

Milk productivity of Camel and growth of calves (*Camelus dromedarius*) in eastern Ethiopia

M B Chimsa¹, Y Y Mummed^{1,2}, M Y Kurtu¹, M U Leta¹

¹*School of Animal and Range Science, University of Haramaya, P.O. Box 135, Ethiopia*

²*Department of Animal and Wildlife Science, University of Pretoria, South Africa*

Corresponding author email: yesihakyus@gmail.com

Abstract

Milk suckled, off take and growth of calves of Camel was measured from August 2008 to July 2009 in eastern Ethiopia with the aim to evaluate the performance of the herd in terms of milk productivity and growth of calves. Data on milk suckled and growth of calves was collected by methods of weight-suckle-weight. Milk off take of the herd was measured by hand milking method. Productivity of the herd in terms of milk was evaluated based on the sum of milk suckled and off take. Average daily milk suckled was 2.00 ± 0.18 kg, daily milk off take was 3.50 ± 0.14 liter, daily weight gains of calves was 0.243 ± 0.01 kg/day, respectively. Average milk productivity as the sum of milk suckled and off take was 5.5 ± 0.16 . Milk suckled, off take and daily weight gain of calves was affected by months of lactation, season of births of calves and parities of dams. Daily milk suckled, off take and weight gain in 3-4 months of lactation was relatively higher than other months of lactation which were 2.17 ± 0.22 kg, 3.55 ± 0.16 liter and 0.300 ± 0.02 kg, respectively. The productivity of the herd in terms of milk yield and growth of calves decrease as the camels advanced in lactation. Daily milk suckled, off take and weight gain was relatively lower in 11-12 months of lactation which was 1.27 ± 0.31 kg, 1.69 ± 0.15 liter and 0.193 ± 0.02 kg, respectively. From the study it was concluded that the Camel herd in eastern Ethiopia managed under arid range condition was comparable to the productivity of Camel in east Africa based on the performance measured in terms of milk productivity and growth of calves.

Keywords: Daily weight gain; Milk off take; Milk suckled

Introduction

The dromedary (*Camelus dromedarius*) is known for its ability to produce milk and survive during dry and drought periods (Wernery 2006). During such periods, camels contribute up to 50% of the nutrient requirement of the pastoral society (Farah et al 2004). The foundation of a camel herd is the calf. Calves form the replacement stock without which the herd cannot grow and neither would milk be available for the camel keepers. However, rearing of Camel calves under traditional pastoral production systems is faced with several challenges that result in retarded growth and high death rates of the calves (Yesihak and Bekele 2004).

The daily milk off take by Rendille, Gabbra and Turkana camel in Kenya was reported in the range from 1 to 3 liter/day. Daily milk yield of Pakistani camel was reported in the range from 4 to 7 liter/day (Infonet-biovision 2010). In eastern Ethiopia, daily milk off take was reported

4.1 liters per day (Bekele et al 2002; Zeleke 2007). Milk productivity of the animal was reported based on the amount of off take. Most study didn't consider the productivity of the breed in terms of milk suckled by calves and growth of the animal.

The aim of this study was therefore to evaluate the productivity of the animal in eastern Ethiopia in terms of milk suckled, off take and growth of calves.

Materials and Methods

Location

The study was conducted at the Errer Valley, eastern part of Ethiopia. The area is located 9^o 14'N latitude and 42^o 14'E longitude at an altitude of 1300 – 1600 m above sea level. The climate condition is semi-arid with yearly average rainfalls and temperature ranging from 400 to 500 mm and 17 ^oC to 31 ^oC, respectively. Season of the year is classified as long rainy, short rainy, long dry and short dry which cover from July to September, March to April, October – February and May – June, respectively. The soils are sandy-dry-loam with some alluvial nature. The vegetation cover mainly includes dwarf shrubs such as *Indigofer* species, large shrubs and trees such as *Acacia* and *Boscias* species.

Animals

Twenty calves and their dams in 3-12 months of age and lactation were used in the study. The parities of dams were 1,2,3,4 and 8. Experimental animals were managed in traditional ways. Dams and their calves browse natural pasture separately for about 8 hrs a day. During the night, calves and lactating camels were kept separately in fenced night enclosure. No supplemental feed was provided for the animal during the study period. Dams watered once in a week during dry seasons. During wet seasons, they get water from green feed they browsed. Experimental calves supplied water once a day. Before the start of the study, calves were identified with plastic ear tag, sprayed against external parasites and dewormed against gastrointestinal parasites.

Data collection

Data was collected at interval of two week on body weights of calves and milk suckled from August 2008 to July 2009. Morning and evening off take was collected at interval of a week. Data was collected from 3 to 12 months of lactation. Lactation period from 1 to 3 months was not considered in the study. This was because by the time budget for the study was secured, dams were in their third stage of lactation. Weight-suckle-weigh technique was used to measure milk suckled during the morning. In this method, calves were weighted before suckling their dams to stimulate let down and after emptying residual milk in the udder. The differences in weights were considered as milk suckled by calves. Morning milk suckled was converted to daily milk suckled based on the correlation obtained between morning milk off take and daily off take. Milk off take data was collected using hand milking done in the morning and evening. Camels were milked after allowing the calves suckle for about 2 minutes to stimulate milk let down. Measuring cylinder was used to determine the volume off take. The same data collected by weight-suckle-weigh method were used to estimate daily weight gain of calves. Weight of calves was measured using digital weighing scale.

Statistical analysis

To study the effect of stage of lactation on milk suckled, off take and daily weight gain of calves, lactation period were divided in to 3-4, 5-6, 7-8, 9-10 and 11-12 months of lactation. Season of the year were divided in to wet and dry season. Moreover, the parities of dam grouped in to 1, 2, 3, 4 and 8. Overall mean of milk suckled and off take was calculated based on the methods of Mason and Buvanendran (1982) which consider average yield as any point between 3 and 6 months of lactation. This was because data was not collected from 1 to 3 months of lactation. Daily milk suckled was calculated based on the correlation factor developed between daily and morning milk off take ($1.97 \times \text{Morning milk suckled} = \text{Daily milk suckled}$). Collected data were subjected to analysis of variance using general linear model procedure of Minitab (1998). Effects of different level of factors were separated using Turkey significant test difference.

The model used to estimate milk suckled by calves was $Y_{ijk} = U + L_i + S_i + P_k + G_l + e_{ijkl}$, Where, Y_{ijk} = observation of average daily milk suckled by calves, U = overall mean, L_i = Fixed effect stage of lactation, S_i = Fixed effect of season of birth, P_k = Fixed effect of parity, G_l = Fixed effects of sex of calves and e_{ijkl} = Effects of random error. Average daily weight gain was analyzed using similar model using the same factor used in the first model. Moreover, average daily, morning and evening milk off take was analyzed using the same model excluding effect of sex of calves. Milk productivity of the herd was measured as the sum of daily milk suckled by calves and off take and was analyzed using the same model as that used on off take.

Results and Discussion

Milk suckled by calves

Least squares means for milk suckled by calves is presented in Table 1. The average daily milk suckled by calves was 2.00 ± 0.18 kg. Milk suckled by calves was affected by months of lactation, season of births of calves and parities of dams. Milk suckled from 1-3 months of lactation was not considered because by the time budget for the study was secured, dams were in their third stage of lactation. Comparing milk suckled from 3-12 months of age, relatively more milk ($P < 0.05$) were suckled in 3-4 (2.17 ± 0.22) months followed by milk suckled in 5-6 (1.83 ± 0.15) and 7-8 (1.89 ± 0.15) months of lactation. The least milk suckled in 11-12 months of lactation (1.27 ± 0.31). The reduction in milk yield as the animal advanced in lactation might be due to reduction in milk secretory cells. Milk suckled during in 3-4 months of lactation was relatively lower than the requirement for this age group which was about 3.5 liter/ day (Coventry 2002).

Milk suckled in the wet season (2.18 ± 0.16 kg) was relatively higher ($P < 0.05$) than the amount suckled in dry seasons (1.67 ± 0.20 kg). This difference could be attributed to relative availability of green feed in wet season compared to dry season. Relatively more ($P < 0.05$) milk was suckled from dams in 4th parities (2.67 ± 0.30 kg). Relatively lower milk was suckled from dams in 1st and 8th parities which were 1.51 ± 0.16 kg and 0.68 ± 0.50 kg, respectively. Relatively lower milk suckled from Camels in the first parity might be due to lower milk production from primiparous dams because udder was not well developed as multiparous dams. On other hand, reduction in milk suckled from Camels in 8th parity might be due to reduction in feed conversion efficiency of older dams as the animal become relatively older (Zelege 2007). Calves sex had shown no significant effect on milk consumption in this study.

Milk off take

Milk off take of Camel is shown in Table 2. The average daily milk off take was 3.50 ± 0.14 liters in this study. The off take in this study was relatively lower than 4.14 kg/day reported based on the study from 1997 to 2000 (Bekele et al 2002); 8.6 and 12.2 kg/day reported for energy and protein supplemented same herd (Dereje and Uden 2005) and Pakistani Camel which produced 4-7 liter/day (Infonet-biovision 2010). The difference might be difference in year, feeding condition and breed, respectively. However, it was comparable to the yield by Rendille, Gabbra and Turkana camel in Kenya which range from 1-3 liter/day (Infonet-biovision 2010). Milk off take was affected by months of lactation, season of the year and parities of dams. Milk off take in 3-4 (3.55 ± 0.16 liter) and 5-6 (3.44 ± 0.12 liter) months of lactation was relatively higher ($P < 0.001$) than milk off take from 7-8 (2.81 ± 0.10 liter) and 9-10 months (2.36 ± 0.10) of lactation. Milk off take was relatively lower in 11-12 months of lactation (1.69 ± 0.15). The higher off take in early months of lactation might be due to presence of the higher number of milk secretory cells which reduce in number as the animal advanced in lactation. The amount of off take in 3-6 months of lactation in present study was comparable to the report for Sudanese Camel breed in the mid lactation (Eisa and Mustafa 2011). Moreover, the off take in late stage of lactation in this study was comparable to the yield by the Sudanese camel which range from 2.18 – 2.86 liter/day in late stage of lactation (Eisa and Mustafa 2011).

The off take in wet season (3.35 ± 0.22 liter/day) was relatively higher ($P < 0.001$) than dry season (2.19 ± 0.08 liters/day) in this study. The difference could be the availability of feed and water in the former than the latter season. The effect of season was similarly reported with the previous findings (Zelege 2007). The lower milk yield obtained during the dry season indicates option for improvement of productivity of milk by improving availability of feed and water for animals. Relatively more ($P < 0.001$) milk off take was observed in this study for dams in 4th parity which was 3.73 ± 0.16 liters/day followed by dams in by dams in 3rd (3.20 ± 0.07 liters/day) and 2nd parities (3.10 ± 0.10 liters/day).

Dams in 1st parities produced relatively lower milk off take which was 1.50 ± 0.09 liters/day. Relatively lower milk off take from camel in the first parity is due to the partition of nutrients for growth and milk production as the animals are still growing (Zelege 2007).

Average morning and evening milk off take was 1.78 ± 0.08 and 1.72 ± 0.07 liters, respectively. The morning milk off take in this study was relatively higher to the report by Bekele et al (2011) which range from 1.1-1.3 liter under different regime of watering. Average morning milk off take was about 3% higher than evening off take in this study. The difference between morning and evening milk yield in this study was relatively lower than the difference reported by Khan and Iqbal (2001) for Sudanese camel which was 27%. The difference might be due to the difference in months of lactation considered, breed and environment. Lactation curve for morning and evening off take is shown in Fig. 1. The curve for morning yield was above the curve for evening. Morning and evening off take were relatively steady from 3 - 6 months of lactation and thereafter, reduced linearly to 12 months of lactation.

Table 1. Milk suckled by Camel calves estimated by weigh suckle weigh method

Source of variation	Morning milk suckled		Daily milk suckled ^{##}	
	Mean (kg)	SD	Mean (kg)	SD
Overall mean [#]	1.02	0.09	2.00	0.18
Month of lactation	*		*	
3-4	1.10 ^a	0.11	2.17 ^a	0.22
5-6	0.93 ^{ab}	0.07	1.83 ^{ab}	0.15
7-8	0.96 ^{ab}	0.08	1.89 ^{ab}	0.15
9-10	0.80 ^b	0.10	1.58 ^b	0.20
11-12	0.64 ^b	0.16	1.27 ^b	0.31
Season	*		*	
wet	1.11 ^a	0.08	2.18 ^a	0.16
Dry	0.85 ^b	0.10	1.67 ^b	0.20
Parity	*		*	
1	0.77 ^b	0.08	1.51 ^b	0.16
2	0.91 ^{ab}	0.07	1.80 ^{ab}	0.13
3	1.06 ^{ab}	0.09	2.08 ^{ab}	0.17
4	1.36 ^a	0.15	2.67 ^a	0.30
8	0.35 ^b	0.25	0.68 ^c	0.50
Sex	ns		ns	
Female	0.85	0.08	1.68	0.16
Male	0.92	0.07	1.82	0.14

[#] overall mean was calculated based Mason and Buvanendran (1982) method of estimating milk as an average yield between 3 and 6 months of lactation; ^{##} Daily milk suckled was calculated based on the correlation factor developed between daily and morning milk off take ($1.97 * \text{Morning milk suckled} = \text{Daily milk suckled}$).

* $P < 0.05$; ns -no significant ; ^{abc} Means in the same column without common letter are different at $p < 0.05$

Milk yield of Camel

The productivity of Camel measured as the summation of milk suckled and off take is shown in Table 3. Average milk productivity of the herd was 5.5 ± 0.16 liter/day. Milk yield was affected by months of lactation, season and parities of dams. Relatively more milk was produced in the 3-4 months of lactation (5.72 ± 0.19) which reduce in amount as the animal advanced in lactation. Relatively lower milk was produced in 11-12 months of lactation which was 2.96 ± 0.23 liter per day. The authors didn't come across documented information on productivity of Camel measured as the sum of suckled and off take milk so that comparison could be made.

Table 2. Average milk off take (liter) of Camel measured by hand milking method

Source	Daily off take	SEM	Am off take	SEM	Pm off take	SEM
Overall mean [#]	3.50	0.14	1.78	0.08	1.72	0.07
Months of lactation	**		**		**	
3-4	3.55 ^a	0.16	1.82 ^a	0.09	1.73 ^a	0.08
5-6	3.44 ^a	0.12	1.74 ^a	0.06	1.70 ^a	0.06
7-8	2.81 ^b	0.10	1.44 ^b	0.05	1.37 ^b	0.05
9-10	2.36 ^c	0.10	1.24 ^c	0.06	1.13 ^c	0.05
11-12	1.69 ^d	0.15	0.92 ^d	0.08	0.76 ^d	0.08
Season	**		**		**	
Wet	3.35 ^a	0.22	1.73 ^a	0.13	1.62 ^a	0.11
Dry	2.19 ^b	0.08	1.14 ^b	0.06	1.06 ^b	0.04
Parity	**		**		**	
1	1.50 ^d	0.09	0.77 ^d	0.05	0.73 ^d	0.04
2	3.10 ^b	0.10	1.58 ^b	0.06	1.52 ^b	0.05
3	3.20 ^b	0.07	1.63 ^b	0.04	1.57 ^b	0.04
4	3.73 ^a	0.16	1.95 ^a	0.09	1.78 ^a	0.08
8	2.32 ^c	0.20	1.23 ^c	0.11	1.10 ^c	0.10

[#] overall mean was calculated based Mason and Buvanendran (1982) method of estimating milk as an average yield between 3 and 6 months of lactation

** $P < 0.001$; ns -no significant ;^{abc} Means in the same column without common letter are different at $p < 0.05$

Daily weigh gain of camel calves

Daily weight gain of calves from 3-12 months is shown in Table 4. The overall average daily weight gain of the calves was 0.243 ± 0.01 kg/day. The gain didn't considered growth from 1 to 3 months of age. This might under estimate the average performance of the calves to weaning because animal grow faster in earlier ages. The growth in this study was comparable to the growth rate for tribal camel calves in dry years in Kenya which was 222gm/day (Kadim et al 2008). However, it was relatively lower than growth reported for Pakistani camel calves which was 0.75 kg (Iqbal et al 2001).

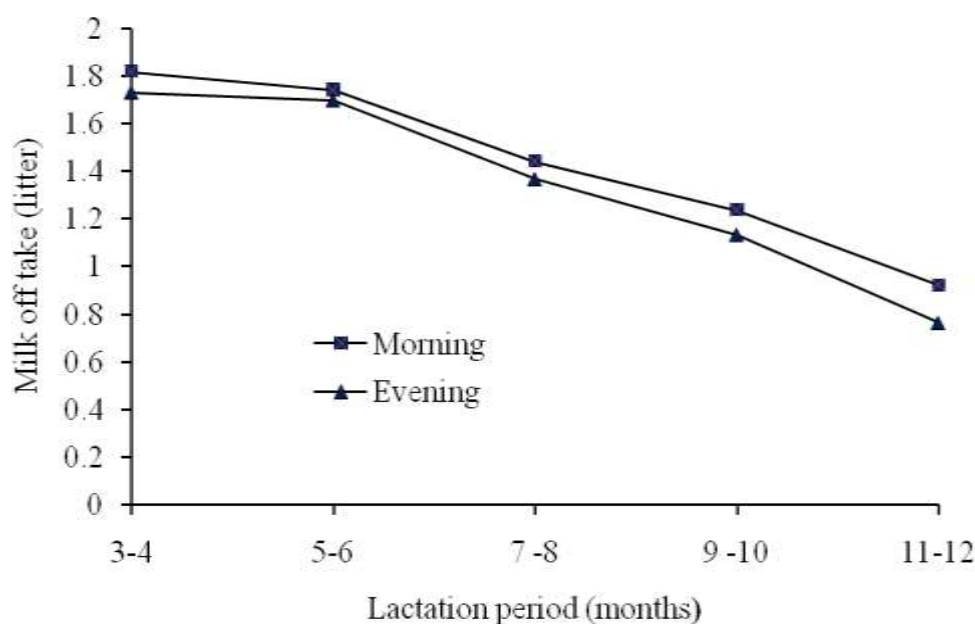


Figure 1. Lactation curve for morning and evening milk offtake

Daily weight gain of calves was affected by months of lactation of calves, season of birth, parities of dams and sex of calves. Growth of calves in 3-4 months of lactation (0.300 ± 0.02 kg/day) was not significantly different from growth in 5-8 months of lactation but relatively higher ($P < 0.001$) than the growth in 9-10 (0.238 ± 0.01 kg/day) and 11-12 months of lactation (0.193 ± 0.02 kg/day). The growth rate in 3-4 months of lactation in this study was lower than the report by Hammadi et al (2001) and Bissa (1996) which were 580g/day and 733g/day, respectively. Relative higher growths rate in 3-4 months of lactation which was not significantly different from growth in 5 - 8 months of lactation (Table 1) coincide with the more milk suckled by calves in 3 - 4 months of age which didn't differ significantly from the growth in 5 - 8 months of age of calves (Table 2). On the other hand lower daily gains in 9-12 months of age coincide with lower milk suckled in the same period. The association between daily gain, suckled milk and off take indicated the influence of milk production on daily gain of calves to weaning age as there were no supplemental feed provided for the calves.

Daily weight gain in wet season (0.269 ± 0.01 kg/day) was relatively higher ($P < 0.05$) than the dry season (0.222 ± 0.01 kg/day). The dry season gain in this study was comparable to the report for the Kenyan camel in dry years. However, the wet season gain was lower than 655 g/day reported for Kenyan camel in same season (Kadim et al 2008). Relatively higher growth rate for wet season over dry season could be the availability of forage in quantity and quality for calves to browse and dams to produce more milk. Calves born from dams in 4th and 3rd parities (0.339 ± 0.03 and 0.282 ± 0.01 kg/day) were relatively heavier than those born from 1st and 8th parities (0.193 ± 0.01 and 0.182 ± 0.02 kg/day). The lower gain from calves born from dams in these parities coincides with the lower milk suckled (Table 1). Female calves grow relatively faster ($P < 0.001$) than male calves in this study which were 0.313 ± 0.01 and 0.192 ± 0.01 kg/day, respectively.

Table 3. Milk productivity of Camel as a sum of milk off take and suckled by calves

Source	Daily off take		Daily suckled		Yield ^{##}	
	Mean (liter)	SD	Mean (liter)	SD	Mean (liter)	SD
Overall mean [#]	3.50	0.14	2.00	0.18	5.5	0.16
Months of lactation	**		*		**	
3-4	3.55 ^a	0.16	2.17 ^a	0.22	5.72 ^a	0.19
5-6	3.44 ^a	0.12	1.83 ^{ab}	0.15	5.27 ^{ab}	0.13
7-8	2.81 ^b	0.10	1.89 ^{ab}	0.15	4.70 ^b	0.12
9-10	2.36 ^c	0.10	1.58 ^b	0.20	3.94 ^c	0.15
11-12	1.69 ^d	0.15	1.27 ^b	0.31	2.96 ^d	0.23
Season	**		*		**	
Wet	3.35 ^a	0.22	2.18 ^a	0.16	5.53 ^a	0.19
Dry	2.19 ^b	0.08	1.67 ^b	0.20	3.86 ^b	0.14
Parity	**		*		**	
1	1.50 ^d	0.09	1.51 ^b	0.16	3.01 ^c	0.13
2	3.10 ^b	0.10	1.80 ^{ab}	0.13	4.90 ^b	0.11
3	3.20 ^b	0.07	2.08 ^{ab}	0.17	5.28 ^b	0.12
4	3.73 ^a	0.16	2.67 ^a	0.30	6.40 ^a	0.23
8	2.32 ^c	0.20	0.68 ^c	0.50	3.00 ^c	0.35

[#] overall mean was calculated based Mason and Buvanendran (1982) method of estimating milk as an average yield between 3 and 6 months of lactation; ^{##} yield is the sum of milk off take and suckled

* P<0.05; ** P<0.001; ^{abc} Means in the same column without common letter are different at p<0.05

Survivability of calves to weaning

Three head of calves were dead during study period which made the mortality rate about 15%. The death occurred after 10 months of lactation. Those dead calves were seen reduced in weight before their death. There was no confirmed diagnosis for the cause of death observed. The mortality rate in this study was comparable to mortality in commercial ranches which was 15% (Chowdhary 1986) but lower than the report for pastoral Camel which was about 60% (Njanja 2007; Kuria 2011).

Table 4. Weight gain of camel calves in 3-12 months of lactation (Mean \pm SEM)

Sources	Mean (kg)	SEM
Overall mean [#]	0.243	0.01
Months of lactation	**	
3-4	0.300 ^a	0.02
5-6	0.270 ^{ab}	0.01
7-8	0.262 ^b	0.01
9-10	0.238 ^{bc}	0.01
11-12	0.193 ^c	0.02
Season of birth	*	
Wet	0.269 ^a	0.01
Dry	0.222 ^b	0.01
parity	**	
1	0.193 ^c	0.01
2	0.269 ^b	0.02
3	0.282 ^{ab}	0.01
4	0.339 ^a	0.03
8	0.182 ^c	0.02
Sex	**	
Female	0.313 ^a	0.01
Male	0.192 ^b	0.01

[#] Overall mean of daily weight gain was calculated based on performance 3-12 months of age

* $P < 0.05$; ** $P < 0.001$; ^{abc} Means in the same column without common letter are different at $p < 0.05$

To see association between mortality, milk suckled, off take and daily gain of calves, data was log transformed and depicted in figure 2. As seen from the graph milk off take, suckled, daily weight gain of calves reduced linearly as the lactation stage advanced. The rate of decrease in milk suckled become more fast as the calves go beyond in 8th months of age. Moreover, deaths of calves were observed between 10 and 12 months of lactation. The rate of decline in daily weight gain and milk suckled by calves further escalated as the animal go beyond 10 months of lactation. This association might explain the importance of volume of milk produced by dams and shared by calves for its daily gain and survivability in late stage of lactation (8-12 months) in situation where calves were not supplemented with solid feed.

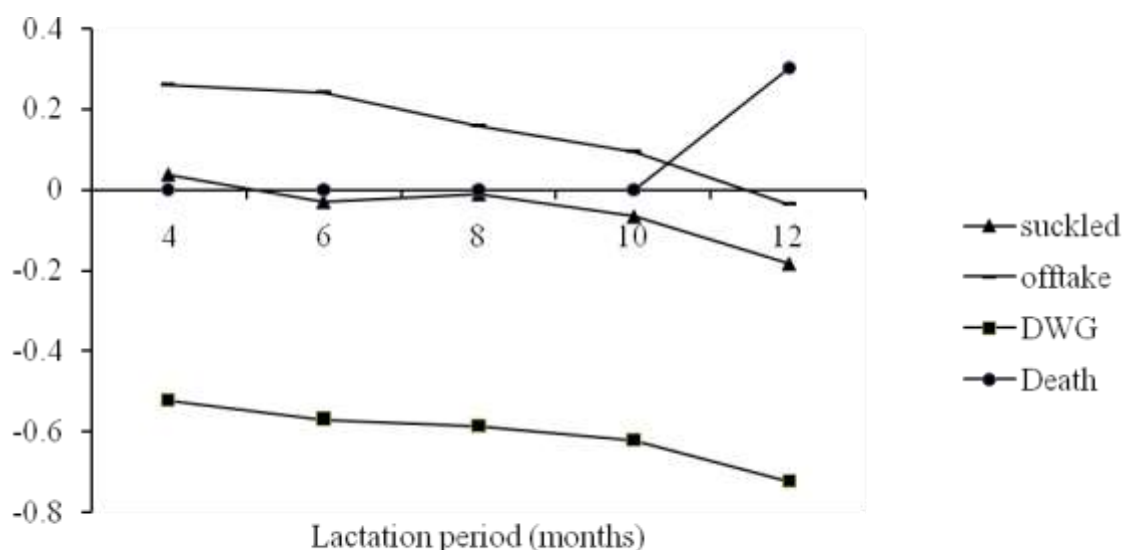


Figure 2: Logtransformed milk offtake, milk suckled, daily gain and mortality of calves

Conclusions

From the study it was concluded that the Camel herd in eastern Ethiopia managed under arid range condition was comparable to the productivity of Camel in east Africa based on the performance measured in terms of milk productivity. However, the growth rate of calves and milk suckled was relatively lower, particularly in the latter stage of lactation. This confirm the importance of supplementing calves in the latter stage of lactation as the milk suckled was become low and the competition increased between calves and farmer for milk.

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