Lactation and Function of Curve Parameters in Yankasa Sheep

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ABSTRACT : The accuracy of the gamma function to describe lactation curve of Yankasa ewes was investigated using milk production data obtained from 168 ewes with either complete or incomplete 84 day lactation records. Ewes were daily hand milked after over-night separation from lamb and thorough disinfection of the udder. The daily milk yield on the average was estimated from the weekly total yield. The effect of type of birth, parity, season of birth and lactation length on the components of lactation curve (a, b, c and s) were analysed by least-square procedures. All factors except parity significantly ($p<0.01$) influenced the curve parameters. The goodness of fit of the function did not differ between the two classes of varying duration of lactation; incomplete lactation however, showed a lower persistency and as expected lower level of production. Correlations (r_p) between lamb weight gain and milk yield using the weight records from lamb weighed at weekly intervals indicated a high and positive relationship in the early lactation that decreased in intensity as the lactation advanced. ***(Asian-Aust. J. Anim. Sci. 2002. Vol 15, No. 6 : 890-894)***

Key Words : Yankasa Ewes, Curve Parameters, Pre-, Post- and Peak Lactations

INTRODUCTION

Several mathematical equations of varying complexity have been used to describe the variation in milk yield data of both the tropical cattle (Abubakar and Buvanendran, 1981) and European cattle (Rao and Sundareesan, 1979). One of such function is the gamma function of Wood (1969) derived by regression;

$$Y_n = An^{b} e^{-cn}$$

where Y_n is the yield in the n^{th} week, A, b and c are curve parameters and e is the base of the natural logarithm. In this model, A describes the general level of production while b and c describes the parameter of pre- and post peak curvature respectively. The studies on lactation curves are useful in predicting milk production pattern in animals in order to decide on the optimum level of supplementation required for either maintenance or production performance. Moreover, selection of animals with the best production performance as parents for future generation could be improved.

Yankasa breed of sheep are meat sheep widely spread throughout most ecological zones of Nigeria. Its distribution extends from the sub-humid through the semi-arid zones (FDLPCS, 1991). It has an estimated population size of 22.1 million that constituted about 60 percent of the national sheep flock (Osinowo, 1992). Earlier study with Yankasa sheep by Ehoche et al. (1990) has indicated that milk yield accounted 40-50 per cent variation in weaning weight and pre-weaning average daily gain of lamb. However, there is no information available about the pattern of lactation curves in tropical sheep, particularly Yankasa sheep. This study was therefore undertaken to determine the adequacy of gamma function in describing the course of lactation in Yankasa ewes. Furthermore, the value of the model in evaluating some important factors of milk production was investigated.

MATERIALS AND METHODS

Animals and treatments

The data consisted of lactation records from 168 ewes with varying parities. These animals were purebred Yankasa sheep kept as part of the open nucleus breeding scheme of the National Animal Production Research Institute, Shika, located in the sub-humid, Northern Guinea Savanna Zone of Nigeria. This region receives a mean precipitation of 1,107 mm per annum, stretching over 120-170 days from late April to early September. Seasonal distribution of rainfall is approximately 0.1% in the late dry (January-March), 25.8% in early wet (April-June), 69.6% in late wet (July-September) and 4.5% in the early dry (October-December) season, respectively. In general, these animals are grazed on good quality forage in paddocks for 6-8 h daily and are given additional 0.3-3.5 kg/head/day of a 15-20% crude protein concentrate supplement depending on season.

Recording of the daily milk yield of the ewes commenced from about a week after lambing to the 14th week of lactation. On each collection day, lambs were separated from their dam over-night and milked 24 h later to obtain the day's milk yield. The dams were milked dry by hand milking after thorough disinfection of the udder. The

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milk collected per ewe was weighed and then fed to each corresponding lamb. The lambs were weighed on weekly basis and were left with their dams until weaning. All lambs were allowed free access to both grazing and concentrate supplement feeds given to their dams except on milking days. Details management of animal and milk extraction is as reported by Afolayan et al. (2001).

Statistical analysis

Mean daily yield of individual animal per week of lactation was computed from the weekly total yield. These data were fitted to Wood's gamma function after transforming it to the logarithm form given as:

$$\ln Y=\ln A+b\ln n-cn$$

The parameters ln A(a), b and c were estimated for each lactation by fitting multiple regressions on ln (Y) on ln (n) and n. The persistence of yield (s) was calculated according to Wood (1969) as:

$$s=-(b+c)\ln n$$

Higher values of s indicate higher persistence. The proportion of the variation in log weekly yield (R^2) accounted for by the gamma function was estimated for each lactation curve. Its root, which is the correlation coefficient (R), was transformed by Fisher's Z-transformation for least squares analysis.

Least-squares analysis according to Harvey (1990) was used to determine the effects type of birth, parity, season of birth and lactation length on the components of lactation (a, b, c and s). Type of birth classification was either single or twin. However, twin lambed ewes that suckled single (as a result of death of one) were assumed to be single mother. The lambing seasons were early wet (April-June) and late wet (July-September). Parity classification were five classes of 1st, 2nd, 3rd, 4th and >4th parity. Lactation lengths were classified into two classes, of below and equal to 84 days.

The statistical model used was $Y_{ijklm}=U+B_i+S_j+P_k+L_l+e_{ijklm}$

Where:

Y_{ijklm}=the observation on the m^{th} animal in the l^{th} lactation length class of the k^{th} parity in the j^{th} and i^{th} season and type of birth respectively.

U=the overall mean

B_i=the effect of the ith type of birth (i=1, 2)

S_j=the effect of the jth season of birth (j=1, 2)

P_k=the effect of the kth parity (k=1,......, 5)

L_l=the effect of the lth lactation length class (l=1, 2)

e_{ijklm}=random error

Consequent upon data adjustment for the effects due to environmental factors, phenotypic correlations were computed between pre-weaning weight gains and milk yield using the Pearson correlation module while test of significance at 5% was carried out using Bonferroni probabilities in accordance with the procedures of Wilkinson (1988) using SYSTAT.

RESULTS

The results of the least square analysis of variance and means are shown in tables 1 and 2. The rate of rise to peak production (a) and rate of decline from peak production (b) were significantly influenced by all factors under consideration except parity. However, the general level of production (a) and persistency (s) were significantly influenced only by season and lactation length. The mean correlation coefficient (R) between lactation curve functions and actual yields after transformation was 0.78 (table 2). Considerable variations on season and lactation length were observed for the R values.

Figure 1 indicates an increased daily milk yield post-partum to reach a peak in the second to third week of lactation followed by a gradual decline to the end of lactation. The pattern of the lactation curve was similar for ewes with single and twin lambs. The parameters of equation obtained for lactation curve when gamma function was fitted after regression on adjusted total lactation data (168 ewes) was:

$$Y_n=270.697\ n^{0.697}\ e^{-0.298n}\ (R^2=0.71;\ p<0.001)$$

with total yield estimates of 13.44 kg and corresponding

Table 1. Least-square analysis of variance for the functions of the lactation curve

Source of variance	DF	a	b	c	s
Type of birth	1	0.25	0.14*	0.06*	2.05
Parity	4	0.02	0.08	0.01	0.69
Lambing season	1	1.08*	0.19**	0.05*	2.75*
Lactation length	1	1.27*	6.60**	1.06**	49.26**
Error	158	0.18	0.09	0.01	0.83

* p<0.05, ** p<0.01.

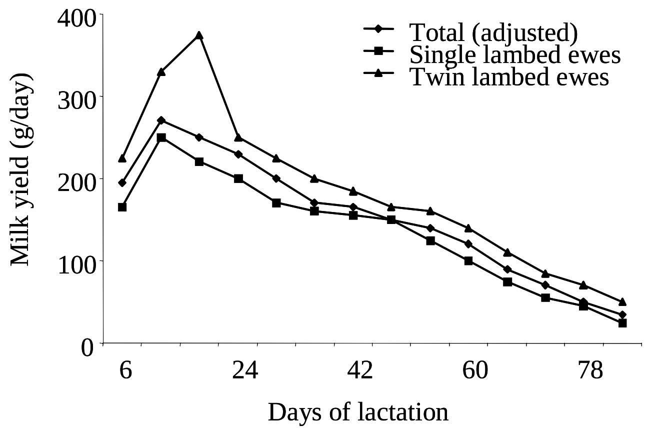

Figure 1. Lactation curve for Yankasa ewes.

Table 2. Least square means for the functions of the lactation curves (a, b and c), persistency (s) and the correlation coefficient (R) in Yankasa ewes

Classification	No.	a	b	c	d	R
Overall mean	168	5.51±0.06	0.38±0.06	0.27±0.02	-1.37±0.19	0.78±0.02
Type of birth						
Single	150	5.44±0.07	0.43^{y}±0.05	0.31^{y}±0.02	-1.57±0.16	0.79±0.01
Twin	18	5.58±0.13	0.32^{x}±0.09	0.24^{x}±0.03	-1.18±0.27	0.76±0.02
Parity						
1	59	5.53±0.09	0.34±0.06	0.26±0.02	-1.27±0.02	0.78±0.02
2	35	5.53±0.12	0.33±0.08	0.26±0.03	-1.23±0.25	0.79±0.02
3	21	5.53±0.53	0.48±0.08	0.31±0.03	-1.69±0.26	0.78±0.02
4	27	5.54±0.12	0.35±0.08	0.25±0.03	-1.26±0.26	0.78±0.02
>4	26	5.47±0.15	0.38±0.10	0.28±0.03	-1.39±0.31	0.77±0.02
Lambing season						
1(April-June)	58	5.55^{x}±0.08	0.49^{y}±0.06	0.32^{y}±0.02	-1.82^{x}±0.17	0.84^{y}±0.02
2(July-Sept.)	110	5.76^{y}±0.08	0.31^{x}±0.10	0.25^{x}±0.04	-1.15^{y}±0.31	0.75^{x}±0.03
Lact. length						
84 day	143	5.65^{y}±0.09	0.06^{x}±0.06	0.15^{x}±0.02	-0.52^{y}±0.20	0.78^{y}±0.02
<84 day	25	5.38^{x}±0.11	0.69^{y}±0.08	0.40^{y}±0.03	-2.22^{x}±0.23	0.77^{x}±0.02

Within each variable, means±S.E with the same superscript are not significantly different.

average daily yield of 149 g in 84 days lactation. The peak yield of 250 g/day was obtained between the 2nd and 3rd weeks of lactation.

The estimates of correlation (r_p) between weight gains of lambs to different ages and milk yield of dam at various stages of lactation were presented in table 3. The highest and highly significant ($p<0.01$) relationship of 0.31 was obtained between the 3rd stage of lactation and postpartum weight gain to 54 days.

DISCUSSION

The higher general production level (a) observed in dams with twin lambs compared with those with singles supported earlier reports (Karam et al., 1971; Doney et al., 1981). However, the non-significant difference obtained between these two dam groups for (a) may be explained by the assertion of other workers that, rather than number born, it is the number of lambs suckled by the dam that determines the milk yield (Doney and Munro, 1962; Peart, 1967; Corbelt, 1968). Linzell and Peaker (1971) also attributed no physiological relevance to the increased milk production from dams with twins but to the frequency of suckling. As in this study, Snowder and Glimp (1990) obtained higher rate of rise (b) to peak production and decline (c) from peak production with dams that produced single compared to those with twin lambs. On the contrary, ewes nursing twin rather than single lamb are reported to persist (s) more in production (Peart, 1967) as obtainable herein.

Table 3. Phenotypic correlations between weight gains of lamb and milk yield of dam at different stages of lactation

Stages of lactation	Weight gains			
	1	2	3	4
6-24 days	0.16	0.19	0.17	0.16
25-48 days	0.17	0.19	0.16	0.12
49-72 days	0.25	0.31**	0.28*	0.23
73-84 days	0.07	0.06	0.07	0.05
6-84 days	0.20	0.24	0.21	0.18

1-Lamb weight gain to 30 days.
2-Lamb weight gain to 54 days.
3-Lamb weight gain to 78 days.
4-Lamb weight gain to 90 days.
* p<0.05, ** p<0.01.

The significant seasonal variation on lactation functions (a, b, c and s) was in agreement with earlier findings (Martini et al., 1980; Scardella and Pilla, 1989). Scardella and Pilla (1989) reported that the month of lambing, which is a function of season of lambing, constituted among other environmental factors about 80% of variation in the milk yield of Comisana sheep. In this regard, the significant ($p<0.01$) higher values for the general production level (a) and persistency (s) observed in season 2 (July-September) compared to season 1 (April-June) might be due to the fact that the former coincides with the period of peak rain during which forage is abundance. Moreover, there is less heat load due to lower temperature and higher cloud cover during this season.

The function used in the present study gave as good a fit to shorter lactation (R=0.77) as well as lactation of longer duration (R=0.78) as shown in table 2. However, the former showed a faster rate of rise to peak yield (b) and a much quicker rate of decline from the peak (c) as compared to the latter. Moreover, the general level of production (a) and persistency (s) was also lower in shorter lactation. It would therefore imply that ewes with shorter lactation length might also suffer from a low level of production so that the net effect on yield would be a reduction due to the combination of these factors.

The peak yield observed within the 2nd and 3rd week of lactation herein compared with the findings of many authors (Peart et al., 1975; Aboul-Nagal et al., 1981; Ehoche et al., 1990). Aboul-Nagal et al. (1981) noticed that while the milk of barki ewes declined steadily after peaking at the 2nd week, the peak lactation of Rahamani and Ossimi ewes extended until the 3rd week of lactation. Ehoche and Buvanendran (1983) also observed the same pattern of lactation in Red Sokoto does, however there appeared to be a sharp drop after the second week for the goats.

In general, the values of pre-weaning milk yield obtained from Yankasa ewes in this study is quite low compared to other tropical breeds like Hamdani (Maroof et al., 1986); Karadi (Mohammed, 1982; Kuitaibani, 1981) and Awassi (Eliya and Juma, 1970; Karam et al., 1971). This might partly be due to differences in method of milk extraction by these authors. Why some authors used oxytocin injections prior to milking, others estimated milk yield using lamb weight differences before and after suckling. The use of hand milking herein without any prior stimulation might be inefficient for total evacuation of milk from the udder. Moreover, there was difficulty in extracting milk from Yankasa breed of sheep because of the small sized teat. The other reason attributed to the low milk yield was the shorter lactation lengths (84 days) used in this study compared to other breeds reported from the cited literatures.

The phenotypic correlation (r_p) between weight gains and milk yield obtained in this study clearly showed a particular trend. It could be observed that both early and late weight gain of lambs could not strictly be attributed to the milk yield of their dams. This was because, while the growth performance of the lamb in the early age depends on the confounded effects of both the dam's uterine condition and post-partum milk production, the weight gains later in life (after about 10 weeks of age) would mainly be accounted for by the quality and quantity of the available forage. The older age herein coincides with the period when the lamb decreasingly depends on milk while increasingly depends on forage intake. These therefore explained why low and non- significant r_p were obtained between lamb weight gains and dam milk yield at both stages of growth. The moderate and significant ($p<0.01$) r_p observed between weight gain to 54 days and milk yield at the 3rd stage of lactation might indicate the total dependency of lambs on milk at this stage.

In conclusion, gamma function adequately described the pattern of lactation in Yankasa ewes with reasonable R^2 value. Effects of some environmental factors on sheep lactation curve have been identified that warrant corrections in order to accurately define the curve. Ewes with incomplete lactation had a low persistency and a general low level of milk production and the net effect would be a reduced yield that may invariably affect lamb production. Few individuals among those ewes used in the present study had milk production of up to 1 litre per head per day that could guarantee the feasibility of systematic selection against reduced milk yield in Yankasa sheep flock.

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