

Effect of parity on lactation traits in crossbred Holstein Friesian in Ethiopia

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Abstract

This study has assessed the effects of parity on lactation length, lactation milk yield, and lactation curves for each lactation stage at Haramaya University dairy research and teaching farm. Thirty-one synchronized Holstein Friesian crossbred heifers; with nearly similar age were selected and stall-fed for the whole lactation period. Data were collected on daily milk yield at each stage, days in milk and lactation milk yield, 305 days milk yield, and analyzed using the t-test for means. There was an insignificant effect on lactation length, total lactation milk yield, 305 days total milk yield, mid and late lactation milk yield between the 1st and 2nd lactation numbers. The rate of variation was very high (13.4%) during the early lactation stage. The daily milk yield was significantly influenced by parity ($P < 0.05$). The variation rate of milk yield in the morning milking was ranging from 10- 51%. Further study is required to examine additional aspects of parity on lactation traits such as milk composition and reproductive traits with more lactation numbers

Keywords: Crossbred cow; Lactation stages; Milk yield; Parity

Introduction

Parity is one of the major sources of variation in milk yield and production increases from parity 1 to 3 after which it dropped (Epaphras et al., 2004). On the other hand, younger cows took longer to attain peak milk yield than older cows and this response seems to be because young cows are not physically mature (Coffey *et al.*, 2006); when they are approaching their first lactation they are in a different metabolic state compared with that of multiparous cows because they require nutrients for their continued growth in addition to that of their udder development and milk synthesis (Wathes et al., 2007). Many studies on the effect of lactation number on milk yields of cows have been conducted and essentially all studies have demonstrated that milk production increases with lactation number and is maximized in the fourth or fifth lactation (Arbel et al., 2001). This is a result of the increasing development and size of the udder (Sorensen et al., 2006) with a consequent increase in the number of secretory cells (Dado and Allen, 1994). Other reasons for increased milk yield with increased parity are differences in the control of tissue mobilization between primiparous and multiparous cows (Wathes et al., 2007), different endocrine background at parturition in the less mature cows, which limits partitioning of nutrients into milk (Wathes et al., 2007), lower consumption of feed per day of primiparous cows than multiparous cows (Dado and Allen, 1994) and the increasing body size of older cows over that of first-lactation animals.

Primiparous cows had significantly longer lactation lengths than multiparous cows (Kashoma et al., 2015). The longer least-square means value for lactation length reflects that the cows were not allowed to dry off at the proper time and continued to milk for an extended period (Krishantan and Sinniah, 2014). Lactation length should not exceed the standard length of 305 for cattle breeds because it will increase the calving interval and decrease the number of calves that could be obtained during the life span of a cow (Krishantan and Sinniah, 2014). 80% variations in milk yields of dairy cows were attributed to environmental factors and parity is among the non-genetic factors influencing lactation milk yield (Kashoma et al., 2015) and lactation length (Kumar et al. 2014). Parity has also an effect on lactation pattern or curved shape that helps to identify feeding and management problems within a dairy herd (Epaphras et al., 2004). Little information is available on lactation traits and curves in Ethiopia. Moreover, the effect of parity on milk yield during different stages of lactation is not extensively studied. Therefore; the objective of this study was to assess the effects of parity on lactation length and pattern of milk yield for stall-fed crossbred Holstein Friesian cows.

Materials and Methods

Study area

The study was conducted at Haramaya University dairy research farm, located at 505 km east of Addis Ababa and situated at an altitude of 1980 meter above sea level, 9°26'N latitude and 42°3'E longitude. The area has an average annual rainfall of 741.6 mm. The mean annual minimum and maximum temperatures are 8.25 °C and 3.4 °C, respectively.

Study sample and methods

Among synchronized Holstein Friesian crossbred heifers, thirty-one (31) with nearly similar age and first calvers were purposefully selected and stall-fed for the whole lactation of 1st parity. Among the thirty-one cows naturally bred for the 2nd parity, fourteen (14) cows that gave birth nearly in the same month for the 2nd times were purposefully chosen and similarly managed for the whole lactation period.

Animal management

Animals were maintained under intensive systems. Cows were tied in a barn and individually fed at a rate of 0.5 kg per 1 kg of milk-based on the recommendation given by earlier scholars (Pandey and Voskuil, 2011). The feeds used were mixed on the farm, from grains or by-products such as wheat bran, soybean meal, peanut cake, ground maize, salt, and ruminant premix. Animals were fed the calculated amount of concentrate ration in three equal feedings every eight-hour intervals (at 7:00 am, 3:00 pm, and 17:00) whereas during the dry period animals were individually stall-fed 3kg mixed concentrate feeds once every day at 8:00 am. During the entire day, drinking water was provided as *ad libitum*. All animals were fed hay in groups in the morning starting at 8:00 Am and corn silage in the afternoon starting at 1:00 pm as *ad libitum*. Animals were milked twice a day by a milking machine at 6:00 am and 6: 00 pm.

Data collection

Starting at seven days postpartum to the end of lactation, the daily milk yield of cows were individually recorded for the morning and afternoon milking separately using sensitive balance. At the end of each lactation, other data collected were lactation length, total lactation milk yield, 305 days milk yield, daily milk yield of lactation, daily milk yield of 305 days lactation, Early (7-100days), Mid (101-200 days) and Late (201-305 days) daily lactation milk yield.

Data handling and analysis

Data entry and management were made using Microsoft Excel sheets and analyzed using the t-Test Paired for two samples for means tool performed to ascertain if the null hypothesis can be accepted or rejected. The least-square means comparison was performed using significance level at ($p < 0.05$). The rate of variation in milk between first and second parity was calculated. The statistical model used during data analysis was: $Y_{ij} = \mu + P_i + e_{ij}$. Where: Y_{ij} = Observation on parameters under consideration, μ =overall mean, P_i =Effects of i^{th} parity, e_{ij} = Random error

Results and Discussion

Lactation length (LL)

The overall mean of lactation length (Table 1) in this study is close to the optimal lactation length (305 days) generally agreed upon in the cow's calendar. The mean LL was shorter than the mean value of 366 in Pakistan (Usman et al., 2012), 332 in Sudan (Amasaib et al., 2008); 366.5 days under subtropical conditions (Usman et al., 2012) for Holstein Friesian cows, however; it was higher than 291.86±6.55 days in Pakistan for the same breed (Sattar et al., 2005). Parity had no significant effect ($P > 0.05$) on LL (Table 1) and this agreed to an earlier study that reported as lactation number has no significant effect on lactation duration (Erdem et al., 2007, Parineeta et al., 2017). In contrast, the effect of parity on LL ($P < 0.05$) conformed to the findings reported in earlier study (Kumar et al. 2014). In this report, the lactation duration for parity one is slightly higher than parity two and this is agreed to (Sattar et al., 2005) who reported the decrease of lactation lengths with an increase in parity. Whereas this study has disagreed with Wondossen et al. (2018) who reported slightly increased lactation length with an increase in parity of cow. Generally, the lactation duration observed in this study was in a similar range (284.7-333 days) reported in a previous study for Holstein cows (Erdem et al., 2007). The overall lactation length in this study is close to the optimum value of 305 days required to maintain the optimum calving interval of 12-13 months. This implied that animals on the farm are provided good management.

Total lactation milk yield (TLMY)

The overall mean TLMY was found in Table 1 and this is far above the value reported than 2772.76 liters (Sattar et al., 2005), 3438 (Usman et al., 2012) reported for Holstein Friesian cows in Ethiopia, India, Pakistan, and subtropical conditions, respectively. In contrast, it is by far less than 5519 (Kollalpitiya et al., 2012), 5468 (Amasaib et al. 2008) that reported in different countries for HF cows. This lower LMY of HF cows in this study might be due to the use of young cows in lactation which is in the 1st and 2nd parity. This is agreed to earlier studies that reported that first lactation cows produce approximately 75% of the milk produced by mature cows (Lateef et al., 2008). Parity had no significant difference ($P > 0.05$) on LMY, however, it showed an increase of more than 157 liters (3.28%) on average from lactation one to two. In contrast, (Metaxas, 2016) reported a large significant difference between the first and second lactation (+310 kg more in parity two). Besides, the significant effect of parity on LMY was reported in previous studies (Wondossen et al., 2018). Moreover, (Lateef et al., 2008) reported a non-significant difference existed between first and second lactations among Holstein Friesian cows. An increase in milk production from lactation one to two (+ 1000 liters more in parity two) in Holstein Friesian was also reported by (Amani et al., 2007). The overall mean milk yield per lactation for parity one and two in this study was higher than 3186.689±93.577 and 3186.69±93.58 for parity one and 3496.299±93.580 and 3496.30±93.58 for parity two in Sudan (Metaxas, 2016). Almost the same values of total lactation milk yield of 4729.5 and 4979.24 liters were reported for parity one and two, respectively (Kashoma et al., 2015). This study report conformed to Wondossen et al. (2018) who reported the lowest milk production in first lactation cows. As well, Kashoma et al. (2015) reported an increase in lactation milk yield with an increase in parity because mature cows use most of the nutrients for milk production and have the ability to gain body weight and condition quickly after calving whereas the first calvers face lactation stress and partition nutrients for continuous body growth and milk production. Dijkstra et al. (1997) also reported low milk yield in young cows due to underdeveloped udders and hence low alveoli activity, however, this improves with the age of an animal as a result of cell proliferation until a later age when the rate of cell death surpasses proliferation leading to a drop again in milk yield.

305 Days total milk yield

Parity had no significant effect ($p > 0.05$) on adjusted 305 days milk yield (Table1). This has concurred to a non-significant effect of lactation number on 305 days milk yield reported in previous studies (Kocak et al., 2007). Opposing this finding, earlier scholars reported the significant effect of lactation number on 305 days milk yield (Erdem et al., 2007). The overall 305 days total milk yield in this finding is almost the same as 4557 liters reported in Kenya (Ojango and Pollott, 2001) for 305 days milk yield. However, lower (2015 liters) of 305 days milk yield was reported for Holstein Friesian in Zimbabwe (Ngongoni et al., 2006).

Daily milk yield

This study revealed a significant effect ($P < 0.05$) of parity on the mean daily milk yield of lactation (Table 1). This is agreed to earlier study reports that depicted the significant influences of parity on daily milk yield (Bytyqi et al., 2009, Wondossen et al., 2018). However, the daily milk test on the standard lactation length (305 days) is not influenced by parity ($P > 0.05$). In contrast, several scholars indicated the effect of parity ($P < 0.01$) on 305-day milk yield (Parineeta et al., 2017). This is probably due to the variation in lactation length besides other genetic and environmental factors. The results show that cows in the 2nd lactation produce more milk compared to the 1st (Table 1) and it disagrees with Bytyqi et al. (2009) who reported that cows in the first lactation produce more milk (18.43 kg/day) compared to the 2nd (17.20), 3rd (17.73), 4th (16.91), and those in lactation \geq 5th (17.72 kg/day). The mean daily milk yield of lactation and 305 days obtained in this study (Table 1) for 1st and 2nd parity are higher than the results reported for 1st (11.24), 2nd (12.34), 3rd (12.66), and 4th (12.93 Kg/day) (Metaxas, 2016). The overall mean daily milk yield of lactation and 305 days (Table 1) for Holstein Friesian cows are higher than the results reported Holstein Friesian breed, that is 13.15 in Sudan (Amasaib et al., 2008), 9.4 in Pakistan (Usman et al., 2012), 8.4 liters/day in Ethiopia (Belay et al., 2012), 13.2 in Egypt (36) whereas it is lower than 16.5 (Amasaib et al., 2008) and 16.7 liters/day (Ojango and Pollott, 2001) results reported in Sudan, Tunisia, and Kenya, respectively. This lower mean daily milk yield reported in this study might be due to the variation in lactation number/parity as this study evaluated data only for 1st and 2nd parity. Besides, variations in the genetic constitute of the cows, lactation length, and management given to the animals are among the major factors that contributed to the variation in daily milk yield.

Table 1 Effect of parity on lactation length and milk production

Variables	Parity 1 (n=32)	Parity 2 (n=14)	Overall mean (n=46)	P-value	SL
Lactation length (days)	322.38	304.08	313.23	0.385	NS
Total lactation milk yield (Kg/cow)	4659.28	4817.27	4738.28	0.654	NS
305 days total milk yield (Kg/cow)	4318.91	4762.36	4550.64	0.165	NS
Daily milk yield of lactation (kg/cow)	14.45 ^b	15.88 ^a	15.17	0.022	*
Daily milk yield on 305 days lactation (Kg/cow)	14.16	15.61	14.89	0.165	NS
Early lactation milk yield (7-100days)	15.35 ^b	17.67 ^a	16.51	0.0019	**
Mid lactation milk yield (101-200 days)	14.26	14.74	14.50	0.482	NS
Late lactation milk yield (201-305 days)	12.40	11.73	12.07	0.339	NS

n – Number of observations; NS-non significant,SL-Significant level

Table 2 Effect of parity on morning and afternoon milk yield

Variables	Parity 1	Parity 2	Variation	P-value	SL
Total morning lactation milk yield (Kg/cow)	2426.80	2401.80	-25.0	0.887	NS
Total afternoon lactation milk yield (Kg/cow)	2083.40	1967.20	-116.2	0.491	NS
305 days total morning milk yield (Kg/cow)	2235.50	2330.90	95.4	0.3531	NS
305 days total afternoon milk yield (Kg/cow)	1838.56	1948.48	109.92	0.2115	NS
Daily morning milk yield on 305 days lactation (kg)/cow	7.94	8.01	0.07	0.879	NS
Daily afternoon milk yield on 305 days lactation (kg)/cow	6.63	6.81	0.18	0.137	NS
Mean morning early milk yield (7-100days) (kg)/cow	8.19 ^b	9.26 ^a	1.07	<0.021	*
Mean morning mid milk yield (101-200 days) (kg)/cow	7.97	7.97	0.00	0.990	NS
Mean morning late milk yield (201-305 days) (kg)/cow	6.76	6.59	-0.17	0.0504	NS
Mean afternoon early lactation milk yield (7-100days)	7.22 ^b	8.20 ^a	0.98	<0.0187	*
Mean afternoon mid -lactation milk yield (101-200 days)	6.32	6.74	0.42	<0.193	NS
Mean afternoon late lactation milk yield (201-305 days)	5.43	5.11	-0.32	0.349	NS

SL-Significant level; NS-non significant

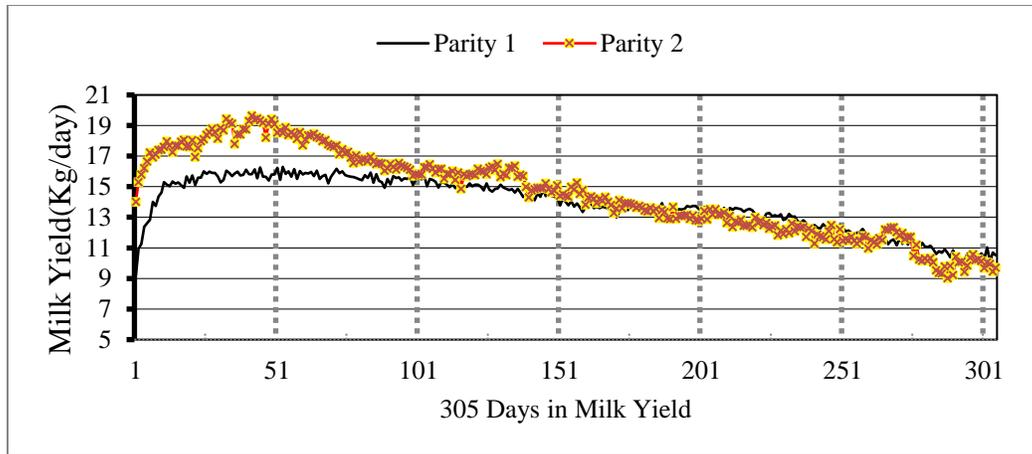


Figure 1. The pattern of milk yield through the lactation period

Lactation stage and lactation curve

This study revealed that there was a significant ($p < 0.01$) difference between first and second parity during the first 100 days (Table 1). The mean daily milk yield during the early lactation for the 2nd parity is higher by 2.32 liters (13.4%) than the daily mean milk yield for the 1st parity. This agreed with Cho et al. (2016) who reported a difference between first and second parity as for stage of lactation. The pattern of mean daily milk production throughout the lactation period (Fig 1) and during the early lactation stage (Fig 2) indicated that first lactation cows have the lowest peak yields but the highest days in milk (DIM) at peak and more persistent than the second lactation cows. This is consistent with Rekika et al. (2003) who reported that first lactation cows have the lowest total and peak yields but the highest DIM at peak and persistency. Moreover, (Teklerli et al., 2000) reported as first lactation cows produce lower yields than older cows at the beginning of the lactation but more persistent. The rate of variation between the first and second parity (fig 5) is very high during the early lactation (13.4%) and relatively low during the late lactation (2.82%). This indicated that the significant difference ($P < 0.05$) between parity 1 and 2 in mean daily milk yield per lactation (Table 1) is due to the high variation that comes from the early lactation. The higher total and daily milk yield in the second parity cows during the early lactation is since mature cows can gain body weight and condition quickly after calving whereas the first calvers face lactation stress and partition nutrients for continuous body growth and milk production which is in agreement to Kashoma et al. (2015). Also, this shows the same result that persistency of lactation in the first parity is higher than in the second parity but there was a lower peak milk yield in the first parity (Cho et al. 2016). However, higher daily milk yield in the first parity cows obtained during the late lactation (fig 3) might be related to the ability to gain body weight and condition in the first calvers at a late stage after full recovery from lactation stress and full mature age. In support of this, the rate of variation between 1st and 2nd parity (fig 5) is lower during the late than any other lactation stages.

Table 2 shows the least-squares means of first and second parity morning and afternoon lactation and daily milk yield. There was no significant difference ($P > 0.05$) between the first and second parity in morning and afternoon total, 305 days lactation, and daily milk yield. These traits were also not significant during the mid and late lactation, however, the mean daily milk yield produced was only significant ($P < 0.05$) between the first and second parity for the morning and afternoon during the early lactation stage, and at this stage, the daily milk yield is enhanced by 1.07Kg (13.06%) and 0.98 Kg (13.57%) for parity 2 in the morning and afternoon respectively. Besides, the result presented in fig 6 clearly illustrated the existence of high variation in daily milk yield for the morning and afternoon between parity 1 and 2 during the first 100 days. The total morning and afternoon lactation milk yield is decreased by 25 and 116 Kg respectively in parity 2 which is associated with the shorter lactation length in parity 2 than parity 1. Besides, the mean morning and afternoon late lactation daily milk yield are relatively lower in parity 2 than parity 1 which might be related to the ability to gain body weight and condition in the first calvers at a late stage after full recovery from lactation stress and full mature age. The mean daily milk in the morning increased for parity 2 on average by 29.14, 26.14, and 24.31% during early, mid, and late stage of lactation respectively, and the rate of variation (fig 5) in the daily morning milk yield between parity 1 and 2 ranges from 10-51%. The mean daily milk in the afternoon is also increased for parity 2 on average by 13.93, and 6.73 % during early and mid-stage of lactation respectively but decreased on average by 5.4 % during the late stage of lactation. The rate of variation in the daily afternoon milk yield between parity 1 and 2 ranged from -19.73-50% (fig 6).

Generally, this study revealed the influence of parity on the morning and afternoon mean daily milk and showed the existence of high variation between parity 1 and 2 in the morning and afternoon mean daily milk yield.

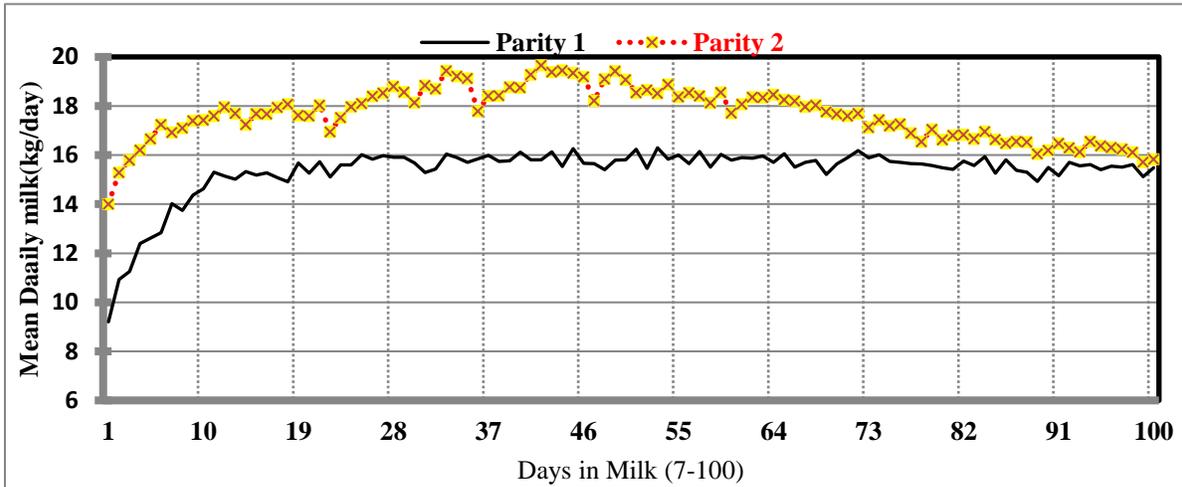


Figure 2. Lactation pattern during the early lactation stage

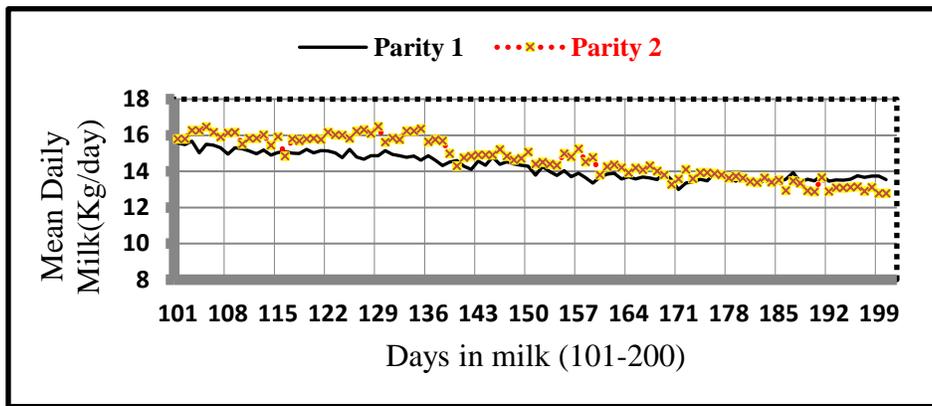


Figure 3. The pattern of milk yield during mid-lactation

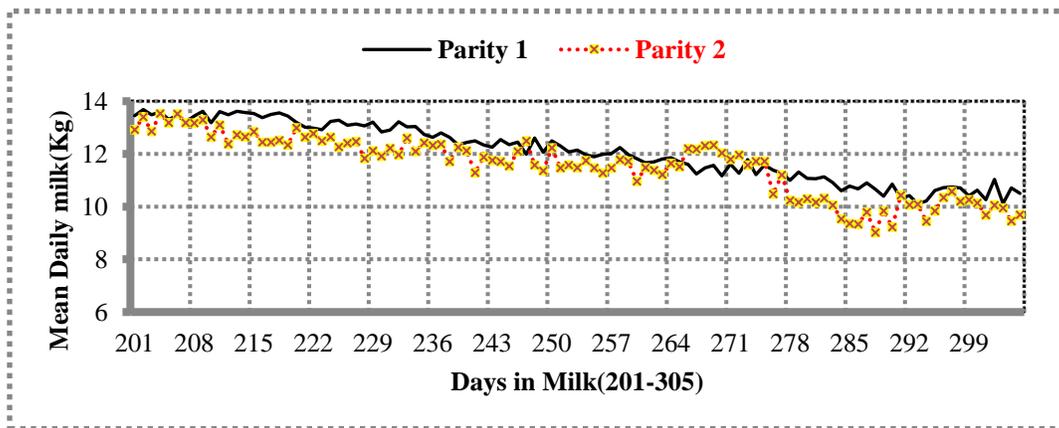


Figure 4. The pattern of lactation during the late lactation stage

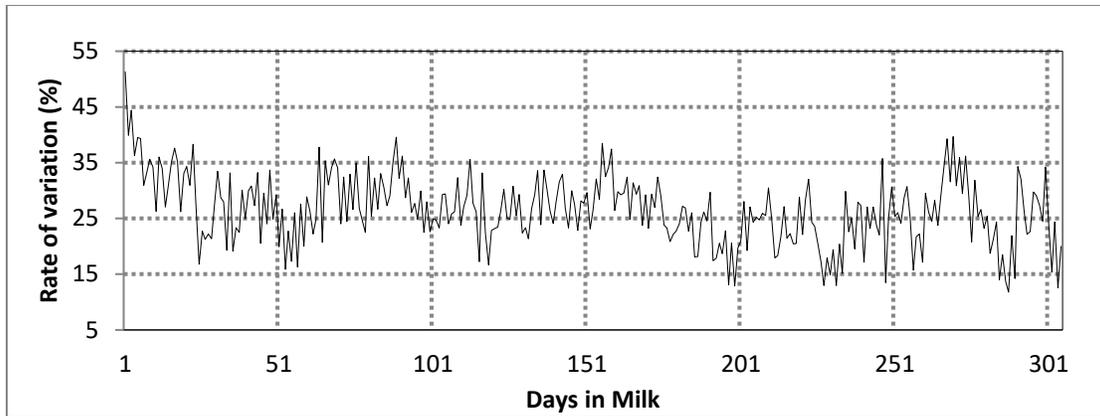


Figure 5. Rate of variations in daily morning milk yield between parities

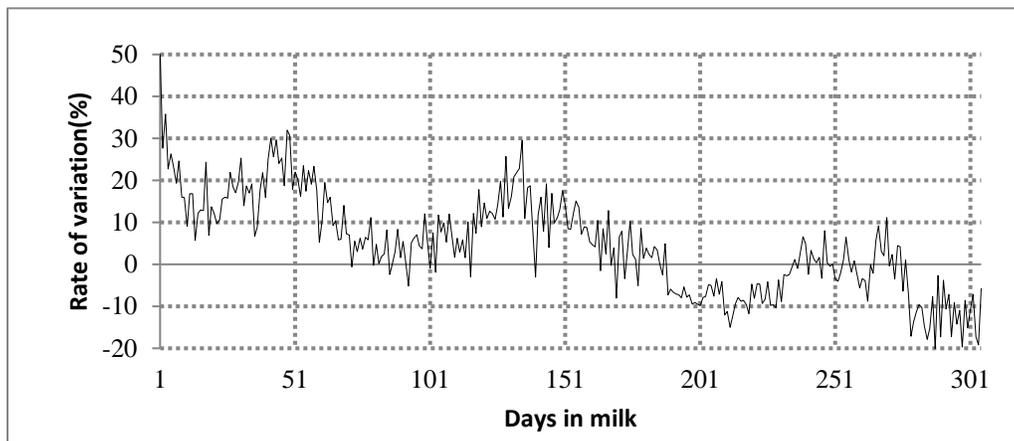


Figure 6. Rate of variations in daily afternoon milk yield between parities

Conclusions

Parity was significantly influenced the daily milk yield of lactation. Cows in the first lactation had the lowest peak yields but the highest days in milk at peak and more persistent than cows in the second lactation. Further study is required to examine additional aspects of parity on lactation traits such as milk composition and reproductive traits with more lactation numbers.

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Authors' contribution The first author developed the study concept and design, material preparation, data collection, and analysis, wrote the manuscript. The second author collected milk samples and did laboratory, read, and approved the final manuscript.

Conflict of interest None.

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