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THE EFFECTS OF PARITY NUMBER, SEASON AND YEAR OF CALVING OF SUDANESE ZEBU CATTLE (BUTANA) ON THE LACTATION CURVE AND MILK YIELD

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ABSTRACT: *The present study was conducted to investigate the effects of parity number, season and year of calving of Sudanese Zebu cattle (Butana) on the lactation curve and milk yield. A Wood's model (1967) was adopted for the description of the curve, it is a gamma function utilized for regression of milk yield on time lapse post-partum. The regression equation is presented by [$Y_{(n)} = an^b e^{-cn}$]; where: $Y_{(n)}$ is the total milk yield for n^{th} week, a, is the initial milk yield and is considered as a factor which could influence the height of the curve across time but has no effect on the curve. b is the rate of increase of milk yield pre-peak and is considered as the linear constant that measures the average slope of the curve during the increase phase. c is the rate of decrease of milk post-peak, a linear constant that describes the rate of change of the slope of the curve during the decline phase and determines the slope of the curve during this phase. Records of 178 cows were taken from the fifth days of lactation till 30 weeks from the year 1994 – 2001. The records were grouped according to parity (till eight parities), season of calving (dry and wet summer and winter) and year of calving. The results revealed that effect of parity on initial milk yield, although significant, but variable. The peak week, persistency and rate of increase of milk pre-peak were the highest (P<0.01) in parity 1 compared to other parities. However, rate of decrease post-peak was not affected by parity number. Peak yield and total yield increased steadily from parity one to parity 6 then decreased. Calving weight increased significantly (P<0.01) from 1 to 8. Season of calving was shown to have a significant effect on initial milk yield, a, peak week and persistency where, a, was the highest (P<0.01) in wet summer than winter and dry summer and hence was increased to the maximum peak during wet summer with shorter persistency around the peak compared to dry summer and winter. Year of calving significantly affected the rate of decrease post-peak, c, peak yield, weekly and total milk yields. It was shown that cows that calved in year 1997 and 2000 had the lowest (P<0.01) rate of decrease in milk yield, weekly and total yields.*

Key words: *Butana, Parity Number, Season of Calving, Lactation Curve, Milk Yield*

ORIGINAL ARTICLE

INTRODUCTION

Sudan is a well-known country for its animal wealth. Cattle alone were estimated to amount to 132.5 million heads (MARF, 2002). Cattle have served and continue to serve as a valuable role in sustainable agricultural systems. Among cattle in Sudan, Kenana and Butana Zebu breeds proved to be relatively the highest milk producers. In the area of study (eastern Sudan), Butana makes an important social contribution in the area. A dairy farm was established in the mid of the seventies with the objective of improving Butana breed through a selective breeding programme.

The lactation curve is found to be affected by many factors; mainly parity number, season and year of calving. Furthermore, the various components that define the curve are also affected in various ways. Milk yield was found to rise to its maximum to about 5th calving (Vij et al., 1992), although other workers indicated small increases after the 3rd parity (Hammond et al., 1976). The rate of increase of milk pre- or rate of decrease pot-peak with advancement of parity was related to the efficiency of the use of body reserves in mature cows and heifers (O'Connor and Oltenacu, 1988). Season has an obvious effect on the lactation curve because each season is characterized by specific climatic factors such as, temperature, relative humidity, wind movement, solar radiation, light intensity (Peters et al., 1981) and light durations which significantly alters animal's physiological behavior (Phillips and

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Schofield, 1989). The main effects of these factors are the upsetting of the balance between heat production and heat loss causing either hyperthermia or hypothermia which in turn causes decrease in milk yield (Esmay, 1978). Also the effect of season of calving is exerted through the availability of good quality pasture and adequate energy intake (Emery, 1988). In addition of thermoregulatory demands (Madalena et al., 1979). However, supply of and energy intake rather than direct climate are found to affect peak yield and persistency (Yadav and Rathi, 1992). The effect of year of calving on the lactation curve is generally related to differences in nutrition, managerial practices and change in the genetic make-up over the years (Garcha and Tiwana, 1980).

MATERIALS AND METHODS

Anima housing

A dairy research station was established on an area of 5.88 ha in the River Nile Province (northern Sudan). The area lies within the latitude 17° 42' and longitude 33° 58' at 345 meters above sea level and characterized by semi-arid environment; maximum temperature 47.4°C during summer and minimum of 15°C during winter with rainfall between 70 – 100 mm and relative humidity 32.5%..

The animal housing was constructed to accommodate 80 animals. The ceiling was made from local insulated materials and corrugated galvanized metal sheets. An open yard of 15 X 20 m was used for animal exercise. Animals were grouped according to their physiological status (lactating, late pregnancy and dry cows). Cows used in this study were a pure Zebu type (Butana). The animal has a thin neck, light brisket shoulders, but broad hind quarters. Bones, dewlap and hump are small but udder is quite large with high rear attachment with teats about 2 inches. Color is solid red. Average body weight at 1 year is 140 kg (Madani, 1996) and average milk production 1389 kg in 267 days. (Gotbi, 1968) and average age at first calving is 44 months (Alim, 1962) with calving interval 416 – 485 days (Madani, 1996).

Husbandry practices

Cows were identified by names, dehorning of calves was done at two months of age. Hoof trimming was done when required, usually during autumn, culling was done according to productivity or age. The herd was allowed to graze freely in an open area of 3.78 ha that belonged to the research station and which is cultivated with different fodders according to season. The grazing hours are extended to five hours in the afternoon. For the milking cows cut fodders are given at a rate of 2.3 kg for each 100 kg body weight and a concentrate mixture (Table 1) to each cow; 2 kg in the morning and 2 kg in the evening during hand milking time. The present study utilized records of 178 cows for 8 years (1994 - 2001). The data focused on lactation curves of these cows up to 30 weeks following five days of calving as well as body weights.

Table 1 - Ingredients and proximate analysis of concentrate mixer fed to Butana cows in the research station

Ingredients	%
Cotton Seed Cake	34.5
Wheat Bran	34.5
Sorghum Grain	30.0
Salt	01.0
Total	100
Chemical Composition (On Dry Matter Basis)	
Moisture	04.0
Ether Extract	05.0
Crude Protein	22.9
Crude Fiber	14.0
Nitrogen Free Extract	47.7
Ash	0.60
Total	100

RESULTS

Effect of parity

Effect of parity on the different components that defined the lactation curve is shown in Table 2. Significant (P<0.01) increases in initial milk yield, a, weekly and total yields started from parity 2 and nearly maintained afterwards up to the 8th parity. While significant (P<0.01) decreases in the rate of increase pre-peak ,b, peak week (n-max) and persistency were observed from parity 2 which was maintained up to parity 8. Calving weight increase significantly (P<0.01) and progressively from parity 1 to 8, whereas the rate of decrease post-peak, c, was not affected by parity.

Effect of season

Data were pooled to investigate the effect of season irrespective of parity. As shown in Table 3, and n-max were significantly (P<0.01) higher in wet summer than both dry summer and winter, whereas persistency was the lowest (P<0.01) in wet summer compared to dry summer only.

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Table 2 - Effect of parity number (means ±SE) on different variables of the lactation curve of Butana cows

Parities \ Variable	No. cows	a1 Kg	b2 Kg/week	c3 Kg/week	Peak week (n-max)	Peak yield (Kg)	persistency	Weekly yield (Kg/week)	Total yield (Kg/week)	Calving weight (Kg)
1	23	15.38±9.3^{C}	0.63 ±0.4^{A}	0.06 ±0.03	10.5 ±4.5^{A}	33.5 ±10.3^{D}	4.71 ±0.6^{A}	26.5 ±7.7^{C}	795.1±230^{C}	52.3 ±8.4^{H}
2	24	24.71±12.4^{B}	0.41±0.3^{B}	0.06±0.03	7.66±3.8^{B}	36.13±14.1^{CD}	4.25±0.5^{B}	28.32±11.3^{BC}	849.59±338^{BC}	66.54±9.9^{G}
3	21	30.36±12.1^{AB}	0.37±0.2^{B}	0.05±0.03	6.66±3.4^{B}	41.83±12.6B^{C}	4.13±0.6^{B}	32.83±11.1^{AB}	984.8±333^{AB}	84..75±14.9^{F}
4	19	29.44±10.1^{AB}	0.38±0.2^{B}	0.05±0.03	7.46±3.4^{B}	41.46±7.4B^{C}	4.11±0.5^{B}	32.62±7.0^{AB}	978.48±211^{AB}	94.61±13.8^{E}
5	26	35.38±15.3^{A}	0.38±0.2^{B}	0.06±0.02	6.08±2.8^{B}	48.56±14.6^{AB}	3.97±0.4^{B}	37.13±12.0^{A}	1113.96±360^{A}	103.6±11.0^{D}
6	25	32.21±10.4^{AB}	0.47±0.2^{B}	0.07±0.04	7.08±4.3^{B}	50.27±9.9^{A}	4.04±0.5^{B}	37.09±8.0^{A}	1112.66±240^{A}	116.08±12.4^{C}
7	20	37.35±17.5^{A}	0.34±0.3^{B}	0.05±0.04	6.67±3.0^{B}	48.20±15.1^{AB}	4.05±0.6^{B}	36.83±9.5^{A}	1104±285^{A}	123.59 ±12.5^{B}
8	18	32.16±11.7^{AB}	0.43±0.3^{B}	0.06±0.03	7.16±2.9^{B}	47.64±11.9AB	4.14±0.6B	36.01±10.3^{A}	1080.23±264^{A}	135.81 ±12.1^{A}

^{ABCDEFGH}Values within the same column bearing different superscripts vary significantly at P < 0.01. a1: initial milk yield, b2: average slope of the curve during the increase phase pre-peak, c3: average slope of the curve during the decrease phase post-peak.

Table 3 - Effect of season of calving (means ±SE) on different variables of the lactation curve of Butana cows

Season of calving \ Variable	No. cows	a1 Kg	b2 Kg/week	c3 Kg/week	Peak week (n-max)	Peak yield (Kg)	persistency	Weekly yield (Kg/week)	Total yield (Kg/week)	Calving weight (Kg)
Wet summer	40	35.19±13.9^{A}	0.43±0.3	0.07±0.04	6.20±2.8^{b}	47.66±12.1	3.83±0.5^{B}	33.70±8.8	1011.04±263	103.02±25.5
Dry summer	60	26.86±13.6^{B}	0.16±0.3	0.06±0.03	8.30±4.2 ^{a}	41.83±13.4	4.30±0.6^{A}	33.03±10.6	990.95±318	92.03±27.9
winter	76	28.63±14.1^{B}	0.41±0.3	0.05±0.02	7.60±3.6 ^{a}	42.44±13.9	4.25±0.5^{AB}	33.50±10.9	1004.85±326	95.35±31.1

^{ABCDEFGH}Values within the same column bearing different superscripts vary significantly at P < 0.01. a1: initial milk yield, b2: average slope of the curve during the increase phase pre-peak, c3: average slope of the curve during the decrease phase post-peak.

Table 4 - Effect of year of calving (means ±SE) for 8 years (1994 – 2002) on different variables of the lactation curves of Butana cows

Year of calving \ Variable	No. cows	a1 Kg	b2 Kg/week	c3 Kg/week	Peak week (n-max)	Peak yield (Kg)	persistency	Weekly yield (Kg/week)	Total yield (Kg/week)	Calving weight (Kg)
1994	35	32.89±14.1	0.44 ±0.2	0.06 ±0.03^{A}	7.79±3.7	49.22±14.7^{a}	4.17 ±0.5	37.84±11.5^{A}	1135.0±345^{A}	95.0±27.2
1995	23	32.98±13.9	0.47±0.3	0.07±0.04^{A}	6.48±2.4	47.48±12.4^{a}	3.92±0.5	34.40±8.9^{A}	1032.0±369^{A}	107.6±24.4
1996	30	27.8±12.6	0.44±0.3	0.06±0.02^{A}	7.20±3.7	41.42±11.3^{a}	4.12±0.6	31.50±8.4^{A}	945±251^{A}	97.3±30.4
1997	19	25.65±15.6	0.40±0.3	0.05±0.02^{BC}	8.06±3.2	37.71±13.6^{a}	4.42±0.5	31.15±11.7^{A}	934±350^{A}	91.9±27.7
1998	24	28.99±11.9	0.47±0.4	0.06±0.04^{AB}	8.00±2.9	44.24±8.9^{a}	4.30±0.6	35.20±7.6^{A}	1055.8±228^{A}	95.5±31.1
1999	26	30.72±15.4	0.43±0.3	0.06±0.02^{AB}	6.70±4.0	44.98±12.9^{a}	4.05±0.6	33.38±10.2^{A}	1001±305^{A}	93.9±33.2
2001	16	24.12±14.1	0.29±0.2	0.04±0.03^{C}	7.94±6.2	30.72±11.3^{b}	4.41±0.7	26.26±11.5^{B}	787.8±285^{B}	92.5±27.2
2002	05	25.53±16.0	0.52±0.03	0.06±0.02^{AB}	7.78±3.4	40.33±8.9^{ab}	4.24±0.6	31.66±8.3^{AB}	945.7±254^{AB}	78.7±26.2

^{ABCDEFGH}Values within the same column bearing different superscripts vary significantly at P < 0.01; lower case letters at P <0.05. a1: initial milk yield, b2: average slope of the curve during the increase phase pre-peak, c3: average slope of the curve during the decrease phase post-peak.

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Effect of year of calving

Milk yield (weekly and total yields) and rate of decrease of milk post-calving, c, were the only parameters affected by year of calving (Table 4). Weekly and total yields were the lowest (P<0.01) in year 2000, although significant differences could not are detected between years 2000 and 2001. Also, c, was the lowest (P<0.01) in year 2000, although significant differences could not be detected between years 2000 and 1997.

DISCUSSION

Effect of parity

The gradual increase in initial milk yield with advancement in parity could be related to more alveolar cells added to each successive lactation (Jakopovic, 1993; Dhangar et al., 1991). The initial milk yield obtained by Sudanese Butana Zebu breed under the current study was lower than that obtained by Holstein-Frisian (Madalena et al., 1976). The highest yield were observed in parities 5 and 7 with productions comparable to those obtained by Vij et al (1992) but different from those obtained by Kellogg et al. (1977). The present study showed that higher rates of increase of milk yield pre-peak ,b, with first parity, whereas other studies showed little or no effect of parity on ,b,values (Ahuno and Kabuga, 1994; Mehto et al., 1980). In lines with some studies rate of decrease of milk production post-peak, c, was not affected with parity (Jakopric, 1993).

Time spent to attain peak week (n-max) was the longest with the first parity. This was inconsistent with other studies (Biradar, 1990). Peak yield was observed to increase with advancement of parity, the highest value was observed in parity 6. Similar observations were obtained in Frisian X Sahiwal (Romachandraiah et al., 1990). Persistency around the peak was the longest with the first parity with gradual decreases towards advancement of parity. Similar trends were observed by other workers in European breeds and buffaloes (Garcha and Tiwana, 1980). However, longer persistency was obtained in the 3rd parity in both Holstein-Frisian (Mehto et al., 1980) and Frisian X White Fulani (Ibeauchi and Okoro, 1980).

The effect of parity on persistency could be due to the fact that, older animals which started lactation at higher levels had a rapid rate of decline, also the regression of alveolar cells increases with advancing age which means a decline in udder productivity.

In the present study, weekly and total milk yields increased with the increase in parity number. Similar results were obtained by other authors (De-Loss and Menedez, 1987). Milk production reached the highest yield with the 5th lactation then declined. Similar results were in Sudanese Kenana cows (El Amin, 1969) and in Frisian cows (Abdelgani and Fahmi, 1966).

The significant steady increase in cows' weights with advancement of parity was in line with the results obtained by Paul (1995). However, a decrease in body weight was observed in Holstein cows with the increase in parity number (Hooven et al., 1968), whereas no relationship was obtained between body weight and parity number in buffaloes (Swanson, 1967). Generally changes in body weights with different lactations are largely due to management programmes and are mostly environmentally determined.

Effect of season of calving

In this study, season of calving was shown to have a significant effect on the initial milk yield, where the wet summer calvers had the highest yield compared to dry summer and winter. Other studies had also observed higher milk yields during the rainy season in Holstein-Frisian X Gir (Madalena et al., 1979) which was related to the availability of good quality forage. n-max was also significantly affected by season where wet summer calvers took the shortest time to reach peak production. These results were in agreement with those obtained in Ghana (Ahunu and Kabuga, 1994) and in USA (Perera et al., 1986) with Holstein-Frisian. At other locations, winter calvers showed shorter durations to reach the peak as with Jersey and Frisian heifers in Germany (Romachandraiah et al., 1990). Persistency around the peak was also significantly influenced by season of calving; shorter persistency was depicted by the wet summer calvers. Weekly and total milk yields increased from summer to winter but no significant differences could be detected. Similar results were obtained by some workers (Udebibe et al., 1985). However, other could detect the significant effect of season (Singh and Gopal, 1982).

Effect of year of calving

In the current study, the rates of increase of milk pre-peak or rate of decrease post-peak were found to be significantly affected by the year of calving, where years 1998 and 2001 showed the highest rates in increase of milk, whereas years 1997 and 2000 showed the lowest rates of decrease. In line with this study, the significant increase in the rate of milk was obtained by some authors (Ahunu and Kabuga, 1994; Duraes et al., 1992) and rate of decrease (Duraes et al., 1992; Madalena et al., 1979). Other studies could not detect the significant effect of year on milk rates of production (Bhutia and Pandy, 1982).

In this study, initial milk yield, weekly and total yields as well as peak yields were significantly affected by the year of calving where years 1994, 1995 and 1999 showed the highest initial yields. Lowest values for weekly, total and peak yields were detected in the year 2000. Similar effects for the year of calving on initial milk yield was obtained by Duraes et al. (1992) and Madalena et al. (1979). Also for the weekly and total yields significant effects were obtained by Queiroz et al. (1987). According to Garcha and Tiwana (1980), the significant effect of year of calving could be related to differences in nutrition and management practices as well as changes in the genetic constitution of the herd.

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