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PERFORMANCE CHARACTERISTICS AND NITROGEN UTILIZATION OF WEST AFRICAN DWARF GOATS FED SELECTED FORAGE SPECIES AS SUPPLEMENT TO ELEPHANT GRASS

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ABSTRACT

Feed availability all the year round is a major constraint to the expansion of ruminant production in Nigeria. Rapid decline in the quantity and quality of forages during the dry season leads to poor animal performance. The nutritive qualities of five selected forages (*Spondias mombin*, *Ageratum conyzoides*, *Calopogonium mucunoides*, *Terminalia catappa* and *Dialium guineense*) were investigated. Twenty four West African Dwarf (WAD) goats were subjected to six dietary treatments with four animals per treatment in a completely randomized design in *in vivo* experiment that lasted 84 days. All the forages were used to supplement *Pennisetum purpureum*. Performance characteristics and nitrogen utilization parameters were determined. There were significant ($p<0.05$) differences in weight gain of goats fed various diets. Goats fed *P. purpureum* + *S. mombin* had the highest weight gain (4.65 kg) while the least weight gain (1.58 kg) was observed in goats fed *P. purpureum* + *A. conyzoides*. The best feed conversion ratio (14.00) was recorded in goats fed *P. purpureum* + *S. mombin*. The highest nitrogen intake (14.77 g/d) was observed in goats fed *P. purpureum* + *S. mombin*. The study concluded that goats fed *Spondias mombin* supplemented with *Pennisetum purpureum* gave the best performance.

INTRODUCTION

Feed availability all year round has been a major constraint to the expansion of ruminant production in tropical Africa. Dry season results in a rapid decline in the quantity and quality of forages leading to low forage intake which results in poor animal performance. Adegbola (2002) reported that poor quality roughages fed to ruminants without supplementation during the dry season caused considerable weight losses and general poor performances. The browse plants provide part of the solution to the shortage of protein and other nutrients during the dry season for the supplementation of low quality forages fed by goats. Browse plants play a significant role in the eradication of food shortage most especially during the dry season and contribute to the national economy growth through the production of ruminant animals by reducing the cost of feed stuffs. The local farmers can easily integrate production of fodder trees and shrubs into the farming system and manage them without assistance from the extension agent. Browse plants are considered to be high in the production of good quality forage in terms of protein and minerals contents, palatability and digestibility (Ogunbosoye and Babayemi, 2012).

The West African Dwarf (WAD) goat is the dominant breed of small ruminants and makes up to 38% of the 38million goats found in the West African humid zone (Gall, 1996). It is well adapted to this environment and trypanotolerant. The main feed resources of this animal are native grasses, legumes that occur naturally in grasslands, tree leaves and crop residues. Generally, the feeding pattern of this animal is

characterized by the native husbandry practice whereby it scavenges for food to meet its daily nutrient requirements (Daramola *et al*., 2005).

The potentials of trees and shrubs as alternative fodder resources in ruminant nutrition have attracted the attention of researchers worldwide (El Hassan *et al*., 2000). Several indigenous and exotic browse species have been investigated and evaluated for inclusion in ruminant feeding system in Nigeria. A substantial inclusion of unconventional feed resources such as *Spondias mombin* (Hoglum), *Ageratum conyzoides* (Goat weed), *Calopogonium mucunoides* (Calopo), *Terminalia catappa (*Almond leaves) and *Dialium guineense* (Black velvet) is one of the ways of improving the utilization of low quality forages. Therefore, future hope of feeding the millions of people and safeguarding their food security will depend on the better utilization of non-conventional feed resources (Makkar, 2003).

MATERIALS AND METHODS

Location of the experiment

The experiment was carried out at the premises of Yaba College of Technology, Epe Campus, Lagos State. It is situated at latitude 6.58^{o}N and longitude 3.98^{o}E. It is 42m above the sea level along Epe Ijebu-ode road on km 16. Epe lies in lowland rain forest vegetation zone within the savanna agro-ecological zone of Southwest Nigeria (Google earth, 2016).

Experimental feed materials and sources

The five forage plants selected were harvested around the premises of the campus (Yaba College of Technology, School of Agriculture Odoragunshin Epe campus, Lagos State) and fed fresh to the animals as supplement to grass at 5% body weight as shown below:

Diet I (Control) –*Pennisetum purpureum* only (100%)

Diet II – *Spondias mombin* (40%) *and Pennisetum purpureum* (60%)

Diet III – *Ageratum conyzoides* (40%) and *Pennisetum purpureum* (60%)

Diet IV – *Calopogonium mucunoides* (40%) and *Pennisetum purpureum* (60%)

Diet V - *Terminalia catappa* (40%) and *Pennisetum purpureum* (60%)

Diet VI- *Dialium guineense* (40%) and *Pennisetum purpureum* (60%)

According to Omoniyi (2014)

Feeding and management of animals

Twenty four (24) male growing West African Dwarf bucks weighing between 11.10 – 14.20kg were randomly assigned to six dietary treatments having four replicates per diet in a completely randomized design. The pens were thoroughly washed and disinfected. Animals were de-wormed with Albendazole® 2.5% oral suspension (*Anthelmintic*) at 1ml/10kg body weight and treated against ectoparasites with Cypermethrin® Pour-on at 1ml/10 kg body weight before allotting them to individual pens. Weights of the animals were taken before the commencement of the experiment and thereafter weekly to monitor weight changes during the trial. A known quantity (40%) of selected forage plants with (60%) *Pennisetum purpureum* were offered to the animals while (100%) *Pennisetum purpureum* only was served to the control animals. Clean water was offered daily *ad libitum.* After two weeks adaptation period had been observed, leftover feed was weighed and discarded every morning. Voluntary feed intake was determined as the difference between feed offered and feed refused. The period of the experiment was 84 days (12 weeks).

Digestibility of studies

Digestibility was carried out by the total faecal and urine collection (McDonald *et al*., 1987). Three animals per treatment were weighed and transferred into individual metabolic cages for 14 days. During the last seven days, faeces and urine voided by each animal was collected; weighed and 10% was kept for analyses. To avoid ammonia losses, urine was collected into bottles

with few drops of concentrated H_2SO_4. Weights of goats were measured at the beginning and at the end of the collection period.

Urine samples were frozen while faecal samples were oven-dried at 60^oC to constant weight, ground and stored in air tight container pending analysis.

Chemical analysis

Oven dried faecal samples were analysed for their proximate compositions: crude protein, crude fibre, ether extract and ash content (AOAC, 2005) protocol. Neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) were determined (Van Soest *et al*., 1991). Cellulose and hemicellulose were calculated as differences between ADF and ADL, and NDF and ADF respectively.

Statistical analysis

All data collected were subjected to one-way Analysis of Variance (ANOVA) while significant differences among means were compared using Duncan's Multiple Range Test (SAS, 2005).

Statistical model

$Y_{ij} = \mu + T_i + {}_{ij+} \varepsilon_{ij}$

Where

Y_{ij}= observation from animal j receiving diet i

μ= population mean

T_i= mean effect of selected browse plants

ε_{ij}=Residual error

RESULTS

Performance characteristics of WAD goat fed selected forages

As revealed in Table 1, significant ($P < 0.05$) variations were observed in the parameters measured. Goats on control diet had highest significant ($P < 0.05$) total grass intake while goats on *P. purpureum + S. mombin* recorded highest ($P < 0.05$) browse intake. There was no significant variation ($P > 0.05$) was observed in the total feed intake of goats fed *P. purpureum + C. mucunoides* and *P. purpureum + S. mombin* and likewise goats fed with control diet and *P. purpureum + D. guineense* whereas the least total feed intake value (52.68) was recorded in goats fed *P. purpureum + A. conyzoides*. Diets influenced the total weight gain of the goats, significant ($P < 0.05$) highest weight gain (4.65 kg) was observed in goats fed *P. purpureum + S. mombin* while the least value of 1.58 kg was recorded in goats fed *P. purpureum + A. conyzoides*, the same trend was observed in the daily weight gain while the best feed conversion ratio (14.00) was observed in goats fed *P. purpureum + S. mombin* even though not significantly ($P > 0.05$) different in goats fed with *P. purpureum + C. mucunoides* (18.28) and *P. purpureum + T. catappa* (17.51).

Table 1: Performance characteristics of WAD goats fed selected forages

parameters	*P.purpureum* sole	*P.purpureum +D. guineense*	*P.purpureum +C. mucunoides*	*P.purpureum+ S. mombin*	*P.purpureum+ A. conyzoides*	*P.purpureum +T. catappa*	SEM
Av.total grass intake (kg)	54.94^{a}	31.73^{b}	34.35^{b}	33.79^{b}	32.40^{b}	33.57^{b}	1.73
Av.total browse intake (kg)	0.00^{d}	23.05b^{c}	26.52^{ab}	27.55^{a}	20.28^{c}	25.49^{ab}	2.01
Av. Total feed intake (kg)	54.94^{bc}	54.77^{bc}	60.87^{a}	61.34^{a}	52.68^{c}	59.07^{ab}	0.86
Av.daily grass intake (g/day)	654.02^{a}	377.68^{b}	408.93^{b}	402.23^{b}	385.71^{b}	399.67^{b}	20.63
Av.daily browse intake (g/day)	0.00^{d}	274.35^{bc}	315.71^{ab}	327.98^{a}	241.37^{c}	303.48^{ab}	23.99
Av.total daily feed intake (g/day)	654.02^{bc}	652.02b^{c}	724.64^{a}	730.21^{a}	627.08^{c}	703.15^{ab}	10.22
Av.total weight gain (kg)	2.00d^{c}	2.63^{bcd}	3.63^{abc}	4.65^{a}	1.58^{d}	3.75^{ab}	0.30
Av. Daily weight gain (g/day)	23.81^{dc}	31.25^{bcd}	43.16^{abc}	55.36^{a}	18.75^{d}	44.64^{ab}	3.53
Feed conversion ratio (FCR)	31.56^{a}	23.99^{ab}	18.28^{b}	14.00^{b}	34.23^{a}	17.51^{b}	2.08

^{a,b,c} Means along the same row with different superscripts are significantly different (P<0.05)
SEM: Standard error of mean

Nitrogen utilization of WAD goat fed selected forages

Table 2 shows the nitrogen utilization of WAD goat fed selected forages. Significant variations (P < 0.05) were observed in the values recorded in all the parameters. Animals fed *P. purpureum + S. mombin* highest (P < 0.05) value (3.53 g/d) of urinary nitrogen while no significant (P > 0.05) variations were observed in other treatments. Faecal nitrogen ranged from 1.91g/d in animal fed *P. purpureum + S. mombin* to 2.86g/d in animal fed *P. purpureum + A. conyzoides*. Nitrogen absorbed was least in animal fed *P. purpureum +A. conyzoides* while significant highest (P < 0.05) value was recorded in animal fed *P. purpureum + S. mombin* (12.86g/d). Animal fed *P. purpureum + A. conyzoides* recorded lowest nitrogen balance (6.14 g/d) while the highest value (9.91g/d) was observed in animal fed *P. purpureum +C. mucunoides*. However the highest nitrogen balance percentage (67.79%) was obtained in animal fed *P. purpureum + C. mucunoides* while the least value (53.81%) was obtained in animal fed *P.*

purpureum + A. conyzoides. Improved nitrogen digestibility percentage value (87.02%) was recorded in animal fed *P. purpureum + S. mombin* whereas lowest value (74.93%) was observed in animal fed *P. purpureum + A. conyzoides*.

Table 2: Nitrogen utilization of WAD goats fed selected forage plants

parameters	*P.purpureum* only	*P.purpureum +D. guineense*	*P.purpureum+C. mucunoides*	*P.purpureum+ S. mombin*	*P.purpureum+ A. conyzoides*	*P.purpureum +T. catappa*	SEM
Urinary Nitrogen	2.44^{b}	2.04^{b}	1.95^{b}	3.53^{a}	2.41^{b}	2.31^{b}	0.14
Faecal Nitrogen	2.49^{ab}	2.69^{ab}	2.72^{ab}	1.91^{b}	2.86^{a}	2.16^{ab}	0.12
Total Nitrogen Intake	13.10^{b}	12.60^{b}	14.58^{a}	14.77^{a}	11.41^{c}	13.29^{b}	0.27
Nitrogen Absorbed	10.61^{c}	9.91^{c}	11.86^{ab}	12.86^{a}	8.56^{d}	11.13^{bc}	0.32
Nitrogen Retention Balance	8.17^{bc}	7.87^{c}	9.91^{a}	9.33^{ab}	6.14^{d}	8.82^{abc}	0.29
Nitrogen Retention (%)	62.38^{a}	62.46^{a}	67.97^{a}	63.12^{a}	53.81^{b}	66.39^{a}	1.35
Nitrogen Digestibility (%)	80.85^{abc}	78.72^{bc}	81.40^{ab}	87.02^{a}	74.93^{c}	83.69^{ab}	1.07

a,b,c,d Means along the same row with different superscripts are significantly different (P<0.05)

SEM: Standard error of mean

DISCUSSION

Addition of browse forage to the basal diet (*P. purpureum*) significantly increased the total feed intake of goats. Highest significant total feed intake (61.34 kg) which was observed in the goats supplemented *with S. mombin* was significantly lower to the range of total feed intake of 37.40 – 53.88 kg recorded by Njidda and Ikhimioya (2010) when WAD goats were fed semi-arid browse forages. Values reported for daily feed intake (627.08 – 730.21DM kg/day) compared favourably with values (0.69 – 0.72 kg/day) reported by Omoniyi *et al*, (2012) when WAD goats were fed with urea molasses multinutrient feed blocks. Lower values of daily feed intake were also reported (174 – 217 and 259 – 271.59 g/day) by Ogungbesan *et al.* (2013) and Fajemisin *et al.* (2013) when WAD goats were

fed selected browse plants and cassava peels and when WAD bucks were fed cassava peels substituted with graded levels of *Cajanas cajan* hay respectively. Positive correlation was observed between the total feed intake and the total weight gain. High feed intake observed in the goats supplemented with *C. mucunoides* as well as those fed with *S. mombin* could be attributed to the texture of the plants, familiarity and palatability of the plants. This assumption was in line with the report of Daovy *et al.*, (2008) and Van (2006) that structure of the leaves, coarse, soft versus hard, smooth versus waxy or hairy, content of substances causing the foliage to taste or smell distinctly or morphology of the plants resulting in different bite sizes. Grovum (1988) confirmed that animals need some time to get used to a new feed and also with Provenza and Cincotta (1994) reported that conditioning influences preference of small ruminants for forages. Freer (1981) reported that intake of browse plants is affected both by their physical structure i.e. texture of the leaf and the chemical compositions. The reduction in the feed intake of the goats supplemented with *A. conyzoides* as well as those fed with *D. guineense* when compare with those on the control diet could be ascribed to the bitter taste and odour of the plants. Omoniyi (2014) attributed low preference of *T.diversifolia* to the bitter taste associated with the plant as animals had a bite and abandoned for other plants. This same observation was noticed by Fadiyimu *et al.* (2011), Okunade *et al.* (2013) and Yusuf *et al.* (2013) when WAD sheep, Red Sokoto goats and yearling cattle were fed selected browse plants in separate experiments respectively. Least daily weight gain 18.75 g/d observed in the goats fed with of *P.purpureum* + *A. conyzoides* was lower to the range of the daily weight gain (23.81 – 44.64 g/d) reported by Ajayi *et al.,* (2005).

The result of average weight gain however compared favourably with the values reported by Yeshambel and Mekuriaw (2012) when washera sheep fed mixture of lowland bamboo leaves and natural pasture grass hay at different ratios. Daily weight gain of the animals fed with *P.purpureum* + *D. guineense* compared favourably with the highest value (34.3 g/d) reported by Bamikole *et al*. (2003) when WAD goats fed (75%) *Ficus religiosa*. The improvements observed in the average final weight as well as average weight gain of the goats supplemented with *C. mucunoides* and *S. mombin* could be related to the CP content of the browse plants joined with the CP intakes of the animals. This was affirmed by Oni (2009) who reported highest weight gains of the animals fed 60% inclusion of dried cassava leaves and Yusuf (2011) that protein intake is a major determinant of ruminant performance due to increased availability of fermentable nitrogen and other nutrients required by rumen bacteria as well as the greater opportunities for some of the protein to escape rumen fermentation (by-pass protein).

The best feed conversion ratio (FCR) (14.00) observed in goats fed with *P. purpureum* + *S. mombin* was lower compared with the range of 7.56 – 8.18 reported by Wuanor *et al.* (2013) when WAD goats were fed forages and cassava processing by products. This value compared favourably with the FCR of sheep fed with *B. macaranthi* + *P. maximum* (14.25), Omoniyi (2014). The highest live weight gain and best feed conversion ratio obtained in goats fed with *P. purpureum* + *S. mombin* indicated better performance in terms of weight gain with addition of browse forages. This could as well be attributed to the tannin rich in the browse plants which prevented degradation of CP and thereby increase ruminal by pass protein which led to increased absorption of essential amino acid from small intestine and cause increase in the ruminal productivity without affecting voluntary feed intake and thus improving the efficiency of feed conversion (Oni 2009, Barry and Mc Nabb, 1999). Barry (1989) suggested that condensed tannin level at 2 - 4% of DM in the diet will increase protein flow into duodenum which ultimately will improve the protein fraction absorbed; hence animal's growth is improved. Condensed tannin has been efficient in improving

live weight gain (Wagham, *et al.*, 1999). In sheep and deer, condensed tannin has been shown to improve lambing percentages (Min *et al.*, 1999, Athanasiadou *et al.*, 2000, 2001 and Hoskin *et al.*, 2000).

Effects of the selected browse forages were observed in the nitrogen utilisation of the goats. The highest nitrogen intake in this study was obtained in goats fed with *P.purpureum+S.mombin* while the least was recorded in *P.purpureum+ A.conyzoides*. The least nitrogen intake (11.41) observed in *P.purpureum+A.conyzoides* was higher than the highest nitrogen intake of 3.19 g/d observed in WAD goats fed with Mango leaves+*P.maximum*+concentrate (Ajayi *et al*., 2005). The range of nitrogen intake observed in this study was lower to the range of 18.67 – 21.75 g/d observed in WAD goats fed with Elephant grass and different proportion of plantain and mango peels (Okoruwa *et al*., 2013). Areegbe *et al.* (2013) reported higher values of nitrogen intake values (77.51 – 80.64 g/d) in WAD sheep fed agro-industrial by-products as supplement, however, the least nitrogen intake value of 11.41 g/d observed in this study which was observed in goats fed with *P.purpureum+A.conyzoides* was higher when compare with the range (5.30 – 8.92, 7.75 – 10.16, 5.0 – 6.20, 5.80 – 8.51 g/d) reported by Aye and Adegun (2010), Adelusi (2011), Ahamefule and Elendu (2010) as well as Okah *et al.*(2012) respectively. However, the nitrogen intake values reported in this study fell within the reported values by Aderinboye *et al*. (2012) when WAD goats fed dietary monensin.

The range of urinary nitrogen observed in this study fell within the reported values by Okoruwa *et al*., 2013 except in goats fed with *P.purpureum+S.mombin* which is slightly higher than the highest value reported by the authors whereas the highest faecal nitrogen (2.86 g/day) observed in goats fed with *P.purpureum+A.conyzoides* was lower than the least value of 2.90 g/d observed in WAD goats fed with some selected browse forages (Isah *et al*., 2013) while the percentage nitrogen retained observed in this study fell within the reported values by the same author. The least percentage nitrogen retention/balance observed in animals fed *P.purpureum+A.conyzoides* could be as a result of least DM intake which led to less nitrogen intake and should excrete less nitrogen in urine, this finding was affirmed by Ibeawuchi *et al* (1993). The positive nitrogen balance values obtained in all the treatments indicated that the maintenance requirements of the experimental animals were adequately met by the rations they consumed; this could also be explained by the fact that none of the experimental animals lost weight during the study.

CONCLUSION

The following conclusions were drawn from the result of this study:

- Goats fed *P. purpureum* supplemented and wit*h C. mucunoides, S. mombin* and *T. catappa* improved the goats feed intake and weight gain. Goats fed *Spondias mombin* supplemented with *Pennisetum purpureum* gave the best performance.
- The nitrogen utilization of WAD goats was high and comparable to supplementation with *C. mucunoides, S. mombin* and *T. catappa* forages.

RECOMMENDATIONS

- Selected forages can be fed to ruminants to improve the nutrient intake and weight gain of the animals.
- *S. mombin* may be fed to ruminants due to its high tannin rich content which prevents degradation of crude protein and thereby increase the rumen by-pass protein.

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