MEDWELL PUBLISHING
Journal of Animal and Veterinary Advances 8 (6): 1145-1148, 2009
ISSN: 1680-5593

Milk Yield Traits of Holstein Friesian x Bunaji Crossbred Cows with Different Holstein Friesian Inheritance

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Abstract: The objective of the study was to determine the optimum Holstein Friesian (HF) inheritance for an improved milk yield of HF x Bunaji (BJ) crossbred cows. Data of HF and BJ dairy cows with 50, 75, 87.5 and 100% HF inheritance kept at the West African Milk Company (WAMCO) farm in Vom, Plateau State, Nigeria, between 1998 and 2004 were used for the study. The independent variables considered included genotype, method of service, calf birth season and parity, while Total Milk Yield (TMY), Lactation Length (LL) and adjusted 305 days milk yield (Adj. 305-DMY) were the dependent variables. The data were analyzed with the General Linear Model (GLM) and where differences were observed, the least square mean obtained for the effects were compared using the Probability of Difference (PDIFF) procedure of Statistical Analysis System (SAS). Results showed that calf birth season and parity had significant ($p<0.05$) influence on TMY and LL. Only parity exerted a significant ($p<0.05$) effect on Adj. 305-DMY. Cows lactating during the early and late dry seasons produced significantly ($p<0.05$) more milk than those lactating in the early and late wet seasons. TMY was highest in the 2nd and 3rd parities.

Key words: Bunaji, holstein friesian, inheritance, lactation length, milk yield, parity

INTRODUCTION

The increasing demand for milk and dairy products in Nigeria, occasioned by increasing population and improving standard of living may worsen if the bulk of milk produced is continuously based on the use of Fulani pastoralists multi-purpose indigenous cows, which are genetically low in milk yield (Ibeawuchi, 1988).

To improve the milk yield potentials and reproductive efficiency of the indigenous heifer, the best option is to combine the hardiness of *Bos indicus* with the genetically high reproductive and milk yield potentials of *Bos taurus* through cross breeding (Cunningham and Syrstad, 1988). The resulting, heterosis in the crossbreeds is exhibited through superior reproductive performance and high milk yield (Hayman, 1973). In a bid to exploit this genetical advantage, Nigeria, many decades ago imported several Holstein-Friesian (HF) bulls for crossbreeding with the local dairy breeds, especially Bunaji (BJ) heifers. This resulted in considerable improvement in milk yield and reproductive potentials (Mbap and Ngere, 1989).

Since, then there has been increasing interest in the use of pure HF or their imported frozen semen to upgrade the indigenous dairy cow. Since the temperate dairy breeds cannot fully express their genetic potentials (for high milk yield and reproductive efficiency) in the tropical environment and with the low genetic potentials of the indigenous breeds, crossbreeding provides a platform for improved performance. Crossbreeding brings about rapid genetic changes by incorporating genes from parents, removing inbreeding depression and capitalizing on gene interactions that cause heterosis (Wiener, 1994; Haille-Mariam *et al*., 2008). The progenies from parents with such a wide genetic difference will exhibit superior high milk yield and reproductive performance from the temperate parents and high disease resistance from the indigenous parents. However, knowledge of the effects of upgrading indigenous dairy cows, using various proportions of HF inheritance is still not fully known.

The objective of this study therefore, was to reverse the gradual and steady decline in the production of milk and dairy products in Nigeria by determining the optimum HF inheritance for an improved milk yield.

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MATERIALS AND METHODS

Study area: The research was carried out using data from West African Milk Company (WAMCO) farm, a privately owned integrated commercial dairy enterprise producing a wide variety of milk products. The 1st set of animals used in the farm were imported from Holland in 1988 and comprised 76 pregnant pure bred HF cows and a few bulls, while the BJ heifers were sourced locally. The farm is located at about 1280 m above sea level and lies between longitude 08°45'E and latitude 09°43'N. It occupies 500 ha of land in the Guinea savannah belt of Nigeria. The total rainfall recorded in the farm during the period of this study (1998-2004), ranged from 1010.75-1479.77 mm, with a mean annual rainfall of 1235.88 mm. Based on the pattern of rainfall distribution, 2 major seasons (wet and dry) were identified and each of these seasons was sub-divided into early and late season. The wet season ranged from late March to early September with the peak period being between July and August and the dry season ranged from late September to early March. Maximum temperature during the period of study was 20.7°C and relative humidity taken at 10:00 am synoptic hours was 50.45%. The vegetative cover was a mixed-planted pasture sown with *Chloris guayana*.

Animal management/breeding programme: Calves were allowed to suckle their dams for 4 days after, which they were separated and bucket-fed with whole milk in the morning and evening at the rate of 10% of their body weight. At 4 weeks, calf ration containing 23.9% crude protein, hay and maize silage was fed *ad libitum.* They were weaned at 10 weeks after a live weight of between 70 and 75 kg. The heifers were fed with young-stock stable concentrate containing maize silage and whey.

Heifers were bred after they attained a body weight of 375 kg through Artificial Insemination (AI) using frozen semen of HF bulls. Natural mating was however, used after any 3 consecutive unsuccessful inseminations. Estrous was monitored in the mornings and evenings and animals showing signs of heat were mated within 12 h. Pregnancy was 1st checked at 30 days and confirmed 60 days after breeding.

Data collection, preparation and statistical analysis: Data used in this study were extracted from records kept for heifers bred in WAMCO farm from 1998-2004. Calving interval for pregnant cows whose pregnancy was confirmed was estimated at 280 days. The data were initially coded and entered into a computer file using dBase V programme. It was later crosschecked for completeness and conformity manually and later by cross tabulation using the Statistical Package for Social Sciences (SPSS).

Data with incomplete information were deleted thus, leaving a total of 88 for the analysis. The independent variables considered included genotype, method of service, calf birth season and parity, while the dependent variables were Total Milk Yield (TMY), Lactation Length (LL) and adjusted 305 Days Milk Yield (Adj. 305-DMY).

The final analysis of the data was carried out using the General Linear Model (GLM) procedure of SAS (1999). Where differences were observed, the least square mean obtained for the effects was compared using the Probability of Difference (PDIFF) procedures of SAS (1999). The final statistical model used for the analysis is stated:

$$Y_{ijklm} = \mu + G_i + M_J + S_k + C_l + E_{ijklm}$$

where:

- Y_{ijklm} = Single observation on a productive trait
- μ = Overall mean
- G_i = Mean of the ith genotype (i = 50, 75, 87.5 and 100% HF)
- M_J = Mean of the jth method of service
- S_k = Mean of the kth calf birth season
- C_I = Mean of the lth parity
- E_{ijklm} = Random error associated with the measurement, which is assumed to be normally, identically and independently distributed with a zero mean and common error variance, i.e. 2nd ($0.\acute{o}^2e$)

RESULTS

The different effects of the independent variables on the dependent variables are presented in Table 1. Calf birth season and parity significantly ($p<0.05$) influenced TMY and LL, while parity only was significantly ($p<0.05$) expressed in the Adj. 305-DMY. Cows lactating in early and late dry seasons, had similar TMY values (5596.90±484.74 and 5305.05±450.71 kg, respectively), which were statistically not significant ($p>0.05$).

They however, produced more milk than cows lactating in early wet (3892.18±380.05 kg) and late wet (3223.69±435.06 kg) season. The highest TMY (5596.90±484.74 kg) was experienced in the early dry season, while cows lactating in late wet season had the least TMY value (3223.69±435.06 kg). TMY in the 1st-3rd parities were significantly ($p<0.05$) higher than the milk yield of cows in their 4th parity.

Genotype did not influence milk yield significantly ($p>0.05$). However, cows with 50% HF inheritance yielded the least quantity of milk (3721.84±863.30 kg), while the pure bred cows (100% HF) produced the highest quantity (5251.90±364.53 kg). Cows with 75% HF

Table 1: Least Square Means (LSM) and Standard Error (SE) of effects of genetic and non-genetic factors on milk yield traits of Holstein-Friesian (HF) x Bunaji (BJ) cows

Effects	Total Milk Yield (TMY) (kg)	Lactation Length (LL) (days)	Adjusted 305-days milk yield (kg)
Overall	4629.64±1594.46	239.94±64.66	6099.97±1334.57
Genotype			
50%	3721.84±863.30	244.86±35.01	5184.19±722.50
75%	4827.23±285.50	246.00±11.58	6113.51±238.97
87.5%	4216.86±588.00	256.83±23.84	5545.89±492.16
100%	5251.90±364.53	253.86±14.78	6456.02±305.11
Method of service			
AI	4289.34±316.33	239.53±12.83	5869.91±264.77
NM	4719.56±483.01	261.25±19.59	5779.89±404.28
Calf birth season			
Early dry	5596.90±484.74^a	311.08±19.66^a	5680.84±405.73
Late dry	5305.05±450.71^a	276.42±18.28^a	6153.98±377.25
Early wet	3892.18±380.05^b	222.20±15.41^b	5789.22±318.10
Late wet	3223.69±435.06^c	191.85±17.64^c	5675.56±364.14
Parity			
1	4554.07±469.71^a	283.11±19.05^a	4794.61±393.15^a
2	5427.65±455.88^a	282.14±18.49^a	5973.75±381.57^b
3	5139.57±441.48^a	301.85±17.91^a	5346.28±369.52^a
4	2896.34±430.67^b	134.46±17.46^b	7184.96±360.47^c

^{a,b,c}Means in the same column for a given factor with different superscripts are significantly different ($p<0.05$); AI = Artificial Insemination; NM = Natural Method

inheritance yielded more milk (4827.23±285.50 kg) than their counterparts with 87.5% HF inheritance (4216.86±588.0 kg).

The LL for cows that calved in late wet season was significantly ($p<0.05$) shorter at 191.85±17.64 days than those that calved during other seasons as shown in Table 1. No significant ($p>0.05$) difference was observed in the LL for early dry and late dry season cows (311.08±19.66 and 276.42±18.28 days, respectively), but early dry season cows produced milk for 34.66 days longer than late dry season cows. There was a significant ($p<0.05$) difference in the LL of cows in the 4th parity when compared to the LL of cows in the 1st-3rd parities. Parity was the only independent variable that exerted a significant ($p<0.05$) influence on the Adj. 305-DMY. Genotype and method of service statistically ($p>0.05$) did not influence TMY, LL and Adj. 305-DMY.

DISCUSSION

The superior performance of the crossbred with increasing (up to 75%) HF inheritance must have been due to the greater heterozygosis resulting from a wide genetic distance existing between the 2 parents as earlier observed in *Bos taurus* x *Bos indicus* cows by Cunningham and Syrstad (1988). The significant seasonal variations in TMY observed among the crossbred were in agreement with previous studies of (Khattab and Ashmawy, 1988; Vij *et al*., 1992), who observed a linear decrease in TMY from early dry through late wet seasons. The general expectation in this study was that cows lactating during the wet season should have produced more milk than dry season cows since they depended on natural pastures, which flourished during the wet season (Negussie *et al*., 1999). However, the high values of TMY during the dry season may be attributed more to the prevailing favourable climatic conditions at Vom rather than the feeding practice in the farm. The high humidity (63.86%) noted during the wet season might have reinforced the effect of the high temperature (21.57°C), thereby depressing feed intake with a resultant reduction in TMY.

The increased TMY with age when compared to yields in the 1st parity can be attributed to both greater mammary development and increased gut capacity (Green *et al*., 1991). Furthermore, a general physiological growth is known to continue in dairy cows after the 1st lactation till the 4th parity (Maynard *et al*., 1979). This growth stimulates extensive proliferation of new secretory cells that will produce more milk in subsequent lactations (Brown *et al*., 2005). The sudden decline in TMY observed in the 4th parity was contrary to the findings of Ibeawuchi (1988), who reported a significant ($p<0.05$) increase in the 3rd and 4th parities among F_1 HF x BJ cows. The low milk yield in the 4th parity may therefore be attributed to a high number of lactating cows that were either in their advanced stage of gestation or lactation and possibly nearing their drying-off period.

The overall mean of LL (239.94±64.66 days) was about 65 days shorter than the 305 days desired for dairy cows in the tropics (Syrstad, 1993). The 305 days lactation could not be attained because cows were observed to dry up twice (133.17±70.69 days) earlier than the period required for 305-days lactation at the WAMCO farm. A similar observation was made by Syrstad (1991), who noticed that milk production in tropical cattle can cease several months before the next calving. The excellent performance of dry season lactating cows could have been due to the relatively conducive climatic factors, which resulted in cooler temperatures and lower relative humidity than those obtained in the wet seasons (Azage *et al*., 1981). Cows in their 4th parity yielded a significantly ($p<0.05$) higher Adj. 305-DMY than those in the 1st-3rd parities. This could be as a result of the fact that cows that were in the 4th parity did not complete their lactation but were at various levels of production when this study was carried out.

CONCLUSION

The results of this study showed that BJ cows with 75% HF inheritance on the average, exhibited greater potential for increased milk yield than other genotypes. The dry season was the best season for optimum milk yield as cows calving during this season lactated for a significantly longer period with higher milk yield than the wet season lactating cows.

ACKNOWLEDGEMENT

The authors are very grateful to the management of West African Milk Company (WAMCO) Vom, Plateau State, Nigeria for providing the data and allowing free access to their facilities.

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