Thermophysiological Responses of West African Dwarf (WAD) Bucks Fed *Pennisetumpurpureum* and Unripe Plantain Peels.

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Target Audience: Ruminant Nutritionists, Goat Farmers,Forage Scientists.

Abstract

The study was conducted to determine the physiological responses of West African Dwarf (WAD) bucks fed Pennisetum purpureum (PP) and unripe plantain peels (UPP). Thirty 30 growingWAD bucks with average weight of 7.00 ± 0.55kg and aged between 8 and 9 months old, were allotted to three (3) dietary treatments (A, B and C) with ten bucks per treatment in a complete randomized design. The compared diets were; A (Pennisetum purpureum which served as control group), B (equal ratio of Pennisetum purpureum with unripe plantain peels) and C(unripe plantain peels). The results showed that parameters observed under thermophysiological, haematological and serum biochemical parameters were significantly (P<0.05) affected by dietary treatments with the exception of albumin and globulin. PVC (30.02± 1.36%), Hb (10.02± 0.02 g/l), RBC (11.01 ± 0.46 x 10^6/µl),MCH (9.85± 0.34 Pg), MCV (28.02± 0.58fl), MCHC (33.86± 0.39g/dl), total protein(7.20± 0.20 g/dl), triglyceride (10.59± 0.66 mg/dl) and urea (17.04± 0.02 mg/ dl) were significantly (P<0.05) highest in diet A while creatinine (1.95± 0.04 mg/dl) was highest in diet B. Rectal temperature (40.02 ± 0.02^0C), respiratory rate (18.34± 0.21 breaths/min), pulse rate (89.01±0.41 beats /mins), heat stress index (1.09± 0.03), WBC (13.02±0.45 x 10^6/µl) and cholesterol (66.88± 0.61mg/dl) were significantly (P<0.05) better in diet C. It was concluded that equal ratio of Pennisetum purpureum and unripe plantain peels has the potential to improve physiological responses in WAD bucks.

Key words: *Unripe plantain peels, thermophysiological responses, WAD bucks.*

Description of problem

Small ruminants rank second among important grazing livestock species found in Nigeria (1). This suggests the relative importance of small ruminants within the livestock economy of Nigeria. Goats are widely distributed in the tropics and sub-tropics where they play very important role in agriculture and in various social obligations (2). They constitute one of the most populous ruminants across Nigeria. They are found in houses, villages and cities where they are kept in small numbers, given less attention and reared under extensive system of management. The major supply of goats in Nigeria is still in the hands of peasant farmers who are greatly relied upon to provide enough to meet rising demands nationwide (1). Despite these assertions, goat production in Nigeriais still been plagued with many problems associated with nutrition that have resulted to an increase in demand for protein of animal origin by the populace.Optimal level of feeding has remained one of the most important factors determining the profitability of small ruminant livestock enterprise (2). This adequate level of feeding is most problematic to achieve during the dry season when forage is scare and low in nutritive value (3).

Pennisetum purpureum is a perennial tropical forage grass that is favoured by hot and humid conditions. Its yield and quality declines rapidly towards the dry season leading to a shortage in supply of good quality forage during the period (4). The high cost of conventional feeds due to stiff competition for their use by man and other livestock species has worsen the situation of inadequate and poor quality feed supply with concomitant increase in the cost of small ruminant products. These factors with others are presently threatening continued goat production in most parts of Nigeria. However the challenge to animal scientists and researchers presently is the seasonal forage deficits and high cost with erratic supply of conventional feed ingredients particularly in the dry season which normally resulted to a marked decrease in ruminants weight gain and performance.Therefore, there is need for exploitation of other feed resources as alternatives to forages and conventional feeds, if small ruminant enterprise in the country is to be sustained.

Plantain *(Musa paradisiaca*) peel is a by-product of plantain fruit and one of the alternative feed resources that is readily available and relatively cheap in Edo States, Nigeria.Its nutritive values for livestock are estimated to be similar to that of cassava peel or citrus peel (5). Unripe plantain peels have been reported to contain higher metabolisable energy than the ripe plantain pulp (6).Unripe plantain peels are rich in energy and minerals if properly harness as feeds for livestock (5). Though information is not available on the potential of unripe plantain peels to the resultant reproductive performance of ruminants, little is known about its utilization by goats.

Badru*et al* (7) reported that haematological and serum biochemical indices with heat stress index in livestock could indicate the physiological response of livestock to their nutrition. Body temperature is often measured as rectal temperature, heart rate and respiratory rate have been found to be of value in the determination of health status in livestock (7). Adaptability of livestock to stressful situations can also be determined by the same parameters (7). Blood components screening in the nutritional research can act as an essential supportive clue for more accurate and reliable diagnosis of various physiological disorders and these pictures should be comprehensively, interpreted by correlation with other nutritional parameters (8). The present study was therefore designed to assess the thermophysiological responses of West Africa Dwarf bucks fed *Pennisetum purpureum* and unripe plantain peels.

Materials and Methods

Study Location

The experiment was conducted at the Teaching and Research Farm, Ambrose Alli University, Ekpoma, Edo State, Nigeria. The study area is located within longitude 6.09^{O}E and latitude 6.42^{o}N with an average annual rainfall of about 1556mm. The mean annual minimum and maximum temperatures were about 26^{o}C and 34^{o}C respectively.

Sources and preparation of experimental diets

Experimental diets were prepared for the trial (basal and supplementary diets). *Pennisetum purpureum* and unripe plantain peels were used as basal diets. Fresh *Pennisetum purpurem* was harvested from a pasture land within the Teaching and Research Farm and were allowed to wilt over night before being chopped manually using matchet to lengths of approximately 4-5cm. Fresh unripe plantain peels were collected from a plantain MillCenter located within Ekpoma metropolis. They were chopped and immediately dried under shade for several days,before milled to obtain unripe plantain peels (UPP) meal. Concentrate supplement ingredients were purchased in Ekpoma and the formulation consisted; 78% wheat offal, 20% brewery dried grain, 0.75% lime stone, 0.5% dicalcium phosphate, 0.5% salt and 0.25% vitamin premix. Three (3) experimental diets A, B, and Cwere prepared and offered to the animals at 5% (dry matter basis) of their body weight in a ratio of 68:32 (for the diets and concentrate) respectively. Diet A which is the control is made up of 68% *Pennisetum purpureum* (PP), diet B consisted of *Pennisetum purpureum* and unripe plantain peel (34:34)% (PPUPP) and diet C was 68% unripe plantain peel.The concentrate supplement 32% (CS) was offered to all the animals.

Experimental animals and their management

Thirty (30) growing WAD buck kids, aged between 8 and 9 months with mean body weight of 7.00± 0.55kg were purchased from villages and local markets within Ekpoma. The experimental animals were randomly assigned to three dietary treatments (A, B and C) of ten animals per treatment in five replicates. The design was completely randomized design. The trial lasted for 12 weeks after a 14 – day adjustment period of animal to the experimental diets. Bucks were treated against ecto and endo parasites during the adjustment period as precautionary measure against micro-organism infections. The experimental pens were cleaned and disinfected before animals were allotted to individual pens. Diets were offered once daily at 8.00am with concentrate supplement first before basal diets were given. Water and salt lick were also provided for each animal *ad libitum.*

Thermophysiological studies of experimental animals

Rectal temperature, respiratory rate and pulse rate of the animals were measured in the morning, afternoon and eveningdaily throughout the experimental period. Rectal temperature was taken on each animal using a digital thermometer. The sensory tip was disinfected and inserted into the rectum at the display of L^0C by the thermometer (which indicated that the thermometer was set for temperature reading).This was removedafter the sound of alarm signal. The displayed body temperature was then recorded. Respiratory rate was determined by counting the number of abdominal movements per minute, while pulse rate was determined for each animal by placing the finger tips on the femoral arteries of the hind limb for one minute and read form the stopwatch. The relationship between pulse rate and respiratory rate together with their normal average values were used to derive heat stress index as reported by (20).

On the last day of the feeding trial period, animals were fasted over night and bled in the morning to avoid excessive bleeding. Two sets of blood samples were collected from fives (5) animals per treatment group, from the jugular vein using sterile disposable 10*ml* needles of 20 gauge and syringes. A set ofblood samples (5*ml*) were collected and transferred immediately into plastic tubes containinganti-coagulant ethylene diaminetetra-acetic acid (EDTA) for haematological study. Another set of blood samples (5*ml*) were collected into sterile anti- coagulant free plastic tubes for serum biochemical study.

Laboratory and statistical analysis

The proximate composition of the basal diet and concentrate supplement offered to the experimental animals were determined according to the procedures (9). Thehaemotological and serum biochemical indices were determined using the methods described (10; 11). Data generated from thermophysiological indices were subjected to analysis of variance (ANOVA) and significant differences between means were separated using the Duncan's Multiple Range Test (12).

Results and Discussion

The proximate composition of the experimental basal and concentrate supplement diets is shown in Table 1. The dry matter values of the experimental diets were quite high and varied from 90.31 to 86.24% with unripe plantain peels (UPP) being the highest and concentrate supplement (CS) the lowest.The proximate values for *Pennisetum purpureum* (PP) and unripe plantain peels (UPP) obtained in the present study fell within the range earlier reported for *Pennisetum purpureum* (PP) (13) and unripe plantain peels (UPP) (14; 15). The crude protein (CP) value (19.98%) of concentrate supplement was above the recommended range of crude protein required by ruminants for minimum growth performance. Gatem by (16) indicated 10-12% CP as moderate level for ruminant production; hence the experimental diets would provide adequate nitrogen required by rumen microbes to maximally digest the components of dietary fibre. Results on physiological parameters of West African Dwarf (WAD) bucks are shown in Table 2. Results showed no significant differences (P>0.05) between diets A and B, but diet C values were all significantly (P<0.05) highestin all the parameters considered. Rectal temperature and respiratory rate values ranged from 38.71 ± *0.*21 to 41.02 ± 0.02^{o}C and 16.95 ± 0.85 to 19.67 ± 0.21 breaths /min, respectively. The higher significant (P<0.05) value of rectal temperature was observed in animals on diet C.

Table 1: Proximate composition (% dry matter basis) of the experimental basal and concentrate supplement diets

Pennisetum Nutrient	Unripe Plantain *purpureum*(PP)	Concentrate Peels (UPP)	Supplement (CS)
Dry matter (DM)	87.65	90.31	86.24
Crude Protein (CP)	8.11	10.25	19.98
Ether extract (EE)	1.15	5.50	1.06
Crude fibre (CF)	29.55	9.05	12.06
Ash	11.95	11.25	7.95
Nitrogen free extract (NFE)	49.24	63.95	58.95

The higher temperatures observed for animals on diets B and C could probably be due to the evolution of heat in the fermentation process of unripe plantain peels (UPP).This is in agreement with the finding of (17) who earlier reported that the rumen temperature is the effect of body temperature and may be used to predict diseases or heat stress. The increase in respiratory rate as the inclusion level of UPP increased in the diets, was a clear indication that respiratory rate rises in response to the environmental temperature and evolution of heat in the fermentation process in goats and sheep in order to maintain homeostasis (8). However, the rectal temperature and respiratory rate values obtained in this findings were within the range of 38.40±0.36 to 39.30± 0.67^{0}C and 12.00± 0.01 to 20.00± 0.39 breaths/min, respectively, as earlier reported by (19, 20) for WAD goats and sheep. Pulse rate was significantly (P<0.05) influenced by dietary treatments with animals on diet C (90.01±0.41 beats/min) significantly (P<0.05) higher than diets A (85.62±0.26beats/min) and B (86.06±0.56 beats/min). This variation in pulse rate has been reported (21) to reflect the rate at which the heart pumps blood through the body, hence the pumping rate of blood in animals on diet C was higher than diets A and B. Heat stress index values 0.98±0.01, 0.99±0.08 and 1.09±0.03 were recorded for diets

A,B and C, respectively. The highest value of heat stress index obtained in animals on diet C was in consonance with high values exhibited in rectal temperature and pulse rate in animals on diet C which was an indication of heat stress. This confirms the report that rectal temperature and pulse rate are used to determine the physiological status and adaptability of domestic animals to stressful condition (8).

Table 2: Thermoregulatory parameters of West African Dwarf buck fed experimental diets

	Dietary Treatments		
	A	B	C
Parameters	(PP68%+CS32%)	(PP34%+UPP34%CS32%)	(UPP68%+CS32%)
Rectal temperature ^{o}C	38.71±0.21 ^{b}	38.98 ±0.34 ^{b}	41.02 ±0.02 ^{a}
Respiratory rate (breaths/mins)	16.95 ± 0.85^{b}	17.01±0.31^{b}	19.67±0.21^{a}
Pulse rate (beats/min)	85.62 ± 0.26^{b}	86.06± 0.56^{b}	90.01± 0.41^{a}
Heat stress index	0.98± 0.01^{b}	0.99± 0.087^{b}	1.09± 0.03^{a}

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

Table 3 presents the result for haematological parameters of WAD bucks fed experimental diets. The quality and quantity of blood are indicators in determining the health of an organism (22). Blood also acts as a pathological indicator of the whole body and hence haematological parameters are important in diagnosing the functional status of an exposed animal to suspected toxicant. Haematological parameters of most goats have been studies with the aim of establishing normal valueranges and any deviation from them may indicate a distance in the physiological process (11). The haematological parameters observed were all significantly (P<0.05) influencedby the dietary treatments. The packed cell volume (PCV) values ranged from 25.04±1.62 to 30.02±1.36% with animals on diet A being the highest (P<0.05) among the treatments. Values for PCV observed was within the range of values (25.30±1.20 to 31.30± 2.10%) earlier reported for WAD goats (23) but disagreed with the range of values (27.06±1.36 to 28.95±*i*0.76%)obtained for Sahel goats (11).The haemoglobin (Hb) concentration and Red blood cell (RBC) values were significantly (P<0.05) highest for animals on diet A(10.02± 0.02g/l and 11.01±0.46 x 10^{6} /µl), followed by diet B (9.50±1.06g/l and 10.54±0.71x10^{6}/µl) and diet C (7.68±1.86g/l and 8.33±0.31x10^{6}/µl). The Hb and RBC values in the study agreed with the Hb (7.60± 0.30 to 10,30±1.70g/l) and RBC (8.32± 0.30 to 11.80±2.80 x10^{6}/µl) values reported (23) for WAD goats. However, the comparatively high PVC, Hb and RBC values observed in animals on diets A and B compared with diet C suggested their superiority in terms of their capability of supporting high oxygen carrying capacity of the blood and absence of anaemia related diseases which might be due to iron deficiency. The mean corpuscular haemoglobin (MCH), mean corpuscular volume (MCV) and mean corpuscular haemoglobin concentration (MCHC) values differed significantly (P<0.05) across the dietary treatments with animals on diet A being significantly (P<0.05) better than diets B and C. The range of values for MCH (7.63±0.41 to 9.8±0.34pg), MCV (26.15±0.71 to 28.02± 0.58fl) andMCHC (31.96±0.51 to 33.86±0.39g/dl) were consistence with the range of values for Sahel goats earlier reported (11).

Table 3: Effects of dietary treatments on haematological and serum biochemical indices of West African Dwarf bucks

	Dietary Treatments		
Parameters	A (PP68%+CS32%)	B (PP34%+UPP34%CS32%)	C (UPP68%+CS32%)
PCV (%)	30.02 ± 1.36^a	28.62 ± 1.91^b	25.04 ± 1.62^c
Hb (g/I)	10.02 ± 0.02^a	9.50 ± 1.06^b	7.68 ± 1.86^c
RBC (x10^6/ul)	11.01 ± 0.46^a	10.54 ± 0.71^b	8.33 ± 0.31^c
MCH (Pg)	9.85 ± 0.34^a	8.02 ± 0.37^b	7.63 ± 0.41^c
MCV (FL)	28.02 ± 0.58^a	26.78 ± 0.36^b	26.15 ± 0.71^b
MCHC (G/dl)	33.86 ± 0.39^a	32.36 ± 1.01^b	31.96 ± 0.51^c
WBC (x10^6/ul)	11.21 ± 0.21^b	11.03 ± 0.35^b	13.01 ± 0.45^a
Serum biochemical indices			
Total protein (g/dl)	7.20 ± 0.20^a	6.43 ± 0.91^b	5.96 ± 0.62^c
Albumin (g/dl)	3.60 ± 0.40	3.40 ± 0.71	3.05 ± 0.10
Globulin (g/dl)	3.60 ± 0.20	3.03 ± 0.21	2.91 ± 0.46
Cholesterol (mg/dl)	55.02 ± 0.40^b	53.90 ± 0.20^c	66.88 ± 0.61^a
Creatinine (mg/dl)	1.90 ± 0.36^a	1.95 ± 0.40^a	0.93 ± 0.62^b
Triglyceride (mg/dl)	10.59 ± 0.66^a	10.24 ± 0.30^a	8.72 ± 0.43^b
Urea (mg/dl)	14.91 ± 0.02^a	15.62 ± 0.61^b	17.04 ± 0.24^c

[a,b,c]Means within the same row with different superscripts differ significantly P<0.05)

The reduction in MCH, MCV, and MCHC values at highest substitution rate of unripe plantain peels (UPP) on diet C wasvalidated by the low PVC, Hb and RBC on diet C which further reveals the possible susceptibility to disease and physiological stress on the health status of the goats studied. Previous haematological studies of nutritional efforts brought knowledge that PVC, Hb and RBC are major and reliable indicators of various sources of stress[10]. The white blood cell (WBC) did not significantly (P>0.05) differ between animals on dietsA (11.21±0.21 x10^6/µl) and B (11.03±0.35 x 10^6/µl) but diet C ($13.01±0.45x10^6/µl$) was significantly (P<0.05) higher than diets A and B. The higher value recorded on diet C might be properly be due to some haemopoietic function which might be attributed to parasitic and bacterial injection with the resultant production of adequate WBC (10). The WBC values were comparable to the range of values 9.42±1.25 to 13.08±0.65 x $10^6/µl$ for Sahel goats reported earlier (11).

The serum biochemical parameters of WAD bucks fed experimental diets is shown in Table 3. Significant differences (P<0.05) were observed for all the parameters measured except albumin and globulin. Serum total protein is important in osmotic regulation, immunity and transport of several substancesin the animal body. Total protein values of 7.20±0.20, 6.43±0.91 and 5.96± 0.56 g/dl were obtained for diets A,B and C respectively. Though no significant (P>0.05) differences were observed for albumin and globulin among dietary treatments, highest mean value were recorded on animals in diet A (3.60±0.40 and3.60±0.20g/dl), followed by diet B (3.40±0.71 and 3.30±0.21g/dl) and reduced to 3.05±0.10 and 2.91±0.46g/dl in diet C. The values obtained for total protein, albumin and globulin in the present study compared favourably with total protein: 7.30±0.20, albumin: 3.70±0.40 and globulin: 3.60±0.10g/dl for WAD goats (24).The observed decrease in trend for total protein, albumin, globulin as the level of UPP inclusion increased suggeststhat the test diet could contain some level of residual toxic substances known to diminish nutrient permeability in gut walls as well as increase excretion of endogenous protein which is subsequently passed out in feaces and so may alter protein metabolism (10). Cholesterol was significantly highest (P<0.05) in animals on diet (66.88±0.61mg/dl) compared to animals on diet A (55.02±0.40g/dl) and B (53.90±0.20mg/dl). The observed high level of cholesterol in diet C could properly be due to the involvement of the diet in altering the plasma low density lipoprotein (25). However, the combinations of PP and UPP in diet B have a reducing effect on cholesterol levels in tissue. Reducing effect is particularly helpful to humans that are very conscious of cholesterol intake (23).Serum creatinine values showed no significant differences (P<0.05) between diets A (1.90±0.36mg/dl) and B (1.95±0.40mg/dl) but diet C (0.93 ±0.62mg/dl) was significantly (P<0.05) lower than diet A or B. Triglyceride values showed a similar pattern of variation as observed for creatinine. The low creatinine and triglyceride level for animals on diet Cindicated the residual toxic substance in the diet that would have interfered with nutrient utilization thus affecting body mass function and energy metabolism as reported (24). Urea values ranged from 14.91±0.24 to 17.04±0.02mg/dl, with animals on diet C being significantly (P<0.05) higher than diets B and A. The relatively higher values obtained for serum urea on diet C compared to diets B and A indicated the physiological basis for the poor performance of the experimental animals in its nitrogen utilization and conservation (10). This fact is evident in the higher values obtained for total protein in animals on diet C.

Conclusion and Application

It was concluded that:

1. The inclusion of unripe plantain peels (UPP) to *Pennisetum purpureum* (PP) improved thermophysiological parameters of West African Dwarf (WAD) bucks.
2. When equal proportions of unripe plantain peels (UPP) and*Pennisetum purpureum* (PP) (34:34) were fed with concentrate supplement (CS) to WAD buck, improved performance was observed.

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