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Growth, Reproduction and Milk Yield of Holstein Friesian Heifers Born and Adapted in Kuwait

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Abstract: Kuwait's dairy producers import pregnant Holstein Friesian Heifers and they thrive for 2.3 lactations with poor milk yield. Offspring of imported dams are subjected to high mortality, poor growth and reproduction. This study investigated growth, reproduction, milk yield and composition of locally born heifers fed two types of diets. Total 92 weaned 90 d old heifers born in Kuwait from imported dams were assigned to two different diets. Control (C): 25 heifers were fed commercial diet and Treatment (T): 67 heifers were fed balanced improved diets containing 17.5% and 15.1% CP, respectively. T diet was also balanced with vitamins and minerals, where, as C diets were not. Both herds were individually monitored for their heights and live weights; followed by reproductive and lactation performance. Herd T gained significantly ($p<0.05$) better live weight (T: 0.88 Kg vs. C: 0.71 Kg/h/d) than that of C and reaching significantly ($p<0.01$) better heights (T: 59% vs. C: 15%) of total standard height of 132 cm. Farm to farm differences in first service (mean±SD) conception rate and pregnancy rate did not differ between C and T herds ($p = 0.05$). Milk yield differences for C and T herds were 16.86±0.70 and 18.30±1.40 L/cow/day, respectively as well as Milk composition were not significant ($p= 0.05$). Milk Urea Nitrogen (MUN) concentration was significantly higher ($p<0.001$) in T herd than that of C reflecting a better protein nutritional status in T than that of C herd.

Key words: Dairy heifers, growth, reproduction, milk yield

INTRODUCTION

Heifer rearing is one of the most important elements of dairy herd replacement for a successful dairy operation. Dairy producers in Kuwait rarely raise their replacement heifers, therefore, had to rely mostly on importation of pregnant heifers from the temperate countries. Imported cattle can be used for 2.3 lactations with a poorer milk yield in Kuwait than their country of origin (Worker *et al*., 1995; Razzaque *et al*., 2001). Summer temperature in Kuwait ranges from 35-39°C reaching to 50°C at noon and short time winter temperature can be as low as -4-0°C.

Dairy producers in Kuwait were faced with very high mortality rates reaching 90% (mean 43.6%) in intensively raised pre-weaned calves under the climatic extremes. Information on adaptability and performance of heifer calves born from imported dams in Kuwait were scarce. The constraints of calf and young heifer rearing in Kuwait were identified during the survey research (Razzaque *et al*., 2004). Implementation of intervention measures resulted in a significant reduction of mortality of preweaned calves from mean 43.6-4% and their growth rate of improved by 100% (Razzaque, 2005, Razzaque *et al*., 2009). Rearing of replacement heifers had been a challenging research area in commercial dairy operations of Kuwait.

Dietary management of replacement heifers during their grow-out period from their weaning to the calving appeared to be a key factor negatively influencing the life-time cow performance. The most important factor was the age, weight and height of heifers at mating (Ettema and Santos, 2004; Losinger and Heinrichs, 1997). Other factors were management of first parity heifers, their reproductive performance and first lactation milk yield. Considering the problems of rearing replacement heifers in Kuwait's dairy herds, present study was undertaken to evaluate the growth, reproductive and lactation performance of heifers born in Kuwait.

MATERIALS AND METHODS

Farm location and climate: Three commercial dairy farms used for the study were of sizes small, medium and large having 250, 400 and 600 cattle herds, respectively. Farms were located at Sulaibiya dairy farm area 25 Km northwest of Kuwait city. Summer mean daily temperature ranges from 35-39°C reaching 48-50°C in July to August at noon. Short duration winter (December to January) temperature can reach - 4°C at night (Razzaque, 2006).

Growth performance: A total of 280 heifer calves of Holstein Friesian breed were weaned at three commercial dairy farms during the calving season of 2002/03. From this herd, 92 heifer calves (32.85% of total) of 4 mo. age were randomly divided to 2 groups having 25 heifers Control (C) and 67 Treatments (T). Diets (Table 1) for T herd comprised of 80% concentrate

Table 1: Feed ingredient (kg/ton) and analytical composition (g/100 g) of concentrate mixture for Control (C) and Treatment (T) herds

Ingredients	C				T			
	Heifers (Ages)			Cows	Heifers (Ages)			Cows
	4-6 mo.	7-15 mo.	16-24 mo.	25-33 mo.	4-6 mo.	7-15 mo.	16-24 mo.	25-33mo.
Barley	100	100	100	100	280	200	200	200
Corn	150	100	100	100	250	200	200	200
Mixed feeds*	600	600	600	600	--	--	--	--
Wheat bran	130	80	80	80	250	350	350	350
Sugar beet residues	Nil	100	100	100	Nil	120	120	120
Limestone and salt (1:1)	20	20	20	20	11	20	20	20
Soyabean meal	-	-	-	-	195	11	100	100
Vitamin and mineral premix	-	-	-	-	14	10	10	10
Analytical Composition On DM								
DM	90.3±0.0	92.5±0.0	94.3±0.0	90.3±1.6	90.2±1.0	89.9±0.0	91.2±2.4	91.2±1.8
Ash	4.2±0.0	5.3±0.0	3.6±0.0	7.5±1.7	9.6±0.3	N/A	7.3±2.1	6.4±0.7
CP	12.4±0.0	10.9±0.0	11.5±0.0	15.1±0.0	17.2±2.7	16.9±0.0	17.3±0.4	17.5±1.8
EE	3.9±0.0	3.0±0.0	2.8±0.0	2.2±0.8	2.4±0.0	N/A	2.8±0.5	2.8±0.2
NDF	31.0±0.0	27.7±0.0	36.9±0.0	31.7±0.0	25.9±0.0	30.5±0.0	24.3±1.1	28.6±0.0
ADF	7.1±0.0	7.0±0.0	14.4±0.0	11.8±0.0	8.6±0.0	10.7±0.0	6.5±0.4	12.4±2.0

* Commercial

mixtures and 20% roughages (10% straw + 10% alfalfa hay). This diet was balanced and supplemented with protein, vitamins and minerals according to NRC (2001) recommendations. Diet of herd C consisted of commercial concentrate mixtures and straws (not supplemented; Table 1) fed at the ratio of 80%: 20% (Table 1). Heifers were fed on a group basis twice daily with *ad-libitum* access to fresh water. Live weights and heights of heifers were taken at weaning at 90 d age and then monthly till the heifers reached 15 mo.

Reproductive performance: Heifers were selected based on a set of criteria (Westwood *et al*., 2000; Harris and Shearer, 2002). Heifers attaining (from 280 heifers) the target height (132 cm height and live weight 350-380 kg) were randomly assigned to a breeding herd to facilitate estrus synchronization and mating by artificial insemination (AI). For mating, the heifers were synchronized with two ProstaglandinF$_2$alfa (PGF$_{2á}$) injections (Preloban produced by Intervet, European Union) 11 days apart (Xu and Burton, 1999). They were inseminated artificially (A1) 72 h after the second injection of PGF$_{2á}$ and second A1 was carried out at 24 h after the first AI.

Lactation performance: Total 40 first lactation cows were assigned randomly to two dietary regimes having 20 cows in each of C and T herd. Herds C and T were fed under the improved (balanced diet) and commercial dietary regime, respectively (Table 1). Housing, watering, health and milking management were similar to both T and C herds.

Feed and milk analyses: Each ingredient and concentrate mixtures were analyzed for proximate components according to AOAC (2002) methods, NDF, ADF were analyzed by procedure of Van Soest (1973) and Van Soest *et al*. (1991). Milk samples were analyzed using a portable milk analyzer Lactoscan (Milkotronic Ltd, Bulgaria) for solid non–fat (SNF), fat, protein and lactose. Milk Urea Nitrogen (MUN) concentrations of milk were analyzed according to procedures of Jonker *et al*. (1999).

Data of performance of heifers and cows were calculated using ‘t’ test of Panacea program (Pan Livestock Services, 1987).

Table 2: Growth performance of heifers C and T herds

Parameters	C	T
No. of heifers	25	67
Reaching standard height (%)	15[b]	59[a]
Reaching standard weight (%)	14[b]	34[a]
Daily live weight gain (Kg/day)	0.71[b]	0.88[a]

Means with different superscripts in the same rows are significantly different ($p<0.01$)

RESULTS

Growth rates: Heifers of T group showed significantly ($p = 0.01$) higher live weight gain and heights than that of C (Table 2). Average of 34% of the heifers reached standard live weight of 350-380 kg at 15 mo compared to 14% in C herd. The differences between standard height and daily live weight gains were also highly significant ($p = 0.01$). The mortality rate in heifers from their weaning to calving in both herds was negligible (mean 0.04%).

Reproduction: First service conception rates (Table 3) of heifers ranged from 72.5±12.0-77.0±25.5 (not significant, $p = 0.05$). Farm to farm variations in first

Table 3: Reproductive parameters (Mean±SD) of heifers of 3 herds*

Farm	A	B	C	Overall mean±SD
Parameters				
First service conception (%)	77±25.5	72.5±12.0	72.5±38.9	74±2.6
Heifers pregnant (%)	86±12.7	72.5±12.0	69±33.90	75.8±9.0
Age at conception (day)	554±8.5	496.5±0.70	540±62.2	530.2±30.0

* The effects of diets on reproduction were not investigated in this study.

Table 4: Milk yield and feed cost of first lactation cows born and adapted in Kuwait two dietary regimes (Mean±SD)

Parameters	C	T
Milk yield (L/cow/day)	16.86±0.70	18.30±1.40
Feed cost (KD*/L)	0.12^a±0.00	$0.10±0.00^b$
Feed cost (US$*/L)	0.41^a±0.00	$0.35± 0.05^b$

Means with different superscript (a, b) in the same rows are significantly different (p $\leq$ 0.05), *Kuwaiti Dinar 0.350 = One (1) US dollar

Table 5: Milk composition and Milk Urea Nitrogen (MUN) concentration of two herds of first lactation cows

Parameters	C	T
pH value	6.60±0.10	6.50±0.20
SNF (%)	8.90±0.60	8.60±0.70
Fat (%)	3.10±1.50	3.82±0.20
Protein (%)	3.10±0.20	3.00±0.10
Lactose (%)	4.70±0.40	4.60±0.20
Density value	30.10±2.30	31.40±1.40
MUN mg/dL	$7.10±2.60^b$	$16.80±4.00^a$

Means with different superscript (a, b) in the same rows are highly significant p $\leq$ 0.001

service conception rates were quite large. Average ages at conception and calving were variable at both conception and calving (Table 3).

Milk yield and cost of feed: Milk yield of first lactation cows of T and C herds (Table 4) did not differ (p = 0.05), although, there was an apparent difference of 1.5 milk/L/day between the herds. However, the feed cost/L milk production was KD 0.100 per liter (US$ 0.35) for T vs KD 0.120 per liter (US$ 0.41) for C differed significantly (p $\leq$ 0.05). Feed cost contributed to major expense in Kuwait representing 70% of the total dairy operational costs and the nutritional economics appeared to be a great concern to the dairy enterprises (Razzaque *et al*., 2007).

Milk Composition and Milk Urea Nitrogen (MUN): Table 5 shows that the milk composition was almost similar in both T and C herds. However, a highly significant difference (p = 0.01) was observed between the two herds in MUN concentrations (C: 7.1±2.6 mg/dL vs. T: 16.8±4 mg/dL). This difference was expected as the CP of the diet of T was 17.5% compared to C 15.1%.

DISCUSSION

Growth and mortality: Hesitations of dairy producers in Kuwait and many developing countries to rear their own replacement heifers from locally born calves were due to alarmingly high rate of pre-weaned calf mortality. Problems of calf-hood diseases and the causes of their high mortality rates were investigated in Kuwait and intervention measures were applied to address the problems of calf hood diseases during the years 1992-2003 (Razzaque *et al*., 2003). Execution of strategic intervention measures resulted in reducing the pre-weaned calf mortality rate from a mean high 43.6% to low 4% (Razzaque *et al*., 2004; Razzaque, 2005a,b). In present study, a very low average mortality rate (0.04%) of growing heifers between 4-15 mo age demonstrated an excellent adaptive ability of heifers born in Kuwait. It is worth noting that around 7 mo duration of the year (April to October), the temperature in Kuwait remains above the acceptable range for dairy cattle.

Optimum performance of dairy cattle was found to be within the temperature range of 4-26°C without loss of production, growth and feed intake (Hahn, 1981). Whereas, Primmault (1979) reported living conditions of different classes of dairy cattle for breeding were 5-20°C, milk cows 0°C-15°C and young fattening herd 10-20°C. The data obtained from our studies showed a high growth rate ranging from 0.710-0.880 Kg/h/day enabling 59 and 34% of the total heifers reaching height of 132 cm and weight of 350-380 kg, respectively.

For maximum efficiency of protein utilization, Zanton and Heinrichs (2008a) recommended that pre-pubertal and post-pubertal heifers should be fed rations containing 14-5 and 13-14% CP in their rations, respectively. The rations of our feedlot heifers were formulated with a higher concentration of CP (17%) than the observed results in the above studies in order to compensate the reduced feed intake during the summer time. The dietary CP density had to be slightly higher in our research in Kuwait than that was used by Zanton and Heinrichs (2008b). Fox and Tylutki (1998) observed that the daily weight gain of very large dairy herds ranged from 0.53-0.88Kg/h/day when, the animals were exposed to the thermal comfort zone of climate. The practice of feeding heifers early morning (4.30-5.30 AM) and evening (6.30-7.30 PM) appeared to have positive impact on feed intake of heifers (Razzaque *et al*., 2005a)

The studies of St. Pierre *et al*. (2002) showed that in Arizona, Alabama, Florida, Louisiana, Missouri and Texas the DM intake of growing cattle were reduced during the summer ranging from 16.0-26.2 Kg/h/year. Consequently, growth losses ranged from 4.8-7.9 Kg/h/year. However, Kuwait's situation is different from those states in the USA, as Kuwait's high temperature was associated with very low RH %.

Reproduction: Data of reproductive performance specially, conception rate (Table 3) showed that the heifers could be bred at their age between 16.6-18.4 mo. This is a good progress in Kuwait, where the commercial dairy producers usually breed their locally raised heifers at an average age of 21 mo to calve at 30 mo age (Razzaque et al., 2005b).

Lactation: Milk yield of both C (16.86 L/day) and T (18.3 L/day) first lactation cows was low. (Table 4). Moss (2003) observed that mating time live weights of heifers were 300-380 kg between the ages of 12 mo and 16 mo. depending on the birth weights of heifers for moderate first lactation milk yield ranging between 5000-8000 L/lactation. In our study in Kuwait mean milk yield is 4880-5490 L/lactation in first lactation cows born here, which was below the standard production compared to the milk yield recorded in temperate region. It is worth noting that the first lactation milk yield of imported pregnant Holstein Friesian heifers in Kuwait ranged only from 2500-4500 L/lactation (Worker *et al*., 1995; Razzaque *et al*., 2001). Obviously, these imported pregnant heifers had adaptation problems to Kuwait's climate (Armstrong *et al*., 1995).

Milk urea nitrogen: MUN concentration in T herd was 2.37 times higher than C herd indicating differences in deficiency of nitrogen utilization between the two. Moharrery (2004) and Godden *et al*. (2001) observed that ammonia escaping rumen microbial metabolism were absorbed, converted to urea in the liver, recycled through saliva and excreted through milk and urine. Therefore, MUN reflected Blood Urea Nitrogen (BUN), Rumen Degradable Protein (RDP) and overall efficiency of nitrogen utilization (Baker *et al*., 1995). BUN and RDP contents were not monitored in our study to elucidate these aspects of nitrogen metabolism further.

CONCLUSION

It is concluded that despite harsh environment, locally born heifers could be adapted to Kuwait with an acceptable growth rate to breed them at an earlier age than normally practiced. Further studies on improvements of replacement heifer performance and economics of heifer rearing in Kuwait are underway.

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