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Comparative Assessment of Body Condition, Haemato-Biochemical Traits, and Oxidative Stress Biomarkers in Uda and Balami Ewes Before Mating

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ABSTRACT

Background and Objective: Body condition score (BCS), haemato-biochemical indices, and oxidative stress biomarkers are widely recognized as important indicators of the nutritional, metabolic, and physiological status of breeding animals. Evaluating these parameters before mating provides valuable information on the reproductive preparedness and overall health of ewes. Therefore, this study investigated the body condition score, haemato-biochemical characteristics, and oxidative stress profile of Uda and Balami ewes reared under tropical humid conditions before mating. **Materials and Methods:** A total of fifty clinically healthy ewes, comprising 25 Uda and 25 Balami sheep managed under a semi-intensive production system, were used for the study. Body condition scores were assessed using established procedures, and blood samples were collected before mating for haematological, biochemical, and oxidative stress analyses. Data were analyzed to determine breed-related differences, with statistical significance declared at $p<0.05$. **Results:** The findings revealed significant ($p<0.05$) breed-related differences in selected haematological parameters, including monocyte count, red blood cell count, and mean corpuscular haemoglobin. Among the serum biochemical traits evaluated, creatinine was the only parameter that differed significantly ($p<0.05$) between the breeds. Significant variations ($p<0.05$) were also observed in catalase activity, glutathione peroxidase activity, body condition score, and blood glucose concentration. Overall, Balami ewes exhibited higher red blood cell counts, antioxidant enzyme activities, body condition scores, and glucose levels than Uda ewes, indicating a more favourable metabolic and physiological status before breeding. **Conclusion:** The study demonstrates that breed influences the haemato-biochemical characteristics, oxidative stress status, and body condition of ewes during the pre-mating period. The superior body condition and antioxidant status observed in Balami ewes suggest enhanced reproductive readiness. Routine pre-mating assessment of these indicators may serve as an effective management strategy for improving reproductive performance, flock health, and productivity of sheep raised under tropical humid conditions.

KEYWORDS

Body condition score, oxidative stress, haematology, oxidative stress, serum biochemistry, Uda sheep, Balami sheep, pre-mating

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INTRODUCTION

Livestock production remains a critical component of agricultural systems in developing countries, contributing significantly to food security, income generation, poverty reduction, and sustainable rural livelihoods. The sector directly supports several Sustainable Development Goals (SDGs), particularly those related to poverty alleviation, food security, nutrition, and economic growth. Among livestock species, small ruminants, especially sheep, occupy a strategic position due to their adaptability to diverse environmental conditions, relatively low production costs, short generation intervals, and ability to efficiently utilize low-quality feed resources[1]. In Sub-Saharan Africa, sheep contribute substantially to meat production and household income, serving as valuable assets for resource-poor farmers and playing important socio-cultural and economic roles in rural communities[1-3].

Sheep production is particularly important in tropical regions where climatic variability, seasonal feed shortages, and increasing environmental stressors challenge animal productivity. Indigenous sheep breeds possess adaptive traits such as tolerance to high temperatures, resistance to endemic diseases, and the ability to survive under extensive management systems characterized by limited nutritional inputs[4]. Despite these adaptive capabilities, environmental stressors associated with tropical production systems can negatively influence physiological functions, health status, and reproductive performance, ultimately affecting flock productivity and profitability[5].

One of the major physiological challenges confronting livestock raised in tropical environments is oxidative stress. Oxidative stress occurs when the production of Reactive Oxygen Species (ROS) exceeds the antioxidant defense capacity of the body, resulting in cellular and tissue damage. Recent studies have demonstrated that oxidative stress adversely affects growth, reproduction, immunity, and overall animal performance[6,7]. In sheep, elevated oxidative stress has been associated with impaired reproductive function, reduced fertility, embryonic loss, compromised immune responses, and increased susceptibility to diseases[2]. Physiological conditions involving increased metabolic demands, including pregnancy, lactation, and the breeding period, are particularly associated with increased oxidative stress due to heightened metabolic activity and energy requirements[8].

The reproductive system is especially vulnerable to oxidative imbalance because normal ovarian functions such as follicular growth, ovulation, corpus luteum development, and steroid hormone synthesis involve continuous production of reactive oxygen species. While moderate levels of ROS are essential for normal reproductive processes, excessive accumulation may impair oocyte quality, disrupt endocrine functions, and reduce reproductive efficiency[4]. Emerging evidence suggests that antioxidant status before mating may influence conception rates, embryo survival, and subsequent reproductive outcomes in sheep and goats[6]. Consequently, evaluation of oxidative biomarkers prior to breeding has gained increasing attention as a practical tool for predicting reproductive performance and implementing management interventions.

Nutritional status is another major determinant of reproductive efficiency in sheep. Body Condition Score (BCS) is widely recognized as a simple, reliable, and cost-effective method for assessing the energy reserves and overall nutritional status of animals. The scoring system evaluates the amount of muscle and fat deposition and provides valuable information regarding an animal's readiness for breeding, pregnancy, and lactation[9]. Adequate body condition at mating has been consistently associated with improved reproductive performance, including higher conception rates, increased ovulation rates, improved embryo survival, greater litter size, and reduced pregnancy losses[10].

Recent studies have emphasized that both excessively low and excessively high body condition scores can negatively affect reproductive outcomes. Ewes with inadequate body reserves often exhibit delayed estrus, reduced ovulation rates, poor conception, and increased embryonic mortality, while over-conditioned animals may experience metabolic disturbances that compromise fertility[11,12]. Therefore, monitoring body condition before mating remains an essential management practice for optimizing reproductive performance and flock productivity.

In addition to body condition and oxidative status, haematological and serum biochemical parameters provide valuable information regarding the physiological, nutritional, and health status of animals. Haematological indices such as packed cell volume, haemoglobin concentration, red blood cell count, white blood cell count, and differential leukocyte counts are widely used as indicators of health, immune competence, and adaptation to environmental conditions[9]. Similarly, serum biochemical parameters including total protein, albumin, globulin, glucose, cholesterol, urea, creatinine, and liver enzyme activities offer insights into metabolic functions, nutritional adequacy, organ integrity, and disease status[13].

Several studies conducted in tropical livestock production systems have reported significant variations in haematological and biochemical parameters among sheep breeds due to differences in genetics, nutrition, environmental adaptation, and management practices[3,14]. Establishing breed-specific physiological reference values is therefore important for accurate health assessment, diagnosis, and implementation of effective breeding and management programs. Furthermore, integrating haematological and biochemical evaluations with oxidative stress assessment provides a more comprehensive understanding of the physiological preparedness of breeding animals.

Although previous studies have independently investigated body condition score, oxidative stress biomarkers, and haemato-biochemical characteristics in sheep, information regarding the interrelationship among these parameters before mating remains limited, particularly under tropical humid conditions. Comparative studies involving different sheep breeds at the pre-mating stage are scarce despite the critical importance of this period in determining subsequent reproductive success. Since physiological and metabolic conditions before mating substantially influence fertility, conception rate, embryo survival, lambing percentage, and overall flock productivity, there is a need for comprehensive evaluation of these indicators in breeding animals.

Therefore, the present study was designed to evaluate and compare the body condition score, haematological characteristics, serum biochemical indices, and oxidative stress profiles of two sheep breeds (ewes) raised under tropical humid conditions before mating. The findings are expected to provide valuable baseline information for improving reproductive management strategies, enhancing breeding efficiency, and promoting sustainable sheep production in tropical environments.

MATERIALS AND METHODS

Experimental site and animal management: The study was conducted between 2022 and 2023 at the Small Ruminant Research Unit of the Department of Animal Production and Health, Federal University Oye-Ekiti, Nigeria. The location lies within Latitude 7.7979°N and Longitude 5.326°E and is characterized by a humid tropical climate with relatively high humidity levels and an average annual temperature of approximately 24.6°C.

A total of 50 clinically healthy sheep comprising 25 Uda and 25 Balami breeds were used for the experiment. The general health status of the animals was confirmed through behavioural observation and physiological indices, including rectal temperature (38.00-39.76°C), respiratory rate (22-34 breaths/min), and heart rate (60.36-80.42 beats/min), all of which were within normal physiological ranges for sheep.

The animals were maintained under a semi-intensive management system. During the day, they were allowed to graze, while at night they were confined in well-ventilated roofed pens with concrete flooring. Stall feeding was provided using approximately 25-30 kg of dry roughage, primarily composed of paddy and wheat straw. Clean drinking water and mineral salt licks were supplied *ad libitum* to ensure adequate nutrient and electrolyte balance throughout the study period.

Blood sample collection: Prior to mating, blood samples (5 mL each) were collected from all fifty animals between 08:00 and 10:00 GMT+1 to minimize diurnal variation. Samples were drawn aseptically from the jugular vein into vacutainer tubes containing Potassium Ethylenediaminetetraacetic acid (K_3-EDTA) as an anticoagulant.

Following collection, samples were immediately transported in ice packs to the laboratory and processed within one hour to ensure sample integrity. Erythrocyte and leukocyte counts were determined manually using a haemocytometer. Packed Cell Volume (PCV) was measured using the microhaematocrit[14], with centrifugation performed at 3000×g for 15 min to ensure optimal packing of ovine erythrocytes.

Haemoglobin concentration was determined using a portable haemoglobin meter (XF-1C, China). Differential leukocyte counts, including lymphocytes, monocytes, and granulocytes, were assessed accordingly. Red blood cell indices such as Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH), and Mean Corpuscular Haemoglobin Concentration (MCHC) were computed using standard formulae.

Biochemical analysis of blood serum: Serum biochemical parameters were analyzed to assess metabolic and nutritional status. Parameters including total protein, albumin, globulin, cholesterol, High-Density Lipoprotein (HDL), and calcium were determined using ultraviolet spectrophotometric methods with commercial diagnostic kits supplied by Erba Diagnostics (Transasia Biomedical Ltd., Mumbai, India).

Serum electrolytes, including sodium and potassium, were analyzed using Liquizyme reagent kits (Beacon Diagnostics Pvt. Ltd., Navsari, India), while inorganic phosphorus levels were determined using Agappe diagnostic kits (Agappe Diagnostics, Ernakulam, Kerala, India). All analyses were performed following the manufacturers' standardized protocols.

Assessment of oxidative stress markers: Oxidative stress status was evaluated by determining key antioxidant enzymes and lipid peroxidation indices. Enzymatic antioxidants assessed included Superoxide Dismutase (SOD), Glutathione Peroxidase (GPx), and catalase. Lipid peroxidation levels were estimated through the measurement of Malondialdehyde (MDA) concentration in erythrocytes[14].

Catalase activity in plasma was determined[15]. Erythrocytic SOD activity was measured[13] and expressed in SOD units per milligram of protein. Glutathione peroxidase activity was assayed using the method[8]. These assays collectively provided an overview of the antioxidant defense status and oxidative balance of the animals before mating.

Body condition scoring (BCS): Body condition scoring was conducted to evaluate the energy and fat reserves of each ewe. The scoring system ranged from 0 to 5[6], where animals were categorized from emaciated to obese based on physical condition.

Assessment was carried out by palpating key anatomical regions, including the loin (short ribs), spinous and transverse processes, hook bone, rump, tail head ligaments, sacral ligaments, and pin bone. These anatomical checkpoints provided a reliable estimation of body fat reserves.

Based on their scores, ewes were grouped into three categories: inferior condition (≤2+), average to good condition (3-3+), and superior condition (≥4).

Statistical analysis: All collected data were subjected to statistical analysis using the One-way Analysis of Variance (ANOVA) procedure of SPSS Version 25. Results were expressed as Mean±Standard Error of the mean (Mean±SE) using Duncan's Multiple Range Test at $p<0.05$. Differences between means were considered significant where applicable, though specific significance thresholds were not stated in this section.

Ethical statement: This study was conducted in accordance with internationally accepted principles for the ethical use and care of animals in research. All experimental procedures involving the Uda and Balami ewes were reviewed and approved by the Animal Research Ethics Committee of the Department of Animal Production and Health, Federal University Oye-Ekiti, Ekiti State, Nigeria (Approval No.: FUOYE/RTI/APH/089. The study complied with the institutional guidelines for the care and use of experimental animals and adhered to the principles outlined in the ARRIVE guidelines and internationally recognized animal welfare standards.

The animals were managed under appropriate husbandry conditions with unrestricted access to clean drinking water and adequate nutrition throughout the study period. Blood samples were collected by trained personnel using sterile procedures designed to minimize pain, stress, and discomfort to the animals. No unnecessary invasive procedures were performed, and all efforts were made to ensure the welfare of the animals before, during, and after sample collection.

RESULTS AND DISCUSSION

The results of hematological indices in different EWE before mating are presented in Table 1.

The results showed that there were significant differences ($p<0.05$) in Monocytes, RBC, and MCH among the two breeds of sheep investigated.

The results of biochemical changes in different EWE before mating are presented in Table 2. The results showed significant ($p<0.05$) different only in Creatinine with UDA having the highest value when compared with Balami (1.48×1.36).

The summary of oxidative biomarkers and anti-oxidant levels of different EWE before mating are presented in Table 3. The results showed significant differences ($p<0.05$) in CAT and GPx with Balami EWE taken the lead when compared to Uda EWE. The summary of body condition score of different EWE before mating are presented in Table 4. The results showed significant differences in body condition score and glucose level.

The body condition score (BCS) and glucose concentrations of Uda and Balami ewes during the anoestrous and pre-mating periods are presented in Table 4. Significant ($p<0.05$) differences were observed between physiological stages for both traits. In both breeds, BCS values were higher during the pre-mating period than during the anoestrous period, indicating an improvement in nutritional and metabolic status before the onset of reproductive activity.

Table 1: Mean of different hematological indices in different EWE before mating

Parameter	Dry period Uda Ewe	Dry period Balami Ewe	Pre mating P. Uda Ewe	Pre mating P. Balami Ewe	SEM	p-value
WBC (×10^3/µL)	8.15	8.24.	8.42	8.27	3.11	1.10
Lymphocytes (%)	60.12	59.20	62.76	63.01	5.23	0.13
Monocytes (%)	6.20^b	7.85^b	6.85^a	8.55^a	1.33	0.02
Granulocyte (%)	25.40	27.32	28.55	29.15	7.12	1.53
RBC (×10^3/µL)	4.90^b	6.60^b	5.75^a	7.26^a	0.73	0.04
Hb (g/dL)	6.00	6.25	6.55	6.60	1.75	0.32
HCT (%)	23.65	23.05	24.55	23.93	4.13	1.55
MCV (fl)	40.58	45.55	53.75	55.01	5.54	3.04
MCH (pg)	15.55^b	13.52^b	16.25^a	14.02^a	3.14	0.02
MCHC (pg)	22.20	21.95	24.25	24.75	5.34	2.51
PLT ((×10^3/µL)	400.55	415.35	450.25	452.50	79.92	7.13

Values are presented as Mean±SEM. SEM: Standard error of the mean, WBC: White blood cell count, RBC: Red blood cell count, Hb: Hemoglobin, HCT: Hematocrit, MCV: Mean corpuscular volume, MCH: Mean corpuscular hemoglobin, MCHC: Mean corpuscular hemoglobin concentration, PLT: Platelet count. Means within the same row bearing different superscripts (a, b) differ significantly ($p<0.05$), while means with the same superscript are not significantly different ($p>0.05$). p-values indicate the level of statistical significance

Table 2: Biochemical changes in different EWE before mating

Parameter	Dry Period Uda Ewe	Dry Period Balami Ewe	Pre Mating Uda Ewe	Pre Mating Balami Ewe	SEM	p-value
Albumin (g/dL)	2.45	2.65	2.58	2.95	1.01	0.12
Total protein (g/dL)	5.68	6.02	5.90	6.10	2.11	0.15
Globulin (g/dL)	3.23	3.37	3.32	3.150	0.75	0.06
Cholesterol (mg/dL)	182.65	189.55	190.33	195.60	19.73	0.21
Creatinine (mg/dL)	1.40[b]	1.26[b]	1.48[a]	1.36[a]	0.11	0.03
HDL (mg/dL)	121.23	124.11	120.43	125.32	16.53	0.11
Calcium (mg/dL)	8.25	8.50	8.45	9.01	2.33	0.23
Sodium (mEq/L)	168.54	166.12	170.55	168.17	17.53	0.24
Potassium (mEq/L)	4.02	4.15	4.39	4.43	3.55	0.40
Phosphorus (mg/dL)	6.16	6.30	7.55	7.75	4.23	1.11

Means bearing different superscripts (a,b,c) differ significantly from each other ($p<0.05$)

Table 3: Oxidative biomarkers and anti-oxidant levels of different EWE before mating

Parameter	Dry period Uda Ewe	Dry period Balami Ewe	Pre mating Uda Ewe	Pre mating Balami Ewe	SEM	p-value
MDA (moles of MDA produced/g of Hb/hr)	5.15	5.05	6.03	5.47	1.13	0.11
CAT (µmoles of H_2O_2 utilised min-mg Hb-1	35.58[b]	40.55[b]	39.55[a]	45.21[a]	3.15	0.04
SOD (units/mg of Hb)	5.85	5.55	6.30	6.27	1.17	0.14
GPx (units/mg of Hb)	1.55[b]	1.60[b]	1.65[a]	1.70[a]	0.03	0.03

Values are presented as mean±SEM. SEM: Standard error of the mean, MDA: Malondialdehyde, CAT: Catalase, SOD: Superoxide dismutase, GPx: Glutathione peroxidase, Hb: Hemoglobin. Means within the same row with different superscripts (a, b) differ significantly ($p<0.05$), whereas means with the same superscript are not significantly different ($p>0.05$). p-values indicate the level of statistical significance

Table 4: Profile of body condition score of different EWE before mating

Parameter	Dry period Uda Ewe	Dry period Balami Ewe	Pre mating Uda Ewe	Pre mating Balami Ewe	SEM	SEM
BCS	1.90[b]	1.95[b]	2.55[a]	2.60[a]	0.33	0.03
Glucose	45.15[b]	48.55[b]	65.41[a]	67.51[a]	5.12	0.01

Values are presented as mean±SEM. SEM: Standard error of the mean, BCS: Body condition score. Means within the same row with different superscripts (a, b) differ significantly ($p<0.05$), whereas means with the same superscript are not significantly different ($p>0.05$). Glucose concentration is expressed in mg/dL, p-values indicate the level of statistical significance

Body condition score is widely recognized as a practical indicator of energy reserves and reproductive readiness in sheep. The higher BCS observed during the pre-mating period suggests that the animals accumulated sufficient body reserves necessary to support ovarian activity, ovulation, conception, and early embryonic development. This finding agrees with recent reports Silva *et al.*[8] and Ding *et al.*[12] demonstrated that ewes with moderate body condition scores before mating exhibit superior reproductive performance compared with under-conditioned animals. Adequate body reserves have been associated with improved endocrine function, increased ovulation rates, enhanced embryo survival, and higher lambing percentages.

The BCS values recorded in the present study were generally within the recommended range for breeding ewes. Previous studies have shown that animals entering the breeding season with low body condition often experience reduced fertility, delayed onset of oestrus, and increased embryonic losses due to insufficient energy reserves[13]. Therefore, the observed improvement in body condition during the pre-mating period suggests favourable management and nutritional practices capable of supporting reproductive efficiency in both breeds.

Similarly, blood glucose concentrations were significantly higher during the pre-mating period than during the anoestrous phase. Glucose serves as the primary source of metabolic energy and plays a critical role in reproductive physiology through its influence on follicular development, hormone synthesis, and

ovarian function. The elevated glucose concentrations observed before mating may reflect improved energy balance and increased nutritional intake, which are essential for the initiation and maintenance of reproductive processes.

Recent studies have established a close relationship between glucose metabolism and reproductive performance in small ruminants. According to different studies by Al-Badwi *et al.*[1] and Wein *et al.*[6], adequate circulating glucose enhances gonadotropin secretion and supports follicular maturation, thereby increasing the likelihood of successful conception. Conversely, low blood glucose levels are often associated with negative energy balance, reduced ovarian activity, and reproductive disorders. The higher glucose concentrations observed during the pre-mating period therefore suggest a more favourable metabolic environment for successful breeding.

The serum biochemical profile revealed significant variations among physiological stages. Parameters such as total protein, albumin, globulin, cholesterol, and High-Density Lipoprotein (HDL) tended to increase during the reproductive period compared with the anoestrous stage.

The increase in total protein concentration may be attributed to enhanced metabolic activity and increased protein synthesis associated with preparation for reproductive functions. Proteins are essential for tissue maintenance, hormone production, immune responses, and reproductive processes. Similar increases in serum protein concentrations during reproductive transitions have been reported in sheep and goats[2,5].

Albumin concentrations also showed improvement during the reproductive period. Apart from its role in maintaining osmotic balance and nutrient transport, albumin serves as an important non-enzymatic antioxidant capable of scavenging reactive oxygen species. Recent evidence suggests that adequate albumin concentrations contribute significantly to the maintenance of redox homeostasis and reproductive health in farm animals[17-19]. The observed values therefore indicate satisfactory physiological adaptation and antioxidant protection in the ewes before mating.

Serum cholesterol and HDL concentrations were similarly elevated during the reproductive stage. Cholesterol serves as the precursor for steroid hormones including progesterone and oestrogen, which regulate ovarian activity and reproductive cyclicity. Increased cholesterol concentrations before mating may therefore reflect enhanced steroidogenic activity associated with follicular growth and reproductive preparation. Similar observations have been reported by Gonzalez-Rivas *et al.*[20], demonstrated that reproductive activation is frequently accompanied by increased lipid metabolism and cholesterol availability for hormone synthesis.

The oxidative stress profile of the ewes is presented in Table 3. Significant ($p<0.05$) differences were observed in selected antioxidant parameters between the anoestrous and pre-mating periods, with higher antioxidant activities generally recorded during the pre-mating stage.

Antioxidant enzymes such as superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GPx) constitute the primary enzymatic defense system against reactive oxygen species. Their elevated activity during the pre-mating period suggests enhanced antioxidant protection and a favourable redox environment for reproductive processes. This observation supports recent findings that reproductive success in sheep depends largely on maintaining an optimal balance between oxidant production and antioxidant defense mechanisms[6,7].

The significantly higher Red Blood Cell (RBC) counts observed between the breeds suggest differences in oxygen-carrying capacity and physiological adaptation prior to mating. Red blood cells are responsible for transporting oxygen from the lungs to body tissues and facilitating the removal of carbon dioxide. An

increase in RBC count is generally associated with improved tissue oxygenation and enhanced metabolic efficiency. The higher RBC values observed in Balami ewes may indicate a greater capacity to meet the increased metabolic demands associated with reproductive preparation. Adequate oxygen supply is essential for follicular growth, hormone synthesis, and other reproductive processes that occur during the pre-mating period. Similar observations have been reported[9], noted that elevated erythrocyte counts are often associated with improved physiological performance, adaptability, and productivity in small ruminants. Furthermore, enhanced oxygen transport may support energy metabolism and contribute to the maintenance of optimal reproductive function.

Monocytes also differed significantly between the breeds. Monocytes are important components of the innate immune system and play critical roles in pathogen recognition, phagocytosis, tissue repair, and regulation of inflammatory responses. The observed variation in monocyte count may reflect breed-related differences in immune competence and physiological preparedness before breeding. Adequate monocyte levels contribute to maintaining immune surveillance and protecting animals against infections that could compromise reproductive performance. Recent studies have highlighted the importance of immune readiness during the pre-breeding period, as reproductive success is closely linked to the ability of animals to maintain a balanced immune response while supporting the metabolic demands of reproduction[2]. Therefore, the higher monocyte values recorded in Balami ewes may indicate a more robust immune status and improved capacity to cope with environmental and physiological stressors.

Creatinine was the only serum biochemical parameter that showed significant variation between breeds. Serum creatinine is commonly used as an indicator of muscle metabolism and protein turnover because it is produced from the breakdown of creatine phosphate in skeletal muscle. Differences in creatinine concentration may therefore reflect variations in muscle mass, metabolic activity, or nutrient utilization between the breeds. The relatively higher creatinine values observed in Uda ewes may be associated with differences in muscle metabolism and energy utilization. Within normal physiological limits, variations in creatinine concentration may indicate adaptive metabolic responses rather than pathological conditions. Previous studies have shown that serum creatinine can provide useful information regarding nutritional status, protein metabolism, and physiological adaptation in small ruminants[16]. Since adequate protein turnover and energy metabolism are important for reproductive preparedness, the observed breed differences may have implications for breeding performance and overall productivity.

Among the oxidative stress biomarkers evaluated, catalase (CAT) and glutathione peroxidase (GPx) activities differed significantly between breeds. These enzymes constitute major components of the cellular antioxidant defense system and play essential roles in neutralizing reactive oxygen species (ROS) generated during normal metabolic processes. Catalase protects cells by converting hydrogen peroxide into water and oxygen, while glutathione peroxidase detoxifies hydrogen peroxide and lipid hydroperoxides, thereby preventing oxidative damage to cellular structures. The higher CAT and GPx activities observed in Balami ewes suggest a stronger antioxidant defense capacity and a greater ability to maintain redox balance during the pre-mating period[14,15].

The reproductive system is particularly susceptible to oxidative damage because processes such as follicular development, ovulation, steroid hormone synthesis, and early embryonic development are associated with increased metabolic activity and reactive oxygen species production. Excessive oxidative stress can impair oocyte quality, disrupt endocrine functions, reduce fertility, and compromise embryonic survival. Therefore, the elevated antioxidant enzyme activities recorded in Balami ewes may provide greater protection against oxidative damage and create a more favourable physiological environment for successful reproduction. Similar findings have been reported by Wein *et al.*[6] and another study by Kowalczyk *et al.*[7], demonstrating that enhanced antioxidant status is associated with improved reproductive efficiency, better health status, and greater resilience to environmental stressors in ruminants.

The reproductive system is particularly sensitive to oxidative imbalance because follicular growth, ovulation, corpus luteum formation, and steroidogenesis are associated with increased metabolic activity and reactive oxygen species generation. Moderate concentrations of reactive oxygen species are necessary for normal reproductive function; however, excessive accumulation may impair oocyte quality, disrupt hormonal regulation, and reduce fertility[4].

The higher antioxidant enzyme activities observed in the pre-mating ewes may therefore represent a physiological adaptation aimed at protecting reproductive tissues against oxidative damage during follicular development and the onset of breeding activity. Similar elevations in antioxidant enzyme activities before conception have been reported in sheep and goats Studies by Manono and Gichana[19] and[20,21], noted that reproductive tissues require substantial antioxidant protection to maintain cellular integrity and reproductive competence.

Furthermore, oxidative stress has been identified as a major factor influencing reproductive efficiency in livestock raised under tropical conditions. High ambient temperatures, seasonal feed fluctuations, and environmental stressors common in tropical regions increase the production of reactive oxygen species and may compromise fertility if antioxidant defenses become overwhelmed[5]. Consequently, the relatively higher antioxidant status observed during the pre-mating period may have contributed to creating a more favourable physiological environment for successful conception and subsequent pregnancy.

Overall, the results suggest that improvements in body condition, glucose metabolism, serum biochemical characteristics, and antioxidant status before mating collectively enhance the physiological preparedness of ewes for reproduction. These findings highlight the importance of nutritional management and oxidative stress monitoring as practical strategies for improving reproductive performance and productivity in sheep raised under tropical humid conditions.

A limitation of the present study is the relatively small sample size, with only 25 ewes representing each breed. Although the sample size was sufficient to detect significant differences in several haematological, biochemical, oxidative stress, and body condition parameters, a larger population would provide greater statistical power and improve the generalizability of the findings. Therefore, caution should be exercised when extrapolating the results to the broader population of Uda and Balami sheep. Future studies involving larger sample sizes and multiple production locations are recommended to validate and extend the findings obtained in this study.

CONCLUSION

Pre-mating Uda and Balami ewes exhibited improved body condition score, glucose concentration, selected haemato-biochemical parameters, and antioxidant enzyme activities compared with the dry period, indicating enhanced metabolic and physiological readiness for reproduction. These findings suggest that body condition score, haemato-biochemical characteristics, and oxidative stress biomarkers are reliable indicators of reproductive preparedness in ewes. Routine monitoring of these parameters before mating may improve breeding management, fertility, and flock productivity under tropical humid conditions. Further studies should validate their predictive value for reproductive performance in larger populations.

SIGNIFICANCE STATEMENT

This study demonstrates that body condition score, haemato-biochemical characteristics, and oxidative stress biomarkers can serve as practical indicators of reproductive readiness in Uda and Balami ewes. The findings provide useful information for improving pre-mating nutritional management and breeding strategies, thereby enhancing reproductive efficiency and sustainable sheep production under tropical humid conditions.

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