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Growth Pattern for Body Weight, Hip Height and Body Length of Brakmas Cattle

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Abstract: The objective of this study was to determine the growth pattern for body weight, hip height and body length using non-linear model and the correlation between the parameters in Brakmas cows. Cross-sectional data of body weight, hip height and body length of 363 heads of Brakmas cows were collected to determine the growth pattern using Brody and Gompertz growth model. The results showed that Gompertz growth function had the best goodness of fit to describe the growth of Brakmas cattle for body weight, hip height and body length as shown by its high coefficient of determination (0.96, 0.99 and 0.99, respectively). Brody model estimated higher mature sizes compared to Gompertz model as the rate of maturing derived by Brody model are lower for the parameters as shown by negative correlation between mature size and maturing. Body length-body weight has the highest correlation coefficient (0.95) and hip height-body weight showed the lowest relationship (0.92).

Key words: Brakmas cattle, non-linear model, mature sizes

INTRODUCTION

Cattle population in Malaysia showed a slightly increasing trend from 842,186 in 2007 to 855,543 in 2011 and only meet 11.26% of the national self sufficiency level for beef (DVS, 2012). As a result, live cattle and beef from Australia and India were imported causing negative balance of trade. One of the problems in developing cattle industry in Malaysia is the absence of quality breeding animals that are competitive to be propagated. Local indigenous Kedah-Kelantan cattle are tolerant to the hot and humid climate of Malaysia, but do not have good growth rates and low in average daily gain (Johari and Jasmi, 2009). These two traits are very important for a sustainable beef cattle operation. Crossbreeding is a powerful tool to use genetic resources optimally according to the environment. It allows the combination of local genetic resources and others to produce a better breed in terms of productivity from the economic perspective (Lema *et al*., 2011).

Malaysian Agricultural Research and Development Institute (MARDI) conducted a crossbreeding and selection project for producing a new composite beef cattle breed namely Brakmas. Brakmas cattle had been developed by crossbreeding and selection of Brahman bulls from Texas, USA and local indigenous Kedah-Kelantan (KK) cows in 1999. Brakmas is a synthetic breed with great potential for beef production in Malaysia under livestock-crop integration system (Hafiz *et al*., 2008). Currently in Malaysia, there are four multiplier herds of Brakmas, which involving the government link companies. Although Brakmas has the potential to be developed commercially, the information on this breed is still scarce. Growth characteristics such as birth, weaning and yearling weights were recorded and analyzed on a routine basis in the genetic evaluation by cattle breeders. Non-linear algebraic models have long been used to describe individual growth patterns. Some models tend to reduce the environmental impact of temporary/random variations and adapt to a non-linear relationship between age and live weight or body size (Berry *et al*., 2005).

Growth models were used to summarize the characteristics of significant growth, as growth rate, earliness to reach mature size, daily weight gain, feed conversion ratio, mature body size and weight and the interval between birth and maturity (Gbangboche *et al*., 2011). Other than estimating mature weight, non-linear function is also used to determine the growth curve for lamb fat tail measurement (Hamouda and Atti, 2011), cannon bone length (Meyer, 1995) and the testicle growth of sheep (Jimenez-Severiano *et al*., 2010) and scrotal circumference in cattle (Loaiza-Echeverri *et al*., 2013). Among the non-linear function that is often used to describe the sigmoidal pattern of growth in the dairy and beef is Brody, Gompertz, Logistic, von Bertalanffy and Richards growth model (Berry *et al*., 2005).

The objective of this study was to determine the growth pattern of three body size measurements, namely

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Body Weight (BW), Body Length (BL) and Hip Height (HH), of Brakmas cattle using Brody and Gompertz growth model.

MATERIALS AND METHODS

Cross sectional data of BW, HH and BL on Brakmas cattle were collected from 363 heads of Brakmas female with age ranging from one to 12 years old to determine their growth pattern. The Brakmas cattle were from a nucleus breeding herd located in MARDI Muadzam Shah Research Station, Pahang, Malaysia. Brakmas cattle were managed extensively on *Bracharia decumbens* pastures with the palm kernel cake pellet provided as supplementary feed. Data of BW was obtained using an electronic weighing scale. The body length was measured by using a measuring tape, which measured the distance from the point of withers to the pin bone. The hip height measurement was taken as the vertical distance from the top of the hip to the ground level as described by Gilbert *et al.* (1993). Two growth functions, namely Brody and Gompertz, were used in this study to describe the growth pattern for BW, HH and BL of Brakmas cattle. These two growth curve models are described by Gbangboche *et al.* (2011) as below:

$$\text{Brody model: } Y=Ai(1-B_ie^{-k_it})$$

$$\text{Gompertz model: } Y=Ae^{-Be^{-kt}}$$

Where Wt is the observed measurement of size (BW, HH, BL) at age t (month), A is the asymptote for measure of size, B is the constant of integration and k is maturing rate per day. The A parameter is the asymptotic limit for the size measurement and did not indicate the estimation of the largest size that can be reached by the animals, while the constant of integration B has no biological interpretation. The maturing rate was the growth rate after birth relative to the mature size. The SAS package PROC NLIN (SAS 9.3, 2011) was utilized to estimate the growth parameters of the two growth curve models and PROC CORR to estimate the relationship between body size measurements.

RESULTS AND DISCUSSION

Growth models: Gompertz growth curve model gave a higher goodness of fit for the three measurements of sizes: BW, HH and BL compared to Brody as shown in Table 1. The R^2 values for Gompertz vs Brody for BW, HH and BL were 95.88 and 87.64%, 99.61 and 81.69%, 99.24 and 79.53%, respectively.

Table 1: The growth parameters and coefficient of determination (R^2) for the brody and Gompertz models fitted to body weight (BW), body length (BL) and hip height (HH) for Brakmas cows

	Growth model	
Measure of size	Brody	Gompertz
BW		
A (kg)	495.1±54.632	372.5±14.332
B	0.91±0.008	1.99±0.058
K	0.02±0.004	0.05±0.004
R^2 (%)	87.640	95.880
HH		
A (cm)	127.50±1.374	126.90±1.269
B	0.37±0.008	0.44±0.012
K	0.06±0.005	0.07±0.005
R^2 (%)	81.690	99.610
BL		
A (cm)	139.80±3.188	137.30±2.559
B	0.46±0.011	0.59±0.018
K	0.04±0.050	0.05±0.005
R^2 (%)	79.530	99.240

A: Asymptotic measure of size (mature size); B: Constant of integration; k: Rate of maturing R^2

The estimated mature weight of Brakmas cows as derived from Brody model was higher than Gompertz model. The rate of maturing was higher in Gompertz model, indicating that this model estimates lower mature weight and attain the mature weight earlier compared to Brody model. Brody growth curve model also showed higher value of mature size for body length and hip height. As derived by Brody model, the estimated mature sizes of hip height were higher compared to Gompertz, i.e., 127.5±1.374 and 126.9±1.269 cm, respectively. The Brody growth model estimates longer body length at maturity compared to Gompertz model by 1.79%. In particular, the Brody model estimated length of body at maturity was 139.8±3.188 cm while the estimated body length at maturity by Gompertz was 137.3±2.559 cm.

Parameter k indicates the animal's growth rate to reach asymptotic size measurements. Animals with higher estimates of the parameters k will reach mature size faster than animals with low k value (Lopes *et al.*, 2012). The negative genetic correlation between A and k indicates that the animal that attain the mature size earlier have a small body size compared to the animals with low rate of maturing as shown in Table 2. The negative genetic correlations between the A and k parameters indicated that cows with lighter mature weights reached that weight at younger ages (DeNise and Brinks, 1985). The relationship between mature size measurements and rate of maturing was found to be negative in Brakmas cows, indicating cows with low rate of maturing will have higher mature size measurements. This negative correlation was also found in Jamnapari and Boer goats (Ariff *et al.*, 2010), Santa Inês sheep (Da Silva *et al.*, 2012) and Holstein cattle (Kratochvilova *et al.*, 2002). However, positive correlation between A and k was found in Morkaraman and Awassi

Table 2: The correlation coefficients between the mature size (A) and rate of maturing (k) derived from the brody and Gompertz growth models

Measure of size	Brody	Gompertz
Body weight	-0.99	-0.89
Hip height	-0.80	-0.75
Body length	-0.90	-0.85

Table 3: The correlation coefficient between body weight, hip height and body length of Brakmas cows

Measure of size	Body weight	Hip height	Body length
Body weight	1.00		
Hip height	0.92	1.00	
Body length	0.95	0.94	1.00

sheep (Topal *et al*., 2004). Negative correlation also found in both Brody and Gompertz models between mature size and rate of maturing for hip height and body length.

Correlation between body size measurements: Table 3 indicates that BW was highly associated with body length while BW and hip height showed the lowest relationship as shown by correlation coefficients value. It is in agreement with Brown *et al*. (1974) where cattle with longer bodies were associated with heavier body weight.

Although the correlation between HH and BW is the lowest, it is still a reliable combination in farm animal evaluation as the ratio of BW to hip height has been an indicator of Body Condition Score (BCS) in cows (Klosterman *et al*., 1968). Body size measurements can be used to develop equation to predict body weight (Yan *et al*., 2009).

CONCLUSION

Comparing the two models, Gompertz model seemed to be the most suitable growth function to describe the growth pattern of the three body measurements in Brakmas cattle as shown by its higher R^2 value. It revealed that rate of maturing was negatively correlated with mature size as derived by Brody and Gompertz models in Brakmas cattle indicating that Brakmas cattle will attain the mature weight at later age. The study also revealed high correlation between body length and body weight where this association will be a useful tool to select the animals for herd improvement program.

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