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Growth Pattern for Body Weight, Height at Withers and Body Length of Kalahari Red Goats

[1,2]R.M. Hifzan, [1]Ismail Idris and [1]H. Yaakub
[1]Department of Animal Science, Faculty of Agriculture, Universiti Putra Malaysia, Serdang, Selangor, Malaysia
[2]Animal Science Research Centre, MARDI, Serdang, Selangor, Malaysia

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Corresponding Author:
Ismail Idris
Department of Animal Science,
Faculty of Agriculture, University Putra Malaysia, Serdang, Selangor, Malaysia

ABSTRACT
The objective of this research was to examine the growth pattern for body weight, body length and height at withers of Kalahari Red goats using non-linear models. The body size measurement data were collected from 227 Kalahari Red female goats and fit into Gompertz and Brody growth model. The results revealed that Gompertz growth model had the best goodness of fit to describe the growth of Kalahari Red goats for body weight, body length and height at withers as shown by higher coefficient of determination (97.9, 98.9 and 99.1, respectively). The correlation coefficients between A and k for body weight, body length and height at withers were negative in both models, implying that goats of larger mature size tended to have a slower growth rate in relation to their mature size. Height at withers-body weight has the highest correlation coefficient (0.96).

Key words: Goats, Kalahari Red, growth models, mature size

INTRODUCTION

The Malaysian goat population in 2007 was 428,263 heads and increased slightly to 523,800 heads in 2011 and only meet 11.28% self sufficiency level for goats in Malaysia (DVS., 2012). There are many efforts taken by the government to achieve 25% self-sufficiency in 2015 level of chevon production, such as importing new breeds to increase the numbers and quality of goats in Malaysia. The goat population in Malaysia comprises mainly of the indigenous goat namely Katjang and its crosses. Local Katjang goats are well adapted to hot and humid climate of Malaysia, but low in average daily gain and growth rates. The average of daily weight gain is 55 g/day with mature weight of 25 kg (males) and 20 kg (females) (Ernie Muneerah *et al*., 2010). The height at withers is about 50-60 cm and the average birth weight is about 1.5 kg. To initiate the establishment of a sustainable meat goat industry, a number of farms have imported several meat goat breeds from South Africa and Australia and one of the breed is Kalahari Red goats.

The Kalahari Red goats were developed for meat production in South Africa and have been brought into Malaysia in 2009 by Malaysian Agricultural Research and Development Institute (MARDI) for evaluation purpose. This breed has been observed to acclimatize well to the Malaysian environment characterized by the temperature range of 26-32°C, relative humidity of 80-90% and an average total annual rainfall of 2500 mm. The imported Kalahari Red goats were purebred and high grade stock, possessing common features of predominantly red hair color. The Kalahari Red goats mature weight was smaller than Boer goats and well known for its good foraging and mothering abilities (Kotze *et al*., 2004). Kalahari Red goats are also easy to handle and can give maximum profit to the farmers (Ramsay *et al*., 2001).

The growth is explained by Brody, Gompertz, Logistic, Richard's and von Bertalanffy growth models, each of which is defined as a non-linear growth model (Gaddour *et al*., 2012). These non-linear models are more suitable to describe animal growth because the growth has a sigmoid curve form (Waheed *et al*., 2011). Usually the non-linear growth models used to describe relationships between lifetime weight and age allows us to determine managerial problems and ideal slaughtering age in goats. The growth curve was varied depends on model and breed (Akbas *et al*., 1999).

Although, there were many studies conducted on growth models for different goat breeds, there was no published information on growth model for Kalahari Red goats. The objective of this study was to determine the growth pattern of three measures of size: body weight, body length and height at withers of Kalahari Red goats under semi-intensive production system using Brody and Gompertz growth models.

MATERIALS AND METHODS

Data from 227 Kalahari Red female goats at the Malaysian Agricultural Research and Development Institute (MARDI) Research Station, Kluang, Johore, Malaysia were used in this study. Animals were raised semi-intensively where they were allowed to graze on native and cultivated pastures (*Panicum maximum*) from the morning until early afternoon (0900 until 1500) and were fed with supplementary concentrate during the rest of the day in slatted raised floor-houses.

The data were collected from the records to determine the age at the time of parameters measured. The age of goats were categorized over 10 different groups (Table 1).

The cross-sectional data of body weight, body length and height at withers were collected from female Kalahari Red goats. Body weight was measured using an electronic weighing scale and recorded in kilogram (kg). Body length was measured as the horizontal distance from the point of the withers to the pin bone and height at withers was measured as the vertical distance from top of the withers to the ground. Body length and height at withers, taken using a measuring tape, were recorded in centimeters (cm). The animals were in average body condition score of 3 (The 5-point body condition score used: 1 being thin, lean, 3 being in moderate fat cover and 5 being in excess fat cover) when their weight and body measurement were taken (Ariff *et al*., 2010).

Two growth models namely Gompertz and Brody (Waheed *et al*., 2011) were used to fit to individual's records for body weight, body length and height at withers of the Kalahari Red goat datasets. The PROC NLIN (SAS 9.3, 2011) was utilized to estimate the growth parameters of the two growth curves as below:

Table 1: Number of female goats of Kalahari Red goat breed by age groups

Age group (months)	No.
Birth	37
01-3	28
04-9	31
10-15	19
16-21	17
22- 27	17
28-33	26
34-39	15
40-45	18
>45	19
Total	227

Brody model:

$$Wt = A_i\ (1\text{-}B_i e^{-k_i t})$$

Gompertz model:

$$Wt = Ae^{-Be^{-kt}}$$

where, Wt is the observed measure of size (body weight, body length or height at withers) at age t in months, A is the asymptote for measure of size, B is a constant of integration and k is the rate of maturing per day. The parameter A is the asymptotic limit for measure of size and it is not an estimate of the largest measure of size reached by an animal. The constant of integration, B, has no biological interpretation. Rate of maturing, k, is rate of growth after birth relative to mature measure of size.

The correlation coefficients between parameter measures (body weight, body length and height at withers) were obtained using PROC CORR of SAS 9.3 (2011) package.

RESULTS AND DISCUSSION

Based on R^2 values, Gompertz growth curve model gave a higher goodness of fit for the three measurements of size namely body weight, body length and height at withers compared to Brody model as shown in Table 2. The R^2 values for Gompertz vs Brody model for body weight, body length and height at withers were 97.9, 98.9 and 99.1, 97.7, 68.4 and 71.6%, respectively. Malhado *et al.* (2009), Karakus *et al.* (2008) and Topal *et al.* (2004) reported an almost similar R^2 value found in their study on sheep for Gompertz model ranging from 97.8-99.7% while Tsukahara *et al.* (2008) found a slightly lower R^2 value (93.7%) for the same model. In Brody model, Karakus *et al.* (2008) and Topal *et al.* (2004) reported a higher value of R^2 (98.9 and 99.1%) for body weight compared to Kalahari Red body weight (97.7%).

Table 2: Growth parameters and coefficient of determination for Brody and Gompertz models fitted to body weight, body length and height at withers for Kalahari Red goats

Parameters	Brody	Gompertz
Body weight (kg)		
A	52.90±1.048	48.90±0.706
B	0.89±0.008	1.84±0.044
k	0.08±0.005	0.15±0.007
R^2	97.7	97.9
Height at withers (cm)		
A	66.20±0.879	65.30±0.749
B	0.53±0.022	0.73±0.042
k	0.57±0.058	0.74±0.071
R^2	71.6	99.1
Body length (cm)		
A	75.70±2.244	73.70±2.164
B	0.41±0.016	0.51±0.026
k	0.57±0.009	0.64±0.009
R^2	68.4	98.9

A: Asymptotic measure of size (mature size), B: Constant of integration, k: Rate of maturing, R^2: Co-efficient of determination

For all size measurements, the values of mature size (A) derived from Brody model was larger than Gompertz model. The estimated mature weight of Kalahari Red goats derived from Brody model was higher than Gompertz model (52.9 vs. 48.9 kg). The Brody growth model estimated a heavier body weight at maturity compared to Gompertz model by 7.56%. The A values gave the better chances to make a direct comparison among models (Brown *et al*., 1976). But, the Brody model tended to overestimate mature size and this became one of its disadvantages (Lopez de Torre *et al*., 1992; Malhado *et al*., 2009; Ozdemir and Dellal, 2009; Tatar *et al*., 2009; Waheed *et al*., 2011). Meanwhile, the Gompertz model estimated height at withers at maturity for Kalahari Red does was 65.3±0.749, while the estimated height at withers at maturity by Brody model was 66.2±0.879.

The rate of maturing (k) shows the animals' growth rate to reach asymptotic size measurement. In all parameters measured, the k value was lower in Brody model than Gompertz model, thus Brody model estimates higher mature size and attain the mature size later compared to Gompertz model. Waheed *et al*. (2011) also found the greater value of k in Gompertz model. Animals with lower value of k will reach mature size later than animals with high k value (Lopes *et al*., 2012).

This study revealed that negative correlation existed between estimated mature weight (A) and estimated rate of maturing (k) of Kalahari Red goats, ranging from -0.5077 to -0.6341 by Gompertz model and -0.5754 to -0.8345 by Brody model (Table 3). Negative correlation also found in both model between mature size and rate of maturing for body length and height at withers. The negative correlation between A and k indicates that goats with smaller mature size have faster rate of maturing compared to animal with high maturing rate. This negative correlation also found in Santa Ines sheep (Da Silva *et al*., 2012), Dorper crossbred sheep (Malhado *et al.*, 2009), Katjang and its crosses (Tsukahara *et al.*, 2008), Boer and Jamnapari goats (Ariff *et al.*, 2010) and Brakmas cattle (Hafiz *et al*., 2014).

Correlation coefficients among body weight, body length and height at withers for Kalahari Red female goats were positive as shown in Table 4. Hassen *et al.* (2012) found that Ethiopian indigenous goats also have a positive relationship among measure of size (body weight, heart girth and body length). Kalahari Red goat body weight was highly correlated to height at withers compared to body length (0.96 vs. 0.92). It is in agreement with research on Uganda native breed goats where they have a higher association of height at withers with body weight as found by Jimmy *et al.* (2010). However, Brown *et al*. (1976) reported that bulls have highest association between body weight and body length.

Table 3: Correlation coefficients between mature size and rate of maturing derived from Gompertz and Brody growth models

Parameters	Brody	Gompertz
Body weight	-0.83	-0.63
Body length	-0.60	-0.50
Height at wither	-0.57	-0.57

Table 4: Correlation coefficients between body weights, height at wither and body length in Kalahari red goats

Parameters	Body weight	Height at wither	Body length
Body weight	1.00		
Height at wither	0.96	1.00	
Body length	0.92	0.88	1.00

CONCLUSION

The Gompertz model provided a better goodness of fit to three body measurement (body weight, body length and height at withers) in Kalahari Red goats as shown by its higher R^2 value while the Brody model tended to over-estimate the mature size. Negative correlation also existed between mature size and rate of maturing derived by Gompertz and Brody models indicating that Kalahari Red goats will attain the mature size at later age. The results on correlation coefficient showed high relationship between body weight and height at withers where using this association may be an effective tool to get an ideal growth curve for selection of Kalahari Red goats.

REFERENCES

Akbas, Y., T. Taskin and E. Demiroren, 1999. Comparison of several models to fit the growth curves of Kivircik and Daglic male lambs. Turk. J. Vet. Anim. Sci., 23: 537-544.

Ariff, O.M., R.M. Hifzan, A.B.M. Zuki, A.J. Jiken and S.M. Lehan, 2010. Maturing pattern for body weight, body length and height at withers of Jamnapari and Boer goats. Pertanika J. Trop. Agric. Sci., 33: 269-276.

Brown, J.E., H.A. Fitzhugh and T.C. Cartwright, 1976. A comparison of nonlinear models for describing weight-age relationships in cattle. J. Anim. Sci., 42: 810-818.

DVS., 2012. Malaysia: Livestock products self-sufficiency rate, (%) 2003-2012. Department of Veterinary Services, Putrajaya, Malaysia. http://www.dvs.gov.my/documents/10157/77c2c28b-1263-4118-b3ed-90581731f668.

Da Silva, L.S.A., A.B. Fraga, F. de Lima da Silva, P.M.G. Beelen, R.M. de Oliveira Silva, H. Tonhati and C. da Costa Barros, 2012. Growth curve in Santa Ines sheep. Small Rumin. Res., 105: 182-185.

Ernie Muneerah, M.A., S.I. Salleh, A.K. Raymond, I. Zawawi and A.R. Hafiz *et al*., 2010. Development of Katjang goat conservation centre. Proceeding of the 2nd National Conference on Agrobiodiversity Conservation and Sustainable Utilization, May 11-13, 2010, Tawau, Sabah, pp: 167-169.

Gaddour, A., M. Ouni and S. Najari, 2012. Growth curve estimation in pure goat breeds and crosses of first and second generation in Tunisian oases. J. Cell Anim. Biol., 6: 99-103.

Hafiz, A.W.M., I. Idris and H. Yaakub, 2014. Growth pattern for body weight, hip height and body length of Brakmas cattle. Pak. J. Biol. Sci., 17: 952-955.

Hassen, H., M. Baum, B. Rischkowsky and M. Tibbo, 2012. Phenotypic characterization of Ethiopian indigenous goat populations. Afr. J. Biotechnol., 11: 13838-13846.

Jimmy, S., M. David, K.R. Donald and M. Dennis, 2010. Variability in body morphometric measurements and their application in predicting live body weight of Mubende and Small East African goat breeds in Uganda. Middle-East J. Sci. Res., 5: 98-105.

Karakus, K., E. Eyduran, D. Kum, T. Ozdemir and F. Cengiz, 2008. Determination of the best growth curve and measurement interval in Norduz male lambs. J. Anim. Vet. Adv., 7: 1464-1466.

Kotze, A., H. Swart, J.P. Grobler and A. Nemaangani, 2004. A genetic profile of the Kalahari Red goat breed from Southern Africa. S. Afr. J. Anim. Sci., 34: 10-12.

Lopes, F.B., M.C. da Silva, E.G. Marques and C.M. McManus, 2012. Analysis of longitudinal data of beef cattle raised on pasture from northern Brazil using nonlinear models. Trop. Anim. Health Prod., 44: 1945-1951.

Lopez de Torre, G., J.J. Candotti, A. Reverter, M.M. Bellido, P. Vasco, L.J. Garcia and J.S. Brinks, 1992. Effects of growth curve parameters on cow efficiency. J. Anim. Sci., 70: 2668-2672.

Malhado, C.H.M., P.L.S. Carneiro, P.R.A.M. Affonso, A.A.O. Souza and J.L.R. Sarmento, 2009. Growth curves in Dorper sheep crossed with the local Brazilian breeds, Morada Nova, Rabo Largo and Santa Ines. Small Rumin. Res., 84: 16-21.

Ozdemir, H. and G. Dellal, 2009. Determination of growth curves in young Angora goats. Tarim Bilimleri Gergisi, 15: 358-362.

Ramsay, K., L. Harris and A. Kotze, 2001. Landrace Breeds: South Africa's Indigenous and Locally Developed Farm Animals. Farm Animal Conservation Trust, South Africa, ISBN: 9780620254939, Pages: 112.

SAS 9.3, 2011. SAS/STAT User's Guide. Version 6.12, SAS Inst., Cary, NC.

Tatar, A.M., N. Tekel, M. Ozkan, I. Baritci and G. Dellal, 2009. The determination of growth function in young hair goat. J. Anim. Vet. Adv., 8: 213-216.

Topal, M., M. Ozdemir, V. Aksakal, N. Yildiz and U. Dogru, 2004. Determination of the best nonlinear function in order to estimate growth in Morkaraman and Awassi lambs. Small Rumin. Res., 55: 229-232.

Tsukahara, Y., Y. Chomei, K. Oishi, A.K. Kahi, J.M. Panandam, T.K. Mukherjee and H. Hirooka, 2008. Analysis of growth patterns in purebred Kambing Katjang goat and its crosses with the German Fawn. Small Rumin. Res., 80: 8-15.

Waheed, A., M.S. Khan, S. Ali and M. Sarwar, 2011. Estimation of growth curve parameters in Beetal goats. Arch. Tierz, 54: 287-296.