

Effects of Feeding Graded Levels of *Balanitesaegyptiaca* Leaves as Supplement to Urea Treated Maize Stover on the Performance of Red Sokoto Goats

ABSTRACT

The study was conducted to evaluate the effect of feeding graded levels of *Balanitesaegyptiaca* leaf forage as supplement to urea treated maize stover on nutrient intake, weight gain, nitrogen retention and rumen parameters of Red Sokoto goats. Sixteen (16) Red Sokoto goats weighing on average 9.36 ± 0.67 Kg were used for the experiment in a completely randomised design (CRD) for a duration of ten (10) weeks. The treatments were; A (control): the basal diet (maize stover treated with 4% urea) plus 100g maize bran, B: control diet plus 100g *Balanitesaegyptiaca*, C: control diet plus 200g *Balanitesaegyptiaca* and D: control diet plus 300g *Balanitesaegyptiaca*. All animals were allowed *ad libitum* access to water and mineral lick. Supplementing urea treated maize stover with *Balanitesaegyptiaca* resulted in total dry matter (DM) intake ($p < 0.05$) from 346.53, to 420.37, 490.97 and 546.87 g/day (for treatments A, B, C and D respectively) but did not positively influence the DM intake of the basal diet. Supplementation significantly ($p < 0.05$) increased daily weight gains. Treatment D had the highest average daily weight gain (54.29g/day). All the total nutrient intake recorded were significantly influenced ($p < 0.05$) by supplementation with treatment D having the highest values. Nitrogen utilization, rumen ammonia concentration and rumen pH were significantly influenced ($p < 0.05$) by supplementation with treatment A recording the lowest values and treatment D recording the highest values. According to the finding of this study, *Balanitesaegyptiaca* supplementing urea treated maize stover with *Balanitesaegyptiaca* greatly improved the performance of the animals and thus, *Balanitesaegyptiaca* is a good protein supplement and should be utilized when feeding goats with low quality basal diets.

Key words: *Balanitesaegyptiaca*, maize stover, goats, nutrient intake, nitrogen utilization, ammonia concentration, pH.

1. INTRODUCTION

The Sokoto Red, Kano Brown or Maradi goat is probably the most widespread and well-known type in Nigeria [1]. It is the usual village goat in the northern two-thirds of the country although it is less common with transhumant pastoralists. Livestock production is an important tool in the economy of developing countries. Goats particularly play an important role in the livelihood of small scale farmers as a major component of livestock mixed farming systems, which produce meat, milk, skin, fibre, and manure to large number of low income earners [2]. Livestock farmers in developing countries are faced with various challenges that led to a considerable fall in the production of certain livestock species like goats, cattle, swine and poultry. The major problem was the high cost of production due to increased prices of locally available feed ingredients [3]. [4] also stated that the systems of small ruminant production (sheep and goats) in Nigeria are usually characterised by limitations poised by non-availability of year round feed resources due to prolonged dry season especially in the Northern part of Nigeria.

Crop residues from maize, sorghum, millet, cowpea and groundnut are important livestock feed in the West African savannah particularly during the long dry season [5]. As stated by [6], crop residues especially cereal types are characterised by low nutrient content and digestibility, and poor voluntary consumption by ruminant animals. Ruminant feeding

Comment [U1]: Write the common n

Comment [U2]: Use upper case

Comment [U3]: How did you arrive at when data was collected for eight (8) we

Comment [U4]: This sentence is hang lacks flow of idea. Merge it with the sent before it and remove unnecessary elements: Sixteen (16) Red Sokoto goats weighing 9.36 ± 0.67 Kg on average were randomly grouped into four and exposed to dietary treatments: A (control), B (100g *B. aegyptiaca*), C (200g *B. aegyptiaca*) and D (300g *B. aegyptiaca*), with each treatment having four goats and a goat formed a completely randomized design (C

Comment [U5]: Unnecessary

Comment [U6]: Upper case

Comment [U7]: Delete it. Your result table has shown significant differences across parameters. How then are you reporting significant effect? or what do you mean?

Comment [U8]: How? Make complete statements. For instance what increased decreased?

Comment [U9]: How? Make complete statements. For instance what increased decreased?

Comment [U10]: Cumbersome and unnecessary.

Comment [U11]: This sentence should be before the first one

Comment [U12]: Insert have before I

Comment [U13]: Replace was with is

Comment [U14]: Move to end of sentence

Comment [U15]: 'a' of also should be case.

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30 systems based on poor quality tropical foliages, crop residues or agro-industrial by-products,
31 in which protein is one of the first limiting factors, may require additional protein and
32 roughage to maintain an efficient rumen ecosystem that will stimulate nutrient intake and
33 improve animal performance [7].

34 Supplementation of straw based diets is often necessary as these are low in protein and
35 energy so as to meet the nutrient requirements even for maintenance [8]. Tree fodders
36 (browse plants) are important in providing nutrients to grazing ruminants in arid and semi-
37 arid environments, where feed supply are a major constraint to livestock production [9].
38 According to [10], *Balanitesaegyptiaca* is a promising economic plant for both the arid and
39 semi-arid regions of tropical Africa, the Middle East and India. It can be found in many kinds
40 of habitat, tolerating a wide variety of soil types, from sand to heavy clay, and climatic
41 moisture levels. As a multipurpose tree, *Balanitesaegyptiaca* offers food, medicines,
42 cosmetics, fodder, fuel wood and pesticides valued for subsistence living in the arid and
43 semi-arid areas where other options are few [11].

Comment [U18]: new paragraph

Comment [U19]: Write more on *Balanitesaegyptiaca*; chemical composition; previous reports on its uses as livestock feed and effects on such species

44 The study was designed to determine the dry matter and nutrient intake, weight gain,
45 nitrogen retention, rumen ammonia concentration and rumen pH in Red Sokoto goats when
46 fed graded levels of *Balanitesaegyptiaca* leaf forage as a supplement to urea treated maize
47 stover.

48 2. MATERIALS AND METHODS

49 2.1 Study Area

50 The experiment was conducted at the Teaching and Research Farm of the Department of
51 Animal Science and Range Management, ModibboAdama University of Technology Yola,
52 Adamawa state. Yola is located in the North Eastern part of Nigeria. It is situated within the
53 Savannah region and lies between latitude 9° 14' North and longitude 12° 28' East and
54 altitude of about 152m above sea level. Yola has a tropical climate marked by rainy and dry
55 seasons. Maximum temperature can reach 40°C particularly in April, while minimum
56 temperature can be as low as 18°C. Annual rainfall is less than 1000mm [12].

Comment [U20]: Use upper case

Comment [U21]: Use upper case

Comment [U22]: Report the temperature appropriately (maximum; Y1 to Y2, or Y± same with minimum)

57 2.2 Source and Preparation of Feed

58 The leaves of *Balanitesaegyptiaca* were collected around Rumde-Kila and Mayo-Ine villages
59 of Yola South Local Government Area, Adamawa state. After collection, the leaves were
60 shade-dried for 7-10 days and then stored in bags. Maize stover was obtained from farms
61 around the university area. The maize stover was chopped using a cutlass to a size of 2-
62 4cm before treatment with 4% urea for three weeks (400g of urea in 10 litres of water per 10
63 kg of stover). The treated stover was placed for 3 weeks in black polythene sheets and
64 covered with sacks. The urea treated maize stover served as the basal diet and the browse
65 leaves served as the supplement.

Comment [U23]: delete

Comment [U24]: Place after 4cm

Comment [U25]: Place after sheets

66 2.3 Experimental Animals and Their Management

67 Sixteen (16) Red Sokoto male goats weighing on average 9.36 ± 0.67 Kg were used for the
68 experiment. All the animals were treated against external and internal parasites, using
69 ivermectin and albendazole respectively. Terramycin long acting (TLA) injection was used to
70 take care of subclinical bacterial infections. The animals were confined in an individual, well
71 ventilated raised pens within a common house. The roof of the house was relatively high so
72 as to reduce heat. Proper hygiene of the house was ensured all through the period of the
73 experiment.

Comment [U26]: You may need to cite reference from which your control was from since control is supposed to be standard and are still talking about treatment of stover

Comment [U27]: Place after weighing

74 2.4 Experimental Treatments and Design

75 Four (4) treatment diets were offered in a Completely Randomized Design (CRD) with four 4
76 animals per treatment. Urea treated maize stover, mineral salt lick and water were offered
77 *ad-libitum*. The 4 treatments were:

- 78 A) Urea treated maize stover + mineral salt lick + 100g maize bran (control)
79 B) Control diet + 100g of *Balanitesaegyptiaca*

Comment [U28]: Start with the animal number, how the weight variation was handled, grouping per treatment and replicate, before talking about how they were exposed to

- 80 C) Control diet + 200g of *Balanitesaegyptiaca*
81 D) Control diet + 300g of *Balanitesaegyptiaca*

Comment [U29]: Move to 2.2

82 2.5 Experimental Procedure

83 The live weight of each animal was obtained before the commencement of the experiment.
84 The supplement was offered in the morning before the basal diet was offered. Feed refusals
85 were collected and weighed in the morning before fresh diet was offered. Salt licks and fresh
86 water were provided *ad libitum*. The goats were weighed weekly so as to determine the
87 weight gain. The experiment lasted for ten (10) weeks in which there was two (2) weeks of
88 adaptation period.

Comment [U30]: Rewrite this section sentences are careless and unconnected

89 2.6 Data Collection

90 2.6.1 Feed intake

91 Feed intake was determined by collecting and weighing the amount of leftover every
92 morning before feeding, and subtracting the refusal from the total amount of feed offered to
93 the animals.

94 2.6.2 Weight gain

95 Weight gain of each animal was determined by subtracting the initial weight of the animal
96 from the final weight of the animal. Daily weight gain was obtained by dividing total weight
97 gain by fifty six (56) days of the collection period.

Comment [U31]: Unnecessary segments and repetitions with 2.5. Merge it

98 2.6.3 Rumen liquor collection

99 Rumen liquor was collected in the last week of the experiment by restraining the animals'
100 fore and rear legs on the ground in a standing position and the fluid was collected using a
101 suction tube. The fluid was collected before feeding and four (4) hours after feeding. About
102 20ml of the fluid was drawn from the animals and transferred into the sample bottles. The pH
103 was taken by using a pocket size pH indicator strips (non-bleeding). The samples were
104 immediately taken to the laboratory for pH confirmatory test and rumen ammonia
105 concentration analysis.

Comment [U32]: Remove unnecessary in these sentences, merge some and shorten section. Explain how the rumen concentration analysis was done and the method referenced.

106 2.7 Chemical Analysis

107 The proximate composition of the experimental feeds and faeces were determined following
108 standard methods [13]. Neutral detergent fibre (NDF) and acid detergent fibre (ADF) were
109 determined by the method of [14].

Comment [U33]: You have not described how you collected faeces and how you did it.

110 2.8 Statistical Analysis

111 All data generated from the experiment were subjected to one way analysis of variance
112 (ANOVA) in a completely randomized design (CRD) according to [15]. Treatment means
113 were separated using Duncan's multiple range test (DMRT) [16].

Comment [U34]: Where you say ANOVA mention the name before inserting the number

114 3. RESULTS AND DISCUSSION

115 3.1 Proximate Composition of Experimental Diets

Comment [U35]: Diets ?

116 The result of the proximate composition of the experimental diets is shown in Table 1. The
117 DM content obtained for urea treated maize stover (91.0%) is higher than 65.47% reported
118 by [17] but lower than 95.6% reported by [18]. The DM content recorded for
119 *Balanitesaegyptiaca* (92.5%) is lower than the value 955.00 g/KgDM (95.5%) reported by
120 [19]. Maize bran DM obtained is higher than 91.5% reported by [20]. CP content for urea
121 treated maize stover (9.7%) is higher than the value (5.09%) reported by [8].
122 *Balanitesaegyptiaca* had a CP content of 11.9%, which is lower than 15.0% reported by [21].
123 The CP content of maize bran (10.3%) is similar to 10.9% reported by [20]. [22] reported a
124 CF content of 27.03%, which is similar in value (28.0%) to the CF obtained for urea treated

Comment [U36]: Change to upper case

Comment [U37]: As in U34

Comment [U38]: As in U34 and make this style. Try to make a complete sentence inserting the reference number.

125 maize stover. [23]reported 17.33% as CF for *Balanitesaegyptiaca*, which is lower than
 126 20.0% obtained. [24]reported a CF content of 31.21% for maize bran, which is much higher
 127 than 7.5% obtained.

128 Ash content obtained for urea treated maize sover (8.1%) is similar to 7.92% reported by
 129 [17]. The ash content obtained for *Balanitesaegyptiaca* (10.4%) is lower than 15.0% reported
 130 by [23]. [25]reported an ash content of 5.50% for maize bran, which is lower than 8.1%
 131 obtained. 3.6% EE content obtained for urea treated maize stover is higher than 2.15%
 132 reported by [8]. [23]reported an EE content of 6.15% for *Balanitesaegyptiaca*, which is
 133 higher than 3.3% obtained. [26]reported 82.0g/KgDM (8.2%) as EE content for maize bran,
 134 which is lower than 9.6% obtained. The NFE obtained for urea treated maize stover (41.6%)
 135 is lower than 58.69% reported by [24]. [19] reported an NFE of 581.80g/KgDM (58.18%) for
 136 *Balanitesaegyptiaca*, which is higher than 46.9% obtained. [24]reported an NFE of 44.30%
 137 for maize bran which is lower than 61.8% obtained.

138 NDF, ADF and OM contents for urea treated maize stover obtained are comparable to
 139 76.15% [17], 53.6% [18] and 93.72% [8] respectively. [27], [28] and [26] reported
 140 349g/KgDM (34.9%), 257g/KgDM (25.7%) and 103.9g/KgDM (10.39%) for NDF, ADF and
 141 OM respectively for *Balanitesaegyptiaca*, which are all comparable to the values obtained.
 142 [26]reported 189.1g/KgDM (18.91%) NDF for maize bran which is lower to the value
 143 obtained and 103.9g/KgDM (10.39%) ADF, which is higher than 9.2% obtained. [20]reported
 144 OM of 94.9% for maize bran which is similar to 95.2% obtained.

145

146 **Table 1: Chemical composition of experimental diets (%DM)**

Parameters	Urea treated Maize stover	<i>Balanites aegyptiaca</i>	Maize bran
Dry matter	91.0	92.5	94.0
Crude protein	9.7	11.9	10.3
Crude fibre	28.0	20.0	7.5
Ash	8.1	10.4	4.8
Ether extract	3.6	3.3	9.6
Nitrogen free extract	41.6	46.9	61.8
Organic matter	91.9	89.6	95.2
Neutral detergent fibre	74.4	33.8	28.6
Acid detergent fibre	52.5	26.4	9.2

147

Comment [U39]: 1.Rearrange the such that you deal with a particular m before moving to another one (for inst discussing maize bran, exhaust it before to another feedstuff).

2.You have done review of what has b reported but there is no explanation to variations or similarities.

3. As already pointed out, this sentence [28] and [26] reported 349g/KgDM 257g/KgDM (25.7%) and 103.9g/Kg (10.39%) for NDF, ADF and OM res for *Balanitesaegyptiaca*, which are comparable to the values obtained' to 140, should have the references the end of the sentence.

Comment [U40]: Are these diets? Th diets. Use the appropriate term.

Comment [U41]: Discuss clearly, wha is responsible for low fibre in this maize b

148
149

Table 2: Dry matter intake and nutrient intake (DM basis) of Red Sokoto goats offered urea treated maize stover and graded levels of *Balanitesaegyptiaca*

Parameters	Treatments				SEM
	A	B	C	D	
DMI (g/day)					
UTMS	252.53 ^a	234.33 ^b	216.13 ^c	191.10 ^d	3.01*
<i>B. aegyptiaca</i>	-	92.04 ^c	180.84 ^b	261.77 ^a	0.65*
Maize bran	94	94	94	94	
Total	346.53 ^d	420.37 ^c	490.97 ^b	546.87 ^a	2.70*
CPI (g/day)					
UTMS	24.50 ^a	22.73 ^b	20.96 ^c	18.54 ^d	0.29*
<i>B. aegyptiaca</i>	-	10.96 ^c	21.52 ^b	31.15 ^a	0.08*
Maize bran	9.68	9.68	9.68	9.68	
Total	34.18 ^d	43.37 ^c	52.16 ^b	59.37 ^a	0.26*
CFI (g/day)					
UTMS	70.71 ^a	65.61 ^b	60.52 ^c	53.51 ^d	0.84*
<i>B. aegyptiaca</i>	-	18.41 ^c	36.17 ^b	52.36 ^a	0.13*
Maize bran	7.05	7.05	7.05	7.05	
Total	77.76 ^d	91.07 ^c	103.74 ^b	112.92 ^a	0.78*
Ash (g/day)					
UTMS	20.46 ^a	18.98 ^b	17.51 ^c	15.48 ^d	0.24*
<i>B. aegyptiaca</i>	-	9.57 ^c	18.81 ^b	27.23 ^a	0.07*
Maize bran	4.51	4.51	4.51	4.51	
Total	24.97 ^d	33.06 ^c	40.83 ^b	47.22 ^a	0.21*
EEI (g/day)					
UTMS	9.09 ^a	8.44 ^b	7.78 ^c	6.88 ^d	0.11*
<i>B. aegyptiaca</i>	-	3.04 ^c	5.97 ^b	8.64 ^a	0.02*
Maize bran	9.02	9.02	9.02	9.02	
Total	18.11 ^d	20.50 ^c	22.77 ^b	24.54 ^a	0.10*
OMI (g/day)					
UTMS	232.07 ^a	215.35 ^b	198.62 ^c	175.62 ^d	2.77*
<i>B. aegyptiaca</i>	-	82.47 ^c	162.03 ^b	234.55 ^a	0.58*
Maize bran	89.49	89.49	89.49	89.49	
Total	321.56 ^d	387.31 ^c	450.14 ^b	499.66 ^a	2.48*
NDFI (g/day)					
UTMS	187.88 ^a	174.34 ^b	160.80 ^c	142.18 ^d	2.24*
<i>B. aegyptiaca</i>	-	31.11 ^c	61.13 ^b	88.48 ^a	0.22*
Maize bran	26.88	26.88	26.88	26.88	
Total	214.76 ^d	232.33 ^c	248.80 ^b	257.54 ^a	2.13*
ADFI (g/day)					
UTMS	132.57 ^a	123.03 ^b	113.47 ^c	100.33 ^d	1.58*
<i>B. aegyptiaca</i>	-	24.30 ^c	47.74 ^b	69.11 ^a	0.17*
Maize bran	8.65	8.65	8.65	8.65	
Total	141.22 ^d	155.98 ^c	169.86 ^b	178.09 ^a	1.49*

Comment [U42]: Insert p values after the tables

150 Means with different superscript in the same row differ significantly ($p < 0.05$)
 151 SEM = Standard error of mean, * = Significant at ($p < 0.05$), UTMS = Urea treated maize
 152 stover, *B. aegyptiaca* = *Balanitesaegyptiaca*, DMI = Dry matter intake, CPI = Crude protein
 153 intake, CFI = Crude fibre intake, EEI = Ether extract intake, OMI = Organic matter intake,
 154 NDFI = Neutral detergent fibre intake, ADFI = Acid detergent fibre intake.

155

3.2 Dry Matter and Nutrient Intake (DM Basis)

The stover DM intake ranged from 252.53 to 191.10 g/day. There were significant differences ($P<0.05$) between the treatments. [18] stated that the lower basal diet DM intake in high level of supplementation could be attributed to the high intake of the supplement DM as a proportion of total dry matter intake, thus preventing maximum intake of the basal feed. The total DM intake for treatments A, B, C and D were 346.53, 420.37, 490.97 and 546.87 g/day respectively. The treatments were significantly different ($P<0.05$) from each other. The progressive increase in the value of the total DM intake from treatment A-D can be attributed to the increase in the amount of the supplement consumed. [29] reported DM intake of 582.0 g/day for goats fed urea treated maize stover supplement with *Tithonia* foliage and 360 g/day for the control (urea treated maize stover), which are relatively higher than the values obtained.

Nutrient intake (DM basis) for the different treatments vary significantly ($P<0.05$). For the stover nutrient intake, treatment A had the highest intake (obviously due to the high amount of the stover consumed), followed by treatments B, C and D respectively. For *Balanitesaegyptiaca* nutrient intake, treatment D had the highest nutrient intake, followed by treatments C and B respectively. This can be attributed to the increasing levels of the supplement offered. The total nutrient intake increased with increasing level of supplementation. Thus, the trend is; treatment D was having the highest total nutrient intakes, then treatments C, B and A for all parameters measured. [8] reported 14.49 g/day as CP intake for goats fed urea sprayed maize stover, which is lower than 24.50 g/day obtained.

Comment [U43]: Sharpen the language remove redundant phrases and words.

3.3 Nitrogen Utilization and Weight Gain

Nitrogen intake has been found to increase with an increase in the inclusion of *Balanitesaegyptiaca*. There were no significant difference ($P>0.05$) between the treatments for nitrogen intake. Treatment D was having the highest nitrogen intake of 13.70 g/day which can be attributed to high total dry matter and crude protein intake. [30] reported a range of 10.87-13.85 g/day for nitrogen intake in goats fed bovine rumen content and wheat offal as supplement to groundnut haulms, which is comparable to the range of 12.25-13.70 g/day obtained. The data recorded for nitrogen in faeces (1.28-1.36 g/day) is similar to such reported by [31], which ranged from 1.42 to 1.56 g/day when pregnant West African dwarf goats were fed groundnut cake, urea and rumen epithelial wastes in cassava flour and citrus pulp-based diets. There were no significant difference ($P>0.05$) between the treatments for nitrogen in faeces. Treatment A was having the lowest nitrogen excreted in faeces (1.28 g/day) which might be attributed to the low amount of total nitrogen ingested when compared to other treatments. [32] reported mean values of 1.73 ± 0.78 and 1.74 ± 0.72 g/day for urinary nitrogen in goats fed medium protein diet amidst limited water supply (70 and 50% reduction in water supply respectively) which is comparable to the value for nitrogen in urine obtained. There were no significant differences ($P>0.05$) between the treatments for nitrogen in urine. Treatment D had the lowest urinary nitrogen (1.24 g/day), which could be attributed to high efficiency in the utilization of nitrogen. It was observed that there was an increase in nitrogen balance from treatment A (9.26 g/day) to treatment D (11.10 g/day) possibly due to an increase in total nitrogen intake and utilization. The result obtained for nitrogen balance is in agreement with the statement reported by [29] that nitrogen retention increases if protein-tannin complexes are protected from rumen degradation but released further down the digestive tract and digested. [29] reported a nitrogen balance of 4.44, 1.10 and 4.98 g/day for goat offered urea treated maize stover and supplemented with *Tithonia*, *Calliandra* and *Sesbania* foliage respectively, which are lower when compared to the values obtained. The nitrogen balance obtained (9.26-11.10 g/day) is relatively higher than 7.45-10.70 g/day reported by [30] but lower than 15.01-15.84 g/day reported by [31]. There were significant differences ($P>0.05$) between the treatments for nitrogen balance. Treatment D had the highest value (11.10 g/day).

The average daily weight gain for treatments A, B, C and D were 23.75, 36.07, 46.43 and 54.29g respectively. There were significant difference ($P<0.05$) between treatments. [8] reported an average daily weight gain of 20.9 g/day for animals in the control (4% urea treated maize stover), which is lower when compared to 23.75 g/day obtained for the control

Comment [U44]: Differences

212 in this study. For feed conversion ratio, treatment D was having the best ratio and treatment
213 A was the least which can be attributed to the absence of supplement.

214 3.4 Rumen Ammonia Concentration and pH

215 The rumen ammonia concentration levels obtained (2.41-5.78 and 3.87-6.96 mg/100ml)
216 before and after feeding respectively are similar to 2.6-7.96 mg/100ml reported by [33]. A
217 minimum ammonia-nitrogen level of 2-5 mg/100ml rumen fluid has been suggested to
218 maximize rumen microbial synthesis [34], which fell in the range of values obtained. As the
219 level of the supplement was increased, the level of rumen ammonia increased. Higher
220 rumen ammonia levels were obtained after the animals were fed. There were significant
221 differences ($P<0.05$) between the treatments observed for rumen ammonia concentration
222 both before and after feeding. Treatment D had the highest values for rumen ammonia
223 concentration both before and after feeding.

224 Rumen pH was within the optimal range of 6.0-7.0 for cellulolytic bacterial activity as
225 reported by [35]. The rumen pH was slightly affected by supplementation and it was
226 maintained within a narrower range both before and after feeding (6.14-6.78 and 7.05-7.52
227 respectively). The values were in the range of 6.14 and 7.52, which is considered optimal for
228 microbial activity and growth as observed by [36], who reported an overall pH mean of 6.7 in
229 steers fed different crude protein content of napier-based diets. [33] reported a rumen pH of
230 6.41-6.73 for goats fed mature veld hay ground with deep litter poultry manure and
231 supplemented with graded levels of poorly managed groundnut hay, which is similar to the
232 range of 6.14-6.78 obtained before the animals were fed. pH levels obtained before feeding
233 is also similar to 6.45 ± 0.34 and 6.13 ± 0.36 reported by [37] for goats fed rice straw
234 supplemented with soybean meal and soybean meal+sago meal respectively. The pH
235 values obtained before (6.14-6.78) and after (7.05-7.52) feeding are comparable to the
236 values 6.69-6.89 (before feeding) and 7.04-7.19 (after feeding) reported by [29]. There were
237 significant differences ($P<0.05$) between the treatments for rumen pH before feeding but no
238 significant difference ($P>0.05$) was observed for rumen pH after feeding. Treatment D had
239 the highest values for rumen pH both before and after feeding, which could be attributed to
240 greater microbial activity.

241 **Table 3: Nitrogen utilization and weight gain of Red sokotogoats offered graded**
242 **levels of *Balanitesaegyptiaca* and urea treated maize stover**

Parameters	Treatments				SEM
	A	B	C	D	
Nitrogen intake (g/day)	12.25 ^a	12.97 ^a	13.43 ^a	13.70 ^a	0.51 ^{NS}
Nitrogen in faeces (g/day)	1.28 ^a	1.31 ^a	1.34 ^a	1.36 ^a	0.14 ^{NS}
Nitrogen in urine (g/day)	1.71 ^a	1.60 ^a	1.53 ^a	1.24 ^a	0.16 ^{NS}
Nitrogen balance (g/day)	9.26 ^c	10.06 ^{bc}	10.56 ^{ab}	11.10 ^a	0.14 [*]
Nitrogen balance (%)	75.57	77.56	78.63	81.02	
Growth performance					
Initial live weight (Kg)	10.10	9.68	9.10	8.56	0.46
Final live weight(Kg)	11.43	11.70	11.70	11.60	0.48
Total weight gain (Kg)	1.33 ^b	2.02 ^{ab}	2.60 ^a	3.04 ^a	0.21 [*]

Comment [U45]: Sharpen the language, remove redundant phrases and words. For 'Nitrogen intake has been found to increase an increase in the inclusion of *Balanitesaegyptiaca*', the first sentence simply read: **Nitrogen intake increased** *Balanitesaegyptiaca* level increased. These redundant phrases and or words are many; unnecessarily lengthening the manuscript and boring to read.

Comment [U46]: Why incomplete?

Comment [U47]: Your initial weight v... You may not convincingly attribute variation in intake and weight gain to the effect of *Balanitesaegyptiaca* because the weight was not balanced and the difference between treatments could be significant; even appearing to be deliberately reduced.

Daily weight gain (g)	23.75 ^c	36.07 ^b	46.43 ^{ab}	54.29 ^a	3.73*
Feed conversion ratio	14.59 ^c	11.65 ^b	10.57 ^a	10.07 ^a	1.94*

Means with different superscript in the same row differ significantly ($p < 0.05$)

SEM = Standard error of mean

^{NS} = Not Significant; * = Significant at ($p < 0.05$)

Table 4: Effect of feeding graded levels of *Balanitesaegyptiaca* and urea treated maize stover on rumen ammonia concentration and rumen pH in Red Sokoto goats

Parameters		Treatments				SEM
		A	B	C	D	
Rumen ammonia (mg/100ml)	BF	2.41 ^c	4.13 ^b	5.02 ^a	5.78 ^a	0.15*
Rumen ammonia (mg/100ml)	AF	3.87 ^c	5.54 ^b	6.03 ^b	6.96 ^a	0.11*
Rumen pH	BF	6.14 ^b	6.35 ^{ab}	6.51 ^{ab}	6.78 ^b	0.15*
Rumen pH	AF	7.05 ^a	7.40 ^a	7.43 ^a	7.52 ^a	0.08 ^{NS}

Means with different superscript in the same row differ significantly ($p < 0.05$)

SEM = Standard error of mean

^{NS} = Not Significant; * = Significant at ($p < 0.05$)

BF = Before feeding; AF = (4 hours) After feeding

4. CONCLUSION

The use of *Balanitesaegyptiaca* as a supplement for urea treated maize stover greatly improve the total dry and nutrients intake, average daily gains, nitrogen utilization, rumen ammonia concentration and rumen pH. *Balanitesaegyptiaca* has the potential to be used as a protein supplement and could be utilized for supplementing cereal crop residues and low quality roughages.

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Comment [U48]: improved

Comment [U49]: utilization

Comment [U50]: the protein content of *Balanitesaegyptiaca* (11.9) is not sufficient to be called a protein supplement. You may use that phrase.

Comment [U51]: In all the references, use the journal format

Include web site where available

Majority of the references are old. Where newer ones are available, replace

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