Genetic Parameters for Growth Traits in Ongole Grade Cattle

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ABSTRACT

Body weight is an economically important trait of Ongole Grade (OG) cattle which should be genetically improved. To improve the body weight of OG cattle, their genetic parameters ought to be estimated inclusive heritability, breeding values and genetic correlations between traits. This research was aimed to evaluate genetic parameters of traits related to growth of OG cattle in Tanjung Sari district, one of OG breeding center in Lampung Selatan regency. (Co)variance components for birth weight (BW), weaning weight (WW) and yearling weight (YW) were estimated on 104 OG cattle born between 2014 and 2019 and generated from 39 dams and 9 sires. Univariate and bivariate models were employed in WOMBAT software. This study resulted that heritability for BW, WW, and YW were estimated as 0.22 ± 0.05, 0.55 ± 0.19, and 0.43 ± 0.18, respectively. Genetic as well as phenotypic correlations between subsequent BW, WW and YW were positive: 0.35 ± 0.12 and 0.40 ± 0.24 for BW-WW, 0.47 ± 0.15 and 0.42 ± 0.10 for BW-YW, and 0.46 ± 0.11 and 0.81 ± 0.14 for WW-YW, respectively. The results of this study indicated that heritability estimates were in moderate to high category and all correlations between traits were positive suggesting that growth traits in OG cattle can be improved concurrently in a breeding program.

Keywords: *Genetic and phenotypic correlation, Growth traits, heritability, Ongole Grade cattle*.

1. INTRODUCTION

Ongole Grade (OG) cattle known as “Sapi PO” is one of the prominent Indonesian cattle breeds. This breed of cattle is originated from crossing between Sumba Ongole cattle (originated from India) and Javanese cattle (*Bos javanicus*) and is adapted to tropical environments in Indonesia since a hundred years ago [1,2]. The cattle which is predominant breed especially in Java Island and also it spreads in many island in Indonesia, reared primarily for meat production.

Previously, OG cattle was used for plowing the land for farming, transportation (male cattle) and religious sacrifice. This cattle is also as saving for farmer and can be cashed when needed. Currently, OG cattle are no longer used to plow agricultural land, but are used to continuously produce calves due to land plowing substitution with tractor machine and the increasing market demand of red meat. Even the demand for red meat in Indonesia cannot be met by cattle production in Indonesia, but is met by importing feeder cattle from Australia.

For the government, it is difficult to increase the productivity of OG cattle because most of the OG cattle are raised by traditional farmers who raise cattle as they are, and with the low education of these farmers, it is difficult to increase the productivity of these beef cattle. One of the strategies to increase the productivity of OG cattle, the Indonesian government is collaborating with Australia in the Indonesia Australia Commercial Cattle Breeding project in 2017. One of the pilot cattle breeding projects is at Livestock Production Cooperative (Koperasi Produksi Ternak, KPT) Maju Sejahtera in Tanjung Sari District, Lampung Selatan Regency. It is hoped that this area will become a center for beef cattle development in Indonesia.

KPT Maju Sejahtera was founded in 2014 and currently there are 38 farmer groups. The population of beef cattle that are members of KPT Maju Sejahtera is around 2,885 heads with a number of breeders as many

as 730 heads of households and a scale of ownership of 2-3 cows, all of which focus on cattle breeding [3]. Nearly ninety percent of the types of cattle developed are OG cattle and 10% of other types of cattle such as Brahman Cross, Limousin, Simental and Bali. At KPT Maju Sejahtera, breeders are required to record the development of cattle productivity such as body weight at birth (birth weight = BW), weaning weight (WW) and yearling weight (YW). However, breeders do not understand about the use of this recording for future cattle development, for example for selection programs. Therefore, it is important to help breeders in knowing the condition of their cattle, especially regarding the genetic parameters of cattle that currently exist.

On the other hand, research on genetic parameters of growth traits of OG cattle was limited. Adinata (2013) [4] reported that heritability estimate using paternal half sib correlation for birth weight of OG cattle was 0.69 ± 0.53, while Supartini and Darmawan [5] reported that heritability estimate for birth weight of OG cattle was 0.78. Furthermore, according to Wijono et al. [6], phenotypic correlation between traits BW and WW of OG cattle was 0.22 and between WW and YW was 0.73. This study aimed to estimate the genetic parameters (heritability estimates) of BW, WW, and YW, to determine the genetic and phenotypic correlations between the traits, and to estimate breeding value of OG cattle in KPT Maju Sejahtera.

2. MATERIALS AND METHODS

This research was performed in livestock groups in the Maju Sejahtera Livestock Production Cooperative, Wawasan Village, Tanjung Sari District, South Lampung Regency. The research material used in this research was data records of 104 individual male and female cattle generated from 39 dams and 9 sires from 2014-2019 which included birth records, body weight records, pedigree records, environmental records of maintenance, records of feed given, and others related to things that affect the performance of individual livestock. These data were tabulated using an Excel program which then be used as data for analysis to predict genetic parameters (heritability values, genetic correlations and phenotypic correlations between traits and individual breeding values) as well as the phenotypic parameters of the observed traits (BW, WW, and YW). The parameters were estimated using WOMBAT software [7,8].

Weaning weight was calibrated to 205 days of age (WW205) and calculated as follows.

$$WW205 = \left(\frac{Actual\ weight - Birth\ weight}{Weaning\ age\ in\ days}\right) * 205 + Birth\ weight$$

Yearling weight was adjusted to 365 days of age (YW365) and calculated as follows.

$$YW365 = \left(\frac{Yearling\ weight - Weaning\ weight}{Yearling\ age - Weaning\ age\ in\ days}\right) * 160 + WW205$$

Univariate analysis using the animal model based on BLUP was applied to estimate the heritability estimates and EBV (estimated breeding value) of individual animal, while to estimate genetic and phenotypic correlation between two traits, bivariate analysis was performed. The univariate animal model is described as follows.

$$y = Xb + Z_1a + Z_2m + e$$

In this model, y is the vector of phenotypic observations (BW, WW, and YW), while the vector of fixed effects (sex, age,) was *b*, and *a* was the vector of additive genetic effects of the animals (random). The random maternal genetic effects was in vector *m* and e was the vector of random residual errors associated with the observations. The incidence matrices related to the model's variable were *X*, Z_1, and Z_2, respectively. The covariance of the direct and maternal genetic effects was assumed to be zero.

The bivariate animal model is described as follows.

$$\begin{bmatrix} y_1 \\ y_2 \end{bmatrix} = \begin{bmatrix} X_1 & 0 \\ 0 & X_2 \end{bmatrix}\begin{bmatrix} \beta_1 \\ \beta_2 \end{bmatrix} + \begin{bmatrix} Z_1 & 0 \\ 0 & Z_2 \end{bmatrix}\begin{bmatrix} a_1 \\ a_2 \end{bmatrix} + \begin{bmatrix} W_1 & 0 \\ 0 & W_2 \end{bmatrix}\begin{bmatrix} m_1 \\ m_2 \end{bmatrix} + \begin{bmatrix} e_1 \\ e_2 \end{bmatrix}$$

where y_1, y_2 were traits observation vector for the first and the second trait (for example birth weight and weaning weight); the incidence matrix for the observations and the fixed effects (year of birth, year of weaning and sex) were X_1, X_2; β_1, β_2 were the solutions for the fixed effects of the first and the second trait; Z_1, Z_2 *were the i*ncidence matrix related to the observations and the direct additive genetic effects; a_1,a_2 were the solutions for direct random effects; W_1, W_2 were the incidence matrix related to the maternal random effect; m_1, m_2 were the solutions for maternal effects; and e_1, e_2 were statistical error.

The heritability value of the growth trait of OG cattle is useful for determining the accuracy and effectiveness of the selection program, while the EBV is useful as a reference or criterion for the selection program. Individual livestock with a high EBV relative to the livestock population means that these animals are superior and can be selected to serve as parents for the next generation. In this study, the EBV of OG cattle resulted from animal model analysis using WOMBAT program was then described descriptively with normal distribution graph.

3. RESULTS AND DISCUSSION

Growth traits of OG cattle in KPT Maju Sejahtera in Wawasan Village are presented in Table 1. Table 1 shows us that the average BW, WW, WW adjusted to 205 days (WW205), YW and YW adjusted to 365 days (YW365) of OG cattle were 23.98 ± 2.27 kg, 104.17 ± 14.09 kg,

114.10 ± 13.97 kg, 130.09 ± 24.23 kg, and 136.60 ± 23.44 kg, respectively. The coefficient of variance of the three variables was quite good, ranging from 9.46-18.63% which indicated that the variation in body weight at each age stage ranged from low to moderate category. The result of this study also showed that with increasing age of cattle, variations in body weight of OG cattle were increasing.

The results of this study were higher than those reported by Wijono et al. [6] stated that the mean BW, WW (205 days) and YW (365 days) of OG cattle were 22.34 ± 2.96 kg, 84.14 ± 17.76, and 120.97 ± 27.45 kg, respectively. The results of this study were also higher than the results reported by Ikhsanuddin et al. [9] that in Aceh cattle BW was 13.66 ± 1.08 kg, WW was 71.60 ± 7.92 kg (205 days old), and YW was 104.66 ± 11.72 kg (365 days old). However, the WW and YW of OG cattle of this study were not much different from the results of research of Prihandini et al. [10] who reported that WW and YW of OG cattle were 109.10 ± 18.35 kg and 132.70 ± 19.93 kg, respectively, and from the result of research of Sumadi et al. [11,12] who reported that WW of Ongole Grade cattle in Kebumen was 119.40 ± 36.61 kg.

The results showed in Table 2 indicated that the heritability estimates of birth weight, weaning weight and yearling weight of OG cattle of this study were in the medium to high category (0.22-0.55). This showed that the selection of OG cattle based on these three traits

Table 1. Statistics of growth traits of OG cattle

Variables	BW	WW	WW205	YW	YW365
Mean (kg)	23.98	104.17	114.10	130.09	136.60
SD (kg)	2.27	14.09	13.97	24.23	23.44
Maximum (kg)	29.00	164.00	182.43	203.00	216.30
Minimum (kg)	19.00	80.00	86.96	102.00	108.00
CV (%)	9.46	13.53	13.97	18.63	17.16
Average age (days)	0.00	182.71	205.00	365.41	365.00

Notes: BW = birth weight, WW = weaning weight, WW205 = weaning weight adjusted to 205 days, YW = yearling weight, YW365 = yearling weight adjusted to 365 days, SD = standard deviation, CV = coefficient of variation

Table 2. Genetic correlation (below diagonal), phenotypic correlation (above diagonal) and heritability estimates (in the diagonal, bold) of each variable.

Traits	Birth weight	Weaning weight	Yearling weight
Birth weight	**0.22 ± 0.05**	0.40 ± 0.24	0.42 ± 0.10
Weaning weight	0.35 ± 0.12	**0.55 ± 0.19**	0.81 ± 0.14
Yearling weight	0.47 ± 0.15	0.46 ± 0.11	**0.43 ± 0.18**

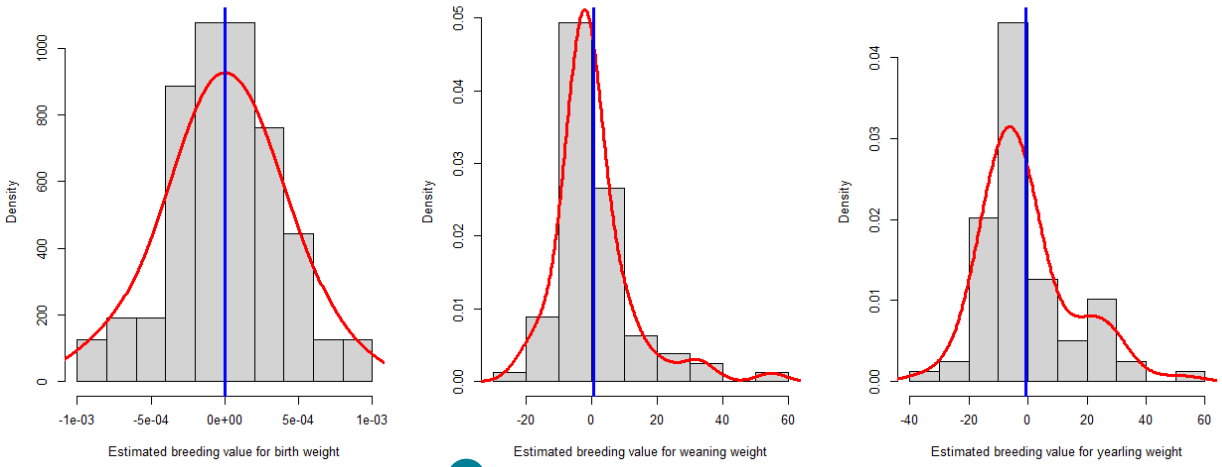

Figure 1. Estimated breeding value (EBV) of birth weight, weaning weight and yearling weight of OG cattle

(especially weaning weight) will produce quite high accuracy as well. The heritability estimate of birth weight in this study was lower than that of the result reported by Fathoni et al. [13] for OG cattle in Kebumen Regency, namely 0.76 ± 0.12 and the results of research by Kaswati et al. [14] in Bali cattle, namely 0.85 ± 0.44, the result reported by Karnaen [15] in Madura cattle, namely 0.33 ± 0.24, the result reported by Suhada et al. [16] in Simental cattle, namely 0.11 ± 0.09 , the result reported by Estrada-León et al. [17], namely 0.41 ± 0.09, and the research results of Putra et al. (2014) [18] in Aceh cattle, namely 0.15 ± 0.13. The heritability value of birth weight of PO cattle as a result of this study is in agreement with the results of Lopez et al. [19] research on Hanwoo cattle, which was 0.22 ± 0.02.

The heritability estimate of the weaning weight of this study was greater than that of Fathoni et al. [13] in OG cattle, namely 0.36 ± 0.21, the results of Suhada et al. [16] in Simental cattle, namely 0.39 ± 0.16, the results of Putra's research in Aceh cattle, namely 0.48 ± 0.58, and from the result of Estrada-León et al. [17], namely 0.43 ± 0.09, but lower than the results of Karnaen [15] research in Madura cattle, namely 0.87 ± 0.45. The heritability estimate of the weaning weight of this study was not different form that of Lopez et al. [19] result on Hanwoo cattle, which was 0.51 ± 0.03.

The yearling weight of the results of this study was in line with the results of preceding studies, which ranges from 0.27 to 0.54 [20]. The difference in the estimated heritability with the previous studies may be caused by differences in the breed of cattle and location of the study where genetic and environmental factors also influence the magnitude of the heritability value.

The results presented in Table 2 showed that the genetic correlation between BW and WW, between WW and YW, and between BW and YW was in the high category, namely 0.55 ± 0.22, 0.46 ± 0.11, and 0.47 ± 0.15, respectively. These results were higher than that of Fathoni et al. [13] who reported that the genetic correlation between BW and WW of OG cattle in Kebumen Regency was 0.42 ± 0.67. Suhada et al. [16] reported the value of the genetic correlation between the same growth variables of Simmental cattle reared at the Upper Padang Mangatas Beef Cattle Breeding Center were 0.29 ± 0.37, 0.68 ± 0.16, and 0.46 ± 0.33, respectively.

The phenotypic correlation values between BW and WW, WW and YW, and BW and YW in this study were 0.40 ± 0.24, 0.81 ± 0.14, and 0.22 ± 0.10, respectively. The phenotypic correlation between BW and WW were more correlated phenotypically than BW and WW of OG cattle reported by Wijono et al. [6], namely 0.22. Likewise, the estimated correlation between the WW and YW was higher than that of Wijono et al. [6], namely 0.73.

The results of this study showed that about 50% of OG cattle in the population had positive EBV of BW, while for WW and YW the positive EBV was around 40 and 30%, respectively (Table 1). The results also showed that there were 27 OG cattle that had high positive EBV for BW, 28 heads for WW and 17 heads for YW. These results indicated that there are around 40% of OG cattle that could be selected as bulls or dams for future generation based on WW EBV because of the highest heritability estimates of this trait.

4. CONCLUSION

Based on the results of the study, it can be concluded that the mean BW, WW, and YW of OG cattle are 23.98 ± 2.27 kg, 104.17 ± 14.09 kg and 130.09 ± 24.23 kg, respectively. The heritability values of BW, WW, and YW are in the moderate to high category, while the genetic correlation between BW and WW, between WW and YW, and between BW and YW are in the high positive category. The phenotypic correlation values between BW and WW, between WW and YW, and between BW and YW of the results of this study are in the moderate to high category. The results showed that 27 OG cattle had high positive EBV for BW, 28 heads for WW and 17 heads for YW. Ongole Grade cattle in KPT Maju Sejahtera can be selected based on BW, WW, and YW because in addition to the heritability value of these traits are moderate to high category, the genetic correlations value between traits are positive so that selection for increased BW, for example, will be followed by an increase in WW and YW.

AUTHORS' CONTRIBUTIONS

Authors contributed equally in this research.

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