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UTILIZATION OF STOVER FROM SIX IMPROVED DUAL-PURPOSE GROUNDNUT(*ARACHIS HYPOGAEA* L.) CULTIVARS BY WEST AFRICAN DWARF SHEEP

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ABSTRACT

The study was set up to evaluate fodder from six dual-purpose groundnut (*Arachis hypogaea* L.) cultivars for animal performance and rumen dry matter (DM) degradability characteristics. Thirty-six West African dwarf (WAD) sheep were used to evaluate the utilization of groundnut stover from six improved dual-purpose cultivars (M170-80I; M554-76; M572-80I; RMP-12; UGA-2; UGA-5) as sole diets over 70 d. Rumen DM degradability characteristics were studied using four WAD sheep in a completely randomized design. Dry matter, crude protein (CP), neutral detergent fibre (NDF), acid detergent fibre (ADF), acid detergent lignin (ADL) and metabolisable energy (ME) contents were similar while, cultivar RMP-12 recorded the highest (P < 0.05) hemicellulose (64 g/kg DM and cellulose (396 g/kg DM) contents. Organic matter (58.1 to 71.9 g/kg metabolic weight ($W^{0.75}$)/d) and NDF (32 to 41 g/kg $W^{0.75}$/d) intake were significantly different (P < 0.05). The digestibility of DM (508 to 623 g/kg DM), OM (498 to 626 g/kg DM) and CP (488 to 588 g/kg DM) differed (P < 0.05). Similarly, NDF digestibility (488 to 635 g/kg DM) and ADF digestibility (406 to 572 g/kg DM) were significantly different (P < 0.05). Nitrogen balance (3.0±0.98 g/d) was similar (P > 0.05) among cultivars, whereas available protein ranged (P < 0.05) from 2.5 g d^{-1} for RMP-12 to 29.0 g d^{-1} for M170-80I. Liveweight changes (LWC) varied between 6 g/d weight loss by sheep on UGA-2 fodder and 46 g/d in M170-80I. Soluble fraction (***a***) differed significantly (P < 0.05) ranging between 197 and 351 g/kg DM, while degradable fraction (***b***) and rate of degradation of ***b*** (***c***) were not significantly different. The 48-h degradation (501 to 596 g/kg DM), potential degradability; ***PD*** (584 to 687 g/kg DM) and effective degradability; ***ED*** (415 to 489 g/kg DM) varied (P < 0.05). Groundnut stover could be fed as sole diets or supplements to WAD sheep, and the cultivars ranked in decreasing order of stover quality as: M170-80I > UGA-5 > M572-80I = UGA-2 > 50 RMP-12 > M554-76. While sole-feeding groundnut has been illustrated to result in improved weight gain in WAD sheep, it might also be economical to use the fodder as a supplement.

Key words: Cultivar, degradability, feed value, sheep

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INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is a cash crop cultivated in Nigeria and other parts of sub-Saharan Africa where the stover also serves as an excellent source of feed during the dry season. Plant breeders have always tried to develop groundnut cultivars that differ in fodder and grain yields to meet specific production targets [1]. However, such groundnut improvement programmes mostly focus on higher grain/pod yields, pest/disease resistance, and water stress tolerance while crop residue quality is rarely a priority [2, 3]. A study on 38 groundnut cultivars identified the six cultivars used in the present study as capable of producing appreciable quantities of both grains (peanuts) and hay (crop residues) with promising fodder quality [4, 5]. On-farm feed and forage yields studies conducted using three improved groundnut varieties and a local variety led to the conclusion that the improved varieties were better than the local varieties with respect to all the parameters assessed [6]. In a related study, it was shown that groundnut forage contained sufficient concentration of nutrients to support livestock production during the critical periods of the farming season, with the improved cultivars out-performing the local (control) cultivar [7].

In the past, most feeding trials on groundnut hay have focused on supplemented diets with only a few on sole feeding or comparing several cultivars [8, 9]. Other studies have indicated that groundnut hay could meet the maintenance energy requirements of adult goats even at increasing levels of dietary inclusion [10, 11]. Results from animal fattening studies in Nigeria have indicated that animals fed chopped haulms gained more weight compared to those fed unchopped haulms [12]. However, forage quality is best defined in terms of animal output when fed alone [13]. It has been shown that the feed value of a crop depends on the biomass produced, voluntary intake, digestibility, and growth rate by an animal; which is best assessed through sole feeding [13]. Thus, the experiment was designed to evaluate DM voluntary intake, apparent nutrient digestibility, nitrogen balance, and liveweight changes by intact West African dwarf breed of rams, and later rumen DM degradability were carried out on the stover using rumen-fistulated West African dwarf (WAD) sheep to determine feed quality by sole feeding stover from six dual-purpose groundnut cultivars to the animals.

MATERIALS AND METHODS

Experimental site and treatments

The experiment was conducted on the research farm of ILRI-West Africa at Ibadan (07°30' N; 03°54' E). Average weather conditions per month at the time of the experiment were 93.6 mm total rainfall with 16 rainy days (days with > 0.2 mm), 85% relative humidity (range: 70% to 99%), 12.47 MJ m^{-2} d^{-1} solar radiation, and 25.9°C (range: 22.6°C to 29.1°C). Sun-cured forage from six dual-purpose groundnut cultivars (M170-80I, M554-76, M572-80I, RMP-12, UGA-2 and UGA-5) harvested at maturity (between 4 and 5 months after planting, MAP) were evaluated. Details of cultural practices for the cultivars were as described for the cultivars classified as either medium or high potential dual-purpose cultivars based on grain and fodder yields [5].

Animals and pre-experimental management

Forty yearling WAD sheep with an average LW of 23.0±3.66 kg were purchased from a local market and allowed to adapt to the experimental site over a 30-d period. Deadline® (Bayer, Germany) applied against ectoparasites was administered at 1 ml per 10 kg LW after dissolving 50 ml in 200 l of distilled water while, Banminth-F*® (Pfizer, Nigeria) against endoparasites was administered at 1 ml per 2 kg LW. At 7 d preceding commencement of the experiment (from day 23 to 30 of the quarantine period), animals were flushed with wheat bran at 700 g head^{-1} d$^{-1,}$ to maintain all animals at similar rumen physiological levels. Clean drinking water and mineral licks were provided *ad libitum* for each animal, throughout the duration of the experiment.

Growth and feeding trials

At the end of the pre-experimental period, animals were individually weighed (range: 19.7 to 26.2 kg) and balanced for weight in six treatment groups of six replications. A total of 36 healthy WAD sheep were selected and used in a randomized complete block design with the animals blocked based on initial body weight and each represented a replicate and each of the six groundnut cultivars represented the treatments. The trials lasted 70 d period (minus 30 days of quarantine?). Feed was offered daily at 50 g DM kg/LW at 09:00 h after discarding refusals (orts) of the previous day. Animals were weighed, individually, on day 1 and thereafter on a weekly basis throughout the experimental period. One animal was excluded mid-way into the experiment because it developed buccal dysfunction. From days 49 to 70, animals were transferred to wooden metabolism cages measuring about 0.40 m x 0.60 m x 1.00 m with a platform of 0.02 m wire mesh for 21 d digestibility trial (14 d adjustment and 7 d collection period).

Daily records of feed offered and orts were weighed each morning between 08:00 and 09:00 h. On days 63 to 70, feed offered, orts and total faecal output were recorded for each animal and a 10% sub-sample taken to determine DM content, bulked per animal and stored in the freezer at -20°C for subsequent chemical analyses. Voluntary nutrient intake and apparent digestibility were computed per animal as the average daily DM intake and the proportion of those absorbed computed as a percentage of the total computed daily intake to determine apparent digestibility. Prior to feeding each morning during the 63rd to 70th d collection period, total urine samples were also collected from individual animal in 2.4 L bottles containing 100 mL of 1M aqueous tetraoxosulphate (VI) acid or sulphuric acid ($H_2SO_{4(aq)}$) solution. This dilution rate was to prevent uric acid precipitation and ammonia gas ($NH_3(g)$) volatilization in collected urine samples, while adequately retaining urine nitrogen content. After each day's collection and recording, 5% of total urine output for that day was sub-sampled into a 250 mL plastic bottle, bulked per animal and stored in the freezer until required for total nitrogen analysis.

In sacco rumen degradation

Dried groundnut stover was milled to 2.5 mm using a Christy *Hunt* laboratory mill (Christy Hunt Engineering Ltd., England) and used for *in sacco* or nylon bag rumen DM degradation analysis. Samples were incubated in duplicates for 6, 12, 24, 48, 72 and 96 h in the rumens of four cannulated WAD rams, using pre-weighed 10 x 17 cm nylon bags (polyester, Switzerland) of 40 µm pore size and containing 3 g of test feed samples. At the end of each incubation period, nylon bags plus residues were withdrawn from the rumen, washed in a cool bucket of water at room temperature (28°C) and rinsed under running tap water until the dripping water turned almost clear. Bags plus residues were then dried at 60°C for 72 h in a forced-air Gallenkamp oven to constant weights and and weights later used for computing DM disappearance percent (***p***). The ***p*** data were then fitted to the exponential model, $\boldsymbol{p} = \boldsymbol{a} + \boldsymbol{b}(1 - e^{-ct})$, according to Ørskov and McDonald [14], to estimate rumen degradation characteristics (***a***, soluble fraction; ***b***, degradable fraction; ***c***, rate of degradation of ***b***; ***PD***, potential degradability = ***a*** + ***b***; ***ED***, effective degradability = ***a*** + [***bc***/(***c*** + ***k***)]; ***k*** is the assumed rumen outflow rate (3%/h) of particulate materials) using PROC NLIN option of the SAS Institute Inc. [15].

Chemical analyses

The sub-samples of feed offered, orts and faeces collected were dried at 60°C for 72 h in a thermostatically controlled Gallenkamp moisture extraction oven. Feed and faecal samples were milled through 1.0 mm screen, using a Retsch GmbH milling machine (West Germany) and analysed for total nitrogen (CP = %N x 6.25), NDF, ADF, ADL, HC and CL. Urine samples were analysed for total nitrogen and used for computing nitrogen balance. Analyses for DM and nitrogen were done according to the micro-Kjeldahl procedures as outlined by AOAC [16] and fibre analyses followed the procedures described by Goering and Van Soest [17] and later modified [18]. Metabolisable energy (ME) contents were estimated according to the procedures of MAFF [19].

Statistical analyses

The growth, intake, digestibility and nitrogen balance data and other parameters (available protein; liveweight changes; degradation characteristics) were analysed using general linear model (GLM) procedures of SAS Institute Inc. version 8 [15].

RESULTS

Table 1 presents the chemical composition and metabolisable energy contents of stover from the six dual-purpose groundnut cultivars. There were no significant differences in the recorded DM, CP, NDF, ADF, ADL and metabolisable energy (ME) contents for all six cultivars. The mean HC 39 g/kg DM (6 to 64 g/kg DM) and CL 378 g/kg DM (352 to 396 g/kg DM) contents were significantly different ($P < 0.05$). The results in Table 2 show the nutrient intake (in g/kg $W^{0.75}$/d) and digestibility (in g/kg DM) by WAD sheep fed stover from six dual-purpose groundnut cultivars. There were no significant differences ($P \leq 0.05$) in the intake of DM, CP and

ADF while OM (58.1 to 71.9 g/kg$^{0.75}$/d) and NDFI (32 to 41 g/kg$^{0.75}$/d) were significantly different (P < 0.05) among the cultivars. The digestibilities of DM (508 g/kg DM in M554-76 to 623 g/kg DM in M170-80I), OM (498 g/kg DM in M554-76 to 626 g/kg DM in M170-80I), CP (488 g/kg DM in RMP-12 to 588 g/kg DM in M170-80I), NDF (488 g/kg DM in M554-76 to 635 g/kg DM in M170-80I) and ADF (406 g/kg DM in M554-76 to 572 g/kg DM in M170-80I) were significantly different (P < 0.05).

Nitrogen utilization patterns by WAD sheep fed on groundnut stover from six dual-purpose cultivars are shown in Table 3. The differences among cultivars were not significant in nitrogen intake, faecal nitrogen, nitrogen absorbed, urinary nitrogen and nitrogen balance. The crude protein intake and nitrogen retention pattern indicate available protein ranging between 2.5 g/d in cultivar RMP-12 and 29.0 g/d in cultivar M170-80I (Table 4). Daily liveweight changes (LWC) among the cultivars were also significantly different (P < 0.05) ranging between –6 g/d for UGA-2 and 46 g/d for M170-80I (Table 4).

The rumen DM degradation characteristics of the groundnut stover are presented in Table 5. Cultivar RMP-12 gave the lowest (P < 0.05) soluble fraction (***a***) while M572-80I gave the highest. There were no significant differences in degradable fraction (***b***) and rate of degradation of ***b*** (***c***) among the cultivars. Recorded 48-h degradation ranged (P < 0.05) between 501 g/kg DM for M554-76 and 596 g/kg DM for UGA-2. Potential degradability (***PD***) differed (P < 0.05) from 584 g/kg DM for cultivar M170-80I to 687 g/kg DM for M572-80I. The effective degradability (***ED***) also showed significant differences (P < 0.05) ranging between 415 g/kg DM for M170-80I and 489 g/kg DM for UGA-2.

DISCUSSION

Previous studies had concluded that groundnut stover could be fed to small ruminants as sole diet or supplement [9, 20]. Crude protein (CP) recorded were above the recommended 70 g/kg DM minimum requirements for ruminants [21]. Generally, all six cultivars used in current experiment recorded CP contents greater than 80 g/kg DM, suggesting that they could supply enough rumen nitrogen for microbial activities as previously reported [21]. The crude protein values were similar to those earlier reported by Elgunaid [20], but higher than those reported by other people [10, 22]. However they were lower than values reported by other authors [7, 23, 24].

Neutral detergent fibre (NDF) was higher than in earlier reports on groundnut fodder [10, 25, 26] except for M572-80I, but lower than 656 g/kg DM reported by Badr and Elhag [22], whereas acid detergent fibre (ADF) contents were similar to the reported values by some workers [7], but lower than 552 g/kg DM, 392 g/kg DM, 169 g/kg DM and 471 g/kg DM recorded by others [22, 23, 24, 26]. The observed differences in HC and CL are likely to influence intake and digestibility of the groundnut stover from the six cultivars. The inconsistencies in CP and fibre contents reported by different authors might have resulted partly from differences in plant management, leaf-to-stem ratios, cell wall configuration or cultivar [5]. Estimated ME values were lower than the 9.7 ME MJ/kg DM reported by Elgunaid [20], but similar to 7.7 MJ/kg OM reported by Njie and Reed [25].

Dry matter intake (DMI) was similar to those reported for sheep and goats fed groundnut crop residues-based diets [8; 21]. Similarly, CP intake was within the range recorded by Adebowale and Taiwo [27]. The NDF and ADF intake were highest for M170-80I but similar for the other cultivars and could be attributable to its observed highest DMI. Lower OM digestibility was earlier reported for groundnut hay [8, 20]. The DM and CP digestibility were lower than values reported by Ikhatua and Adu [8], higher than those published by others [21, 25], but similar to that reported by Adebowale and Taiwo [27]. The DM digestibility values were above 500 g/kg DM, the minimum requirement at zero liveweight gain or maintenance in ruminants, which was similar to the observations, made for groundnut and crop residues, in general [20]. Also, the NDF and ADF digestibility values for cultivars M170-80I, UGA-2 and UGA-5 were above 500 g/kg DM; a fibre digestibility level considered being an optimum level.

When animals are not fasted, the excreted nitrogen in faeces are derived from structural nitrogen of dietary sources while those in urine are mostly derived from broken down microbial protein not utilized by the animal as well as absorbed excess ammonia excreted as urea [21]. The relatively high proportion of nitrogen intake excreted in faeces and urine for cultivar RMP-12 is an indication of the poor quality of its protein, since it was not properly digested (those in the faeces) or it was wastefully broken down and excreted in the urine [28]. The faecal and urinary nitrogen contents (expressed as percent of total nitrogen intake) were similar to the earlier workers [21], but were lower than others [9]. Furthermore, the positive nitrogen balance for the six cultivars suggests good nitrogen utilization by the animals with cultivar RMP-12 numerically recording the least nitrogen balance. The results further indicated that nitrogen was better utilized in cultivars M170-80I and UGA-5 than the other four, being highest in the proportion of total nitrogen intake absorbed.

Findings from the daily available protein intake by the animals on each groundnut cultivar showed that only cultivars M170-80I and UGA-5 met the recommended minimum available protein requirements of 20 g/d for maintenance and 50 g/d growth by sheep of similar liveweight range [29]. The available protein indicates the utilizable protein needed to meet the animal’s maintenance and growth requirements. The recorded liveweight change values suggest the suitability of groundnut stover for maintaining or improving liveweight of animals raised wholly or partly on it. Liveweight gains of 88.39 g/d over 56 d by goats fed sole groundnut haulms had been reported by Ikhatua and Adu [8] while, a range of 40.33 to 86.76 g/d over 84 d by lambs fed complete rations of groundnut haulms were reported by others [9]. In another study, it was shown that goats fed 2% groundnut stover recorded higher daily weight gains than the control raised on rangeland alone [30]. However, the lower than recommended liveweight changes recorded for cultivars M170-80I and UGA-5 might have resulted from the source of crude protein and the tropical environment that is generally different from the temperate region and cattle breeds mostly used for the ARC recommendations.

There is only limited information on rumen DM degradation characteristics of the groundnut cultivars [5]. The ***a***-values, representing rapidly soluble protein and carbohydrate fractions in the stover, were lowest in RMP-12. The 48-h rumen DM degradation and ***PD***-values were well above the recommended 500 g/kg OM digestibility for maintenance in ruminants [20]. This conforms to the mean DM digestibility values (556±17.0 g/kg DM). However, the computed ***ED***-values were below this recommended minimum requirement, while the *in vivo* apparent digestibility, 48-h rumen DM degradation and ***PD***-value were above the recommended 500 g/kg OM digestibility minimum requirements. The low ***ED***-values recorded suggest that these materials would require longer periods in the system to achieve enough nutrients digestibility and uptake. Contrary to this, the observed ***a***, ***b***, ***c*** and ***PD*** values were all lower than figures reported by others [24]. The difference in animal species (sheep versus bull) used for both studies could be responsible for the differences.

CONCLUSIONS

Overall observations on the nutritional quality of stover from the six dual-purpose groundnut cultivars, as sole diets for West African dwarf sheep, indicate that they could support adequate nutrient intake, digestibility, daily liveweight change and nitrogen balance. However, their use as supplements to poor quality roughages during the dry season might be less demanding since their use as sole diets appears to require more feed per animal.

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Table 1: Chemical composition (g/kg DM) and metabolisable energy (MJ/kg DM) of stover from six dual-purpose groundnut genotypes

Parameter	Groundnut genotype						Mean	SEM
	M170-80I	M554-76	M572-80I	RMP-12	UGA-2	UGA-5		(df=12)
Dry matter, DM	890[a]	890[a]	870[a]	890[a]	860[a]	860[a]	877	21.3
Crude protein, CP	86[a]	91[a]	85[a]	87[a]	89[a]	85[a]	87	3.4
Neutral detergent fibre, NDF	536[a]	558[a]	519[a]	586[a]	532[a]	526[a]	543	35.2
Acid detergent fibre, ADF	490[a]	493[a]	488[a]	522[a]	500[a]	520[a]	502	21.4
Acid detergent lignin, ADL	114[a]	116[a]	105[a]	126[a]	148[a]	135[a]	124	22.1
Hemicellulose, HC	46[b]	57[a]	31[c]	64[a]	32[c]	6[d]	39	3.4
Cellulose, CL	376[b]	377[b]	383[b]	396[a]	352[c]	385[ab]	378	4.8
Metabolisable energy, ME	9.00[a]	7.12[a]	7.79[a]	7.31[a]	8.03[a]	8.33[a]	7.93	0.97

[a,b,c]Means with different superscripts in the same row are significantly different ($P < 0.05$)

Table 2: Nutrient intake and digestibility by WAD sheep fed stover from six dual-purpose groundnut genotypes

Parameter	Groundnut genotype						Mean	SEM (df=24)
	M170-80I	M554-76	M572-80I	RMP-12	UGA-2	UGA-5		
Nutrient intake (g/kg $W^{0.75}$/d):								
Dry matter, DM	80	65	67	65	65	66	68	5.1
Organic matter, OM	71.9^{a}	58.1^{b}	60.0^{b}	58.1^{b}	58.3^{b}	59.2^{b}	60.9	3.2
Crude protein, CP	7.0	6.7	5.8	5.9	5.9	5.8	6.2	0.49
Neutral detergent fibre, NDF	41^{a}	32^{b}	32^{b}	38^{ab}	33^{b}	32^{b}	35	3.0
Acid detergent fibre, ADF	39	30	32	32	32	34	33	2.8
Nutrient digestibility (g/kg DM):								
Dry matter, DM	623^{a}	508^{d}	546^{bc}	515^{cd}	561^{b}	580^{b}	556	17.0
Organic matter, OM	626^{a}	498^{c}	544^{bc}	511^{c}	560^{bc}	580^{ab}	553	29.3
Crude protein, CP	588^{a}	530^{bc}	539^{ab}	488^{c}	548^{ab}	573^{ab}	544	24.3
Neutral detergent fibre, NDF	635^{a}	488^{c}	497^{bc}	572^{abc}	576^{ab}	514^{bc}	547	41.2
Acid detergent fibre, ADF	572^{a}	406^{d}	458^{cd}	484^{bc}	500^{bc}	537^{ab}	493	26.9

[a-d]Means with different superscripts in the same row are significantly different ($P < 0.05$)

Table 3: Nitrogen utilization patterns by WAD sheep fed stover from six dual-purpose groundnut genotypes

Parameter (gN/animal/d)	Groundnut genotype						Mean	SEM (df=24)
	M170-80I	M554-76	M572-80I	RMP-12	UGA-2	UGA-5		
Nitrogen intake	11.6	11.2	9.9	9.9	10.2	9.6	10.4	0.86
Faecal nitrogen	4.8	5.2	4.6	5.0	4.6	4.1	4.7	0.39
Nitrogen absorbed	6.8	5.9	5.4	4.9	5.6	5.5	5.7	0.59
Urinary nitrogen	2.5	3.0	2.2	3.6	2.7	2.2	2.7	0.62
Nitrogen balance	4.3	3.0	3.1	1.2	2.8	3.3	3.0	0.98

[a,b]Means with different superscripts in the same row are significantly different ($P < 0.05$)

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Table 4: Available protein and liveweight changes by WAD sheep fed stover from six dual-purpose groundnut genotypes

Parameter (g/kg W/d)	Groundnut genotype						Mean	SEM (df=24)
	M170-80I	M554-76	M572-80I	RMP-12	UGA-2	UGA-5		
Available protein	29.0[a]	18.5[b]	19.9[b]	2.5[c]	17.6[b]	21.7[b]	18.2	2.06
Growth rate:								
Initial liveweight	22.5	22.8	23.4	22.9	23.8	22.7	23.0	3.66
Final liveweight	25.7	24.5	25.2	25.1	23.4	25.4	24.9	4.45
Liveweight changes, LWC	46[a]	24[c]	26[bc]	31[bc]	-6[d]	38[b]	26	5.7

[a-d]Means with different superscripts in the same row are significantly different ($P < 0.05$)

Table 5: Rumen dry matter degradation characteristics (g/kg DM) of stover from six dual-purpose groundnut genotypes by WAD sheep

[1]Parameter	Groundnut genotype						Mean	SEM (df=16)
	M170-80I	M554-76	M572-80I	RMP-12	UGA-2	UGA-5		
Soluble fraction, ***a***	232^{bc}	270^{bc}	351^{a}	197^{c}	251^{bc}	295^{ab}	266	37.9
Degradable fraction, ***b***	352	318	336	402	389	342	357	27.0
Rate of degradation, ***c*** (%/h)	0.0329	0.0315	0.0221	0.0476	0.0473	0.0424	0.0373	0.0111
48-h degradation	502^{c}	501^{c}	583^{a}	539^{b}	596^{a}	567^{ab}	548	14.2
Potential degradability, ***PD***	584^{b}	588^{b}	687^{a}	599^{b}	640^{ab}	637^{ab}	623	25.3
Effective degradability, ***ED***	415^{b}	432^{b}	487^{a}	428^{b}	489^{a}	487^{a}	456	10.8

[1]***a, b, c*** estimated from the model $p = a + b(1 - e^{-ct})$, $PD = a + b$ and $ED = a + [bc/(c + 0.03)]$

[a,b,c]Means with different superscripts in the same row are significantly different ($P < 0.05$)

REFERENCES

1. **Ntare BR and F Waliyar** ICRISAT groundnut program in West and Central Africa. *Arachide Infos*, 1998; **8**: 20-22.

2. **Pande S, Bandyopadhyay R, Blümmel M, Narayana RJ, Thomas D and SS Navi** Disease management factors influencing yield and quality of sorghum and groundnut crop residues. *Field Crops Res.*, 2003; **84**: 89-103.

3. **Parthasarathy RP and AJ Hall** 2003. Importance of crop residues in crop-livestock systems in India and farmers' perception of fodder quality in coarse cereals. *Field Crops Res.*, 2003; **84**: 189-198.

4. **Larbi A, Olorunju PE, Dung DD and I Etela** Selecting groundnut varieties for crop-livestock systems? Do not forget the farmer's cattle! *Arachide Infos*, 1998; **8**: 12-14.

5. **Larbi A, Dung DD, Olorunju PE, Smith JW, Tanko RJ, Muhammad IR and IO Adekunle** Groundnut (*Arachis hypogaea*) for food and fodder in crop-livestock systems: forage and seed yields, chemical composition and rumen degradation of leaf and stem fractions of 38 cultivars. *Anim. Feed Sci. Technol.*, 1999; **77**: 33-47.

6. **Dung DD, Larbi A, Olorunju PE, Tanko RJ and DY Goska** On-farm assessment of dual purpose groundnut (*Arachis hypogaea* L.) varieties. **In: Joseph JK, Awosanya B, Apata DF, Belewu MA, Atteh JO and KL Ayorinde** (Eds), *Enhancing livestock production in Nigeria*, Proceedings of the 26th annual conference of the Nigerian Society for Animal Production (NSAP), Kwara Hotels, Ilorin, Kwara State, Nigeria, March 21-25, 1999; 500 pp.

7. **Omokanye AT, Olorunju PE, Onifade OS and L Olaosebikan** 2002. On-farm assessment of selected dual-purpose groundnut (*Arachis hypogaea*) cultivars for food and feed. *Nig. J. Anim. Prod.*, 2002; **29**: 299-307.

8. **Ikhatua UJ and IF Adu** A comparative evaluation of the utilization of groundnut haulms and *Digitaria smutsii* hay by Red Sokoto goats. *J. Anim. Prod. Res.*, 1984; **4**: 145-152.

9. **Durga Prasad RD, Prasad DA and RR Reddy** Evaluation of complete rations containing groundnut haulms for lambs. *Indian J. Anim. Sci.*, 1986; **56**: 258-261.

10. **Ndlovu LR and L Hove** Intake, digestion and rumen parameters of goats fed mature veld hay ground with deep litter poultry manure and supplemented with graded levels of poorly managed groundnut hay. *Livest. Res. Rural Dev.*; 1995; **6**, http://www.cipav.org.co/lrrd/lrrd6/3/ndlov.htm, 1995 Accessed on April 4, 2009).

11. **Malau-Aduli BS, Eduvie L, Lakpini C and EO Malau-Aduli** Chemical compositions, feed intakes and digestibilities of crop residue based rations in non-lactating Red Sokoto goats in the subhumid zone of Nigeria. *Anim. Sci. J.*, 2003; **74**: 89-94.

12. **Alawa JP and NN Umunna** Alternative feed formulation in the developing countries: prospects for utilization of agro-industrial by-products. *J. Anim. Prod. Res.*, 1993; **13**: 63-98.

13. **Devendra C** Crop residues for feeding animals in Asia: technology development and adoption in crop/livestock systems. **In: Renard C** (Eds), Crop residues in sustainable mixed crop/livestock farming systems, CAB International, 1997; 322 pp.

14. **Ørskov ER and I McDonald** 1979. The estimation of protein degradability in the rumen from incubation measurements weighted according to rate of passage. *J. Agric. Sci. (Camb.)*, 1979; **92**: 499-503.

15. **SAS Institute Inc.** (Statistical Analysis Systems Institute Inc.) *SAS for Windows*, Version 8, Cary, NC, USA, 1999.

16. **AOAC (Association of Official Analytical Chemists)** Official methods of analysis. 15th edition, Washington, DC, USA, 1990; 1298 pp.

17. **Goering HK and PJ Van Soest** *Forage and fibre analysis. (apparatus, reagents, procedures, and some applications), agriculture handbook*, 1970; 379. Agricultural Research Service, Department of Agriculture, Washington, DC, USA, 20 pp.

18. **Van Soest PJ, Robertson JB and BA Lewis** Methods for dietary fibre, neutral detergent fibre and nonstarch polysaccharides in relation to animal nutrition. *J. Dairy Sci.*, 1991; **74**: 3583-3597.

19. **MAFF.** *Energy allowances and feeding systems for ruminants, reference book 433*. Her Majesty's Stationery Office, London. MAFF (Ministry of Agriculture, Fisheries and Food, Department of Agriculture and Fisheries for Scotland, Department of Agriculture for Northern Ireland), 1984; 85 pp.

20. **Elgunaid EM** Nutritional quality of important fodder resources in the Eastern Butana. *Anim. Res. Dev.*, 1994; **39**: 27-40.

21. **Van Soest PJ** Nutritional ecology of the ruminant, O & B Books, Inc. Oregon, USA, 1982; pp. 234-248.

22. **Badr NAG and MG Elhag** Effect of ensiling on the nutritive value of groundnut-hulls and wheat straw. *Sudan J. Anim. Prod.*, 1989; **2**: 1-8.

23. **Prasad JR, Dhanunjayudu T, Rao ZP and DS Rao** Inclusion of legume fodders in complete rations of Nellore Brown sheep. In: Proceedings of the 8th world conference on animal production, Seoul National University, Seoul, Korea, Vol. 1, June 28 - July 4, 1998; 1021 pp.

24. **Nouala FS, Akinbamijo OO, Smith OB and VS Pandey** 2004. Horticultural residues as ruminant feed in peri-urban area of The Gambia. *Livest. Res. Rural Dev.*, 2004; Vol. 16Art #37, *http://www.cipav.org.co/lrrd/lrrd16/6/noua16037.htm* (Accessed on April 4, 2009).

25. **Njie M and JD Reed** Potential of crop residues and agricultural by-products for feeding sheep in a Gambian village. *Anim. Feed Sci. Technol.*, 1995; **52**: 313-323.

26. **Mandibaya W, Mutisi C, Hamudikuwanda H and M Titterton** The nutritive value, intake, digestibility and nitrogen balance of farm grown and prepared sunflower-based dairy calf meals. *Trop. Anim. Hlth Prod.*, 1999; **31**: 321-331.

27. **Adebowale EA and AA Taiwo** Utilization of crop residues and agro-industrial by-products as complete diets for West African dwarf sheep and goats. *Nig. J. Anim. Prod.*, 1996; **23**: 153-160.

28. **Fraser MD, Fychan R and R Jones** Voluntary intake, digestibility and nitrogen utilization by sheep fed ensiled forage legumes. *Grass and Forage Sci.*, 2000; **55**: 271-279.

29. **ARC (Agricultural Research Council)** *The Nutrient Requirements of Farm Livestock*, No. 2 Ruminants, Technical Reviews and Summaries, Henry Burt & Son Ltd., College Street, Kempston, Bedford, London, 1965; 264 pp.

30. **Packard CE, Muir JP and RD Wittie** Effects of groundnut stover or Bermuda hay supplementation to doe kids and winter hardwood range. *Small Rumin. Res.*, 2007; **67**: 1-6.