Genetic selection to improve Thai synthetic chicken lines for growth and egg production

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Summary

Performances in term of growth and egg production in Four Thai synthetic chicken lines were improved using integrated techniques in genetic evaluation and marker assisted selection. The findings showed that those selection tools were successful in bringing significant change. We could identify specific genotypes for interesting performances in the selected group of chickens. The performances of selected Thai synthetic chickens over 9 generations were clearly improved. The superior meat production breed was found in one breed (Khai Mook Esarn) meanwhile the egg production potential of four breeds were similar.

Keywords: Thai synthetic chicken, growth rate, egg production

Introduction

Poultry production and consumption in Thailand have greatly increased over the past few decades. Thai consumers prefer meat from native breeds of chicken because meat texture is tastier and cholesterol content is lower compared to commercial broilers (Wattanachant et al., 2004; Jaturasitha et al., 2008). However, almost chickens are raised in rural backyards, and their genetic potential has not been fully utilized. Therefore, improvements of native breeds through selection for specific traits for higher growth and egg production should be carried out. For a breeding program, a variety of tools should be integrated for accelerating genetic improvement. Genetic evaluation is widely used for the detection of superior animals (Anang et al., 2000). Marker assisted selection can be applied to accelerate the breeding program. In terms of growth, the *IGF-I* gene has been used in the Thai native chicken and the Thai synthetic chicken selection programs (Promwatee et al., 2013). In addition, genotypes at the *24BP-PRL* and *VIPR-1* genes were associated with egg production (Duangjinda et al., 2014). In the present study was therefore aimed to evaluate genetic progress in four Thai synthetic chicken lines: Kaen Thong, Khai Mook Esarn, Soi Nin, and Soi Pet using integrated techniques in genetic evaluation and marker assisted selection for improvement of production in terms of growth rate and egg production performances.

Material and methods

Data

A total of 15,199 chickens from four Thai synthetic chicken lines (subsequently termed "synthetic chickens"), including Khai Mook Esarn (N = 4,579), Soi Pet (N = 4,295), Kaen Thong (N = 2,555), and Soi Nin (N = 3,770) ,were used in this study. These chickens were developed from nine generations of inter se mating between Thai native chickens, known as Chee (sire line), crossed with exotic commercial layers (dam line). Breeding was conducted at the Research and Development Network Center for Animal Breeding (Native Chicken), Khon Kaen University, Thailand. They were fed *ad libitum* with a commercial layer diet. Phenotypic characteristics of the four synthetic chicken lines are shown in Figure 1. For selection procedures, we started inseminated artificially 250 hens with 50 cocks (5:1). At 8 weeks of age of their offspring in each generation, blood samples were collected to examined investigated genotypes (*IGF-I, 24BP-PRL* and *VIPR-1* genes) using PCR-RFLP methods. At 12 weeks of age, EBV and gene association of growth performances were evaluated. If chickens had low growth rate at 12 weeks, they were excluded from study. For egg trait they were examined on 365-day cumulative egg production.

Model

A multiple-trait animal model was used to analyze variance components and genetic parameters of three economic traits: body weight of age at 12 weeks, breast circumference of age at 12 weeks and 365-day cumulative egg production. The model was as follows:

$$\mathbf{y_1} = \mathbf{X_1\beta_1} + \mathbf{Z_1a_1} + \boldsymbol{\varepsilon}_1$$

$$\mathbf{y_2} = \mathbf{X_2\beta_2} + \mathbf{Z_2a_2} + \boldsymbol{\varepsilon}_2$$

$$\mathbf{y_3} = \mathbf{X_3\beta_3} + \mathbf{Z_3a_3} + \boldsymbol{\varepsilon}_3$$

$$\begin{bmatrix} \mathbf{y_1} \\ \mathbf{y_2} \\ \mathbf{y_3} \end{bmatrix} = \begin{bmatrix} \mathbf{X_1} & \mathbf{0} & \mathbf{0} \\ \mathbf{0} & \mathbf{X_2} & \mathbf{0} \\ \mathbf{0} & \mathbf{0} & \mathbf{X_3} \end{bmatrix} \begin{bmatrix} \boldsymbol{\beta}_1 \\ \boldsymbol{\beta}_2 \\ \boldsymbol{\beta}_3 \end{bmatrix} + \begin{bmatrix} \mathbf{Z_1} & \mathbf{0} & \mathbf{0} \\ \mathbf{0} & \mathbf{Z_2} & \mathbf{0} \\ \mathbf{0} & \mathbf{0} & \mathbf{Z_3} \end{bmatrix} \begin{bmatrix} \mathbf{a_1} \\ \mathbf{a_2} \\ \mathbf{a_3} \end{bmatrix} + \begin{bmatrix} \boldsymbol{\varepsilon}_1 \\ \boldsymbol{\varepsilon}_2 \\ \boldsymbol{\varepsilon}_3 \end{bmatrix}$$

where $\mathbf{y}_1$, $\mathbf{y}_2$, $\mathbf{y}_3$ are vectors of observations for body weight of age at 12 weeks, breast circumference of age at 12 weeks, and 365-day cumulative egg production, respectively; $\boldsymbol{\beta}_1, \boldsymbol{\beta}_2, \boldsymbol{\beta}_3$ are vectors of fixed effects, including hatch, generation, sex, and age at first egg of hen; a_1, a_2, a_3 are vectors of random animal genetic effect; $\boldsymbol{\varepsilon}$ are vectors of random residual effects; $\mathbf{X}, \mathbf{Z}$ are incidence matrices related to β and a effects, respectively. Variance components and genetic parameters were estimated by the AI-REML. Selection response was analyzed by the BLUP technique. For gene association among *IGF-I, 24BP-PRL* and *VIPR-1* genes, PCR-RFLP methods were used. Moreover their associations with growth performance and egg production traits were studied. A general linear model (animal model) was used to analyze associations of the *IGF-I, 24BP-PRL,* and *VIPR-1* polymorphisms with these traits.

Results and discussion

The average±SD body weight at 12 weeks of age in 4 Thai synthetic chicken lines sorted by descending order of chicken were 1176±229 g (Khai Mook Esarn), 1129±220 g (Soi Pet), 1111±204 g (Soi Nin), and 1029±225 g (Kaen Thong), respectively. For average±SD 365-day cumulative egg production were 178±37 egg (Khai Mook Esarn), 169±35 egg (Soi Pet), 172±35 egg (Soi Nin), and 183±42 egg (Kaen Thong), respectively. Table 1 shows the heritability of each trait in the four Thai synthetic chicken lines. Heritability of body weight at 12 weeks of age was moderate in every line (0.27-0.39). While heritabilities of breast circumference at 12 weeks of age (0.12-0.27) and 365-day cumulative egg production (0.16-

0.36) ranged from low to moderate. Moreover, we found that the genotype at the investigated genes were associated with growth performance and egg production traits. For body weight at 12 weeks of age, the AC genotype of the IGFI gene was associated with higher body weight in the Kaen Thong, Khai Mook Esarn, and Soi Nin breeds, while the CC genotype was associated with higher body weight in Soi Pet. For 365-day cumulative egg production, the DD genotype of the *24BP-PRL gene* was associated with higher egg production in Khai Mook Esarn, Soi Pet, and Soi Nin, while the II genotype of the *24BP-PRL gene* was associated with higher egg production in Kaen Thong. In addition, the CC genotype of the *VIPR-1* gene was associated with egg production in every chicken line. According to Figure 2, the performances of selected Thai synthetic chicken lines were clearly improved over 9 generations. Interestingly, Khai Mook Esarn was a superior meat production breed, while the egg production potential was similar for the four breeds.

Conclusions

Based on results from this study, all Thai synthetic chicken lines had high production (both growth performance and egg production) efficiency. The Kaen Thong is possible to be improved as dam line for egg production, while the Khai Mook Esarn is possible to be improved as sire line for growth performance. The Soi Pet and Soi Nin lines could be improved as dual propose.

Table 1. Variance components, heritability, and genotypes associated with traits of growth performance and egg production in 4 Thai synthetic chicken lines.

Traits	Kaen Thong				Khai Mook Esarn			
	Vp	Va	h^2	SE	Vp	Va	h^2	SE
Body weight at 12 weeks of age (grams)	38752	15277	0.39	0.04	38108	10416	0.27	0.02
Breast circumference at 12 weeks of age (centimetres)	71.92	13.57	0.18	0.03	51.78	12.22	0.24	0.02
365-day cumulative egg production (eggs)	644.09	193.10	0.29	0.12	1244.22	449.00	0.36	0.07
IGF-I genotype associated with growth trait	AC (EBV = +9 gram/gen)				AC (EBV = +20 gram/gen)			
24BP-PRL genotype associated with egg production trait	II (EBV = +2.5 egg/gen)				DD (EBV = +1.5 egg/gen)			
VIPR-1 genotype associated with egg production trait	CC (EBV = +2.8 egg/gen)				CC (EBV = +2.0 egg/gen)			
	Soi Pet				Soi Nin			
	Vp	Va	h^2	SE	Vp	Va	h^2	SE
Body weight at 12 weeks of age (grams)	34552	11600	0.34	0.03	35964	10969	0.34	0.03
Breast circumference at 12 weeks of age (centimetres)	36.8	10.1	0.27	0.02	58.0	7.2	0.12	0.02
365-day cumulative egg production (eggs)	1141.8	184.0	0.16	0.10	997.2	262.9	0.26	0.08
IGF-I genotype associated with growth trait	CC (EBV = +14 gram/gen)				AC (EBV = +13 gram/gen)			
24BP-PRL genotype associated with egg production trait	DD (EBV = +0.5 egg/gen)				DD (EBV = +0.5 egg/gen)			
VIPR-1 genotype associated with egg production trait	CC (EBV = +1.0 egg/gen)				CC (EBV = +1.0 egg/gen)			

Note: Vp = total variance; Va = additive variance; h^2 = heritability; SE = standard error

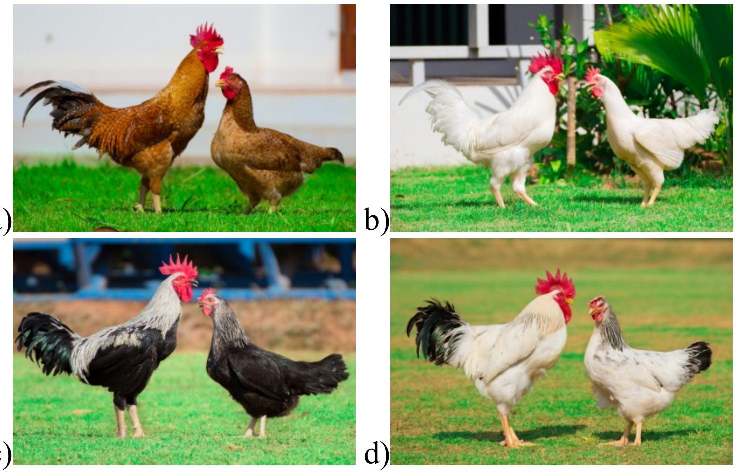

Figure 1. Male (left) and female (right) Thai synthetic chicken lines. a) Kaen Thong; b) Khai Mook Esarn; c) Soi Pet; d) Soi Nin.

Figure 2. Genetic trends for a) body weight at 12 weeks of age (gen1-gen9) and b) 365-day cumulative egg production (gen1-gen8) in Thai synthetic chicken lines.

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