

Research Article

Serum Biochemical Profiles of Apparently Healthy Goats in Sokoto Metropolis, Northwestern Nigeria: Preliminary Local Reference Values

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Abstract

Serum biochemical parameters provide valuable information on the physiological, metabolic, and health status of animals and are commonly used in veterinary clinical practice. However, biochemical values vary with breed, nutrition, management, environmental conditions, age, sex, and physiological status, highlighting the need for locally relevant data. This study examined serum biochemical parameters of goats in Sokoto Metropolis, to produce preliminary local biochemical values for clinical assessment. Forty (40) apparently healthy goats were randomly selected from households, farms, and semi-intensive production systems. Approximately 5 mL of blood was collected from the jugular vein into plain tubes, and serum was analyzed using an automated chemistry analyzer at the Clinical Pathology Laboratory. Total protein, albumin, globulin, ALT, AST, ALP, urea, creatinine, total bilirubin, and direct bilirubin were Parameters assessed. The data were summarized using descriptive statistics. Mean $\pm$ SD values were 8.28 ± 1.02 g/dL for total protein, 2.61 ± 0.23 g/dL for albumin, 5.67 ± 1.05 g/dL for globulin, 40.89 ± 71.10 U/L for ALT, 32.23 ± 36.84 U/L for AST, 99.49 ± 78.65 U/L for ALP, 47.64 ± 24.87 mg/dL for urea, 4.35 ± 0.53 mg/dL for creatinine, 3.84 ± 4.02 mg/dL for total bilirubin, and 6.52 ± 1.56 mg/dL for direct bilirubin. Most values were mostly comparable with previous reports for indigenous Nigerian goats, even though considerable variation occurred in some liver enzymes and bilirubin indices. These findings provide preliminary local biochemical data and emphasize the importance of regional, nutritional, environmental, and management factors in interpreting serum biochemical results.

Keywords

Liver Function, Renal Function, Red Sokoto Goat, Sokoto

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1. Introduction

Livestock production plays a vital role in the agricultural economy of Nigeria, serving as a major source of food, income, and employment for rural households [1]. Among the various livestock species, goats are of particular importance due to their adaptability to diverse climatic conditions, relatively low maintenance cost, and ability to thrive on marginal feed resources [2, 3]. In northern Nigeria, and particularly within Sokoto Metropolis, goats constitute a significant proportion of the small ruminant population, providing meat, milk, hides, manure, and serving as a form of financial security for rural dwellers [4, 5]. The Red Sokoto goat is especially significant in northwest Nigeria due to its ability to adapt to the semi-arid climate and its economic value to livestock owners [6]. However, nutritional deficits, environmental stress, parasite infections, and infectious diseases may have an impact on goat output in the area [3, 7]. For efficient health monitoring, disease identification, and management, it is crucial to evaluate the physiological and biochemical state of goats [8].

Animal physiological and metabolic conditions can be inferred from serum biochemical measurements [4]. They include details on protein metabolism, overall nutritional status, and the health of essential organs, including the kidneys and liver [9]. In veterinary clinical investigations, parameters like total protein, albumin, globulin, urea, creatinine, and serum enzymes like alanine aminotransferase (ALT), aspartate aminotransferase (AST), and alkaline phosphatase (ALP) are frequently assessed because changes in their concentrations may indicate changes in organ function or metabolic status [10, 11].

Interpretation of serum biochemical results should consider normal biological variability, as these parameters can be affected by factors such as breed, age, sex, nutritional and reproductive status, season, ambient temperature, and management practices [12]. Nutritional status is an important determinant of serum biochemical profiles, as variations in dietary protein and energy intake can affect serum protein concentrations, urea, glucose levels, and enzymatic activities [13, 14]. Likewise, environmental factors such as heat stress and seasonal changes in feed and water availability can influence metabolic processes and consequently affect serum biochemical profiles in goats [15, 16].

Breed variations can also limit the direct application of biochemical reference values across goat populations [17]. Indigenous Nigerian breeds, such as Red Sokoto, Sahel, and West African Dwarf goats, may demonstrate variations in serum biochemical profiles due to genetic relation, body size, metabolic characteristics, and adaptation to their respective environments [3, 5]. Therefore, biochemical reference values determined under different ecological and management conditions may not be directly applicable to goat populations in other regions.

Sokoto Metropolis has a semi-arid climate portrayed by high ambient temperatures, seasonal rainfall variation, and

changes in feed obtainability [18]. Goats are commonly raised under extensive or semi-intensive systems, relying largely on natural grazing, household food residues, and crop by-products for nutrition [19]. Such environmental and management factors may contribute to variations in their physiological and serum biochemical profiles [20]. Despite the significant contribution of goats to livestock production in the region, available serum biochemical data for apparently healthy goats remain limited [21].

Previous researches have provided beneficial information on the serum biochemical profiles of Nigerian goats across different breeds, nutritional statuses, and management systems [4, 5, 11]. However, variations in geographical location, environmental conditions, management practices, and animal characteristics highlight the need for region-specific baseline data. Such information can help veterinarians and researchers distinguish normal physiological variation from pathological changes and improve the clinical interpretation of serum biochemical findings.

Therefore, this study assessed protein metabolism, hepatic and renal function, and bilirubin metabolism indicators with the aim of generating preliminary local biochemical data to support clinical assessment and provide a baseline for future research in the region.

2. Materials and Methods

2.1. Study Area

The study was performed in Sokoto Metropolis, the city is located in Northwestern Nigeria, which is characterized by a semi-arid climate, with a long dry season spreading from October to May and a relatively short wet season from June to September. The annual rainfall ranges from approximately 500-750 mm, while ambient temperatures may range from 30-42 °C [3]. Livestock production constitutes a significant economic activity in the area, with goats forming an important component of smallholder production systems because of their adaptability to the local environment and relatively low feed requirements [5].

The main goat population in Sokoto are the Red Sokoto (Maradi) goat, even though other indigenous goats and cross-bred are also available. Goats are commonly managed under extensive and semi-intensive systems, relying on natural grazing, household food residues, and crop by-products. While, the serum biochemical analyses were performed at the Clinical Pathology Laboratory of the Veterinary Teaching Hospital, faculty of Veterinary Medicine, Usmanu Danfodiyo University, Sokoto, using an automated chemistry analyzer.

2.2. Study Animals and Sampling

A total of number of 40 apparently healthy goats were randomly selected from different households, farms, and semi-intensive production systems within Sokoto Metropolis. The animals were considered apparently healthy based on physical examination, such as assessment of body condition score, posture, appetite, respiratory rate, and the absence of noticeable clinical signs such as nasal discharge, diarrhea, or lameness.

The animals were kept under their prevailing natural feeding and watering conditions. The study was proposed to obtain biochemical information of goats kept under typical field conditions in Sokoto Metropolis. Designated age and sex records were not available for all sampled animals and were therefore not incorporated into the data analysis.

2.3. Blood Collection and Serum Preparation

Approximately a total of 5 mL of blood sample was collected aseptically from the jugular vein of each animal using sterile disposable needles and plain vacutainer tubes. The samples were labeled and transported in ice packs to the Laboratory.

The samples were allowed to clot at room temperature for approximately 30 min. Serum was subsequently separated by centrifugation at 3,000 rpm for 10 min, carefully transferred into clean sample tubes, and stored at -20 °C until biochemical analysis.

2.4. Serum Biochemical Analysis

Serum biochemical analyses were performed using an automated chemistry analyzer at the Clinical Pathology Laboratory. The following parameters were examined: Total protein (TP), Albumin (ALB), Globulin (GLOB), Alanine aminotransferase (ALT), Aspartate aminotransferase (AST), Alkaline phosphatase (ALP), Urea, Creatinine, Total bilirubin, and Direct bilirubin.

Globulin concentration was calculated as the difference between total protein and albumin concentrations (TP - ALB). All assays were performed according to standard laboratory procedures and the manufacturer's instructions for the automated analyzer. The selected parameters were used to assess protein metabolism and indicators of hepatic and renal function.

2.5. Statistical Analysis

Data were subjected to descriptive statistical analysis. The mean, median, standard deviation, minimum, maximum, and observed range were calculated for each biochemical indices. The 2.5th and 97.5th percentiles were used to describe the central 95% of the observed values as preliminary observed intervals. Because the study was exploratory and the sampling design did not strictly conform to established ASVCP/CLSI recommendations for formal reference-interval determination, the resulting values are interpreted as preliminary local biochemical values/observed intervals rather than definitive clinical reference intervals.

2.6. Ethical Considerations

Animal handling and blood collection were performed under the supervision of licensed veterinarian with consideration to animal welfare. The animals were restrained during blood collection, and sterile needles and vacutainer tubes were used. Minimized pressure was applied to the collection site to reduce the risk of hematoma. The study was approved by the Department of Veterinary Pathology, Faculty of Veterinary Medicine, Usmanu Danfodiyo University, Sokoto, in accordance with institutional animal-care guidelines.

3. Results

Serum biochemical profile

The descriptive statistics of the serum biochemical parameters measured in the 40 apparently healthy goats are presented in [Table 1](#). The mean concentrations of total protein, albumin, and globulin were 8.28 ± 1.02 , 2.61 ± 0.23 , and 5.67 ± 1.05 g/dL, respectively. The mean concentrations of creatinine and urea were 4.35 ± 0.53 and 47.64 ± 24.87 mg/dL, respectively. Among the hepatic enzymes, ALT, AST, and ALP showed mean activities of 40.89 ± 71.10 , 32.23 ± 36.84 , and 99.49 ± 78.65 U/L, respectively. Total and direct bilirubin concentrations were 3.84 ± 4.02 and 6.52 ± 1.56 mg/dL, respectively. Considerable variability was observed for ALT, AST, urea, total bilirubin, and ALP, as reflected by their relatively wide observed ranges.

Table 1. Descriptive values of serum biochemical parameters in apparently healthy goats in Sokoto Metropolis (n = 40).

Parameter	Unit	Mean $\pm$ SD	Median	Minimum	Maximum	Observed range
Creatinine	mg/dL	4.35 ± 0.53	4.50	3.00	5.10	2.10
Albumin	g/dL	2.61 ± 0.23	2.65	1.91	3.14	1.23
Globulin	g/dL	5.67 ± 1.05	5.79	3.36	7.70	4.34

Parameter	Unit	Mean $\pm$ SD	Median	Minimum	Maximum	Observed range
Total protein	g/dL	8.28 $\pm$ 1.02	8.30	6.40	10.40	4.00
ALT	U/L	40.89 $\pm$ 71.10	13.05	1.20	295.40	294.20
AST	U/L	32.23 $\pm$ 36.84	23.31	1.48	218.29	216.81
Urea	mg/dL	47.64 $\pm$ 24.87	42.50	11.00	159.36	148.36
Total bilirubin	mg/dL	3.84 $\pm$ 4.02	1.75	0.54	15.35	14.81
Direct bilirubin	mg/dL	6.52 $\pm$ 1.56	6.06	4.57	9.71	5.14
ALP	U/L	99.49 $\pm$ 78.65	98.97	1.36	270.35	268.99

Key: ALT (alanine aminotransferase) AST (aspartate aminotransferase) ALP (alkaline phosphatase). Values are presented as mean $\pm$ SD together with median, minimum, maximum, and observed range.

4. Discussion

The serum biochemical profile of this study revealed normal nutritional status and preserved hepatic and renal functions. The total protein and albumin values were within ranges previously reported for Nigerian indigenous goats [2, 4, 10], suggesting acceptable protein metabolism and hepatic synthetic ability. The moderately high globulin values and consequently lower albumin-to-globulin ratio may reflect increased immunological activity associated with continuous exposure to environmental antigens and endemic pathogens under tropical and semi-arid situations. Similar findings have been reported in goats reared under comparable environmental conditions [3, 5].

The liver enzymatic profile further suggested the absence of hepatic injury. Although ALT and ALP showed considerable individual variation, the mean ALT and AST values were generally comparable with values previously reported in healthy Nigerian goats [4, 10]. The moderately elevated ALP value may be associated with physiological variation, growth-related bone turnover, nutritional factors, or mild hepatic stress rather than pathological liver damage. Differences in serum enzyme activities among studies may also arise from variations in age, diet, breed, management practices, and environment.

Renal biochemical markers similarly suggested preserved kidney function. Serum creatinine values were comparable with previously reported values for Red Sokoto and West African Dwarf goats [15], supporting normal muscle metabolism and glomerular filtration. The slightly elevated urea concentration may be influenced by dietary protein intake, hydration status, and environmental stress. In ruminants, serum urea is remarkably responsive to dietary nitrogen availability; therefore, differences in browse quality or supplementary feed may account for the variation observed in this study [3, 4].

The observed bilirubin values fluctuated from previously reported values in Nigerian indigenous goats, while the direct

bilirubin value being higher than total bilirubin suggests potential analytical or pre-analytical variation. Factors such as hemolysis during blood collection, delayed serum separation, dehydration, nutritional status, and assay-related variability can influence bilirubin amounts [3, 5].

Finally, this findings suggest that the sampled goats were clinically and metabolically healthy. The differences observed in individual biochemical parameters are more likely to reflect changes in nutrition, environmental exposure, physiological status, and sample handling than clear hepatic or renal pathology. These findings also show the importance of considering breed, age, nutritional status, environmental conditions, and analytical procedures when establishing or interpreting biochemical reference values for goats in semi-arid regions.

5. Conclusion

The present study revealed preliminary serum biochemical reference values for apparently healthy goats in Sokoto Metropolis. The findings were mostly comparable with reports from similar ecological regions, while also displaying the influence of local environmental, nutritional, and management conditions. These data present beneficial baseline knowledge for veterinary diagnosis and herd health monitoring in north-western Nigeria. Veterinary laboratories and clinicians should consider these localized values when interpreting biochemical results. However, larger studies involving different breeds, ages, sexes, seasons, and physiological conditions are suggested to validate and refine the reference intervals. Standardized sample collection, handling, and storage should also be adopted to minimize pre-analytical variation, specifically for bilirubin and enzyme measurements.

Abbreviations

ALT	Alanine Aminotransferase
AST	Aspartate Aminotransferase
ALP	Alkaline Phosphatase

TP	Total Protein
Cr	Creatinine
ALB	Albumin
EBO	Erythropoietin
BILI	Bilirubin

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Author Contributions

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Nafisat Abdulazeez: Resources
Ibrahim Maina Hassan: Project administration

Data Availability Statement

The data generated and/or analyzed during the present study are available from Dr. Ibrahim Maina Hassan upon reasonable request and with permission from the corresponding authority at Usmanu Danfodiyo University, Sokoto, Nigeria.

Conflicts of Interest

The authors declare no conflicts of interest.

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