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Effect of Storage Place and Storage Period on Nutritive Qualityof Hay Produced from Three Forage Grasses

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Target audience: Forage Agronomists, Animal scientists; Animal nutritionists; Livestock (ruminant) farmers

Abstract

A study was conducted to investigate the effect of storage place and storage period on the proximate composition, in vitro gas production and post incubation parameters of hay produced from A. gayanus, B. decumbens and P. pedicellatum. The two storage places were in the room and in the shed while the storage periods were 4, 8 and 12 weeks. Results of this study showed that the dry matter (DM), crude protein (CP), ether extract (EE), crude fibre (CF) and ash of the hays produced from the three grasses were significantly affected (P<0.05) by the interactive effect of the storage place, storage period and species. Brachiariadecumbens produced higher (P<0.05) DM (99.50%) in the shed at 4 weeks of storage (WS) and a lower DM (86.20%) in the room at 12 WS. Ether extract of Andropogongayanus and B. decumbens significantly (P<0.05) differed at both storage places and at the three storage periods. Brachiariadecumbens produced higher (P<0.05) (14.50%) and lower (4.50%) EE contents in the room at 4 and 12 WS respectively. Similarly, ash contents of the hays significantly (p<0.05) ranged from 3.50% in the storage of B. decumbens in the shed for 12weeks to 36.33% for storing P. pedicellatum in the room for 4 WS. Cumulative in vitro gas production of the grasses though similar (p>0.05) increased over the incubation periods. The post incubation parameters of the hays were all similar (p>0.05), except the organic matter digestibility (OMD) values (p<0.05).It is concluded that the CP contents of the three grasses fell below ruminant requirement and slightly declined with increase in storage period, thereby suggesting earlier harvesting before the onset of dry season and serious lignification. Andropogongayanus and B. decumbens proved to be better hays vis-a-vis storage in the shed, higher crude protein and dry matter contents while P. pedicellatum possessed better ash contents. Conclusively, it is more economical to store grass hays in the shed as there was no distinct difference in the results obtained in the two storage places.

Keywords: Grasses; Hay; Nutritive quality; Storage.

Description of problem

Forage is considered the cheapest major nutritional component in the diets of ruminant animal particularly in rural and sub-urban area of the tropics (1). Ruminant livestock production in Nigeria is seriously embattled by seasonal shortages in the quantity and quality of available forages. The productivity of livestock in Nigeria is therefore below its genetic potential, principally due to poor nutrition and inadequacy of good quality feed (2). The use of concentrates has been a usual practice to supplement feed inadequacy during the dry season. There have been cases of marked reduction in production, and as a result, some livestock owners are forced to cull or sell off some of the animals to reduce cost of feeding during the dry season (3). Even the transhumance normadism could not satisfactorily address the problems of dry season feeding as animal losses are often recorded as a result of stress associated with prolonged search for green herbage that are usually of very poor quality (3). Improved animal performance during the period of scarcity can be achieved by the use of conserved forage in form of hay or silage (4). Forage conservation is therefore aimed at producing feed suitable for animal feeding with minimal loss of nutrient value and at relatively low cost. Hay making thus involves science and art that capture the nutrients in grass in a storable form to make them available as enriched animal feed in the dry season (5).Therefore, forage conservation through hay or silage production provides a viable option for resolving feed deficiencies during the dry season or period of scarcity (6). The objectives of this study are to investigate the effect of storage place and storage period on the proximate composition,*in vitro* gas production and post-incubation parameters of hay produced from *Andropogongayanus,Brachiariadecumbens,* and *Pennisetumpedicellatum.*

Materials and methods

The study was carried out at the Teaching and Research Farms of the College of Animal Science and Livestock Production (COLANIM Farm) and Department of Pasture and Range Management Laboratory, both of the Federal University of Agriculture, Abeokuta (FUNAAB), Ogun State, Nigeria. The area has a mean annual rainfall of 1230mm in a bimodal distribution pattern. Mean monthly temperature ranges between 25.70°C in July and 30.20°C in February. The study was arranged as a 3×2×3 factorial experiment comprising three forage grasses (*Brachiariadecumbens, Andropogongayanus* and *Pennisetumpedicellatum*), two storage places (room and shed) and three sampling periods (4, 8 and 12 weeks' interval). Three species of grasses were harvested on December 4, 2010 within the COLANIM Farm of the Federal University of Agriculture, Abeokuta. These forages were chopped to 5cm and later sun-dried for a day. Thereafter, each grass species was partitioned into two of about 8kg each. The partitioned forages were bagged with sacks and stored either in a room or under a shed. The room has a dimension of 3m length, 2.4m width and 2.55m height. It has a concrete floor, plastered wall and the roof was built with iron sheets and wood. It has a wooden

door, ceilings and louvre blades. However, the shed has a dimension of 2.4m height, 9.6m length and 3.87m width. It has a concrete floor, plastered short wall and the roof consists of iron sheets and woods. Moreover, above the short-walls were fenced with woven wire up to the roof. The proximate composition of the forages wereanalyzed according to the procedure of (7). The *in vitro* gas production was determined following the procedure of (8). Rates and extent of gas production were determined for each sample by fitting the cumulative gas production datainto the non-linear regression model of (9):

$GV\ (ml/200mg\ DM) = b\ (1 - e^{-c\ (t\text{-}lag)})$

Where:GV= potential gas production volume at time t, b = fermentation of insoluble fraction,c= gas production rate constant (hr^{-1})

Organic matter digestibility (OMD), Metabolizable energy (ME) and SCFA were calculated as:

$OMD = 14.88 + 0.889GV + 0.45\ CP + 0.651\ ash$ (8)

$ME = 2.20 + 0.1375GV + 0.0057\ CP + 0.0002859\ EE^2$ (8)

$SCFA = 0.0239\ GV - 0.0601$ ..(10)

Data collected were subjected to Analysis of Variance (ANOVA) and treatment means were separated using Duncan Multiple Range Test (DMRT) at 5% level of significance (11).

Results and Discussion

The proximate composition (%) of hay produced from the three tropical grasses (*Andropogon gayanus, Brachiariadecumbens* and *Pennisetumpedicellatum*) were significantly affected ($P<0.05$) by the interactive effect of the storage place, storage period and species.*Brachiariadecumbens*produced higher ($P<0.05$) DM (99.50%) in the shed at 4 weeks of storage (WS) and a lower DM (86.20%) in the room at 12 WS. Ether extract of *Andropogongayanus*and*B. decumbens* significantly ($P<0.05$) differed at both storage places and at the three sampling periods.*Brachiariadecumbens*produced higher ($P<0.05$) (14.50%) and lower (4.50%) EE contents in the room at 4 and 12 WS respectively. The crude protein (CP) contents of the grasses were significantly influenced ($p<0.05$) by the storage places and storage periods. Higher CP (7.35%) was obtained from the separate storage and sampling of *A. gayanus*and *B. decumbens*in the shed at 8 and 4 WS respectively. The storage of *B. decumbens* for 8 and 12 WS in the room and shed produced similar ($p>0.05$) CP values. CP contents obtained from the three grasses fell below the recommended minimum requirement (6%) for ruminant animals from tropical feeds (12). Harvesting of the grasses in this part of the world, earlier than December a non-wet period, before serious lignification would be preferable to conserve forage of higher CP content that would meet the requirements of the ruminants.The CP content of *B. decumbens*and *P. pedicellatum* slightly declined ($P<0.05$) in the two storage places as the storage period advanced from 4 to 8 WS. This is line with the report of (13) that CP levels declined only slightly with advance in

storage period. In addition, (14) and (15) had reported that spontaneous heating can reduce CP by 0.25% units per month of long-term storage because of volatilization of ammonia and other nitrogenous compounds which are lost in storage of baled hay. Higher (41.00%) CF was recorded from *A. gayanus*when stored in the shed for 12 WS while *P. pedicellatum*produced a lower (25.00%) crude fibre content in the room at the same storage period.

Table 1: Interactive effect of storage place, storage period and species on proximate composition of hay produced from *A. gayanus*, *B. decumbens* and *P. pedicellatum*.

Species	Storage period	Storage place	DM	EE	CP	CF	ASH
A. gayanus	4	Room	95.40^{abc}	5.00^{c}	5.60^{a-d}	37.00^{a-d}	4.50^{c}
		Shed	99.00^{a}	9.00^{bc}	4.55^{bcd}	40.00^{a}	5.00^{bc}
	8	Room	97.60^{ab}	5.00^{c}	5.25^{a-d}	38.00^{d-g}	8.00^{abc}
		Shed	94.80^{abc}	10.00^{b}	7.35^{a}	37.00^{a-d}	5.50^{bc}
	12	Room	97.70^{a}	8.50^{bc}	5.25^{a-d}	39.00^{ab}	34.67^{ab}
		Shed	99.30^{a}	5.00^{b}	6.30^{abc}	41.00^{a}	8.00^{abc}
B. decumbens	4	Room	98.50^{a}	14.50^{ab}	4.55^{bcd}	34.00^{a-f}	28.67^{abc}
		Shed	99.50^{a}	7.00^{bc}	7.35^{a}	28.00^{fg}	6.00^{bc}
	8	Room	94.80^{abc}	5.00^{b}	4.20^{a}	34.00^{a-f}	8.67^{abc}
		Shed	90.98^{d}	5.50^{b}	4.20^{a}	31.00^{c-g}	5.70^{bc}
	12	Room	86.20^{d}	4.50^{c}	4.90^{a}	39.00^{a-f}	7.17^{bc}
		Shed	98.60^{a}	5.00^{b}	4.90^{a}	29.00^{e-g}	3.50^{bc}
P. pedicellatum	4	Room	95.10^{abc}	11.00^{bc}	5.60^{a-d}	30.00^{d-g}	36.33^{a}
		Shed	97.70^{a}	9.50^{bc}	6.65^{ab}	36.00^{abc}	6.00^{bc}
	8	Room	91.60^{bcd}	7.00^{bc}	3.50^{d}	40.00^{a}	10.00^{abc}
		Shed	95.00^{abc}	10.50^{bc}	4.20^{cd}	32.00^{b-g}	4.50^{c}
	12	Room	99.00^{a}	8.00^{bc}	3.50^{d}	25.00^{g}	7.83^{a}
		Shed	91.17^{cd}	6.50^{bc}	6.07^{abc}	35.00^{a-f}	7.33^{a}
SEM			0.59	0.73	0.21	0.76	0.57

$^{a,b:}$ Means on the same column with different superscripts are significantly different ($P < 0.05$); SEM= Standard error of mean; DM: Dry matter; CP: Crude Protein; CF: Crude Fibre; EE: Ether Extract; WS: Weeks of storage; HR: Hours

The CF values fell within the range (30 to 40%) earlier reported on *Stylosanthes* species by (16) and (17). Ash contents of the hays significantly ($p<0.05$) ranged from 3.50% for the 12 WS storage of *B. decumbens*in the shed to 36.33% for 4 WS storage of *P. pedicellatum* in the room. The cumulative *in vitro* gas production of the grasses though similar ($p>0.05$) increased over the incubation periods (Table 2; Figure 1). The increase could beassociated with the high metabolizable energy of the hay. In addition, digestibility has been reported to be synonymous to *in vitro* gas production; the higher the gas production, the higher the digestibility (18).

Table 2: Interactive effect of storage place, storage period and species on *in vitro* gas production of hay produced from *A. gayanus*, *B. decumbens* and *P. pedicellatum*

Species	Storage period (WS)	Storage place	3HR	6HR	9HR	12HR	24HR	36HR	48HR
A. gayanus	4	Room	1.67	3.00	4.67	6.00	13.00	19.33	23.67
		Shed	0.33	1.67	2.67	3.67	8.67	15.00	20.00
	8	Room	0.67	2.33	3.33	5.00	10.33	18.00	21.00
		Shed	0.33	1.33	1.67	2.67	7.67	11.67	15.00
	12	Room	1.67	2.67	4.67	8.33	20.00	25.00	29.67
		Shed	0.33	2.00	3.00	4.00	9.00	15.33	19.67
B. decumbens	4	Room	1.33	3.33	4.00	5.67	13.67	21.33	27.33
		Shed	1.00	1.67	2.67	3.67	13.00	19.33	24.33
	8	Room	1.33	3.33	4.33	6.33	16.00	23.33	28.00
		Shed	0.33	1.33	2.33	4.67	9.67	16.00	20.33
	12	Room	1.00	1.67	7.33	10.00	19.67	28.00	33.33
		Shed	0.67	1.67	3.33	4.67	10.67	18.00	23.33
P. pedicellatum	4	Room	0.33	2.00	3.00	4.00	10.00	16.00	22.33
		Shed	0.67	2.33	3.33	4.67	12.67	19.67	25.33
	8	Room	0.33	1.67	3.67	4.00	11.00	18.00	21.67
		Shed	1.33	2.67	4.33	5.67	13.33	18.00	21.00
	12	Room	0.67	1.67	5.33	6.67	12.00	14.33	20.67
		Shed	1.00	3.00	5.00	7.00	15.33	22.33	26.33
SEM			0.12	0.25	0.37	0.51	1.02	1.34	1.46

[a,b]: Means on the same column with different superscripts are significantly different (P < 0.05);SEM= Standard error of mean; WS: Weeks of storage; HR: Hours

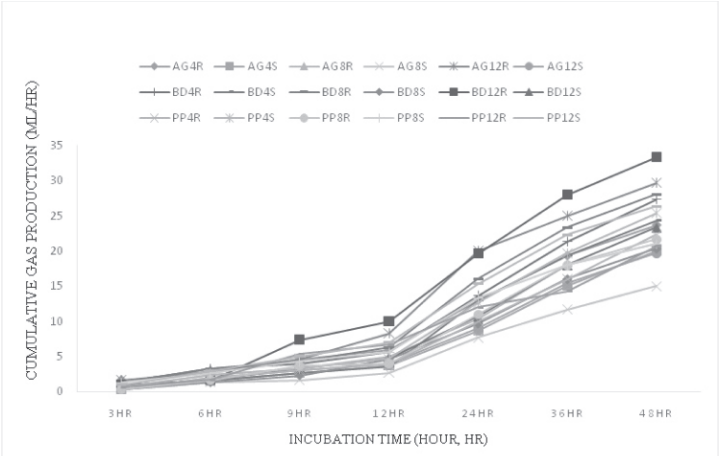

Figure 1: Interactive effect of storage place, storage period and species on the trend of the cumulative *in vitro* gas production of hays produced from *A. gayanus*, *B. decumbens* and *P. pedicellatum*.

AG4R: *A. gayanus* + 4 weeks of storage + Room,
BD4R: *B. decumbens* + 4 weeks of storage + Room,
PP4R: *P. pedicellatum* + 4 weeks of storage + Room,
AG4S: *A. gayanus* + 4 weeks of storage + Shed,
BD4S: *B. decumbens* + 4 weeks of storage + Shed,
PP4S: *P. pedicellatum* + 4 weeks of storage + Shed,
AG8R: *A. gayanus* + 8 weeks of storage + Room,
BD8R: *B. decumbens* + 8 weeks of storage + Room,
PP8R: *P. pedicellatum* + 8 weeks of storage + Room,
AG8R: *A. gayanus* + 8 weeks of storage + Shed,
BD8R: *B. decumbens* + 8 weeks of storage + Shed,
PP8R: *P. pedicellatum* + 8 weeks of storage + Shed,
AG12R: *A. gayanus* + 12 weeks of storage + Room,
BD12R: *B. decumbens* + 12 weeks of storage + Room,
PP12R: *B. decumbens* + 12 weeks of storage + Room,
AG12S: *A. gayanus* + 12 weeks of storage + Shed,
BD12S: *B. decumbens* + 12 weeks of storage + Shed,
PP12S: *B. decumbens* + 12 weeks of storage + Shed

The post-incubation parameters of hay produced from *A. gayanus*, *B. decumbens*and *P. pedicellatum*were all similar ($p>0.05$), except the organic matter digestibility (OMD) values ($p<0.05$) (Table 3).The OMD values (27.89-57.59%) of the grasseswere lower than that reported for *P. maximum* (19) and the OMD reported for 60 and 90 days old Napier grass (20).The lower rate of degradation observed in the grasses might be due to the higher fibre contents and low digestibility of the grasses as a result of maturity.

Table 3: Interactive effect of storage place, storage period and species on post - incubation parameters of hay produced from *A. gayanus* , *B. decumbens* and *P. pedicellatum*

Species	Storage period (WS)	Storage place	C (hr^{-1})	ME (MJ/kg DM)	SCFA	OMD (%)	GV (ml/0.2g DM)
A. gayanus	4	Room	3.70	4.27	0.25	31.89^{a}	13.00
		Shed	2.66	3.55	0.15	27.89^{a}	8.67
	8	Room	1.29	3.86	0.19	31.64^{a}	10.33
		Shed	2.10	3.90	0.12	28.58^{a}	7.67
	12	Room	0.36	5.16	0.42	57.59^{a}	20.00
		Shed	2.25	3.93	0.16	30.92^{b}	9.00
B. decumbens	4	Room	3.15	4.22	0.27	47.74^{ab}	13.67
		Shed	1.27	4.87	0.25	33.65^{b}	13.00
	8	Room	3.46	4.49	0.32	36.64^{ab}	16.00
		Shed	3.46	3.64	0.17	29.07^{b}	9.67
	12	Room	1.41	5.08	0.41	39.23^{ab}	19.67
		Shed	1.02	3.85	0.19	32.10^{b}	10.67
P. pedicellatum	4	Room	3.43	3.89	0.18	49.94^{ab}	10.00
		Shed	4.21	4.54	0.24	33.04^{b}	12.67
	8	Room	0.57	3.77	0.20	32.74^{b}	11.00
		Shed	1.62	4.14	0.26	31.55^{b}	13.33
	12	Room	1.17	3.91	0.23	32.22^{b}	12.00
		Shed	1.52	4.68	0.31	36.02^{b}	15.33
SEM			0.34	0.14	0.02	1.69	1.02

^{a,b}: Means on the same column with different superscripts are significantly different ($p<0.05$); SEM= standard error of means; c = gas production rate constant (h^{-1}); SCFA= short chain fatty acid (µmol); OMD = organic matter digestibility (%); ME= Metabolizable energy (MJ/kg DM); GV = Gas volume (ml/0.2g DM); WS: Weeks of storage

Conclusions and applications

1. The study concluded that thecrude protein contents of the hays fell below ruminant requirement and slightly declined with increase in storage period, thereby suggesting earlier harvesting before the onset of dry season and serious lignification.

2. *Andropogongayanus*and *B. decumbens* proved to be better hays vis-a-vis storage in the shed, higher crude protein and dry matter contents while

P.pedicellatum possessed better ash contents.

3. However, it is more economical to store grass hays in the shed as there was no distinct difference in the results obtained from the two storage places.

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