

Factors Influencing Milk Yield Characteristics in Bunaji and Friesian x Bunaji Cows in Northern Nigeria

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Abstract. This study was conducted to determine the effect of hemoglobin(Hb) type, breed, sex and season of calving on milk yield characteristics of Bunaji and Friesian x Bunaji cows. The experimental animals consisted of 24 Bunaji and 26 (F1) cross bred (Friesian x Bunaji) cows. The milk yield characteristics were initial milk yield (IMY), end of lactation yield (ELY), peak yield (PY), total milk yield (TMY), and lactation length (LL). The mean values of the milk yield characteristics were 13.69 kg, 61.25 kg, 10.87 kg, 1740 kg and 325.92 days for IMY, PY, ELY, TMY and LL, respectively. These milk yield characteristics were highly variable, with their CV ranging from 11.60 (LL) to 83.00 (IMY). Hb-type significantly influenced milk yield characteristics of the cows. The Hb^{AA} was superior in IMY, PY and TMY compared to Hb^{AB} and Hb^{BB}. The Hb^{AB} was superior in ELY, while Hb^{BB} had the longest LL of 343 days. Breed significantly influenced milk yield characteristics except IMY. The Friesian x Bunaji cows were superior to Bunaji in all the milk yield characteristics. Sex of calves had significant effect on IMY, and LL but not on PY, ELY and TMY. Cows bearing female calves were superior to cows bearing male calves in IMY, while cows with male calves had longer LL. Season of calving significantly affected the milk yield characteristics of cows. Early wet season was superior in IMY and PY, while late wet season had higher PY, ELY, and LL. The TMY was higher and statistically the same in both early wet and late wet season, while the early dry season had the least TMY. In view of the significant influence of these factors on milk yield characteristics of these cows it is therefore important to take them into consideration in any selection programme aim at improving the milk yield characteristics of the cows.

Key Words: Bunaji, Friesian, hemoglobin, milk yield characteristics

Introduction

The white Fulani (Bunaji) is the most numerous and wide spread of all the Nigerian cattle breeds accounting for about 37% of the national cattle population (Oni et al., 2001). The Bunaji as a breed of cattle has been comprehensively reviewed by Tawah and Rege (1996). They are mainly owned by the Nomadic Fulani people who occupy the belt between the Sahara and the costal rainforest from the west of the river Senegal to the east of Lake Chad, including parts of western Senegal, Southern Mauritania, in and around the flood plains of the Niger, Chad, Northern Nigeria and Cameroon. Origin and classification of the white Fulani cattle remain controversial. Tawah and Rege (1996) have summarized existing theories about the genetic constitution of the white

Fulani, including evidences suggesting that it has both *Bos Taurus* and *Bos indicus* ancestry. The main limiting factors of these tropical breeds as it relates to milk yield include: late sexual maturity, long interval between calving and short lactation length (Alphonsus, 2008). In Nigeria, cattle provide more than 90% of the total annual domestic milk output (Walshe et al., 1991) with the Bunaji breed recognized as the principal producer (Adeneye, 1989). Of all the local breeds of cattle in Nigeria, Bunaji (White Fulani) is the most wide spread and extensively studied. It was first introduced to National Animal Production Research Institute (NAPRI) Shika in 1928 and for many years it constituted the entire milking herd until 1964 when cross-breeding with Friesian sires commenced (Malau-Aduli and Abubakar, 1992). The introduction of Friesian sire in Nigeria has

produced a stabilized crossbred Friesian x Bunaji cows whose dairy performance has been adjudged to be higher than the pure Bunaji. First generation cross bred generally have been reported (Richard, 1993) to yield twice that of the indigenous pure breeds. The evaluation of the milk yield characteristics of these indigenous breed and there crosses as well as the factors that could influenced there dairy performance is very important in formulation of breeding programme aimed at improving their dairy performance. Therefore, the objective of this study was to determine the effect of some factors on milk yield characteristics of Bunaji and Friesian X Bunaji cows.

Materials and Methods

Location

The study was conducted on the dairy herd of the National Animal Production Research Institute (NAPRI) Shika, Nigeria, located between latitude 11^o and 12^o N at an altitude of 640 m above sea level, and lies within the northern guinea savannah zone. The mean annual rainfall in this zone is 1,100 m which commence from May and last till October, of which 90% falls during the wet rainy season (June–September). Following the wet season is a period of dry, cool weather called “harmattan”, which marks the onset of the dry season, this extends from mid-October to January. The dry season (February–May) is characterized by very hot weather conditions. At this period daily temperature range from 21 to 36 °C, the mean relative humidity is 21 and 72% during “harmattan” and the rainy season, respectively (Oni et al., 2001)

Experimental animals and their management

The experimental animals consisted of 24 Bunaji and 26 (F₁) cross bred (Friesian x Bunaji). The animals were allowed free grazing on both natural and sown pasture under the supervision of the herd men for about 7–9 hour daily. Two kilogram of concentrate mixture (88% dry

matter, 15% crude protein and 55% total digestible nutrient) fortified with a mineral mixture and salt was offered to each animal daily in evening, when they were tied in a shed. The animals had free access to water throughout the day, and regular spraying against ticks was observed while vaccination was carried out against contagious diseases.

Blood sampling and hemoglobin genotype analysis

Hemoglobin type was analyzed by electrophoresis at hematological laboratory of Ahmadu Bello University Teaching Hospital, Zaria. The hemoglobin types identified were AA, AB and BB. Interpretations were made based on the relative mobility of the haemoglobin bands towards the anode with hemoglobin AB (double band) having slow and fast bands, the HbA (single band) being the slowest and HbB (single band) being the fastest. Result was documented for each animal

Milk sampling, milk yield determination analysis

Cows were milked with hand and the frequency of milking was one’s daily (morning) for Bunaji and twice daily (morning and evening) for the crossbred, commencing 3–4 day postpartum. The daily milk yield of the cows was measured in liters using calibrated measuring cylinder. The milk yield of the cows throughout it lactation was used to determine the initial milk yield (IMY), peak yield (PY), end of lactation yield (ELY), total milk yield (TMY) and average lactation length (LL) of the cows.

Data analysis

Analysis of variance procedure of SAS (SAS, 1998), was used to determine the effect of hemoglobintype, breed, sex of calf, season of calving on milk yield characteristics. The seasons were grouped into four according to the weather pattern as follows:

Season 1: January–March (late dry); Season 2: April–June (Early wet); Season 3: July–September (late wet) and Season 4: October–

December (early dry). The model used is as follows $Y_{ijkl} = \mu + B_i + C_j + H_k + S_L + e_{ijkl}$
 Where: Y_{ijkl} = estimates of a given measurable characteristics; μ = over all mean; B_i = effect of i^{th} breed (i = Bunaji, Friesian x Bunaji); C_j = effect of j^{th} sex of calf (j = male, female); H_k = effect of k^{th} hemoglobin types (k = AA, AB, BB); S_L = effect of l^{th} season of lactation (l = 1...4); e_{ijkl} = random error.

Results and Discussion

The summary statistics of the average milk yield and milk composition characteristics of the cows is shown in Table 1. The observed mean values were initial milk yield (IMY) 13.69 kg, peak yield (PY) 61.25 kg, end of lactation yield (ELY) 10.87 kg, total milk yield (TMY) 1740 kg and lactation length (LL) 325.92 days. The observed characteristics were highly variable, with their CV ranging from 11.60 to 83.00. The most variable trait was IMY while LL was the least variable.

The effect of Hb type on milk yield characteristics is presented in Table 2. Hemoglobin type significantly ($P < 0.05$) influenced milk yield characteristics in both Bunaji and Friesian x Bunaji cows. The Hb^{AA} was superior for IY, PY, TMY and intermediate for ELY and LL compared to Hb^{AB} and Hb^{BB}. The Hb^{AB} was superior in ELY compared to Hb^{AA} and Hb^{BB}, however Hb^{BB} had longer LL but inferior in all other traits.

The effect of breed on milk yield characteristics is presented in Table 3. Breed significantly ($P < 0.05$) influenced milk yield characteristics except IMY. The Friesian x Bunaji cows were superior to Bunaji in all the milk yield

performance characteristics. Sex of calf significantly ($P < 0.05$) influenced IMY and LL but not PY, ELY and TMY (Table 4). Female bearing cows were superior to male bearing cows in IMY, while cows with male calves in turn had longer LL.

The effect of season on milk yield characteristics is presented in Table 5. Season of calving significantly ($P < 0.05$) influenced the milk yield characteristics of cows. Early wet season was superior in IMY and PY, while late wet season had higher PY, ELY, and LL. The total milk yield was higher and statistically the same in both early wet and late wet season, while the early dry season had the least TMY.

The high variation of the milk yield characteristics in this study suggest that these traits can be improved through selection, this is in line with the earlier report of Pollott (2004) and Alphonsus et al. (2010) that milk yield characteristics are traits with adequate genetic variation to allow selection responses. This is evident by the observed high coefficient of variation in this study which ranged from 11.60 to 83.00%.

The Bunaji has since been recognized in Nigeria and other parts of West Africa as a good dual purpose breed. Mondal et al. (2005) quoted total milk yield/lactation of 1,082 kg with over 7.5% butter fat in 305 days. Akpa et al. (2006) and Aduli (1992) reported 2,078 kg and 2,420 kg, respectively in Friesian x Bunaji cows. The average TMY of 1,740 kg obtained in this study was within these previous studies but much higher than the 945 kg reported by Akpa et al. (2007) in Friesian x Bunaji heifers. However, the mean total yield in this study was

Table 1. Summary statistics of milk composition and milk yield of Bunaji and Friesian x Bunaji cows

Characteristics	N	Mean \pm SE	Coefficient Variance (%)	Variance
Initial Yield (kg)	50	13.69 \pm 1.61	83.00	129.14
End of Laction Yield (kg)	50	10.87 \pm 0.93	60.62	43.46
Peak yield (kg)	50	61.25 \pm 2.94	34.00	433.57
Total Milk Yield (kg)	50	1740 \pm 89.65	36.43	401886.68
Lactation Length (days)	50	325.92 \pm 5.34	11.60	1428.32

Table 2 Effect of haemoglobin type on milk yield characteristic

Characteristics	Hemoglobin Types			SEM	LOS
	AA	AB	BB		
Initial Milk Yield (kg)	15.56 ^a	11.22 ^b	10.15 ^b	1.609	*
Peak Yield (kg)	66.36 ^a	56.01 ^b	36.95 ^c	2.83	*
End of Lactation Yield (kg)	10.33 ^b	11.75 ^a	10.45 ^b	0.947	*
Total Milk Yield (kg)	1846.50 ^a	1600.60 ^b	1525.60 ^b	89.69	*
Lactation Length (days)	330.21 ^b	317.58 ^c	342.00 ^a	5.361	*
Number of observation	24	26	50		

Values bearing different superscript at the same row differ significantly ($P < 0.05$). * = $P > 0.05$

Table 3. Effect of breed on milk yield characteristics

Milk yield characteristics	Breed		SEM	LOS
	Bunaji	Friesian x Bunaji		
Initial Milk Yield (kg)	13.68	13.70	1.624	ns
Peak Yield (kg)	48.47 ^b	73.04 ^a	2.390	*
End of Lactation Yield (kg)	8.86 ^b	12.72 ^a	0.877	*
Total Milk Yield (kg)	1322.30 ^b	2126.10 ^a	69.611	*
Lactation Length (days)	311.50 ^b	339.23 ^a	5.016	*
Number of observation	24	26	50	

Values bearing different superscript at the same row differ significantly ($P < 0.05$); * = $P > 0.05$; ns = non significant

Table 4. Effect of sex of calf on milk yield characteristics

Milk yield characteristics	Sex of calf		SEM	LOS
	Male	Female		
Initial Milk Yield (kg)	10.17 ^b	16.70 ^a	1.554	*
Peak Yield (kg)	59.93	62.37	2.970	ns
End of Lactation Yield (kg)	10.92	10.81	0.942	ns
Total Milk Yield (kg)	1731.70	1747.50	90.576	ns
Lactation Length (days)	333.87 ^a	319.15 ^b	5.295	*
Number of observation	23	27	50	

Values bearing different superscript at the same row differ significantly ($P < 0.05$); * = $P > 0.05$; ns = non significant

Table 5. Effect of season on milk yield characteristic

Milk yield Characteristics	Season				SEM	LOS
	Early dry	Late dry	Early wet	Late wet		
Initial Milk Yield (kg)	12.56 ^b	12.93 ^b	17.13 ^a	10.99 ^b	1.619	*
Peak Yield (kg)	50.41 ^c	52.46 ^c	71.06 ^a	64.95 ^b	2.758	*
End of Lactation Yield (kg)	8.80 ^d	9.37 ^c	10.43 ^b	14.29 ^a	0.911	*
Total Milk Yield (kg)	1227.60 ^c	1525.00 ^b	1954.20 ^a	2053.40 ^a	79.530	*
Lactation Length (days)	298.20 ^d	321.36 ^c	332.06 ^b	343.54 ^a	4.997	*
Number of observation	10	11	16	13	50	

Values bearing different superscript at the same row differ significantly ($P < 0.05$); * = $P > 0.05$

far lower than the 6,198 kg and 6,440 kg reported by Mantyssari et al. (2002) for Friesian and Ayrshire breed, respectively and the 6,679 kg reported by Kadarmideen (2004) in Swiss Holstein. The Friesian, Ayrshire and Swiss Holstein are pure breeds developed as dairy breeds and therefore, they are bound to be superior in milk production. Syrstad (1991)

reported that cattle in the tropics have on average, lower milk yield and shorter lactation length than cattle in temperate countries. The difference is caused by both genetic and non-genetic factors.

The average lactation length of 325.92 days in this study was higher than the 218, 250 and 246.40 days reported by Akpa et al. (2006),

Aduli (1992) and Alphonsus (2008) in Friesian Bunaji crosses. Although the value reported in this study was higher than the one reported by these authors. It is however closed to the 310 days reported by Kahi et al. (2000) in Brown Swiss-Sahiwal crossbred cows. The observed differences may be due to both genetic and Environmental factors. The average peak yield of 61.25 kg obtain in this studies was higher than 7.4 kg and 9.3 kg reported by Akpa et al. (2006) and Tekerli et al. (2001), respectively in Friesian x Bunaji and Anatolian buffaloes.

The observed variation in milk yield characteristics with Hb-type had earlier been reported by Samarineanu et al. (1982). These author observed that Hb^{AB} were superior to both Hb^{AA} and Hb^{BB} in milk yield. However, in this study, cows with Hb^{AA} were superior to Hb^{AB} and Hb^{BB} in IMY, PY and TMY. The variation in the performance of the cows due to differences in Hb-types suggests that different Hb-types may have selective advantage in different geographical region (Ndamukong, 1995). Therefore, haemoglobin which is a simplest of the genetic markers can be explore to help in improving the dairy performance of the indigenous cattle breed by identifying the Hb-type that is more adaptive to a particular environment and has a comparative advantage in milk yield characteristics. The observation in this study suggest that in the study area, Zaria, Bunaji cows and their crosses with Hb^{AA} have high potential for milk yield than those with Hb-type AB and BB.

The observed significant effect of breed on milk yield characteristics had also been reported by Syrstard (1991) and Murray (1992). The significant difference in milk yield characteristics of Bunaji and Friesian x Bunaji cow is an indication that the percentage of Friesian genes in the crosses had significant influence on the dairy performance of the cows (Alphonsus, 2008). The crossbred cows were superior to the pure breed in all the milk yield characteristics. The higher milk yield of the

Friesian x Bunaji over the pure Bunaji agreed with the principle of heterosis in animal breeding where by offspring of crosses are expected to perform above the average of the two parents (Legates and Warwick, 1990; Bryant et al., 2005). This therefore, suggests that the basic strategy for improving the dairy performance of this indigenous genotype is by crossbreeding with the high yield temperate breed. This would help in blending the adaptability of the indigenous breed with the temperate breed (Roche et al., 2006). The first generation crossbred has been reported to generally yield twice that of the indigenous purebred (Roche et al., 2006). However, increase in the number of the temperate genes beyond the first generation crossbred may reduce the performance of their offspring due to loss of heterosis and reduced adaptability. Madalenaet et al. (1980) suggested that performance of higher levels of upgrade crossbred cattle can be disappointing, because milk production per cow may decrease after the first cross because of loss of heterosis, recombinant genetic effect or deterioration of environment levels (feeding and management). The introduction of Friesian sire in Nigeria has produced a stabilized crossbred Friesian x Bunaji cows whose dairy performance has been adjudged to be higher than the pure Bunaji (Richard, 1993).

The effect of sex on milk yield has been reported by Alphonsus (2008) with the male bearing cows having higher milk yield than their female bearing counterpart. However, in this study the effect of sex of calf was significant on IMY, PY and LL. The male bearing cows had higher PY and longer LL.

The significant effect of season on milk yield characteristics agreed with the earlier reports of Akpaet al. (2003), Akpaet al. (2006) and Gebeyehu et al. (2007). Milk yield was significantly higher during the early wet season (April-June) in line with some previous studies (Akpaet al., 2006; Alphonsus, 2008). This is

probably so because the cows were able to utilize the lush of pasture growth that coincides with the onset of the rains. The variations observed in the milk yield with season may be due to the changes in quality and quantity of pasture available to the cows to feed on across the seasons (Akpa et al., 2006). The significant effect of season on the milk yield is an indication of the high contribution of the environment to the milk yield characteristics of the cows, thus poor management and other environmental factors can affect the milk yield characteristics of these cows.

Regarding the milk yield characteristics of these cows, the wet season (early and late wet) was the best with high IMY, PY, ELY, TMY and longer LL. This implies that breeding season of the cows should be plan in such a way that the cows calve during the early wet season at the onset of the rains so as to coincide with the period of abundant pasture.

The significant effect of year of calving on milk yield is a reflection of possible fluctuation in the environmental influences on the lactating cows across the years. In situations where both the amount and distribution of the annual rainfall fluctuates greatly such significant differences are expected since it will affect the quality and quantity of pasture available for the cows to feed on (Akpa et al., 2006). However, almost all the milk yield characteristics were significantly influenced by the variations in the years of calving.

Conclusions

The significant effect of hemoglobin type, breed, sex of calf and season of calving on milk yield characteristics of these cows suggests that these factors are important sources of variation in the dairy performance of these cows, thus they should be taking into consideration in the formulation of dairyprogramme aim at improving the milk yield characteristics of the cows.

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