Nitrogen distribution in the milk and blood of Bunaji (White Fulani) cattle fed broiler-litter-based concentrate diets as supplement to *Panicum maximum* (Jacq) hay

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SUMMARY

A study was conducted to determine effects of feeding autoclaved-broiler-litter-based concentrate diet (ABL) at 20, 40 and 60 per cent level of inclusion on the distribution of milk nitrogen and blood nitrogen fractions of Bunaji cattle fed guinea grass hay *ad libitum*. Nine lactating Bunaji cows (238.2 ± 7.88 kg initial BW) in a 3 × 3 latin square design consumed *Panicum maximum* hay, *ad libitum*, supplemented with diets A (20 per cent), B (40 per cent), and C (60 per cent) ABL inclusion levels, respectively, in an 84-day experiment. Litter contained 20.32 per cent ash, 18.40 per cent crude protein, and 68.30 per cent neutral detergent fibre (NDF). True protein nitrogen (TPN) varied between 685.7 and 690.3 mg/100 ml milk and this constituted 94.55 and 94.10 per cent of total nitrogen (TN). There were consistent trends for linear changes in several response parameters due to increased dietary feeding level of ABL. The protein nitrogen (PN) value expressed as the percentage of TN increased for cows fed diets A and C while corresponding values recorded for animals on diets A and B were similar (P>0.05). Non-protein nitrogen (NPN) fractions gave 31.74, 37.82 and 27.92 per cent of non-casein nitrogen (NCN) for diets A, B and C, respectively, but significant variations were considerable due to advancing lactation. The combined linear effect of crude protein and energy intake contributed significantly (R^2 = 87 per cent) to the variation in the total protein content of the milk while TPN varied directly with total nitrogen and NPN (R^2 =97 per cent). In conclusion, mixed broiler litter, cassava waste supplement increased the nitrogen content of milk of Bunaji lactating cows with higher TPN and casein nitrogen (CN).

RÉSUMÉ

BELEWU, M. A.: *La distribution d'azote dans le lait et le sang du bétail Bunaji (Fulani Blanc) nourri avec des régimes concentrés basés sur la litière de poulet de chair comme un supplément au foin de* Panicum maximum *(Jacq).* Une étude s'est déroulée pour déterminer les effets de suivre les régimes concentrés basés sur la litiére de poulet de chair autoclavée (LPA) aux niveaux de 20, 40 et 60 pour cent d'inclusion sur la distribution d'azote de lait et d'azote de sang du bétail Bunaji nourri avec le foin d'herbe de Guinée *ad lib*. Neuf vaches Bunaji de lactation (238.2 +7.88 kg d'initial BW). dans un dessin de 3×3 carré de latin consommaient le foin de *Panicum maximum ad lib*, ajouté à des régimes complémentaires A(20 pour cent), B (40 pour cent) et C (60 pour cent) des niveaux d' inclusion de LPA respectivement, dans une expérience de 84 jours. La litière contenait 20.32 pour cent de cendre, 18.40 pour cent de protéine brute et 68.30 pour cent de fibre neutre détergent (FND). L' azote de protéine véridique (APV) variant entre 685.7 et 690.3 mg/100 ml de lait et ceci constituait 94.55 et 94.10 pour cent d'azote total (AT). Il y avaient des tendances conséquentes pour des change-ments linéaires dans un nombre de paramétres de réponse dû au niveau d'alimentation diététique augmenté de LPA. La valeur d'AP exprimé comme le pourcentage d'AT augmentait pour les vaches nourries avec les régimes A et C pendant que les valeurs correspondantes enregistrées pour les animaux aux régimes. A et B étaient semblables (P>0.05). Les fractions d'azote non-proteine (ANP) donnaient 31.74, 37.82 et 27.92 pour cent d' azote non-caséine (ANC) pour les régime A, B, et C respectivement, mais des variations importantes étaient considérables dû à la lactation avançant. L'effet linéaire combiné de protéin brute et la consommation d'énergie contribuaient considérablement (R^2 =87 pour cent) à la variation dans le contenu protéine total du lait pendant qu'APV variait directement avec l'azote total et ANP (R^2 = 97 pour cent). En conclusion, la litiére de poulet de chair mélangée, le complément des déchets de manoic, augmentaient le contenu d'azote de lait de vaches Bunaji en lactation avec PNV et l'azote de caséine plus élevés.

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Introduction

The use of animal and crop wastes in the diet of livestock has aroused the interest of many scientists because the wastes constitute a nuisance to the environment, although its inclusion in dairy cattle ration will reduce scarcity and high cost of feed. Broiler litter (manure plus wood shavings) is of greatest value as a feedstuff for ruminants when given at about 40 per cent of the total ration, with the addition of readily soluble carbohydrate (e.g. cassava and pineapple wastes) (FAO, 1980). The high, neutral detergent fibre (68.3 per cent) and crude protein (18.4 per cent) of the litter could increase the protein content of milk (NRC, 1998).

The economic value of milk is based on its fat and protein contents which are vital in the production of various milk products such as butter, cheese, evaporated and condensed milk, butter milk, yoghurt, cream, butter oil, whey, ice cream, skim milk, and sour milk. Nigeria, unlike developed countries, has not fully realized the importance of the protein and fat contents of milk in the manufacture of cheese for which a high casein content in milk is very vital. Milk supplied to the cheese industries in Holland are paid for by the protein and fat contents (Politick, 1966). Reaner (1968) also reported similar findings in Denmark, Poland, and Switzerland. Cerbulis & Farrell (1975) recorded a mean NPN content of 4.9 per cent, casein, 2.89 per cent, and whey fraction, 22.1 per cent, of the milk. The NPN fraction in whey comprises 22.3 per cent while that of casein is 6.16 per cent. The percentage of NPN in the TN of milk is between 5 and 6 per cent (Corbin & Whithies, 1965). Lewis, Mill & Annison (1957) observed similarities in the level of blood protein and non-protein in sheep fed a high protein diet.

The economic trend in the developed countries as well as predicted world protein shortage (Cerbulis & Farrell, 1975) suggest that milk with higher protein content (casein) should be encouraged. However, adequate data on the distribution of milk protein between whey and casein fractions are not well elucidated in Nigeria.

This study therefore aimed to assess blood protein fraction as well as variation of composition of milk protein distribution between the casein and whey fractions of milk of cows fed autoclaved broiler-litter-based diets, since milk used for cheese production should have higher casein content.

Materials and methods

Nine lactating Bunaji cattle, weighing an average of 238.2 kg, were used in a 3 × 3 latin square design experiment replicated three times, involving three dietary treatments A, B and C; the treatments contained 20, 40 and 60 per cent autoclaved broiler litter, respectively, as a replacement for cassava wastes (containing rinds, small tubers, and some pulp of *Manihot* sp.) (Table 1). Water and basal diet (*Panicum maximum* hay) were offered *ad libitum.*

Parameters studied during each period of 28 days were concentration of total protein (TP), casein nitrogen (CN), non-casein nitrogen (NCN), non-protein nitrogen (NPN), true protein nitrogen (TPN), true whey protein nitrogen (TWPN) in milk, and various protein and non-protein constituents of the blood of Bunaji cattle.

Composite (24 h) milk samples were collected twice a week into labelled 200-ml plastic bottles. Blood samples (30 ml) were drawn fortnightly from the jugular vein of the experimental animals into oxalated bottles, after morning feeding. The

TABLE 1

Composition of the Broiler-litter-based Diets A-C Fed as a Supplement to Panicum maximum *(Jacq) hay*

Ingredients and nutrient content (%)	Diets *A*	*B*	*C*	*ABL*	*CWM*	Panicum maximum *hay*
Ingredients						
Cassava wastes	78.00	58.00	38.00			
Autoclaved broiler litter	20.00	40.00	60.00			
Vitamin premix*	1.00	1.00	1.00			
Common salt	1.00	1.00	1.00			
Total	100.00	100.00	100.00			
Nutrient content						
Dry matter	95.82	96.65	87.40	86.00	91.50	80.45
Crude protein	8.72	12.10	18.10	18.40	4.72	7.36
Ether extract	2.30	2.18	2.10	1.33	1.10	1.30
Crude fibre	22.96	19.66	22.46	24.66	11.56	23.84
Gross energy (Kcal.1 g)	4.79	4.68	4.58	3.21	5.42	3.88

*Supplied per kg of diet: vit. A., 800 000 iu; vit. D_3., 1500 000 iu.; vit. E., 3 000 iu; vit. K_3, 300 g; vit. B_2, 250 g; Nicotinic acid 8.00 g; Calcium, D-pantothenate, 3.00 g; vit. B_6., 0.03 g; vit., B_{12}, 8.00 mg; Mn., 10.00 g; Fe, 5.00

samples were centrifuged at 2000 r.p.m. for 20 min. Plasma was collected, mixed with an equal volume of saturated magnesium sulphate, filtered, and stored at -5 °C until needed for analysis.

TN content of the milk was determined by the standard micro kjeldahl method (AOAC, 1975). The nitrogen conversion factor of 6.38 was used to calculate the protein content of the milk sample and its various nitrogen fractions. TPN was calculated as the difference between TN and NPN while whey nitrogen (WN) was determined by the AOAC (1970) procedure; whey protein nitrogen (WPN) was the difference between WN and NPN. Casein nitrogen was calculated as the difference between TN and WN or as the difference between TN and NCN. The NPN was determined by the method prescribed by Shahani & Sommer (1951).

Data collected were subjected to analysis of variance by the model for a 3×3 latin square design. Significant differences between treatment means were determined by Duncan (1955) multiple range test. Interaction between various nitrogen fractions in milk samples of the experimental animals were subjected to multiple regression analyses. Estimation factors for nitrogen fractions of cows fed autoclaved-broiler-litter-based diets were developed. Also, correlation between TN content of milk and blood was computed.

Results and discussion

Table 2 shows the influence of dietary treatment on nitrogen fractions of Bunaji cow milk. The tendency for the total and casein nitrogen to decline with increasing broiler litter and decreasing cassava waste levels in rations A to C was similar (P>0.05).

The mean casein content reported in this study was higher than that reported by Adeneye (1988). However, Harland, Coulter & Jenness (1955), Rook & Campling (1965), and Burton (1967) reported lower value for temperate breeds of cattle (75-77 per cent). Dietary effect on NCN, NPN, WPN, and TPN showed linear trends with maximal yield at 20 per cent autoclaved broiler litter (ABL).

TABLE 2

Percentage Dry Matter Intake and Nitrogen Distribution in Milk Sample of Bunaji (White Fulani) Cattle

Components	*Treatments*			*Contrast*[1]		
	A	*B*	*C*	± *SEM*	*Li*	Qd
% DMI (supplement)[a]	58.86	57.03	56.01	0.10	-	-
Nitrogen fractions						
(mg/100 ml)						
Total nitrogen	728.70	718.80	714.00	25.33 ns	0.01	0.82
Casein nitrogen	593.20	590.50	574.60	41.77 ns	0.02	0.02
Non-casein nitrogen	135.50	136.30	139.40	11.90 ns	0.07	0.78
Non-protein nitrogen	43.00	48.67	39.00	1.93 ns	0.36	1.75
True protein nitrogen	685.70	678.30	675.10	22.48 ns	0.02	0.93
True whey protein nitrogen	92.50	95.80	100.50	20.06 ns	0.13	0.41
% NPN: Total whey nitrogen	31.74	37.82	27.92	1.79 ns	-	-

NS = No significant difference (P>0.05)
[1]Probabilities for contrasts: Li = Linear, Qd = Quadratic

Table 2 shows variation in the value (mg/100 ml) of various protein and non-protein nitrogen. The differences were small between treatments (P>0.05).

When expressed as percentage of TN, only the dietary effect on TPN was substantial, with the value for ration B being significantly lower (P<0.05) than that for ration C, but not for A (Table 3). The CN reported in this study fell within the upper limit of the range of 76-85 per cent reported for temperate breeds of cattle (Rangapapa & Achaya, 1974), while the NCN value (17.85 - 19.52 per cent) reported in this study was lower than the value of Adeneye ((1988). The difference might be due to the high CN (casein number) reported for Bunaji cow milk in this study. The observed value of 5.45 - 6.25 per cent for NPN fell within the range of 4.4-6.6 per cent reported for this and temperate breeds of cattle (Burton, 1967; McDowell, 1972; Adeneye, 1988). The observed WPN (17.85 - 19.52 per cent) was similar to that reported by Cerbulis & Farrell (1975). Irrespective of the diets, the result showed that CN, NCN, PN, NPN, and WPN constituted 81.60, 18.30, 93.97, 6.03, and 18.65 per cent, respectively.

There was no significant difference (P>0.05)

TABLE 3

Nitrogen Fractions as Percentage of Total Nitrogen in the Milk of Bunaji (White Fulani) Cattle

Components (%)	*Treatments*				*Contrast*[1]	
	A	*B*	*C*	± *SEM*	*Li*	Qd
Casein nitrogen (casein number)	81.41	82.15	80.48	2.78 ns	3.01	0.48
Non-protein nitrogen	5.90	6.25	5.45	0.25 ns	0.31	2.57
Non-casein nitrogen	18.58	17.85	19.52	2.43 ns	0.02	0.03
True protein nitrogen	94.10[b]	93.25[b]	94.55[a]	0.22 ns	1.12	3.14
Whey nitrogen	18.59	17.85	19.52	2.96 ns	0.09	0.24

Treatment means within a row without a common superscript differ (P<0.05)
NS: No significant difference (P>0.05)
SEM: Standard error of treatment means
[1]Probabilities for contrasts: Li = Linear, Qd = Quadratic

in the levels of PN and NPN content of the blood of the experimental animals (Table 4). This supported the report that the mixture of amino-acids eventually entering the animal blood is unrelated to the amino-acid make up of the original diet, since the rumen microbes are capable of synthesizing all the essential amino-acids required by the animals (Lewis, Mill & Annison, 1957).

TABLE 4

Mean Concentration of Various Non-protein and Ammonia Nitrogen Content in Blood Plasma of Bunaji (White Fulani) Cattle

Parameter (mg/100 ml)	*Treatments* A	B	C	± *SEM*
Total protein	6 680	6 770	6 300	21.0 ns
Uric acid	3 000	3 100	3 240	18.0 ns
Globulin	3 780	3 290	2 910	38.0 ns
Urea-nitrogen	2 608	2 983	3 136	70.4 ns
Creatinine	2 550	2 760	1 900	33.0 ns
Albumen	2 920	2 890	2 900	35.0 ns

NS: No significant difference ($P>0.05$)
SEM = Standard error of treatment means

The linear correlation between TP of the milk and blood showed no significant difference ($r=0.011$). Table 5 shows the results of various combinations of N fractions which were used in multiple regression to estimate the TN, WPN and CN. Generally, the R^2 values were all above 80 per cent. There was a difference of 0.4 per cent in the estimating accuracy between the N fractions which indicates the accuracy of estimation. This confirms the reports by McDowell (1972), Cerbulis & Farrell (1975), and Adeneye (1988) during the analysis of various milk samples of cattle. The magnitude of the interrelationship in the amount of the CN accounted for by the TN and WN, independently, is higher than for any of the other N fractions of the milk. Table 5 also shows that the TPN varied directly with the TN and NPN while WPN on WN and NPN showed similar trend, although the magnitude of the variation was not so great as for TPN.

TABLE 5

Multiple Regression of Various Nitrogen Fractions

Type	*Intercept*	b_1	b_2	R^2
1	-0.25	1.75	-7.57	0.97
2	-17.94	127.27	26.98	0.88
3	-0.15	0.93	0.53	0.98

Type 1 represents total protein nitrogen on total nitrogen and whey protein nitrogen.
Type 2 represents whey protein nitrogen on whey nitrogen and non-protein nitrogen.
Type 3 represents casein nitrogen on total nitrogen and whey nitrogen.

Dietary crude protein (16.07 g/day/animal/ metabolic size) was regressed (Multiple) on TP content of the milk and blood and the fitted equation was $Y=9.16+0.19x_1+4.22x_2$. This shows that only 3 per cent of the protein content of the blood and milk can be accounted for by crude protein intake while multiple regression of milk protein content on crude protein and energy intake (23.68 M.cal) gave a fitted equation of $Y=41.82+11.39x_1-0.001x_2$ which was significant at 5 per cent level of probability. Thus, the combined linear effect of crude protein and energy intake contribute significantly to the variation in the TP content of the milk. The larger the R^2 value, the better the result and 87 per cent of the total variation of milk protein content can be accounted for by a linear function involving crude protein and energy intake. This is in support of results reported by Cragle *et al.* (1986), Apori (1988) and Abubalkar (1990).

In conclusion, the study has shown that inclusion of 60 per cent autoclaved broiler-litter and 38 per cent cassava wastes in the diets of Bunaji lactating cattle increased the nitrogen content of the milk with higher true protein nitrogen (which is vital in the cheese industry) and improved casein number, which is a valuable index of the milk secreting efficiency of the quarters.

REFERENCES

Abubalkar, M. M. (1990) Dietary energy supply and utilization for milk production. *Paper Presented at*

National Conference on Nigeria Livestock Industry and Prospects for 1990. Nov. 19-22, 1990.

Adeneye, J. A. (1988) Evaluation of the nitrogen fractions in milk of Bunaji (White Fulani) cattle in hot humid environment. *Nig. J. Anim. Prod.* **15**, 29-36.

Apori, S. O. (1988) *Replacement value of yam peels for maize in the diet of White Fulani cattle* (Ph D Thesis). University of Ibadan, Ibadan.

AOAC (1975) *Official methods of analysis, 10th* ed., Washington, DC: Association of Official Analytical Chemists.

AOAC (1990) *Official methods of analysis,* 11th ed. Washington, DC: Association of Official Analytical Chemists.

Burton, H. (1967) Seasonal variation in deposit formation from whole milk on heated surface. *J. Dairy Res.* **34**, 137-143.

Cerbulis, J. & Farrell, H. M. J. (1975) Composition of milks of dairy cattle. 1. Protein, lactose and fat contents and distribution of protein fraction. *J. Dairy Sci.* **58**, 817-827.

Corbin, E. A. & Whitties, E. O. (1965) In *Fundamentals of dairy chemistry,* p. 30 (B. H. Webb & A. H. Johnson). Westport, Connecticut: Avi Publishing Co.

Cragle, R. G., Murphy, M. R., Williams, S. W. & Clark, J. H. (1986) Effect of altering milk production and composition by feeding on multiple component milk pricing system. *J. Dairy Sci.* **69**, 286-289.

Duncan, D. B. (1955) Multiple range and multiple F-test. *Biometrics* **11**, 1-42.

Harland, H. A., Coulter, S. T. & Jenness, R. (1955) Natural variation of milk serum protein as a limitation of their use in evaluating the heat treatment of milk. *J. Dairy Sci.* **38**, 858-869.

Lewis, D., Mill, K. L. & Annison, E. F. (1957) Studies on the portal blood of sheep. 1. Absorption of ammonia from the rumen of sheep. *Biochem. J.* **66**, 587-592.

McDowell, A. K. R. (1972) Seasonal variations in the total nitrogen content of Friesion and Jersey milk. *J. Dairy Res.* **39**, 27-33.

NRC (1978) *Nutrient requirement of dairy cattle,* 6th rev. ed. Washington, DC: National Research Council, National Academy of Science.

Politick, R. D. (1966) Probleme der Züchung auf Milcheiweiss beim Rind. *Wiss Z Humboldt Univ. Berlin, Math, Natur wissen, Reshe* **15**, 333.

Rangappa, K. S. & Achaya, K. T. (1974) *Indian dairy production,* pp. 42-47. Bombay: Asian Publishing House.

Reäner, E. (1968) Der Eiweissgehalt der Milch in Abhãngigkeit Von genetischen-und Umwelt-faktoren. *Mölkerel-und Kåserei-eitung* **19**, 195.

Rook, J. A. F. & Campling, R. C. (1965) Effect of stage and number of lactation on the yield and composition of cow milk. *J. Dairy Res.* **32**, 45-55.