NIGERIAN VETERINARY JOURNAL
ISSN 0331-3026
Nig. Vet. J., June 2021 Vol 42 (2): 171 – 180.
https://dx.doi.org/10.4314/nvj.v42i2.8 ORIGINAL ARTICLE

# Evaluation of Occurrence of Renal Dysfunction in Goats Using Some Biochemical Markers.

**Udeh, N.E[1*].; Ihedioha, J.I.[2]; Orji, E[1].**

[1]Department of Veterinary Biochemistry and Animal Production, College of Veterinary Medicine, Michael Okpara University of Agriculture, Umudke.[2]Department of Veterinary Pathology, Faculty of Veterinary Medicine, University of Nigeria, Nsukka. *Corresponding author: udehnkiru3@yahoo.com, mobile no:+2347030390379

## SUMMARY

This cross-sectional study evaluated the demographical distribution and occurrence of kidney dysfunction in goats in Umuahia, Abia state, using known biochemical markers. A total of 145 goats presented for slaughter at the Ahiaeke abattoir were evaluated. Prior to slaughter, sex, age, breed and health status of the goats were determined. Blood was collected from the jugular vein at slaughter for haematology and serum biochemical analyses. Urine was collected from the bladder for urinalysis using test strips. Standard procedures were adapted for all the analyses performed. Results showed that 56.6 % of the goats were females, 89 % were adults, 92.4 % were Red Sokoto breed and 95.2 % were apparently healthy. Out of 145 goats sampled, 3 (2.1 %) were diagnosed with kidney dysfunction based on positive serum creatinine and urine protein levels, while 10 (6.9 %) had positive serum urea values. There was significant association (P and < 0.05) between the health status of goats and all the biochemical parameters measured to ascertain renal dysfunction. No such associations exist between sex, breed and the biochemical markers measured. We conclude that kidney dysfunction exists in Nigerian goats, and health status is a determinant of renal dysfunction.

**Keywords** : renal biomarkers, health status, sex, breed, age, goat

## INTRODUCTION

The domestic goat (*Capra aegagrus hircus*) is a member of the animal family Bovidae and the subfamily Caprinae, meaning it is closely related to the sheep, with 300 distinct breeds (Ezewudo *et al.*, 2017). Goats are one of the oldest domesticated species of animal, and have been used for milk, meat, fur and skins across much of the world (Wilson, 1987). They play an important role in both health and economy as they are not affected by any religious and cultural taboo and so, are reared and consumed in areas where beef, pork and any other livestock are forbidden (Adeyeye and Adewumi, 2015).

The kidney is one of the vital organs in the mammalian body and is responsible for intricate aspects of homeostasis: regulation of water and electrolytes homeostasis, waste product excretion, acid–base homeostasis, regulation of arterial blood pressure, synthesis of vitamin D, gluconeogenesis, and hormone secretion (Ihedioha *et al.*, 2019).

Renal dysfunction is routinely diagnosed using biomarkers. A biomarker is measured and evaluated as an indicator of normal biological, pathologic processes, or

pharmacologic responses to a therapeutic intervention (Ramachandran, 2006) and they play a role in accurate diagnosis, prognosis and treatment of diseases (Gowda *etal.*, 2010).Creatinine, urea, uric acid and electrolytes are used for routine diagnosis of renal dysfunction, and more recently, cystatin and β-Trace protein (Gowda *etal*., 2010) as well as Kidney Injury Molecule-1, interleukin-18, *N*-acetyl-β-D-glucosaminidase, and L-type fatty acid-binding protein (L-FABP) (Andreucci *et al*., 2016). Creatinine is produced as the result of normal muscle metabolism. Phosphocreatine, an energy-storing molecule in muscle, undergoes spontaneous, non-enzymatic cyclization to form creatine and inorganic phosphorous. Creatine then decomposes to creatinine. In health, production and excretion of creatinine are fairly constant in an individual animal, resulting in low variation (Zuo *et al*., 2008), it isless influenced by extra-renal factors like hydration and so, is a more accurate biomarker. Urea is produced by the breakdown of proteins and is excreted in the urine and because its level is affected by circadian rhythm, diet, liver function, hydration, and intestinal absorption, it is less accurate as a biomarker (Rosner and Bolton, 2005). Persistent proteinuria that is, presence of protein in the urine, in the absence of lower urinary tract disease or reproductive tract disease, is usually an indication of renal damage or dysfunction (Harley and Langston, 2012).

Renal diseases are important clinical problems and are causes of illness and death in many animals' species, including goats (Mahouz *et al*., 2015). Although, there is a global increase in kidney damage in man (Lucykx, 2018), reports of kidney damage in animals are scant. However, studies on the prevalence of renal disease in goats currently available in literature were in other climes and mostly abattoir studies using gross lesions (Ansari-Lari, 2007; Dutta *et al*, 2016). In Nigeria, however, kidney disease has been reported in cattle (Ihedioha *et al*., 2019) and there are hitherto, no reports of kidney disease in Nigerian goats known to us. Also, kidney studies using biomarkers for renal disease to detect renal dysfunction in goats are not readily available in literature. This study provides these data.

## MATERIALS AND METHODS

*Study location.*

The study was carried out in the goat abattoir in Ahiaeke, Umuahia North Local Government Area, and Abia State, Nigeria. The coordinates of Ahiaeke abattoir are 5.5120° N, 7.5300° E.

### *Study Design*

The study was a cross-sectional survey of goats presented for slaughter at the Ahiaeke abattoir, Industrial Market, Umuahia. The study design was a cross-sectional survey, and was approved by the Institutional Animal Care and Use Committee (IACUC) of the Faculty of Veterinary Medicine, University of Nigeria Nsukka, Nigeria.

### *Animals*

The study populations include all goats slaughtered at the Ahiaeke goat abattoir between November 2019 and April 2020. Research visits to the abattoir was done once in a week, and all slaughtered goats during the days of research visit made up the sample population. A total of 145 goats were evaluated. The goats were examined physically before the slaughtering, and data on sex, age, and breed and health status were collected. At slaughter, blood was drawn from the jugular vein and urine samples were collected from the bladder of each of them.

### *Sample Collection*

Blood for haematology and serum biochemistry analyses were taken immediately to the Veterinary Biochemistry Laboratory, Michael Okpara

University of Agriculture, Umudike. Blood samples for haematology and fibrinogen determination were collected in sample bottles containing ethylenediaminetetracetic acid (EDTA) anticoagulant, while those for serum biochemistry were dispensed into a plain glass tubes and allowed to stand for 45 minutes to clot. Clotted blood was separated from serum by centrifugation at 3000 revolutions per minute (rpm) for 10 minutes. Part of the blood collected into EDTA container was centrifuged at 3000 rpm to obtain plasma for fibrinogen determination. Urine for urinalysis was obtained from the bladder at the point of slaughter by cystocentesis (Yam, 1994).

*Laboratory Methods*

Serum creatinine levels were assayed using the modified Jaffe method (Blass *et al.,* 1974) using Quimica Clinica Applicada (QCA) Creatinine test kit (QCA, Spain). Serum urea levels were determined by the modified Berthelot-Searcy method (Lamb and Price 2008) using the Dialab Urea (urease/colorimetric) test kit (Dialab, Neudorf, Austria).

Urine protein was assayed using Combostik® 11 urinalysis reagent test strips (DFI Co. Ltd., Korea) based on the tetrabromophenol blue colorimetric method.

***Data Analysis***

Data was analysed using SPSS; occurrence was determined using descriptive statistics and presented as percentages. Possible associations between renal impairment and age or sex was analysed using Fisher's exact test, and significance was accepted at $p < 0.05$. Haematological and serum biochemical profile of goats with kidney dysfunction were compared with that of apparently healthy goats using Student's t test.

## RESULTS

*Demography of sampled goats.*

The distribution of sampled goats according to sex, age, breed and health status is presented in Table I. Female goats accounted for 56.6 % of 145 sampled goats, while 89.0 % of the sampled goats were adults. The predominant breed was the Red sokoto (92.4 %) while 95.2 % of goats were apparently healthy (Table I).

**TABLE I. Demographic characteristics of the sample population of goats evaluated.**

| ***Demographic Characteristic*** | ***Categories*** | ***No. out of the total sample population of 145*** | ***Percentages*** |
|---|---|---|---|
| ***Sex*** | Females | 82 | 56.6% |
| | Males | 63 | 43.4% |
| ***Age*** | Adults | 129 | 89.0% |
| | Young | 16 | 11.0% |
| | Mixed | 3 | 2.1% |
| ***Breeds*** | Red Sokoto | 134 | 92.4% |
| | Sahel | 8 | 5.5% |
| | Apparently Healthy | 138 | 95.2% |
| ***Health Status*** | Obviously Unhealthy | 7 | 4.8% |

***Occurrence of renal dysfunction***

Cut-off points for serum creatinine, serum urea and urine protein (Njidda *et al*, 2013); were used to determine the occurrence of renal dysfunction in sampled goats. Goats with serum creatinine higher than 120 mg/kg were classified as having renal dysfunction and they made up 2.1 % of the sampled goats; goats with serum urea greater than 42. 0 mg/kg were positive and made up 6.9 % of the sampled goats while

goats with serum protein higher than 1000 mg/kg which was 2.1 % of goats sampled, were positive (Table II).

**TABLE II. Occurrence of renal dysfunction based on the levels of serum creatinine, serum urea and urine protein cut off points*.**

| *Parameter* | *Categories* | *No. out of the total of 145* | *Percentages* |
|---|---|---|---|
| ***Serum Creatinine (mg/dl)*** | ≥ 1.20 (positive) | 3 | 2.1% |
| | < 1.20 (negative) | 142 | 97.9% |
| ***Serum Urea (mg/dl)*** | ≥ 42.0 (positive) | 10 | 6.9% |
| | < 42.0 (negative) | 135 | 93.1% |
| ***Urine Protein (mg/dl)*** | ≥ 1000.0 (positive) | 3 | 2.1% |
| | < 1000.0 (negative) | 142 | 97.9% |

* Njidda *et al*. 2013

*Relationship between sex and occurrence of renal dysfunction.*

Based on positive serum creatinine levels, 1.2 % of 82 female goats had renal dysfunction, while 3.2 % of 63 male goats sampled were positive. Based on positive serum urea levels, 3.7 % of female goats sampled had renal dysfunction while 11.1 % of male goats were positive. Based on urine protein, 1.2 % of female goats, and 3.2 % of male goats had renal dysfunction. However, there were no significant correlation between sex and occurrence of renal dysfunction based on serum creatinine, serum urea and urine protein (Table III).

**TABLE III. Contingency table showing the relationship between sex and occurrence of renal dysfunction in the goats sampled.**

| ***Based on Serum Creatinine levels:*** | | | | |
|---|---|---|---|---|
| ***Sex*** | No. with serum creatinine ≥ 1.20 mg/dl (positive) | No. with serum creatinine < 1.20 mg/dl (negative) | Total of each sex in the sample population | Percentage of each sex positive |
| ***Females*** | 1 | 81 | 82 | 1.2% |
| ***Males*** | 2 | 61 | 63 | 3.2% |
| ***Totals*** | 3 | 142 | 145 | |
| No significant association between sex and occurrence of renal dysfunction based on serum creatinine levels, p = 0.58 | | | | |
| ***Based on Serum Urea levels:*** | | | | |
| ***Sex*** | No. with serum urea ≥ 42.0 mg/dl (positive) | No. with serum urea < 42.0 mg/dl (negative) | Total of each sex in the sample population | Percentage of each sex positive |
| ***Females*** | 3 | 79 | 82 | 3.7% |
| ***Males*** | 7 | 56 | 63 | 11.1% |
| ***Totals*** | 10 | 135 | 145 | |
| No significant association between sex and occurrence of renal dysfunction based on serum urea levels, p = 0.103 | | | | |
| ***Based on Urine Protein levels:*** | | | | |
| ***Sex*** | No. with urine protein ≥ 1000 mg/dl (positive) | No. with urine protein < 1000 mg/dl (negative) | Total of each sex in the sample population | Percentage of each sex positive |
| ***Females*** | 1 | 81 | 82 | 1.2% |
| ***Males*** | 2 | 61 | 63 | 3.2% |
| ***Totals*** | 3 | 142 | 145 | |
| No significant association between sex and occurrence of renal dysfunction based on urine protein levels, p = 0.58 | | | | |

No significant association (p > 0.05) between sex and occurrence of renal dysfunction in the goats sampled.

***Relationship between breed and occurrence of renal dysfunction***

Table IV shows the relationship between breed and occurrence of renal dysfunction in sampled goats.The red sokoto breed accounted for all the positive cases (2.2%) on the basis of serum creatinine; the sahel breed recorded the highest number of positive serum urea cases (12. 5%); while the positive cases based on urine protein was mainly attributable to the red sokoto goats (2.2 %). These were however not statistically significant (P > 0.05).

**TABLE IV. Contingency table showing the relationship between breed and occurrence of renal dysfunction in the goats sampled.**

| ***Based on Serum Creatinine levels:*** | | | | |
|---|---|---|---|---|
| ***Breed*** | No. with serum creatinine ≥ 1.20 mg/dl (positive) | No. with serum creatinine < 1.20 mg/dl (negative) | Total of each breed in the sample population | Percentage of each breed positive |
| ***Mixed*** | 0 | 3 | 3 | 0% |
| ***Red Sokoto*** | 3 | 131 | 134 | 2.2% |
| ***Sahel*** | 0 | 8 | 8 | 0% |
| ***Totals*** | 3 | 142 | 145 | |
| No significant association between breed and occurrence of renal dysfunction based on serum creatinine levels, p = 0.882 | | | | |
| ***Based on Serum Urea levels:*** | | | | |
| ***Breed*** | No. with serum urea ≥ 42.0 mg/dl (positive) | No. with serum urea < 42.0 mg/dl (negative) | Total of each breed in the sample population | Percentage of each breed positive |
| ***Mixed*** | 0 | 3 | 3 | 0% |
| ***Red Sokoto*** | 9 | 125 | 134 | 6.7% |
| ***Sahel*** | 1 | 7 | 8 | 12.5% |
| ***Totals*** | 10 | 135 | 145 | |
| No significant association between breed and occurrence of renal dysfunction based on serum urea levels, p = 0.733 | | | | |
| ***Based on Urine Protein levels:*** | | | | |
| ***Breed*** | No. with urine protein ≥ 1000 mg/dl (positive) | No. with urine protein < 1000 mg/dl (negative) | Total of each breed in the sample population | Percentage of each breed positive |
| ***Mixed*** | 0 | 3 | 3 | 0% |
| ***Red Sokoto*** | 3 | 131 | 134 | 2.2% |
| ***Sahel*** | 0 | 8 | 8 | 0% |
| ***Totals*** | 3 | 142 | 145 | |
| No significant association between breed and occurrence of renal dysfunction based on urine protein levels, p = 0.882 | | | | |

No significant association (p > 0.05) between breed and occurrence of renal dysfunction in the goats sampled.

RELATIONSHIP BETWEEN HEALTH STATUS AND OCCURRENCE OF RENAL DYSFUNCTION IN GOAT

Obviously unhealthy goats accounted for 28.6 %, 42.9 % and 28.6 % of sampled goats, on the basis of positive serum creatinine, serum urea and urine protein levels respectively (Table V). These associations were significant (P < 0.05).

**TABLE V. Contingency table showing the relationship between health status and occurrence of renal dysfunction in the goats sampled.**

There was a significant association (P < 0.05) between health status and occurrence of renal dysfunction in the goats sampled.

| ***Based on Serum Creatinine levels:*** | | | | |
|---|---|---|---|---|
| ***Health status*** | No. with serum creatinine ≥ 1.20 mg/dl (positive) | No. with serum creatinine < 1.20 mg/dl (negative) | Total of each health status in the sample population | Percentage of each health status positive |
| ***Apparently healthy*** | 1 | 137 | 138 | 0.7% |
| ***Obviously unhealthy*** | 2 | 5 | 7 | 28.6% |
| ***Totals*** | 3 | 142 | 145 | |
| There was a significant association between health status and occurrence of renal dysfunction based on serum creatinine levels, p = 0.006 | | | | |
| ***Based on Serum Urea levels:*** | | | | |
| ***Health status*** | No. with serum urea ≥ 42.0 mg/dl (positive) | No. with serum urea < 42.0 mg/dl (negative) | Total of each health status in the sample population | Percentage of each health status positive |
| ***Apparently healthy*** | 7 | 131 | 138 | 5.1% |
| ***Obviously unhealthy*** | 3 | 4 | 7 | 42.9% |
| ***Totals*** | 10 | 135 | 145 | |
| There was a significant association between health status and occurrence of renal dysfunction based on serum urea levels, p = 0.007 | | | | |
| ***Based on Urine Protein levels:*** | | | | |
| ***Health status*** | No. with urine protein ≥ 1000 mg/dl (positive) | No. with urine protein < 1000 mg/dl (negative) | Total of each health status in the sample population | Percentage of each health status positive |
| ***Apparently healthy*** | 1 | 137 | 138 | 0.7% |
| ***Obviously unhealthy*** | 2 | 5 | 7 | 28.6% |
| ***Totals*** | 3 | 142 | 145 | |
| There was a significant association between health status and occurrence of renal dysfunction based on urine protein levels, P = 0.006 | | | | |

## DISCUSSION

The results from the demographic study showed that female goats were more predominant than the males in the sampled animals. The predominance of female animals in slaughter houses has been documented by previous studies (Berhanu *et al*., 2012, Okorie-Kanu *et al.*, 2018, Aba *et al*., 2020). This trend is an evidence of the primordial nature of livestock production in our environment. In more organized livestock production as seen in developed economies, female animals are rarely slaughtered. It could also be due to a preference by the buyers or cost implication (Aba *et al*., 2020). However, female goats were more positive for all the markers of kidney function assayed than male goats.

Most of the goats slaughtered were apparently healthy. This is in contrast with reports from abattoir studies where many animals slaughtered had poor body condition scores (Lamy *et al*., 2012; Shittu *etal*., 2014). Animals presented for slaughter in abattoirs are usually stressed

probably due to transportation and disease. However, from our study, goats that are apparently healthy were predominant. This could be due to the fact that the slaughter house is located right within the goat market and people purchase these healthy goats and take them directly to the abattoir. Red Sokoto breed of goats were the most predominant. This agrees with previous findings (Shittu *et al.*, 2014; Okorie-Kanu *et al.*, 2018). The predominance of Red sokoto goats over the local breeds could be attributable to the demand for animal protein, hence the procurement of large sized breeds over the small sized local breeds.

There were more positive urea cases than positive creatinine in the goats. Creatinine is more specific for renal dysfunction than urea because the amount of creatinine secreted daily is a function of the muscle mass. It amounts to approximately 2% of the body stores of creatinine phosphate and is roughly 1-2g/day for adult (Njidda *et al.*, 2013). The diagnosis of renal failure is usually suspected when serum creatinine is greater than the upper limit of the "normal" interval. In chronic renal failure and uraemia, an eventual reduction occurs in the excretion of creatinine by both the glomeruli and the tubules (Edmund and David, 2006). However, there are reports that creatinine values may alter as its generation may not be simply a product of muscle mass but influenced by muscle function, muscle composition, activity, diet and health status (Banfi and Del, 2006). The increased tubular secretion of creatinine in some patients with kidney dysfunction could give false negative value (Branten *et al.*, 2005). The Jaffe reaction creatinine assay is affected by non-creatinine substances including glucose, uric acid, ketones, cephalosporins, furosemide, hemoglobin, paraproteins, paraquat, and diquat which may lead to false elevations in serum creatinine values (Stevens *et al.*, 2007). Furthermore, Andreucci (2016) opined that it is both a late and indirect marker of kidney injury (Andreucci, 2016). Consequently, creatinine alone is not enough to test for kidney function. Therefore, assay of urine protein was done to determine if goats with positive creatinine also had proteinuria. From the results, goats with positive creatinine also had positive proteinuria; although the normal alkaline pH of goat urine could influence protein reaction and lead to elevated protein levels (Stockham and Scott, 2008). Proteinuria can be physiological (following a protein meal) or pathological as seen in acute renal disease and is a sensitive biomarker for drug induced kidney injury (Griffin *et al.*, 2019). Therefore, simultaneous diagnosis with positive creatinine is highly indicativeof renal dysfunction. Urea, on the other hand, is a metabolite synthesized from ammonia in the liver during protein metabolism and is largely dependent on protein intake (Rosner and Bolton, 2005). It is increased in many non-renal conditions, including dehydration, heart failure, use of drugs like tetracycline and corticosteroids (Luke, 1981).This could explain the occurrence of more positive urea cases, compared to other biomarkers. Therefore, positive urea cases alone are not sufficient to diagnose renal disorders.

There were significant associations ($P \leq 0.05$) between health status and occurrence of renal dysfunction. Health status was determined by body condition, and visibly emaciated goats had renal dysfunction, based on creatinine, urea and urine protein levels. Studies have shown that renal diseases rarely present with signs and symptoms at the early stages (Rosner and Bolton, 2005). The implication is that by the time the patient presents with signs, the damage to the kidney would have been severe and the body condition would have deteriorated. Renal biomarkers therefore, are very useful in detection of early renal disease so that effective treatment can be achieved

## CONCLUSION

It was concluded that the occurrence of renal dysfunction in the Red Sokoto goats sampled in this study is 2.2 % based on serum creatinine and urine protein RI, and the occurrence was significantly associated with the health status of the goats, but not with their age or sex.

A major limitation of this study is the absence of an abattoir exclusively for slaughtering of goats in the study area. This made sample collection very difficult, and is of urgent public health significance as there is absence of proper meat inspection for goat meats slaughtered in the study area. It will also be impossible to carry out retrospective studies due to absence of data on goats slaughtered.

**Acknowledgement**

Authors wish to thank Dr Chukwuka Ojiako for assisting in collection of the samples.

## REFERENCES

ABA, P. E., IHEDIOHA, J. I. and NWAOGU, I. C. (2020): Reference values for certain serum biochemical markers of liver damage in apparently healthy Red Sokoto goats. *Thai. J. Vet.Med*. 50(1):81-88

ADEYEYE, E., and ADESINA, A. (2015): Lipid composition of the brains of she-goat and castrated goat consumed in Ekiti State, Nigeria. *Bangladesh J. Sci.Ind. Res*. 50(2): 153-162. https://doi.org/10.3329/bjsir.v50i2.24357

ANDREUCCI, M., FAGA, T., RICCIO, E., SABBATINI, M., PISANI, A., and MICHAEL, A. (2016): The potential use of biomarkers in predicting contrast-induced acute kidney injury. *Int. J. Nephrol.Renovasc. Dis.*(9):205–221. https://doi.org/10.2147/IJNRD.S105124.

ANSARI-LARI, M. (2007): Abattoir Survey of Kidney Condemnation in Food Animals in Shiraz, South of Iran (1999-2004). *International Journal of Dairy Science*, 2: 100-103.

BANFI, G. and DEL. F. (2006): Serum creatinine values in elite athletes competing in 8 different sports: comparison with sedentary people. *Clin. Chem*. 52:330–331.

BLASS, K.A., THUBERT, R. J, and LAM, L.K. (1974): A study of mechanism of Jaffe reaction. *J.f Clin.l Chem*. 12: 336–343.

BERHANU, T., THIENGTHAM, J., TUDSRI, S., ABEBE, G., TERA, A. and PRASANPANICH, S (2012): Purposes of keeping goats, breed preferences and selection criteria in pastoral and agro-pastoral districts of South Omo Zone. *Livestock Res. Rural Dev.* 24 (12):1-12.

BRANTEN, A.J., VERVOORT, G., and WETZELS, J.F. (2005): Serum creatinine is a poor marker of GFR in nephrotic syndrome. *Nephrol. Dial. Transplant*. 20:707–711. DOI**:**10.3923/ijds.2007.100.103.

DUTTA, S., RAHMAN, S., AZNI, S., DRAWEZ, S., KOUR, N. and WANI, H. (2016): Patho-morphological changes in kidneys of slaughtered sheep and goats in Jammu region.*J. Ani. Res.* 6(4): 705-709, DOI: 10.5958/2277-940X.2016.00086.3.

EDMUND, L. and DAVID J. (2006). Kidney Function Tests. In: Textbook of Clinical Chemistry and Molecular Diagnostics. 4th Ed.A. B. Carl, R. Edward and E. DavidElsevier Inc: New Delhi: 797– 808.

EZEWUDO, E. A., ABUBAKAR, G.R., EGENA, SUNDAY S. A., ALABI O. J. (2007): Is it possible to obtain zero estimates of genetic diversity? A case study of the Nigerian indigenous goat breeds at the β-lactoglobulin gene locus. *Biotechnology in Animal Husbandry* 33(4): 375- 388, https://doi.org/10.2298/BAH1704375E

GOWDA, S., DESAI, P.B., KULKARNI, S.S., HULL, V.V., MATH, A.A. and VERNEKAR, S.N. (2010): Markers of renal function tests. *N. Am. J. Med. Sc*i. 2(4):170-173.

LUKE R. G. (1981): Uraemia and the BUN.*N. Engl. J. Med.* 305:1213-1215. DOI: 10.1056/NEJM198111123052010

GRIFFIN, B. R., FAUBEL, S., andEDELSTEIN, C. L. (2019): Biomarkers of Drug-Induced Kidney Toxicity. *Therapeutic drug monitoring*.41 (2):213–226. https://doi.org/10.1097/FTD.0000000000000589

HARLEY, L. andLANGSTON, C. (2012): Proteinuria in dogs and cats. *The Canadian Veterinary journal = La revue veterinaries canadienne*.53 (6): 631–638.

IHEDIOHA J. I., UKACHUKWU C. V., UGOCHUKWU I. C. I. andANYOGU D. C. (2019): Evaluation of kidney function and urinary analytes in Nigerian trade cattle. *Tropical Animal Health*, 51(7):1867-1875. doi: 10.1007/s11250-019-01879-1.

LAMB, C.J., and PRICE, C.P. (2008): Creatinine, Urea and Uric Acid. In: Tietz Fundamentals of Clinical Chemistry.6thEd.C.A. Burtus, E.R. Ashowod, and D.E. Bruns, Sauder Elsevier: Missouri: 363–372.

LAMY, E., VAN HARTEN, S., SALES-BAPTISTA, E., MENDES-GUERRA, M. M. and DE ALMEIDA, A. M. (2012): Factors Influencing Livestock Productivity. In: Environmental Stress and Amelioration in Livestock Production. V. Sejian, S. M. K. Naqvi, T. Ezeji, J. Lakritz and R. Lal, Springer: 19-51http://www.springer.com/978-3642-29204-0

LUYCKX, V. A., TONELLI, M., andSTANIFER, J. W. (2018): The global burden of kidney disease and the sustainable development goals. *Bulletin of the World Health Organization*, 96(6): 414–422D. https://doi.org/10.2471/BLT.17.206441.

MAHOUZ, F., BENCHAIB KHOUDJA, F. AND CHIKHAOUI, M. 2015. Pathological study of renal diseases in cattle and sheep. Journal of Animal and Veterinary Advances, 14(12), 357-360.

NJIDDA, A. A., HASSAN, I. T., AND OLATUNJI, E. A. 2013. Haematological and biochemical parameters of goats of semi-arid environment fed on natural grazing rangeland of Northern Nigeria. IOSR *Journal of Agriculture and Veterinary Science*, 3: 1-8.

OKORIE-KANU, O. J., EZENDUKA, E. V., OKORIE-KANU, C. O., ANYAOHA, C. O., ATTAH, C. A., EJIOFOR, T. E. and ONWUMERE-IDOLOH, S. O. (2018): Slaughter of pregnant goats for meat at Nsukka slaughterhouse and its economic implications: A public health concern. *Veterinary world*, *11*(8): 1139–1144. https://doi.org/10.14202/vetworld.2018.1139-1144.

RAMACHANDRAN, S. V. (2006): Biomarkers of Cardiovascular Disease Molecular Basis and Practical Considerations. *Circulation.*113:2335–2362.

ROSNER, M. H. and BOLTON, W. K. 2005. Renal Function tests. *Core curriculum in nephrology*, 47(1): 17-183.DOI: https://doi.org/10.1053.ajkd.2005.08.038

SHITTU, A., ZAHARADEEN, M.M., FASINA. F. O., UMARU, M. A. and ABDULLAHI, A. (2014): Classification of slaughtered animals and estimation of body condition score during rainy season in Sokoto abattoir, *Sokoto Journal of Veterinary Sciences* 12(2):31-40

STEVENS, L.A., LAFAYETTE, R.A., PERRONE, and R.D. and LEVEY, A.S. (2007): Laboratory Evaluation of Kidney Function. In: Diseases of the Kidney and Urinary Tract. 8thEd. R.W Schrier Lippincott, Williams and Wilkin: Philadelphia: 299–336.

STOCKHAM, S. L. and SCOTT, M.A. (2008): Fundamentals of Veterinary Clinical Pathology, 2nd Ed, Blackwell Publishing, Iowa.

THRALL, M.A. and WEISER, M.G. (2002): Haematology. In: Laboratory Procedures for Veterinary Technicians. 4thEd. C.M. Hendrix, Mosby Inc: Missouri: 29–74.

WILSON, R.T. (1987): Livestock production in Central Mali: environmental factors affecting weight in traditionally managed goats and sheep. *Anim. Prod.*45:223–232DOI**:** https://doi.org/10.1017/S0003356100018 81X.

YAM, P. (1994). Cystocentesis in the dog and cat. *In Practice*, 16: 319–320.

ZUO, Y., WANG, C., ZHOU, J., SACHDEVA, A. and RUELOS, V.C. (2008): Simultaneous determination of creatinine and uric acid in human urine by high-performance liquid chromatography. *Anal. Sci*. 24(12):1589-1592.