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Variations in Weekly Milk Yield and Compositons of Muturu, N'dama and White Fulani Cows in Early Lactation

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Abstract: The milk yield and compositions of 9 lactating cows made up of 3 Muturu, N'dama and White Fulani dams were compared in a 12-weeks study. The animals in their early lactation and 1st parity grazed natural pasture and each received in addition 1 kg day^{-1} of 17% CP concentrate supplement. Milking was once a day (0800-0900 h), daily milk yield was quantified and bulked weekly per animal per breed. Lactose was determined in milk samples daily while bulked samples were analysed for Total Solids (TS), Butterfat (BF), Solids-not-fat (SNF), Crude Protein (CP) and ash. Results showed that average weekly milk yield generally increased ($p<0.05$) with lactation and attained peak production in weeks 7 and 11 for Muturu (0.77 kg) and N'dama (1.34 kg) cows, respectively. The White Fulani however attained peak production in weeks 12 (2.43 kg) or probably beyond. All milk constituents differed significantly within weeks among breeds ($p<0.05$) except TS and SNF in N'dama and lactose in Muturu and White Fulani. In Muturu, TS and SNF had peak concentrations in week 4, BF in week 1 and CP and ash in weeks 11 and 12, respectively; lactose was fairly constant ($p<0.05$). In N'dama, TS, SNF and ash were fairly constant ($p<0.05$), while BF, lactose and CP were highest in weeks 1, 4 and 12, respectively. For White Fulani, weekly lactose values did not differ significantly ($p<0.05$), however, the highest comparable values for TS were in 5th and 8-12th week, BF (1-4th week), SNF (5th, 7-12th week), CP (9-11th week) and ash (8th, 11-12th week). White Fulani produced significantly ($p<0.05$) more milk than any other breed in all the weeks of study. N'dama had superior ($p<0.05$) TS in milk in weeks 1, 3 and 4 and thereafter this milk component remained fairly constant for all breeds. BF differed significantly ($p<0.05$) in weeks 1 and 7 among the breeds, SNF in weeks 1, 3 and 4, CP in weeks 1 and 6 and ash in week 4. Lactose in the milk was not influenced by breed ($p<0.05$) within the weeks of study. Milk yield of different constituents can be harnessed from Nigerian indigenous cattle through timed articulated milking programme.

Key words: Variations, milk yield, composition, Muturu and N' Dama, early laction

INTRODUCTION

Milk plays a vital role in the nutrition of Nigerians and the world over. Its significance in bridging the gap between the prevalent and the expected per capita animal protein consumption of Nigerians is well recognized (Ibeawuchi *et al*., 2000; Ahamefule *et al*., 2007). Milk from ruminants (cattle, sheep and goats) can be harvested and processed into various forms and products. In developed countries, where due to available technology it is possible to produce milk of various constitutions (for example low butterfat, low protein etc), life expectancy has been enhanced possibly because of the positive influence nutrition has on health care delivery. 'We are what we eat'. For instance, patients with blood pressure problems are most times medically advised to consume more of skimmed than whole milk, but the technologies to achieve some of these variable milk formulae are not available in third world countries. This had often given rise to poor dietary attention to the sick and convalescing patients with possible increases in untimely and avoidable deaths. Nutritional health problems are some of the easiest human problems to solve and can promptly be handled through proper dieting.

The White Fulani, N'dama and Muturu are some the indigenous cattle breeds found in Nigeria. There are no conscious efforts to milk these animals on a substantial scale in Nigeria except for White Fulani where the Fulani herdsmen are compelled to attempt subsistent milking because they depend on the proceeds realized from such harvests for upkeep of their families. This poor attitude of Nigerians and the Nigerian Government towards effective College of Animal Science and Animal Production Michael Okpara University of Agriculture, Umudike

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maximization of the milking potentials of these indigenous cattle breeds have led to the dismal performance of the dairy industry in the country with the result that she imports most of milk and dairy products. These products are naturally manufactured to meet the basic needs of the people such as augmenting the low per capita animal protein consumption. The specialized formulations where they exist are very expensive and beyond the reach of the average Nigerian with the result that those, who for health reasons, may be requiring special milk formulations, suffer or eventually die from lack of attention. In the lactation cycle of ruminants, nature has provided that milk yield and compositions vary between and within lactation phases. It could be possible to exploit this phenomenon to realize milk of various constitutions and therefore attempt to provide for some of the nutritional needs of the less privileged in the society. It may be possible through good management and timeliness, to harvest milk of various constituents to suit the desires of the producer and invariably the end user. Since, there are inherent differences between cattle breeds, animals of the same species would tend to differ in milk yield and composition at any given time in lactation. By evaluation of the weekly milk yield and compositions of Nigeria's indigenous cows, each breed's capabilities could be highlighted and this will provide guided information on best time of harvest (milk) to meet certain target goals. It is in the light of these objectives that this study was designed.

MATERIALS AND METHODS

Environment of study: The study was carried out at the Livestock Unit of Teaching and Research Farm, Michael Okpara University of Agriculture, Umudike, Abia State of Nigeria. Umudike bears the co-ordinate of 5° 28' North and 7° 31' East, and lies at an altitude of 122 m above sea level. Located within the tropical rainforest zone, the environment is characterized by an annual rainfall of about 2177 mm. The relative humidity during rainy season is well above 72%. Monthly ambient temperature ranged from 17-36°C. March is the warmest month with an average temperature range from 22-30°C.

Animal management: Nine lactating dams in their first parity and early lactation, comprising 3 Muturu, N'dama and White Fulani cows respectively, were selected from the University (mixed) herd and used in this study. The animals which were semi-intensively managed, grazed natural pasture during the day (0900-1500 h) and were returned to shed in the evening (1600 h) where each in-dam received a 17% CP concentrate supplementary ration at the rate of 1 kg/animal/day. The forage grazed comprised mainly of Panicum maximum, Calapogonium mucunoides, Centrosema pubescens and others while, the concentrate ration was formulated from maize, groundnut cake, palm kernel cake, brewers dried grain, bone meal and common salt. The concentrate regimen was initiated 2 weeks pre-partum and terminated at 16 weeks post-partum. The animals were routinely dewormed using Fenbendazole (quarterly and bimonthly in the dry and rainy seasons, respectively) while ectoparasites were controlled monthly by spraying with Pfizona. The animals had liberal access to fresh clean water.

Milk sampling/measurements: The 9 lactating cows were weekly sampled within the 12 weeks of study. Lactation for each cow was based on 305 days. Milk collection for each cow was initiated on the 7th day post partum (after colostrums) and terminated on the 90th day of lactation. Milk was harvested between 0800-0900 h. daily by hand. Prior to each day's milking, calves were separated from their dams at 1800 h. On the evening preceding the day of milking and subsequently returned to their dams in the morning after milking. The quantity of milk harvested from each cow was measured using graduated glass cylinder and weighed back to the nearest gram.

Analytical procedure: Samples from daily milk yield for each cow were analysed for lactose content immediately after collection, then bulked and subsequently analysed weekly for TS, BF, CP (N × 6.38), SNF, ash and energy. The bulked samples were often stored in a refrigerator (-50°C) until required for analysis. Total solids were determined by drying about 5 g of milk to a constant at 105°C for 24 h. Lactose was estimated from fresh samples by Marrier and Boulet (1959) procedure. Butterfat was obtained by the Roese-Gottlieb method (AOAC, 1980). Milk protein (N×6.38) was determined by the semi-micro distillation method using Kjeldahl and Markhamps apparatus. Solids-not-fat was determined as the difference between total solids and butterfat. Feed samples were analysed for proximate components using AOAC (1990) methods.

Statistical analysis: The data obtained on weekly milk yield and compositions of the 3 ruminant breeds were subjected to analysis of variance (ANOVA) procedure (Steel and Torrie, 1980). Significant means were separated using Duncan's Multiple Range Test (Duncan, 1955).

Table 1: Weekly variations in milk yield and composition of Muturu cow in early lactation during late-dry season (Jan-March)

	Weeks												
Parameters	1	2	3	4	5	6	7	8	9	10	11	12	SEM
Milk yield (kg)	0.36^{f}	0.46^{ef}	0.56^{de}	0.60^{cd}	0.70^{abc}	0.73^{abc}	0.77^{a}	0.72^{abc}	0.61^{bcd}	0.73^{ab}	0.63^{bcd}	0.53^{de}	0.002
Total solids (%)	9.23^{f}	12.61^{ab}	11.37^{cd}	13.10^{a}	10.51^{de}	10.12^{ef}	11.40^{cd}	12.18^{abc}	12.12^{abc}	11.92^{bc}	12.05^{abc}	12.13^{abc}	0.20
Butter fat (%)	3.17^{a}	3.16^{a}	3.11^{ab}	3.08^{abc}	3.03^{bc}	2.98^{c}	2.73^{d}	2.70^{d}	2.68^{d}	2.69^{d}	2.67^{d}	2.66^{d}	0.002
Solids-not-fat(%)	6.12^{c}	9.26^{a}	8.29^{b}	9.92^{a}	3.03^{d}	2.98^{d}	2.73^{d}	2.70^{d}	2.68^{d}	2.69^{d}	2.67^{d}	2.66^{d}	0.12
Crude protein(%)	3.84^{cd}	3.84^{cd}	3.66^{de}	3.75^{d}	3.66^{d}	3.84^{c}	3.75^{d}	4.10^{b}	4.29^{a}	4.10^{ab}	4.29^{a}	4.29^{a}	0.008
Lactose (%)	4.40	4.55	4.55	4.60	4.60	4.56	4.30	4.20	4.32	4.31	4.21	4.20	0.06
Ash (%)	0.76^{ab}	0.81^{a}	0.68^{cd}	0.79^{a}	0.63^{d}	0.64^{d}	0.71^{b}	0.79^{a}	0.78^{a}	0.76^{a}	0.79^{a}	0.79^{a}	0.008

Table 2: Weekly variations in milk yield and composition of White Fulani cow in early lactation during late dry season (Jan-March)

	Weeks												
Parameters	1	2	3	4	5	6	7	8	9	10	11	12	SEM
Milk Yield (kg)	0.81^{f}	0.88^{ef}	1.07^{ef}	1.25^{def}	1.50^{cde}	1.74^{bcd}	1.93^{abc}	2.07^{abc}	2.17^{ab}	2.27^{ab}	2.28^{ab}	2.43^{a}	0.07
Total solids (%)	9.70^{b}	11.30^{ab}	10.18^{ab}	9.94^{b}	12.34^{a}	10.52^{ab}	11.62^{ab}	12.24^{a}	12.14^{a}	12.26^{a}	12.30^{a}	12.25^{a}	0.73
Butter fat (%)	3.14^{a}	3.13^{a}	3.13^{a}	3.12^{a}	3.08^{ab}	3.00^{b}	2.83^{c}	2.70^{d}	2.67^{d}	2.66^{d}	2.66^{d}	2.63^{d}	0.001
Solids-not-fat(%)	6.62^{b}	8.16^{ab}	7.05^{b}	6.81^{b}	9.26^{a}	7.52^{ab}	9.12^{a}	9.54^{a}	9.46^{a}	9.60^{a}	9.66^{a}	9.62^{a}	0.69
Crude Protein(%)	4.02^{abc}	4.10^{abc}	3.93^{bc}	3.87^{c}	3.87^{c}	3.93^{b}	3.87^{c}	4.11^{abc}	4.22^{a}	4.28^{a}	4.22^{a}	4.16^{ab}	0.005
Lactose (%)	4.70	4.25	4.40	4.40	4.38	4.53	4.38	4.30	4.33	4.33	4.28	4.27	0.04
Ash (%)	0.70^{abc}	0.69^{abc}	0.63^{bc}	0.56^{c}	0.75^{ab}	0.69^{abc}	0.72^{ab}	0.79^{a}	0.76^{ab}	0.77^{ab}	0.78^{a}	0.78^{a}	0.003

RESULTS AND DISCUSSION

The variations in the weekly milk yield and compositions of Muturu, N'dama and White Fulani cows, in early lactation, are respectively summarized in Table 1-3. Generally, average milk yield differed significantly ($p<0.05$) within weeks for each of the 3 cattle breeds. Muturu showed a consistent rise in weekly milk production up till the 7th week (0.77 kg) (Table 1) before declining. Correspondingly, milk yield for N'dama (Table 2) and White Fulani (Table 3) were also consistently enhanced up to the 12th week; the values recorded however, were comparatively higher for the White Fulani (1.34 v 2.43 kg). This observation probably suggest that in late dry season, lactating Muturu cows in their first parity and early lactation are more likely to reach peak production in their 7th week of lactation while N'dama and White Fulani cows are probably not likely to attain peak production before the 12th week. Reports have shown that milk production generally increases with lactation (Ibeawuchi *et al*., 2003); the peak would however depend on breed which invariably is influenced by genetic constitution, management and environment. Investigations have also shown that peak production are reached within 4-6 weeks of lactation in tropical cattle (Mchau and Syrstad, 1991); these timings are realistic only when cows have enjoyed the benefits of rainfall with the accompanying feed availability during the last 5-6 months of pregnancy (Agyemang *et al*., 1991b). Agyemang *et al.* (1991 b) however, observed that milk offtake declined steadily from 1.25-0.8 kg day^{-1} for N'dama cows that calved in late-dry season with peak production extended to 24 weeks post partum. For indigenous cattle breeds therefore, peak production may be influenced by seasons. Daily milk offtake for cows that calved during or close to the rainy season were reported to be higher than those of their counterparts that calved in rainy season (Singye, 1981). This view was also corroborated by Nordufer (1985). This study was carried out in late-dry season (Jan-March); this may be responsible for the low weekly milk offtakes recorded for the breeds as well as time of attaining peak production. A comparative evaluation of the weekly milk yield of the 3 cattle breeds (Table 3) showed that were significant differences ($p<0.05$) within the 12 weeks of study; the White Fulani showed superior performance relatively, in all the weeks. This observation is in consonance with the findings of Ahamefule *et al.* (2007a). Adeneye (1993) had earlier reported that White Fulani is the principal milk producer in Nigeria and accounted for over 90% of the total domestic milk output (Walshe *et al*., 1991).

Total solids, save for N'dama (Table 2), differed significantly ($p<0.05$) weekly in the milks of Muturu (Table 1) and White Fulani (Table 3). While, the concentration was highest in week 4 for Muturu, peak TS was observed in week 5 for White Fulani even though values recorded for the breed in weeks 8-12 compared favourably ($p>0.05$) to that of week 5. The significance of this is that for Muturu and White Fulani, it may be possible to harvest milk of variable TS in early lactation. This may be of primary importance to patients or individuals, who for one reason or the other, may have the need to regulate protein, fat or sugar intake in their diets, probably because of the influence these metabolites on blood pressure. Moreover, the values recorded within each week for the breeds (Table 3) were fairly similar except in weeks 1, 3 and 4 where they differed significantly ($p<0.05$) with N' dama having superior

Table 3: Comparative evaluation of weekly milk yield and compositions of White Fulani, N'dama andMuturu cows

		Parameters						
Week	Breed	MY	TS	BF	SNF	CP	Lactose	Ash
1	Muturu	0.36^{c}	9.23^{b}	3.11^{ab}	6.12^{b}	3.84^{b}	4.40	0.76
	N'dama	0.50^{b}	13.70^{a}	3.18^{a}	10.52^{a}	3.84^{b}	4.36	0.75
	WF	0.81^{a}	10.52^{b}	3.00^{c}	11.12^{a}	4.21^{a}	4.25	0.70
	SEM	0.001	0.705	0.003	0.67	0.004	0.005	0.001
2	Muturu	0.46^{c}	12.61	11.30	9.26	3.84	4.55	0.81
`	N'dama	0.68^{b}	13.10	3.15	9.94	3. 93	4.33	0.82
	WF	0.88^{a}	11.30	3.14	8. 16	4.10	3. 92	0.69
	SEM	0.005	1.63	0.004	1.61	0.01	0.11	0.005
3	Muturu	0.45^{c}	11.37^{bc}	3.08	8.29^{bc}	3.66	4.55	0.68
	N'dama	0.72^{bc}	12.54^{a}	3.01	9.53 ^{a}	3. 93	4.53	0.78
	WF	1.07^{a}	10.18^{c}	3.12	7.05^{c}	3.93	4.40	0.63
	SEM	0.001	0.31	0.001	0.31	0.01	0.04	0.001
4	Muturu	0.60^{b}	13.10^{a}	3.17	9.92^{a}	3.75	4.60	0.79^{a}
	N'dama	0.79^{b}	13.35^{a}	3.10	10.25^{a}	3. 98	4.66	0. 82^{a}
	WF	1.25^{a}	9.94^{b}	3.13	6.81^{b}	3.87	4.62	0.56^{b}
	SEM	0.02	0.47	0.001	0.43	0.01	0.01	0.005
5	Muturu	0.70^{b}	10.51	3.03	7.18	3.66	4.60	0.63
	N'dama	0.84^{b}	11.46	2.99	8.48	3. 69	4.56	0.72
	WF	1.50^{a}	12.34	3.08	9.26	3.87	4.38	0.75
	SEM	0.02	1.07	0.002	1.21	0.01	0.01	0.005
6	Muturu	0.73^{b}	10.12	2.98	7.14	3.48^{b}	4.50	0.64
	N'dama	0.95^{b}	12.05	2.97	9.08	3. 45^{b}	4.60	0.76
	WF	1.74^{a}	10.32	3.00	7.52	3.93^{a}	4.53	0.69
	SEM	0.02	1.96	0.005	1.88	0.005	0.01	0.005
7	Muturu	0.77^{b}	11.40	2.73^{b}	8.67	3.75	4.30	0.71
	N'dama	0.84^{b}	12.70	2.80^{ab}	9.90	3. 75	4.39	0.79
	WF	1.93^{a}	11.62	2.83^{a}	8.79	3.87	4.38	0.72
	SEM	0.02	1.01	0.005	1.05	0.01	0.005	0.004
8	Muturu	0.72^{b}	12.18	2.70	9.48	4.02	4.20	0.79
	`N'dama	0.93^{b}	12.98	2.71	10.26	3. 93	4.25	0.84
	WF	2.07^{a}	12.22	2.70	9.48	4.11	4.30	0.79
	SEM	0.04	0.84	0.005	0.83	0.01	0.005	0.004
9	Muturu	0.61^{b}	12.12	2.68	9.44	4.19	4.32	0.78
	N'dama	1.10^{b}	13.06	2.70	10.36	4. 10	4.26	0.82
	WF	2.17^{a}	12.14	2.67	9.46	4.22	4.33	0.76
	SEM	0.07	0.80	0.005	0.82	0.005	0.002	0.003
10	Muturu	0.73^{b}	11.92	2.69	9.23	4.10	4.31	0.76
	N'dama	1.25^{b}	12.22	2.66	9.56	4. 22	4.26	0.78
	WF	2.27^{a}	12.26	2.66	9.60	4.28	4.33	0.77
	SEM	0.10	0.05	0.004	0.06	0.01	0.003	0.005
11	Muturu	0.63^{b}	12.05	2.67	9.38	4.29	4.21	0.78
	N'dama	1.34^{b}	13.77	2.65	11.12	4. 21	4.25	0.87
	WF	2.28^{a}	12.30	2.66	9.66	4.22	4.28	0.78
	SEM	0.10	0.46	0.003	0.48	0.005	0.005	0.001
12	Muturu	0.53^{c}	12.13	2.66	9.47	4.29	3.33	0.79
	N'dama	1.32^{b}	13.62	2.63	11.20	4. 28	4.34	0.86
	WF	2.43^{a}	12.25	2.63	9.62	4.16	4.27	0.78
	SEM	0.08	0.37	0.0002	0.49	0.005	0.23	0.001

MY = Milk yield, TS = Total solids, BF = Butterfat, SNF = Solids-not-fat, CP = Crude protein, WF = White Fulani, SEM = Standard error of mean

concentration in milk. The TS range obtained for Muturu (9.30-13.10%), N'dama (11.46-13.77%) and White Fulani (9.94-12.34%) in this study (Table 3) is within the limits of 11.56, 12.87 and 11.46%, respectively reported for the 3 breeds in a recent study (Ahamefule *et al*., 2007a).

Butterfat percentage also differed ($p<0.05$) within weeks in the milk of each of the breeds. The peak concentration was recorded in week 1 for all breeds, the respective values however did not differ ($p>0.05$) significantly from BF percent obtained for Muturu in week 2, for N'dama in weeks 2 and 3 and for White Fulani in weeks 2, 3, 4. Generally, peak BF in weekly milk samples among the breeds tended to be associated with low milk yield. Earlier investigations (Ibeawuchi, 1985; Agyemang *et al*., 1991 b) reported negative correlation between milk yield and butterfat which in agreement with the findings of this study. Recent reports also collaborate this finding (Ahamefule and Ibeawuchi, 2005; Ndubueze *et al*., 2006; Ukah, 2007; Ahamefule *et al*., 2007a, b). The weekly peak of 3.17, 3.18 and 3.14% BF reported, respectively for Muturu, N'dama and White Fulani in this study lies within the range of what has been reported elsewhere (Agyemang *et al*., 1991a; Tawah and Rege, 1996; Ndubueze *et al*., 2006; Ahamefule *et al*., 2007b) for same breeds. Meanwhile, except in week 1 (Table 3) where BF values differed significantly ($p<0.05$)

among treatment groups, its concentration in milk of the 3 cow breeds remained fairly of equal concentration ($p>0.05$) from weeks 2-12.

Solids-not-fat (%) was high and fairly similar ($p>0.05$) for N'dama in all weeks of study, however values recorded for Muturu and White Fulani within the study duration differed significantly ($p<0.05$). Except for a slight drop in concentration in week 3 for Muturu, SNF values progressively increased from week 1, attaining peak in weeks 4 before drastically reducing in weeks 5 and thereafter. For White Fulani, values obtained from weeks 5-12 were fairly similar ($p>0.05$) with actual peak concentration recorded in week 10. SNF is a consolidation of all milk components that is devoid of fat. It is a very vital constituent of milk because it highlights on a face value the nutritive level of milk. This is because of its (SNF) high and positive correlation with CP. Table 2 and 3 buttresses this observation. Meanwhile, weekly SNF values differed significantly ($p<0.05$) among breeds (Table 3) in weeks I, 3 and 4 of the study with White Fulani (1) and N'dama (3, 4) having highest concentrations in milk in the highlighted weeks. However, the mean SNF values recorded in the milk samples are within the limits of what has been reported for Muturu, N'dama and White Fulani cows in a similar experiment (Ohaeri, 2007).

The milk protein was also influenced significantly ($p<0.05$) by weeks in the milk of the 3 cow breeds. Milk protein experienced a slight drop in concentration among the breeds in the 5-7th week of lactation and subsequently became enhanced, attaining peak value in 10-12th week. Agyemang *et al.* (1991 b) reported an increase in milk protein from a mean of 2.6% in N'dama cows in 16 weeks of lactation to a mean of 3.5% in 50-54 weeks of lactation. The increase in milk protein as lactation advances was perceived as desirable for suckling calves since milk available for suckling decreases with lactation. The mean weekly milk protein values obtained in this study is comparable to the values of 3.9% (Ohaeri, 2007), 3.5% (Agyemang *et al.*, 1991a) and 4.06% (Ahamefule *et al.*, 2007a) highlighted, respectively for Muturu, N'dama and White Fulani, elsewhere. The White Fulani nevertheless had superior protein in milk relative to others in weeks I and 6 of this study (Table 1).

Lactose in milk remained fairly constant ($p>0.05$) during the weeks in early lactation for Muturu, Ndama and White Fulani cows. Lactose has been reported (Ibeawuchi and Dagut, 1998) to be fairly constant in milk. The mean values obtained are also within the range of what has been reported for the breeds (Ahamefule *et al.*, 2007a). Comparatively, there were no significant differences ($p>0.05$) in lactose concentration in the milk of the three indigenous cattle breeds in all the weeks of study.

Weekly ash values (%) differed significantly ($p<0.05$) in Muturu and White Fulani milk while values obtained for N'dama remained fairly constant ($p>0.05$). In Muturu, there was a discordant pattern whereas in White Fulani, ash concentration in milk declined towards the 4th week before rising. Mean values obtained were also within the range of what has been reported for each breed. Also, ash content of milk did not differ among the breeds within the weeks of study except in week 4 where Muturu and N'dama had relatively higher concentrations ($p<0.05$) in milk than the White Fulani. Ohaeri (2007) however observed significant ash composition in the milk of N'dama relative to Muturu or White Fulani, in early lactation.

CONCLUSION

In conclusion, the milk yield and compositions of Nigerian indigenous cattle breeds (namely Muturu, N'dama and White Fulani,) vary within weeks of lactation. In the wake of dearth of sophisticated equipment to produce milk of special formulations for the needy masses, these natural variations can be exploited to produce milk of varied constituents to meet target nutritional needs of both the healthy and those on dietary stipulations.

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