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Research Article

Effect of Legume Fodder on Rumen Degradation of Sorghum Forages by Yankasa Sheep

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Abstract
A study was conducted to determine the proximate composition and degradability of sorghum fodder in combination with legume fodder from improved cereal and legume cultivars using Yankasa breed of sheep, in semi-arid Nigeria. The crude protein (CP), ether extract (EE) and ash components were determined using the procedure described by AOAC. Procedures described by Van Soest were used in determining the fiber fractions; acid detergent fiber (ADF) and neutral detergent fiber (NDF). *In Sacco* rumen degradation technique was used to examine the effect of legume fodder on degradability of sorghum fodder. Cultivars of groundnut (samnut23 and samnut26), cowpea (X-IITA) and sorghum (Deko) were evaluated and examined. Mixed proportions of cereal and legumes as 60:40, 50:50 and 40:60 were ruminally degraded. Results from the experiment unveiled mixture of 50:50 (Deko: samnut26) had better proximate composition, while mixture of 50:50 (Deko:X-IITA) was better in fiber composition. The Potential Degradabilities of both mixtures were 66.94% and 54.46% effectively degraded, respectively. It can be concluded that mixture of 50:50 (Deko: Samnut26) and mixture of 50:50 (Deko:X-IITA) facilitates the effective degradation of sorghum fodder. It is therefore recommended that residue from Deko, haulms from Samnut23 and Samnut26; and X-IITA be fed to sheep at 50:50 for optimal residue utilization.

Keywords: *Dual purpose legumes, Fodder, In Sacco degradability, Rumen degradation, Sheep*

Introduction

A major constraint to livestock production in Nigeria is the scarcity and fluctuation in quantity and quality of feeds supply all year round (Orskov, 1999). Large quantity of crop residues of sorghum husk, cowpea husk and groundnut haulms produced on farms in Nigeria are wasted yearly. Some are left on the farm to improve soil fertility while most of them are burnt (Williams, Rivera, and Kelly, 1997). Out of 3.8 billion metric tons of total crop residues in the world as estimated by (Lal, 2005) cereals contribute 74%, sugar crops 10%, legumes 8% and tubers and oil crops 5% and 3% respectively.

Forages from cereal crops are poor in protein which show their low quality and nutritive value (Eskandari, Gambari, and Javanmard, 2009). Groundnut and cowpea are among the economic legume crops for food and feed in mixed crop-livestock systems of the semi-arid tropics, where the pods serve as food for humans and the haulms as fodder for livestock (Larbi, *et al.* 1999; Omokanye, *et al.* 2001, Singh; Ajeigbe, Tarawali, Fernandez-Rivera & Musa, 2003). Their contribution towards human food and livestock fodder is valuable and their dual-purpose character makes them very suitable where land is becoming inadequate (Singh, *et al.*, 2003; Singh and Tarawali, 1997).

Chumpawadee, Anut and Piyanate (2007), acknowledged that factors that determine the nutritive value of ruminant feed are concentration of its chemical compositions and the rate of its digestion in the rumen. Therefore, utilization of

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the straws in complete feed depends on its nutritive value. (Venkateswarlu, Srinivas Kumar, and RaghavaRao, 2013) In order to evaluate the nutritive value of feedstuffs, various techniques have been used including *in sacco*, *in vivo* and *in vitro* techniques (Maheri-Sis et al., 2008). Their degradability also must be ascertained in order to predict which feedstuff can support productive functions in the animal, since most of these crop residues are usually poor in protein, energy, minerals and vitamins (Bogoro, 1997). Therefore, a study was carried out to examine the chemical composition and ruminal degradation characteristics of various proportions of cereal and legume mixture of different improved cultivars of cereal and legume crops using *in sacco* nylon bag technique. The nylon bag technique is an efficient method of feedstuffs evaluation and measuring the rate and extent of degradation in the rumen (Ørskov, DeBHovell and Mould 1980). The rumen degradation characteristics of crop residues are important determinations of forage quality, because they are better predictors of animal performance (Orskov, 1990).

Materials and Methods

Description of the Study Area

The study was carried out at Bayero University Kano. Kano metropolis lies between latitude 11^0N and 14^0N that extends northward to the international boundary of the Republic of Niger. It is characterized by seasonal drought and frequent change in weather conditions. Kano has a land mass of about 43000km^2, annual rainfall of 600-1000 mm, length of dry season is about 4 to 8 months (KNARDA, 2012), maximum and minimum temperature of 43 and 15.18^0C respectively. The relative humidity is between 20-40% in January and rises to about 60-80% in July/August. The area is conducive for crop cultivation and livestock rearing. Species of livestock found are cattle, sheep, goats, rabbits, donkeys, horses and poultry (Muhammad, 2008).

Sampling and Data Collection

Crop residues from sorghum (cultivar Deko), groundnut (cultivars Samnut23 and Samnut26) and cowpea (cultivar X-IITA) were evaluated using the nylon bag technique (Orskov *et al.* 1990). Samples were ground to pass through a 2.5mm sieve for the determination of *In Sacco* dry matter degradation. Two, rumen-fistulated Yankasa rams of average live weight of 25kg were used. The animals were sourced from the University Farm and supplemented with cowpea husk wheat offal, sesame offal, groundnut haulm, sorghum fodder and mineral salts in a mixed ration at 1kg per head per day. Water was provided ad-libitum.

Different combinations of the ground cereal and legume fodder (60:40, 50:50 and 40:60) for each cultivar were formed to carry out degradability studies. Three (3) g of the ground samples for each combination were weighed into nylon bags with a pore size of 41µm for incubation at 8, 16, 24, 48 and 72hours. After incubation, the bags were washed under running tap-water, shed-dried and weighed at room temperature to determine dry matter loss. The experiment was laid in completely Randomized Design (CRD).

Degradation constants were estimated using a non-linear model (Orskov and McDonald, 1979),

$y=a + b (1-e^{-ct})$

y= degradation at time t,
a= zero time intercept,
b= insoluble but fermentable fraction in time t,
c= the degradation rate constant,
a + b= the potential degradation.

Effective degradability (ED) will be estimated as $(a + b) / c(c + 0.03)$, assuming a passage rate of 0.03% per hour. The variables a, b, and c were estimated from the non-linear equation by an iterative least squares method using the solver procedure (Microsoft Excel).

Chemical Analysis

The forage samples were ground using a high speed grinder (FW80-1) to pass 1mm sieve. The crude protein (CP), ether extract (EE) and ash components were determined using the procedure described by AOAC (1999). Procedures described by Van Soest *et al.* (1991) were used in determining the fiber fractions; acid detergent fiber (ADF) and neutral detergent fiber (NDF).

Statistical Analysis

The results of the proximate composition and the potential and effective degradability were subjected to analysis of variance (ANOVA) using SAS, 2002 as the statistical package. Statistically

different means were separated using Duncan Multiple Range Test, at 5% level of significance.

Results and Discussions

Proximate Composition of Mixtures of Improved Sorghum, Groundnut and Cowpea fodder

Table 1, present the proximate composition of different combinations of sorghum fodder with different percentages of groundnut and cowpea fodder. There were significant differences ($P<0.05$) in all the treatments in terms of their dry matter, crude protein, crude fiber, ether extract, nitrogen free extract, acid detergent fiber, nutrient detergent fiber and ash contents.

For improved livestock production, no single feed component provides the required nutrients. Similarly, during feeding, animals select fractions or components of feed to meet their nutritional requirement. Feedstuffs differ in nutrient composition. Muhammad *et al.,* (2009) reported that in feeding mixtures of cereal and legume, the cereal provides the soluble carbohydrates while the legume provides protein.

From the present study, based on the critical level of 10.88% CP (1.74% N) for ruminants (NRC 1976), all mixtures examined met the requirements for ruminant production in the dry season. Also, mixtures of 50:50 of Deko and samnut26 resulted in feed with better proximate composition, while mixture of 50:50 of Deko and X-IITA provides better fiber fractions. Findings from the study of Undi, Kawonga and Musendo (2001) depicted that inclusion of less than 50% pasture legumes to maize stover improves palatability and enough to meet the maintenance requirement of sheep. This implies that the legumes contribute protein components to improve the quality of cereal as reported by Muhammad*et al*., (2009) in their study using Gamba grass and varieties of legumes for silage and Undi, Kawonga and Musendo (2001) in their study using mixtures of pasture legumes and maize stover.

Dry Matter Disappearance (DMD) of Mixtures of Improved Deko with samnut23, samnut26 and X-IITA Fodder at Different Incubation Time

Table 2, showed the %DMD of sorghum fodder combined with 40%, 50% and 60% of samnut23, samnut26 and X-IITA. %DMD of sorghum fodder was higher when combined with 40% of samnut23, 60% of samnut26 and also when combined with 60% of X-IITA. At 16hrs of incubation, similarities were observed statistically among samples. Sample D40:S60 was statistically similar with D50:G50 and D50:V50, and can be compared with other samples except for sample D60:G40. More than 50% of all the feed combinations were degraded within 48 hours of incubation. This showed that degradability of sorghum fodder could be improved with the addition of groundnut (samnut23 and samnut26) and cowpea (X-IITA) fodder.

Going by the degradation rate recommended by FAO, (1986) of 40% to 50% a 48 hours incubation time, all the treatments (mixtures) except D60:G40 began to attain degradation within 24 hours. All the mixtures were highly degraded at 48 hours and 72 hours of incubation. More than 50% of all the mixtures were degraded within 48 hours. This showed that they had good forage quality and can be used as feed for livestock (Larbi *et al.*, 1999). The mean DMD was also similar with the report of Oni *et al.*, (2008) who recorded 69.39% for crop residues. The values were also similar to report by Audu, (2015) who recorded 57.00%-66.0% and 48.40% - 58.60% for inoculated and non-inoculated soyabean residue at 48 hours incubation. The mean DMD obtained was also similar with the report of Musa, (2016); (48.67%-64.67) for the mixture of late maturing sorghum and groundnut genotypes at 48hours incubation time.

Degradation Parameters of Mixtures of Deko, Samnut23, Samnut26 and X-IITA fodder

The potential degradability (PD) parameters of the mixtures from improved sorghum, groundnut and cowpea cultivars were recorded in Table 3. There were significant differences ($P<0.05$) between the treatments in ED and (a- zero time intercept) and (b-the insoluble but fermentable fraction in time t) fractions, while no significant difference ($P<0.05$)

in PD and degradation rate constant (c). The Values obtained for water soluble (a) fraction ranged from 10.67 to 18.73 while that obtained for the insoluble but fermentable fraction (b) ranged from 41.18% to 80.58%. The PD values obtained ranged from 57.18% to 96.86%, while ED values were from 36.40% to 41.33%. Values obtained for the degradation rate constant (c) for all the treatments ranged from 0.024 to 0.055.

The PD estimated from the constants generated using Orskov equation indicated that all the feed combinations were above the 40% minimum recommendation of FAO, (1986). The degradation parameters, PD and ED values were in agreement with the report of Larbi *et al*., (1999) Furthermore, diet from mixtures of 50:50 Deko and Samnut26 and 50:50 Deko and X-IITA had PD of 66.31% and 57.18% respectively. The estimated ED indicated that the PD for mixture of 50:50 Deko and Samnut26 was 82.02% effectively degraded, while the PD for mixture of 50:50 Deko and X-IITA was 54.46% effectively degraded. This indicated that 50% inclusion of legume (groundnut; Samnut26 and Cowpea; X-IITA) will give a feed with better nutrient content. It is not in agreement with Muhammad*et al.*, (2009), who recommended 40% inclusion of legume to improve the ensiling quality of Gamba grass at full bloom stage of maturity. This may be as a result of the decline in nutrient content in crop residues due to plant maturity and dryness, whereby some nutrients sink or escaped. Thus, the addition of more crop residues will bridge the gap in order to meet the nutritional requirement of animals. Moreover, Ajeigbe *et al*, 2011 recommended the inclusion of 300g-500g of legume per head per day in feeding sheep with cereal residues, to minimize wastage and improve performance.

Conclusion

The study concluded that mixture of 50:50 (Deko: Samnut26) had better proximate composition, while mixture of 50:50 (Deko: X-IITA) was better in fiber composition. Also, the Potential Degradabilities of both mixtures were 66.94% and 54.46% effectively degraded, respectively.

Recommendations

Addition of 50% of groundnut or cowpea fodder in combination with sorghum fodder is recommended to be used as feed for ruminant animals. This is in order to enhance the degradation and effective utilization of residues from sorghum for better animals' performance.

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Table 1. Proximate composition and fiber fractions of different combinations of sorghum, groundnut and cowpea fodder

Parameters (%)								
Treatments	ASH	DM	CP	CF	EE	NFE	ADF	NDF
D60:G40	3.58^{b}	98.13^{c}	19.14^{c}	17.14^{b}	1.39^{c}	58.77^{bc}	36.00^{bc}	45.50^{de}
D50:G50	3.30^{b}	98.43^{b}	20.23^{bc}	15.29^{f}	1.45^{ab}	59.74^{bc}	38.50^{a}	47.50^{c}
D40:G60	3.45^{b}	98.55^{a}	21.88^{b}	15.24^{f}	1.44^{b}	57.99^{cd}	35.50^{bc}	45.50^{de}
D60:S40	4.25^{a}	98.65^{a}	21.33^{b}	16.13^{d}	1.46^{ab}	56.83^{de}	36.50^{abc}	46.50^{cd}
D50:S50	2.40^{c}	98.63^{a}	24.61^{a}	17.31^{a}	1.45^{ab}	54.24^{f}	35.00^{c}	44.50^{e}
D40:S60	2.45^{c}	98.60^{a}	23.78^{a}	16.43^{c}	1.45^{ab}	55.90^{ef}	37.50^{ab}	49.50^{b}
D60:V40	1.25^{d}	96.78^{d}	21.33^{b}	16.02^{d}	1.47^{a}	59.94^{a}	34.50^{a}	46.50^{cd}
D50:V50	1.08^{d}	96.68^{d}	19.14^{c}	15.82^{e}	1.46^{ab}	62.52^{a}	37.50^{ab}	51.50^{a}
D40:V60	1.25^{d}	96.80^{d}	20.23^{bc}	17.26^{ab}	1.46^{ab}	59.71^{bc}	35.00^{c}	47.50^{c}

a,b,c,d,e,f =Means within column with different superscripts differ significantly (P<0.05). DM = Dry Matter, CP = Crude Protein, CF = Crude Fiber, EE = Ether extract, NFE = Nitrogen free extract, ADF = Acid detergent fiber, NDF = Neutral detergent fiber, D= sorghum cultivar (Deko), G=groundnut cultivar (samnut23), S=groundnut cultivar (samnut26), V=cowpea cultivar (X-IITA).

Table 2. Dry Matter Disappearance (DMD) of Mixtures of Improved Deko with samnut23, samnut26, and X-IITA Fodder at Different Incubation Time

		Incubation time(hrs)				
Treatments	0	8	16	24	48	72
D60:G40	16.10	18.33^{c}	42.13^{a}	44.10	62.54^{a}	64.77^{ab}
D50:G50	16.13	29.43^{a}	34.13^{bdc}	44.90	56.07^{ab}	61.47^{ab}
D40:G60	13.90	21.03^{c}	37.27^{ab}	49.10	57.10^{ab}	55.90^{b}
D60:S40	16.10	28.53^{ab}	27.00^{d}	38.60	56.01^{ab}	57.40^{b}
D50:S50	15.73	12.37^{d}	35.67^{abc}	43.73	54.34^{b}	56.77^{b}
D40:S60	14.53	24.37^{abc}	32.10^{bdc}	40.80	51.98^{b}	58.30^{b}
D60:V40	20.03	27.33^{ab}	28.30^{dc}	44.97	52.34^{b}	55.43^{b}
D50:V50	18.97	22.70^{bc}	32.73^{bdc}	42.63	56.00^{ab}	49.47^{b}
D40:V60	16.53	22.57^{c}	28.30^{dc}	42.90	56.46^{ab}	75.24^{a}

a,b,c,d,=Means within column with different letter superscript differ significantly (P<0.05). D=deko sorghum cultivar, G=samnut23 (groundnut), S= samnut26 (groundnut), V =X-IITA (cowpea)

Table 3. Degradation Parameters of the Mixtures of Improved Deko, Samnut23, Samnut26 and X-IITA Fodder (%)

Treatments	A	B	C	PD	ED
D60:G40	12.78^{bc}	60.72	0.033^{ab}	73.50	41.33^{a}
D50:G50	16.28^{ab}	52.82	0.030^{ab}	69.10	40.36^{ab}
D40:G60	11.80^{bc}	53.39	0.055^{a}	65.19	39.05^{ab}
D60:S40	16.28^{ab}	80.58	0.024^{b}	96.86	37.27^{ab}
D50:S50	10.67^{c}	55.64	0.035^{ab}	66.31	36.43^{ab}
D40:S60	14.21^{abc}	50.30	0.029^{ab}	64.52	37.01^{ab}
D60:V40	18.73^{a}	44.39	0.028^{ab}	63.12	38.08^{ab}
D50:V50	16.00^{b}	41.18	0.042^{ab}	57.18	37.02^{ab}
D40:V60	14.86^{abc}	52.93	0.027^{b}	67.79	36.40^{b}

a,b,c,=Means within column with different letter superscript differ significantly (P<0.05). a=water soluble fraction, b=insoluble but fermentable fraction at time t, PD= potential degradability, c=degradation rate constant, ED=effective degradability D=deko sorghum cultivar, G=samnut23 (groundnut), S= samnut26 (groundnut), V =X-IITA (cowpea)