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# Phenotypic characterization of Thai native black-bone chickens indigenous to northern Thailand

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## *Abstract*

The aim of this study was to describe the phenotypic characteristics of native black-bone chickens indigenous to Northern Thailand. Nine qualitative and 6 quantitative traits were taken from 57 adult chickens of three genotypes, namely Chee Fah, Fah Luang and Papasoong. Only single type of comb and black shank were observed for all genotypes. The most prominent color of the comb was black followed by red and blackish red, respectively. Variations of hackle and plumage feather colors were found in Chee Fah and Fah Luang chickens, whereas those features of Papasoong were only white. Chee Fah had the lowest breast length, whereas Papasoong had the longest shank ( $p < 0.05$ ). Most of the quantitative variables showed significantly strong positive relationships to each other ( $r = 0.469$  to  $0.830$ ). These investigations indicated that the native black-bone chickens in Northern Thailand represented phenotypic variations in both qualitative and quantitative characteristics.

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**Keywords:** native black-bone chickens, Northern Thailand, phenotype, qualitative traits, quantitative traits

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## Introduction

Thai indigenous chickens have good adaptability to climate and resistance against diseases and stresses, and many preferable features such as pigmentation, taste, flavor and leanness (Choprakarn and Wongpichet, 2007), even if their productivities are lower than commercial or exotic breeds. For these reasons, they are an important part of socio-cultural roles, a source of income for many small-scale farmers, particularly those living in rural areas, (Choprakarn and Wongpichet, 2007; Laenoi et al., 2015) covering a good source of animal protein.

There are different breeds of indigenous chicken found in each region of Thailand. In the northern area, black-bone chicken is one of the locals which are widely reared in the highlands. Similar to other indigenous chickens, variations of phenotypes, which are considered as qualitative and quantitative traits, might be observed in the black-bone populations. Furthermore, morphological variation is the first important criterion to be used to breed characteristic identification. It is also a cheap and easy criterion to be applied by small-scale farmers. However, there are few published studies related to Thai native black-bone chickens (Intarachote et al., 2003; Jaturasitha et al., 2008; Sungkhapreecha et al., 2015), which is not sufficient for exact conclusions and further applications, especially genetic conservation. Therefore, the objective of this study was to characterize the phenotypic features of Northern Thai native black-bone chickens based on some qualitative and quantitative traits.

## Materials and Methods

**Study site:** This study was conducted at the Livestock Development and Research Center Region 5, Chiang Rai, Thailand. The site is located at latitude 19.9986 N, longitude 99.8227 E in the upper Northern Thailand and occupies about 1.53 km<sup>2</sup>. It has an average altitude of 413.26 m above sea level. The average annual temperature is 24.0°C with the average minimum and maximum of 18.6 and 30.7°C, respectively. It has an annual rainfall of 1,768 mm and relative humidity of 76.2%.

**Birds and management:** Three different genotypes of black-bone chickens, comprising Chee Fah, Fah Luang and Papasoong, are indigenous to Northern Thailand and widely reared in the highland areas of Chiang Rai province, Thailand. They are usually reared for the purposes of household consumption, leisure and rituals. Moreover, they are the main ingredient of the black-bone chicken soup, one of Doi Mae Salong's tourist attractions. However, all chickens used in this study were reared in the Livestock Development and Research Center Region 5, Chiang Rai, for the aim of breed conservation. The birds were raised separately by breed in a semi-confined system with a paddock area of 200 m<sup>2</sup> which was subdivided into pastured (168 m<sup>2</sup>) and covered areas (32 m<sup>2</sup>) for feeding and resting. The birds were fed *ad libitum* with corn-soybean based diets containing 14 to 16% CP according to the nutrient requirements of NRC (1994) and had

free access to water. All animals were cared for in accordance with the guidelines of the Department of Livestock Development, Ministry of Agriculture and Cooperative, Thailand.

**Data collection and traits:** Data were collected from 57 mature male and female birds (17 Chee Fah, 20 Fah Luang and 20 Papasoong). Qualitative traits were considered as comb type and colors of comb, face, eye, beak, earlobe, hackle, plumage and shank. Quantitative parameters were recorded as follows: body weight (BW); body length (BL), measured from the thoracic vertebrae to the sacral vertebrae; breast width (BrW), measured at the anterior end of the keel while the chicken was held on its back; breast length (BrL), measured as the length of keel; breast girth (BrG), measured as the circumference of the breast region; and shank length (SL), measured as the length of tarso-metatarsus from the hock joint to the metatarsal pad.

**Statistical analysis:** The dataset of phenotypes was handled and descriptive statistics were analyzed using R program (R Core Team, 2015). The quantitative traits were analyzed by the analysis of variance (ANOVA), differences were compared among means of the three genotypes by Duncan's new multiple range test (DMRT) and correlation coefficients among them were evaluated using the same program.

## Results

**Qualitative traits:** The morphological characteristics of the three genotypes of Thai native black-bone chickens are represented in Table 1 and Figures 1 to 3. No variations were observed in the comb type and shank color among the three genotypes of chickens. The comb color varied from black (59.65%), blackish red (10.53%) to red (29.82%). The Chee Fah population had only black comb. Furthermore, the results showed relationship between the comb and face color of the chickens. The earlobe color of Chee Fah and Fah Luang was black, while that of Papasoong was red. Considering the hackle and plumage, the maximum proportion of hackle color was black with white stripes in Chee Fah (52.94%) and dark yellow with white stripes in Fah Luang (70.00%). The predominant color of the plumage was black (82.35% for Chee Fah and 60.00% for Fah Luang). However, black color was not observed in any characteristics, i.e. comb, face earlobe and feathers, of the Papasoong population.

**Quantitative traits:** The least square means of quantitative traits of Thai native black-bone chickens are given in Table 2 for all genotypes. The male chickens in each genotype showed greater performance than the females for all traits ( $p < 0.05$ ), except for BrW and BrG in Chee Fah, which did not statistically differ. There were no statistically significant differences among the genotypes for BW ( $p > 0.05$ ), nonetheless, the Papasoong black-bone chickens showed the highest average BW (1.82 kg) followed by Fah Luang (1.79 kg) and Chee Fah (1.63 kg), respectively. The Papasoong and Fah Luang chickens had longer bodies than Chee Fah ( $p < 0.05$ ).

Although the BrW, BrL and BrG did not differ significantly among the three genotypes ( $p>0.05$ ), the Fah Luang chickens showed higher average values of BrW and BrL but lower BrG than the others. The SL of

chickens in the current study ranged from 7.90 to 11.96 cm. The Papasoong chickens had a significantly longer SL (9.62 cm) than the Chee Fah and Fah Luang chickens (9.10 and 9.07, respectively) ( $p>0.05$ ).

**Table 1** Morphological characteristics of Northern Thai native black-bone chickens

Trait (%)	Genotype <sup>1</sup>			All genotypes (n = 57)
	CF (n = 17)	FL (n = 20)	PS (n = 20)	
Comb type				
Single	100.00	100.00	100.00	100.00
Comb color				
Black	100.00	85.00	-	59.65
Blackish red	-	15.00	15.00	10.53
Red	-	-	85.00	29.82
Face color				
Black	94.12	65.00	-	50.88
Blackish red	5.88	35.00	15.00	19.30
Red	-	-	85.00	29.82
Eye color				
Black	100.00	100.00	10.00	68.42
Orangish black	-	-	15.00	5.26
Orangish yellow	-	-	75.00	26.32
Beak color				
Black	100.00	100.00	30.00	75.44
Black with white tip	-	-	70.00	24.56
Earlobe color				
Black	100.00	100.00	-	64.91
Red	-	-	100.00	35.09
Hackle color				
Black	35.29	10.00	-	14.04
Black with white stripes	52.94	-	-	15.79
Dark yellow with white stripes	-	70.00	-	24.56
Yellowish orange	-	20.00	-	7.02
Light yellow with white stripes	11.76	-	-	3.51
White	-	-	100.00	35.09
Plumage color				
Black	82.35	60.00	-	45.61
Blackish green	5.88	15.00	-	7.02
Black with yellowish orange stripes	-	10.00	-	3.51
Yellowish orange with black stripes	-	15.00	-	5.26
White with white black stripes	11.76	-	-	3.51
White	-	-	100.00	35.09
Shank color				
Black	100.00	100.00	100.00	100.00

<sup>1</sup> CF = Chee Fah, FL = Fah Luang, PS = Papasoong

**Table 2** Least square means of quantitative traits for each breed of Northern Thai native black-bone chickens

Trait	Genotype			SEM
	Chee Fah	Fah Luang	Papasoong	
Body weight (kg)	1.63	1.79	1.82	0.05
Male	2.20 <sup>a</sup>	2.28 <sup>a</sup>	2.42 <sup>a</sup>	0.05
Female	1.55 <sup>b</sup>	1.63 <sup>b</sup>	1.62 <sup>b</sup>	0.04
Body length (cm)	16.34 <sup>B</sup>	17.41 <sup>A</sup>	18.20 <sup>A</sup>	0.26
Male	19.82 <sup>a</sup>	19.06 <sup>a</sup>	20.72 <sup>a</sup>	0.27
Female	15.88 <sup>b</sup>	16.86 <sup>b</sup>	7.36 <sup>b</sup>	0.24
Breast width (cm)	5.19	5.48	5.25	0.07
Male	5.64	5.91 <sup>a</sup>	5.59 <sup>a</sup>	0.19
Female	5.14	5.33 <sup>b</sup>	5.13 <sup>b</sup>	0.07
Breast length (cm)	10.54	11.08	10.39	0.17
Male	12.86 <sup>a</sup>	12.51 <sup>a</sup>	11.83 <sup>a</sup>	0.28
Female	10.23 <sup>b</sup>	10.60 <sup>b</sup>	9.90 <sup>b</sup>	0.14
Breast girth (cm)	32.87	31.20	32.95	0.37
Male	35.25	33.20 <sup>a</sup>	34.90 <sup>a</sup>	0.57
Female	32.55	30.53 <sup>b</sup>	32.30 <sup>b</sup>	0.42
Shank length (cm)	9.10 <sup>B</sup>	9.07 <sup>B</sup>	9.62 <sup>A</sup>	0.14
Male	11.69 <sup>a</sup>	10.68 <sup>a</sup>	10.91 <sup>a</sup>	0.21
Female	8.75 <sup>b</sup>	8.53 <sup>b</sup>	9.19 <sup>b</sup>	0.09

<sup>A, B</sup> Different superscript letters within each row are significantly different ( $p<0.05$ ).

<sup>a, b</sup> Different superscript letters within each column are significantly different ( $p<0.05$ ).

**Table 3** Correlations between body weight, body length, breast width, breast length, breast girth and shank length of Northern Thai native black-bone chickens

Trait	Genotype			All genotypes
	Chee Fah	Fah Luang	Papasoong	
Body weight				
vs. Body length	0.586*	0.657**	0.717***	0.656***
vs. Breast width	0.611**	0.616**	0.637**	0.569***
vs. Breast length	0.677**	0.739***	0.698***	0.669***
vs. Breast girth	0.530*	0.735***	0.799***	0.586***
vs. Shank length	0.573*	0.830***	0.763***	0.721***
Body length				
vs. Breast width	0.324	0.232	0.505*	0.307*
vs. Breast length	0.289	0.483*	0.690***	0.401**
vs. Breast girth	0.510*	0.305	0.541*	0.411**
vs. Shank length	0.593*	0.615**	0.727***	0.641***
Breast width				
vs. Breast length	0.345	0.581**	0.469*	0.472***
vs. Breast girth	0.144	0.426	0.594**	0.213
vs. Shank length	0.234	0.502*	0.432	0.320*
Breast length				
vs. Breast girth	0.226	0.712***	0.440	0.318*
vs. Shank length	0.662**	0.740***	0.668**	0.607***
Breast girth				
vs. Shank length	0.233	0.626**	0.526*	0.437***

\* ( $p < 0.05$ ), \*\* ( $p < 0.01$ ), \*\*\* ( $p < 0.001$ )

**Figure 1** Male (left) and female (right) Chee Fah chickens which are predominantly of black feature color**Figure 2** Fah Luang chickens, male (left) and female (right), with the prominent color of dark yellow with white stripes (hackle) and black (plumage)

Correlations among the quantitative characteristics of Northern Thai indigenous black-bone chickens are demonstrated in Table 3. In terms of all genotypes, the results showed that all positive relationships among the studied traits were significant, except between BrW and BrG. The BW of chickens showed strong positive relationships to the BL, BrW, BrL, BrG and SL for all

genotypes ( $r = 0.530$  to  $0.830$ ). Significant positive correlations between BL and all other traits were only found in the Papasoong population. There were no significant associations between BrW and BrL and between BrG and SL of the Chee Fah chickens. Moreover, relationships between BrW and BrG in Fah Luang and between BrW and SL in Papasoong were

not observed. The BrL significantly correlated with BrG in the Fah Luang chickens ( $r = 0.712$ ), and

significantly correlated with SL for all groups ( $r = 0.662$  to  $0.740$ ).



**Figure 3** The white color predominantly characterizes the male (left) and female (right) Papasoong chickens

### Discussion

Only the single type of comb was found in this study, which is in agreement with the native chickens in Bangladesh (non-descript Desi, Hilly and Naked Neck), which had only the single type of comb (Faruque et al., 2010). Similarly, the free-range local chickens in Zimbabwe showed 96% of the single comb (McAinsh et al., 2004). On the contrary, only pea type was observed in Pradu-hangdum chickens (Leotaragul et al., 2015) and the predominant comb type of the Ethiopian indigenous chickens was pea followed by rose, single and walnut, respectively (Halima et al., 2007; Dana et al., 2010). The findings of plumage color of the Chee Fah and Fah Luang chickens correlate with the results of other studies which reported that black color was the prominent plumage color of the Thai native chickens (Laenoi et al., 2015; Leotaragul et al., 2015). Moreover, our investigations are consistent with others which reported various feather colors (Dana et al., 2010; Egahi et al., 2010; Daikwo et al., 2011). The variation in feature color observed in our chicken populations agrees with the findings of McAinsh et al. (2004), who revealed that variation in phenotype was exactly what characterized local chickens. The birds in the current study represented only black color of shank, which is different from many reports that showed variation of shank color (Msoffe et al., 2001; McAinsh et al., 2004; Halima et al., 2007; Egahi et al., 2010). A possible reason for this conflict is partly associated with genetic make-up of chickens, especially the black-bone chicken, which has black pigment in most parts of the body, including the shanks (Chang et al., 1997).

According to a study of Intarachote et al. (2003), F<sub>1</sub> Fah Luang population had BW of 1.85 kg for males and 1.41 kg for females, which are slightly lower than the BW of Fah Luang chickens in the present study. The average values in this study corresponded to BW of other Thai native chickens reported by some authors, ranging from 1.58 to 2.07 kg (Chatreewong and Waree, 2006; Kenchaiwong et al., 2007; Laenoi et al., 2015). Sungkhapreecha et al. (2015) studied various black chicken lines and revealed that the average of body weight at 16 weeks of age ranged from 1.06 to 1.95 kg. However, our findings showed higher values than

Thai cross-bred synthetic chickens, of which the body weight varied from 1.25 to 1.38 kg (Promwatee et al., 2012). Various investigations into BW of native chickens in other countries were also published. Average body weight ranging from 1.50 to 2.27 was found in Tanzanian local chickens (Msoffe et al., 2001) and native chickens in South Africa (van Marle-Köster and Casey, 2001; Alabi et al., 2012), whereas smaller chickens were observed in Northwest Ethiopia (Halima et al., 2007) and Dekina, Nigeria (Daikwo et al., 2011). These variations might be caused by different genetic backgrounds, maturity of chickens and environment, covering farm management which crucially affects the quantitative traits. Furthermore, many studies revealed the association of genetic background with growth performance by molecular method (Li and Li, 2006; Mekchay et al., 2014; Kuadsantia et al., 2015). The Northern Thai indigenous black-bone chickens in the current study had higher values than other black chickens for breast width and breast girth (Sungkhapreecha et al., 2015). According to the study of local chickens in Nigeria (Daikwo et al., 2011), they represented a longer breast (14.30 cm) than chickens in this study, while their breast girth (31.50 cm) was not different. The SL data in the current study fell within those of previous reports, ranging from 7.53 to 11.09 cm (Halima et al., 2007; Faruque et al., 2010; Melesse and Negesse, 2011).

The correlations of BW with BL, BrW, BrL, BrG and SL in this study are similar to many studies which revealed significant correlations of those features (Faruque et al., 2010; Apuno et al., 2011; Alabi et al., 2012). The correlation between BrG and SL of our chickens was significantly positive and high, conversely, Daikwo et al. (2011), who studied phenotypic characteristics of local chickens in Dekina, Nigeria, stated that the correlations between those traits was non-significant and low. The current results indicated that the shank length could be used as an indicator of body weight, body length and breast length of Northern Thai indigenous black-bone chickens. In addition, their correlations could be an aid in selection program (Falconer and Mackay, 1996). Our findings are supported by several previous studies which reported that the shank length of native chickens had a positive association with body weight (Faruque

et al., 2010; Daikwo et al., 2011) and body length (Apuno et al., 2011; Alabi et al., 2012).

### Conclusion

The results indicated that Thai native black-bone chickens indigenous to Northern Thailand represented variations of qualitative traits. Most phenotypic characteristics of Papasoong were white color, distinctly different from Chee Fah and Fah Luang. Moreover, Papasoong tended to have the greatest body structure followed by Fah Luang and Chee Fah, respectively. The correlations among quantitative traits were almost significantly positive and high. These investigations justify further detailed studies on larger number of chickens by conventional and molecular methods.

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## บทคัดย่อ

### ลักษณะปรากฏของไก่อกระดูกดำพื้นเมืองไทยที่มีถิ่นกำเนิดทางภาคเหนือของประเทศไทย

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การศึกษาค้นคว้าครั้งนี้มีวัตถุประสงค์เพื่อศึกษาลักษณะปรากฏของไก่อกระดูกดำพื้นเมืองที่มีถิ่นกำเนิดทางภาคเหนือของประเทศไทย ข้อมูลเชิงคุณภาพ 9 ลักษณะ และข้อมูลเชิงปริมาณ 6 ลักษณะ ที่ใช้ในการศึกษาค้นคว้านี้ได้มาจากไก่อกระดูกดำโตเต็มวัยทั้งหมด 57 ตัว จาก 3 พันธุ์ ได้แก่ พันธุ์ซีฟ้า พันธุ์ฟ้าหลวง และพันธุ์ป่าซุง การศึกษาพบว่า ไก่อกระดูกดำทั้ง 3 พันธุ์มีหงอนแบบหงอนจักรและสีของแข้งเป็นสีดำ สีของหงอนส่วนใหญ่เป็นสีดำ รองลงมาคือ สีแดง และสีดำแดง ตามลำดับ สร้อยคอและสร้อยหลังของไก่อพันธุ์ซีฟ้าและพันธุ์ฟ้าหลวงมีความหลากหลายของสี ขณะที่ไก่อพันธุ์ป่าซุงพบเพียงสีขาวเดียว ไก่อพันธุ์ซีฟ้ามีความยาวของหน้าอกน้อยที่สุด แต่ไก่อพันธุ์ป่าซุงมีความยาวของแข้งมากที่สุด ( $p < 0.05$ ) ลักษณะเชิงปริมาณส่วนใหญ่มีความสัมพันธ์ซึ่งกันและกัน และเป็นไปในทิศทางเดียวกัน ( $r = 0.469$  ถึง  $0.830$ ) ผลจากการศึกษาในครั้งนี้แสดงให้เห็นว่า ไก่อกระดูกดำพื้นเมืองที่มีถิ่นกำเนิดทางภาคเหนือของประเทศไทยยังมีความหลากหลายของลักษณะปรากฏทั้งในเชิงคุณภาพและเชิงปริมาณ

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**คำสำคัญ:** ไก่อพื้นเมืองกระดูกดำ ภาคเหนือของประเทศไทย ลักษณะเชิงคุณภาพ ลักษณะเชิงปริมาณ ลักษณะปรากฏ

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