ZIBELINE INTERNATIONAL™ PUBLISHING

ISSN: 2710-6012 (Online)
CODEN: JWBMAO

Journal of Wastes and Biomass Management (JWBM)

DOI: http://doi.org/10.26480/jwbm.01.2025.06.12

RESEARCH ARTICLE

EFFECT OF DIETARY INCLUSION OF ONION PEEL POWDER ON PERFORMANCE AND BLOOD PROFILE OF SHEEP FED GUINEA GRASS AND COWPEA HUSK BASED DIET

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ARTICLE DETAILS

Article History:

Received 02 November 2024
Revised 31 December 2024
Accepted 15 January 2025
Available online 14 February 2025

ABSTRACT

The study was conducted to assess the effect of onion peel powder on performance and blood profile of sheep fed guinea grass and cowpea husk based diet. Sixteen West African dwarf female sheep of approximately 6 to 7 months old with average body weight of 6.00 ± 0.46kg were selected for the study. They were randomly allotted to four dietary treatments in a completely randomized design. The compared treatment diets; T_1, T_2, T_3 and T_4 contained 0%, 1%, 2% and 3% inclusion of onion peel powder respectively.. All parameters examined were subjected to one-way analyses of variance (ANOVA). Results showed that diet T_1 was significantly ($p<0.05$) higher in feed intake (278.24g/day), feed conversion ratio (7.78), ether extract digestibility (69.03%), cholesterol (64.01mg/ml) and urea (13.02 mg/ml). Sheep on T_4 were significantly ($p<0.05$) increased in final weight (10.31kg), total and daily weight gain (4.03kg and 47.48g), digestibility of dry matter(72.66%), crude protein (71.01%), crude fibre (70.31%), ash (66.98%), with nitrogen free extract (70.34%), digestible crude protein(9.57%), total digestible nutrient (73.15%), packed cell volume (30.86%), haemoglobin (7.46g/dl), red blood cell (6.93 x10^6/ml), mean corpuscular haemoglobin (10.14pg), mean corpuscular haemoglobin concentration (32.09%), white blood cell (8.71 x10^6/ml), lymphocytes (54.33%), eosinophils (4.49%), neutrophils (48.74%), monocytes (2.59%), total protein (7.18 g/dl), albumin (3.20g/dl), glucose (71.54mg/dl) and triglyceride (23.41mg/dl). However, significant difference did not occur in initial body weight, mean corpuscular volume, globulin and creatinine. It can be concluded that inclusion of 3% onion peel powder in supplementary diet enhance performance and blood profile of sheep

KEYWORDS

Herb plant, performance, blood, sheep.

1. INTRODUCTION

Small ruminants are known to occupy a strategic position in food supply chain and nutritional security in Nigeria as they provide animal protein for human consumption. They also play crucial and cultural roles in flexible financial reserves for mankind in rural populace. However, sheep can be classified as multi-functional ruminants, because of their several unique characteristics that enable them to survive in adverse and harsh environment. (Chouhan et al., 2023). Hence, sheep farming in Nigeria is plagued with numerous problems among which is nutrition that play a major role in driving the functional efficacy and production of sheep. Their production suffer insufficient feed supply due to scarcity and prohibitive cost of feed ingredients that are in strict competition with man's dietary needs (Okoruwa and Edoror, 2019).

This challenge with rapid decline in nutrient quality of natural pasture has led to low feed intake and performance most especially during the dry season. Consequently, the need to improve sheep production efficiency has made it necessary to continuous searching for locally available alternative feeds. In particular, a group researcher reported that there is an increasing interest by ruminant farmers to search for non-conventional feeds such as agro-industrial by-products and crop residues that are cheaper and locally available for sheep (Okoruwa et al., 2023). Notwithstanding, these non-conventional feed ingredients could have been the most successful approach, but their high fibre content and anti-nutritional factors lead to poor digestibility that limit their uses as sustainable feeds. Hence, many ruminant nutritionists are now actively engaged in the use of plant derived products as supplements or additives to augment these unconventional feeds in order to increase their utilization and reduce heavy economic losses of sheep.

Natural feed additives can modify rumen function to improve nutritional quality of high fibre feeds for better nutrient digestibility, body physiology and thus reducing high feeding cost of ruminants (Edeoga et al., 2015). These herbal feed additives also possess great potentials that can benefit ruminants in several ways, such as ability to boost the immune system, stimulate the endocrine system and intermediate nutrient metabolism that enhance digestion (Okwu and Josiah, 2006). The ban on the use of synthetic antibiotics in feed has pushed many animal nutritionists to use herbal plants as replacement for chemical feed additives that have been criticised for their potential negative impact on livestock and their consumers' health status. However, spice plants are now being widely advocated as natural feed additives, due to their reported widespread beneficial effects on livestock production (Ifesan et al., 2014). They contain anti-microbial, anti-oxidant, anti-inflammatory with bioactive properties for improving growth performance and immune system in livestock.

Onion (*Allium cepa*) peel powder is such spice that contain essential nutrients like vitamins, minerals, carbohydrates and phytogenic components that have the ability to low blood pressure and cholesterol in animals (Prakash et al., 2009). It also promote gut activity by stimulate secretion and digestive enzymes to enhance acceptability, feed intake,

Quick Response Code	Access this article online	
	Website: www.jwbm.com.my	DOI: 10.26480/jwbm.01.2024.06.12

Cite the Article: Okoruwa M. I., Eguabor C.O (2025). Effect of Dietary Inclusion of Onion Peel Powder on Performance and Blood Profile of Sheep Fed Guinea Grass and Cowpea Husk Based Diet. *Journal of Wastes and Biomass Management, 7(1): 06-12.*

energy efficiency that reduce passage rate of digesta through the gastrointestinal tract for better digestion, absorption and utilization of feed. Furthermore, the remarkable utilization of onion peel powder by ruminants is still increasingly examined because of its phytochemicals and multiple secondary metabolites like flavonoids, tannins, quercetin and phenolic compounds that can favourably altered rumen microbial fermentation to improve sheep productivity (Ifesan, 2017). In view of this, the study was designed to determine the effect of dietary inclusion of onion peel powder on performance and blood profile of sheep fed guinea grass and cowpea husk-based diet.

2. Material and Methods

2.1 Area of Study

The study was carried out at the Sheep and Goat Unit of the Teaching and Research Farm of Ambrose Alli University, Ekpoma. The location is on longitude 6.09^{0}E and latitude 6.42^{0}N of humid climatic zone of south-south Nigeria. The vegetation of this geographical zone represents an interface of between tropical rainforest and derived savannah. . The location has a prevailing tropical climate with an average annual rainfall and temperature that was about 1556mm and 31^{0}C respectively.

2.2 Experimental Diets

Onion peels were collected from their processing and selling points within Ekpoma. They were sun dried for 3 days on a concrete slab to obtain a consistent dry matter level before milled to a particular size with hammer mill model SAS 2 THM to pass through a 1mm sieve to get onion peel powder and stored in airtight container until later required for incorporate in treatment diets. However, onion peel powder with other feed ingredients that were sourced in reputable feed mill was used to formulate the different supplementary diets as showed in Table, 1. Succulent and less hardened part of guinea grass was cut at a re-growth age of about 7 to 8 weeks and chopped to smaller lengths of about 4 to 5cm. Subsequently, cowpea husk was also collected from their processing areas within Ekpoma and removed foreign materials such as stones and debris before used. Thereafter, the chopped guinea grass thoroughly mixed with cowpea husk and used as basal diet for all sheep on treatments.

The basal diet of 45% guinea grass and 15% cowpea husk with 40% concentrate diets made up the experimental diets. However, the compared diets contained; T_1 (no onion peel powder that served as the control group), T_2 (1% onion peel powder), T_3 (2% onion peel powder) and T_4 (3% onion peel powder) inclusion levels in the treatment diets

Table 1: Gross composition (%) of concentrate diets

Ingredients	Treatment Diets			
	T_1	T_2	T_3	T_4
Wheat offal	48.00	42.00	36.00	30.00
Brewery dried grain	32.00	35.00	38.00	41.00
Coconut pulp	11.00	12.00	13.00	14.00
Broken groundnut/shell	5.00	6.00	7.00	8.00
Onion peel powder	-	1.00	2.00	3.00
Bone meal	2.00	2.00	2.00	2.00
Vitamin Premix	1.50	1.50	1.50	1.50
Salt	0.50	0.50	0.50	0.50
Total	100	100	100	100

2.3 Animals and their Management

Sixteen West African dwarf female sheep of approximately similar age of about 6 to 7 months old with initial average body weight of 6.00 ± 0.46kg were selected for the study. They were sourced within Ekpoma market in Esan North East local Government Area, Edo State. Sheep were housed in individual thoroughly washed, cleaned and disinfected pen that has facilities for feeding and watering. The pens were semi-open sided well-ventilated which were bedded with wood shavings. Sheep were acclimatized for 14 days before the beginning of the study that lasted for 12 weeks. Vaccinations against main diseases and deworming as for veterinary sector guidance were strictly administered to all sheep before the commencement of the experiment. Thereafter, sheep were randomly divided into four treatment groups (n=4) of four animals each with two replicates of two animals per replicate on the basis of body weight in a completely randomised design. However, they were offered feed twice at about 8:00am and 4:00pm daily. Clean drinking water and mineral blocks were available to sheep at all time throughout the study.

2.4 Growth Study

The difference in the total quantity of feed offered and leftovers, if any were collected, weighted and recorded on dry matter basis before daily morning feeding to sheep for determining feed intake. The average daily feed intake was individually recorded throughout the whole experimental period as the difference between the amounts of feed offered and refusal of each sheep after 24 hours. The amount of feed offered was adjusted after every week according to change in their body weight. However, initial body weights of animals were recorded at the beginning of the feeding trial. Subsequently, sheep were weighed individually every week to the nearest kilogram with measuretech® hanging scale prior to morning feeding to evaluate changes in body weight throughout the experimental period, Total body weight gain was obtained by the difference between the accumulated final weight and initial body weight. The average daily weight gain was calculated as total body weight divided by the number of days throughout the trial period which was 84 days. Feed conversion ratio was calculated by dividing average daily feed intake with average daily weight gain.

2.5 Digestibility Trial

At the end of growth study, eight sheep, two from each treatment were transferred to individual metabolic cages for metabolic trial. Each cage was modified with provision for feeding and watering troughs and stainless steel wire mesh that was placed on the floor to keep feacal matter away from urine which passed through a stream into drainage. An adaption period of 7days was allowed, followed by 7 days collection period. Samples of refused feed and fecal output were collected, weighed and recorded daily in the morning before offering the morning feed during the collection period. However, daily fecal sample for each sheep was bulked, quantified and homogenised before approximately 10% sub-sampled were pooled and stored in plastic bags in the refrigerator at -4^{0}C until chemical analysis. Apparent Digestibility Coefficient (ADC) for each nutrient was calculated as the difference between nutrient intake and nutrient in faeces expressed as a percentage of nutrient intakes. Thus, digestion coefficient of nutrient was calculated for dry matter, crude protein, crude fibre, ash, ether extract and nitrogen free extract from each dietary treatment using the equation proposed (McDonald et al., 2002)

$$\text{ADC \%} = \frac{\text{Total amount of nutrient intake} - \text{Total amount of nutrient in faeces}}{\text{Total amount of nutrient intake}} \times 100$$

Nutritive values in terms of Total Digestible Nutrients (TDN) and Digestible Crude Protein (DCP) were calculated according to the classic formula of NRC (2007)

$$TDN\% = DCP\% + DCF\% + DNFE\% + (DEE\% \times 2.25)$$

Where
DCP = Digestible crude protein

DCF = Digestible crude fiber

DNFE = Digestible nitrogen-free extract

DEE = Digestible ether extract

2.6 Blood Sampling and Assay

Blood was sampled from each sheep at the end of digestibility trial before termination of the experiment. Notwithstanding, 10ml of blood sample was collected from the jugular venipucture using disposable heparinised syringes into sterilized evacuated collection tubes before morning feeding. The 5ml of the blood sampled was transferred into sterilized evacuated bottles containing ethylene-diamine tetra-acetic acid (EDTA) which served as anti-coagulant for haematological parameters determination which were; Haemoglobin (Hb) and Packed Cell Volume (PCV) concentration that were determined by using cyano-methaemoglobin (using filter-paper technique) and micro-haematocrit methods respectively as described (Dacie and Lewis, 1975). Red Blood Cell (RBC) count and total White Blood Cell (WBC) were estimated by the haematocytometry method as described (Bush, 1991). The erythrocytic indices which were; Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH) and Mean Corpuscular Haemoglobin Concentration (MCHC) were computed as described (Jain, 1993). Differential count of leucocytes that were neutrophil, lymphocyte, monocyte and eosinophil counts were obtained from blood stained with a wrights dye laboratory counter.

The remaining 5ml of the sampled blood was taken to anti-coagulant free

plastic tubes and gently inverted a couple of times, kept in an ice box to allow coagulation at room temperature. They were later centrifuged for 15 minutes at 890xg at 4^0C and maintained for 8 hours in refrigerator at 4^0C for separation of supernatant serum. The serum decanted were stored in a freezer at -20°C for serum biochemical constituents' estimation which include total protein that was measured using biuret reaction while albumin was analyzed by colorimetric estimation using sigma diagnostic kits (Baker, 2007). Globulin was determined by difference between total protein serum and albumin (Hassan et al., 2016). Urea in the serum sample was estimated using the diacetylmonoxime method and creatinine was obtained by the Jaffe reaction method while blood glucose was derived by enzymatic colorimetric test. Total cholesterol and triglyceride concentrations were obtained by procedures of Green Cross MS in Korea using the procedures described (Kim et al., 2012).

2.7 Chemical Analysis of feeds and faeces

Samples of experimental basal diet (guinea grass and cowpea husk), onion peel powder, experimental diets and faeces were collected and dried in a forced-air oven-dried at 65Oc for 72 hours to determine the dry matter (DM) content before milled to pass through a 1mm screen in a Wlley mill for proximate analysis according to (AOAC, 2005). Dry matter was measured using hot air circulation oven (Heraeus Ut20, Germany) at 105 ^{0}C for 3 hours. Crude protein was measured using Kjeltec system 2100, FOSS-Sweden. Either extract was determined by Soxhlet extraction system 2045, FOSS- Sweden. Ash was measured by combustion of the dried material in a muffle furnace at 600°C for 8 hours. Crude fibre was measured by Fibertherm system Gerhard-Germany, using the method of (AOAC, 2005). Neutral detergent fiber (NDF) and acid detergent fiber (ADF) were determined without using sodium sulphite or ∝-amylase according to (Van Soest et al., 1991).

2.8 Statistical Analysis

Data generated from growth, digestibility and blood parameters were subjected to one-way analysis of variance (ANOVA) and expressed as means with a standard error of mean (Mean±SEM), using SPSS for Windows Version 16.0. Chicago, SPSS Inc. Where significant different occur, treatment means were separated ($p<0.05$) by Duncan's multiple range test (Duncan, 1955).

3. Results

Feed ingredients analysed in Table, 2 indicated that Cowpea Husk (CH) had highest values in dry matter, crude protein and crude fibre as compared with Onion Peel Powder (OPP) and Guinea Grass (GG). Ether extract and ash content recorded higher values in GG than what were obtained in CH and OPP. However, nitrogen free extract appeared higher in OPP followed by GG before value registered in CH.

Dry matter content registered in all the concentrate diets was quite high with slight variation. Diets T_1 and T_2 had similar higher values in crude protein and ether extract than values recorded in diets T_3 and T_4. However, remarkable differences were observed in crude fibre values with diets T_3 and T_4 appeared to be higher than diets T_1 and T_2. The discrepancy that occurred in ash values followed the same pattern of variation as obtained in crude protein values while that of nitrogen free extract followed the same trend as observed in crude fibre content.

Table 2: Proximate composition (%DM) of feed ingredients and concentrate diets.

	Feed Ingredients			Concentrate diets			
	GG	CH	OPP	T_1	T_2	T_3	T_4
Dry matter	86.20	98.30	91.80	82.99	83.75	85.92	87.68
Crude protein	7.04	14.24	0.88	12.72	12.21	11.71	11.20
Ether extract	9.23	8.69	0.98	3.89	3.24	2.71	2.48
Crude fibre	29.01	31.00	0.15	22.35	23.68	24.15	24.43
Ash	12.52	5.65	0.59	5.92	5.56	4.79	4.52
Nitrogen free extract	49.49	40.51	88.56	55.12	55.31	56.64	57.37

GG = *Guinea Grass*, CH = Cowpea Husk, OPP = *Onion Peel Powder*

Initial body weight of sheep that ranged from 6.28 to 6.64 kg did not show any significant difference ($p>0.05$) between dietary treatments. Values recorded in sheep on test diet T_4 had higher significant mean ($p<0.05$) value in final body weight, followed by those on T_3 and T_2 before sheep on T_1. However, sheep found among treatment diets seen to have variation in total and daily weight gains that followed almost the same trend as in final body weight. Feed intake and feed conversion ratio values obtained in the study were higher significantly ($p<0.05$) in sheep on diets T_1 than values registered in diets T_2, T_3 and T_4.

The digestibility coefficient of dry matter and crude protein recorded in sheep on diets T_3 and T_4 improved significantly ($p<0.05$) than values observed in sheep on diets T_1 and T_2. Crude fibre digestibility was significantly ($p<0.05$) higher in diet T_4 followed by diets T_3 and T_2 before diet T_1.that appeared to be the lowest. However, ash digestibility mean values obtained in test diets T_4 and T_3 were significantly ($p<0.05$) better in sheep as compared with average values recorded in diets T_2 and T_1. Ether extract digestibility values were better digested ($p<0.05$) in sheep on control diet (T_1) than those on test diets (T_2, T_3 and T_4). Nitrogen extract digestibility values followed the same pattern of variation as observed in crude fibre digestibility in the study. Digestible crude protein values were seen to be significantly ($p<0.05$) increased in diets T_4 and T_3 than values obtained in diets T_1 and T_2. Total digestible nutrient that was observed to be significantly ($p<0.05$) improved in test diets than control diet was similar in order of variation with nitrogen free extract.

Table 3: Growth performance and digestibility coefficients of sheep fed experimental diets

Parameters	Treatment Diets				
	T_1	T_2	T_3	T_4	SEM±
Growth					
Initial body weight (kg)	6.64	6.49	6.40	6.28	0.41
Finial body weight (kg)	9.62^b	10.02^a	10.29^a	10.31^a	0.52
Total weight gain (kg)	2.98^c	3.53^b	3.89^b	4.03^a	0.19
Daily weight gain (g/day)	35.48^c	42.02^b	46.31^a	47.98^a	0.63
Feed intake (g/day)	276.24^a	250.64^b	231.15^{bc}	216.79^c	1.96
Feed conversion ratio	7.78^a	5.97^b	4.99^c	4.52^c	0.28
Digestibility coefficients (%)					
Dry matter	65.96^c	67.32^b	70.95^a	72.06^a	0.79
Crude protein	66.13^c	69.52^b	70.22^a	71.01^a	0.69
Crude fibre	62.34^c	65.21^b	67.09^b	70.31^a	0.81
Ash	60.93^c	63.46^c	65.89^b	66.98^a	0.67

Table 3 (cont): Growth performance and digestibility coefficients of sheep fed experimental diets					
Ether extract	69.03[a]	65.32[b]	61.29[c]	61.29[c]	0.85
Nitrogen free extract	62.36[c]	65.68[b]	70.34[a]	70.34[a]	0.72
Nutritive Value (%)					
Digestible crude protein	8.42[b]	8.96[b]	9.57[a]	9.57[a]	0.46
Total digestible nutrients	63.98[c]	65.74[b]	73.15[a]	73.15[a]	0.77

[a,b,c] Means on the same row with different superscripts are significantly different (P < 0.05)

SEM = Standard error of mean.

Haematological indices of sheep were significantly (P<0.05) affected by treatment diets except mean corpuscular volume that was not influenced (P>0.05) as seen in Table 4. Packed cell volume and haemoglobin values were relatively higher in diets T_3 and T_4 as compared with diets T_2 and T_1 that were significantly (P>0.05) lower in the study. Red blood cell values appeared to be significantly (P>0.05) increased in sheep on test diets than those on control diet. Mean corpuscular haemoglobin and mean corpuscular heamoglobin concentration were found to be varied among treatment diets with sheep on diets T_3 and T_4 appeared to be significantly (P>0.05) improved than those on diets T_2 and T_1. Sheep on diets with onion peel powder were higher significantly (P>0.05) in values of white blood cell, lymphocyte, erosinophils and neutrophil than diet without onion peel powder. Sheep on diets T_3 and T_4 had higher (P>0.05) values of monocyte counts than the values recorded on diets T_2 and T_1.Table 4 also showed serum biochemical parameters of sheep fed experimental diets.

All parameters assessed were significantly (p<0.05) influenced by treatment diets except globulin and creatinine values that were not significantly (p>0.05) affected. Total serum protein was significantly (p<0.05) higher in sheep placed on diets T_3 and T_4 than values recorded in diets T_2 and T_1. However, albumin values obtained in sheep appeared to be higher significantly (p<0.05) in diets T_4, T_3 and T_2 as compared with what was registered in T_1. Serum glucose and triglyceride concentration had higher significant (p<0.05) values in diet T_4 than values that were recorded in sheep on treatment diets T_3, T_2 and T_1. Cholesterol concentration were better (p<0.05) in value recorded in control diet than values registered in test diets. Serum urea concentration obtained in the study followed the same trend as observed in cholesterol, indicating that diet without onion peel powder had higher significant (p<0.05) value as compared with onion peel powder inclusion diets.

Table 4: Blood profile of sheep fed experimental diets.					
Parameters	**Treatment Diets**				
	T_1	**T_2**	**T_3**	**T_4**	**SEM±**
Haematological parameters					
Packed cell volume (%)	26.42[c]	28.53[b]	30.02[a]	30.86[a]	0.87
Haemoglobin (g/dl)	5.79[b]	6.58[b]	7.13[a]	7.46[a]	0.06
Red Blood Cell (x10^6 /ml)	5.84[b]	6.29[a]	6.58[a]	6.93[a]	0.08
MCV (fl)	34.01	34.27	34.77	34.92	0.49
MCH (pg)	7.84[b]	8.58[b]	10.06[a]	10.14[a]	0.31
MCHC (%)	30.76[c]	31.45[b]	31.96[b]	32.09[a]	0.17
White Blood Cell (x10^6 /ml)	6.08[c]	8.03[a]	8.47[a]	8.71[a]	0.06
Lymphocytes (%)	45.31[b]	53.24[a]	53.65[a]	54.33[a]	0.59
Eosinophils(%)	3.56[b]	4.27[a]	4.32[a]	4.49[a]	0.07
Neutrophils(%)	42.01[b]	46.81[a]	48.26[a]	48.74[a]	0.74
Monocytes(%)	1.68[b]	1.99[b]	2.37[a]	2.59[a]	0.05
Serum Biochemical indices					
Total protein (g/dl)	6.64[b]	6.82[b]	7.01[a]	7.18[a]	0.07
Albumin (g/dl)	2.95[b]	3.06[a]	3.12[a]	3.20[a]	0.04
Globulin (g/dl)	3.69	3.76	3.89	3.94	0.05
Glucose (mg/dl)	64.52[b]	66.93[b]	68.57[b]	71.54[a]	0.92
Triglyceride (mg/dl)	19.89[b]	21.01[b]	21.63[b]	23.11[a]	0.53
Cholesterol (mg/dl)	64.01[a]	51.41[b]	50.83[c]	50.51[c]	0.81
Creatinine (mg/dl)	0.98	0.65	0.59	0.57	0.02
Urea (mg/dl)	13.02[a]	9.69[b]	7.89[c]	7.84[c]	0.06

[a,b,c] Means on the same row with different superscripts are significantly different (P < 0.05)

SEM = standard error of mean. MCV = Mean corpuscular volume, MCH = Mean corpuscular haemoglobin, MCHC = Mean corpuscular haemoglobin concentration

4. Discussion

4.1 Proximate composition of feed ingredients and concentrate diets

Proximate composition values of feed ingredients registered in the study were within the average values earlier reported for guinea grass, for cowpea husk and for onion peel powder with exception of dry matter that was different from the reported values (Okoruwa, 2023; Mafindi et al., 2018; Ifesan, 2017). However, variation observed in nutrient content of concentrate diets was a reflection of different feed ingredients that comprised the diets. Notwithstanding, the crude protein content of the concentrate diets were above 8 to 9% minimum requirement of crude protein for small ruminants maintenance as reported by (Norton, 2003).

4.2 Growth performance and nutrient digestibility

The initial body weight of sheep was not affected by dietary addition of onion peel powder to the treatment diets. In contrast, the final body weight of sheep was positively influenced by the inclusion of onion peel powder in the diets. This could probably due to the biochemical components in the test ingredients that improved the voluntary feed intake, efficiency of feed utilization and the physiological state of the sheep. This trend of body weight improvement was clearly seen in total and daily heavy weight gain in sheep, indicating that the addition of varying levels of onion peel powder in the feeds had beneficial effects as

they stimulated growth for optimal performance in sheep. This fact is in agreement with the views of a group researchers that garlic powder enhances the activities of pancreatic enzymes and provide micro-environment for better utilization of nutrients (Chouhan et al., 2023). The daily weight gain values recorded in this study were within the mean value of 43.95g/day obtained in the finding earlier reported (Okoruwa and Okunlola, 2017).

Feed intake is described as an important factor in the utilization of feed by ruminants and also a critical determinant of energy and performance in sheep and goats (Mafindi et al., 2018). The observed changes in feed intake could be as a result of improvement in the nutrient status phytogenic content of the diets which enhance rumen micro-organisms proliferation that encourages more rapid and thorough digestion of ingesta leading to assimilation. The values of feed intake recorded were within the recommended daily feed intake of 3 to 4% body weight of ruminants as noted (ARC, 1980). Feed conversion ratio (FCR) that decreased with increasing levels of onion peel powder across diets was an indication of efficient feed utilization which reflected in lower feed conversion ratio in the test diets. This revealed that sheep on test diets had better ability to convert their feed consumed to heavy weight gain. Contrary to the above findings, a group researcher observed that inclusion of supplemental levels of herbal additive in a diet of growing lambs have no effect on FCR (Bampidis et al., 2005). The reasons for these differences could be related to high levels of dietary supplementation with additives as well as difference in animal type and diet composition.

Digestibility of nutrient is governed by so many factors such as nature and quality of feeds, level of feed intake, manner of rumen fermentation and flow rate in gastro-intestine (Okoruwa et al., 2023). Thus, nutrient digestibility explains the rate at which feeds are being digested and utilized by animals. It is interesting to know that the influence of onion peel powder in diets of sheep possibly stimulated the activity of rumen floral for better availability of nutrient utilization as noticed in improvement of dry matter, crude protein and crude fibre digestibility. This observation could be as a result of phytochemical and bioactive activities of the test ingredient that manipulated rumen microbes to enhance appreciable quantity and quality of nutrient availability in the post rumen digestibility. This concurred with the assertion of a group researcher that the digestibility of fibre and protein in ruminants can be augment with concentrate diets and modulation effect of test additive which favour the functioning of the rumen for high fermentation and better digestibility of fibre.

The considerable increase observed in ash digestibility in test diets signify better feed efficiency which further attest the superiority of the diets. This inference further reaffirmed the fact earlier reported by that easy digestible feature in feeds additive improves the activity of rumen degrading microbes for better nutrient digestion (Hassan et al., 2016). However, the supplementation with onion peel powder led to reduction of ether extract digestibility. The interaction between the bioactive components and oil in the test diets could probably disrupt the activity of rumen microbial enzymes reaction by forming an indigestible complex for oil-degrading components (Candyrine et al., 2019). Furthermore, the better digestibility of values of nitrogen free extract, digestible crude protein and total digestible nutrients were traceable to the synchronous availability of protein and fibre digestion in the diets. This observation logically harmonious with who stated that digestibility of nutrients varies with nutrient composition of the diet (Mafindi et al., 2018).

4.3 Blood profile of sheep

Changes in haematological parameters are often used to assess various health status and stress of animals due to nutritional, environmental and pathological factors (Ibrahim *et al.,* 2022). The higher and positive comparative values of Packed cell volume (PCV), haemoglobin (Hb) and red blood cell (RBC) observed in sheep on diets with onion peel powder is an indication of a very low susceptibility to anemia-related disease conditions by the animals. Their values recorded in this study were similar to the reference mean values of PCV (29.86%), Hb (7.34 g/dl) and RBC (6.09 $x10^6$ /ml) reported by when normal healthy Yankasa rams were fed with diets containing varying inclusion levels of ginger powder (Ibrahim et al., 2016). This suggests that even at the highest level of onion peel powder inclusion in the study diets, the aforementioned parameters were not affected. Though mean corpuscular volume values were not influenced by treatment diets but mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration values that explain bone marrow capacity for blood cells production and diagnosis of anaemia were correlated with higher PCV, Hb and RBC values recorded in the test diets. This further explains the quality of the test ingredient that did not pose any health challenges but sequent improve the sheep.

The white blood cell (WBC) counts provide protective mechanism with rapid and potent defense against infection agents in animals. Their higher counts in test diets explain the attributed of some phyto-chemical components which improved the activities of phagocytosis as seen in immune system, antibodies production and disease fighting ability of the sheep. It was noted that WBC in animals possess phagocytes functions that are used as an indicator of stress and immune response to certain conditions like ill-health in animals (Ibrahim et al., 2022). The WBC values registered for sheep in this study tallies with the mean value (8.02 $x10^6$/ml) for normal healthy sheep as reported (Ikhimioya and Okoruwa, 2017). Similar higher values of neutrophil and lymphocyte counts imply that these diets had no adverse effect on blood and health status of sheep. Notwithstanding, the low counts of monocytes and eosinophils showed the tendency of sheep not being susceptible to microbial infection or disease condition. This further proved their immune system that was not challenged with the residual anti-nutritional substances present in the test feeds. However, their values indicated good resistance to diseases and did not portend any danger, as they were within the normal range of 10-50% neutrophils, 40-75% lymphocytes, 1-5% monocytes, 1-8% eosinophils for small ruminants as pointed out (Okoruwa et al., 2023).

The dietary inclusion effect of onion peel powder on total protein and albumin of sheep resulted in higher values, explaining nutrient adequacy in terms of protein quality in the diet that was well digested and efficiently utilized by sheep. However, serum globulin counts observed in sheep were not influenced by treatment diets. It was stated that good quality protein feed always express high concentrate in serum protein components after digestion (Al-Azaza et al., 2018). It also appears that phytogenic characteristics in the test diets improved the soluble digestible energy metabolism as noticed in higher serum glucose and triglyceride. Natural additives modulate metabolism in the rumen to improve energy metabolic efficiency for better performance. Onion peel powder has been reported by to low serum cholesterol in animals, hence the phyto-chemical components in the test diets could probably attributed to the reduction in the level of serum cholesterol (Ifasan, 2017). A group researchers stated that cholesterol concentration level of 180 mg/dl and below is safe for sheep and may not result in arteriosclerosis (Al-Azaza et al., 2018). Serum urea measures the excess amount of nitrogen waste due to protein deamination in the serum.

Thus, the low levels of urea in the test diets signify balanced nitrogen and safety of feeds consumption by sheep. Low serum urea also connected with better kidney function, since protein intake and kidney functioning are affected by quantity of blood urea nitrogen (Ibrahim et al., 2022). On the other hand, high level of serum urea has been reported to be associated with poor protein utilization, leading to catabolism of amino-acid and subsequently degraded to urea. Creatinine is an indicator of normal muscle function in animals, hence is a chemical waste product in the blood that increases with increase in animal muscles (Kim et al., 2012). However, the significant reduction in levels of creatinine observed in the test diets further attest the quality of the test ingredient in terms of adequate protein utilization and reduction in muscle mass wastage. The serum urea and creatinine concentration recorded were similar with reference mean values of 8.92 mg/dl and 1.03 mg/dl respectively as reported (Ibrahim et al., 2022).

5. Conclusion

The study indicated that the dietary inclusion of onion peel powder in the supplementary diets of sheep had valuable potential that could go a long way in solving the problem of feed scarcity in south-south Nigeria. Furthermore, results obtained in the study showed that the inclusion of this 40% supplementary concentrate diets with based diet of 45 % guinea grass and 15% cowpea husk could significantly enhanced performance and improved blood profile of sheep. However, these improvements were more satisfactory and beneficial to sheep on treatment diet T_4 that contained 3% inclusion of onion peel powder. Hence, the diet was strongly recommended to sheep.

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