J. Amin. Prod. Res. (2013) 25:87-96

EFFECT OF UREA TREATED MAIZE STOVER BASED COMPLETE DIETS ON THE BIOCHEMICAL CHANGES IN THE RUMEN AND BLOOD PARAMETERS OF CROSSBRED BULLS

H. I. Finangwai., O.W. Ehoche.* G.N. Akpa and P.P. Barje ***

Department of Agricultural Science, Federal College of Education, Pankshin.
**National Animal Production Research Institute, Shika, Zaria*
***Department of Animal Science, Ahmadu Bello University, Zaria.*

ABSTRACT

The experiment was conducted to determine the effect of urea-ammonia treated maize stover (UTMS) based complete diets on biochemical changes in blood and rumen liquor of Friesian x Bunaji bulls. Sixteen Friesian x Bunaji crossbred bulls averaging 158kg were divided into four groups of four animals each and randomly allocated to four complete diets containing 40,50,60 and 70% urea –ammonia treated maize stover. Strained rumen liquor (SRL) and blood sample were collected to determine rumen and serum biochemical parameters. The pH of SRL did not differ significantly (P>0.05) between treatments and sampling time. However, Total nitrogen (P<0.01), Ammonia-N (P<0.05) and Total Volatile Fatty acid (*TVFA) differ significantly (P<0.05) both across treatment and sampling time. Their peak concentration times were at 2h post feeding for total nitrogen and ammonia-N and 4-8hours post-feeding for TVFA. There were no significant differences (P>0.05) in serum urea, creatinine, glucose and protein across treatment groups. Values obtained were within normal ranges. Sampling time did not significantly (P>0.05) affect both serum urea and glucose; and they had their peak concentrations at 0-2h and 0h post-feeding, respectively. At 4h post-feeding, serum creatinine differed significantly (P<0.05). Serum protein differed (P<0.05) between 2-4h post-feeding. The result showed that the values for serum urea nitrogen, creatinine, glucose and protein were similar across treatments and were within normal physiological ranges. Thus, small holder cattle farmers can adopt urea-ammonia treatment as a cheaper measure of improving the nutritional value of poor quality roughages.*

Key words: maize stover, urea, Friesian x Bunaji bulls

INTRODUCTION

The feed resources available to smallholder farmers in the tropics are mainly range forages, crop residues and agro - industrial by-products. Cereal crop residues, which form the bulk of the crop residues, are generally low in protein and high in cellulose contents (Alhassan *et al.*, 1983). The use of urea-ammonia treatment to improve the quality of crop residues is cheaper and therefore has practical application at the smallholder level in developing countries (Ehoche, 2002). Urea-ammonia treatment of crop residues has been reported to improve digestibility, milk yield, weight gain and feed efficiency in animals (Djibrillou *et al.*, 1998). Blending of roughages and concentrate as a complete diet, enhanced feed consumption, live weight gain and feed efficiency in animals (Reddy and Reddy, 1999; Sureshkumar *et al.*, 2000).

There is scarcity of information on urea-ammonia treated maize stover based complete diet to animals. Therefore, this study was conducted to determine the effect of urea-ammonia treated maize stover (UTMS) based complete diets on biochemical changes in blood and rumen liquor of Friesian x Bunaji bulls.

MATERIALS AND METHODS

Maize stover collected after grain harvest was chopped to a size of 2cm, using a forage chopper. The stover was treated with urea solution (4.0% urea and 50% water). Four complete diets were formulated to contain 40, 50, 60, and 70 percent urea treated maize stover and 60, 50, 40 and 30 percent concentrate mixture, respectively. Feed was analyzed for proximate sample (AOAC, 1995), and cell wall constituents (Goering and Van Soest, 1970).The concentrate mixture consisted of wheat bran, cottonseed cake, maize grain, bone meal and common salt. Sixteen (16) Friesian x Bunaji crossbred bulls averaging 158kg were randomly divided into four groups on the basis of their body weight and allocated to the complete diets in a completely randomized design (CRD). The animals were housed in individual pens and fed *ad libitum* on the respective diets for a period of 70 days. Rumen liquor was collected for 2 consecutive day's midway into the feeding trial using a stomach tube before feeding at 0 and at 2, 4 and 8hours post feeding. The rumen liquor was strained through 4 layered muslin cloths and pH was determined immediately after collection using digital pH meter. The strained rumen liquor with a few drops of saturated mercuric chloride solution was bulked and stored at -4^0C till analyzed. Following rumen liquor collection, blood samples were also taken from the bulls by jugular puncture at 0, 2, 4 and 8h post feeding.

Laboratory analysis

The bulk sample of strained rumen liquor with a few drops of saturated mercuric chloride solution was analyzed for total nitrogen (AOAC, 1995), ammonia nitrogen (Conway, 1957) and total volatile fatty acids (Barnett and Reid, 1957). The blood samples were analyzed for glucose (Folin and Wu, 1920), serum protein (Lowry *et al*, 1951), creatinine (Brod and Sirota, 1948) and urea (wooton, 1964).

Data Analysis

Data collected were analyzed using the least square method of SAS (1990). The significant differences between means were separated using the Duncan Multiple Range Test (DMRT) Procedure of SAS (1990).

RESULT

Chemical Composition of Complete Diets

The ingredient and chemical composition of complete diets, untreated maize stover and Urea-ammonia treated maize stover (UTMS) are presented in Table (1). Treatment of maize stover with urea-ammonia increased crude protein content from 3.81 to 8.81%. The crude protein content of the complete diets varied from 12.07 to 14.77%. The treatment of maize stover with urea decreased NDF and hemicellulose components. The results also showed that NDF and ADF increased with increase in the level of urea-ammonia treated maize stover in the complete diets.

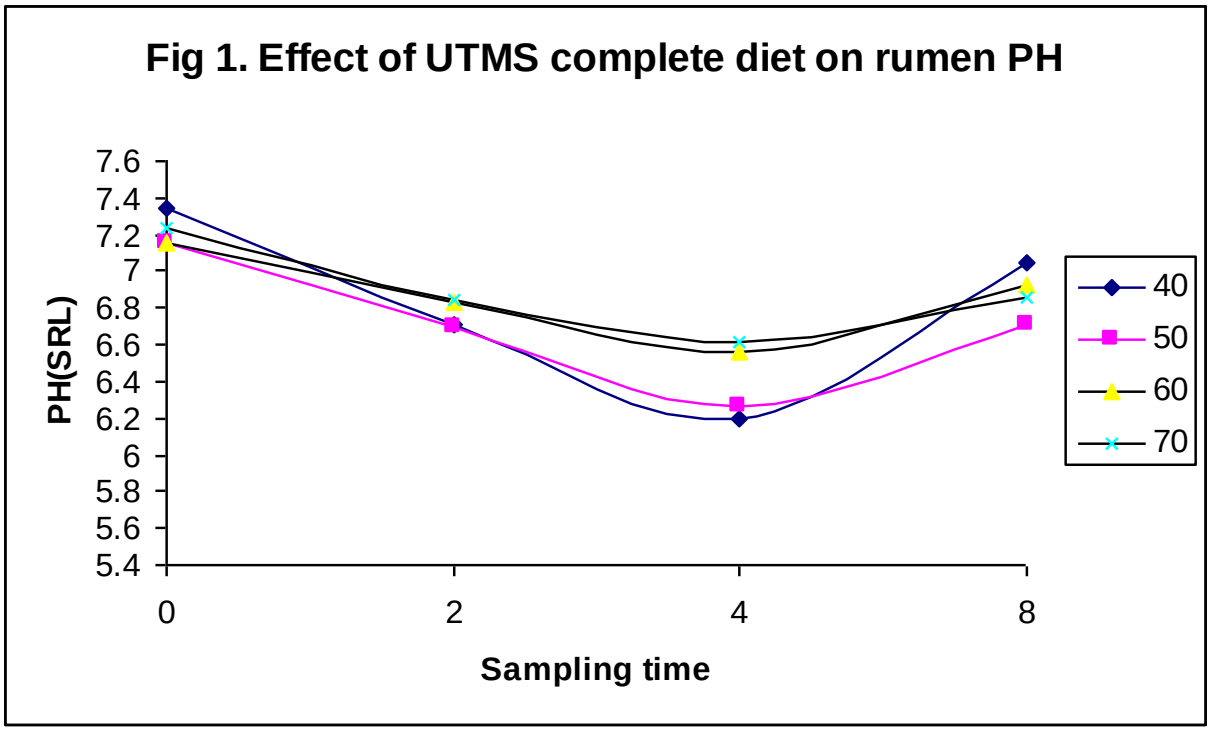
Table 1: Chemical composition of UMS and Diets

Parameters	Levels of inclusion of UTMS in complete diets (%)					
	40	**50**	**60**	**70**	**UMS**	**UTMS**
Ingredient						
UTMS	40	50	60	70		
MAIZE	8	8	8	8		
CSC	14	14	14	14		
WHEAT BRAN	35	25	15	5		
BONEMEAL	2	2	2	2		
COMMON SALT	1	1	1	1		
DM	94.84	94.32	95.34	93.39	95.01	94.84
OM	88.43	81.99	87.23	83.00	87.47	86.56
ASH	6.41	7.33	8.11	10.58	7.54	8.28
EE	6.82	6.59	12.34	11.94	4.02	13.94
CF	40.41	42.20	45.27	47.20	43.82	42.68
NFE	26.43	19.69	16.99	11.60	35.82	21.13
NDF	49.38	56.66	63.17	66.98	77.96	70.05
ADF	37.54	39.74	47.54	56.53	50.64	58.52
H/CELLULOSE	11.84	16.92	15.63	10.45	27.32	11.53
CP	14.77	13.51	12.63	12.07	3.81	8.81

UMS=untreated maize stover; UMTS=urea treated maize stover CSC=cotton seed cake.

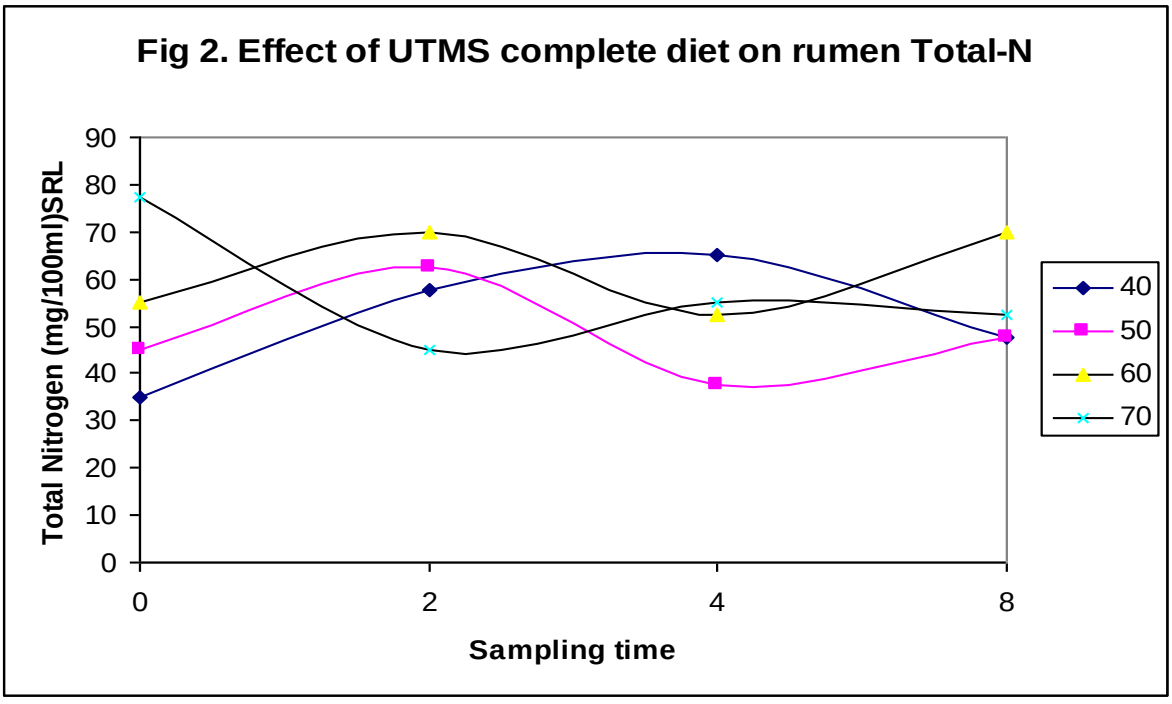
Rumen Metabolites

The results of rumen fermentation pattern of UTMS based complete diets (Fig. 1). Showed no significant difference ($P>0.005$) in pH both between diets and time of sampling. The pH at 0 hour was higher than those at 2, 4, and 8 hours post feeding and lowest at 4hour post -feeding.



Total Nitrogen

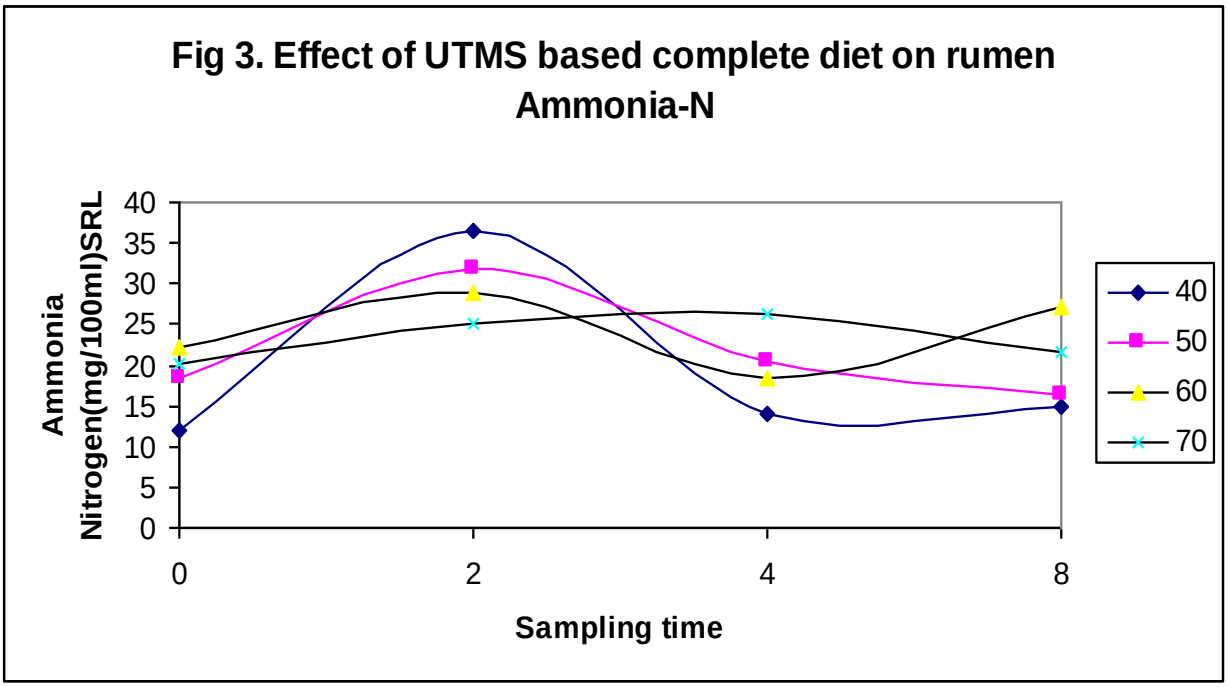
Total nitrogen concentration was significantly (P<0.01) higher in complete diet with 60% level of UTMS inclusion. At 70% level of UTMS, the value was significantly higher (P<0.05) than diets with 40 and 50% levels of UTMS inclusion. Total nitrogen concentration was highest at 2h post feeding, though it was not significantly different



across the sampling time (P>0.05) (Fig. 2).

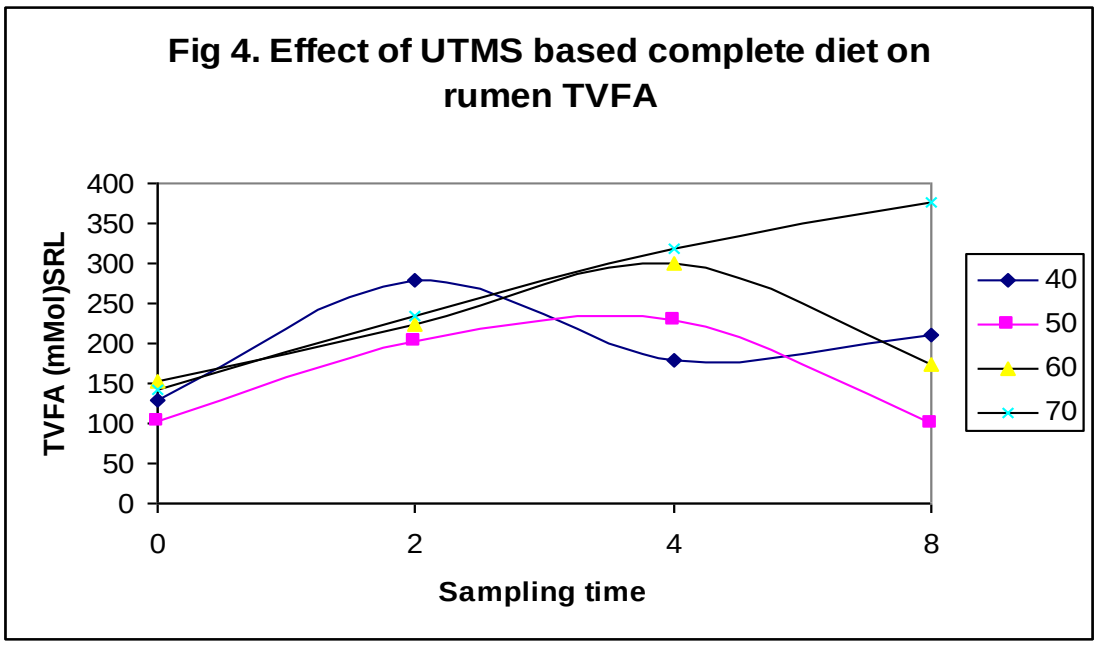
Ammonia Nitrogen

The result showed that rumen NH_3– N concentration increased with increasing level of UTMS up to 60% (24.14mg/100ml). At 70% UTMS NH_3 – N concentration decreased to 23.27 mg/100ml. The values for animals fed Complete diet with 60 and 70% levels of UTMS inclusion were significantly higher ($P<0.05$) than those fed 40% UTMS but similar to those on 50% UTMS inclusion. Rumen NH_3 – N concentration was significantly ($P>0.01$) higher at 2h post feeding than at 0, 4 and 8hours Post feeding (Fig. 3).



Total Volatile Fatty acid (TVFA)

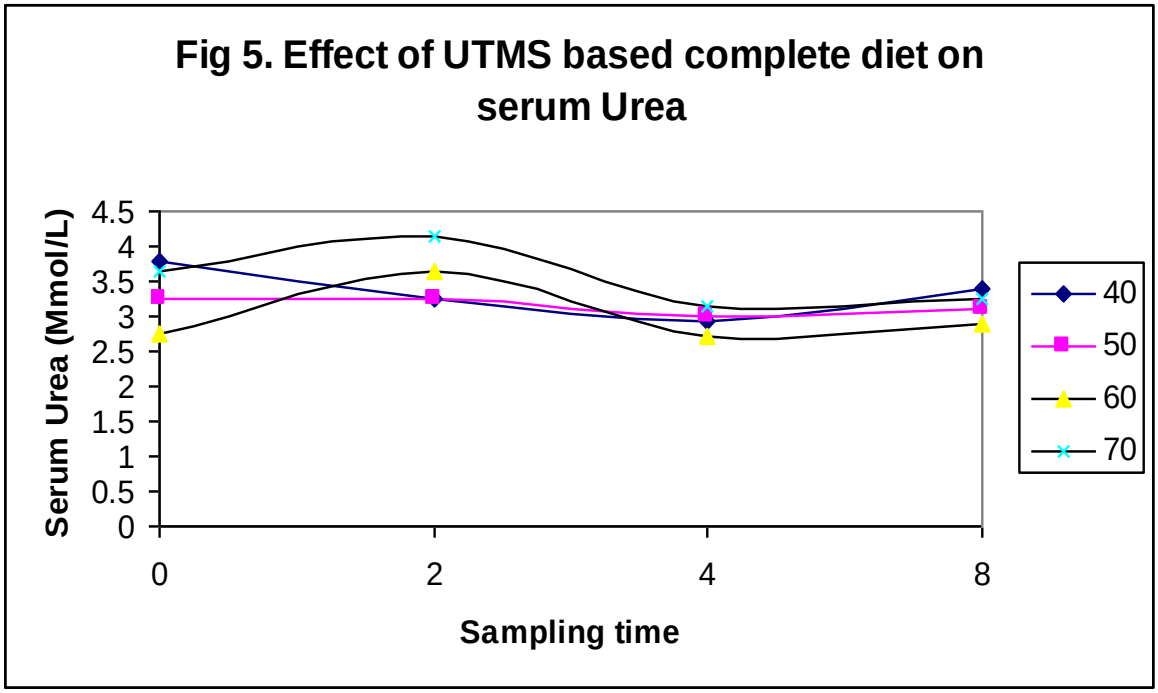
The result of TVFA is shown in (Fig. 4). There was significant difference ($P<0.05$) in rumen TVFA across treatment groups. TVFA concentration in rumen was highest between 2 – 4h post feeding and lowest at 8h post feeding.



SERUM METABOLITES

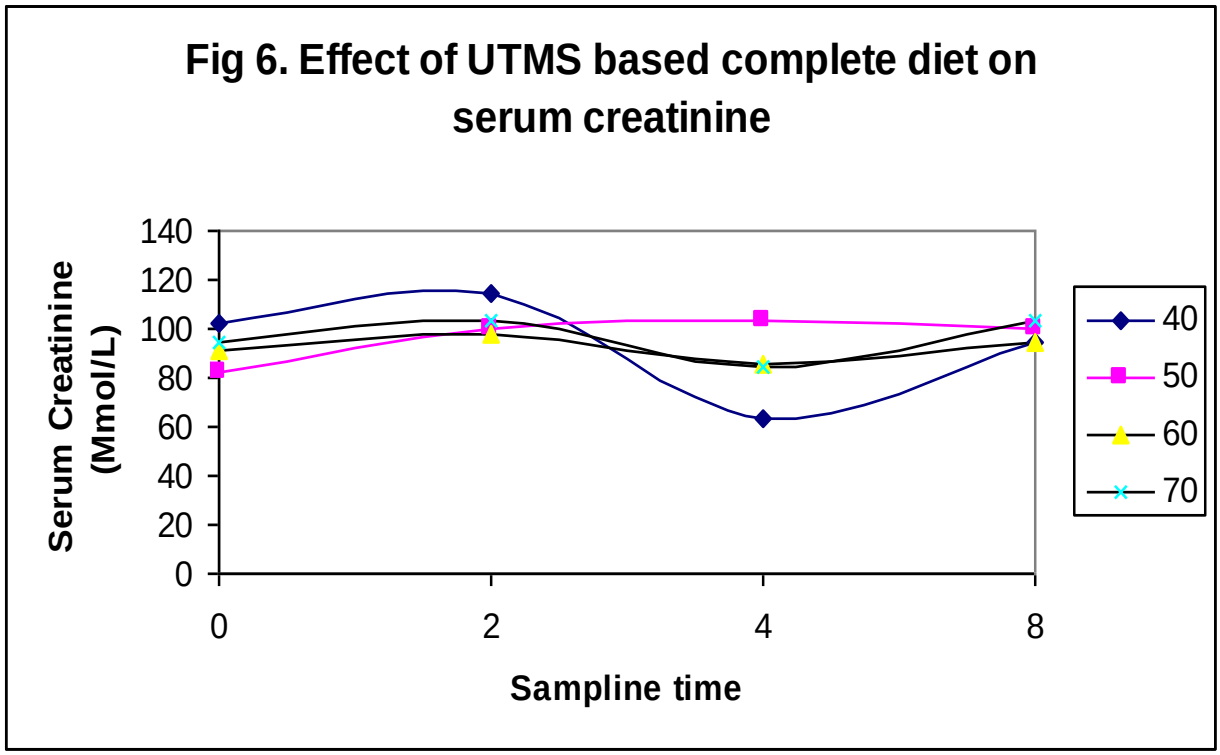
Urea, (Mmol/L)

Changes in serum urea are shown in Fig. 5. The result showed no significant effect of varying levels of UTMS in complete diets on serum urea (P>0.05). The effect of time of sampling on serum urea was noted to be highest at 2hr post feeding and lowest at 4hr post-feeding. There was no significant difference in the means both across the diet and sampling time (P>0.05).



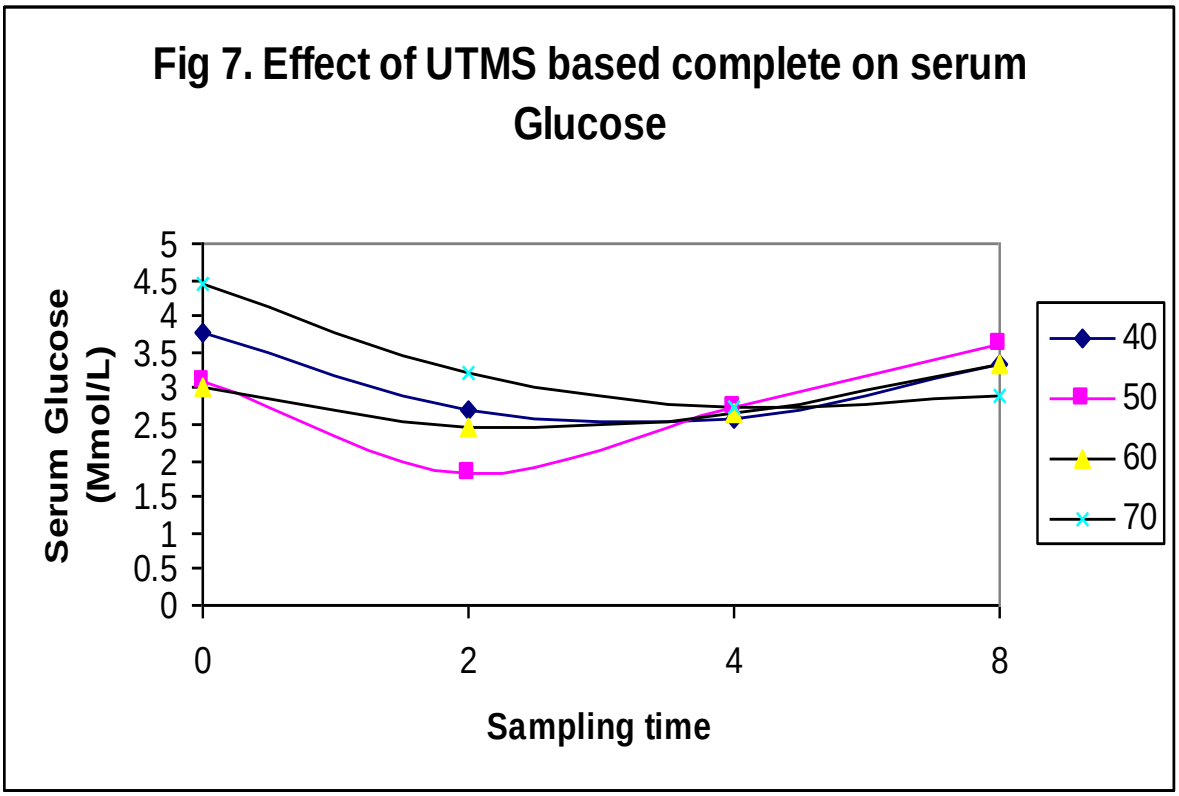
Creatinine (Mmol/L)

Concentration of serum creatinine in Fig. 6. showed values of 93.94, 96.44, and 91. 94 and 96.31mmol/L for 40, 50, 60 and 70% level of UTMS in complete diets, respectively, and were not significantly different (P>0.05). Although serum creatinine concentration value was highest at 2hour post-feeding, it was not significantly different (P>0.05) from sampling times of 0, 4 and 8hours post - feeding.



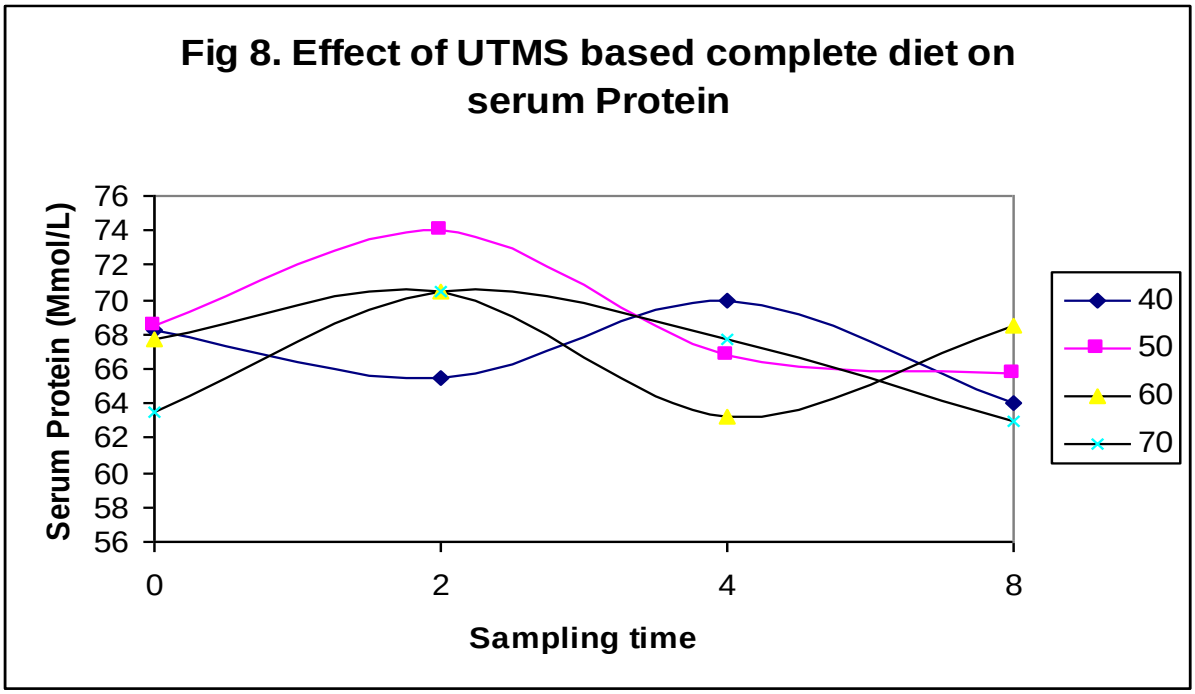
Glucose (Mmol/L)

As shown in Fig. 5, the higher glucose concentrations for 40% and 70% levels of UTMS fed bulls were not significantly different from those of 50 and 60% UTMS inclusion levels.(P>0.05). Glucose level in serum was highest at 0h (P<0.01) although it was not significantly different from 8h. The values of glucose at 4 and 8h post- feeding were similar (P>0.05). (Fig. 7).



Protein (g/L)

Serum protein result showed values of 66.94, 68.95, 67.50, 66.19 which were similar across treatments (P>0.05) for complete diets containing 40, 50, 60 and 70% UTMS respectively. The serum protein concentration was highest at 2 hours post- feeding (70.13g/L) and lowest at 8hours post feeding (62.81g/L). (Fig. 8).



DISCUSSION

Rumen and Serum metabolites

The pH values of 6.71 to 6.88 observed in this trial are in agreement with the earlier reports of Reddy and Reddy (1999) and Adegbola (2002) that urea treated cereal crop residues maintained rumen pH at 6.42 -6.94 from pH value of 8.29 on straw alone. This is probably due to uniform concentration of ammonia in the rumen during these periods (Naik and Sengar 1999). The mean pH values across sampling time showed that at 0h, pH was significantly higher than at 2, 4, 6, and 8h. Orskov (1982) observed similar rumen pH. However, Adegbola (2002) reported a contrary peak pH value time of 2h post feeding.

The range of rumen total nitrogen level of 40.13 to 61.88mg/100ml in this study is lower than the range of 83.91 to 91mg/100ml and 48.2 to 118.2mg/100ml reported by Bakshi *et al*, (1997) and Reddy and Reddy (1999), respectively. The peak concentrations of total nitrogen at 2h post feeding was in agreement with the report of Reddy and Reddy (1999); but was in sharp contrast with the report of Naik and Sengar (1999) who recorded lowest nitrogen concentration at 0-2h post -feeding. The observed peak concentration of total nitrogen at 2h post feeding might probably be due to the active degradation of protein and hydrolysis of non-protein-nitrogen (NPN) substance in the rumen

Rumen NH_3-N concentration increased with increasing level of UTMS in the complete diets. The range of rumen NH_3-N concentration of 19.24 to 24.14mg/100ml obtained in this study is close to the 21.5mg/100ml reported by Naik and Sengar (1999) and the range of 19 to 25mg/100ml reported by Mehrez *et al.* (1977) to be adequate for forage digestion. The peak NH_3-N concentration at 2h post-feeding agrees with the report of Reddy and Reddy (1986) but contrary to Naik and Sengar (1999) who observed a peak NH_3-N concentration time at 4-6h post-feeding. The increase in concentration of NH3-N concentration could likely be due to deamination of amino acid (Blackburn, 1965).

Volatile fatty acid is the main energy source for ruminants feeding mainly on roughage (Jokthan, 2006). The TVFA concentration in this study seems to increase with increased in the inclusion level of UTMS, perhaps due to increase in availability of fermentable energy (Orskov, 1982). The peak concentration of TVFA at 2-4h post-feeding was similar to 2-4h observed by Prasad (1981).

Varying the levels of UTMS in complete diets from 40-70% did not affect serum urea-Nitrogen, Creatinine, Glucose and Protein. The values obtained were within the normal range of 2.5-6.5Mmol/L, 90-126Mmol/L and 3.0-8.3Mmol/L and 60-82g/L for serum urea, creatinine, glucose and protein, respectively (Woodman and Evan, 1974; Mehrez *et al*, 1977; and Gleghorn, 2004). This also revealed better urea-N utilization (Woodman and Evan, 1974). The non-significant difference in serum-urea between 0-8h post-feeding was in agreement with the report of Bakshi *et al.*, (1997). Also Gleghorn *et al.* (2004) observed an increased serum-urea with increase in CP from 13-14% in steers. The serum-creatinine values of 91.94-96.94Mmol/L obtained in this study is probably a reflection of the high content of metabolizable energy in the diets. It has been reported (Bakshi *et al.,* 1997) that feeds low in metabolizable energy significantly increased blood urea, creatinine and lower serum urea. The non-significantly different serum glucose at the feeding intervals had its' peak concentration at 0h and least value at 2-4h post-feeding.

CONCLUSION

The result showed that the values for serum urea nitrogen, creatinine, glucose and protein were similar across treatments and were within normal physiological ranges, indicating that UTMS could be included in complete diets of growing cattle without adverse effects. Thus, small holder cattle farmers can adopt urea-ammonia treatment as a cheaper measure of improving the nutritional value of poor quality roughages.

REFERENCES

A.O.A.C. (1995) *Official Methods of Analysis* (16th edition.). Association of Official Analytical chemists (A.O.A.C.), Arlington, Va, USA.

Alhassan, W.S., Ehoche, O.W., Adu, I.F. and Obilana, A.T. (1983). Crop residue potential of Agricultural Development Projects, Chemical composition of crop residues. *NAPRI Annual Report*. Pp 60 – 62.

Adegbola, T.A. (2002). Nutrient intake, digestibility and rumen metabolites in bulls fed rice straw with or without supplements. *Nigerian Journal Animal Production*, 29 (1): 40-46.

Bakshi, M.P.S.; Wadhawan, V.M, Wadhwa, M. and Langar, P.N. (1997). Effect of supplementing processed poultry litter with urea treated straw preparations on the biochemical changes in the rumen and blood parameters of Buffaloes. *Buffalo Journal*, 2: 127 – 134.

Barnett, A.J.G. and Reid. R.V. (1957). Studies on the production of volatile fatty acids from grass in artificial rumen 1. Volatile fatty acid production from fresh grasses *Journal of Agricultural Science*, 48: 315 – 321.

Blackburn, T.H. and Hobson. P.N. (1965). Proteolysis in sheep rumen by whole and fractionated rumen content. *Journal of General microbiology*, 22: 272 – 281.

Brod, J. and Sirota, J.H. (1948). Blood metabolites. *Journal of Clinical Investigation*, 27: 645.

Conway, F.J. (1957). Micro- diffusion Analysis and Volumetric Error. Crosby and Lockhood, London.

Djibrillou O.A., Pandey, V.S., Gouro, S.A. and Verhulst, A. (1998). Effect of urea-treated or untreated straw with cottonseed on performance of lactating Maradi (Red Sokoto) goats in Niger. *Livestock Production Science*, 55: 117 – 125.

Duncan, D.B (1955). Multiple range and Multiple F-tests. Biometrics, 11:1-42.

Ehoche, O.W. (2002). Feeding strategies for improving milk production. Paper presented at the Annual conference of Animal Science Association of Nigeria held at the University of Agriculture Abeokuta, Nigeria. 16 – 19 September 2002.

Folin, O. and Wu, H. (1920). Protein Measurement *Journal Biological Chemistry*, 41: 367.

Gleghorn, J.F.; Elam, N.A.; Galyean, M.L.; Duff, G.C.; Cole, N.A. and Rivera, J.D. (2004). Effect of crude protein concentration and degradability on performance, carcass characteristics and serum urea nitrogen concentrations in finishing beef steers. *J. Anim. Sci.*, 2: 2705 – 2717.

Goering, H.K. and Van. Soest, P.J. (1970). *Forage Fibre Analysis* (Apparatus, reagents, procedures and some applications). Agric. Handbook No, 379. USDA, Washington, DC.

Jokthan, G.E. (2006). Effect of supplementing Rice straw with Pigeon Pea forages on Rumen and Blood Metabolites of Yankasa sheep. A seminar paper present at the Dept of Animal Science. A.B.U, Zaria, 18th May. 2006.

Lowry, D.H. Rosenberg, N.J., Farr, A.L. and Radull R.J. (1951). Protein measurement with folin-phenol reagent. *Journal of Biological- Chemistry*, 193: 265.

Mehrez, A.Z; Orskov, E.R. and McDonald, I. (1977). Rates of rumen fermentation in relation to ammonia concentration. *Britian Journal of Nutrition*, 38: 437 – 443.

Naik, P.K. and Sengar, S.S. (1999). Rumen fermentation pattern in Buffaloes maintained on complete diets with different sources of nitrogen. *Indian Journal of Animal Nutrition*, 16(3): 233 – 237.

Osuji, P.O., Nsahli, I.V. and Khalili, H. (1993). Feed evaluation. ILCA Mannual. 5. ILCA, Addis Ababa. Ethiopia. Pp. 40.

Orskov, E.R. (1982). Protein Nutrition in Ruminants. Academic press, London.

Prasad, R. (1981). Studies on the relative levels of various nitrogen fractions and total volatile fatty acids in the rumen liquor of buffaloes fed pelleted rations. M.V.Sc. Thesis submitted to A.P. Agric. University, Hyde- rabad, India.

Reddy, G.V.N. and Reddy, M.R. (1986). Effect of ammoniation and processing of cotton straw as the sole source of roughage in complete feeds on rumen characteristics with Murrah buffaloes. *Animal Feed Science and Technology*, 14: 95 – 102.

Reddy, G.V.N. and Reddy, M.N. (1999). Effect of feeding extruded complete diets containing maize cobs in Ongole bull calves. *India J. Anim. Nutr.*, 16: 210 – 214.

Saadullah, M., Hague, M.A. and Dolbergm, F. (1981). Practical Methods for chemical treatment of rice straw for ruminant feeding in Bangladesh. In: Utilization of low quality roughages in Africa. Proc. Workshop in Arusha, Tanzania 18 – 22 January 1981. pp. 85 – 90.

SAS, (1990). Users Guide: *Statistical Analysis System Procedure*. SAS Institute, Inc. Garry North Carolina, U.S.A.

Sureskhkumar, P., Tomar, S.K. and Sengar, S.S. (2000). The effect of wheat straw based complete diets on feed intake and nutrient utilization in buffaloes. *Indian J. Anim. Nutr*., 17: 341 – 343.

Woodman, H.E. and Evan, R.E. (1974). The nutritive value of fodder cellulose when fed to ruminants and pigs. *Agricultural Science*, *xxxvii* 202 – 223.

Wooton, I.D.P. 1964. In Microanalysis in Medical Biochemistry 4th ed. J. and. Churchill Ltd. London pp. 92 – 93.

Yadav, S.G. and Deshmukh, S.V (2001). Nutritional evaluation of spent straw in complete ration of sheep. *Indian Journal of Animal Nutrition*, 18(2), 151-155.