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Assessing the nutritional status of four indigenous breeds of cattle using some blood metabolites in Nigeria

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Abstract
Data on some blood metabolites from five bulls each of Bunaji, Rahaji, Sokoto Gudali and Azawak breeds of cattle were collected. They were fed poultry litter in a concentrate mixture for 90 days and their nutritional status ascertained from the serum metabolic profile. Result showed that the metabolisable energy and crude protein composition of the diet were within the optimum values required for beef cattle. Significant (P<0.05) difference existed between the breeds for creatitnine values. It was highest for Bunaji at the beginning of the experiment, Bunaji and Sokoto Gudali had similar values at the middle. There also significant (P<0.05) difference observed between the breeds in terms of total protein even though it later decline in all the breeds at the middle and slightly went up at the end of the trial. Blood urea nitrogen concentration was significantly (P<0.05) different across the time of collection between the breeds. It slightly declined at the middle and sharply increased at the end for all the breeds. Similarly, the result showed that there was significant (P<0.05) difference in the values obtained for blood glucose. SokotAo Gudali recorded the least value for blood glucose from the beginning to the end of the study. Albumin was only significantly (P<0.05) different at the beginning of the study. In conclusion, the results showed that in general metabolic profiling studies in these breeds of cattle did not identify any clear nutritional constraints to productivity. It can be said with certainty, from the glucose, albumin and urea results, that dietary energy and protein were not limiting.

Key words: Albumin, Bulls, Glucose, Poultry litter, Total protein

1. Introduction

Blood metabolite concentrations represent an integrated index of the adequacy of nutrient supply in relation to nutrient utilization of cattle (Chester-Jones et al 1990). They give an immediate indication of an animal's nutritional status at that point in time (Pambu-Gollah et al 2000). The use of metabolic profiles for assessing the nutritional and health status of cows is widespread (Doornenbal et al 1988; Grunwaldt et al 2005).

More accurate assessment of nutritional states of cattle can be made using blood metabolite concentrations than from assessment of body weights or condition scores alone. Serum concentrations of metabolites such as glucose, cholesterol, Non-esterified fatty acids, blood urea nitrogen, creatinine, total proteins, albumin, globulin and minerals are commonly used to assess the nutritional status of cattle (Grunwaldt et al 2005 and Ndlovu et al 2007).

Use of blood metabolites has been applied mainly in dairy cows (Whitaker et al., 1999) due to the intensive production systems used and their high susceptibility to metabolic disorders. Extensive farming practices in beef production make it difficult to conduct routine sampling from these animals even though beef cattle are also susceptible to metabolic disorders such as grass tetany a condition resulting from calcium and magnesium deficiency. Blood metabolite levels creating reference values for assessing nutritional status of animals; have not yet been established for Nigerian cattle.

The objective of this work therefore was to determine blood metabolite concentrations for Bunaji, Rahaji, Sokoto Gudli and Azawak breeds of cattle which will provide information that serves as the basis for explaining the nutritional status of indigenous cattle breeds in Nigeria.

2. Materials and Methods

2.1 Study site

The study was carried out at the National Animal Production Research Institute, Shika – Zaria. NAPRI is situated in the Northern Guinea Savanna Zone of Nigeria between latitudes 11°N and 12°N and longitudes of 7°E and 8°E at the elevation of 640 meters above sea level.

2.2 Animals' Management

Five bulls each of Bunaji, Rahaji, Sokoto Gudali and Azawak breeds of cattle with live weights ranging between 200 and 235 kg were used for the study. The bulls were divided into four groups in a completely randomized design with each breed constituting a treatment. The animals were de-wormed with Albebdazole® against endo-parasites a week to the start of the experiment and dipped in acaricide - Amitix® solution to control ecto-parasites. The bulls were individually penned and fed ration made up of 60% Maize Offal (MO), 20% Cotton Seed Cake (CSC) and 20% Sun dried Layer Litter (SDLL) as the diet (Table 1). The bulls were fed 1 kg/head/day each of hay and concentrates for fourteen days of adjustment period. When the study started, the concentrate was offered at 2% body weight as well as Digitaria *smutsii* grass hay which served as the basal diet and 30 litres of water was offered daily. This lasted for 90 days.

2.3 Blood Sampling

About 10mls of blood was collected from each bull before the commencement of the trial, at the middle and the end of it via Jugular *vein puncture*. The sample was emptied into vacutainer tubes, spun and the plasma analysed for Blood Urea Nitrogen, Blood glucose, Total protein, albumin and creatinine.

2.4 Biochemical analysis

Blood samples were analyzed for blood urea nitrogen, blood glucose, total protein, albumin and creatinine; Sodium, Potassium, Calcium and Phosphorus levels using the procedure of Archer and Robb (1925) and used by Ogunsanmi et al (2002) at the Chemical Pathology Laboratory of Ahmadu Bello University Teaching Hospital, Zaria.

2.5 Statistical analysis

All data generated from the study were analyzed using procedure of the Statistical Analysis System (SAS 2002) and Microsoft Excel Software (Microsoft XP) to evaluate the performance of the four breeds of cattle. Duncan Multiple Range Test of the SAS package was used to compare treatment means that were significant. The model used was: $Y_{ij} = \mu + B_i + e_{ij}$

Where Y_{ij} = observation on the breed; μ= Overall mean; B_i = Effect of i_{th} Breed: 1, 2, 3, and 4;
e_{ij} = Random error. All statistical tests were done at 5% probability level.

3. Result

3.1 *Composition of experimental diet*

Table 1 presents the ingredients and chemical composition of the experimental diet. The diet used in this study had 92.37% DM, 19.63% CP, 27.40% CF, and 10.01% EE, 80.82% OM, 35.95% ADF, 51.27% NDF and 11.55% Ash. The ME of the diet was 10.52 MJ/kg DM while the CP of the diet was 19.63%.

3.2 *Creatinine*

Figure 4.7 shows the result of creatinine. The result showed that there was significant ($P<0.05$) difference among the breeds at all periods. At the beginning, Bunaji had 86.00µmol/l and was significantly ($P<0.05$) higher than Azawak (72.00µmol/l) and Sokoto Gudali (70.00µmol/l) which also had similar ($P>0.05$) values that were higher than that of Rahaji (58.40µmol/l). At the middle, Sokoto Gudali(76.20µmol/l) and Bunaji (74.00µmol/l) had similar ($P>0.05$) values while Azawak (66.00µmol/l) and Rahaji (63.80µmol/l) had lower values that were also similar ($P>0.05$). The values for all the breeds at the end followed the same pattern as at the beginning. Creatinine concentrations in the blood vary due to an animal's diet, breed, muscle mass and sex (Otto et al. 2000; Hammond 2006). The finding of this study is in conformity with the report of Otto et al (2000) that serum creatinine vary due to breed, age and sex differences.

3.3 *Total protein*

The result of total protein is presented in Figure 1. The result showed significant (P<0.05) difference among breeds across the periods. Bunaji (91.20g/dl) had slightly higher value followed by Rahaji (89.00g/dl) and Sokoto Gudali (86.00g/dl) while Azawk (73.80g/dl) had the least at the beginning. At the middle, all the breeds had similar (P>0.05) values of 76.00, 74.00, 72.0 and 70.20g/dl for Rahaji, Bunaji, Azawak and Sokoto Gudali respectively. At the end, Bunaji (77.60g/dl), Rahaji (77.40g/dl) and Sokoto Gudali(75.40g/dl) had similar (P>0.05) values that were significantly (P<0.05) higher than Azawak (69.60g/dl) which had the least.

3.4 *Blood Urea Nitrogen*

Figure 2 shows the result of blood urea nitrogen. The result showed that there was significant (P<0.05) difference among the breeds at all the periods. Bunaji (4.20mmol/l) and Sokoto Gudali (4.20mmol/l) had higher blood urea level followed by Azawak (3.40mmol/l) while Rahaji (3.10mmol/l) had the least at the beginning of the feeding trial. At the middle of the trial, Bunaji (4.00mmol/l) had significantly (P<0.05) higher value than Sokoto Gudali (3.66mmol) and Azawak (3.66mmol/l) having similar (P>00.05) values while Rahaji (3.20mmol/l) had the least. At the end, Sokoto Gudali (5.20mmol/l) was significantly (P<0.05) different followed by Bunaji (4.80mmol/l) and Rahaji (4.800mmol/l) which had similar values. Azawak (4.40mmol/l) had the least value among all of them.

3.5 *Blood Glucose*

The result of blood glucose levels of the bulls is presented in Figure 3. The result showed that there were significant (P<0.05) differences among breeds and across period. Rahaji (3.42mmol/l) had the highest blood glucose value. It was followed by Bunaji (3.02mmol/l) while Azawak had 2.78mmol/l. Sokoto Gudali (2.54mmol/l) had the least blood glucose level at the beginning of the trial. Azawak (3.14mmol/l) and Bunaji (3.12mmol/l) had similar (P>0.05) values that were significantly (P<0.05) different followed by Rahaji (2.86mmol/l) while Sokoto Gudali (2.54mmol/l) had the least value at the mid stage of the trial. At the end, Azaawak (3.76mmol/l) had significantly (P<0.05) different value from those of Rahaji (3.30mmol/l), Sokoto Gudali (3.26mmol/l) and Bunaji (3.20mmol/l) that were significantly (P>0.05) similar.

3.6 *Albumin*

The result of Albumin presented in Figure 4 showed that there was significant (P<0.05) difference among breeds. At the beginning, Bunaji (39.60g/L) had higher value followed by Sokoto Gudali (37.80g/L). Azawak (35.20g/L) and Rahaji (34.80g/L) had similar (P>0.05) values. At the middle, Bunaji (36.00g/L) and Azawak(35.80g/L) had slightly higher values than Rahaji (34.80g/L) and Sokoto Gudali (33.20g/L). Bunaji (34.60g/L) and Sokoto Gudali (34.60g/L) had similar (P>0.05) values that were slightly higher than those of Azawak (33.40g/L) and Rahaji (32.80g/L) which were also similar (P>0.05) at the end.

4. Discussion

The ME of the diet was 10.52 MJ/kg DM and it was within the range of 10 – 11.6MJ/kg DM recommended for bulls (Rutherglen 1995). The CP of the diet was 19.63%. It was higher than 13% and 13% - 15% CP requirement of beef cattle stated by Rutherglen (1995) and Aduku (2005) respectively. The CF of the diet has exceeded the minimum level of 17% required by beef cattle (NRC 2000). The EE of the diet had exceeded the maximum recommended level of 6% for matured cattle as reported by Parish and Rhinehart (2008).

Creatinine concentrations in the blood vary due to an animal's diet, breed, muscle mass and sex (Otto et al. 2000; Hammond 2006). The genetic make of the different breeds of cattle used may be the cause of the significant differences noticed in the values of creatinine of this study. The finding of this study is in conformity with the report of Otto et al (2000) that serum creatinine vary due to breed, age and sex differences.

Although the levels of total protein in all the breeds at the beginning of the study were higher than at the middle and end, they were similar to the report of Ndlovu et al (2007) but slightly higher than the range of 60 – 82g/L reported by Singh et al (2008). The high level of total protein noticed in this study indicates that the diet fed to the animals had adequate amount of crude protein in it agreeing with the report of Oyedipe et al (1984) which indicated that high protein intake in a diet results to high blood protein. The slight differences in the values of total protein noticed among breeds in the present study followed suit the report of Otto et al (2000) that blood metabolites are influenced by breed, sex, age, and environmental temperature and of course the diet fed to the animals.

Blood urea levels can be used for measuring protein status in cattle from different feeding regimes and seasons (Hammond 2006). The values obtained in this study for blood urea nitrogen of all the breeds fell within the normal range of 2.5 – 6.5mmol/L given by Mehrez et al (1976) for cattle. This indicates that the effective rumen degradable protein was adequate. The results obtained for albumin in this study supports this conclusion. The difference observed in this study with regards to blood urea nitrogen, cannot be completely associated to breed since all the breeds at one period or the other had some values that were similar to each other.

Blood glucose has a moderate diagnostic value in the assessment of nutritional status of cattle as it varies moderately in blood (Ndlovu et al 2007). The blood glucose level for all the breeds were within the normal range values of 2.5 – 6.5mmol/L as reported by Woodman and Evan (1974). Although some bulls in all the breeds had lower values than these, are very similar to those reported for extensive range beef cattle in other areas (Otto et al 2000). The values obtained in this study were slightly below the value of 3.75mmol/L obtained by Ndlovu et al (2007) in their study with *Nguni* breed of cattle in South Africa. Glucose is not sensitive to changes in energy balance because of homeostatic control (Whitaker et al 1999) and usually does not drop until the situation is extreme - which was not our case; it is possible that the reference range is lower for these types. These differences might be due to breed and environmental differences.

Although it was noticed that the albumin values declined from the beginning to the end of the experiment the result showed that they were above the values reported by Whitaker et al (1999). This implies that dietary protein was not limiting and that liver function was likely to be reasonable. The observation made in this present study is at variance with the finding of Otto et al (2000) who did not detect any age difference in albumin levels when they looked at blood profiles of *Anguni* cattle in Mozambique.

5. Conclusion

In conclusion, the results showed that metabolic profiling studies in the four breeds of cattle did not identify any clear nutritional constraints. It can be said with certainty, from the blood glucose, albumin and urea results, that dietary energy and protein were not limiting. However, a number of other findings, such as those for globulin and phosphorus, may be worth pursuing further.

6. Acknowledgement

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Table 1: Ingredients and Chemical composition (%) of concentrate diet

Parameters	(%)
Ingredients	
Maize offals	60
Cottonseed cake	20
Poultry litter	20
Chemical composition	
Dry matter	92.37
Crude protein	19.63
Ether extracts	10.01
Organic matter	80.82
Acid detergent fibre	35.95
Neutral detergent fibre	51.27
Crude fibre	27.40
Ash	11.55
ME (MJ/kg DM)	10.52

The ME value of the experimental diet was calculated as per Alderman (1985) as follows:

ME (MJ/kg DM) $11.78 + 0.00654CP + (0.000665EE)^2 – CF (0.00414EE) – 0.0118A$

Where DM= Dry Matter, CP = Crude Protein, EE = Ether Extract, CF = Crude fibre, A=Ash

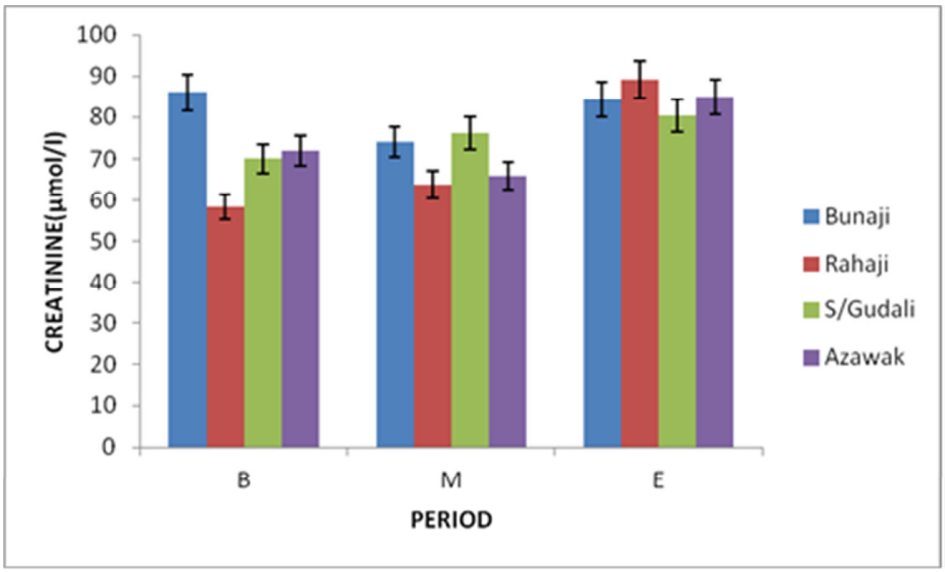

Figure 1: Effect of period of collection on Creatinine of four indigenous breeds of cattle

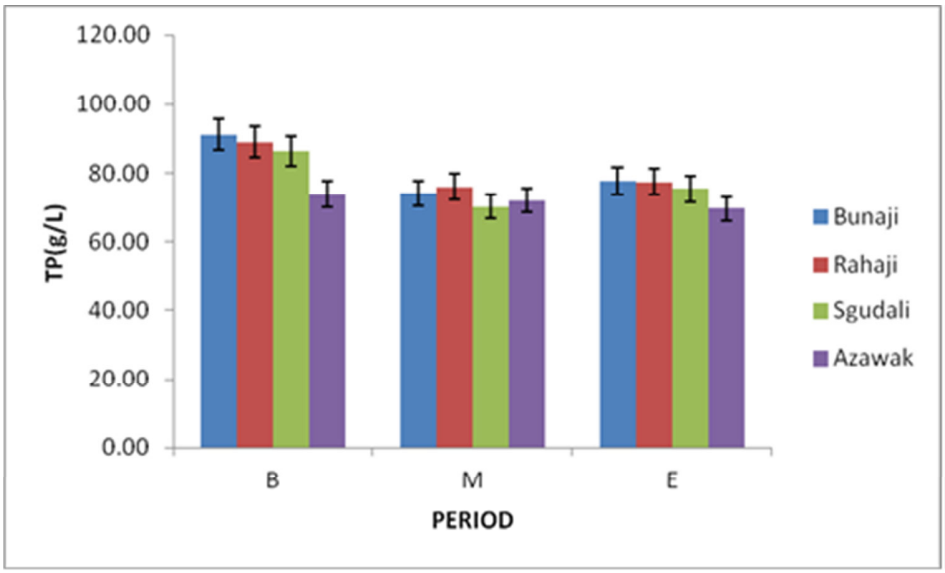

Figure 2: Effect of period of collection on Total protien of four indigenous breeds of Cattle

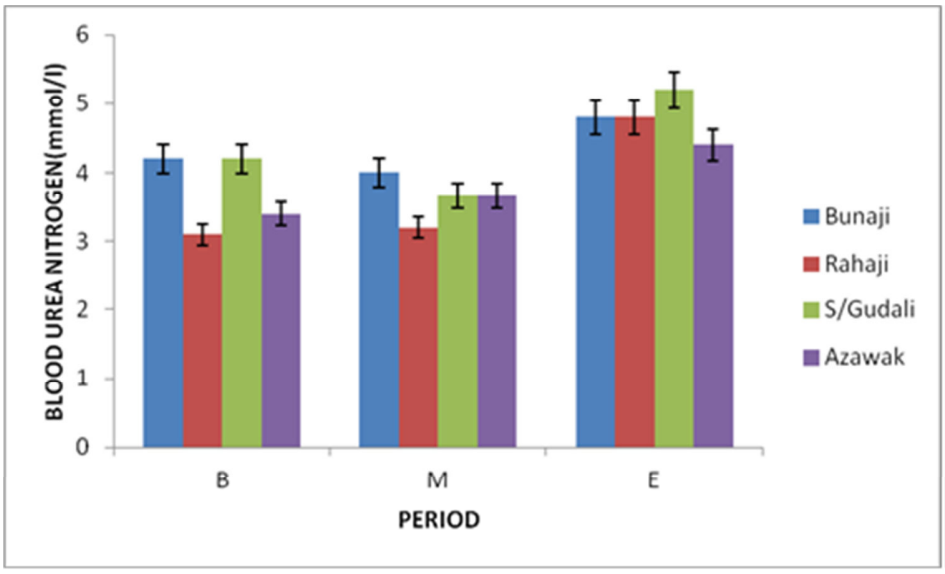

Figure 3: Effect of period of collection on blood urea nitrogen of four indigenous breeds of cattle

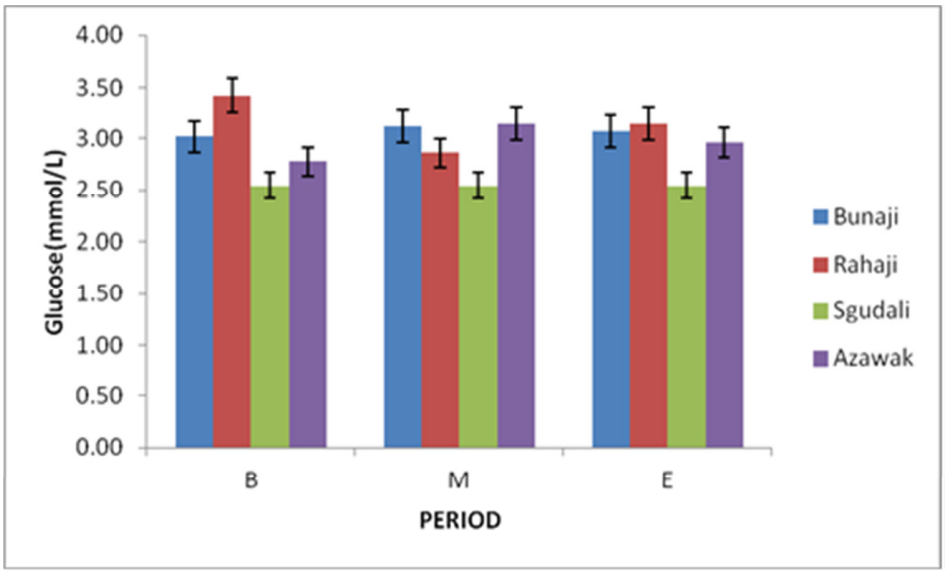

Figure 4 : Effect of experimental diet on blood glucose of four indigenous breeds of cattle.

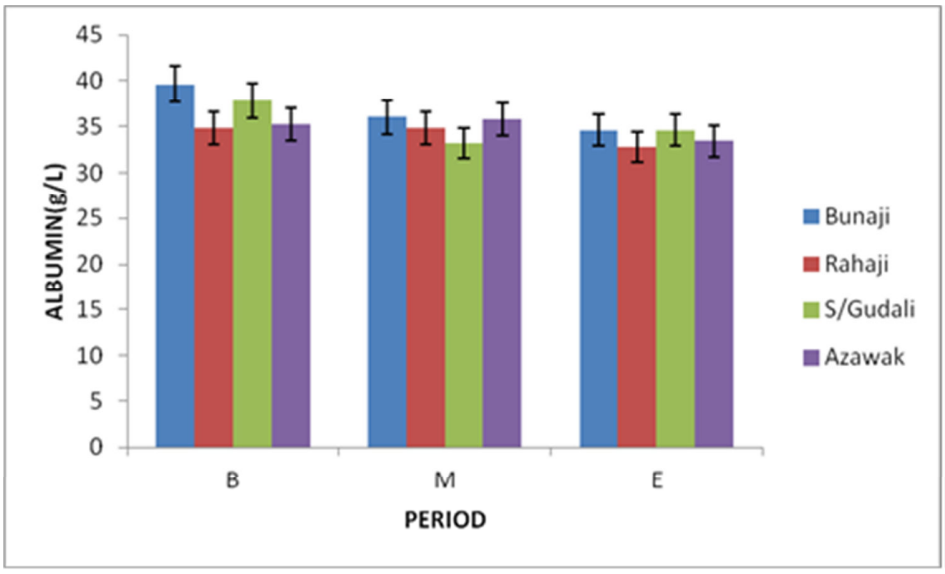

Figure 5: Effect of Period of collection on Albumin of four indigenous breeds of Cattle

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