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Early Selection in Limousine and Simmental Candidate Bulls Based on The Preweaning Growth Curve of Body Weight

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Abstract

Limousine and Simmental cattle (*Bos taurus*) are well known as the best beef cattle in Indonesia. This research was carried out to select the best Limousine and Simmental candidate bulls based on preweaning growth curve of body weight. Hence, four growth curve models of Gompertz, Logistic, Richards and Morgan-Mercer-Flodin (MMF) were used in this study. Total of 13 bulls (7 Limousine and 6 Simmental) reared at Bureau of Embryo Transfer (BET) of Cipelang, Indonesia were used in this study. Research showed that the average of weaning weight (8 months of age) in Limousine and Simmental calves were 155.17 ± 20.88 kg and 146.50 ± 22.04 kg respectively. The growth curve of G model in both breeds had lower of standard error (SE) value. Hence, the growth curve of Gompertz can be selected as the standard for preweaning growth in *Bos taurus* cattle at research site. In addition, calf ID: 811107 (Limousine) and calf ID: 61199 (Simmental) were selected as the best candidate bull because of highest on preweaning growth. It was concluded that the preweaning growth curve of Gompertz can be used as the standard of preweaning growth for *Bos taurus* cattle at BET Cipelang.

Keywords: *Bos taurus*, candidate bulls, preweaning growth curve, body weight

Introduction

Limousine and Simmental are well known as the best beef cattle in Indonesia. In Indonesia, these cattle were used for straw production by Bureau of Artificial Insemination (BAI) and embryo production by Bureau of Embryo Transfer (BET). Commonly, the straw from Limousine and Simmental bulls were used for crossbreeding program for many Indonesian native cattle in smallholds. Moreover, the crossbred cattle had higher of meat production than native cattle. Despite, the price in crossbred cattle was higher than local cattle in the market. Limousine \times Ongole grade (Limpo) and Simmental \times Ongole grade (Simpo) cattle are two the famous crossbred cattle that produced from artificial insemination (AI) or embryo transfer (ET) methods. Previous studies reported that the average of carcass weight in Limpo and Simpo crossbred bulls were 278.84 ± 24.12 kg and 273.61 ± 41.17 kg respectively (Sakti et al., 2013). Meanwhile, the average of adult weight in Limura (Limousine \times Madura) cow at more than 4 years of age was 406.61 ± 28.82 kg (Hartatik et al., 2009).

The best straw is important in AI and ET methods for increasing number of pregnancy and fertility rates of recipients. Despite, the best straw had association to increase meat production in beefcattle. Hence, the best straw can be reached with selection program in candidate bulls. In beef cattle, the weaning weight (WW) was used as the early selection for candidate bulls. The WW trait had high genetic correlation (r_g) value ($r_g < 0.50$) with yearling weight in crossbred cattle (Snelling et al., 2019). The growth curve has been used for early selection in cattle (Coutinho et al., 2015; Onogi et al., 2019). Thus,

the growth curve of cattle can be estimated with Gompertz, Logistic, Richards, Morgan-Mercer-Flodin (MMF) and Weibull models (Putra et al., 2018; Tutkun, 2019). Therefore, previous studies was used the growth curve of to evaluate the body weight in Nellore (Santos et al., 2011), Dhofari (Bahashwan et al., 2015), Aceh (Putra et al., 2018) and Friesian Holstein (Salman et al., 2012; Tutkun, 2019) cattle. In addition, Karnaen (2007) used the logistic growth curve to evaluate the body weight from birth until weaning age (6 months of age) in Madura cattle.

Recently, study to evaluate the growth curve in Indonesian *Bos taurus* cattle was limited. This study was conducted to select the best candidate bulls in BET Cipelang based on the preweaning growth curve of body weight. The results in this study is important as the early information to obtain standard growth curve for *Bos taurus* breeds cattle at Indonesia in the future.

Materials and Methods

Animals and Location

This study was carried ou to select the best candidate bulls based on records data of body weight from birth to 8 months of age (weaning). Total of 13 bulls (7 Limousine and 6 Simmental) reared at Bureau of Embryo Transfer (BET) at Cipelang, Indonesia were used in this study. Each bull was produced from artificial insemination (AI) at year 2011. The research location located at latitude 6°42'24.30 S and longitude 106°46'17.25 E with 1250 m above sea level. The average of air temperature about 18-22 °C and air humidity about 70-80%. The average of rainfall intensity about 2700 mm/year

Animals Management

The newborn calf was kept with dam along four days to get colostrum. Therefore, the five days calf was kept in the colony stall and milk was given 8-10% from the body weight. The calf starter concentrate was given to calf at 2-3 weeks age. The calf starter concentrate had nutrient composition of CP (16-20%) and TDN (75-80%) with Ca/P ratio of 2/1. The water was given *ad libitum*. The feeds management standard in BET Cipelang was presented in Table 1.

Table 1. The feeds management standard in BET Cipelang

| Age (Week) | Body weight estimation (kg) | Liquid milk (litre) | Dry grass / hay (kg) | Fresh grass (kg) | Calf starter concentrate (kg) |
|------------|-----------------------------|---------------------|----------------------|------------------|-------------------------------|
| birth | 30 - 40 | colostrum | - | - | - |
| 1 | 30 - 40 | 4 | - | - | - |
| 2 | 34 - 44 | 4 | - | - | 0.1 |
| 2 - 4 | 41 - 51 | 4 | 0.5 | - | 0.2 |
| 4 - 6 | 48 - 58 | 5 | 0.6 | - | 0.3 |
| 6 - 8 | 55 - 65 | 6 | 0.8 | - | 0.5 |
| 8 - 10 | 62 - 72 | 6 | 1.0 | 5.0 | 0.8 |
| 10 - 12 | 69 - 79 | 4 | 2.0 | 6.0 | 1.0 |
| 12 - 14 | 76 - 86 | 2 | 3.0 | 7.0 | 1.0 |
| 14 - 16 | 83 - 93 | 1 | 4.0 | 8.0 | 1.0 |
| 28 | 175 | - | - | 10 - 12 | 1.5 |
| 32 | 198 | - | - | 12 - 14 | 1.5 |
| 36 | 224 | - | - | 14 - 16 | 1.5 |
| 40 | 250 | - | - | 16 - 18 | 1.5 |
| 44 | 274 | - | - | 18 - 20 | 2.0 |
| 48 | 297 | - | - | > 20 | 2.0 |

Source: BET Cipelang

Data analysis

The records data of body weight in bulls were used to estimate the growth curve with Gompertz, Logistics, Richards and Morgan-Mercer-Flodin (MMF) models with CurveExpert 1.4. software. The mathematics model in each model according to Putra et al. (2018) and Tutkun (2019) as follows:

$$\text{Gompertz : } W_t = ae^{-e^{-b \cdot ct}}$$

$$\text{Logistic : } W_t = \frac{a}{1 + be^{-ct}}$$

$$\text{Richards : } W_t = \frac{a}{(1 + a^{-b \cdot ct})^{1/d}}$$

$$\text{MMF : } W_t = \frac{ab + ct^d}{b + t^d}$$

where, W_t is the body weight (g) at t week of age; a is the asymptotic weight (g) when times goes to infinity; b is the scaling parameters (constant of integration); c is the maturing rate (g/week); d is the constanta; e is the constanta (2.72) and t is the time (week)

Results

The average of weaning weight (8 months age) in Limousine was higher than Simmental bulls but not significantly different (Table 2). Thus, the body weight in 1 months age was showed significantly different ($P < 0.05$). The coefficient of determination (R^2) in the each model of growth curve was similar i.e. $R^2 = 0.99$ and included very high category (Table 3). The Gompertz model in Limousine and Simmental bulls had lowest of SE value. Meanwhile, the highest of SE value was showed in MMF model. The growth curve line in each model were showed similar as presented in Figure 1. Moreover, the growth line in Bull ID: 811107 (Limousine) and Bull ID: 61199 (Simmental) were higher than the others as presented in Figure 2. Thus, the best Limousine and Simmental candidate bulls based on growth curve of Gompertz model were presented in Figure 3.

Table 2. The average of body weight (kg) in Limousine and Simmental candidate bulls at BET Cipelang from birth to 8 months of age

| Breeds | Age (month) | | | | | | | | |
|-----------------|-------------|--------------------|-------|-------|--------|--------|--------|--------|--------|
| | Birth | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Limousine (N=7) | | | | | | | | | |
| Mean | 38.00 | 52.33 ^a | 64.50 | 75.83 | 89.17 | 107.17 | 123.50 | 139.83 | 155.17 |
| SD | 2.24 | 6.13 | 8.90 | 9.95 | 14.33 | 17.73 | 17.27 | 17.96 | 19.75 |
| CV | 0.06 | 0.12 | 0.14 | 0.13 | 0.16 | 0.17 | 0.14 | 0.13 | 0.13 |
| Minimum | 35.00 | 43.00 | 51.00 | 67.00 | 74.00 | 88.00 | 108.00 | 124.00 | 138.00 |
| Maximum | 40.00 | 57.00 | 77.00 | 95.00 | 116.00 | 139.00 | 157.00 | 176.00 | 194.00 |
| Simmental (N=6) | | | | | | | | | |
| Mean | 37.50 | 46.00 | 57.67 | 69.33 | 82.00 | 94.50 | 110.67 | 127.50 | 146.50 |
| SD | 1.64 | 2.00 | 9.56 | 7.63 | 6.66 | 8.17 | 14.46 | 17.03 | 22.04 |
| CV | 0.04 | 0.04 | 0.17 | 0.11 | 0.08 | 0.09 | 0.13 | 0.13 | 0.15 |
| Minimum | 35.00 | 43.00 | 48.00 | 60.00 | 75.00 | 85.00 | 90.00 | 100.00 | 115.00 |
| Maximum | 40.00 | 48.00 | 76.00 | 80.00 | 91.00 | 105.00 | 131.00 | 151.00 | 182.00 |

N: number of animal; SD: standard deviation; CV: coefficient of variation; superscript in the similar raw differ significantly ($P < 0.05$)

Table 3. Technical coefficient of logistics growth curve in preweaning weight of Limousine and Simmental candidate bulls at BET Cipelang

| Breed / Model | a | b | c | d | R ² | SE |
|------------------|---------|-------------|--------------|------|----------------|------|
| Limousine | | | | | | |
| Gompertz | 400.54 | 0.84 | 0.11 | - | 0.99 | 1.54 |
| Logistic | 238.66 | 4.90 | 0.28 | - | 0.99 | 1.66 |
| Richards | 242.16 | 1.49 | 0.27 | 0.95 | 0.99 | 1.81 |
| MMF | 39.70 | 247.48 | 2570.36 | 1.19 | 0.99 | 2.04 |
| Simmental | | | | | | |
| Gompertz | 1003.90 | 1.19 | 0.07 | - | 0.99 | 0.84 |
| Logistic | 313.64 | 7.15 | 0.23 | - | 0.99 | 1.11 |
| Richards | 301.92 | 2.19 | 0.24 | 1.08 | 0.99 | 1.24 |
| MMF | 38.66 | 32709801.52 | 231766232.11 | 1.30 | 0.99 | 1.54 |

a,b,c,d: technical coefficient of growth parameters; R²: coefficient of determination; SE: standard error

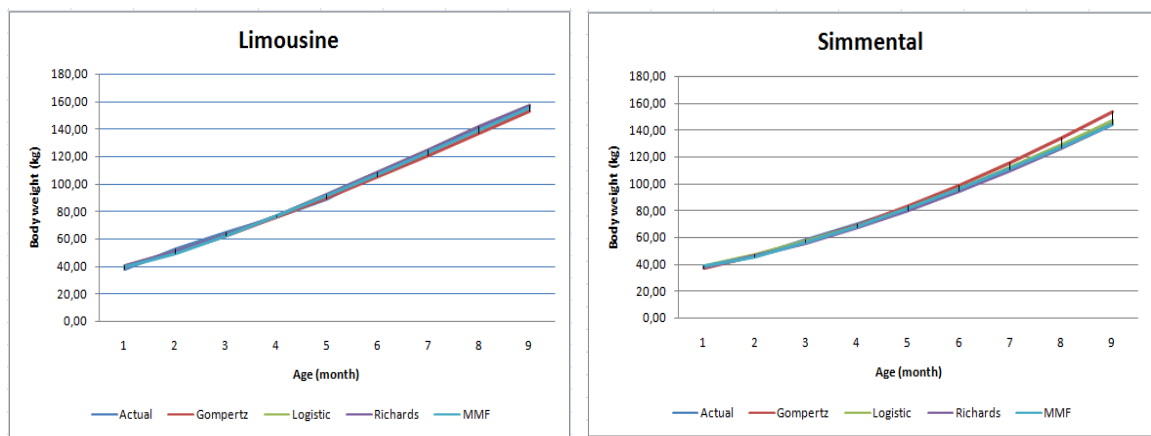


Figure 1. The preweaning growth curve of body weight in Limousine and Simmental candidate bulls at BET Cipelang (R²=0.99)

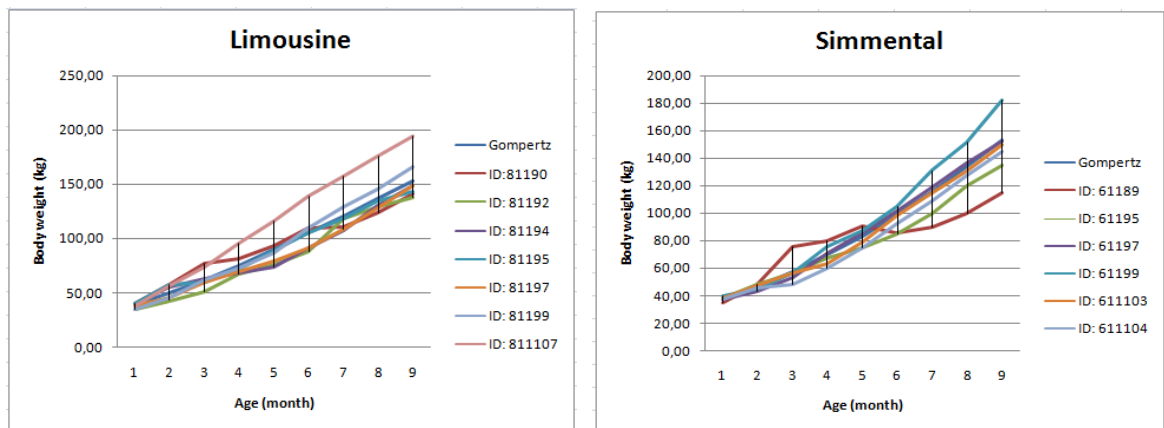


Figure 2. The individual preweaning growth curve of body weight compared to Gompertz model in Limousine and Simmental candidate bulls at BET Cipelang



Figure 3. The best Limousine and Simmental candidate bulls at BET Cipelang based on preweaning growth curve of body weight

Discussion

Pilarczyk and Wojcik (2007) reported that the body weight of Limousine and Simmental bulls at 7 months of age in Poland were 256.20 ± 22.70 kg and 306.50 ± 36.80 kg respectively (higher than in this study). Putra et al. (2017) reported that the body weight of Simmental bulls at 205 days of age managed in breeding station of Indonesia was 197.11 ± 45.73 kg and higher than in this study. In addition, Depison (2010) reported that the average of weaning weight in Limbal (Limousine \times Bali) and Simbal (Simmental \times Bali) cattle were 176.80 ± 29.27 kg and 179.21 ± 26.66 kg respectively (higher than in this study). The body weight of animal was influenced by genetic (sex and breed) and environmental (climate, feed nutrient and animals management system) factors. The R^2 value in each growth curve model was 0.99 (very high category). Meanwhile, the However, the Gompertz model had lowest of SE value than the others. It can be suggested that the growth curve of Gompertz model was accurate to predict preweaning weight in studied animals. Meanwhile, Karnaen (2007) obtained the R^2 value of 0.87 in the preweaning growth curve of body weight in Madura bulls using Logistic model and lower than in this study. So, the logistic growth curve in this study can be used to select the best candidate bulls in research site. According to the growth curve, Bull ID: 811107 (Limousine) and Bull ID: 61199 (Simmental) were the best candidate bulls in research site.

The post-weaning weight records in animals study were not available because all candidate bulls were delivered to Bureau of Artificial Insemination (BAI) of Lembang (other places) for next selection steps i.e. performance test and sperm quality test. Hence, the next recording in these candidate bulls is important to obtain the proven bulls. The performance test (along 1 years) can be started if candidate bulls reached of 600 days of age (Said et al., 2016). Thus the sperm examination can be performed during performance test. Finally, the progeny test must be performed in selected bulls from performance test to get estimation breeding value (EBV) of each selected bulls (Putra et al., 2015). So, a bull with highest of EBV had genetic potency of growth traits due to had good sperm quality.

Conclusion

The growth curve of Gompertz model in this study had highly accuracy to predict body weight from birth until weaning age in candidate bulls at BET Cipelang ($R^2=0.99$). Thus, the growth curve of Gompertz model can be selected as the preweaning growth standard to evaluate the growth profile in the candidate bulls of Limousine and Simmental. Two the best candidate bulls that obtained in this study had the best preweaning growth profile and can be managed in the next selection steps to obtain the best proven bull.

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