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GENETIC PARAMETERS FOR BODY-WEIGHT TRAITS OF A NATIVE POULTRY BREED IN THAILAND

S. Tongsiri[1,2,3], M.G Jeyaruban[1], S. Hermesch[1], J. H. J. van der Werf[2] , L. Li[1] and T. Chormai[3]

[1]Animal Genetics and Breeding Unit, a joint venture of NSW Department of Primary Industries and University of New England, Armidale, NSW 2351, Australia
[2]School of Environmental and Rural Science, University of New England, Australia
[3]Department of Livestock Development, Thailand

SUMMARY

The heritabilities and genetic correlations for body-weights measured at day-old (BW1D), and at 4 (BW4), 8 (BW8), 12 (BW12), 16 (BW16), 20 (BW20) and 24 (BW24) weeks of age, and also at first egg (BWFE) of Thai native chickens (Lueng Hang Kao Kabinburi, LHKK) were estimated using Restricted Maximum Likelihood (REML) procedures. Data were from the Kabinburi Livestock Research and Breeding Center, Thailand and the records contained five generations of performance records on 11,588 birds born from 2003 to 2007. Estimates of heritabilities for additive genetic effects of body-weight traits ranged from 0.10 to 0.51. Heritabilities for maternal genetic effects ranged from 0.04 to 0.25, except for BWFE, which had no significant maternal genetic effects. Significant maternal permanent environmental effects were observed for all traits, except for BW24 and BWFE. Estimates of additive genetic correlations between the body-weight traits ranged from 0.25 to 0.99. Estimated heritabilities and genetic correlations between body-weight traits suggest that the growth performance of LHKK chickens can be improved by selection on one or more juvenile weight traits.

INTRODUCTION

Poultry production in Thailand can be categorised as a) intensive poultry production using commercial strains (80%), and b) backyard poultry production using native chickens (20%) (Information and Communication Technology Center 2016). The Thai native chicken (TC) has been very popular among Thai backyard poultry farmers for many centuries. This is because the TC expresses high disease resistance and can be raised with low-quality feed. Moreover, they are a source of household income and protein supply for rural Thai farmers. The TC has had increased importance since the avian influenza outbreak in Thailand in 2004 (Avian Influenza Control Center 2006). During the outbreak, TC was an important source of poultry meat for domestic consumption due to import and export restrictions imposed on poultry products.

TC meat is preferred by Thai consumers due to its unique taste and texture. However, the meat is 2 to 3 times more expensive than commercial broiler meat. This is because the TC meat production does not adequately support domestic consumption and also it's tastier than broiler meat. The TC has low mature body-weight and reaches 1.5 to 2 kg at 7 months of age (Thummabood *et al.* 2000). Lueng Hang Kao Kabinburi (LHKK) is one of the most popular breeds of the TC and therefore, identified by the Department of Livestock Development (DLD), Thailand to improve its meat production.

The heritability and genetic correlations of production traits are important factors in developing any selection scheme. However, knowledge about genetic parameters for native chickens under tropical climate condition is limited. Therefore, the objective of this study was to estimate genetic parameters on growth traits at different ages for LHKK under tropical condition in Thailand.

MATERIALS AND METHODS

Animal and Data. Pure-bred dual-purpose LHKK chickens were housed on a Thai government farm at the Kabinburi Livestock Research and Breeding Center, between 14.0478º North latitude and 101.3725º East longitude in the Eastern region of Thailand. Data were recorded for five generations from 2003 to 2007. Chickens were randomly mated and mainly selected for breed specific plumage characteristics. Seventy males and three hundred and fifty females were maintained each year to produce 21,500 mixed sex chicks. About 4,000 chicks were retained as replacements and the rest (17,500) were issued to farmers. The replacement chicks were grown on deep litter housing from one day-old to 21 days of age at 7.5 chicks per one square meter and fed with diet containing 18% crude protein and 2,900 Kcal ME/Kg of energy. They moved to grower pens at 21 days of age. During the growth period, chicks were allowed to scavenge during daytime and were sheltered at night. At 22 weeks of age, selected chickens were moved to individual battery cages until culling after 1 year of laying. Traits considered in this study were body-weights at day-old (BW1D), and at 4 (BW4), 8 (BW8), 12 (BW12), 16 (BW16), 20 (BW20), and 24 (BW24) weeks of age, and body-weight at first egg (BWFE) mean age of 28 weeks. Records more than 3 standard deviations from the mean of the data were eliminated. The total number of birds in the pedigree were 17,883 and the number of birds with records were 11,588 from 1,461 dams and 486 sires.

Statistical analyses. SAS (SAS Institute Inc., Cary NC USA) was used to calculate descriptive statistic and to identify significant fixed effects. Genetic parameters were estimated via Restricted Maximum Likelihood (REML) using a mixed linear model and WOMBAT software (Meyer 2007). A log likelihood ratio test was used to test significance of random effects and to identify the best model. For all body weight traits, except for BW24 and BWFE, the model was:

$$Y_{ijklm} = y_i + h_j + s_k + a_l + m_m + pe_m + e_{ijklm}$$

where: Y_{ijklm} is one of the six body-weight traits measured on animal l, in hatch j within year i with sex k, a_l is the random additive genetic effect of animal l, m_m is maternal genetic effect of dam m, pe_m is permanent environmental effect of dam m and e_{ijklm} is the random error associated with this observation. The covariance between additive and maternal effect was assumed to be zero. Only additive genetic and maternal genetic effects were fitted for BW24 and only additive genetic effect was fitted for BWFE. A series of bivariate analyses were used to estimate genetic and phenotypic correlations.

RESULTS AND DISCUSSION

Descriptive statistics. The descriptive statistics for the eight body-weight traits of LHKK chickens measured for five generations are summarized in Table 1. The mean weights observed for the eight traits were similar to the means reported by the Bureau of Animal Husbandry and Genetic Improvement (2016) for four breeds of TC. However, the mean weights of BW8, BW12 and BW16 were slightly heavier (200g) than those of another popular dual-purpose Thai indigenous chicken breed called Pradu Hangdum (Na-Rungsri *et al.* 2007). The higher BWFE of LHKK compared to other native chickens (Sangdaoreung *et al.* 2005) suggests that LHKK chickens could be improved as a dual-purpose chicken.

Genetic parameters. For most weight traits, direct heritability estimates were generally higher than maternal heritability estimates, or the ratio of permanent environmental dam effects variance to total variance (Table 1). Estimates of direct heritability varied from 0.10 (±0.02) to 0.51 (±0.06). The highest heritability was estimated for BWFE and the lowest was for BW1D. Estimated heritabilities for body-weight traits were within the range reported in previous studies. For Pradu Hangdum, Na-Rungsri *et al.* (2007) reported heritabilities of 0.43, 0.46 and 0.39 for BW8, BW12 and BW16, respectively. For BWFE, Boonkum *et al.* (2014) estimated a heritability of 0.51. Estimated maternal heritabilities were low to moderate and ranged from 0.04 (±0.02) to 0.25 (±0.04) for all traits, except for BWFE, for which no significant maternal effects was found. Estimated variance ratio for permanent environmental effects of dams were low to moderate for all traits and ranged from 0.11 (±0.02) to 0.28 (±0.03), except for BW24 and BWFE. Slight increase in permanent environmental effect of dam from BW8 to BW20 might be due to difficulty in portioning maternal and permanent environmental effects with few repeated observations for dams.

Table 1. Descriptive statistic, and estimated heritabilities (±SE) for direct (h^2_d), and maternal genetic effect (h^2_m), the variance ratio for permanent environmental effects (c^2) of dam and phenotypic variance (σ^2_p) for body-weight traits of LHKK chickens

Traits[1]	No. of records	Mean	SD	h^2_d	h^2_m	c^2	σ^2_p
BW1D (g)	11588	30.93	3.38	0.10±0.02	0.25±0.04	0.28±0.03	12.03
BW4 (g)	11201	218.91	56.68	0.28±0.03	0.05±0.02	0.11±0.02	1473.90
BW8 (g)	10807	642.08	138.74	0.33±0.03	0.04±0.02	0.11±0.02	9609.67
BW12 (kg)	9777	1.10	0.21	0.38±0.03	0.05±0.02	0.13±0.02	0.03
BW16 (kg)	8948	1.49	0.31	0.32±0.03	0.08±0.03	0.17±0.02	0.06
BW20 (kg)	7643	1.81	0.41	0.28±0.03	0.05±0.02	0.19±0.03	0.09
BW24 (kg)	6157	2.12	0.47	0.28±0.04	0.11±0.02		0.10
BWFE (kg)	1428	2.05	0.25	0.51±0.06			0.06

[1] BW1D, body-weight at day-old; BW4, BW8, BW12, BW16, BW20 and BW24 are body-weights at 4, 8, 12, 16, and 20 and 24 weeks of age, respectively; BWFE, body-weight at first egg

Table 2. Direct genetic (a), maternal genetic (m) and permanent environmental of dam (pe) correlations (above diagonal) and phenotypic correlation (below diagonal) between body-weights at day-old (BW1D) and 4 (BW4), 8 (BW8), 12 (BW12), 16 (BW16), 20 (BW20), 24 (BW24) weeks of age, and body-weight at first egg (BWFE) of LHKK chickens

Trait	Effect	BW1D	BW4	BW8	BW12	BW16	BW20	BW24	BWFE
BW1D	a		0.37	0.29	0.27	0.30	0.25	0.35	0.65
	m		0.65	0.80	0.67	0.67	0.71	0.66	
	pe		0.31	0.03	-0.13	-0.17	-0.14		
BW4	a	0.22		0.86	0.74	0.60	0.67	0.52	0.55
	m			0.98	0.97	0.79	0.89	1.00	
	pe			0.81	0.58	0.57	0.59		
BW8	a	0.16	0.68		0.97	0.90	0.89	0.81	0.77
	m				0.97	0.98	0.93	1.00	
	pe				0.90	0.84	0.80		
BW12	a	0.14	0.56	0.79		0.98	0.95	0.92	0.78
	m					1.00	1.00	1.00	
	pe					0.97	0.93		
BW16	a	0.14	0.47	0.70	0.85		0.99	0.97	0.81
	m						0.99	1.00	
	pe						0.99		
BW20	a	0.12	0.47	0.66	0.79	0.90		0.99	0.85
	m							1.00	
BW24	a	0.19	0.39	0.59	0.76	0.85	0.90		0.93
BWFE	a	0.14	0.29	0.48	0.58	0.57	0.64	0.63	

Estimated standard error for genetic and phenotypic correlations varied from 0.01 to 0.18 and 0.00 to 0.02, respectively

Phenotypic correlations and correlations for additive, maternal genetic and permanent environmental effects of dam between the body weight traits of LHKK chickens are presented in Table 2. The phenotypic correlations between weight traits at different ages varied from 0.12 to 0.90 and were highest for body-weight traits at adjacent age points. The additive genetic correlations among body-weight traits were generally high and positive, except for correlation with BW1D. Genetic correlations varied from 0.25 to 0.99. Moderate genetic correlations were observed between BW1D and other weight traits, except with BWFE. The highest genetic correlations (0.99) was observed between BW20 and BW16 and BW24. Correlations between maternal genetic effects at different ages ranged from 0.65 to 1.00 and the correlations between permanent environmental effects of dam ranged from -0.17 to 0.99.

Genetic correlations between body-weights at different stages of growth are lacking in literature for the native chickens. However, Lwelamira *et al.* (2009) reported high correlations for additive genetic effects (0.60-0.93) and for phenotypic effects (0.54-0.74) for body-weights at 8, 12, 16, and 20 weeks of age of local chickens in Tanzania. Niknafs *et al.* (2012) reported moderate to high genetic correlations between BW1D and BW8 (0.57) and BW12 (0.36) for local chicken in Iran. The high genetic correlation between BW1D and BWFE suggest that selection for heavy mature hen will indirectly increase the weight of day-old chicks. Moreover, high genetic correlations between body-weights at early growth with BWFE suggest that selecting heavier juvenile birds would increase mature weight in LHKK chickens.

Moderate to high heritabilities for direct additive genetic effects on body-weight traits suggests that selection for higher body-weight will increase growth rate and meat production of LHKK. This will improve its value as a dual-propose breed. Furthermore, high genetic correlations between body-weights measured during the growth period and the weight measured at maturity suggest that selecting for higher body-weight between 8 to 24 weeks of age would increase the mature weight of LHKK chickens. However, before implementing selection for growth rate, the correlated responses in egg production of LHKK chickens need to be investigated.

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