EVALUATION OF THE NITROGEN FRACTIONS IN MILK OF BUNAJI (WHITE FULANI) CATTLE IN A HOT AND HUMID ENVIRONMENT

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ABSTRACT

One hundred millilitres of milk produced in the first 150 days of lactation of 24 Bunaji (White Fulani) cattle in Ibadan contained an average of 703, 659, 44, 557, 146, 21, 27 and 54 mg total nitrogen (TN), protein nitrogen (PN), non-protein nitrogen (NPN), casein nitrogen (CN), non-casein nitrogen (NCN), proteoses-peptone nitrogen (PPN), lactoglobulin nitrogen (LGN) and lactalbumin nitrogen (LAN) respectively. CN, NCN, PN, NPN, PPN, LGN and LAN accounted for 79.2, 20.8, 93.7, 6.3, 3.1, 3.9 and 7.6% of TN respectively. CN constituted 83.3% of PN while one-third of NCN consisted of PPN and LGN. The most abundant component of NCN was LAN which occurred twice as high as LGN.

The influence of stage of lactation was significant ($P < 0.05$) on TN, more remarkable on PN and CN but not significant ($P > 0.05$) on NCN, NPN, PPN, LGN and LAN. Only TN and CN were significantly ($P < 0.05$) correlated ($r = 0.989$). The positive or negative relationships between the other nitrogen fractions were trivial.

Key Words: Bunaji Cattle, Milk, Nitrogen Fractions

INTRODUCTION

The nutritional significance of dietary protein has long been well established. Consequently, the determination of the nitrogen (N) content of foods and feeds has continued to receive the attention of researchers. Milk, for example, is known to contain various forms of N classified as protein and non-protein N. Casein, albumin, globulin and proteoses-peptones constitute the milk proteins, while the non-protein nitrogen (NPN) fractions include ammonia, urea, creatinine, creatine, uric acid, amino acids, enzymes vitamins, phospholipids and cerebrosides.

Cheese manufacture, for example, depends on the coagulation of the casein component of milk. The determination of the casein content of the milk of Bunaji cattle will therefore help in the understanding of the yield and composition of the unripened soft cheese ('warankasi') manufactured locally from the milk of this breed. The casein content can also serve as an indicator of the degree of mastitic infection in the breed because Schmidt (1971) had shown that mastitic cows have lower casein concentration in their milk. According to Shahani and Sommer (1951) and Ide *et al.* (1966), milk from cows fed high protein low energy diets would contain high NPN and urea N which may affect milk properties and be responsible for the observed changes in milk during various processing treatments. Normal milk adulterated with colostrum would also contain abnormal concentrations of globulin and proteose N.

Several workers (Davis, 1932, 1935, 1939; Golding *et al.*, 1932; Rowland, 1938; Rook and Campling, 1965; Burton, 1967; McDowell, 1972) have determined the content of the various N fractions in the milk of the different temperate dairy cattle breeds and the influence of stage of lactation and season of calving on the fractions. A similar published information on the milk of Bunaji cattle is scarce.

This paper therefore contains a report on the various N fractions in the milk of Bunaji cattle reared under the hot and humid conditions of Ibadan, western Nigeria. The influence of the stage of lactation on the fractions, the interrelationships between the fractions during the first 150 days of lactation are also included.

MATERIALS AND METHODS

At the University of Ibadan, Ibadan, where this study was carried out, the monthly minimum and maximum temperatures averaged 21.0 (range = 17.4 – 23.3) and 32.3 (range = 29.0 – 36.5)°C respectively. The differences between the monthly minimum and maximum temperatures were lowest, intermediate and highest during July-November, March-June and December-February, the averages being 9.9, 10.9 and 13.7°C respectively during the study period. The mean relative humidity at 7 a.m., 10 a.m., 4 p.m. and 6 p.m. local time was 93.9, 79.2, 62.0 and 69.9% respectively. There were two peak rainfall periods in May and August, the mean values (208.5 v. 248.2 mm) indicating greater intensity in the latter month. The total precipitation during the dry January, February and December months was 111.4 mm.

The Bunaji cattle herd at the University Teaching and Research Farm was semi-intensively managed, being freely grazed on available pastures, edible weeds, abandoned poultry litter and whole ripe; pods of leguminous trees between 8.00 a.m. and 2.00 p.m. daily. The feeding of dairy concentrate diet, brewer's wet grains, salt lick and the degree of veterinary attention depended largely on adequate and timely availability of funds. The animals were hand-milked twice daily at 6.30 a.m. and 3.30 p.m.

Separate representative samples of the milk produced in the morning and evening during the first 150 days of the lactation of each of 24 Bunaji animals that calved between January 1984 and April 1986 on the farm were taken monthly. Each mixed a.m. and p.m. sample was analysed in duplicate for its content of total nitrogen (TN), casein nitrogen (CN), non-casein nitrogen (NCN), non-protein nitrogen (NPN), proteose-peptone nitrogen (PPN), lactoglobulin nitrogen (LGN), and lactalbumin nitrogen (LAN) according to the procedures of Rowland (1938). Protein N (PN) was calculated as the difference between TN and NPN. Each N fraction was later expressed as a percentage of TN while the NPN, PPN, LGN and LAN was each expressed as a percentage of NCN.

The data was then subjected to a randomised block design of analysis (Steel and Torrie, 1960) and the means separated by Duncan's (1955) multiple range test. The effect of season of calving was thus confounded with that of the stage of lactation since both of them could not be separated. However, the correlation coefficients between the various N fractions were calculated.

RESULTS

The average of each N fraction in the milk of Bunaji animals is given in Table 1 while each fraction as a percentage of TN or of NCN is shown in Tables 2 and 3 respectively.

TN ranged from 556 to 820 and averaged 703 mg/100ml milk. Consequently, the total protein content (N x 6.38) ranged from 3.55 to 5.23 and averaged 4.49 ± 0.22%. The lowest TN level was observed during the second month of lactation ($P<0.05$). Milk from individual animals varied little ($P>0.05$) in TN level.

Casein content averaged 3.55 ± 0.19% (range = 2.78-4.06%). CN accounted for a range of 75.6-81.8 and a mean of 79.2 ± 0.58% of TN. Both TN and CN were significantly ($P<0.05$) correlated ($r = 0.989$). Animals did not differ significantly in CN of their milk. However, the state of lactation very significantly ($P<0.01$) influenced CN which was lowest (4567 mg/100ml) during the second month of lactation, increased to significantly high but similar levels in the subsequent months and averaged 557 ± 30mg/100 (range = 435-657 in 150 days of lactation.

NCN varied between 121 and 164 and averaged 146mg/100ml. It constituted 18.2-24.4% (average = 20.82%) of TN. Both PPN and LGN accounted for one third of NCN fraction while LAN, its most abundant component, was twice its LGN fraction. NCN was positively though not significantly ($P>0.05$) correlated with LAN, CN, NPN, PPN and LGN in descending order. Except during the second month of lactation, NCN was virtually unaffected by the stage of lactation.

Mean Pn was 659 ± 32 mg/100ml. CN accounted for 83.3% of PN. When expressed as a percentage of TN, PN was constant throughout 150 days of lactation and averaged 83.73%. But the influence of the stage of lactation on actual PN values was highly significant ($P<0.05$). PN was high in the first month of lactation, lowered significantly to its lowest level in the second and increased consistently afterwards.

Bunaji milk contained a range of 35-54 and an average of 44 ± 2 mg NPN/100ml. NPN constituted an average of 6.27 ± 0.08% (range = 5.20-7.11%) of TN or 30.2 ± 0.58% (range = 26.8-33.6%) of NCN. The stage of lactation and individuality of animals had little effect on NPN of milk.

PPN ranged from 17 to 27 and averaged 21mg/100ml milk. It was fairly constant throughout 150 days of lactation and accounted for 2.35-3.95% (mean = 3.07%) of TN or 11.5-18.2% (mean = 14.7%) of NCN. The stage of lactation significantly influenced ($P<0.05$) not the PPN but PPN expressed as a percentage of TN or of NCN, with higher values in the first 60 days. Differences among animals were small ($P>0.05$).

The values of LGN varied from 22 to 33 and averaged 27mg/100ml. Between 3.16 and 5.43% (mean = 3.86%) of TN or 14.7 and 22.3% (mean = 18.4%) of NCN was LGN. The effect of stage of lactation was significant only on LGN expressed as a percentage of TN or NCN. Such values peaked during the second month and declined very significantly ($P<0.01$) to similar levels in later months of lactation.

LAN varied from 43 to 68mg/100ml, averaged 54mg and accounted for 7.63% of TN or 36.7% of NCN. It declined slightly during the second month but was fairly constant throughout 150 days of lactation.

The real relationships between the various N fractions are shown in Table 4. Only the correlation coefficient between TN and CN ($r = 0.989$) was significant ($P<0.05$). LGN was negatively correlated though not significantly with TN, CN and NPN.

DISCUSSION

The observed mean total protein content (TN x 6.38) of Bunaji milk (4.48%) was higher than 3.04% for American Holstein,

Table 1
Influence of stage of lactation on nitrogen fractions in milk of Bunaji (White Fulani) cattle in Ibadan

		Month of lactation					
		1st	2nd	3rd	4th	5th	1st-5th
Mean Total nitrogen	(mg/100ml)	663a	590b	734c	758c	770d	703 ± 30
" Protein nitrogen	(")	621a	551b	689c	711c	722d	659 ± 32
" (Non-protein nitrogen	(")	42a	39a	45a	47a	48a	44 ± 2
" Casein nitrogen	(")	517a	547b	587c	606c	619d	557 ± 30
" Non-casein nitrogen	(")	146a	133b	147a	152a	152a	146 ± 3
" Proteose-peptone nitrogen	(")	24a	20b	21a	21a	21a	21 ± 1
" Lactoglobulin nitrogen	(")	29a	27a	26a	26a	26a	27 ± 1
" Lactalbumin nitrogen	(")	52a	47a	56a	58a	57a	54 ± 2

* Values along the same row followed by the same letters are not significantly ($P > 0.05$) different.

Table 2
Nitrogen fractions as percentages of total nitrogen in milk of Bunaji (White Fulani) Cattle in Ibadan

		Month of Lactation					
		1st	2nd	3rd	4th	5th	1st-5th
Total nitrogen		100	100	100	100	100	100
Protein nitrogen	%	93.75a*	93.43a	93.91a	93.91a	93.77a	93.78a93.73 ± 0.08
Non-protein nitrogen	%	6.25a	6.57a	6.09a	6.23a	6.22a	6.27 ± 0.08
Casein nitrogen	%	78.03a	77.53a	80.01b	79.91b	80.41b	79.18 ± 0.58
Non-casein nitrogen	%	21.97a	22.47a	19.99b	20.06b	19.59b	20.82 ± 0.58
Proteose-peptone nitrogen	%	3.64a	3.44a	2.78b	2.77b	2.77b	3.07 ± 0.19
Lactoglobulin nitrogen	%	4.31a	4.47a	3.51b	3.46b	3.43b	3.86 ± 0.27
Lactalbumin nitrogen	%	7.77a	7.89a	7.61a	&.60a	7.28a	7.63 ± 0.10

Table 3
Influence of stage of lactation on nitrogen fractions as percentages of non-casein nitrogen in Bunaji cattle milk at Ibadan

		Month of Lactation					
		1st	2nd	3rd	4th	5th	1st-5th
Non-casein nitrogen	%	100	100	100	100	100	100
Non-protein nitrogen	%	28.5	29.2	30.4	31.2	31.6	30.2 ± 0.58
Proteose-peptone nitrogen	%	16.8	15.3	13.9	13.8	13.9	14.7 ± 0.57
Lactoglobulin nitrogen	%	19.4	20.3	17.6	17.3	17.5	18.4 ± 0.60
Lactalbumin nitrogen	%	35.4	35.2	38.1	37.7	37.0	36.7 ± 0.60

Table 4
Correlation coefficients between various nitrogen fractions in milk of Bunaji cattle in Ibadan

	TN	CN	NCN	NPN	PPN	LGN	LAN
TN	—	0.989*	0.115	0.666	0.119	-0.095	0.542
CN		—	0.714	0.602	0.082	-0.105	0.481
NCN			—	0.697	0.250	0.042	0.724
NPN				—	-0.187	-0.302	0.380
PPN					—	0.167	0.207
LGN						—	0.155
LAN							—

* P < 0.05
TN = Total nitrogen;
CN = Casein nitrogen;
NCN = Non-casein nitrogen;
PPN = Proteose peptone nitrogen;
LGN = Lactoglobulin nitrogen;
LAN = Lactalbumin nitrogen;
NPN = Non-protein nitrogen.

3.60% for German Friesian in Ibadan (Adeneye, 1972; Akinsoyinu, 1981) and the range of 2.71-3.81% for cattle breeds in temperate countries (Harland *et al.*, 1955; Rook and Campling, 1965; Nickerson, 1960; Burton, 1967; Prokhorova, 1969; Senft and Klobasa, 1969; Davis and Woodward, 1969; McDowell, 1972). The lower milk yield of Bunaji (Adeneye *et al.*, 1970; Olaloku and Oyenuga, 1971; Olaloku, 1972) might be responsible. An inverse relationship exists between milk yield and its protein content (Schmidt, 1971; Adeneye, 1972).

The steady increase in total protein content during lactation and the lowest protein level during the second month of lactation are consistent with previous reports (Rook and Campling, 1965; Webb *et al.*, 1974).

Average values ranging from 2.22 to 2.75% for casein content had been reported for milk of temperate breeds (Nickerson, 1960; Shahani and Sommer, 1951; Harland *et al.*, 1955; Rook and Campling, 1965; Burton, 1967). These values were considerably lower than 3.55% mean casein content of Bunaji milk and suggested that the milk of Bunaji would be a better material for cheese manufacture than the milk of temperate breeds. The significant correlation between TN and CN ($r = 0.989$) suggested that CN was responsible for the higher TN of Bunaji milk. The observed percentage of CN in TN (79.2%) fell within the range of 76-85% reported for European and Indian cows (Davis, 1935; Golding *et al.*, 1932, Rowland, 1938; Shahani and Sommer, 1951, Rangappa and Achaya, 1974). According to Bath *et al.* (1978), casein has the greatest variability compared to other milk proteins. This was confirmed in the present report.

Harland *et al.* (1955), Nickerson (1960), Rook and Camping (1965), Burton (1967) and McDowell (1972) had reported a range of 22-54 mg/100ml for NPN in milk of European cattle breeds. The range in Bunaji milk fell largely within the upper limit of the range for temperate breeds and resulted in a higher average of 44.2mg NPN.100ml (Table 1). NPN seemed the second largest component of NCN, next to LAN. There is agreement between the present and previous reports that except in early stages, NPN is fairly constant throughout lactation.

NPN constituted 4.4-6.5% of TN in the milk of temperate breeds (Reinart and Nesbitt, 1956; Burton, 1967; Corbin and Whittier, 1965; McDowell, 1972). The high but comparable mean value for Bunaji in this report suggested that the breed of animal had little influence on the percentage NPN in TN of milk.

The casein content of Bunaji milk averaged 4.21% compared with the lower mean values (range = 2.75-3.52%) for temperate cattle. It constituted 93.73% of total protein in Bunaji milk, and was similar to 93.5%-95.6% in literature.

The mean proteose-peptone content (0.13%) suggested that it was the least protein in milk. It amounted to 77.8, 38.9, 47.7, 3.8 and 3.0% of lactoglobulin, lactalbumin, non-protein, casein and total protein content of the milk respectively. PPN also constituted 11.2-18.0 (mean = 14.7%) of NCN. Milk of temperate breeds contained PPN averages of 14.3-21.7 mg/100ml. The mean for Bunaji ranked among the highest values for temperate breeds.

The observed average 0.17% lactoglobulin was comparable with the range of 0.14-0.21% for the milk of temperate breeds. Expressed as a percentage of TN, LGN mean value (3.86%) fell within the range of 3.1-6.3% averages of European breeds. In the present report, globulin content was half of lactalbumin content as it was in the milk of temperate breeds.

Higher PPN and LGN during the first 60 days of lactation was a probable reflection of the high levels of the two proteins in the colostrum. The levels are known to decline soon after the colostral period (Rook and

Campling, 1965). The results therefore suggested that it apparently took PPN and LGN about 30 and 60 days respectively to return to their constant low levels in mature milk, and that their levels would remain low till at least 150 days post-partum.

Lactalbumin content of Bunaji milk ranged from 0.27 to 0.43% (mean = 0.34%) compared with the range of 0.14 to 0.29% (mean = 0.23%) for temperate breeds. The combined globulin and albumin content of Bunaji milk averaged 0.51% compared with 0.42 for temperate breeds. Lactalbumin N accounted for an average of 7.63% of TN. It was 5.0-13.4% among temperate breeds (Davis, 1932, 1935; Rowland, 1938; Shahani and Sommer, 1951; Nickerson, 1960; Rook and Campling, 1965).

Table 3 suggested that PPN and LGN accounted for a third of the NCN in Bunaji milk while the non-significant correlation between NPN and Tn or CN (Table 4) was supported by the results of Senft and Klobasa (1969).

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