VARIATION IN YIELD AND COMPOSTION OF MILK FROM DIFFERENT UDDER QUARTERS OF LACTATING WHITE FULANI CATTLE IN A TROPICAL ENVIRONMENT

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ABSTRACT

For the first 150 days of lactation, 12 White Fulani early dry season calvers produced a daily average of 2.5kg milk containing 12.6% total solids, 3.8% fat, 8.9% solids-not-fat, 4.2% protein, 4.0% lactose and 0.7% total ash. Poor nutrition, inbreeding, age and weight of animals appeared to be largely responsible for the low yield. Substantially more milk (P< 0.01) was produced in the morning (62.4%) than evening and from the rear (56%) than fore udders. Both the evening and rear udder milk were remarkably (P.01) richer in total solids, fat and solids-not-fat. Evening and fore udder milk contained significantly less lactose but more protein (P< 0.01). The udder position x time of milking interactions on milk yield and composition were highly significant (P 0.01) but the effects of year were negligible (P 0.05). The stage of lactation influenced fat, protein and total ash content very significantly (P 0.01). Peak milk production occurred during the second month of lactation.

Key words:- Udder quarters, evening, morning milk composition White Fulani.

INTRODUCTION

Since the four quarters of a cow's udder are anatomically and physiologically different (Benton, 1929), udder characteristics would therefore contribute significantly to the variations in the amount and composition of milk. For example, Schmidt (1971) and Bath et al., (1978) have shown that the rear udders are larger than the fore udders and secrete an average of 60% of the milk obtained per day from a cow. The rear udders have also been found to be more richly supplied with blood vessels than the fore udders (Dyce and Wensing, 1971). According to Suchanek and Kvapilik (1974), the concentrations of total solids and solids-not-fat in fore and rear udder milk differ significantly.

There are reports that milking intervals also influence milk yield and composition. Morning milk yield is known to be greater than evening milk but poorer in its content of total solids (TS), fat, solids-not-fat (SNF) and protein (Schmidt, 1960; Laben, 1963; Gilmore and Gaunt, 1963; Everest and Wadell, 1970; Gilbert et al., 1973).

Evidence of influence of stage of lactation on yield and composition of milk also exists. Maximum milk produced during the second to third month of lactation contains the least concentrations of TS, fat, and SNF (Legates, 1960; Johnson et al., 1961; Ghosh and Anantakrishnan, 1964; Maynard and Loosli, 1969; Gilbert et al., 1973).

There is as yet no published information on the yield and composition of morning (a.m) and evening (p.m) milk from the fore and rear udders of lactating White Fulani cattle in the hot and humid western Nigeria environment. This paper meets that need.

MATERIALS AND METHODS

Twelve White Fulani animals that calved at the beginning (October-November) of 1985/86 and 1986/87 dry seasons were used for the experiment which lasted the first 150 days of lactation. They were dewormed, deticked, housed in open-sided asbestos- roofed individual pens with bedded concrete floor, and routinely managed semi- intensively. They were fed a supplementary dairy concentrate ration consisting of 53% wheat offals, 30% dried brewer's grains, 10% palm kernel meal, 5% maize, 1% oystershell, 0.5% common salt and 0.5% vitamin premix, once daily at 8.00a.m. at the rate of 1kg per kg milk produced by each animal. They were grazed on paddocks sown to Cynodon nlemfuensis and Panicum maximum but overgrown with inedible weeds such as Sida sp., Amaranthus spinosus, Calopogonium mucunoides and sedges. Additional grazing on surrounding bushes, abandoned poultry litter, Tridax procumbens and fallen pods from leguminous trees provided unknown dry matter and nutrient intake. Grazing period was 9.00a.m. to 3.00p.m. local time. Water and salt lick were provided ad libitum. Wet brewer's grains were fed in pens when available.

The animals which were chosen from the White Fulani herd kept at the University of Ibadan Teaching and Research Farm and inbred for more than three decades (1950 to date) were conventionally hand-milked twice daily (6.30a.m and 3.30p.m.).

At each milking, milk from the fore and udders was collected separately into clean labelled buckets and accurately weighed. Representative milk samples were taken monthly for laboratory analyses of TS, fat, protein and total ash by the A.O.A.C. (1975) procedures. SNF was obtained by difference. Lactose determination was by Barnett and Tawab (1957) methods as modified by Marier and Boulet (1959).

A 5-way classification analysis was imposed on the data (Steel and Torrie, 1960). The Duncan's multiple range test (1955) was appled and correlation analysis carried out on fore and rear udders as well as a.m. and p.m. milking time.

(DMY) averaged 2.5kg (range = 1.88 - 3.85kg) in the first 150 days of lactation. There was considerable variation ($P < 0.01$) in milk production among the animals.

Mean a.m. milk from both udders (1.56 kg/day) constituted 62.4% of the average DMY and appreciably ($P < 0.01$) exceeded p.m. milk by 0.62 kg/day. A negative correlation ($r = -0.45$) observed between a.m. and p.m. milk was not significant ($P > 0.05$).

Substantially more milk ($P < 0.01$) was obtained from the rear than fore udders (1.40 v. 1.10 kg/head/day). The rear udder milk amounted to 56% of the average DMY. The mean daily milk yields from the fore and rear udders were highly correlated ($r = 0.90$).

The rear udder produced 55.8 and 56.4% of the a.m. and p.m. milk respectively. Also, a.m. milk from the rear udder (0.87kg/day) con-

TABLE 1 MEAN MORNING AND EVENING MILK YIELD (KG/DAY) FROM THE FORE AND HIND UDDERS OF WHITE FULANI CATTLE IN IBADAN

Milking Time	Udder Position	Month of lactation 1st	2nd	3rd	4th	5th	1st - 5th
a.m.	Fore	0.70	0.73	0.61	0.69	0.75	0.69 ± 0.02
	Hind	0.89	0.88	0.75	0.86	0.94	0.87 ± 0.03
	Both	1.59	1.61	1.36	1.55	1.69	1.56 ± 0.05
p.m.	Fore	0.40	0.49	0.46	0.39	0.32	0.41 ± 0.03
	Hind	0 57	0.63	0.56	0.47	0.40	0.53 ± 0.04
	Both	0.97	1.12	1.02	0.86	0.72	0.94 ± 0.07
a.m. plus p.m.	Fore	1.10	1.22	1.07	1.08	1.07	1.10 ± 0.03
	Hind	1.46	1.51	1.31	1.33	1.34	1.40 ± 0.04
	Both	2.56	2.72	2.38	2.41	2.41	2.50 ± 0.06
a.m. minus p.m.	Fore	0.30	0.24	0.15	0.30	0.43	0.28 ± 0.05
	Hind	0.32	0.25	0.19	0.39	0.54	0.43 ± 0.06
	Both	0.62	0.49	0.34	0.69	0.97	0.62 ± 0.11

RESULTS

Milk yield

The a.m. and p.m. milk yield from the fore and rear udders of White Fulani (WF) animals that calved at the beginning of the two consecutive dry seasons is in Table 1. Daily milk yield

stituted 62.1% of the DMY from the hind udder p.m. milk was 59.4% of the average fore udder a.m. milk. These observed differences were highly significant ($P < 0.01$).

Mean DMY from the fore, rear and both udders peaked during the second month of lactation and declined to a fairly constant level later.

This trend was, however, different with the a.m. and p.m. milk. The mean a.m. daily milk yield increased slightly during the second month of lactation, declined to a minimum level during the third month and increased to a maximum of 1.69 kg/day at the fifth month of lactation. But the average p.m. DMY peaked in the second month and declined gradually as lactation advanced. The effect of stage of lactation on milk yield was small ($P > 0.05$) but the interaction effects of time of milking, udder position and stage of lactation were significant ($P < 0.05$).

The differences between a.m. and p.m. milk from the fore, rear and both udders were high in the first month of lactation, declined to the lowest levels during the fifth month. They were lower in the fore than hind udder throughout the lactation period studied.

Total solids (TS)

There was a highly significant (P 0.01) greater concentration of TS in p.m. than a.m. milk (13.2 v 12.0%, Table 2). A similar highly remarkable

TABLE 2 MEAN TOTAL SOLIDS AND FAT CONTENT OF MORNING AND EVENING MILK FROM FORE AND REAR UDDERS OF WHITE FULANI CATTLE IN IBADAN.

Milking time	Udder position	Month of lactation 1st	2nd	3rd	4th	5th	1st - 5th
		Total Solids (%)					
a.m.	Fore	11.5	11.3	11.2	11.9	12.3	11.7 ± 0.20
	Rear	12.6	12.2	12.4	11.9	12.8	12.4 ± 0.16
	Both	12.1	11.8	11.8	11.9	12.6	12.0 ± 0.15
p.m.	Fore	12.9	12.4	12.2	12.6	13.0	12.6 ± 0.14
	Rear	14.2	13.5	14.0	13.4	13.5	13.7 ± 0.16
	Both	13.5	12.9	13.1	13.0	13.2	13.2 ± 0.11
a.m. + p.m.	Fore	12.2	11.9	11.7	12.3	12.6	12.1 ± 0.16
	Rear	13.4	12.8	13.2	12.7	13.2	13.0 ± 0.14
	Both	12.8	12.4	12.5	12.5	12.9	12.6 ± 0.11
a.m.-p.m.	Fore	-1.3	-1.1	-1.0	-0.7	-0.7	-1.0
	Rear	-1.6	-1.3	-1.5	-1.4	-0.7	-0.7
	Both	-1.5	-1.2	-1.3	-1.1	-0.7	-1.1
		Milk fat (%)					
a.m.	Fore	2.9	2.8	2.8	3.3	4.1	3.2 ± 0.24
	Rear	3.9	3.5	3.3	3.3	4.2	3.6 ± 0.17
	Both	3.4	3.2	3.0	3.3	4.1	3.4 ± 0.19
p.m.	Fore	4.2	3.9	3.2	3.6	4.0	3.8 ± 0.18
	Rear	4.9	4.7	4.5	4.0	4.0	4.4 ± 0.19
	Both	4.6	4.3	3.8	3.8	4.0	4.1 ± 0.15
a.m. + p.m.	Fore	3.5	3.4	3.0	3.5	4.0	3.5 ± 0.17
	Rear	4.4	4.1	3.9	3.6	4.1	4.0 ± 0.13
	Both	4.0	3.8	3.4	3.6	4.1	3.8 ± 0.12
a.m. - p.m.	Fore	-1.3	-1.1	-0.4	-0.3	0.0	-0.6
	Rear	-1.1	-1.2	-1.2	-0.7	0.1	-0.8
	Both	-1.2	-1.2	-0.8	-0.5	0.01	-0.7

difference was found between the TS content of fore udder p.m. milk was richer in TS than fore udder a.m. milk by 1%. The TS percentage of hind udder p.m. milk exceeded that of a.m. milk from the fore, rear and both udders by 2.1, 1.3 and 1.7% respectively. Morning milk from the fore udder contained the least TS (Table 2). The effects of udder position and interactions between udder position and time of milking were highly significant ($P < 0.01$).

Average TS content of milk from the udders was high in the first month of lactation, declined in second month and generally increased thereafter but the effect of stage of lactation on TS percentage was not significant ($P > 0.05$).

Variations in TS content of milk of individual animals were negligible ($P > 0.05$). But on the whole, the milk of the dry season calvers contained an average of 12.6% TS.

The superiority of TS content of p.m. milk over that of a.m. milk from the fore, hind, and both udders diminished as lactation progressed and averaged 1.0, 1.3 and 1.1% respectively (Table 2).

A positive correlation ($r = 0.47$) found between TS content of a.m and p.m. milk was not significant ($p > 0.05$).

Milk fat

Table 2 shows the milk fat values. The fat content of the milk produced during the first five months of lactation by WF dry season calvers averaged 3.8% and constituted 29.8% of the dry milk solids. Evening milk and milk from the rear udder wer appreciably richer ($P < 0.01$) in fat, 4.1 and 4.0% respectively, than the a.m. and fore udder milk which contained 3.4 and 3.5% respectively. Morning milk from the fore udder was poorest in fat content during the first 90 days of lactation unlike the hind udder p.m. milk with the highest fat percentage during the first 120 days. The interaction effect was highly significant ($P < 0.01$). The average fat content of p.m milk from the rear udder exceeded tha of a.m. milk from the fore, hind and both udders, as well as of p.m. milk from the fore udder by 1.3, 0.8, 1.0 and 0.7% respectively.

The fat content of milk produced daily from all udders declined from 4.0% in the first month of lactation, reached the lowest level (3.4%) in the third month and incresed thereafter to the highest 4.1% level in the fifth month. The effect of stage of lactation on fat content was significant ($P < 0.05$).

Differences between the fat content of a.m. and p.m. milk from the fore and both udders diminished during the first fout months of lactation. The trend was not so with milk from the hind udder.

Variations in the milk fat content of individual animals were small ($P > 0.05$). Similarly, the positive correlations observed between the fat content of a.m. and p.m. milk ($r = 0.13$) and of fore and rear udder milk ($r = 0.26$) were not significant ($P > 0.05$).

Solids-not-fat (SNF)

As shown in Table 3, both the p.m. and hind udder milk were appreciably richer ($P < 0.01$) in SNF than the a.m. and fore udder milk. SNF content of milk secreted by individual animals varied little (P 0.05). The concentration of SNF was high in the first month of lactation, least in the second month and increased thereafter but the effect of stage of lactation was not significant ($P > 0.05$). Morning milk from the fore udder and p.m. milk from the rear udder contained the least and highest SNF persentage respectively. In fact, p.m. milk from the hind udder was richer in SNF than the average milk produced daily by both udders during the first five months f lactation. On the whole, the mean SNF content (8.9%) amounted to 70.2% of the milk dry solids. SNF concentration in the fore and rear udders were positively correlated ($r = 0.77$) but not significantly ($P > 0.05$).

Differences between the SNF content of a.m. and p.m. milk from the udders were small in the first month of lactation, least in the second month but increased considerably as lactation progressed. During the entire 150 days of lactation, SNF content of p.m. milk form the fore, rear and both udders was 0.4, 0.5 and 0.4% higher respectively than the corresponding a.m. milk from the udders.

Protein

Protein content of p.m. milk was considerably superior ($P < 0.01$) to that of a.m. milk, 4.5 v. 3.8%. Milk from fore udder was also significantly richer ($P < 0.05$) in protein content than hind udder milk, being 4.3 and 4.0% respectively. Animals differed little ($P > 0.05$) in their milk protein content but the effect of stage of lactation was highly significant (P 0.01). Milk protein percentage declined sharply from 4.1% in the first month of lactation to the lowest 3.9% in the second, increased to a constant level in the 3rd-

TABLE 3 : MEAN SOLIDS-NOT-FAT, PROTEIN, LACTOSE AND ASH CONTENT OF MORNING AND EVENING MILK FROM THE FORE AND REAR UDDERS OF WHITE FULANI CATTLE IN IBADAN

Milking time	Udder position	Month of lactation						Month of lactation					
		1st	2nd	3rd	4th	5th	1st - 5th	1st	2nd	3rd	4th	5th	1st - 5th
		Solids-not-fat (%)						Lactose (%)					
a.m.	Fore	8.7	8.5	8.5	8.6	8.2	8.5 ± 0.07	3.6	3.7	3.6	3.5	3.6	3.6 ± 0.03
	Rear	8.8	8.7	9.1	8.7	8.7	8.8 ± 0.08	4.5	4.4	4.8	4.4	4.2	4.5 ± 0.01
	Both	8.8	8.6	8.8	8.7	8.5	8.7 ± 0.06	4.1	4.1	4.2	4.0	3.9	4.1 ± 0.05
p.m.	Fore	8.7	8.5	9.1	9.0	9.0	8.8 ± 0.11	3.5	3.7	4.1	3.8	3.7	3.8 ± 0.10
	Rear	9.3	8.7	9.5	9.4	9.5	9.3 ± 0.14	4.2	3.9	3.9	4.0	4.2	4.3 ± 0.06
	Both	9.0	8.6	9.3	9.2	9.3	9.1 ± 0.12	3.9	3.8	4.0	3.9	3.9	3.9 ± 0.03
a.m. + p.m.	Fore	8.7	8.5	8.8	8.8	8.6	8.7 ± 0.06	3.6	3.7	3.9	3.7	3.7	3.7 ± 0.05
	Rear	9.0	8.7	9.3	9.0	9.1	9.0 ± 0.09	4.4	4.2	4.3	4.2	4.2	4.3 ± 0.04
	Both	8.9	8.6	9.1	9.0	8.9	8.9 ± 0.07	4.0	4.0	4.1	4.0	3.9	4.0 ± 0.03
a.m. – p.m.	Fore	0.0	0.0	-0.6	-0.4	-08	-0.3	0.1	0.0	-0.5	-0.3	-0.1	-0.2
	Rear	-0.5	0.0	-0.4	-0.7	-0.8	-0.5	0.3	0.5	0.9	0.4	0.0	0.5
	Both	-0.2	0.0	-0.5	-0.5	-0.8	-0.4	0.2	0.3	0.2	0.1	0.0	0.2
		Protein (%)						Total Ash (%)					
a.m.	Fore	4.3	4.0	4.1	4.3	4.0	4.1 ± 0.06	0.8	0.8	0.8	0.7	0.7	0.8 ± 0.02
	Rear	3.4	3.5	3.6	3.5	3.7	3.5 ± 0.06	0.9	0.9	0.7	0.8	0.7	0.8 ± 0.04
	Both	3.8	3.7	3.9	3.9	3.9	3.8 ± 0.02	0.9	0.9	0.8	0.8	0.7	0.8 ± 0.03
p.m.	Fore	4.5	4.1	4.4	4.7	4.8	4.5 ± 0.12	0.6	0.7	0.5	0.6	0.5	0.6 ± 0.03
	Rear	4.3	4.1	4.9	4.8	4.7	4.6 ± 0.15	0.8	0.7	0.7	0.6	0.6	0.7 ± 0.03
	Both	4.4	4.1	4.7	4.8	4.8	4.6 ± 0.12	0.7	0.7	0.6	0.6	0.6	0.6 ± 0.03
a.m. + p.m.	Fore	4.4	4.1	4.3	4.5	4.4	4.3 ± 0.07	0.7	0.8	0.7	0.7	0.6	0.7 ± 0.02
	Rear	3.9	3.8	4.2	4.1	4.2	4.0 ± 0.10	0.9	0.8	0.7	0.7	0.7	0.8 ± 0.03
	Both	4.1	3.9	4.3	4.3	4.3	4.2 ± 0.07	0.8	0.8	0.7	0.7	0.7	0.7 ± 0.03
a.m. – p.m.	Fore	-0.2	-0.1	-0.3	-0.4	-0.8	-0.4	0.2	0.1	0.3	0.1	0.2	0.2
	Rear	-0.9	-0.6	-1.3	-1.3	-1.0	-1.1	0.1	0.2	0.0	0.2	0.1	0.1
	Both	-0.6	-0.4	-0.8	-0.9	-0.9	-0.8	0.2	0.2	0.2	0.2	0.1	0.2

5th months and averaged 4.2%. Protein constituted 33.2 and 47.2% of the TS and SNF content of milk respectively.

Morning milk from the fore udder was richer in protein than a.m. milk from the rear udder. The reverse was true of p.m. milk. In fact, the mean protein content of a.m. milk from both udders (3.8%) was significantly lower ($P < 0.01$) than the average protein percentage (4.1%) of a.m. milk from the fore udder.

As observed with SNF content, the differences between the protein percentages of a.m. and p.m. milk from the fore, rear and both udders were high in the first month of lactation, minimal during the second month and later appreciated (Table 3). On the whole, the concentration of protein in p.m. milk form the fore, hind and both udders was 0.4, 1.1 and 0.8% superior respectively to that of a.m. milk from the udders.

The content of protein in a.m. and p.m. milk and in fore and rear udder milk were highly but not significantly (P 0.05) related (r = 0.75 and 0.98 respectively).

Lactose

Morning milk was superior to p.m. milk in lactose content (4.1 v. 3.9%). Rear udder milk also contained appreciably more lactose ($P < 0.01$) than fore udder milk (4.3 v. 3.7%).

Milk lactose concentration appeared unaffected as lactation progressed. Lactose percentage in milk of individual animals differed slightly (P 0.05). The average milk produced per day from both udders during 150 days of lactation contained 4% lactose which amounted to 31.5% of the milk dry solids or approximately 45% of the SNF content. The mean lactose content exceede the fat content by 0.2%.

Morning milk from the fore udder and from the rear udder were poorest and richest respectively (3.6 v. 4.5%) in lactose concentration (Table 3). P.M. milk from the hind udder was richer in lactose than a.m. and p.m. milk from the fore udder, being 4.0, 3.6 and 3.8% respectively.

In the first three months of lactation, the differences in lactose content of a.m. and p.m. milk from the udders showed no consistent trend. But between the third and fifth months of lactation, these differences became increasingly smaller.

Positive correlations (r = 0.97 in each case) found between lactose concentrations in a.m. and p.m. milk and in fore and rear udder milk were highly significant ($P < 0.01$).

Total ash

Animals varied little ($P > 0.05$) in the mineral content of their milk. BUt significantly higher (P 0.01) total ash was found in a.m. than p.m. and in rear than fore udder milk Table 3). Milk synthesized in the first two months of lactation contained substantially more minerals ($P < 0.01$) than in later lactation. The minerals in a.m. and p.m. milk and in fore and rear udder milk were positively but not significantly correlated (r = 0.65 and 0.88) respectively.

DISCUSSION

The low mean DMY, 2.5kg (range = 1.88 - 3.85kg) or 2.41kg fat-corrected milk (FCM) obtained during the first 150 days of lactation of WF early dry season calvers was probably dur to many factos. For exampl, the animals were not steamed up in late pregnancy. The concentrate feed supplies were irregular due to acute shortage of funds to buy essential ingredients like maize, groundnut cake and fish meal. Consequently, the concentrate feed supplied contained only 5% maize but no groundnut cake or fish meal. The quantity and qulity of forage and water available during the experiment were adversely affected by the dry season. Poor nutrition was therefore a major problem.

The animals were chosen from a herd that had been inbred for more than three decades. Inbreeding might partly have reduced the milk production potential of the animals.

While two of the animals were first calvers, five others had had five to seven previous lactations. The milk production of such animals is known to be lower thanb that of animals with two to four lactations (Olaloku and Oyenuga, 1971; Schmidt, 1971; Mao et al., 1974). The age and body weight of some of the animals were therefore partly responsible for the low milk yield observed.

In this report, a.m. milk exceeded p.m. milk by an average of 0.62kg/day (range = 0.33 - 0.99kg/day). A significantly higher a.m. than p.m. milk had been previously reported among some other cattle breeds (Schmidt, 1960; Laben, 1963; Gilmore and Gaunt, 1963; Everette and Wadell, 1970; Gilbert et al., 1973) and attributed to the longer interval before a.m. than p.m. milking. In the present report, the intervals were 15 and 9 hours respectively.

Consequently, the smaller p.m. milk was richer in TS, fat, SNF and protein as in earlier reports with temperate breeds (Nicholson et al., 1957; Gilmore and Gaunt, 1963; Ormiston et al., 1967). Milk yield and milkfat content are known to be negatively correlated (McDowell, 1972).

The higher fat content of p.m. milk might also be partly due to the effects of exercise during grazing between milkings. Exercise tends to increase milkfat content (Henry and Harry, 1960; Schmidt, 1971). However, p.m. milk was poorer in lactose and minerals.

Differences of 1.2, 0.7, 0.4 and 0.8% apparently existed between TS, fat, SNF and protein content of a.m. and p.m. milk respectively in this report, Schmidt (1971) and observed that milkfat content of a.m. and p.m. milk might vary by as mush as 1%.

The observed higher proportion of average DMY from the rear udder was supported by Schmidt (1971) and Bath *et al.*, (1978) who attributed it to the larger size of the rear udder. Furthermore, there is evidence (Dyce and-Wensing, 1971) that the rear udder contains a richer supply of blood vessels than the force udder. More blood conveying metabolites for milk synthesis would reach and support greater milk synthesis in the rear udder.

The greater quantity of rear udder milk was richer in TS, fat, SNF, lactose and minerals but poorer in protein than the smaller fore udder milk. The findings of Suchanek and Kvapilik (1974) were similar. This suggested that the negative correlation known to exist between milk yield and milkfat content did not apply to milk from the udders but only to a.m. and p.m. milk. A certain regulatory mechanism within the udder of WF cattle might be responsible for this unusual relationship between milk yield and fat content.

Peak milk production during the second month of lactation had earlier been reported (Olaloku and Oyenuga, 1971) in the herd and was confirmed in the present study. The observed significant interaction effect between time of milking and stage of lactation suggested that at any stage of lactation, the interval preceeding a.m. milking had a more pronounced effect on milk yield than that preceeding p.m. milking.

The concentrations of TS, fat, SNF, protein, lactose and minerals which were high in the first month of lactation declined sharply to the lowest level in the second (TS, SNF, protein and lactose) or third (fat, minerals) month and rose thereafter. Previous evidence (Johnson et al., 1961; Gilmore and Ganut, 1963; Sargnet et al., 1967; Maynard and Loosli, 1969; Gilbert et al., 1973) support this finding. The changes were a probable reflection of the amount of milk produced during lactation. The result tends to suggest that the influence of stage of lactation on milk composition was similar among temperate and tropical breeds of cattle.

The effect of advancing lactation was closely associated with and modified by the effect of season of the year. But the direct effect of the high temperatures *per se* characteristic of the dry season would probably be minimal on the milk yield and composition of White Fulani which is a tropically adapted cattle breed. The year effect was very negligible.

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