



GROWTH PERFORMANCE AND BLOOD CHARACTERISTICS OF WEST AFRICAN DWARF GOATS FED PROCESSED UNRIPE PLANTAIN PEEL MEAL BASED DIETS

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Abstract: A Twelve week feeding trial was conducted to examine the effect of unripe plantain peel meal based diets on the growth performance, haematological and serum biochemical characteristics of West African Dwarf (WAD) goats. Thirty two (32) WAD goats between 5 and 6 months old with average initial body weight of 6.37 kg were allotted to four dietary treatments, of unripe plantain peel at different processing methods, using a Completely Randomized Design (CRD). Growth performance was monitored during the feeding trial. At the end of Twelve weeks feeding trial, blood samples were taken from each goat (16 goats) through the jugular vein using a 10 ml gauge (5 cm) needle with 4 ml of blood drawn from each goat per treatment for analysis. The results showed that the values obtained for final body weight ranged between 7.51 kg and 11.00 kg, and the overall mean for feed intake was between 2079.00 g and 2517.90 g. The overall mean weight gain was between 60.75 g and 379.33 g. The response of the animals to the different processing methods showed that feed intake recorded the highest values in T₃ (fermented unripe plantain peel diet) and T₄ (Urea treated unripe plantain peel diet), though there was no significant (P>0.05) difference. The values obtained for haematological parameters and serum biochemical indices were significantly different (P<0.05) between dietary treatments, and the results obtained showed better values for WAD goats fed urea treated and fermented treatment diets. The study concluded that processed unripe plantain peel meal can serve as an alternative feed source for WAD goats especially when supply of forages is low without any deleterious effect on the growth performance and blood characteristics.

Keywords: plantain peel, wastes, feed resources, WAD goats, blood profile, processing.

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Introduction

Goats have taken a lead role in most sustainable rural development programmes in developing countries (Rastogi *et al.*, 2006). Goat contributes about 24% of Nigeria's meat supply (Oni, 2002) and one of the cheapest sources of animal protein because of its availability and affordability even among rural households. Apart from providing meat, goat plays a vital role by providing milk, fibre, wool, manure and a major source of income or "bank account" that can be tapped at times of need, especially, for rural dwellers. Additionally, goats are useful in socio-cultural functions such as being slaughtered for funeral and marriage ceremonies as well as other traditional rites (Nsoso *et al.*, 2004).

Goat production makes a great contribution to the Nigerian agrarian economy. The West African Dwarf (WAD) goats are found in the south of latitude 14° N across West Africa in the coastal area, which is humid and favours high prevalence of diseases (Daramola *et al.*, 2005). This ecozone is infested with tse-

tse fly and WAD goats thrive well and produce multiple birth with twins and triplets generally common (Oseni *et al.*, 2017), thereby satisfying a part of the meat requirements in this region. In Nigeria and West Africa, goats are reared traditionally at subsistence level. They are left to scavenge and carter for their own nourishment (Oseni *et al.*, 2017). Inadequate nutrition has been recognized as their major constraint to livestock production, especially, goat production in Nigeria (Olubajo and Oyenuga, 2004).

Low productivity of goats in the tropics has been associated with problems of meeting their nutritional requirements (Jansen and Burg, 2003). This is aggravated by seasonal fluctuation that affects the nutritive quality/quantity of natural pasture or agro-wastes, most especially during the dry season or climate change impacts as well as the steady increase in prices of conventional feed ingredients due to competition between man and livestock (Uchele *et al.*, 2022). The use of agro-industrial by-products and crop residues has been identified to play a vital role in the nutrition of

ruminant animal to ensure all year round availability of feeds (Yang *et al.*, 2021; Alimi *et al.*, 2024).

Blood is an important index of physiological and pathological changes in an organism, that is used in assessing the body's ability to respond to haematological and serum biochemical upset. Ogunbajo *et al.* (2009) observed that nutritional studies should not be limited to performance alone, but the effect on the blood constituents is also vital tools that help to detect any deviation from normal in the animal's body. The physiological and the pathological conditions of animals can be assessed by haematological and biochemical analyses of the blood (Khan *et al.*, 2011). Utilization of blood metabolites provides an indication of an animal's nutritional status, and is recommended when assessing the effects of a diet on the performance of animal in the short to medium term (Pambu-Gollah *et al.*, 2000).

Plantain (*Musa paradisiac*) is grown in many tropical countries as an important source of carbohydrate for humans (Adamu *et al.*, 2017). Adeniji *et al.* (2006) reported 100 g edible portion of plantain to contain 67.30 g moisture, 0.4 g crude fat, 31.15 g carbohydrate, 0.95 mg potassium, 35.1 mg sodium, 71.5 mg calcium, 28 mg phosphorous, 2.4 mg iron, and yielded 116 Kcal of energy. Plantain peels are by-products of the plantain processing industry, which are normally dumped in landfills, rivers or unregulated grounds (Osma *et al.*, 2007). The peel of the fruit is discarded as a waste after the inner fleshy portion has been eaten. The peels are the major by-product of plantain fruits, constituting about 40% of the fruits and are largely viewed to be of little or no significance and subsequently discarded, thereby constituting a threat to the environment (Akinwunmi, 2022).

Plantain peels could be processed and used as a cheap source of carbohydrate in the diets of sheep and goats (Okoruwa *et al.*, 2013; Obongekpe, 2020; Ukanwoko *et al.*, 2020; Ferreira *et al.*, 2023). Unripe plantain peels are low in crude fibre, but rich in mineral matter, carbohydrate certain vitamins and bio-active compounds, thus if properly processed, they can be incorporated into livestock rations (Happi *et al.*, 2007; Oyeyinka and Afolayan, 2019; Ukanwoko *et al.*, 2020; Odion *et al.*, 2021; Ferreira *et al.*, 2023, Serna-Jiménez *et al.*, 2023). Since optimizing performance in ruminant fattening is essential to remain competitive in the business and the common goals in fattening are to maximize average daily gain and optimize feed efficiency (Babale *et al.*, 2015; Ajayi *et al.*, 2018), it has become imperative to look for cheaper but efficient feedstuffs for goats.

There is dearth of information on the effect of using unripe plantain peel on the blood parameters of WAD goats (Idowu *et al.*, 2018). Therefore, this study was designed to determine the effect of unripe plantain peel meal based diets on the growth performance, haematological and serum biochemical indices of WAD goats fed processed unripe plantain peel meal based diets.

Inadequate/poor nutrition has been reported as a major constraint to livestock productivity, especially, goat production in Nigeria. Even more worrisome is the fluctuation in quality and quantity of forages and the stiff competition for available feedstuffs between man and livestock, which has led to abnormal increase in the prices of these feedstuffs. Goats provide one of the cheapest or easily available sources of animal proteins in Nigeria, as high producing animals and taking lesser time to mature compared to other ruminants. Therefore, unripe plantain peels could be a cheaper

source of carbohydrate that can be utilized in goat nutrition to reduce cost and for optimum performance.

Materials and Methods

Location of the study

The experiment was carried out at the Goat Unit of the Department of Animal Science Teaching and Research Farm, University of Calabar, Calabar, Nigeria. The geographical location of Calabar is within longitude 8°19'E and latitude 4°5'N of the equator. Calabar is on 98 meters above sea level with an annual temperature and rainfall ranges from 25° C to 30° C and from 1260 mm to 1280 mm, respectively. The relative humidity is between 70 and 90 % (NMA, 2018).

Experimental animals and management

Thirty two (32) growing West African Dwarf goats aged between 5 and 6 months old were used for this experiment. The goats were sourced from weekly sheep and goats market located at Akpabuyo, Cross River State. Before the arrival of the goats, the pens were washed thoroughly with detergent and disinfected with Izal solution and allowed for seven days to break any disease cycle. The goats were allowed 14 days of adaptation after arrival and were fed with conventional forages during this period. Prior to commencement of the experiment, goats were treated against ecto and endo parasites using Ivomec. The goats were then vaccinated against *Peste de petits ruminants* (PPR) disease using homologous Tissue Culture Rinderpest vaccine. The goats were given unrestricted access to water throughout the adaptation period. At the end of the adaptation period, each goat was weighed, tagged, balanced for weight and allocated to one of the respective four experimental treatments using Complete Randomized Design (CRD). Initial body weight of each animal was taken and recorded before embarking on data collection. Experimental diets and clean water were provided every morning and elephant grass was fed to them in the afternoon. Each pen was thoroughly cleaned daily throughout the experimental period, which lasted for 12 weeks. During this period, daily feed intake and weekly weight gain were determined accordingly.

Experimental material

Sourcing, collection and processing of unripe plantain peel

Fresh unripe plantain peels of mixed varieties were collected from fast foods, restaurants, plantain chips and roasted plantain outlets within study location town, Calabar. The peels were cut into slices of 5 mm - 7 mm thick to ease drying. The cut pieces were spread on a clean concrete floor for about 7 to 10 days and turned at regular intervals for even and quick drying. The dried peels were divided into three portions; for the three treatments which contained unripe plantain peel. They were then packed into air tight bags and stored for later use in compounding the experimental diets.

Experimental diets

Four experimental diets were used for this study. T₁ contained no unripe plantain peel and served as the control. Plantain peels for T₂ were further sun-dried for 3 days after which they were ground in hammer mill of 3 mm sieve size, packed into bags and labelled as sun-dried unripe plantain peel meal (SUPPM).

For T₃, fermented unripe plantain peel meal (FUPPM) were obtained by soaking plantain peels in water for 4 - 5 days and

thereafter sun-dried before grounding in hammer mill of 3 mm sieve. They were then packed into bags prior to use.

Plantain peel in T4 was treated with urea according to the procedure outlined by Ayuk *et al.* (2001). One kg of urea was dissolved in 25 litres of water. The resulting solution was mixed with unripe plantain peel meal on volume/weight basis. 25 litres of urea solution was mixed with 25 kg of unripe plantain peel meal. The urea mixed meal was kept in thick polythene bags, tied firmly to eliminate air pockets and kept under shade for 2 weeks. After this period, the sheet was uncovered and the urea treated meal removed and sun-dried for about four days to obtain urea treated unripe plantain peel meal (UTUPPM). The animals were allowed a 14-day adaptation period, after which they were fed their respective diets for 12 weeks. Water was provided *ad libitum*. Table 1 shows the gross composition of the experimental diets.

Experimental design

Thirty two (32) West African Dwarf goats were used for the study. The goats were randomly allocated to four experimental treatments of eight goats per treatment in a Completely Randomized Design

(CRD). Each treatment was further sub-divided into 4 replicates of 2 goats per replicate.

Haematological study

Blood samples were taken from each goat through the jugular vein using a 10 ml gauge (5 cm) needle. 4 ml of blood was drawn from each goat (16 goats) at the 12th week of the study. The blood samples were emptied into heparinized packs containing about 40 mg of anticoagulant (Ethylenediaminetetraacetic acid – EDTA) components. Packed cell volume (PVC), red blood cell (RBC), white blood cell (WBC) and differential counts of WBC (neutrophils, eosinophils and lymphocytes) were determined according to the methods described by Coles (1986). The mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) was calculated as:

Mean corpuscular volume (MCV) (μ^3) = $\frac{\text{haematocrit (PVC)}}{\text{RBC in millions/mm}^3}$ x 10

Table 1. Gross composition of experimental diets

Feed stuffs (Kg)	T ₁	T ₂	T ₃	T ₄
Cassava peel meal	43.50	23.50	23.50	23.50
Unripe plantain peel meal	0.00	20.00	20.00	20.00
Wheat offal	30.00	30.00	30.00	30.00
Palm kernel cake	25.00	25.00	25.00	25.00
Salt	1.00	1.00	1.00	1.00
Premix	0.50	0.50	0.50	0.50
Total	100	100	100	100
Calculated nutrient compositions:				
Crude protein (%)	13.22	12.01	12.01	12.01
Crude fibre (%)	6.90	7.11	7.11	7.11
Metabolizable energy (Kcal/kg)	2590.00	2230.00	2230.00	2230.00

T₁ = control, no unripe plantain peel meal

T₂ = sun-dried unripe plantain peel meal (SUPPM)

T₃ = fermented unripe plantain peel meal (FUPPM)

T₄ = Urea treated unripe plantain peel (UTUPPM)

Mean Corpuscular Haemoglobin (MCH)(pg) = $\frac{\text{Hb in g/100ml blood}}{\text{RBC in millions/mm}^3}$ x 10

RBC in millions/mm

Mean Corpuscular Haemoglobin Concentration (MCHC) % = $\frac{\text{Hb in g/100ml blood}}{\text{RBC in millions/mm}^3}$ x 10

Haematocrit (PVC)

Serum biochemical study

On the last day of the 12th week experimental period, 4 ml of blood sample was taken from each goat per treatment through the jugular venipuncture using 10 ml gauge syringe. The blood sample were collected into anticoagulant free plastic tubes and allowed to coagulate at room temperature and centrifuged for 10 minutes at 300 rpm. The supernatant sera were then stored in a freezer for subsequent biochemical analysis. Biochemical constituents of the serum samples estimated include total protein, cholesterol, urea, glucose, alanine aminotransferase (ALT) and aspartate aminotransferase (AST) as described by Waziri *et al.* (2010).

Data analysis

Data obtained were subjected to a One-way Analysis of Variance (ANOVA) using SAS (2001) package. Duncan Multiple Range Test was used to separate the means where significant differences existed (Duncan, 1955). The experimental model was:

$$Y_{ij} = \mu + T_i + E_{ij}$$

Where:

Y_{ij} : Observed value

μ : Overall mean value

T_i : Random effect on the 1st treatment method of unripe plantain peel meal

E_{ij} : Random residual error

Results and Discussion

Results

Performance characteristics of WAD goats

No significant ($P > 0.05$) differences were observed in all the performance parameters measured. The average initial body weight recorded was 6.37 kg across all the treatments while the final body weights ranged between 7.51 kg and 11.00 kg, in treatment one (T_1) and treatment four (T_4) (Table 2). The first four weeks recorded an average weekly feed intake range of 1542.80 g/week to 2139.20 g/week. Weeks 5-8 recorded an average weekly feed intake range of 2136.40 g/week to 2690.50 g/week while weeks 9-12 recorded a range of 2396.80 g/week to 2786.00 g/week across all dietary treatments (Table 2). Weight gain recorded ranges of 36.35 g/week to 102.50 g/week, 65.00 g/week to 427.75 g/week and 81.00 g/week to 607.75 g/week for the 1st, 2nd and 3rd month, respectively. Feed conversion ratio recorded ranges of 19.63 to 57.16 for the first four weeks, 6.31 to 32.88 for weeks 5 – 8, and 4.58 to 30.25 for the last four weeks. The overall weekly averages for feed intake, weight gain and feed conversion ratio are shown in Table 2.

Haematological parameters of WAD goats

The haematological parameters of WAD goats fed processed unripe plantain peel meal based diets is shown in Table 3 with most of parameters being significantly ($P < 0.05$) affected by dietary treatments. Animals that fed T_3 diet had significantly ($P < 0.05$) higher packed cell volume than those of T_1 and T_2 but similar to those on T_4 . Haemoglobin recorded values were also affected by dietary treatments, Goats that received T_3 diet had significantly ($P < 0.05$) higher haemoglobin values compared to those of other dietary treatments. The values obtained for red blood cells ($\times 10^9/L$) were significantly ($P < 0.05$) by dietary treatments, T_3 and T_4 had significant higher values compared to those of T_1 and T_2 with similar values, while the values for White blood cells were significantly ($P < 0.05$) affected among dietary treatments ($\times 10^9/L$) and the values recorded were $11.70 \times 10^9/L$, $18.60 \times 10^9/L$, $16.30 \times 10^9/L$, and $10.20 \times 10^9/L$ for T_1 , T_2 , T_3 and T_4 , respectively. The values obtained for MCV were 33.60, 33.60, 37.00 and 36.00 fL for T_1 , T_2 , T_3 and T_4 respectively. MCHC recorded values of 14.70 g/dl, 5.20 g/dl, 16.80 g/dl, and 21.70 g/dl for T_1 , T_2 , T_3 and T_4 , respectively, which differed significantly among treatments. Lymphocytes and neutrophils values followed similar trend with T_2 , T_3 and T_4 having significantly ($P < 0.05$) higher values compared to T_1 with the least values. Eosinophils recorded values of 2.90 %, 13.30 %, 13.30 %, and 12.50 % for T_1 , T_2 , T_3 and T_4 , respectively, which did not differ among dietary treatments.

Serum biochemical indices

The serum biochemical indices for WAD goats fed unripe plantain peel meal based diets are shown in Table 4. The cholesterol, total protein, urea and creatinine contents were significantly ($P < 0.05$) influenced by dietary treatments while the glucose, aspartate aminotransferase and alanine aminotransferase did not differ significantly ($P > 0.05$) among dietary treatments. The values obtained for cholesterol were 16.00, 14.70, 12.70 and 7.30 mg/dl for T_1 , T_2 , T_3 and T_4 , respectively. Glucose recorded values of 20.00, 18.30, 21.00 and 12.00 mmol/L for T_1 , T_2 , T_3 and T_4 respectively. Values obtained for total protein were 6.80, 7.70, 7.50 and 6.50 g/dl for T_1 , T_2 , T_3 and T_4 , respectively. Aspartate aminotransferase recorded values of 13.00, 13.00, 13.00 and 14.70 μ l for T_1 , T_2 , T_3 and T_4 respectively while values for alanine aminotransferase was 12.00 μ l each for T_1 , T_2 , T_3 and T_4 , respectively. Values obtained for creatinine were 2.20, 2.30, 2.10 and 2.00 mg/dl for T_1 , T_2 , T_3 and T_4 , respectively.

Table 2. Weekly performance characteristics of WAD goats fed processed UPPM based diets

Parameters and periods	T1	T2	T3	T4	SEM
Initial weight (kg)	6.36	6.37	6.37	6.37	0.01
Final weight (kg)	7.51	7.99	8.40	11.00	2.95
Average weekly feed intake (g)					
1-4 weeks	2072.00	1542.80	2139.20	2012.50	270.90
5-8 weeks	2136.40	2296.00	2656.50	2698.50	475.80
9-12 weeks	2450.00	2396.80	2758.00	2786.00	203.50
Overall weekly mean	2219.49	2079.00	2517.90	2499.00	316.70

Weekly weight gain (g)					
1-4 weeks	36.25	71.25	98.75	102.50	31.20
5-8 weeks	65.00	137.00	172.00	427.75	157.90
9-12 weeks	81.00	196.25	242.75	607.75	227.60
Overall weekly mean	60.75	134.83	171.17	379.33	138.90
Weekly feed conversion ratio					
1-4 weeks	57.16	21.65	21.66	19.63	8.70
5-8 weeks	32.88	16.76	15.44	6.31	3.00
9-12 weeks	30.25	12.21	11.36	4.58	0.89
Overall weekly mean	40.09	16.87	16.15	10.17	4.20

Table 3. Haematological parameters of West African Dwarf goats fed unripe plantain peel meal based diets

Parameters	T ₁	T ₂	T ₃	T ₄	SEM	Ref. Ranges	References
Packed cell volume (%)	24.50 ^b	24.20 ^b	26.20 ^a	25.80 ^{ab}	0.32	20-28	Daramola <i>et al.</i> (2005)
Haemoglobin (g/dl)	7.20 ^c	7.50 ^b	7.90 ^a	7.10 ^c	0.10	7-10	Daramola <i>et al.</i> (2005)
Red blood cell (x10 ⁹ /L)	1.20 ^b	1.20 ^b	1.70 ^a	1.70 ^a	0.01	8-17	Siros (1995)
White blood cell (x10 ⁹ /L)	11.70 ^c	18.60 ^b	16.30 ^a	10.20 ^d	0.70	9-13	Waziri <i>et al.</i> (2010)
MCH (pg)	51.70 ^a	61.10 ^b	46.20 ^{ac}	42.30 ^c	2.30	NA	Feldman <i>et al.</i> (2002)
MCV (fl)	33.60 ^b	33.60 ^b	37.00 ^a	36.00 ^a	0.07	16-25	Feldman <i>et al.</i> (2002)
MCHC (g/dl)	14.70 ^{ac}	5.20 ^b	16.80 ^{ac}	21.70 ^c	2.80	30-36	Feldman <i>et al.</i> (2002)
Lymphocytes (%)	75.60 ^b	39.10 ^a	50.60 ^a	45.80 ^a	6.53	50-70	Feldman <i>et al.</i> (2002)
Neutrophils (%)	21.50 ^b	47.60 ^a	36.20 ^a	40.50 ^a	4.32	30-48	Feldman <i>et al.</i> (2002)
Eosinophils (%)	2.90	13.30	13.30	12.50	3.74	1-8	Feldman <i>et al.</i> (2002)

^{a,b,c} means on the same row with different superscripts differ significantly (P<0.05)

Table 4. Serum biochemical indices for WAD goats fed unripe plantain peel meal based diets

Parameters	T ₁	T ₂	T ₃	T ₄	SEM	Ref. ranges	References
Cholesterol (mg/dl)	16.00 ^a	14.70 ^{ac}	12.70 ^{ac}	7.30 ^b	1.70	80-130	Latimer (2011)
Glucose (mmol/l)	20.00	18.30	21.00	12.00	2.72	69-76	Kaneko (1997)
Total protein (g/dl)	6.80 ^b	7.70 ^a	7.50 ^a	6.50 ^b	0.15	6-7	Okoruwa & Ikhimiya (2014)
Aspartate aminotransferase (μl)	13.00	13.00	13.00	14.70	1.17	2-22	Latimer (2011)
Alanine aminotransferase (μl)	12.00	12.00	12.00	12.00	0.00	6-19	Latimer (2011)
Urea (Mg/dl)	5.10 ^b	5.50 ^a	5.40 ^a	4.80 ^c	0.11	10-20	Latimer (2011)
Creatinine (Mg/dl)	2.20 ^a	2.30 ^b	2.10 ^{ac}	2.00 ^c	0.06	1.08-1.16	Ikhimiya & Imasuen (2007)

^{a,b,c} means on the same row with different superscripts differ significantly (P<0.05)

Discussion

Performance characteristics of WAD goats

A progressive trend in feed intake, and weight gain was consistent with increase in weeks. The first four weeks recorded the lowest range of values for feed intake while the last four weeks recorded the highest values for feed intake. Such progressive increase in feed intake by goats on diets has been reported (Ajagbe *et al.*, 2020). Increasing intake of diets over time probably was a result of rumen adaptation to the quality and components of the diets. Also, feed intake varied across the experimental diets; with T₂ and T₃ recording the least and the highest overall average weekly feed intake respectively. Differences recorded in feed intake among dietary treatments could be attributed to the differences in palatability of diets due to treatment methods of each treatment. Accordingly, Ng'ambi and Keken-Momare, (1996) reported up to 37% increase in voluntary feed intake due to improved palatability resulting from molasses and urea treatment of diet. Generally, the results obtained showed that T₃ (fermented unripe plantain peel diet) and T₄ (urea treated unripe plantain peel diet) recorded the best range of values for voluntary feed intake as compared to T₁ (control diet) and T₂ (sun-dried unripe plantain peel).

Feed intake, weight gain and feed/gain ratio values (Table 2) were influenced by the different processing methods of the diets. WAD goats fed fermented unripe plantain peel diets (T₄) had better intake compared with animals fed other diets. However, the T₃ had slightly higher values for feed intake than T₄. Apart from the differences in palatability identified earlier, this trend may have resulted from better nutritive value of dietary treatments T₃ and T₄ due to treatment methods used. In support of this observation Fajemisin *et al.*, (2012) reported that adequate protein content in livestock diets and low dietary fibre enhances feed intake and digestibility. The goats fed diets T₂, T₃ and T₄ had weight gain values of 134.83 g/week, 171.17 g/week and 379.33 g/week respectively compared to 60.75g/week observed in animals fed diet T₁ (control). The weight gain per week recorded for animals fed diets T₂, T₃, and T₄ fell slightly below the range 248.85 g/week - 271.53 g/week reported by Fajemisin *et al.*, (2013) for WAD goats fed differently treated corn cob silage diets and also fall short of the range 201.25 - 386.4 g/week reported by Alli-Balogun *et al.*, (2003) for small ruminants fed cassava foliage as protein supplement. The lesser values for weight gain recorded in the present study may be due to lower nutritive value of diets used compared to those used by Alli-Balogun *et al.* (2003) and Fajemisin *et al.* (2013). In support of this, Ash and Norton (1987) reported that weight gain by goats is sensitive to protein and energy content of diets. The WAD goats fed diets T₂ and T₄ also converted their feed to flesh better than goats fed the control diet (T₁). However, the best feed/gain ratio (10.17) was observed in goats fed diet T₄, indicating the ability of urea treatments as a better treatment method for processing less nutritive feed materials.

Haematological parameters of WAD goats

The packed cell volume (PCV) for this study ranged between 24.20 % and 26.20 % which is within the range reported by Daramola *et al.* (2005) for clinically healthy goats. This indicated that the PCV was unaffected by the dietary treatments. The values are also similar to the range of values 24.98 % - 25.00 % reported by Okoruwa and Ikhimioya (2014), for goats fed elephant grass with varying levels of mixed plantain and mango peels. Packed cell volume levels in animals have been reported to drop following

infection and stress (Opara *et al.*, 2010). Packed cell volume is the percentage of blood volume filled by erythrocytes and thus, a measure of the oxygen-carrying capacity of the blood. The PCV across the entire treatments fell below the recommended range of values. However, T₃ and T₄ recorded better values than the other treatments. The higher value of PCV for animals on T₃ and T₄ might be due to improve nutrient due to treatment (processing) effect on the diet, which indicates tendency for compensating accelerated production of PCV (Opara *et al.*, 2010).

The concentration of haemoglobin is an indication of the oxygen-carrying capacity of the blood. The values reported in this study were between 7.10 g/dl and 7.90 g/dl. These values fall within the range of values 7 g/dl - 10 g/dl for clinically healthy goats (Daramola *et al.*, 2005). Olafadehan *et al.* (2014) reported that goats fed *Ficus polita* had similar haemoglobin concentration. The implication of the result in the present study is that the experimental diets were capable of supporting high oxygen carrying capacity suggesting that the inclusion of unripe plantain peel meal in the diets did not affect haemoglobin concentration. Also, haemoglobin values within this range indicate the absence of microcytic hypochromic anaemia owing to iron deficiency (Olafadehan *et al.*, 2014).

The RBC values for the current study ranged between $1.20 \times 10^9/l$ and $1.70 \times 10^9/l$. Values reported by Sirios (1995) ranged between $8-17 \times 10^{12}/l$ for clinically healthy goats. Furthermore Feldman *et al.* (2002) obtained values ranging between $8 \times 10^6/\mu l$ and $18 \times 10^6/\mu l$. The low RBC substantiates the low PCV values obtained for goat in this study. This implies that RBC production was inadequate, and there was loss or breakdown of the cells. Low RBCs count may be associated with iron deficiency, bleeding, anaemia or some vitamin deficiency (Sirios, 1995). The distribution of RBC showed RBC showed no definite distribution trend across dietary treatments. However, T₄ value was significantly the highest. This may be due to urea treatment. Red blood cell indices help in the characterization of anaemia. Thus, the RBC values obtained in the current study indicate the possibility of haemolytic anaemia and depression of erythropoiesis (Olafadehan, 2011).

The WBC values for this study ranged between $10.20 \times 10^9/l$ and $18.60 \times 10^9/l$. This range is slightly higher than the range $9 \times 10^9/l$ - $13 \times 10^9/l$ reported by Waziri *et al.* (2010) for clinically healthy goats. Furthermore, Okoruwa and Ikhimioya (2014) reported a range of $10 \times 10^9/l$ - $11 \times 10^9/l$ for goats fed elephant grass with mixed plantain and mango peels. This observation implies that feeding plantain peel meal based diets did not cause health hazard to the animals. However, T₃ and T₄ recorded significantly lower values than the other dietary treatments. This may be due to adverse effect of fermentation and urea treatment on the concentration of WBC for T₃ and T₄ respectively. This is in contrast with the findings of Okoruwa and Ikhimioya (2014) who observed no effect of dietary treatments on WBC concentration in WAD goats fed elephant grass with varying levels of combined plantain and mango peels.

Erythrocyte indices such as MCV, MCH and MCHC are useful in diagnosis of certain forms of anaemia (Pratt, 1985). The MCV for this study ranged between 33.60 fL and 37.00 fL. The range of values for the present study is higher than the range of values 16 fL - 25 fL reported by Feldman *et al.* (2002) for clinically healthy

goats. This may be due to high RBCs count also associated with minerals (iron) and nutrients (vitamins). MCH for the present study ranged between 42.30 pg and 61.10 pg across the four treatments while MCHC ranged between 5.20 g/dl and 21.70 g/dl across the four experimental diets. The range of MCHC for the current study is below the range of 30 g/dl - 36 g/dl reported by Feldman *et al.* (2002) for clinically healthy goats, and this corroborates the low value of RBC obtained. The values obtained for MCV, MCH and MCHC were significantly ($P<0.05$) different between treatments. This is in contrast with the findings of Olafadehan (2011) who reported lack of treatment effects on MCHC values of goats fed forage diets. The values of MCH were significantly different ($P<0.05$) with T_3 having the significantly highest value. Significant differences in erythrocyte indices observed among dietary treatments in this study points towards influences of treatments (processing) on the nutrient compositions of the experimental diets.

Lymphocytes, neutrophils and eosinophils for the present study recorded ranges between 39.10 % and 75.60 %, 21.50 % and 47.60 %, and 2.90 % and 13.30 %, respectively. The range of values of lymphocytes and neutrophils reported for this study is slightly higher than the range of values 50 % - 70% and 30 % - 48% reported by Feldman *et al.* (2002) ranged between 1 % and 8 % for clinically healthy goats.

Serum biochemical indices of WAD goats

Serum biochemical parameters are useful in determining pathophysiological states that help in identifying pathogenesis and causes of diseases (Solaiman *et al.*, 2010). Serum cholesterol for the current study ranged between 7.30 mg/dl and 16.00 mg/dl. This range of values is lower than the range of 80 mg/dl – 130 mg/dl reported by Latimer (2011). This may be due to some inadequacies in the nutritional content of the dietary feed. The values obtained for the current study recorded significant differences among treatments with T_3 and T_4 showing the significantly highest and lowest values respectively. This may be as a result of processing carried out on these treatment diets. According to Ng'ambi and Keken-Monare (1996) processing can reduce or improve palatability and or nutritional value of feed. Generally, the concentration of cholesterol was lower in treatment diets T_2 , T_3 and T_4 than in the control (T_1). Thus, the trend of data appeared to suggest that the inclusion of plantain peel meal in the diets decreased serum cholesterol concentration in the animals and processing tend to have even more adverse effect on cholesterol concentration. The findings of this study agree with that of Okoruwa and Ikhimiya (2014) who observed that cholesterol levels appeared to decline slightly with increasing levels of plantain peel inclusion in the diets. However, low level of cholesterol does not adversely affect the meat's suitability for human consumption.

Glucose levels for all the diets in the current study ranged between 12.00 mmol/l and 21.00 mmol/l and were higher than the range 2.78 mmol/l - 4.16 mmol/l as reported for healthy goats (Kaneko, 1997). Furthermore, a range of 69 mmol/l – 76 mg/dl was reported for goats fed varying levels of concentrates and a mixture of plantain and mango peels by Okoruwa and Ikhimiya, (2014). Glucose concentration showed significant difference among the experimental diets with T_4 having the lowest value. Urea treatment of the diet seemed to have reduced concentration of glucose. Generally, the dietary treatments seemed to have lowered glucose concentrations compared with the control diet (T_1).

The total protein values obtained in this study ranged between 6.50 g/dl and 7.70g/dl. This range of values were close to the normal range (6 g/dl -7 g/dl) reported by Okoruwa and Ikhimiya, (2014) and is comparable to the average value (7.30 g/dl) reported by Taiwo and Ogunsanmi (2003) for WAD goats. Oboh *et al.* (2011) reported that serum total protein of an animal is an indirect index for measuring the nutritional protein adequacy of the animal. Concentrate supplements provide readily fermentable carbohydrates, nitrogen and other essential nutrients, which make up for the deficient nutrients to affect the nutrients absorbed; it also changes the array of nutrients available to host tissues, which impact efficiency of nutrient absorption (Ebro *et al.*, 1998).

The value of ALT for the current study falls within the normal range (6 μ l - 19 μ l) reported by Latimer (2011) and is comparable to the average value of 5.3 reported for WAD goats by Opara *et al.* (2010).

The values of urea for the current study ranged between 4.80 mg/dl and 5.50 mg/dl across the four treatments. This range obtained is lower than the normal range 10 mg/dl - 20 mg/dl reported by Latimer (2011). The concentration of serum urea across the dietary treatments varied significantly ($P<0.05$), with T_4 having the lowest range of value for serum urea among the dietary treatments. Lower value obtained in serum urea for animals on T_4 was an indication of superiority of efficiency in utilization of nitrogen and urea recycling. This fact is however not confirmed due to the low value observed in serum total protein for animals on T_4 . Generally, the relatively low values obtained for serum urea in this study (Tambuwal *et al.*, 2002), indicated the physiological basis for the superiority of WAD goats in its digestive capacity, efficiency of nitrogen utilization, urea recycling and nitrogen conservation (Silanikove, 2010).

Values of serum creatinine obtained in this study ranged between 2.00 mg/dl and 2.30 mg/dl. This range is higher than the average value (0.94 mg/dl) for Sahel goat as reported by Waziri *et al.* (2010) and higher than the range (1.08 mg/dl - 1.16 mg/dl) reported by Ikhimiya and Imasuen (2007) for WAD goats. The values obtained in this study were significantly different ($P<0.05$) between dietary treatments. Prvulovic *et al.* (2012) reported that creatinine level in serum has direct correlation with muscle mass and kidney function in animals.

Summary, Conclusion and Recommendation

Summary

Blood is an important index of physiological and pathological changes in an organism and its primary function is to transport oxygen from respiratory organs to body cells; distributing nutrients and enzymes to cells and carrying away waste products, thereby maintaining homeostasis of the internal environment. The various functions of the blood are carried out by the individual and collective actions of its haematological and biochemical components. Therefore, haematological tests have been widely used for the diagnosis of various diseases and nutritional status of animals. The information gained from the blood parameters would substantiate the physical examination and together with veterinary history provide excellent basis for nutritional judgement.

To this end, unripe plantain peel meal based diets were used for this study. Thirty two WAD goats were divided among four dietary treatments. The treatments comprised of the control (T_1) which

contained no unripe plantain peel and T₂, T₃ and T₄ which contained sun-dried, fermented and urea treated unripe plantain peel meal respectively. The blood characteristics of WAD goats in this study indicated significant differences between the various treatments. Values obtained for haematological parameters such as haemoglobin, white blood cells, Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH), Mean Corpuscular Haemoglobin Concentration (MCHC), lymphocytes, neutrophils and eosinophils were all within the normal established ranges for healthy goats. Serum biochemical parameters such as aspartate aminotransferase, alanine aminotransferase and creatinine were also within previously reported ranges for clinically healthy goats. However, values for cholesterol, glucose, packed cell volume and red blood cells fell below the reported ranges for clinically healthy goats. Also, urea recorded a value lower than previously reported values for healthy goats but total protein was within the range of reported values for healthy goats.

Conclusion

Result obtained in this study showed that the values for most haematological parameter and serum biochemical indices compared favourably with reported values for clinically healthy goats, and therefore confirmed a good effect of using processed unripe plantain peel as alternative feedstuff for WAD goats. The differences observed in some haematological and serum biochemical indices of WAD goats on diet T₃ could be the positive effect of fermentation on palatability which may have influenced feed intake. The decrease of serum cholesterol level in WAD goats was an advantage for the treatment of cardiovascular disorders associated with hypercholesterosis. Most of the results obtained compared favourably with previously reported blood parameters for goats under conventional diets. Generally, results obtained in this study showed that T₃ (fermented UPPM) and T₄ (Urea treated UPPM) recorded the best range of values for voluntary feed intake. Therefore, processed unripe plantain peel meal can serve as an alternative feed source for WAD goats especially when supply of forages is low or as supplements during the season of scarcity.

Recommendations

From the results of this study, given the low values obtained for some blood parameters, it is recommendation that further studies be concluded on the effect of unripe plantain peel in goat diets in order to clarify any uncertainty associated with the findings of this research. However, on the basis of the findings of this study, T₃ and T₄ (fermented and urea diets) recorded the best values for feed intake, haematological and serum biochemical indices. It is therefore recommended that unripe plantain peels should be processed by fermentation or urea treatment for better utilization by WAD goats.

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