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Effect of parity on milk yield in lactating dairy cows

Donald Mandani Chisowa *

School of Agriculture, Department of Animal Science, Southern University, P. O Box 60293, Livingstone, Zambia.

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Abstract

This study evaluated the effect of parity on milk yield among dairy cows fed maize stover improved using legume stover (LS) and feed grade urea fertilizer (UET). The main objective was to assess the effect of parity number on milk yield among dairy cows. The study was carried out at the Livestock Development Trust Centre (LDTC) of the Golden Valley Agricultural Research Trust near Batoka in Southern Province of Zambia. Three feeding trials involving twelve (12) lactating dairy cows were conducted to assess the effect of parity on Daily Milk Yield (DMY). Feed supplements were offered to cows in form of chopped MS supplemented with chopped groundnut stover (cGS), chopped soybean stover (cSS), mineralized groundnut solution (mGS) and mineralized soybean solution (mSS). The mean daily DMYs for the 1st, 2nd and 3rd parities were (5.06ltrs ±2.33, 8.00 ltrs±3.23 and 6.89ltrs±4.00 respectively). These means differed significantly ($p<0.05$). Results of the current study have indicated that milk yield is influenced by parity with cows in 2nd parity showing the highest milk yield of first three parities.

Key words: Parity; Milk yield; Lactating; Dairy Cows

1. Introduction

Msangi et al [1] observed that only body condition score (BCS) at calving contributed to variation in volume of milk sucked by the calf, lactation length and lactation milk yield. BCS at 3 months after calving was improved on farms where labour was hired ($p = 0.041$) and BCS change from calving to 6 months was more than twice as likely to be negative on U than SU and PU farms. It was concluded that milk production was predominantly associated with BCS at calving, lactation milk yield increasing quadratically from score 1 to 3. BCS at calving may provide a simple, single indicator of the nutritional status of a cow population.

It is believed that there is a slight additional growth of secreting cells of dairy cattle during each pregnancy until cows reach about 7 years of age. This is manifested by- the increase in yearly milk (Shanker) [2]. A study by Sandrucci et al [3] that most flow characteristics were influenced by lactation number, days in milk, and peak flow but also strongly affected by pre-milking operations.

The amount of milk produced by the cow increases with advancing lactations (age). This is due to an increase in body weight, which results in a larger digestive system and a larger mammary gland for the secretion of milk. Another reason for increased milk production with age is due to the effects of recurring pregnancies and lactations. Recurring pregnancies and lactation can result in increases of 30% in milk production from the first to the fifth lactation. Increase in milk production 80% by recurring pregnancy and lactations. 20% due to increased body weight Milk production increases with lactation number and is maximized in the fourth or the fifth lactation. This is a result of the increasing development and size of the udder and the increasing body size over that of the first lactation animal. The expected mature yield (mature equivalent) of a primiparous cow calving at two years of age can be estimated by

* Corresponding author: Donald Mudenda Chisowaa

multiplying yield of first lactation by 1.3. First lactation = 1300 kg Fourth/ fifth lactation = 1300 X 1.3 = 1690 kg (Singh) [4].

A significant effect of the Calving Interval (CInt) was noted on all 5 measurements of milk yield, and this effect interacted with parity for ECM per feeding day, Energy Correlated Milk (ECM) per lactating day and ECM per day during late lactation. The results showed that cows were at least able to produce equivalent ECM per feeding day with increasing CInt, and that first- and second-parity cows maintained ECM per lactating day. Cows with a CInt between 17 and 19 mo produced 476 kg of ECM more during the first 305 d compared with cows with a CInt of less than 13 mo. Furthermore, early-lactation ECM yield was greater for all cows and late-lactation ECM yield was less for second-parity and older cows when undergoing an extended compared with a shorter lactation. Increasing CInt increased the dry period length with 3 to 5d. In conclusion, the group of cows with longer CInt were able to produce at least equivalent amounts of ECM per feeding day when the CInt was up to 17 to 19 months on these 4 commercial dairy farms (Lehmann et al) [5].

Results showed milk yield decreased with days in milk from 3·3 kg/donkey/d at the start of the study, to 2·2 kg/donkey/d by the end of the 170 d. Parity 3 donkeys produced 22% more milk than parity 4 donkeys (3·3 kg/donkey/d vs 2·7 kg/donkey/d) (Muhatai et al) [6]. The resulting parameters were analysed in a mixed linear model. Significant effects of parity were observed on the same two parameters as in Friggens et al [7]. On the use of simple ratios between lactation curve coefficients to describe parity effects on milk production breed was also found to have a significant effect on some of the parameters. However, there was no significant interaction between breed and parity (Hansen) [8].

The effects of some non-genetic factors on milk protein fraction contents and relative proportions were estimated in 606 individual milk samples of Mediterranean water buffalo. Contents of most protein fractions showed the typical trends observed for milk components as lactation progressed, with high contents in early lactation, a minimum in mid-lactation, followed by a gradual increase toward the latter part of lactation (Bonfatti et al) [9].

According to Baul et al [10] the order of lactation showed significant differences ($p<0.05$) for the evolution of milk daily quantity (parameter a) between 1st and 3rd lactation (-4.39805 kg). For the daily milk growth rate (parameter b) the difference was significant ($p<0.05$) between lactation 1 and 3 (-0.07683 kg) and for daily milk loss rate (parameter c) there were distinct significant differences ($p<0.01$) between lactation 1st and lactation 3rd (-0.00254). There were significant differences ($p<0.05$) for the rate of decrease in the amount of milk between lactation 2 and lactation 3 (-0.00093 kg). Also, there were significant differences ($p<0.05$) for the growth rate of daily milk between lactation 3 and lactation 5 and above (0.02134 kg) and for daily rate of decrease in the amount of milk the difference being 0.00045 kg.

1.1. Statement of the problem

There are conflicting views given by various scholars on the effect of parity number on milk yield within and between breeds. Documentation of effect of parity on milk yield is significant in economic management of a dairy enterprise in fidelity of dictates of wide variety of dairy breeds. It is against this background that a research project was carried out with an objective of assessing the effect of parity on milk yield in lactating dairy cows.

2. Materials and methods

2.1. Research site

The research was conducted in Southern Province of Zambia. The province lies at an altitude range of 400- 1400 m above sea level. It has a mean annual temperature ranging from 14°C to 28°C. It receives an annual rainfall of 700 mm to 1000 mm .The soil type ranges from clay to sandy loam (Ministry of Agriculture) [11].

2.2. Experimental Units

Cows used during the feeding in this study were all crosses called Batoka crosses in their first, second and third parity. The genetic composition of the Batoka Crossbred cattle is 50% ≥Holstein. The breed was chosen because it is the common breed used by majority of smallholder dairy farmers. Batoka livestock centre breeds and supplies the dairy cross to smallholder dairy farmers because it can withstand local conditions and does well under low levels of management.

The breed is bred by crossing Boran and Holstein Friesian cattle to produce a breed that can withstand local environmental conditions and average management levels as found among smallholder dairy farmers within the research area.

2.3. Animals

In all, twelve (12) crossbred dairy cows were used in the study. These genetic types have a black color with white coat color patches. The average weight for the twelve (12) cows was 350 ± 70 kg live weight. Cows were reared on free range in paddocks equipped with drinking troughs located within paddocks. Twelve (12) cows consisting of four (4) cows of each of 1st, 2nd and 3rd parity were used as experimental units. Each of the four (4) cows of each parity served as a replicate. Milk yield was measured and recorded.

2.4. Treatments

2.4.1. Treatment with urea (Novel Therapy)

Dry maize stover was chopped using a stover chopper (shredder) and treated using the Urea-Ensiling Technique (UET) before being offered to the cows. The standard method of urea treatment used in other developing countries which involves the making of a solution of urea using four(4) kg urea feed grade fertilizer (46%N) into sixty (60) litres of water and mixing this with one hundred(100) kg of stover was used. Pits were dug on raised ground for the purpose of the UET. The stover was chopped into 3-5 cm pieces. These were then mixed with the urea solution using a watering can and buried into the pit. A polythene plastic and compacting were used to ensure an air-tight environment. The stover and straw were ready for feeding in 21 days (the 3 weeks urea incubation period).

2.4.2. Treatment with Legume Stover (Test Therapy)

The quality of maize stover was improved using mineralised and chopped legume stover [Groundnuts (*Arachis hypogea*) and Soybean (*Glycine max*)]. These feeds constituted test therapies. The feed ingredients (maize and legume stover) were all procured from local farmers. Four rations were prepared on the basis of cereal type, legume type, source of nitrogen and method of processing of legumes as follows:

- Chopped Maize stover + mineralized Groundnut stover solution
- Chopped Maize stover + chopped Groundnut stover
- Chopped Maize stover + mineralized Soybean stover solution
- Chopped Maize stover + chopped Soybean stover

Test diets were formulated such that they were iso–nitrogenous (same CP) and iso–energetic (same GE or ME). To ensure that the diets were iso-nitrogenous and iso-energetic, samples of cereal stover and legume stover were analysed for their GE and nitrogen content respectively before rations were compounded. Quantities of cereal and legumes (maize, groundnut and soybean stover) used were computed by simple proportion to equate the energy and nitrogen content in each feed based on the results of the proximate analysis. This was important for the data to be valid and reliable.

2.4.3. Ration formulation

Rations were prepared using the BLP 88 computer programme [12] to meet the nutrient requirements of dairy animals (NRC) [13]. Amounts generated from the ration formulation programme were measured using a scale. These were mixed by rolling and turning several times on polythene plastics spread on concrete floor using a garden fork in order to ensure consistence in the composition.

2.4.4. Feeding trials

Feeding trials involved supplementing cows with a diet of maize (*Zea mays*) stover improved with urea feed grade fertilizer by urea ensiling treatment and diets of maize stover improved using legume stover. The experimental units (dairy cows) were randomly selected and allotted to the five(5) rations rations using simple random numbers from the herd available at Batoka Livestock Trust Research Centre (BLTRC).

The feeding trial commenced by determining the optimum quantity of feed to be given to each animal. Quantities of four kilogram (4 kg), three kilograms (3 kg), two kilograms (2 kg) and one kilogram (1 kg) were tried over a period of seven (7) days. During the trial one kilogram (1 kg) of feed was found to be the appropriate quantity of feeding to appetite during supplementation since rejected quantities were much less.

The experimental cows were allowed to graze from seven (7) to twelve (12) hours and then brought to the milking parlour for milking each day. Each animal was offered one (1 kg) of the ration being administered at a given time. The parameter used to test the effect of parity was milk yield. An adaptation period of seven (7) days was allowed for each feed before data was recorded. The study was carried out for a period lasting twenty one (21) days. Data pertaining to milk yield for each cow was taken at milking time and recorded on score sheets.

2.5. Statistical model

$$Y_i=\mu + P_i + b(x) + \varepsilon_i$$

Where Y_{ij}=observed milk yield on individual cow of a given i^{th} parity.

μ=overall mean

P_i=effect of the i^{th} parity

$b(x)$=b is the regression coefficient for initial milk yield used as a covariate

ε_i=random error component

2.6. Research design and data collection

The twelve (12) dairy cows were arranged in a Complete Randomized Design (CRD). Daily milk yield was recorded on individual score cards identified by animal identity numbers from June 12, 2017 through November 09, 2017.

2.7. Statistical analysis

Data was analysed using the Statistical Analysis System (SAS). Treatment means were compared using the F-test (Table 3).

3. Results

Table 1 Effect of Parity on Milk Yield

		Milk_Yield (Ltrs)	
Parity No.	**N**	**Mean**	**Std Dev**
1	5	5.06000000	2.33944438
2	11	8.00909091	3.23433287
3	10	6.89000000	4.00650859

Table 2 Statistical Descriptors

R-Square	**Coeff Var**	**Root MSE**	**Milk_Yield Mean**
0.245798	49.30759	3.457221	7.011538

Table 3 F-Test

Source	**DF**	**Type I SS**	**Mean Square**	**F Value**	**Pr > F**
Parity	2	16.27401988	8.13700994	0.68	0.5181

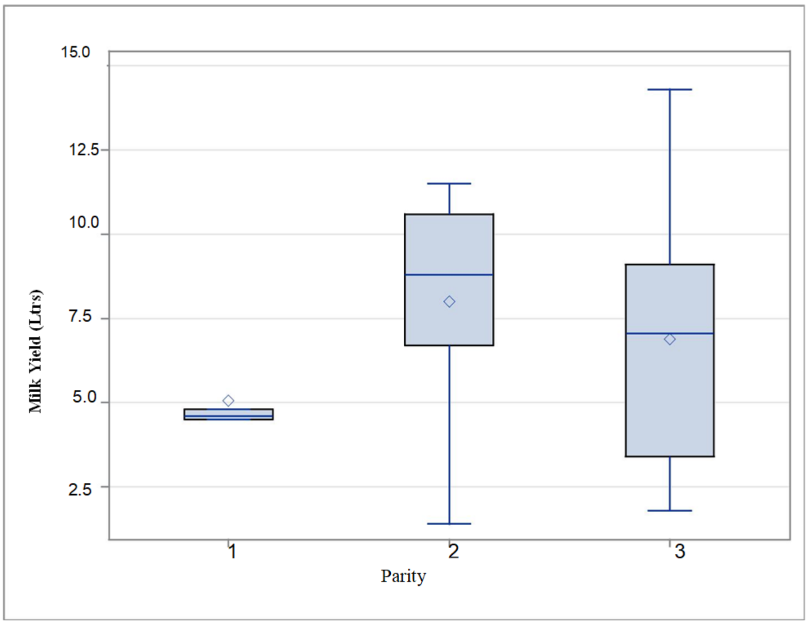

Figure 1 Distribution of _Milk_Yield by Parity

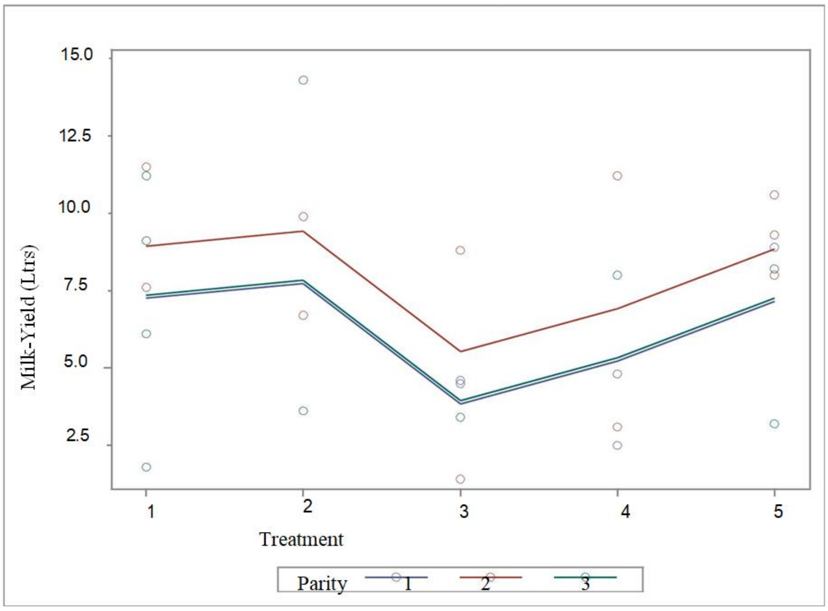

Figure 2 Interaction plot for milk yield by parity

4. Discussion

Stage of lactation affects milk protein and fat percentages very similarly. A study conducted by Van Arendonk et al [14] showed that both lactation stage and energy balance significantly contributed to variation in milk fat composition and helps to alter the activity of different fatty acid pathways.

According to investigation by Gurmessa et al [15] the fat content of milk was significantly higher ($p<0.05$) in early and late than mid age of lactation. However, milk fat content was not significantly ($p<0.05$) varying with age, pregnancy and parity though lactose, SNF and protein contents were significantly ($p<0.05$) different in pregnancy and age. Age tends to cause both milk fat and protein to decline as the animal becomes older. In the current study the mean daily DMYs for the 1st, 2nd and 3rd parities were (5.06ltrs ±2.33, 8.00ltrs±3.23 and 6.89ltrs±4.00 respectively). These means differed significantly ($p<0.05$).

The current study shows that of the three parities cows in the second parity had highest milk yield. These results are in consonance with those reported by Baul et al [11]. These workers reported significant differences ($p<0.05$) for the evolution of milk daily quantity (parameter a) between 1st and 3rd lactation (-4.39805 kg)

5. Conclusion

The study has revealed an increase in milk yield between animals in first and second parity. Thereafter the yield showed a decline from the second and third parity. This decline is at variance with those reported by other scholars who observed consistent increase in milk with increase in parity until a much higher parity when physiological factors come into effect. Results of the current study have indicated that milk yield is influenced by parity with cows in 2^{nd} parity showing the highest milk yield of first three parities.

Compliance with ethical standards

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Disclosure of conflict of interest

The findings of this research might not sit well with breeders of the breed used as experimental units during the research. There is no conflict of interest regarding the publication of this article.

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Author's short biography

Mr. D. M. Chisowa MSc., BSc Animal Nutrition, researcher and lecturer with 40 years in high school and university teaching. Served as Lecturer, HOD and Dean in the Faculty of Agricultural Sciences at Rusangu University and Southern University. Highly passionate about bedrock inventory research in science disciplines, particularly biological and biochemical sciences.