Research Article

Growth and Blood Indices of West African Dwarf Rams Fed Urea Treated Cassava Peels with Graded Levels of *Gliricidia sepium* Fodder

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Abstract | To lessen the detrimental effects on ruminant growth and health during the dry season, several combinations of non-traditional diets are being researched. In order to better understand the growth, haematology, and serum biochemical indicators of West African Dwarf (WAD) ram lambs, a study was designed that included cassava peels ensiled with urea (UTCP) and graded amounts of *Gliricidia sepium* fodder (GSF). Sixteen yearling WAD rams with an average weight of 12±1 kg was randomly assigned into four treatments (T1, T2, T3, and T4) in a ten-week trial. The rams assigned to T2, T3, and T4 were fed 90% UTCP+10% GSF, 80% UTCP+20% GSF, and 70% UTCP+30% GSF, in that order while T1 served as the control group. The data did not show a statistically significant difference (p>0.05) among any of the treatments in feed intake. The experimental animals' final body weight was significantly low in T1 (p<0.05). Although the total weight and average weight gain showed similarities (p>0.05) across different levels of GSF inclusions in the experimental diets, there was a significant increase (p<0.05) in treated groups (T2-T4) as compared to control group (T1). The FCR of the control diet was the poorest (p>0.05) at 8.09, whereas the FCRs of T2 (6.70), T3 (6.89), and T4 (6.56) did not vary (p>0.05). The results also showed that the diets had no significant effect on all the haematological parameters studied except lymphocyte and eosinophil. Lymphocyte was lowest (p<0.05) in T2 (23.33±1.53%) compared to similar (p>0.05) values obtained in the other treatments whereas eosinophil was highest (p<0.05) in T1 (3.00±0.00%) compared to the similar (p>0.05) values obtained in T2, T3, and T4. Additionally, the serum biochemical indices demonstrated typical immune reactions (p<0.05) to the test substances in total protein, globulin, total cholesterol, triglycerides, aspartate aminotransferase, and alkaline phosphatase. In all these except alkaline phosphatase, the animals fed 30% GSF and 70% UTCP (T4) fared better than the animals on other treatments. Therefore, when the grasses in tropical regions dry up during the prolonged dry season, sheep can survive on urea-treated cassava peels and *Gliricidia sepium* fodder.

Keywords | Dry season, *Gliricidia sepium*, Urea, Cassava peel, Blood parameters

Received | June 16, 2023; **Accepted** | August 03, 2023; **Published** | December 25, 2023
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Citation | Adegun MK, Ekundayo FG, Ajayi DD (2023). Growth and blood indices of west african dwarf rams fed urea treated cassava peels with graded levels of gliricidia sepium fodder. J. Anim. Health Prod. 11(4): 420-429.
DOI | http://dx.doi.org/10.17582/journal.jahp/2023/11.4.420.429
ISSN | 2308-2801

INTRODUCTION

Over the years, poor quality, insufficient amount, or nonexistence of grasses, particularly during the dry season, has been the main factor impeding small ruminant production in developing nations (Jiwuba et al., 2021; Bedada et al., 2021). The poor sustenance in term of feeding during this time causes animals to perform poorer, occasionally lose weight, have low birth weights, have weakened immune systems, and eventually die (Mecacil et al., 2021).

The industry of animal feed has experienced a constant rise in production costs and a remarkable loss of animals due to the restricted availability of raw materials and farmers' efforts to save their livestock (Falowo et al., 2022). Due to low productivity and notable mortality rates observed among resource-poor small ruminant farmers in the humid tropics during the dry season, their means of subsistence have been continuously compromised (Adegun et al., 2022). To address the multitude of challenges faced by rural farmers, the key lies in identifying a variety of unconventional feed combinations that can mitigate the negative impacts on growth and health experienced by small ruminants during this period (Beigh et al., 2020). It has been observed that feeding supplements with a balance of energy and protein along with other vital nutrients increases the productivity of small ruminants (Ungerfed et al., 2018). Therefore, supplemental diets in the form of concentrates may encourage small ruminants to grow quickly, increasing propionate production and feed efficiency, but they may be unaffordable for farmers with limited resources. A lot of study has been done on several types of alternative feedstuffs, with the goal of finding alternatives that are affordable, encourage quick development, are easily accessible, safe to eat, and do not directly affect human health.

The majority of the byproduct from processing cassava is cassava peels, which are easily obtainable and reasonably priced when used as an energy source in ruminant feeding systems (Babayemi, 2009; Adegun and Aye, 2013; Adegun and Aye, 2022). However, cassava peels' low protein content and high hydrocyanic acid concentration in some cultivars restrict their usage as animal feed. If not well processed and enriched, this may have a negative impact on the animals' growth and health (Jiwuba et al., 2021). Processing techniques including fermentation and sun-drying are required in an effort to lessen these restrictions, extend the shelf life, and improve the nutritional value of the product (ensiling). To meet the non-protein nitrogen requirements of the ruminal flora, inexpensive nitrogen sources such as poultry manure, cassava leaves, or urea should be added to diets for ruminants that are based on cassava peels. Chemical additives in silages can assist control the alcoholic fermentation by raising pH to the optimal range of 3.8-4.2, and other feed resources can be added during ensiling to improve the nutritional content of the primary feed materials (Fitri et al., 2021).

It has been established that the utilization of N-rich compounds along with fibrous feed is more crucial for ruminants to efficiently utilize low-quality feedstuff, rather than solely relying on the protein content of the feed (Ikhiomioya et al., 2007). Enhancing the rumen environment, including appropriate pH buffering, optimal rumen ammonia concentration, and metabolites, can promote enhanced fermentation of feedstuff and other byproducts by rumen microorganisms (Aye, 2007). Such nutritional advantages can be given to ruminants via feed grade urea, an inexpensive nitrogen molecule. Crop residue can be easily treated with urea, which has improved its nutritional value (Aruwayo, 2018). Goats fed 100% urea-treated cassava peels showed a good weight gain of 39.28 g/day with greater nitrogen retention than untreated cassava peels-based diets in a study conducted to assess the growth performance of goats fed the peels and untreated ones (Adegun and Aye, 2022).

Research on the benefits of *Gliricidia sepium* plant fodder for small ruminants in southwest Nigeria on low-protein diets has been extensive. In the humid tropics, backyards and walking trails are common places to find this evergreen legume feed (Adegun and Aye, 2013). In diets administered to West African Dwarf (WAD) goats during the dry season, 25% to 75% cassava peels supplementation showed moderate and good development; however, goats fed urea-treated cassava peels diet appeared to perform better (Adegun and Aye, 2022). Studies on serum biochemistry and haematopathology highlight the connection between environmental factors and blood parameters, making them valuable pathological markers of an animal's health condition based on the amount of feed they consume (Adegun and Adelabu, 2016). The purpose of this study is to assess the blood indices and growth performance of WAD sheep that are fed *Gliricidia sepium* fodder and cassava peel that has been treated with urea at varying amounts.

MATERIALS AND METHODS

Experimental Site

This study was conducted at Ekiti State University's Teaching and Research Farm's small ruminant unit, Ado-Ekiti, Nigeria. Ado-Ekiti is situated in the southwest of Nigeria. Ekiti State experiences two distinct seasons and a tropical environment. These are known as the dry season (November–March) and the rainy season (April–October). The location lies between longitude 05°13'17"E and latitude 07°37'15"N. The humidity is high and the temperature fluctuates between 21 and 28°C. The savannah covers the northern borders, while the tropical forest is found in the south. With maxima in June and September, the bimodal distribution of the 1,367 mm of precipitation is noteworthy. The study was conducted between January 15, 2022, and April 12, 2022. The Office of Research, Development and Innovation, Ekiti State University, Ado-Ekiti, ethics committee authorised the study. In this investigation, the accepted guidelines for animal welfare were adhered strictly.

Experimental Animals, Management, Feed Preparation and Experimental Procedure

Sixteen (16) West African dwarf ram lambs, weighing 12±1kg, were bought from Ekiti State marketplaces. The animals were quarantined for 21 days in order to allow them to adjust to their new surroundings and were tagged for simple identification in accordance with the guidelines presented by NAPRI (1984) and modified by Aye (2007). Ivermectin injection was used to treat ectoparasites, Albendazole Bolus was used to treat endoparasites, and Oxytetracycline, a long-acting, broad-spectrum antibiotic, was administered intramuscularly to prevent bacterial infections.

Fresh cassava peels were collected at processing locations for cassava tubers in Ado Ekiti, and it was allowed to air dry for two days. After dissolving four kilogrammes of feed-grade urea in twenty litres of water, 100 kg of cassava peel was treated by sprinkling and pulverising it in a container. It was then compressed to remove any air, covered with a plastic sheet, and allowed to ensile for a period of twenty-one days. The basal diet consisted of the ensiled cassava peel. The *Gliricidia sepium* fodder was harvested around the university, which was then fed to the animals in the appropriate amounts after wilting over night. The animals were transferred into individual pens and were randomly assigned to four dietary treatments of four animals per treatment in a completely randomized design (CRD) as shown below:

Treatment 1: Control - 100% Urea treated cassava peel (UTCP)

Treatment 2: 90% UTCP + 10% *Gliricidia sepium* fodder (GSF)

Treatment 3: 80% UTCP + 20% *Gliricidia sepium* fodder (GSF)

Treatment 4: 70% UTCP + 30% *Gliricidia sepium* fodder (GSF)

Data collection started after the animals had seven days to acclimatize to the experimental diets during the preliminary period. Throughout the trial, there was constant access to fresh, clean water.

Data Collection

The feeding experiment started after the adjustment period and ran for eighty-four days, during which time data on feed conversion ratio, body weight gains, and voluntary feed intake were recorded. Animals were provided feed every day at 4% of their body weight, and the amount of feed they refused was tracked. Before being fed to the animal, the urea-treated cassava peel was allowed to air dry overnight in the shade to prevent the animals from ingesting volatile ammonia. The animals' bodyweight were measured every week at roughly 8 a.m. using a spring balance. Live weight changes of the rams were calculated as the difference between the starting and the final weights in each group while the feed conversion ratio was calculated as feed intake divided by weight gain.

Each experimental animal had an average of 8 ml of blood drawn from its jugular vein at the end of the experiment for use in haematological and biochemical analyses. For haematological examination, 4 ml of the blood sample drawn from each animal was decanted into a sterile, labeled universal bottle containing 1.0 mg/ml ethylene diamine tetraacetic acid (EDTA). For biochemical analysis, the final 4 millilitres were poured into anticoagulant-free vials. Haematological indices such as red blood cell (RBC), white blood cell (WBC), packed cell volume (PCV), haemoglobin concentration (Hb), were measured, while monocytes (M), eosinophils (E), neutrophils (N), and lymphocytes were also counted. The numbers of erythrocytes, red blood cells (RBC) and white blood cells (WBC) were measured using Neubauer counting chamber 1364. The packed cell volume (PCV) was measured using the micro-haematocrit method, and haemoglobin (Hb) was measured using Sahli's acid haematocrit method while the components of the WBC (neutrophils, lymphocytes, monocytes) were determined microscopically from account of leukocytes in thin Leishman-stained blood smears as described by Jain (1986). The biochemical parameters determined were serum protein, serum globulin, serum aspartate aminotransferase and alanine amino transferase, total cholesterol, triglyceride, albumin, alkaline phosphatase as described by Cheesbrough (1998).

Chemical Analysis

Test ingredient samples were milled after being oven dried for 48 hours at 60^{0}C. According to (AOAC, 2000), proximate analyses for dry matter (DM), crude protein (CP), ether extract (EE), crude fibre (CF), and nitrogen free extract (NFE) were performed on the milled feed samples. A PARR Instrument, Moline, IL, USA adiabatic bomb calorimeter was used to calculate the gross energy values of the diets. The method of Wood and Cooley (Wood and Cooley 1956) was used to determine the hydrocyanic acid content.

Statistical Analysis

The gathered data were coded appropriately in a Microsoft Spreadsheet, and one-way ANOVA was used for analysis using the MINITAB 8.1 programme. Duncan's multiple range comparison was then performed at a significance level of 5% in cases where there were variations in the mean values.

RESULTS

The proximate compositions of the feed ingredients used in the study are shown in Table 1. The cassava peels contained 87.60±1.8% DM, 7.56±0.6% CP, 22.75±1.2% CF, 10.05±0.4% EE, 11.02±0.8% ash, 44.42±2.0% NFE, 2760.0±22.0 kcal kg^{-1} gross energy (GE), and 25.84mgkg^{-1} HCN. The urea treated cassava peels contained 68.30±1.4% DM, 10.84±1.0% CP, 19.52±1.2% CF, 13.90±0.5% EE, 9.50±0.2% ash, 33.54±2.0% NFE, 2863.8±4.0 kcal kg^{-1} GE, and 18.70mgkg^{-1} HCN. The *Gliricidia sepium* leaf meal contained 28.60±3.4% DM, 18.16±0.8% CP, 20.80±1.4% CF, 4.80±0.6% EE, 13.00±0.4% ash, 41.84±1.6% NFE, 2936.6±31.0 kcal kg^{-1} GE, and 10.06mgkg^{-1} HCN.

Table 2 shows the chemical composition of the experimental diets. The DM of the diets ranged from 88.30±0.42% in control diet (100% UTCP) to 88.69±2.81% in treatment 4 (70% UTCP and 30% GSF). The CP value varies from 10.84±0.28% in T1 to 13.04±0.60% in T4. The CF ranges from 20.52±0.42% in T1 to 20.60±0.21% in T4. The CF was slightly affected by the treatment and the values of EE ranges from 13.90±0.07% to 14.60±0.28% from T1 to T4. The ash value varied from 9.50±0.35% in T1 to 12.80±0.57% in T4 while the NFE ranges from 38.96±0.28% in T4 to 45.24±0.29% in T1.

In Table 3, the summary of the growth performance of WAD ram lambs fed UTCP and GSF is shown. There was no significant difference (P>0.05) among the means of the feed intake in all rams fed urea treated cassava peel diet and *Gliricidia sepium* fodder. The feed intake of the experimental rams was 625g/day for 100% UTCP (Control T1), 597g/day for 90% UTCP + 10% GSF (T2), 616g/day for 80% UTCP+ 20% GSF (T3) and 610g/day for 70% UTCP + 30% GSF (T4). There were significant differences (P<0.05) among the means of the total weight gain in the control diet compared with other treatments which had similar (P>0.05) men values. Lower weight gain (4.33kg) was observed in rams fed control diet compared with other treatments which were similar (P>0.05) among T2 (4.97kg), T3 (5.00kg), and T4 (5.20kg). Average daily weight gain also followed the same pattern with the total weight gain. Significant differences (P<0.05) also existed among the means of the feed conversion ratio (FCR) in all the treatments. The control diet had the poorest FCR of 8.09 while there were no significant differences (p>0.05) in the FCR of T2 (6.70), T3 (6.89) and T4 (6.56).

Table 4 shows the haematological variables of WAD rams fed fed urea treated cassava peels with *Gliricidia sepium* fodder. There were no significant differences (p>0.05) among PCV, Hb, WBC, RBC, Neutrophils, MCV, MCH and MHCH in all the treatments. Packed cell volume ranged from 30.00±2.58% in T3 to 34.33±3.26% in T2. The haemoglobin (Hb) values were 11.60±2.16 g/dl, 12.29±1.50g/dl, 11.03±1.07g/dl and 12.13±1.05g/dl in T1, T2, T3 and T4, respectively. Values of 16.68±0.62 x106µl to 16.77±0.38 x106µl were obtained in T1 to T2 for RBC. White blood cell (WBC) ranged from 9.67±1.36 x106µl in T4 to 10.28±0.50 x106µl in T1. The neutrophils ranged from 59.00±3.61% in the control diets to 70.83±1.00% in T3. Monocytes were T1 (2.67±1.16%), T2 (1.33±0.58%), T3 (1.33±0.58%) and T4 (1.00±0.00%). The values of MCH ranged from 9.16±2.97pg in T3 to 11.61±3.51pg in T1 respectively, while MCHC varied from 32.65±0.79 g/dl in T2 to 34.82±0.63 g/dl in T1. The other differential counts of WBC (lymphocytes and oeosinophils) showed significant differences (p<0.05) in all the treatment groups. Lymphocyte was significantly higher (p<0.05) in T1 (31.33±1.16), while they were lower and similar at 23.33±1.53%, 32.00±2.00%, and 32.00±7.94% in T1, T2, T3 and T4, respectively. For Eosinophils, T1 had higher significant (p<0.05) value of 3.00±0.00%, while T2 (2.00±0.00%), T3 (2.00±0.00%), and T4 (2.33±0.58) did not show any significant (P>0.05) differences.

Serum biochemistry of WAD rams fed urea treated cassava peels with graded levels of *Gliricidia sepium* fodder is shown in Table 5. The total protein (TP) increased significantly (p<0.05) from 5.32±0.60 g dl^{-1} in T1 to 6.94±0.50 g dl^{-1} in T4. However, T2, T3 and T4 had similar (P>0.05) values. The values of albumin showed no significant differences (P>0.05) but ranged from 3.34±.13g dl^{-1} in T1 to 3.94±0.16g dl^{-1} in T4. The globulin showed significant differences (P<0.05) among the treatments with T1 showing the least value at 1.88±0.80g dl^{-1} which differ from the similar (P>0.05) values obtained in T2, T3, and T4. Total cholesterol showed significant differences (P<0.05) between T1 and the other treatment groups which had similar (P>0.05) values. T1 (60.08±0.54g dl^{-1}) had the least value while the values obtained in T2, T3 and T4 range between 74.02±2.80 g dl^{-1} in T2 to 77.02±2.08g dl^{-1} in T4. Triglyceride had similar (P>0.05) values of 16.32±0.11g dl^{-1},16.30±0.19g $dl^{-1}$and 16.78±.0.98g dl^{-1} in T1, T2, and T3 respectively but showed a significantly (P<0.05) higher value in T4 (18.44±3.66g dl^{-1}). In both high and low density lipoproteins there were no significant differences (p>0.05) among the treatments. The High-density lipoprotein ranged between 42.33±0.67mg dl^{-1} in T4 to 46.55±3.32 mg dl^{-1} in T2 while the LDL ranged between 11.92±2.60mg dl^{-1} in T1 to 13.09±0.20 mg dl^{-1} in T3.

The Asparate aminotransferase (AST) showed significant variations (p<0.05) in the rams fed the different diets. The values were similar (P>0.05) at 180.02±1.24Ul dl^{-1} in T3 and 180.12+1.32Ul dl^{-1}in T4 and at 146.46 Ul dl^{-1} in T1 and 124.24 Ul dl^{-1} in T2. The two groups differ (P<0.05) statistically with the earlier group showing higher value than the latter. Alanine aminotransferase (ALT) did not show any significant differences (p>0.05) in all the treat

Table 1: Proximate Composition of cassava peels, urea treated cassava peel and *Gliricidia sepium* fodder

Parameters (%)	Ingredients		
	Cassava peels	Urea treated Cassava peels	Gliricidia sepium
Dry matter	87.60±1.8	68.30±1.4	28.60±3.4
Crude protein	7.56±0.6	10.84±1.0	18.16±0.8
Crude fibre	22.75±1.2	19.52±1.2	20.80±1.4
Ether extract	10.05±0.4	13.90±0.5	4.80±0.6
Ash	11.02±0.8	9.50±0.2	13.00±0.4
Nitrogen free extract	44.42±2.0	33.54±2.0	41.84±1.6
Energy kcal kg^{-1}	2760.0±22.0	2863.8±4.0	2936.6±31.0
HCN (mg kg^{-1})	25.84	18.70	10.06

Table 2: Chemical analysis of urea treated cassava peels with graded levels of *Gliricidia sepium* fodder (%)

Parameters	Dry matter	Crude protein	Crude fibre	Crude fat	Ash	NFE
T1	88.30±0.42	10.84±0.28	20.52±0.42	13.90±0.07	9.50±0.35	45.24±0.29
T2	88.54±9.28	11.57±0.21	20.59±0.42	14.20±0.14	11.30±0.28	42.34±0.32
T3	88.55±0.45	12.28±0.39	20.57±0.14	14.35±0.21	11.95±0.25	40.85±0.21
T4	88.69±2.81	13.04±0.60	20.60±0.21	14.60±0.28	12.80±0.57	38.96±0.28

T1: Control - 100% urea treated cassava peels
T2: 90% - urea treated cassava peels + 10% *Gliricidia sepium* fodder
T3: 80% - urea treated cassava peels + 20% *Gliricidia sepium* fodder
T4: 70% - urea treated cassava peels + 30% *Gliricidia sepium* fodder
NFE – Nitrogen free extract

Table 3: Growth performance of WAD ram lambs fed urea treated cassava peel diet and *Gliricidia sepium* fodder

Parameters	T1	T2	T3	T4	SEM
Initial weight (kg)	12.63	12.33	13.00	12.50	----
Feed intake (gd^{-1})	625.00	597.00	616.00	610.00	1.02
Final wt. (kg)	16.96	17.30	18.00	17.70	----
Total wt. gain (kg)	4.33^{b}	4.97^{a}	5.00^{a}	5.20^{a}	0.30
Average daily wt. gain (gd^{-1})	77.32^{b}	88.75^{a}	89.28^{a}	92.85^{a}	0.86
Av. met. wt. gain ($W^{0.75} g^{-1}$)	26.07	28.92	29.04	29.91	0.54
FCR	8.09^{a}	6.70^{b}	6.89^{b}	6.56^{b}	1.02

^{a,b} means along the same row with different superscripts are significantly different ($P<0.05$)
T1: Control - 100% urea treated cassava peels
T2: 90% - urea treated cassava peels + 10% *Gliricidia sepium* fodder
T3: 80% - urea treated cassava peels + 20% *Gliricidia sepium* fodder
T4: 70% - urea treated cassava peels + 30% *Gliricidia sepium* fodder
FCR- Feed conversion ratio wt.- weight

Table 4: Haematological parameters of WAD ram lambs fed urea treated cassava peels with *Gliricidia sepium* fodder.

Parameter*	T1	T2	T3	T4
PCV (%)	32.03±3.86	34.33±3.26	30.00±2.58	33.33±2.16
HB (g/dl)	11.60±2.16	12.29±1.50	11.03±1.07	12.13±1.05
RBC (10^6/µl)	16.68±0.62	16.77±0.38	16.74±0.54	16.76±0.52
WBC (10^6/µl)	10.28±0.50	10.07±0.76	10.03±1.00	9.67±1.36
Neutrophil (%)	59.00±3.61	68.00±6.93	70.83±1.00	69.67±4.04
Lymphocyte (%)	31.33±1.16^{a}	23.33±1.53^{b}	32.00±2.0^{a}	32.00±7.94^{a}
Monocyte (%)	2.67±1.16	1.33±0.58	1.33±0.58	1.00±0.00
Eosinophil (%)	3.00±0.00^{a}	2.00±0.00^{b}	2.00±0.0^{b}	2.33±0.58^{b}
MCV (fl)	20.88±3.05	21.57±0.69	22.83±1.99	21.67.54±0.5
MCH (pg)	10.16±3.51	10.51±1.99	9.16±2.97	11.61±2.66
MCHC (g/dl)	34.82±0.63	32.65±0.79	34.21±0.45	33.54±0.42

a,b,c, means with different superscripts in the same row were significantly different ($p<0.05$)
T1: Control - 100% urea treated cassava peels
T2: 90% - urea treated cassava peels + 10% *Gliricidia sepium* fodder

T3: 80% - urea treated cassava peels + 20% *Gliricidia sepium* fodder
T4: 70% - urea treated cassava peels + 30% *Gliricidia sepium* fodder
*PCV; packed cell volume, HB; hemoglobin, RBC; red blood cell, WBC; white blood cell, MCV; mean corpuscular volume, MCH; mean corpuscular hemoglobin, MCHC; mean corpuscular hemoglobin concentration.

Table 5: Serum Biochemistry of WAD ram lambs fed urea treated cassava peels with graded levels of *Gliricidia sepium* fodder.

Parameters*	T1	T2	T3	T4
TP g dl^{-1}	5.32±0.60^{b}	6.70±0.88^{a}	6.28±0.62^{a}	6.94±0.50^{a}
Al g dl^{-1}	3.34±.13	3.80±0.20	3.85±0.08	3.94±0.16
Glg dl^{-1}	1.88±0.80^{b}	2.90±0.62^{a}	2.43±.68^{a}	3.00±0.03^{a}
TC mg dl^{-1}	60.08±0.54^{b}	74.02±2.80^{a}	74.80±.0.77^{a}	77.02±2.08^{a}
TG mg dl^{-1}	16.32±0.11^{b}	16.30±0.19^{b}	16.78±.0.98^{b}	18.44±3.66^{a}
HDL mg dl^{-1}	46.27±0.46	46.55±3.32	43.88±0.73	42.33±0.67
LDL mg dl^{-1}	11.92±2.60	12.04±0.12	13.09±0.20	12.65±0.22
AST Ul dl^{-1}	146.56±1.20^{b}	124.42±1.52^{b}	180.02±1.24^{a}	180.12±1.32^{a}
ALT UI dl^{-1}	17.50±0.62	19.10±1.28	17.10±1.04	16.80±1.86
ALP Ul dl^{-1}	123.60± 0.96^{c}	132.02±3.52^{b}	150.50±4.02^{a}	120.32±5.40^{c}

^{a,b,c} means with different superscripts within the same row are significantly ($P < 0.05$) different.
* TP – Total protein; Al- Albumin; Gl- Globulin; TC- Total cholesterol; Tryglycerides; HDL- High density lipoprotein; LDL- Low density lipoprotein; AST – Aspartate aminotransferase; ALT; Alanine aminotransferase; ALP- Alkaline phosphatase
T1: Control - 100% urea treated cassava peels
T2: 90% - urea treated cassava peels + 10% *Gliricidia sepium* fodder
T3: 80% - urea treated cassava peels + 20% *Gliricidia sepium* fodder
T4: 70% - urea treated cassava peels + 30% *Gliricidia sepium* fodder

ment groups. They were 17.50±0.62Ul dl^{-1}, 19.10±1.28Ul dl^{-1}, 17.10±1.04Ul dl^{-1} and 16.80±1.86Ul dl^{-1} in T1, T2, T3 and T4 respectively. The alkaline phosphatase (ALP) was significantly ($p<0.05$) impacted by the diets with T1 and T4 showing the least and similar ($P<0.05$) values at 123.60±0.96Ul and 120.32±5.40Ul, respectively. T4 (150.50±4.02Ul dl^{-1}) had the highest significant value follow by T3 (132.02±3.52Ul dl^{-1}).

DISCUSSION

Proximate composition of urea-ensiled cassava peels and *Gliricidia sepium*

The results of this investigation show that the CP and CF of cassava peel match favourably with 7–7.45gkg^{-1} CP but did not match with 20.56gkg^{-1} CF obtained by Odeyinka (2021). However, the values obtained in this study in both CP and CF are lower than the 3.28gkg^{-1} CP and 4.12gkg^{-1} CF obtained for un-ensiled and ensiled cassava peel by Ashaolu et al. (2012). The increased CP in the ensiled cassava peels was consistent with earlier findings (Ramirez et al., 2007) that urea treatment improved the nutritional value and crude protein content of low-quality crop leftovers. The CP increase of almost 30% from untreated to urea-treated cassava peels is in line with the research conducted by Oduguwa et al (2013). The extended ensilaged duration in this study may be the cause of the variations in values reported by the above authors. It might also be caused by the methods used to make silage, various cassava varieties, seasonal variations, plant maturity, environmental factors and soil fertility. The Nigerian farmers cultivate and sell a wide variety of cassava cultivars; however, since the fresh peels utilised in this study were obtained from several garri processing locations, the cultivars utilised are unknown. Cassava peel has been adjudged to be a rich and valuable source of metabolizable energy and fibre in ruminant feeds with high degradability in the rumen. It contributes to the balancing of nutrients requirements (Anya and Ozung, 2018).

The decrease in CF from 22.75% in untreated cassava peels to 19.52% in treated cassava peel is consistent with the findings of Aruwayo's (2018) study, which suggested that treating crop residues with urea could greatly increase the digestibility of the straw by lowering the silage's fibre content. The ruminant suggested protein requirement of 10-12% by Adegun and Aye (2013) was not met by the untreated cassava peel. Accordingly, animals fed a high percentage of cassava peels would require additional protein to meet their needs for upkeep and growth. Though it compares positively to the value of 20.70 gkg^{-1} obtained by Rusty et al. (2019), the CP of *Gliricidia sepium* in this study was lower than the 24.70 gkg-1 and 28.6 gkg-1 obtained by Ashaolu et al. (2012) and Uza et al. (2005), respectively. These differences may be caused by the time of year the fodder is harvested.

Nonetheless, in tropical regions during the dry season, *Gli-*

ricidia sepium can be utilised to maintain weight and even encourage moderate growth in ruminants due to its high nutritional value (Smith and Staines, 2021). Every test ingredient had a high GE value, indicating that they could be used as sources of energy. In comparison to Odoguwa et al. (2013), the HCN level of cassava peel in this investigation is less than 81.2 mgkg^{-1} obtained by them. According to Otache et al. (2017), the ensiling process causes the intact glucoside to disintegrate through noticeable cell disruption, a drop in pH of the ensiled medium and intense heat generation, all of which lead to a reduction in HCN. The reduction in HCN content in urea-treated cassava peel corroborates their findings.

Growth performance

The results of this investigation are consistent with those of Assefa et al. (2015), who observed that Adilo sheep fed urea-treated wheat straw enriched with enset (*ensete ventricosum*), atella, and their mixes consumed between 333 and 626 g of feed per day. Based on body weight data, however, rams fed the control diet performed poorer in terms of growth than rams fed T2, T3, and T4. This is in disagreement with the non-significant difference in weight gain of goats fed urea-ensiled cassava peels or a combination of urea-ensiled cassava peels and *Gliricidia sepium* reported by by Odoguwa et al. (2013). Urea, an ammonia source, is an economic replacement for feed proteins which is hydrolysed by ureases from rumen bacteria for microbial protein systhesis. The ammonia is utilized by bacteria as a nitrogen source to produce amino acids and peptides necessary for growth (Getahun et al., 2019).

The outcome of this study aligns with the findings of Adejumo (1995), which showed that rams given *Gliricidia sepium* and *Leucaena leucocephala* supplements to baseline silage were more adept at using supplement diets than control diets. It therefore seems that tree forages like *Gliricidia sepium* can provide at least some of the bypass protein required in addition to nitrogen and minerals for the rumen organisms. Browse fodder such as gliricidia in the diet of ruminants improve voluntary DM intake and enhance growth of rumen microbes thereby supplying protein to rumen microbes for enhanced microbial activities and nitrogen retention (Ahmed et al., 2018). The variance in the body weight growth may be caused by the nutrient content of the dietary treatment. *Gliricidia sepium* supplementation was linked to a better daily weight increase, which suggests that some protein may be escaping the rumen unprocessed. The best feed conversion ratio (FCR) recorded in treatment 4 corroborates the result that the best results from fodder tree leaves seem to come when it makes up about 30 percent of the ration (Cobb 2002).

Haematological parameters

The investigation yielded a packed cell volume range of 30±2.58 - 34.33±3.26%, which is within the range of values reported by Aye and Tawose (2016) for normal, healthy sheep. For an animal's tissues to properly oxidise food and release energy for the body, haemoglobin (Hb) must be transported to those tissues. The haemoglobin concentration obtained in the current study ranges within the range of 9 to 12 g/dl reported by Islam et al. (2018) for normal, healthy sheep. As a haemoglobin transporter during breathing, red blood cells (RBCs) interact with blood oxygen. The lower WBC value in T4 may have resulted from the treatment's higher nutritious content, which avoided the need for a rise in WBC to combat illness. The expected value for red blood cell for sheep is 8-18 x10^{6}µl (Yin et al., 2013) while the value of RBC obtained for the study ranges between 16.68 - 16.77x10^{6}µl. Abnormally low packed cell volume, red blood cell counts and heamoglobin concentration signifies aneamia while abnormally high white blood cell count is indicative of microbial or parasitic infections (Olabanji et al., 2007). White blood cell (WBC) obtained from the study at 9.67 - 10.28x10^{6}µl falls within expected value of WBC for healthy sheep which is 4-13 x10^{6}µ as reported by Yin et al. (2013). Animals with high white blood cell are capable of generating antibodies. The lower WBC value obtained in T4 may have resulted from the treatment's higher nutritious content, which avoided the need for a rise in WBC to combat illness.

The body uses neutrophils as defenders against invading germs and antigens. The experimental study yielded a neutrophil value of 59.00+3.61 - 70.83+1.00%, although the estimated normal neutrophil value for small ruminants is between 30 and 50% (Islam et al., 2018). The reason for higher values than necessary could be due to estimation errors, as other parameters fell within the typical ranges. In this study, a range of 2 - 3 % eosinophil was obtained which fell within the range of 1 – 10% reported by Rojas et al. (2015) for healthy sheep. A laboratory measurement used to determine the average size and volume of a red blood cell is called mean corpuscular volume (MCV). It is useful in figuring out the cause of anaemia. The MCV, in this study ranges from 20.88 – 22.83x10^{6}fl which fell within the normal expected value for healthy normal sheep of 16 - 25x10^{6}fl (Gorkhali et al., 2017). The quantity of haemoglobin that carries oxygen throughout an animal's body is measured by its mean corpuscular haemoglobin (MCH), which is the average amount of haemoglobin in each red blood cell. In healthy sheep, the mean corpuscular haemoglobin falls between 8 to 12.0 pg (Gorkhali et al., 2017). The study's mean corpuscular haemoglobin concentration (MCHC) ranges from 32.65 to 34.82g/dl, which fell within the ranges of 31 to 34 g/dl obtained for normal and healthy sheep (Gorkhali et al., 2017). The ability of the animals' bone marrow to produce red blood cells to prevent anaemia during the dry season is indicated by normal values of MCV, MCH, and MCHC obtained in all treatments investigated in this study.

Biochemical study

The total protein readings obtained in this study fell between 5.32+0.60 to 6.94+0.50 g/dl, which is lower than the range of 6.3–7.2 g/dl reported by Bello and Tsado (2013) but still falling within the range of total protein for healthy sheep. The normal blood protein level indicates that the rams' health is good and that the food is not having any negative effects on them. When Yankasa rams were given sesame residue, the globulin mean range of 1.88–3.00 g/dl obtained was lower than the range of 36.50–54.50 g/dl obtained by Garba and Adeola (2020). The albumin mean range values of 3.34 –3.94 g/dl found in this investigation were within the usual range of 2.7–3.0 g/dl for healthy sheep as reported by Careceni et al. (2020). These results demonstrate normal immunoglobulin levels, a sign of a healthy immunological response to all of the treatments in line with the findings of Garba and Adeola (2020). The total cholesterol values of 60.08 – 77.02 mg/dl obtained in this study fell within the typical range of 50.00 – 140.00 mg/dl for sheep in general health Wen et al. (2019). A low value of total cholesterol suggests a low-fat diet, impaired absorption, or sensitivity to carbohydrates. Additionally, High Density Lipoprotein is essential to the male reproductive system and is linked to the acrosome response and sperm capacitation (Francou et al., 2017). In this study, the high-density lipoprotein was found to range between 42.33 mg/dl to 46.27 mg/dl which fell within the range of 40.10 to 71 mg dL^{-1} reported by Wen et al. (2019) in rams. When high density lipoprotein levels are higher than usual, heart disease risk is increased.

Low-density lipoprotein concentration results might be explained by the saturated fats in urea-treated cassava peel and *Gliricidia sepium*, which varied from 11.92 to 12.65 mg/dl given to the rams. Because it supplies phospholipid molecules to the plasma membrane for stability and the prevention of cryo-injury, this lipoprotein is crucial for sperm resistance throughout the cryogenics process. Additionally, LDL reduces sperm toxicity by binding to a few seminal plasma proteins. Additionally, according to Wang et al. (2022), levels as high as 8% improve acrosome membrane, plasmatic membrane integrity, and motility. The information above indicates that genetic or individual variation may be the cause of the variations in values between our observations and those from other research on sheep. It may be suggested that the ALT, AST, and ALP enzyme activities be used as a trustworthy indicator of liver health in rams. The ALT, AST, and ALP values were comparable to those observed when maize was added as a supplement to the PKC-rice straw basal diet that was treated with urea (Saeed, 2019). A bone illness, liver disease, or bile obstruction can be indicated by abnormally high alkaline phosphate levels (Oyibo et al., 2020; Ocheja et al., 2021).

CONCLUSION

This study demonstrated the good growth rate of rams fed cassava peels treated with urea and supplemented with varying concentrations of *Gliricidia sepium*. Furthermore, the analysis of the biochemical and haematological variables showed that the treatments had no negative effects on the animals. Nonetheless, compared to the other treatments, the animals that were fed 30% *Gliricidia sepium* fodder and 70% urea-treated cassava peels fared better. Therefore, during the extended dry season, when grasses dry up in tropical regions, sheep can survive on urea-treated cassava peels and *Gliricidia sepium* fodder.

ACKNOWLEDGMENTS

Authors wish to acknowledge the contributions of the Veterinary staff of Department of Animal Science, Ekiti State University, Ado-Ekiti.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

NOVELTY STATEMENT

Readily available cassava peels can be processed further and enriched with urea to serve as basal diet instead of grasses for small ruminants during the dry season in the tropics.

AUTHORS' CONTRIBUTION

This is to confirm that AMK conceived, analyzed and interpreted the data, drafted the manuscript and revised it critically for important intellectual content. FGE and DDA were involved in the design, analysis and interpretation of the manuscript and revised it critically for important intellectual content.

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