Nig. J. Anim. Prod. 2022, 49(2):215-224.https://doi.org/10.51791/njap.v49i2.3482 *Nigerian Journal of Animal Production*

Influence of phosphorus sources and storage duration on physical characteristics and fibre fractions of *Stylosanthes guianensis* hay

*Amisu, A. A.,[2]Ewetola, I. A.,[1]Okukenu, O. A.,[1]Jimoh, S. O. and [1]Olanite, J. A.

[1]*Department of Pasture and Range Management, Federal University of Agriculture, P. M. B. 2240, Abeokuta, Nigeria.*

[2]*Department of Animal Nutrition and Forage Science, College of Animal Science and Animal Production, Michael Okpara University of Agriculture, Umudike, Abia state.*

[*]**Corresponding author:** amisuaa@funaab.edu.ng; 08052056564

Abstract

Phosphorus is a primary nutrient essential for plant growth and development for regulation of various enzymatic activities while deficiency of phosphorus in soil has an adverse impact on legume production as it is required for energy transformation in nodules and enhanced N-fixation (Yadav et al. 2017). However, most of the agricultural soils have inadequate amounts of P to support efficient biological nitrogen fixation (Brown et al. 2013). So there is a need to review P resources to better legume crop productivity and soil sustainability through increasing efficiency in legumes. Therefore, the research was conducted to evaluate ensis as influenced by phosphorus sources and storage duration. The study was a 3 xphysical characteristics and fibre fractions of hay made from Stylosanthes guian 3 factorial arrangement laidout as split-plot design comprising of threephosphorus sources (SSP, poultry and control) as the main plot while the three storage duration (0, 2 and 4months) as the sub plot, which wasreplicated three times. Resultshowsthat physical characteristics evaluated as influenced by phosphorus sources were significant ($p<0.05$) except for foreign materials. The unfertilized Stylosanthes guianensis hay (12.28) and those fertilized with poultry manure (12.96) recorded higher leafiness than those fertilized with SSP (10.39). The values for color were higher in the unfertilized legume hay (12.65). Odour values ranged from 14.14 in the legume hay fertilized with SSP to 14.77 in those fertilized with poultry manure. However, leafiness and colour were the only parameters influenced by the interaction of phosphorus sources and storage duration. The highest leafiness was recorded for Stylosanthes guianensis hay fertilized with poultry manure stored for zeromonth (14.00) and those fertilized with SSP and stored for two months (13.96). The highest and lowest Neutral detergent fibre (NDF) and Acid detergent lignin (ADL)valueswere recorded for poultry fertilized legume hay (51.55% and 8.41%) and those fertilized with SSP (46.58% and 7.83). The effect of storage duration on the fibre fractions of Stylosanthes guianensis hay followed a similar trend. The NDF (52.53%), ADF (17.10%), ADL (7.50%), and hemicellulose (34.43%) were significantly higher for the legume hay stored for four months and lower in those stored for zero months (48.53%, 16.17%, 7.30%, and 29.37%, respectively). The interaction of phosphorus sources and storage duration was only significant on NDF and hemicellulose. Stylosanthes hay stored for zeroand two months are more palatable due to their high leaf content, while both SSP and poultry manure enhance hay leafiness during storage. In conclusion, the study may imply that the interaction of these factors could provide animals with sufficient nutrient uptake from the higher number of leaves recorded.

Keywords: Fibre fraction; legumes; Stylosanthes; hay; phosphorus

Influence des sources de phosphore et de la durée de stockage sur les caractéristiques physiques et les fractions de fibres du foin de stylosanthes guanensis

Résumé

Le phosphore est un élément nutritif primaire essentiel à la croissance des plantes et au développement de la réglementation de diverses activités enzymatiques, tandis que la carence en phosphore dans le sol a une incidence négative sur la production de légumineuses, car elle est nécessaire pour la transformation de l'énergie dans les nodules et la fixation de nivellement. Cependant, la plupart des sols agricoles ont une quantité inadéquate de P de soutenir une fixation efficace de l'azote biologique (Brown et al. 2013). Il est donc nécessaire d'examiner des ressources pour une meilleure productivité des cultures de légumineuses et une durabilité des sols en augmentant l'efficacité des légumineuses. Par conséquent, les recherches ont été menées pour évaluer les caractéristiques physiques et les fractions de fibres de foin à base de stylosanthes guianensis comme influencée par des sources de phosphore et une durée de stockage. L'étude était un agencement factoriel de 3 x 3 disposé en tant que conception de tracé fractionnée comprenant trois sources de phosphore (SSP, la volaille et la commande) comme la graphique principale tandis que la durée de stockage (0, 2 et 4 mois) comme la sous-parcelle, qui a été reproduit trois fois. Le résultat montre que les caractéristiques physiques évaluées comme influencées par des sources de phosphore étaient importantes (p <0,05) sauf pour les matériaux étrangers. Les foins de stylosanthes non fertilisés guanensis (12,28) et ceux fécondés avec un fumier de volaille (12,96) ont enregistré une lumière plus élevée que celles fécondées avec SSP (10,39). Les valeurs de couleur étaient plus élevées dans le foin de légumineuses non fertilisées (12,65). Les valeurs des odeurs allaient de 14,14 dans le foin de légumineuses fertilisées avec un SSP à 14,77 chez ceux fécondés avec un fumier de volaille. Cependant, la fabrication et la couleur étaient les seuls paramètres influencés par l'interaction des sources de phosphore et la durée de stockage. Le feuillu le plus élevé a été enregistré pour les stylosanthes guanensis foin fécondé avec un fumier de volaille stocké pour un mois zéro (14h00) et ceux fécondés avec SSP et stockés pendant deux mois (13.96). Les valeurs de fibre de détergent neutre (FDN) la plus élevée et la plus faible et de la lignine de détergent acide (LDA) ont été enregistrées pour le foin de légumineuses fertilisées de volaille (51,55% et 8,41%) et celles fécondées avec SSP (46,58% et 7,83). L'effet de la durée du stockage sur les fractions de fibres de stylosanthes guanensis foin a suivi une tendance similaire. Le FDN (52,53%), ADF (17,10%), LDA (7,50%) et l'hémicellulose (34,43%) (34,43%) étaient nettement plus élevés pour le foin de légumineuses stocké pendant quatre mois et moins chez ceux stockés pendant une zéro mois (48,53%, 16,17%, 7,30% et 29,37%, respectivement). L'interaction des sources de phosphore et de la durée du stockage n'était importante que sur le FDN et l'hémicellulose. Les foins de stylosanthes stockés pour zéro et deux mois sont plus agréables en raison de leur teneur élevée en feuille, tandis que la SSP et le fumier de volaille améliorent les feuilles de foin pendant le stockage. En conclusion, l'étude peut impliquer que l'interaction de ces facteurs pourrait fournir aux animaux une absorption suffisante des nutriments provenant du nombre élevé de feuilles enregistrées.

Mots-clés: fraction de fibre, légumineuses, stylosanthes, foins, phosphore

Introduction

Livestock production is one of the fastest-growing agricultural sub-sector in developing countries (Ewetola, 2018). In Nigeria, it contributes 6-8% of the GDP and 20-25% of agricultural GDP (Aishat, 2016). The demand for livestock and their by-products will continue to increase due to population growth and urbanization. However, prolonged yearly dry seasons, on the other hand, have a detrimental impact on plant performance, resulting in a restricted quantity and poor quality of available fodder at this time. This results in lower voluntary feed intake, nutrient utilization, and lower overall ruminants' performance (Ojo *et al*., 2020a). Ruminants relish forages which give them the energy needed to grow, reproduce and stay healthy. They depend on pasture for their nutrition than any other feed resource (Aderinola *et al*., 2008). Hence, forages must be available for livestock consumption during the rainy and dry season to enhance sustainable livestock production. Hay production is an essential method of forage conservation during lush to provide feed resource when grasses become scarce. On the other hand, inclement weather frequently stymies hay production when forages are due for preservation, as the hay must be thoroughly dried for efficient preservation (Michael, 1999). This appears to have deterred farmers from producing and using hay for animal feed, particularly in the humid tropics, where silage production and use has an advantage over hay for farmers who can afford the necessary infrastructure (Ewetola *et al*., 2021; Ojo *et al*., 2020b; Usman *et al*., 2021). Several animal manures have been described as beneficial for soil amendment and increasing the nutritional quality of tropical plants (Ewetola *et al*., 2016; Ojo *et al*., 2015b). Potential soil amendments for agricultural and pasture plants include swine manure (Ojo *et al*., 2020a), cattle dung (Jimoh *et al*., 2019), farmyard manure (Ahmed *et al*., 2012), and poultry droppings (Amisu et al., 2019). As a result, organic manure fertilization of pastureland fits nicely into the context of nutrient recycling and environmental protection (Jimoh *et al*., 2019) while improving the yield and quality of forages (Amisu *et al*., 2019; Idowu *et al*., 2020; Ojo *et al*., 2020b). Moreover, studies on how the length of storage influence hay quality in southwestern Nigeria is relatively limited. This suggests the need for more studies in this front to identify how long hay can be stored in this region. Stylosanthes is a vital fodder legume that has been widely utilized for livestock feed. It is a phosphorus-loving plant (Hanson and Heering, 1994; Nkaa *et al*., 2014). It is native to South America and widely cultivated in South-East Asia, Africa, and Australia, where many cultivars had been developed to suit local conditions (Mannetje, 1992). *Stylosanthes guianensis* is particularly suited for forage in subhumid tropical and subtropical areas with a marked dry season. It is used for hay, cut-and-carry systems and pasture (Cook *et al*., 2005). In this sense, understanding the better source of P for stylosanthes cultivation and the storage duration of the ensuing hay could help increase the availability of feed resources for ruminants during the off-season. Thus, the present study aims to determine the influence of different sources of P fertilizer and storage duration on physical characteristics and fibre fractions of hay produced from *S. guianensis*.

Materials and methods

Experimental site

The field experiment was carried out at the Pasture unit of the Directorate of University Farms (DUFARMS), Federal University of Agriculture, Abeokuta (FUNAAB), Ogun State, Nigeria, located

in the derived savannah zone of the southwest Nigeria on latitude 7° 10' N, longitude 3° 2'E and altitude of 76m above sea level while the laboratory experiment took place at the Department of Pasture and Range Management laboratory, FUNAAB.

Land preparation

The land was ploughed and allowed to rest for two weeks before it was harrowed. The experimental land measuring 336m^2 (28mx12m) was mapped out and pegged, with the main plot (9mx2m) and the sub-plot (2mx2m). A boundary of 2m was set out between blocksprior to planting, soil samples were randomly collected using diagonal method from the field at depth of 0–15cm using soil auger to represent the topsoil. The samples were bulked per replicate, mixed thoroughly and sub-samples were analyzed to determine the pre-planting nutrient status of the soil.

Sourcing and application of fertilizers

The soil amendments used were poultry manure and single superphosphate (SSP). Poultry manure was sourced from the poultry unit, the Directorate of University Farms (DUFARMS) and SSP from a reputableagro-allied store at Igboora, Oyo state. The poultry manure and SSP were applied at 80kgP/ha. The application rate was calculated based on the fertilizers' chemical composition (i.e., P content).

Sourcing of sowing materials, scarification and sowing

Seeds of *S. guianensis* were sourced from the National Animal Production Research Institute (NAPRI) Shika, Ahmadu Bello University, Zaria. The legume seeds were scarified with hot water (80˚C) a day before planting. (Olanite, 1997).The seeds were sown by broadcasting at the rate of 7kg/ha.

Experimental design

The study was a 3×3 factorial arrangement laid out in a split-plot design with an experimental area measuring 336m^2. The sources of phosphorus (SSP, poultry and control) were assigned to the main plot, while the storage duration (0,2 and 4 months) adopted was assigned to the sub-plot.The inter and intra-plot spaces were kept weed free throughout the experimental period by hand weeding

Sample harvesting and hay production

Samples were harvested 10 weeks after sowing. The herbage samples (2 kg) collected on the field were packed into nets and labeledand conserved as hay. Drying was carried out conventionally by spreading the legume on the open floor for gradual dehydration under solar radiation.

Laboratory analysis

Fibrefractions such as Neutral detergent fibre (NDF), Acid detergent fibre (ADF) and Acid detergent lignin (ADL) were determined with the procedure of Van Soest*et al.* (1991). Cellulose content was taken as the difference between ADF and ADL while hemicellulose content was calculated as the difference between NDF and ADF.

Assessment of physical characteristics of hay

Samples taken from the hay were assessed physically according to Vough (2000) procedure to determine the following features: i. Colour ii. Odour iii. Leafiness iv. Presence of foreign materials or weed

Statistical analysis

Data collected were subjected to two-way analysis of variance (ANOVA), and the treatment means were separated using Duncan's Multiple Range Test of SAS (1999) package.

Results

Table 1 shows the effects of phosphorus sources and storage duration on the physical characteristics of hay produced from *stylosanthes guianensis*. The unfertilized S*tylosanthes guianensis* hay (12.28) and those fertilized with poultry manure (12.96) recorded higher leafiness than those fertilized with SSP (10.39). The values for color were higher in the

unfertilized legume hay (12.65) and lower in those fertilized with poultry manure (11.78). Odour values ranged from 14.14 in the legume hay fertilized with SSP to 14.77 in those fertilized with poultry manure. However, no effect of phosphorus sources was observed on foreign materials in the legume hay. For storage duration, leafiness was similar at 0 (13.09) and two months (13.88) but significantly lower at four months (8.47). The values recorded for colour was similar for zero and two months, and the least was observed for the legume hay stored for four months. Odour and foreign materials were not influenced by storage duration.

Only leafiness and colour were influenced by the interaction of phosphorus sources and storage duration (Table 2). The highest leafiness was recorded for *Stylosanthes guianensis* hay fertilized with poultry manure and stored for zero months (14.00) and those fertilized with SSP and stored for two months (13.96). The legume hay fertilized with SSP and stored for zero months, and those fertilized with poultry manure and stored for four months recorded statistically similar values. The lowest leafiness was recorded for the unfertilized legume hay stored for four months.

Table 1: Effects of phosphorus sources and storage duration on physical characteristics of hay produced from *Stylosanthes guianensis*

Factors	Leafiness	colour	odour	Foreign material
Phosphorus sources				
Control	12.28[a]	12.65[a]	14.67[b]	8.33
SSP	10.39[b]	11.92[b]	14.13[c]	10.00
Poultry	12.96[a]	11.78[c]	14.77[a]	9.43
SEM	1.07	1.22	1.67r	1.00
Storage duration				
0 months	13.09[a]	12.30[a]	17.00	8.50
2 months	13.88[a]	14.18[a]	16.43	7.00
4 months	8.47[b]	9.14[b]	13.33	6.90
SEM	0.79	0.96	1.13	1.00

[a,b:] means with same superscript are not significant
SEM = Standard error of mean

Table 2. Interaction effects of phosphorus sources and storage duration on physical characteristics of hay produced from *Stylosanthes guianensis*

		Leafiness	colour	Odour	Foreign material
Control	0 Months	8.00[e]	13.00[b]	12.67	10.00
	2 Months	7.00[f]	12.33[c]	11.33	11.67
	4 Months	5.00[g]	10.00[f]	10.00	9.00
SSP	0 Months	11.63[c]	11.84[d]	17.67	10.00
	2 Months	13.96[a]	15.26[a]	16.00	10.00
	4 Months	9.67[d]	8.48[g]	15.90	8.00
Poultry	0 Months	14.00[a]	15.00[a]	15.00	7.00
	2 Months	13.67[b]	13.00[b]	13.67	7.08
	4 Months	11.95[c]	11.00[e]	11.63	6.50
SEM		0.67	0.64	0.53	0.43

[a,b, c, d e, f, g:] means with same superscript are not significant
SEM = Standard error of mean

Table 3 shows phosphorus sources and storage duration effects on the fibre fractions of hay produced from *Stylosanthes guianensis*. The highest and lowest NDF and ADL were recorded for poultry fertilized legume hay (51.55% and 8.41%) and those fertilized with SSP (46.58% and 7.83%). In contrast, ADF was higher in the legume hay fertilized with SSP (18.75%) and theleast was recorded for the unfertilized hay (17.63%). Phosphorus sources did not influence hemicellulose and cellulose.

The effect of storage duration on the fibre fractions of *Stylosanthes guianensis* hay followed a similar trend. NDF (52.53%), ADF (17.10%), ADL (7.50%), and hemicellulose (34.43%) were significantly higher for the legume hay stored for four months and lower in those stored for zero month (48.53%, 16.17%, 7.30%, and 29.37%, respectively). There was no effect of storage duration on cellulose.

The interaction of phosphorus sources and storage duration was significant on NDF and hemicellulose but not the legume hay's ADF, ADL, and cellulose content as presented in Table four. The highest and lowest NDF was recorded for the unfertilized legume hay stored for zeromonths (62%) and those fertilized with poultry manure and stored for zeromonths (34%). However, the *Stylosanthes guianensis* hay fertilized with SSP and stored for zeromonths (50%) and two months (50%) recorded statistically similar values. Hemicellulose was ($p<0.05$) higher in poultry fertilized legume hay stored for four months (40%) and lower in those fertilized with the same manure and stored for zero months (12%).

Table 3: Effect of phosphorus sources and storage duration on the fibre fraction (%) of hay from *Stylosanthes guainensis*

Factors	NDF	ADF	ADL	Hemicellulose	Cellulose
Phosphorus sources					
Control	49.00^{b}	17.63^{c}	8.17^{b}	29.17	7.67
SSP	46.58^{c}	18.75^{a}	7.83^{c}	25.53	8.92
Poultry	51.55^{a}	18.08^{b}	8.41^{a}	31.67	7.68
SEM	2.05	1.70	0.97	2.73	1.95
Storage duration					
0 months	48.53^{c}	16.17^{c}	7.30^{c}	29.37^{c}	7.47
2 months	51.00^{b}	16.25^{b}	7.47^{b}	31.83^{b}	7.50
4 months	52.53^{a}	17.10^{a}	7.50^{a}	34.43^{a}	7.45
SEM	1.36	1.18	0.62	1.82	1.29

^{a,b,c}: means in the same column with different superscript are significantly different ($p<0.05$)
SEM: Standard error of mean
NDF = Neutral detergent fibre
ADF = Acid detergent fibre
ADL = Acid detergent lignin

Table 4: Interaction effects of phosphorus sources and storage duration on the fibre fractions (%)of hay from *Stylsanthes guainensis*

Factors		NDF	ADF	ADL	Hemicellulose	Cellulose
Control	0 Months	62.00^{a}	23.00	4.67	37.00^{b}	16.33
	2 Months	48.00^{d}	28.33	6.33	17.67^{h}	20.00
	4 Months	52.00^{b}	15.00	8.00	35.00^{c}	5.00
SSP	0 Months	50.00^{c}	18.00	4.67	30.00^{d}	11.33
	2 Months	50.00^{c}	19.00	9.07	29.00^{e}	7.93
	4 Months	43.00^{f}	19.00	8.00	22.00^{f}	9.00
Poultry	0 Months	34.00^{g}	20.00	10.00	12.00^{i}	8.00
	2 Months	46.00^{e}	22.00	11.67	22.00^{g}	8.33
	4 Months	55.00^{ab}	13.00	8.63	40.00^{a}	3.37
SEM		2.22	2.16	1.62	2.12	2.87

$^{a,b\ldots f}$: means in the same column with different superscript are significantly different ($p<0.05$)
SEM: Standard error of mean
NDF = Neutral detergent fibre
ADF = Acid detergent fibre
ADL = Acid detergent lignin

Discussion

In the tropics and subtropics, legumes as an essential component of ruminant feed are widely acknowledged, especially in the dry season (Ojo *et al*., 2015a; Li *et al*., 2017). Forage nutritive value is essential in appraising the suitability of fodder for livestock feeding. When forages are conserved as hay, visual examination of the conserved fodder could help determine the possibility of livestock deriving sufficient nutrients from it. In this sense, factors such as colour, leafiness, proportion and coarseness of stems, odour, moulds, and the presence of foreign materials are considered (Marsalis *et al*. 2009; Salama and Zeid 2016). In this study, leafiness was higher in the unfertilized *Stylosanthes guianensis* hay and those fertilized with poultry manure than in the legume fertilized with SSP. This has the consequence that the former is of higher quality than the latter in terms of leafiness. The result further implies that the unfertilized and poultry manure fertilized hay will have higher nutrient content because most nutrients in plant tissues are found in leaves (Bosworth and Hudson 2017; Corvallis 2016). The hay stored for zero and two months are better than those produced at four months storage because the former had more leaves. Hay leafiness is related to palatability (Marsalis *et al*., 2009), and leaves are more digestible than stems. Hence, the stylosanthes hay stored for zero and two months are more palatable due to their high leaf content. Furthermore, both SSP and poultry manure enhanced hay leafiness at zero and two months' storage, respectively. This implies that the interaction of these factors could provide animals with sufficient nutrient uptake from the higher number of leaves recorded. Although hay colour does not indicate good quality (Ewetola, 2018), it is an index of vitamin A that confers proper curing (Marsalis *et al*., 2009). Hay colour may signify overheating (i.e., bleaching) or microbial activity that leads to heat generation due to microbial respiration in the process of drying (Ewetola, 2018). This study shows that hay colour was in the order control > SSP > poultry. This suggests that the phosphorus sources adopted in this study did not enhance hay colour compared to the control. Notably, the mean hay colour across the treatment suggests bleaching at the surface, which may decline its acceptability by animals. Concerning storage duration, the results indicate that hay colour can be retained for up to two months, beyond which the colour will deteriorate into golden yellow, possibly due to microbial activities (Bosworth and Hudson, 2017). The study found that hay color was better at the interaction level, though with little bleaching, in the stylosanthes fertilized with SSP and poultry manure. Hence, hay from these treatments would be more acceptable by animals than others. Odour depicts the kind of fragrance that will be perceived by animals when consuming cured hay. It is primarily affected by the moisture content in the forage at bailing (Marsalis *et al*.,2009). The unfertilized and P-fertilized legume hay produced in this study had the smell of newly mown hay. This means that the hays are generally of good quality. However, hays that smell mildew or off-odor will have lower quality and not be readily acceptable by animals. The NDF is a cell wall content that comprises cellulose, hemicellulose, lignin, silica, and minerals (Hancock *et al*., 2014). A forage quality index is directly related to animals' dry matter intake (Ojo *et al*., 2017). In this study, the higher NDF recorded for the legume hay fertilized with poultry manure is below 65%, the value generally known to impairs forage intake by ruminants (Van Soest, 1994; Muia, 2000). However, the NDF values recorded across the treatments are higher than 39.1% reported for 'Stylo 184' by (Kiyothong and Wanapat, 2004). The legume hay stored for four months had

higher NDF than those stored for zero and two months, respectively. However, the NDF values across the storage period are higher than the range of 38.48% to 41.06% reported for *Medicago lupiluna*, *Trifolium repens* and two other legumes in Turkey. Further, the values are higher than 44.38% reported for *Vicia sativus* by Tuna *et al*. (2004). The observed differences may be related to variation in growing sites, climate, fertilization, and the legume crops utilized in these studies. Nevertheless, all the NDF values recorded for the interaction of the studied factors are sufficient to promote forage intake by ruminants.

The ADF of forage is related to digestibility. Notably, forages with low digestibility will lack the potential to meet livestock nutrient requirements, necessitating supplementation, which increases production costs (Hancock, 2014). The SSP fertilized legume hay had a higher ADF than other treatments, which will reduce its digestibility when consumed by animals. Further, ADF increases with increasing storage duration, depicting a decline in quality as storage advances. However, the ADF values recorded in this study rank the legume hay as prime (<31% ADF) according to the American Forage and Grassland Council (Marsalis *et al*., 2009). Lignin, a non-digestible cell wall component prevents microbial enzymes from breaking down cellulose and hemicellulose in the rumen (Hancock, 2014). Therefore, the higher lignin recorded for the legume hay fertilized with poultry manure implies lower digestibility. This may impair the ability of the conserved forage hay to provide ruminants with sufficient energy following consumption. The results also show that lignin content in the stylosanthes hay increases with storage duration. Hence, further research is needed to examine possible ways of reducing lignin build-up during hay storage. Hemicellulose is a structural carbohydrate that is only slightly digestible in the rumen of animals, though slowly. Therefore, the high hemicellulose content recorded at four months storage may further slow down its digestion and possibly reduce, if not prevent, animals from deriving energy from it. Moreover, poultry manure fertilized legume hay stored for four months is less digestible than other treatments due to high lignin content. However, the same treatment stored for zero month could better provide animals with energy.

Conclusion

The study showed there were variational effects from the fertilizer and storage duration as stylosanthes hay stored for zero and two months are more palatable due to their high leaf content, while both single super phosphate and poultry manure enhance hay leafiness at zero and two months' storage, respectively. However, poultry manure fertilized legume hay stored for four months is less digestible than other treatments due to high lignin content as results also showed that Acid detergent fibreand lignin content in the stylosanthes hay increased with storage duration depicting a decline in quality as storage advances.

Acknowledgments

I profoundly appreciate the Tertiary Education Trust fund (TETfund), under the National Research Fund (NRF 2019) grant (TETfund/DR&D/CE/NRF/UNI/ABEOKUTA/STI/16/1/Vol1) for financing and creating a workable environment for this research.

References

Aderinola, O. A., Akinlade, J. A., Rafiu, T. A. and Fajimi, T. 2008. Feed intake,digestibility and nitrogen balance of West African Dwarf Sheep and goat fed *Vetiverianigritana* grass. Proceeding of the 32nd Annual

Conference of the Nigeria Society for Animal Production. Calabar. March 18-21,310-312.p

Aishat, O. 2016. Retreat On Livestock and Dairy Development In Nigeria – Keynote Address Delivered By The Hon . Minister Of Agriculture And Rural Development , Chief Audu Ogbeh. Abuja.

Amisu, A. A., Jimoh, S. O., Ewetola, I. O., Ojo, V. O. A. and Olanite, J. A. 2019. Growth features, yield, and botanical composition of Stylosanthes hamata (CV. Verano) as affected by phosphorus sources applied at varying rates, sowing methods and stage of growth. J. Anim. Prod. Res. 31, 179–193.

Bosworth, O. and Hudson, I. 2017. Sensory Evaluation of hay for quality. A published article by University of Vermont Extension Service.

Cook, B. G., Pengelly, B. C., Brown, S. D., Donnelly, J. L., Eagles, D. A., Franco, M. A., Hanson, J., Mullen, B. F., Partridge, I. J., Peters, M. and Schultze-Kraft, R.2005. Tropical forages. CSIRO, DPI&F(Qld), CIAT and ILRI, Brisbane, Australia.

Corvallis.J.2016. List the characteristics of good hay and the steps need to make it. National Forage and Grasslands Curriculum. Department of Crop and Soil Science, Oregon State University, page 1-2.

Ewetola, I.A., 2018. Evaluation of growth, yield, and nutritive quality of fertilized *Panicum maximum* and *Andropogon tectorum* and their hay produced through different drying techniques. Federal University of Agriculture, Abeokuta, Nigeria. https://doi.org/10.4324/9781315776095-58

Ewetola, I.A., Adebayo, K.O., Amisu, A.A., Jimoh, S.O., Dele, P.A., Olanite, J.A., Arigbede, O.M.,2021. Chemical composition of hay produced from three different drying techniques. Niger. J. Anim. Prod. 48, 142–153.

Hancock, D.W., Bernard, J.K., Smith, R.C., 2014. Understanding and improving forage quality. Univ. Georg. Ext. Bull. 1–16.

Idowu, W., Hassan, M.R., Tanko, R.J., Amodu, J.T., Adewumi, A.E., Oyewo, T.O., Adeleke, R.A., Bello, S.S., Kperun, N.T.,2020. Chemical composition of Panicum maximum as affectedby pig manure rates, planting method and harvesting stages in the northern guinea savana of Nigeria. FUDMA J. Sci. 4, 340–347.

Jimoh, S.O., Amisu, A.A., Dele, P.A., Ojo, V.O.A., Adeyemi, T.A., Olanite, J.A., 2019. Effects of animal manures and cutting height on the chemical composition of two *Panicum maximum* varieties (Local and Ntchisi) harvested at different stages of growth. Pertanika J. Trop. Agric. Sci. 42, 359–376.

Kiyothong, K., Wanapat, M.,2004. Supplementation of cassava hay and stylo 184 hay to replace concentrate for lactating dairy cows. Asian-Australasian J. Anim. Sci. 17, 670–677. https://doi.org/10.5713/ajas.2004.670

Li, L., Yang, T., Liu, R., Redden, B., Maalouf, F., Zong, X.,2017. Food legume production in China. Crop J. 5, 115–126. https://doi.org/10.1016/j.cj.2016.06.001

Mannetje, L.'T, 1992. *Stylosanthesguianensis (Aublet) Swartz*. Record from Proseabase.

Mannetje, L.'t and Jones, R.M. (Editors). PROSEA (Plant Resources of South-East Asia) Foundation, Bogor, Indonesia.

Marsalis M. A, Hagevoort G. R, Lauriault L.M. **2009**. Hay quality, sampling, and testing. New Mexico State University, USA. Circular 641, pp. 1-8.

Muia, J.M.K..2000. Use of Napier grass to improve smallholder milk production in Kenya. Ph.DThesis. Wageningen Agricultural University. The Netherlands.

Nkaa, F.A., Nwokeocha, O.W. and Ihuoma, O.2014. Effect of Phosphorus fertilizer on growth and yield of cowpea (Vigna unguiculata). Journal of Pharmacy and Biological Sciences, 9(5), 74–82

Ojo, V.O.A., Adeshina, F.T., Adetokunbo, G.A., Jimoh, S.O., Adeyemi, T.A., Njie, J.L., Onifade, O.S., **2020a**. Effects of swine manure application and row spacing on growth of pearl millet (*Cenchrus americanus*) during the establishment period and quality of silage produced in Southwest Nigeria. Trop. Grasslands-Forrajes Trop. 8, 115–124.

Ojo, V.O.A., Adeshina, F.T., Adetokunbo, G.A., Jimoh, S.O., Adeyemi, T.A., Njie, J.L., Onifade, O.S., 2020b. Effects of swine manure application and row spacing on growth of pearl millet (Cenchrus americanus) during the establishment period and quality of silage produced in Southwest Nigeria. Trop. Grasslands-Forrajes Trop. 8, 115–124. https://doi.org/10.17138/tgft(8)115-124.

Ojo, V.O.A., Jolaosho, A.O., Olanite, J.A., Olorunnisola, D.T., Adeoye, S.A., Adelusi, O.O., Aderinboye, R.Y., Murana, T.O., Amole, T.A.,2015a. Effects of legume species and tilage on the nutritive quality of silage produced from improved natural pastureA, in: Moorby, J.M., Jewkes, E.C. (Eds.), Grassland and Forage Management. Twelfth Research Conference Proceedings of British Grassland Society. British Grassland 5ociety., Aberystwyth, UK, pp. 101–102.

Salama, H.S.A., Zeid, M.M.K.,2016. Hay quality evaluation of summer grass and legume forage monocultures and mixtures grown under irrigated conditions. Aust. J. Crop Sci. 10, 1543–1550. https://doi.org/10.21475/ajcs.2016.10.11.PNE113

Tuna, C., Coskuntuna, L. and Koc, F. 2004. Determination of Nutritional Value of Some Legume and Grasses. Pakistan J. Biol. Sci. 7, 1750–1753. https://doi.org/10.3923/pjbs.2004.1750.1753

Usman, S., Dele, P. A., Jimoh, S.O., Aderinboye, R., Olanite, J.A.,2021. Physical, fermentative, and nutritional quality of silages made from three Sorghum bicolor varieties as affected by ensiling duration in South-west Nigeria. Trop. Anim. Health Prod. 53, 239.

Van Soest, P. J. 1994. Nutritional ecology of the ruminant, 2nd ed. ed. Comstock Publishing Associates/Cornell University Press, Ithaca, NY, USA.

Vough, L. R. 2000. Evaluating hay quality. https://extension.umd.edu/sites/default/files/202104/Evaluating%20Hay%20Fact%20Sheet%20Fs644.

Received: 13th November, 2021
Accepted: 25th February, 2022