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Intake, digestibility and nitrogen retention of graded levels of boiled rubber seed meal fed West African dwarf bucks

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Target Audience: *Animal Scientists, Livestock Farmers and Ruminant Nutritionists*

Abstract

Intake, digestibility and nitrogen retention by West African dwarf (WAD) bucks fed various inclusion levels of boiled rubber seed meal were investigated. Four (4) growing WAD buck 0f between 9 months and 1 year with a mean weight of 8.43±0.16kg were used in this study. Four diets containing graded level of boiled rubber seed meal (0%, 10%, 20% and 30%) with brewer dried grain, palm kernel cake, cassava peels, bone meal and salt of equal part except BDG were formulated as A, B, C and D. Each buck received one of the four diets in 4X4 Latin Square designed experiment. The results revealed that chemical composition of the 4 diets were similar (P>0.05) in all the parameters, with a trend of which CP, EE and ash values increases as BRSM level increases but DM, CF, NFE and energy took reverse trend of decreasing in values as BRSM level increases. The DMI (g/d), DMI (g/d/Wkg$^{0.75}$) and DMI as %BW showed significant differences (P>0.05) among the treatment groups. The value of DMI as %BW range (4.99%-%.41%) showed that goats on the 4 diets had positive DM status. CP intake (g/d), N-intake (g/d), N-faeces (g/d), N-urine (g/d), N-absorbed (g/d), N-balance (g/d) and App. N-digestibility (%) were similar (P>0.05) among the treatment group. The metabolic faecal-N (MFN) value in all the diets were positive and similar (P>0.05) among the treatment. The value of endogenous urinary-N (g/d/Wkg0.75) (EUN) increases as the level of BRSM increases for diet B, C, and D. The biological and digestible CP values did not follow a definite pattern. However, 10% inclusion level of BRSM was better utilised by WAD buck and could be used to formulate alternative concentrate for WAD goat.

Keywords: *Rubber seed, digestibility, nutrient intake, apparent nitrogen digestibility, nitrogen balance*

Description of Problem

Severe and acute scarcity of forage materials for ruminant animal has posed serious challenge to animal producers particularly in the dry season of the year (November-March). Ruminant nutritionists have however involved in tremendous researches on nonconventional feed resources that does not have direct feeding value to human (1). Such ingredient should be less expensive when compared to the cost of conventional feedstuffs like groundnut meal/cake, beans meal/cake, soya bean cake/meal etc.

Rubber seeds are commonly available from July to December of every year, but Nigerians attach no economic important to it as a source of food for man or animal, nor has it been utilized as raw material for industry (2). In Nigeria, 185,000 hectares of rubber plantation has been estimated with seed collection of about 10,175 tonnes per year (3). This quantity of highly nutritious seeds often rots away year in year out in plantations without being utilised in any form (4). The proximate composition of boiled rubber seed is reported as: 85.4% DM, 24.60 CP, 25.13% EE, 4.47 ash, 37.40

NFE and 2.32MJ/kg gross energy (2). The cyanogenic glycosides content in rubber seed are toxic to livestock (4) particularly ruminant (5), thus posing serious thread for it being consume by ruminant animal. Processing of rubber seed by boiling has been reported to reduce hydrocyanic acid (HCN) content to zero level (2). The study therefore was to investigate the intake, digestibility, nitrogen retention and nitrogen balance of graded levels of boiled rubber seed meals by West African dwarf goats.

Materials and methods

Experimental site

The experiment was conducted at the Goat Unit of the Teaching and Research Farm of Akwa Ibom State University, Obio Akpa campus. Obio Akpa is located between latitudes 4^0 30 and $5^0$30 between longitudes $7^0$30 and 8^o00 E with annual rainfall ranging from 3500mm-5000mm and monthly average temperature range of 24^0C-30^0C under relative humidity range of 75-79% (6)

Processing of rubber seeds

Twenty five kilogrammes of raw rubber seeds were introduced into a cooking pot whose water has attained boiling temperature (100^0C) and allowed to boil for 30 minutes after which the water was decanted. The boiled seeds were sun dried for seven days, dehulled and the nuts milled as boiled rubber seed meal (BRSM).

Experimental diets:

Four experimental diets (A, B, C and D) were formulated to contain BRSM at 0%, 10%, 20% and 30% respectively with palm kernel cake, brewer dried grain, cassava peel, bone meal and salt of equal part in the four treatment diets except brewer dried grain that varies as boiled rubber meal varies (Table 1).

Table 1: Composition of Experimental diets

Ingredients	A(0%BRSM)	B(10%BRSM)	C(20%BRSM)	D(30%BRSM)
Cassava peel	30.5	30.5	30.5	30.5
BRSM	0.00	10	20	30
Brewer Dried Grain	50	40	30	20
Palm kernel cake	17	17	17	17
Bone meal	2	2	2	2
Common salt	0.5	0.5	0.5	0.5
Total	100	100	100	100
Calculated constituents				
CP	14.58	15.79	15.85	15.91
*GE (MJ/kg)	1.68	1.72	1.66	1.64

BRSM =Boiled rubber seed meal
*GE= Gross energy

Experimental animals / design

Four (4) growing West African Dwarf bucks with age range between 9 months 1year and a mean weight of 8.43±0.16 were purchased from the local goat farmers within the University environment and quarantine for fourteen days; managed intensively with ab libitum supply of clean water. They were treated with acaricide against ecto-parasite, dewormed and vaccinated against peste des petit ruminants (PPR) during the period of the quarantine. The bucks were subsequently transferred into individual metabolism cage provided with facilities for the collection of faeces and urine separately. They were fed with the four experimental diets (Table 1) in a 4x4 Latin square arrangement.

The animals received the experimental diets consecutively in 4 phases. During phase 1 which lasted for 28 days, each animal received 1 kg of an assigned diet in addition to 2kg Panicum maximum. Drinking water was freely provided for each animal daily. Daily voluntary feed intake was also determined. Total faeces and urine voided by the experimental animals were collected in the last 7 days (22-28) of this initial phase. During phases 2-4, each animal was offered each of the remaining 3 experimental diets in consecutive periods of 28 days each. The last 7 days in each of the respective phases were used as in phase 1 for total urine and faecal collection. Leftovers of diets offered to goats were collected daily, then weighed and used to determine the voluntary intake. Samples of each diet were collected and used for dry mater (DM) determination and chemical composition analysis.

Total faeces were collected in the mornings before feeding and watering, during days 22-28 of each period. The faeces were weighed fresh, dried and bulked for each animal. A sub-sample from each animal was dried in forced draft oven at 100-105^{0}C for 48 hour and used for DM determination. Another sample was dried at 60^{0}C for 48-72 hour for determination of proximate composition.

Total urine from each animal was collected daily in the morning before feeding and watering. The urine was trapped in a graduated transparent plastic container placed under each cage and to which 15ml of 25% concentrated sulphuric acid had been added to curtail volatilization of ammonia from the urine. The total volume of urine output per animal was measured and about 10% of the daily outputs were saved in numbered plastic bottles and stored in a deep freezer at - 5^{0}C. At the end of each 7–day collection period, the samples collected were subjected to analysis.

Analytical procedure

All feed and faecal samples were analysed for proximate components using AOAC (7) methods. Nitrogen in urine samples was also determined by AOAC (6) methods. The data obtained in this study were subjected to analysis of variance (ANOVA) appropriate for a 4x4 Latin square experiment (8). Significant means were separated using Duncan's Multiple Range Test (9). Gross energy in samples was calculated using the regression equation (10).

Result and Discussion

Table 2 presents nutrient intake, dry matter intake and digestibility for treatments A, B, C, and D. These parameters (DMI(g/d), DMI(Wkg$^{0.75}$) and DMI as %BW) differed ($P<0.05$) significantly between the treatment groups. The DMI range values recorded for goats in the four treatment groups showed that the bucks consumed more than 3% of their body weight which is the recommended daily DM consumption requirements for meat goat type in the tropics (11). Nitrogen intake, faecal-N, nitrogen in urine (g/d) for treatment A, B, C and D were similar ($P>0.05$), suggesting that the animal in each group consumed fairly equal amount of nitrogen in feed irrespective of differences in DMI. N-absorbed (g/d) and N-balance (g/d) were similar between the groups and followed the pattern of N-intake (g/d), N-faeces (g/d) and N-urine (g/d), increasing as the inclusion level of BRSM increases. This result is in tandem with observation (12), (13) and (14) that faecal-nitrogen increases as the nitrogen intake increase. The low and non-significant ($P<0.05$) values of N in urine obtained in this work showed that rumen micro-organisms efficiently utilized the CP in all the treatment diets of boiled rubber seed meal. The animals were in positive N-balance; indicating that their maintenance requirements were satisfied by all the diets. The values of N-absorbed and N-balance in this study were higher than the previously reported values (15) with pigeon pea seed meal and (13) with mucuna seed meal. Diets of high crude protein result in high concentration of rumen ammonia-N, which rumen microorganisms may not sufficiently utilize, and the excess ammonia is excreted through the urine (16). The urinary nitrogen values obtained in this study are lower than the values earlier reported for African yam bean (14), an indication that rumen micro-organisms effectively utilized the CP in diets containing various inclusion levels of BRSM.

The relationship between faecal nitrogen (g/kg DM) and N-intake (g/d) shown in Table 3 showed a positive correlation coefficient (r) for treatment A, B, C and D were statistically similar (P>0.05). The regression equation showed that any g/d increase in N-intake will lead to 1.13,0.40,0.93 and 0.69g/kg DM increases in faecal nitrogen in treatment A, B, C and respectively. All treatments were positive in their correlation coefficient between faecal-N and N-intake; showing that increase in N-intake leads to increase in nitrogen output. Metabolic faecal-N (MFN) for treatment B having the least value; suggests that treatment B had least faecal-N loss from metabolic process not directly from the diet. The mean MFN value obtained in this study compared favourably with the value reported earlier (17), but higher than the often quoted value (0.24gN/100gDM) for small ruminants (15).

Table 2: Dry matter, nutrient intake and digestibility of WAD goats fed various level of boiled rubber seed meal based diets.

Parameter	A	B	C	D	SEM
Mean wt(Kg)	8.41	8.44	8.48	8.34	0.16
Mean wt($WKg^{0.75}$)	4.93	4.95	4.97	4.91	0.08
DMI (g/d)	455.65[a]	435.59[b]	427.98[c]	416.43[d]	0.23
DMI per ($WKg^{0.75}$)	98.62[a]	95.34[b]	94.09[c]	92.18[d]	0.18
DMI as % BW	5.41[a]	5.16[b]	5.04[bc]	4.99[c]	0.05
CP intake (g/d)	66.07	65.60	65.91	65.88	0.17
N-intake (g/d)	10.57	10.49	10.53	10.54	0.52
N-faeces (g/d)	3.07	3.06	3.07	3.07	0.03
N-urine (g/d)	1.48	1.47	1.48	1.48	0.02
N-absorbed (g/d)	7.47	7.42	7.44	7.53	0.05
N-balance (g/d)	6.02	5.96	5.98	5.99	0.05
N-intake(g/d /$WKg^{0.75}$)	5.86	5.82	5.84	5.84	0.01
N-balance(g/d/$WKg^{0.75}$)	3.84	3.81	3.82	3.83	0.01
N-absorbed(g/d/$WK^{0.75}$)	4.51	4.49	4.50	4.54	0.01
APP.N-digestibility (%)	70.95	70.82	70.84	70.87	0.18

[a,b,c,d] means on the same row with different superscript are significantly different (P<0.05)

Table 3: Regression Analysis and Correlation Coefficient between Faecal-N (g/Kg DM) (Y) and N-Intake (g/d) in WAD goats fed various level of boiled rubber seed meal based diets.

Diets	Regression equation	Correlation Coefficient(r)	R^2	SEM	Intercept on Y-axis	MFN (g/100gDM
A	Y=8.82+1.13x	0.94	0.88	0.047	8.82	0.882
B	Y=1.17+0.40x	0.47	0.22	0.125	1.17	0.117
C	Y=6.68+0.93x	0.86	0.74	0.067	6.68	0.668
D	Y=4.19+0.69x	0.95	0.90	0.039	4.19	0.419

Y= Dependent variable (goat), X= Independent variable (boiled rubber seed)

Regression analysis and correlation coefficient between urinary-N (g/d/Wkg$^{0.75}$) (Y) and absorbed-N (g/d/Wkg$^{0.75}$) (X) in WAD bucks fed various levels of BRSM based diets is presented in Table 4. The regression equation in table 4 showed positive correlation coefficients between urinary-N (g/d/Wkg$^{0.75}$) (Y) and absorbed-N (g/d/Wkg$^{0.75}$) (X). The values were statistically (P>0.05) similar. The reliability (R^2) was low: 7.0% in treatment B and 8.0% in C and little moderately reliable, but was the same (P>0.05) in treatment A and D (12%), implying that metabolic urinary nitrogen prediction in treatment A and D has element of reliability than treatment B and C (7.0%, 8.0% respectively). The endogenous urinary-N (EUN) was least in treatment A (control) compared to treatment B, C and D. The EUN mean obtained in this study for WAD goats was however higher than the value reported as the EUN value observed within breed; and the reason may be due to urea recycling in the rumen peculiar to ruminants (17; 15; 13).

Table 4: Regression Analysis and Correlation Coefficients between Urinary Nitrogen (g/d/WKg$^{0.75}$) (Y) and Absorbed Nitrogen (g/d/WKg$^{0.75}$) (X) in WAD goats fed various level of boiled rubber seed meal based diets

Diets	Regression equation	Correlation Coefficient(r)	R^2	SEM	Intercept on Y-axis	EUN(g/d/WKg$^{0.75}$)
A	Y = 0.266 + 0.012x	0.35	0.12	0.001	0.266	0.266
B	Y = 0.290 + 0.015x	0.27	0.07	0.002	0.290	0.290
C	Y = 0.289 + 0.005x	0.29	0.08	0.001	0.289	0.289
D	Y = 0.299 + 0.006x	0.34	0.12	0.001	0.299	0.299

Y= Dependent variable (goat), X= Independent variable (boiled rubber seed)

The correlation coefficient showed no significant differences (P<0.05) among the treatment groups A-D in Table 5. The line of gradients linking faecal-N and N-intake were the indices of biological value (BV) while the absorbed-N at zero and N-balance when multiplied by 6.25 gave the digestible crude protein (DCP).

Table 5: Regression analysis and Correlation coefficients between nitrogen balance (g/day/WKg$^{0.75}$) (Y) and absorbed nitrogen (g/day/WKg$^{0.75}$) (X) in WAD goats fed various level of boiled rubber seed meal based diets.

Diets	Regression equation	Correlation coefficient(r)	R^2	SEM	N-absorbed at Zero balance	BV	DCP (g/d/WKg$^{0.75}$)
A	Y = 0.405 + 0.853x	0.56	0.31	0.037	0.405	85.3	2.53
B	Y = 0.385 + 0.793x	0.073	0.005	0.038	0.385	79.3	2.41
C	Y = 0.159 + 0.732x	0.033	0.001	0.044	0.159	73.2	0.99
D	Y = 0.282 + 0.902x	0.107	0.001	0.075	0.282	90.2	1.76

Y= Dependent variable (goat), X= Independent variable (boiled rubber seed)

The apparent digestibility coefficients percent of WAD bucks fed various levels of boiled rubber seed meal based diets is presented in Table 6. In all the parameters, digestibility decreases as BRSM inclusion level increases. The DM contents of all the diets were generously digested by goats in all the treatment groups. The highest value of recorded for diet B agrees with the assertion that DMD decreases as DMI increases and that DMD is negatively correlated with DMI (2). Crude protein showed significant difference (P>0.05) between treatment A and B, but similar (P>0.05) with treatment C and D; while treatment B was also similar (P>0.05) to treatment C and D on CP apparent digestibility coefficient. Other parameters, DM, CF, EE, NFE and energy were statistically similar (P>0.05) in their apparent digestibility coefficient among the treatment group. Treatment B (10%BRSM) with the highest values in DM, CP, NFE and energy, suggest the best utilised inclusion level of BRSM by WAD goats, when compared to A (control), C (20%BRSM) and D (30%BRSM). However, apparent N-digestibility (Table 2) values compared fairly with apparent CP digestibility coefficients (Table 6), thus suggesting that nitrogen supplied by BRSM based diets were efficiently utilised by WAD bucks in all the treatment groups.

Table 6: Apparent digestibility coefficients (%) of WAD goats fed various level of boiled rubber seed meal based diets

Parameter	A	B	C	D	SEM
DM	54.43	62.98	58.83	57.18	3.378
CP	86.50^{b}	92.81^{a}	89.80^{ab}	89.58^{ab}	1.163
CF	85.48	87.38	87.38	88.54	1.294
EE	74.50	71.31	67.90	67.88	2.310
NFE	53.06	60.20	57.65	55.38	3.066
Energy(kcal)	51.17	52.83	57.56	61.55	4.031

DM= Dry matter, CP= Crude protein, CF= Crude fibre, EE= Ether extract, NFE= Nitrogen free extract

Conclusion and Applications

This study revealed that:

1. Animals (WAD bucks) in the three boiled rubber seed meal based diets (10%, 20% and 30%) consumed a higher DMI above the 3% recommended for meat goats in the tropic.
2. Diet B that exhibited less faecal-N, less urinary-N excretion, good percentages of N-absorbed and N-balance, should therefore be a diet of interest to small ruminant animal farmers in the humid tropics.

3. BRSM based diet is hereby recommended to WAD goat farmers as an alternative feed ingredient for WAD goat production in the humid tropics.

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