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Effect of Combining Yam Peels with Cowpea Husk on Nitrogen Metabolism and Serum Biochemical Parameters of West African Dwarf Goats fed Guinea Grass

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Abstract
The study was conducted to investigate the effect of combining yam peels with cowpea husk on nitrogen metabolism and serum biochemical parameters of West African dwarf goats fed guinea grass. Twenty four dwarf male goats with means bodyweight of 7.00±0.25kg and aged between 7 and 8 months old were randomly assigned to three dietary treatments in a completely randomized design with eight goats per treatment. The compared diets which comprised different proportions of yam peels and cowpea husk respectively were: Diet I (65.00 and 10.00%), Diet II (60.00 and 15.00%) and Diet III (55.00 and 20.00%). Results obtained showed that Diet I was significantly ($P<0.05$) highest in serum urea (30.04mg/dl), calcium (2.06mmol/L) and phosphorous 92.43mmol/L) compared to other Diets, while Diet II was best in serum cholesterol (73.86 mg/dl). Nitrogen intake 910.00g/day), urinary nitrogen output (1.09g/day), total nitrogen output (3.38g/day), nitrogen absorbed in g/day and g/day/$BW^{0.75}$ (6.62 and 4.13), nitrogen retention and digestibility (66.20 and 77.11%), serum total protein (8.05g/dl), albumin (3.43g/dl), globulin (4.62g/l) and blood glucose (4.01mmol/L) were highest in diet III and significantly ($P<0.05$) differed from the other diets. Significant difference ($P>0.05$) did not occur in faecal nitrogen output (g/day) and serum creatinine (mg/dl). It is concluded that combination of yam peels and cowpea husk in diet III enhanced nitrogen metabolism and serum biochemical indices of dwarf goats.
Keywords: Nitrogen, serum biochemistry, yam peels, cowpea husk, goats.

Introduction

Sheep and goats form the major group of ruminants' species in livestock industry in the tropics. They are widely distributed in the tropics and sub-tropics, where they play a significant role in the nation economy. Goat is a multi-functional animal that constitute a very important part of the livelihood of livestock farmers in Nigeria (Okoruwa *et al*., 2013a). They also offers the cheapest source of domestically provides meat in the tropics because of their fecundity and low feed requirement when compare to cattle (Tsado *et al*., 2009). The potential of goat production in alleviating the problem of low animal protein intake by man in developing nations like Nigeria has long been noted by some workers (Tsado *et al*., 2009; Adeokun *et al*., 2008). Despite the world-wide importance of goats as provider of essential meat and diary products (Stella *et al*., 2007), low animal protein intake still remain one of the major human nutritional problem in Nigeria especially for the low income earners. Inadequate nutrition is one of the major factors contributing to the insufficiency in goat production. Numerous researchers' data indicated that low productivity of goats in Nigeria (Wiziri *et al*., 2010 ; Okoruwa *et al*., 2013a) is associated with problems of meeting their nutritional requirements. This is aggravated by seasonal fluctuation that affects the nutritive quality of natural pasture most especially during the dry season and the steady increase in prices of feed ingredients due to competition between man and livestock.

The use of agro-industrial by-products has been identified to contribute a vital role in the nutrition of ruminant livestock and ensure all year round availability of feeds for animals. Yam (*Dioscorea* spp) is a primary staple food for people in Nigeria. Ruminant can be fed on the yam peels obtained after processing the yam for food. Facts reported in literature shown that yam peels have high potential as energy source which when fortified with nitrogen promote positive and high performance levels in ruminants (Abara, 2011). Cowpea (*Vigna ungiculata*) husk is a potential supplementary feed for ruminant in the dry season. It is likely to have higher crude protein than yam peels and may thus improve utilization of yams peels if combine as feeds for ruminants. Okoruwa *et al*. (2013b) reported that problem of using unconventional feeds for ruminants can be minimised or tackle, if they are used at the right proportions. However, the combinations of yam peels with cowpea husk are jet to gain much attention in goat nutrition. Hence, the objective of the present study was to determine the effect of combining different levels of yam peels with cowpea husk on nitrogen metabolism and serum biochemical indices of dwarf goats.

Materials and Methods

Location Site: The experiment was carried out at the Teaching and Research Farm, Ambrose Alli University, Ekpoma, Nigeria. The mean annual rainfall of the location was about 1556mm, while the minimum and maximum temperature was about 26^0C and 34^0C respectively. The vegetation represents an interface between the tropical rainforest and the derived savannah.

Experimental Diets: Guinea grass was harvested from the pasture land within the Teaching and Research Farm premises. The guinea grass was allowed to wilt before being chopped manually to about 6 to 7cm. Yam peels and cowpea husk were collected from their processing centre within Ekpoma, sun-dried, crushed and kept in an airtight bags separately till the period of usage.

Guinea grass was fed as basal diet for all the goats while combination of yam peels and cowpea husk at various inclusion levels with concentrate supplement were used as the experimental diets. The composition of the concentrate supplement was as follows: wheat offal 12.00%, brewer's dry grain 9.00%, bone meal 1.75%, salt 1.25% and vitamin 1.00%. However, the three experimental diets that were formulated and designated were:

$$\text{Diet I} = 65.00\% \text{ yam peels} + 10.00\% \text{ cowpea husk} + 25.00\% \text{ concentrate supplement}$$

$$\text{Diet II} = 60.00\% \text{ yam peels} + 15.00\% \text{ cowpea husk} + 25.00\% \text{ concentrate supplement}$$

$$\text{Diet III} = 55.00\% \text{ yam peels} + 20.00\% \text{ cowpea husk} + 25.00\% \text{ concentrate supplement}$$

Management and Feeding of Bucks: Twenty four growing West African dwarf male goats with an average body weight of 7.00 ± 0.25kg and aged between 7 and 8 months old were used for the experiment. The goats were sourced from weekly sheep and goat market located within Ekpoma. At the commencement of the experiment the goats were given prophylactic antibiotic to fight against ecto and endo parasites while ivomec injection was administered to control micro-organism infections. The goats were housed in demarcated individual pens with concreted floor and dwarf wall.

Completely randomized design was adopted for the experiment in which the goats were divided into three treatment groups of eight goats each after balancing for weight and each group was randomly allocated to one of the three dietary treatments. The basal (guinea grass) and the experimental diets were fed to goats once daily in equal ratio of 50:50 respectively, at the rate of 5% (dry matter basis) of their body weight. The weighed experimental diets were offered every morning (8.00am) followed by the guinea grass on exhaustion of the diets. Drinking water was also provided *ad libitum*. Moreover, the feeding trial lasted for 84 days comprising of 20 day adjustment period and 14 days of metabolic study.

Nitrogen Metabolism Trial: Six goats per treatment (totalling 18) were selected and randomly allocated to individual metabolic cages designed for separate collection of faeces and urine. Nitrogen metabolism trial was carried out in the last 7 day feeding regime after 7 day adjustment period.

The quantity of feeds offered and fed refusal which represented the fraction of the quantity of the feed offered to each goat per day and the one that was not consumed were weighed daily. The weight difference between them was recorded and taken as the feed intake. Daily faecal sub-samples were weighed, oven dried, bulked together and stored until needed for analysis. 20 ml of daily urine samples from each goat were collected in sample bottles containing concentrated sulphuric acid and frozen until required for analysis.

Nitrogen absorbed by the goats were calculated as the difference between nitrogen intake and nitrogen excreted from faeces and urine, while nitrogen retention percentage were computed from nitrogen balance expressed as a percentage of nitrogen intake. Apparent nitrogen digestibility was calculated using this formula:

$$Apparent\ nitrogen\ digestibility = \frac{\text{nitrogen intake - nitrogen in faeces}}{\text{nitrogen intake}} \times \frac{100}{1}$$

Serum Biochemical Study: On the last day of an 84 day experimental feeding trial period, 5ml of blood sample was taken from all the goats through jugular venipuncture using a 10ml 20 gauge syringe. The blood sample was collected into anti-coagulant free plastic tubes and allowed to coagulate at room temperature and centrifuged for 10 minutes at 300rmp. The supernatant sera were then stored in a freezer for subsequent biochemical analysis.

Biochemical constituents of the serum samples estimated included total protein, albumin, globulin, cholesterol, creatinine, urea, glucose, calcium and phosphorous as described by Waziri *et al*. (2010).

Chemical and Statistical Analyses: AOAC (2002) methods were used for the determination of proximate composition of the experimental diets, guinea grass as well as nitrogen content of faecal and urine samples. Data obtained on nitrogen metabolism and serum biochemical parameters were analyzed using the general linear model (GLM) procedure for repeated measurement analysis of variance (ANOVA) using the software program of statistical analysis system (SAS, 2003). Statistical means were compared using Duncan Multiple Range Test (DMRT).

Results and Discussion

The proximate composition of the experimental diets and guinea grass are shown in Table 1. The dry matter of the experimental diets that ranged from 89.97% for diet 1 to 96.05% for diet III were high, implying the ability to retain more nutrients in the diets. Crude protein of diet I (12.98%), diet II (14.69%) and diet III 915.32%)

were considerably differed in values with diet III being the highest and diet I the lowest. However the values of crude protein recorded in this study satisfied the Gatemby (2002) recommendation of 10 to 12% crude protein requirement for growth performance of sheep and goats. Crude fibre that ranged from 26.54% to 38.69% in the diets increased with increasing levels of cowpea husk inclusion in the diets. Ether extract that had the highest value in diet III (3.76%) and lowest in diet I (2.93%) followed similar pattern of variation as observed with crude fibre.

Ash and nitrogen free extract that ranged from 4.03 to 5.09% and 38.20 to 52.46% respectively were varied in values and increased with increasing levels of yam peels inclusion in the diets. Moreover, the guinea grass, crude protein and crude fibre values obtained in this study were similar to the reference values of 7.95% crude protein and 31.00% crude fibre as reported by Okoruwa *et al*. (2012).

Table 1: Proximate composition (% DM basis) of the experimental diets and guinea grass.

Parameters	Diets			Guinea grass
	I	II	III	
Dry matter	89.97	94.25	96.05	68.52
Crude protein	12.98	14.69	15.32	7.04
Crude fibre	26.54	32.89	38.69	30.89
Ether extract	2.93	3.38	3.76	3.88
Ash	5.09	4.77	4.03	8.56
Nitrogen free extract	52.46	44.27	38.30	49.63

Table 2: Nitrogen metabolism of dwarf goats fed guinea grass and vary levels of yam peels with cowpea husk.

Parameters	Diets			SEM$\pm$
	I	II	III	
Nitrogen (N) intake (g/day)	6.60^c	8.14^b	10.00^a	0.82
Faecal N-output (g/day)	2.01	2.27	2.29	0.26
Urinary N-output (g/day)	0.82^b	1.04^a	1.09^a	0.09
Total N-output (g/day)	2.83^b	3.31^a	3.38^a	0.93
N-absorbed (g/day)	3.77^c	4.83^b	6.62^a	0.85
N-absorbed (g/day/BW$^{0.75}$)	2.71^c	3.26^b	4.13^a	0.41
N-retention (%)	57.12^c	59.34^b	66.20^a	1.02
Apparent N-digestibility (%)	69.55^c	72.11^b	77.11^a	0.96

$^{a,\ b,\ c}$ means within the same row with different superscripts differ significantly (P<0.05). SEM = Standard error of mean.

Table 3: Serum biochemical parameters of dwarf goats fed experimental diets.

Parameters	Diets			SEM$\pm$
	I	II	III	
Total protein (g/dl)	5.93^c	7.08^b	8.05^a	0.17
Albumin (g/dl)	2.98^b	3.16a	3.43^a	0.02
Globulin (g/dl)	2.95^c	3.92^b	4.62^a	0.06
Cholesterol (g/dl)	62.99^b	73.86^a	58.29^c	0.21
Creatinine (mg/dl)	0.98	0.92	0.88	0.01
Urea (mg/dl)	30.04^a	28.42^a	20.07^b	1.24
Glucose (mmol/L)	3.69^b	3.87^b	4.01^a	0.05
Calcium (mmol/L)	2.06^a	1.99^b	1.89^b	0.08
Phosphorous (mmol/L)	2.43^a	1.92^b	1.76^b	0.10

$^{a,\ b,\ c}$ means within the same row with different superscripts differ significantly (P<0.05). SEM = Standard error of mean.

Nitrogen metabolism of dwarf goats fed experimental diets is summarized in Table 2. All measured parameters were significantly (P<0.05) affected by the treatments except faecal nitrogen (N) – output that was not significant (P>0.05). Nitrogen (N) – intake for diet III (10.00g/day) was the highest and differed significantly (P<0.05) from diets II (8.14g/day) and I (6.60g/day). The highest N – intake for diet III cold probably due to the higher protein content of the diet compared to the protein content in diets II and I. This view is supported by Ahamefule *et al*. (2001) who earlier reported that higher protein content of diet has significant effect on N – intake of dwarf sheep. Though faecal N – output values that ranged from 2.01 to 2.29g/day were not varied significantly (P>0.05) among dietary treatments, diet III recorded the highest while diet I the lowest. Urinary N-output was significantly (P<0.05) higher in diets III (1.09g/day) and II (1.04g/day) compared with diet I (0.82g/day). The higher values found in diets III and II could be a reflection of ammonia nitrogen concentration in the rumen that depend on the quantity and solubility of the diets fed to the goats. This is in line with the reports of Ahamefule and Udo (2010) who reported that nitrogen excreted in urine would depend on urea recycling and then efficiency of utilization of ammonia produced in the rumen by microbes for microbial protein synthesis. Total N-output that was higher in diets III (3.38g/day) and II (3.31g/day) in comparison with diet I (2.83g/day) followed similar pattern of variation as observed in urinary N-output. The higher faecal and urinary N-output recorded for goats on N-output recorded for goats on diets II and III attributed to the higher total N-output obtained for diets II and III. This observation is in consonance with the established facts of Yousuf and Adeloye (2010) who reported that high protein diets promote high N-intake and consequently high faecal and urinary nitrogen. Prvulovic *et al*. (2012) also found that the addition of high protein feeds to a diet, changes the pattern of nitrogen excretion towards increasing nitrogen excretion in faeces and urine.

N-absorbed in g/day and g/day/$BW^{0.75}$ significantly (P<0.05) highest in diet III (6.62 and 4.13) followed by diet II (4.83 and 3.26) before diet I (3.77 and 2.71). The gradual increasing in trend of N-observed by goats as the inclusion levels of cowpea husk increased in the diets could be associated with the level of protein content in cowpea husk and the degree of its utilization in the diets. However, the dietary treatments in this study posted positive N-absorbed for all the experimental goats, suggesting that the protein requirement for the goats were adequately met by the diets. N-retention and N-digestibility which are the function of nitrogen ingested and digested (Ososanya *et al*., 2013) also differed significantly (P<0.05) among dietary treatments. The least N-retention and digestibility were recorded in diet I (57.12 and 6.55%). This increased significantly (P<0.05) to diet II (59.34 and 72.11%) and then to diet III (66.20 and 77.11%). N-retention and digestibility tended to improved as N-intake and consequently N-absorbed increased in the dietary treatments. This relative N-absorbed which might have been influenced by N-intake could have probably contributed in no small measured to the higher N-retention and indeed N-digestibility for the more nitrogen absorbed in diet III. Notwithstanding, the N-retention and digestibility values obtained in this study were higher than the estimated ranged values of N-retention (28.73 to 46.71%) and N-digestibility (57.26 to 65.23%) for dwarf goats as reported by Okoruwa *et al*. (2013c).

Table 3 shows the effects of dietary treatments on serum biochemical indices of dwarf goats. Serum parameters have been reported to be important in the proper maintenance of the osmotic pressure between the circulating fluid and the fluid in the tissue space so that the exchange of materials between the blood and cell could be facilitated (Isidahomen *et al*., 2012). Ikhimioya and Imasuen (2007) also found that serum proteins are important in osmotic regulation, immunity and transport of several substances in the body. Significant differences (P<0.05) were noticed in total proteins, albumin and globulin levels in the serum. Goats offered diet III (8.05, 3.43 and 4.62g/dl) were significantly highest while those fed on diet I (5.93, 2.98 and 2.95g/dl) were the least. One possible explanation for this difference in serum proteins could be the protein availability in the diets for utilization which influenced the proteins level in the serum. However, it is important to note that serum protein values obtained in this study were within the reference mean value of total protein (7.32g/dl), albumin (3.74g/dl) and globulin (3.60g/dl) according to the report of Taiwo and Ogunsanmi (2003) for normal healthy dwarf goats. Measured cholesterol levels in the serum showed significantly (P<0.05) highest values for goats on diet II (73.86mg/dl) followed by diet I (62.99mg/dl) before diet III (58.29mg/dl). The surprising highest effect of cholesterol levels in the serum for diet II could be connected with the enhanced activities of lipase enzymes in the diet that better cholesterol utilization in the digestive tract. This is partially in agreement with the research of Prvulovic *et al*. (2012) who reported that nutritional level and activities of lipase enzymes in the diet improved the activity of cholesterol level in the serum. Treatment diets did not appear to influence (P>0.05) the creatinine level in the blood serum of goats, indicating that treatment diets have no effect on this variable. This explains the effectiveness of body mass function in goats and fewer waste products in the muscle of the goats. Serum urea values of 30.04, 28.42 and 20.07mg/dl were obtained for diets I, II and III respectively. Serum urea is assumed to indicate protein breakdown. The higher significant (P<0.05) serum urea values observed in diets I and II compared with diet III indicate poor dietary protein utilisation and high level of astringent factors associated with yam peels that are known to diminish nutrient permeability in gut wall as well as increasing the excretion of endogenous protein which is subsequently passed out in the faeces and so may alter protein metabolism (Siyanbola and Amao, 2011). Thus, the utilisation of diet III in the digestive tract by goats reduced ammonium absorption and its conversion to urea that resulted in decreased urea concentration in the serum. This corroborates the relatively higher N-retention and digestibility observed for goats on diet III.

Diet III (4.01mmol/L) was significant (P<0.05) higher in blood glucose than diets II (3.87mmol/L) and I (3.69mmol/L). The higher blood glucose activity of diet III could be an indication of the characteristics of the diet that appear to supply and maintain a high and relative constant blood glucose levels in the goats. This corresponds with the findings of Stella *et al*. (2012) on dairy goats, in their research concentration of blood glucose that increased by the characteristics of the diet's nutrient. Calcium and phosphorus levels in the serum that ranged from 1.89 to 2.06mmol/L and 1.76 to 2.43 mmol/L respectively were significantly (P>0.05) not differed with diets II and III but lower than diet I. The variable intake levels of calcium and phosphorus in the diets and environmental condition might have interfered with these marked variations in the serum. However, the values of calcium and phosphorous recorded in this study were within the ranged values of 2.20 to 2.43mmol/L and 1.68 to 2.15mmol/L reported for dwarf goats by Ikhimioya and Imasuen (2007).

Conclusion

Based on the results obtained in this study, it was therefore concluded that the combination of yam peels and cowpea husk as feeds have the potential of balancing nutritional needs in terms of basal diets component for dwarf goats, most especially during the dry season. The response in nitrogen metabolism and serum biochemical indices by dwarf goats indicated that diet III was best improved in goats compared to diets I and II.

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