above decision tree as follows: if diameter at widest part of tarsus ≥ 17.84 mm and body weight < 3575 g and tarsus length < 9.5 cm then chicken breed is Dong Tao. Figure 2 shows the decision tree built on the basis of 5 visual observations. It can be seen that this tree includes a total of seven decision nodes (i.e. criteria) and eight leaf nodes (i.e. classification). Confusion matrix is reported in table 4. 3.75% of Dong Tao chickens are misclassified whereas 6.98% of Ho chickens are misclassified. The general accuracy is about 95.12%.

4. DISCUSSION

Ho and Dong Tao chickens are indigenous breeds that have been raised since a long time in the Red River Delta of Northern Vietnam (Doan and Luu, 2006, Lan Phuong *et al.*, 2015). The morpho-biometry of Ho and Dong Tao chicken is characterized by large body weights. In that respect, Ho and Dong Tao should be considered as a meat chicken breed: Ho and Dong Tao are the biggest native chicken breeds in Vietnam (Le Thi Thuy *et al.*, 2009). In Vietnam, chicken is a traditional product used in important ceremonies associated with spiritual life of Vietnamese people (Moula *et al.*, 2011, Lan Phuong *et al.*, 2015). The males whose feather color is black with gold hackle or yellow are normally chosen for the sacrifice in important ceremonies (Luan *et al.*, 2014). As could be expected, the dominance of the black with gold hackle in the male chicken population has been shown in the present study. This finding is similar to the researches of Doan and Luu (2006) and Le Thi Thuy *et al.* (2009). The feather colors in Ho and Dong Tao males and females are divided into two obvious separate groups. In detail, the male has the dark feather color while the female has the brighter one. In the Red River Delta of northern Vietnam, the female chickens are rarely used in the traditional ceremonies. The females are mainly raised by the farmers to produce eggs, chicks and broilers. This study also showed that the bright color of feather was the most frequent one in the female population. Keambou *et al.* (2007) noted that the

hens of local breeds in tropical regions have feathers shining which provide them for a better adaptability against the weather conditions in their territories. A large diversity of tarsus color has been observed in Ho and Dong Tao chicken. This may be the result of crossbreeding between these breeds and other ones as no control of the matings is performed in the households.

Through a long history under the pressures of natural and artificial selection processes, Ho and Dong Tao chickens have adapted well to the local conditions in the Red River Delta. The direct observation and description of the phenotypes of indigenous chickens is an important work to provide information for the researches targeting an exploitation and a sustainable conservation of the breed. The phenotypic diversity in the existing local chicken population could reveal the introduction of alleles from other breeds into the pure chicken population. This is a potential threat introducing concerns for the genetic resource erosion of the local chicken flock. However, these hybridizations also provide the opportunity to create new and better individuals, fitted to the nowadays conditions while preserving the main characteristics of the original breed, which is also considered as a type of genetic diversity. Consequently, if conservation and exploitation of the breed are the objective, a program targeting the stabilization of the phenotypic characteristics together with a selection program to improve the weak production and reproductive performance should be set-up.

In Vietnam, the farmers are usually used morpho-biometric characteristics for distinguish between native chicken breeds and selection (Pham *et al.*, 2013). They usually base their choice on indicators such as feather color, comb type, and tarsus color. The choices correspond to cultural uses and to the needs of the consumers. For example, characteristics of chicken tarsus are important ones in the traditional ceremonies such as for fortune prediction in Lunar New Year and in praying ceremony (Luan *et al.*, 2014). Moreover, many Vietnamese people like eating chicken tarsus, so they are easily found in Vietnamese traditional restaurants. Vietnamese people are interested not only in the production performance but also in the phenotype of the chickens. This is due to the fact that, besides providing food sources, Vietnamese consumers also use chicken as an article in the most important ceremonies, as a sacrifice or as an ornament in expressing style or social position of the owner. As a freebie, the selling price of a Ho and Dong Tao chicken depends on its phenotype, especially on the body size, the shape and color of tarsus and the live weight: the larger live body weight and bigger tarsus are always sold with the higher prices. The highest prices for a pair of male and female Ho or Dong Tao chickens reached 2,000 to 3,000 USD. A long of time, there is a selective disorientation by farmers, where formed the difference in the morphometric traits of chicken.

This study provides a predictive model to distinguish between Ho and Dong Tao chickens that could be used by the farmers. Two decision trees are proposed: one based on morpho-biometric characteristics and another based on visual observation. The general accuracy of the two decision trees is high (95%). Only 3 morpho-biometric characteristics are necessary to distinguish the two breeds namely diameter at widest part of tarsus, body weight and tarsus length. On the other hand, on basis of visual observations numerous criteria are necessary. However, the advantage is that it does not require any measuring device. The major strength of decision tree lies in its interpretability and ease of use.

5. CONCLUSION

Ho and Dong Tao chicken are Vietnamese indigenous chicken breeds with heavy body weight and large body measurements. Their morphological characteristics are diverse, potentially revealing genotypic heterogeneity.

The morpho-biometric characteristics and visual observations can be easily used to select and distinguish between Ho and Dong Tao chicken breeds with a high accuracy.

ACKNOWLEDGEMENTS

This study was funded by ARES–CCD (Académie de Recherche et d’Enseignement supérieur Commission de la Coopération au Développement).

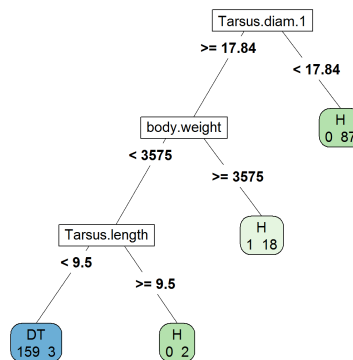
Table 1. Morpho-biometric traits of Ho and Dong Tao chicken breed (LSM±SE)

Variable	Ho		corrected p-value	Dong Tao		corrected p-value
	Males (n=123)	Females (n=42)		Males (n=40)	Females (n=200)	
Body weight(g)	3,765.49±89.73	2,642.56±45.27	***	3,394.75±27.03	2,815.2±11.03	***
Body length (cm)	51.96±0.53	46.23±0.25	***	47.53 ± 0.35	44.67 ± 0.14	***
Neck length (cm)	22.33±0.35	19.97±0.17	***	22.66 ± 0.22	20.38 ± 0.09	***
Back length (cm)	26.07±0.35	22.45±0.20	***	24.86 ± 0.25	24.28 ± 0.10	NS
Wing length(cm)	26.90±0.26	22.72±0.13	***	26.30 ± 0.36	24.21 ± 0.14	***
Thoracic perimeter (cm)	36.13±0.40	33.30±0.24	***	36.21 ± 0.46	34.44 ± 0.18	**
Breast length (cm)	21.05±0.22	17.32±0.13	***	19.54 ± 0.30	17.84 ± 0.12	***
Thigh length (cm)	19.84±0.18	16.03±0.10	***	17.70 ± 0.22	15.96 ± 0.08	***
Tarsus length (cm)	9.78±0.15	7.56±0.07	***	7.83 ± 0.15	7.73 ± 0.06	NS
Tarsus diam 1 (mm)	19.69±0.29	15.31±0.17	***	27.51±0.46	22.81 ± 0.18	***
Tarsus diam 2 (mm)	23.78±0.24	18.62±0.14	***	30.15 ± 0.43	25.57 ± 0.17	***
Beak length (cm)	42.88±0.58	37.73±0.34	***	41.10 ± 0.85	38.16 ± 0.34	*
Comb length (mm)	38.65±0.76	27.86±0.45	***	32.83 ± 1.24	32.19 ± 0.54	NS
Comb height (mm)	18.63±0.62	9.05±0.39	***	21.01 ± 1.27	19.56 ± 0.55	NS
Wattles length (mm)	31.15±0.91	22.88±0.65	***	27.87 ± 0.96	24.92 ± 0.42	*
Wattles height (mm)	27.05±1.27	13.89±0.93	***	23.45 ± 1.25	19.54 ± 0.58	*

Note: diam 1: diameter at widest part of tarsus; diam 2: diameter at thinnest part of tarsus, (): number of animals; Diam 1: Diameter at widest part of tarsus, Diam 2: Diameter at thinnest part of tarsus; *** P<0.001; ** P<0.01; * P< 0.05; NS: P> 0.05; LSM ± SE: Least squares means ± SE. P-value are corrected by a Bonferroni adjustment.

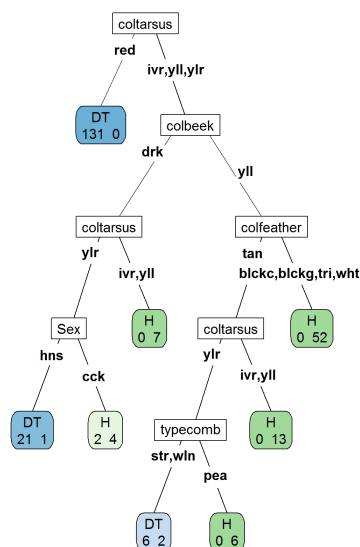
Table 2. Feather, skin, tarsus, beak color and comb types of Ho and Dong Tao breeds

Variable	Ho				Dong Tao				
	Males		Females		Males		Females		
	n	%	n	%	n	%	n	%	
Feather color	Black copper	7	25.93			14	20.29		
	Black, gold hackle	20	74.07			55	79.71		
	Tan			35	34.65			120	70.18
	Tricolor			11	10.89			30	17.54
	Wheat			55	54.46			21	12.28
Tarsus color	Red					65	94.20	137	80.12
	Yellow, red toe	22	81.48	48	47.52	4	5.80	34	19.88
	Ivory white	4	14.82	47	46.54				
	Yellow	1	3.70	6	5.94				
Comb type	Pea	2	7.41	40	39.60	17	24.64	19	11.11
	Strawberry	5	18.52	49	48.52	11	15.94	93	54.39
	Walnut	20	74.07	12	11.88	41	59.42	59	34.50
Beak color	Dark horn	14	51.85	9	8.91	50	72.46	125	73.10
	Yellow	13	48.15	92	91.09	19	27.54	46	26.9



Note: Tarsus.diam.1: diameter at widest part of tarsus; Tarsus.length: Tarsus length; body.weight: Body length; DT: Dong Tao chicken; H: Ho chicken

Figure 1: Decision tree on morpho-biometric characteristics to distinguish between Ho and Dong Tao



Note: coltarsus: Tarsus color; ivr: Ivory white; yll: Yellow; ylr: Yellow, red toe; colbeek: Beak color; drk: Dark horn; colfeather: Feather color; tan: Tan color; blckc: Black copper; blckg: Black, gold hackle; tri: Tricolor; wht: Wheat color; typecomb: Comb type; pea: Pea; str: Strawberry; wln: Walnut; Sex: Sex; hns: Females; cck: Males; DT: Dong Tao chicken; H: Ho chicken

Figure 2: Decision tree on visual observations to distinguish between Ho and Dong Tao

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