Nigerian J. Anim. Sci. 2016 (2):542 - 550

Residual effects of animal manures on physical and chemical characteristics of silage produced from *Panicum maximum* (Ntchisi) in Abeokuta south-west, Nigeria

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Target Audience: Forage agronomist, Ruminant nutritionist, and Livestock farmers

Abstract

This experiment was conducted to investigate effects of animal manures on chemical composition of silage produced from Panicum maximum (Ntchisi) two - years post application. The plots were established in June 2010 during this period, animal manures from cattle dung, swine waste, poultry droppings and small ruminant waste had been applied. In late July 2011, (i.e. after 8 weeks of re-growth) the forage materials were harvested at 25 cm above ground level from the plots where Panicum maximum (Ntchisi)[P. maximum N]fertilized with different animal manures were grown to produce silage. The silages were opened after 45 and 90 days of ensiling and sub samples were taken for determination of physical and chemical characteristics. The experiment consists of two factors namely; four manure types and control (i.e. without manure) and two lengths of ensiling (45 and 90 days).It was 5 x 2 factorial arrangements with 3 replicates. It was observed that all the parameters of physical characteristics of silage were significantly (P < 0.05) influenced except moisture content. Also, proximate and fibre compositions parameters were significantly (P < 0.05) different. The animal manures applied had positive effect on mouldiness of silage and, this was more pronounced in cattle manure at 90 days of ensiling. The silage produced from poultry–manure fertilized grass had desirable crude protein value, but at 90 days of ensiling, the best performance was observed with a considerable low ADF value. To ensure all year-round production of ruminants through adequate feeding with silage, Panicum maximum (Ntchisi) fertilized with poultry manure ensiled for 90 days is therefore recommended for the farmers.

Key words: residual; organic manure; silage; *Panicum maximum* (Ntchisi)

Description of Problem

The considerable interest has been generated regarding the use of organic materials on agricultural lands for restoring soil fertility and sustainability and for preventing potential environmental problems associated with commercial fertilizers. Therefore, animal manure is preferred over commercial fertilizers because of increasing awareness of negative impacts of commercial fertilizers on the environment such as soil toxicity, mineral imbalance and release of Nitrous oxide (1). Also the use of organic manure proved to be more effective in enhancing the chemical composition of tropical grasses when compared with urea fertilizer (2). Thus, linking forage production with animal manure utilization is a sound approach for addressing the problem of disposal of such materials which ordinarily would have constitutes nuisance to the environment. High quality and quantity forage materials could be produced either for immediate utilization or conservation as hay or silage from the sites where manure has accumulated over a period of time, although optimal management of forage and manure applied depends on local site characteristics (3). The utilization of silage has been an alternative to make feed available all year round especially during dry season when there would be low quality forage materials due to imposed environmental stress, and this consequently resulted to poor animal performance. Hence, one of the suitable strategies that have been adopted to maximize the availability of abundance forage materials to ensure all year-round production is the ensiling the green forage as silage (4) and successfully stored and feed to animals during extreme scarcity. Although, the quality of forge will slightly lower than its fresh state (10-15 % lower in good ensiling condition) but it will still be better quality than many of the forages only available during drought period. Conversely, in some location, the silage is used as supplementary feed to other good quality but very slow growing forages (4). Forage should be harvested when excess to feed animals but also when high in nutritive quality especially in the wet season. The ensiling process is often described as one of the ways of minimizing nutrient losses and change in nutritive value of the silage. This is influenced by multitude of factors, both biological and technological. Many of these factors are interrelated and it is difficult to present their significance individually. The fermentable sugar or water soluble carbohydrate (WSC) content has been used to predict the suitability of forage materials for silage making (5). When forage dry matter (DM) is high enough, good silage in terms of both physical and chemical composition can be produced irrespective of WSC, but when DM and WSC are both low, the silage is usually poor (5). In order to produce good quality silage, wilting of the harvested materials is used to increase the DM of the forage by reducing the moisture content before ensiling. The wetter the grass is the lower the pH needs to be and greater amount of lactic acid that needs to be produced. The wet grass of approximately 20 % DM will required a pH of around 4.0 for silage to be stable but grass at 30 % DM will need pH of 4.6 to 4.8 to produce the same result. However, wet silage of approximately 20 % DM should contain 13 % crude protein, 20 % acid detergent fibre, 0.4 % Calcium and 0.8 % Phosphorus, but this depend on the forage species (6,7,8). Therefore, an experiment was conducted to investigate effect of animal manures on chemical and physical compositions of silage produced from Panicum maximum (Ntchisi) two - years post application.

Materials and Methods

Experimental site

This experiment was established in DUFARMS Federal University of Agriculture, Abeokuta, Nigeria (FUNAAB). The laboratory analyses were conducted in Department of Pasture and Range Management laboratory, College of Animal Science and Livestock Production, FUNAAB. The Research Site is located in the derived savannah zone of South Western Nigeria with rainfall ranges of 120 mm (May) to 195 mm (September) and mean monthly temperature range of 22.5°C-33.7°C

Table 1: Main effect of manure types and length of ensiling on physical characteristics of *Panicum maximum* (Ntchisi) silage

	Colour	Odour	Moisture	Mouldiness	pH	Total
Length of ensiling						
45 days	8.80^{b}	21.42^{b}	8.09	7.33^{a}	5.77^{a}	76.07^{a}
90 days	9.60^{a}	23.87^{a}	8.47	6.40^{b}	5.46^{b}	80.56^{b}
SEM	0.23	0.53	0.33	0.36	0.03	1.58
Manure types						
Cattle	9.22	23.11	8.50	7.72^{a}	5.56^{b}	80.93^{a}
SMR	8.89	22.67	8.50	6.94^{a}	5.65^{a}	78.33^{ab}
Poultry	9.28	21.11	7.67	5.28^{b}	5.69^{a}	72.22^{b}
Swine	9.50	23.33	8.44	7.83^{a}	5.72^{a}	81.85^{a}
Control	9.11	23.00	8.28	6.56^{a}	5.46^{c}	78.24^{ab}
SEM	0.42	0.94	0.55	0.47	0.07	2.32

^{a,b,c} means in the same column with different superscripts were significantly different (P<0.05)
SEM: Standard error of mean SMR: Small ruminant

Table 2: Interactive effect of manure types and length of ensiling on the physical characteristics of *Panicum maximum* (Ntchisi) silage

Manure	Length of ensiling	Colour	odour	moisture	Mouldiness	p^{H}	Total
Cattle	45 days	9.67^{ab}	23.00^{abc}	8.22	9.00^{a}	5.91^{a}	83.15^{a}
	90 days	8.78^{ab}	21.56^{abc}	8.00	8.11^{ab}	5.79^{ab}	77.41^{abc}
SMR	45 days	8.22^{b}	21.33^{abc}	7.56	6.78^{bcd}	5.62^{cde}	73.15^{bc}
	90 days	8.11^{b}	20.33^{c}	8.33	7.22^{abc}	5.80^{ab}	73.33^{bc}
Poultry	45 days	9.22^{ab}	20.89^{bc}	8.33	5.56^{cd}	5.73^{bc}	73.33^{bc}
	90 days	9.33^{ab}	23.67^{abc}	8.67	6.67^{bcd}	5.52^{de}	80.56^{ab}
Swine	45 days	9.67^{ab}	24.67^{ab}	9.00	7.33^{abc}	5.33^{f}	84.44^{a}
	90 days	10.00^{a}	24.67^{ab}	9.00	6.33^{bcd}	5.29^{f}	83.33^{a}
Control	45 days	9.67^{ab}	25.00^{a}	8.67	6.67^{bcd}	5.50^{e}	83.33^{a}
	90 days	9.33^{ab}	21.33^{abc}	7.00	5.00^{d}	5.65^{cd}	71.11^{c}
	SEM	0.18	0.43	0.24	0.27	0.04	1.18

$^{a-f}$ means in the same column with different superscripts were significantly different (P<0.05)
SEM: Standard error of mean, SMR: Small ruminant

Table 3: Main effect of manure type s and length of ensiling on chemical composition of *Panicum maximum* (Ntchisi) silage

Factors	DM	CP	EE	ASH	NDF	ADF	ADL	HEM	CEL
Length of ensiling									
45 days	96.10^{a}	6.56	9.39^{a}	12.70^{a}	73.21^{a}	45.94^{a}	12.58^{a}	31.36	33.36^{a}
90 days	91.80^{b}	7.18	7.85^{b}	11.88^{b}	70.17^{b}	41.85^{b}	9.37^{b}	24.33	32.48^{a}
SEM	0.21	0.32	0.59	0.20	1.28	0.42	0.90	1.33	0.92
Manure									
Cattle	94.50^{a}	6.30	7.50^{b}	12.16	74.59^{a}	42.59^{b}	8.09^{c}	31.99^{a}	34.51^{a}
SMR	94.50^{a}	6.66	7.29^{b}	12.42	75.13^{a}	44.43^{a}	13.98^{a}	30.70^{ab}	30.45^{b}
Poultry	93.75^{ab}	7.11	9.91^{a}	12.26	67.86^{b}	44.04^{a}	10.23^{bc}	23.81^{c}	33.81^{a}
Swine	93.75^{ab}	7.50	8.89^{a}	12.51	67.46^{b}	43.60^{ab}	13.03^{ab}	23.86^{c}	30.57^{b}
Control	93.25^{b}	6.78	9.49^{a}	12.08	73.39^{b}	44.80^{a}	9.53^{c}	28.59^{b}	35.27^{a}
SEM	0.99	0.49	0.84	0.32	1.21	1.02	1.24	1.85	1.16

^{a,b,c} means in the same column with different superscripts were significantly different ($P<0.05$)

SEM: Standard error of mean SMR: Small ruminant

DM= dry matter, CP= crude protein, EE= ether extract, NDF= neutral detergent fibre, ADF= acid detergent fibre, ADL= acid detergent lignin, HEM= hemicellulose, CEL= cellulose

(47.08 %) while that of SWM at the same length of ensiling recorded the lowest value (38.86 %). Meanwhile, the silage produced from SRM at 90 days of ensiling observed to be the highest (16.41 %) for ADL, while that of NM at the same length of ensiling had the lowest value (6.25 %) indicating less lignification of the silage produced. The silage produced from the plot that received CM at 45 days of ensiling was observed to obtain the highest value (13.62 %) for ash. This indicates that CM enriched the mineral content of the silage. The silage produced from PM but at 90 days of ensiling recorded the lowest value (11.41 %) in this case. The highest value (36.78 %) of HEM was observed in the silage produced from the plot that received SWM at 45 days of ensiling while silage produced from CM fertilized grasses at the same length of ensiling recorded the lowest value (14.94 %). But this same treatment at 90 days of ensiling recorded the highest value (38.48 %) for CEL and that of SRM at the same length of ensiling had the lowest value (29.89 %). In EE, the silage produced from PM at 45 days of ensiling recorded the highest value (11.26 %) while that of SRM but at 90 days of ensiling recorded the lowest value (3.47 %)

Discussions

The physical characteristics of silage were determined from the colour, odour, moisture and mouldiness of the silage. The moistness of the silage is a good indicator of how well it was conserved as the moistness of the silage fell within the range of no free water and slightly moist silage (9). This is also in conformity with the findings of (13). The slightly mould to no mould silage observed under this study was an evident indication that the silage was well conserved. It was in line with that of findings of (13). The scoring of the silage under this experiment implies that scores fell between fair silage and good silage as rated by (9) which is a good reflection of silage from tropical forages. The reduction in the dry matter content of the silage with increase length of ensiling agreed with findings of (14). This might be due to loss of soluble carbohydrates during fermentation period as reported by (15). The crude protein (CP) content of the silage that was influenced by the residual effects of different manures fall in the range of 6.05 – 8.40 % with silage made from plot with poultry manure having the highest CP. This is an indication that poultry manure releases more nitrogen than others (16). This could be attributed to a faster rate of decomposition of the organic matter in the poultry manure and earlier release of its nutrients in form of N and P for plant uptake.

Table 4: Interactive effect of manure types and length of ensiling on chemical composition of *Panicum maximum* (Ntchisi) silage

Manure	LOE	DM	CP	EE	ASH	NDF	ADF	ADL	HEM	CEL
Cattle	45 days	95.50^{a}	6.60^{ab}	8.21^{bc}	13.62^{a}	59.85^{d}	44.91^{ab}	14.25^{ab}	14.94^{f}	30.66^{c}
	90 days	96.50^{a}	6.54^{ab}	8.14^{bc}	12.44^{abc}	73.55^{a}	46.33^{a}	7.85^{cd}	27.22^{d}	38.48^{a}
SMR	45 days	96.00^{a}	5.84^{b}	8.16^{bc}	11.98^{bc}	74.96^{a}	47.08^{a}	10.17^{bcd}	27.88^{cd}	36.91^{ab}
	90 days	96.50^{a}	7.27^{ab}	3.47^{d}	12.95^{ab}	75.67^{a}	46.31^{a}	16.41^{a}	29.36^{bcd}	29.89^{c}
Poultry	45 days	96.00^{a}	6.57^{ab}	11.26^{a}	12.50^{abc}	66.81^{c}	45.08^{ab}	14.21^{ab}	21.73^{e}	30.87^{c}
	90 days	92.00^{b}	8.40^{a}	9.57^{ab}	11.41^{c}	75.08^{a}	42.30^{c}	11.82^{abc}	32.78^{ab}	30.48^{c}
Swine	45 days	92.50^{a}	6.06^{b}	6.85^{c}	11.89^{bc}	75.64^{a}	38.86^{d}	8.33^{cd}	36.78^{a}	30.53^{c}
	90 days	90.50^{c}	7.72^{ab}	10.83^{a}	12.18^{bc}	71.82^{ab}	42.52^{c}	8.89^{cd}	29.30^{bcd}	33.63^{bc}
Control	45 days	92.50^{b}	6.05^{b}	11.11^{a}	11.90^{bc}	74.60^{a}	42.55^{c}	11.55^{bc}	32.05^{bc}	31.00^{c}
	90 days	91.50^{bc}	7.65^{ab}	8.56^{bc}	12.02^{bc}	68.90^{bc}	43.00^{bc}	6.25^{d}	25.90^{de}	36.75^{ab}
	SEM	0.43	0.23	0.44	0.15	0.98	0.48	0.69	1.14	0.65

a-f means in the same column with different superscripts were significantly different ($P<0.05$)
SEM: Standard error of mean
LOE: length of ensiling
SMR: Small ruminant
DM= dry matter, CP= crude protein, EE= ether extract, NDF= neutral detergent fibre, ADF= acid detergent fibre, ADL= acid detergent lignin, HEM= hemicellulose, CEL= cellulose

Also, poultry droppings are very rich source of Nitrogen due to high accumulation of Uric acid and decomposition of manure could be enhanced by the nature of materials present in it which could in turn hasten the rate of microbial degradation of the manure. Similarly, (17) had observed that poultry manure recorded the highest effects on N and P available in the soil than other animal manure. The observation in this experiment slightly differed from the minimum CP requirement for optimum animal performance (18). The ether extract (EE) falls within and above the 8 % level established by (19) as a limit from which reductions would occur in the DM intake by ruminants. The reduction in EE content of the silage as the length of ensiling increased could be as a result of proteolytic enzymes involved in the breaking down compounds including peptides during ensiling as reported by (20). The ash contents of the silage as affected by manures applied and length of ensiling fell within range of 11.41-13.62 %, this is higher than that which was reported by (21) for silage produced from *P. maximum* (Ntchisi) at different age at harvest. However, the ash contents obtained in this experiment conformed to that which was reported by (22) for Napier grass fertilized with sheep manure. Neutral Detergent Fibre

(NDF) measures the total fibre component of the feedstuff. The range of NDF contents (59.85-75.67 %) in the silages produced in this study was higher than the 65.00 % suggested as limit above which intake of tropical feeds by ruminants would be reduced (11). Earlier findings suggested that high concentration of NDF in silage usually implies that many of the soluble nutrients have been degraded which in turn, reduced the nutritive value of the silage. However, feed high in NDF is essential for increase lactation in dairy cow (19) thus, the silage produced in this experiment may be suitable in dairy production. The ADF measures the least soluble portion of fibre in a given feed and it is also used in predicting the energy content of silage, hay and roughages. The higher the ADF, the less digestible the feed and less energy it contain (23). An increase in forage ADF content reflects a decrease in energy value, the ADF content of the silage produced in this study ranged between 38.86-47.08 %. This is lower than that which reported by (24). The increase in the ADF content observed in this trial could be attributed to utilization of readily digestible soluble content by fermentative bacteria (25). The ADL content of the silage range from 6.25-16.41 % which is higher than that which reported by (26). The increase in the ADL content of the silage produced from the plots that received manure over the control plot might be as a result of better growth performance which enhanced due to Nitrogen released from manures applied. This in turn, led to high lignification of the materials harvested for the silage. This is in line with early report of (27) that the ADL content of plant increased with increasing amounts of Nitrogen in tall fescue. The hemicellulose content ranged between 14.94-36.78 %. The observation in this experiment implies that the increase in hemicellulose content of the silage does not relate to imposed treatment i.e. manure since the silage produced from the plot that received no manure had higher values than those one produced from cattle manure. This might be linked to the trend observed in the NDF content where the silage produced from cattle manure had the lowest value. The cellulose content fell within 29.89-36.75 %, but there was no specific trend to explain the increase in the values obtained in relation to the effect of manures applied and length of ensiling.

Conclusions and Application

The following conclusions were made from the outcomes of this study;

1. The animal manures applied had positive effect on mouldiness of silage produced, since the silage produced from the plot that received cattle manure and at 90 days of ensiling produced silage without mould.
2. The silage produced from poultry–manure fertilized grass had higher crude protein and low ADF values, and at 90 days of ensiling.
3. For good quality silage, livestock farmers should fertilized their grasses with poultry manure and ensiled for 90 days.

References

1. Malhi, S. S., Harapiak, J.T., Gill,

K. S., and Flore, N. (2002). Long term Nitrates and subsequent Lime application effects on macro elements concentration in soil and brome grass hay. *Journal Sustainable Agriculture* 21:79-97.

2. Arigbede, O. M., Anele, U.Y., Südekum, K. H., Olanite, J. A., Oni, A.O., Dele, P.A. and Bolaji, O. J. (2010). Effects of different manure sources and urea application on chemical composition of three tropical pasture grasses. Proceedings, 89th Annual Conference of American Society of Animal Science, 11 – 15th July, 2010, Denver Colorado, USA.
3. Newton, G. L. Bernard, J. K. Hubbard, R. K. V. Allison, J. R. Lawrence, R. R. Gascho, G. J. Gates, R. N. and Vellidis, G. (2003). Managing manure nutrients through multi crop forage production. *Journal Dairy Science* 86: 224-225pp.
4. John, M. (2005). Tropical dairy farming: feeding management for smallholder dairy farmers in the humid tropics. Making quality silage, chapter 9, page 85-86.
5. McDonald, P. (1981). The Biochemistry of silage. New York: John Wiley and Sons.
6. Mudavadi, P. (2011). Preparing for the Dry spell: Farmers in Kipkaren and Ol Kalou in Kenya, experiment with the polythene tube silage technology.
7. Ouma, R., Njoroge, L., Romney, D., Ochungo, P., Staal, S., and Baltenweck, I. (2007). Targeting dairy interventions in Kenya; A guide for development planners,researchers and extension workers. Nairobi, Kenya: SDP/KDDP.
8. Savala, C. E., Omare, M. N., and Woomer, P. L. (2003). Organic resource management in Kenya: perspectives and guidelines. (C. E. Savala, Ed.) Forum for Organic Resource Management and Agricultural Technologies.
9. Bates, G. (1998b). Alfafa: High quality forage production. The University of Tennessee Agricultural Extension Service. SP 434-C.
10. A. O. A. C. (1990). The Offical of Analysis Association of Offical Analytical Chemist. Washington D. C.
11. Van Soest, P. J., Robertson, J. B. And Lewis, B. A. (1991). Methods for dietary fibre, neutral detergent fibre and non-starch polysaccharides in relation to animal nutrition. *Journal of Dairy Science* 74(10): 3583-3597.
12. SAS Institute Inc. (1999) SAS/STAT Guide for personal Computer. Version 10th ed. Cary, North Carolina,USA.
13. Ukanwoko, A. I. and Igwe, N. C. (2012). Proximate composition of some grasses and legume silages prepared in a humid tropical environment. *International Research Journal of Agricultural Science and Soil*

Science 2 (2): 68-71.

14. Adegbola, A.A., and Asaoulu, O. (1986). Preparation of cassava peels for use in small ruminant production in Western Nigeria. In Preston T.R. and Nuwanyakpa, M.Y. (eds) Proceeding of a workshop held at the University of Alexandria, Egypt, October, 1985, ILCA, Addis Ababa, Ethiopia, 109-115.
15. Oelberg, T. J., Clark, A. K., Mguffey, R. K. And Schingoethe, D. J. (1993). Evaluation of covering dry matter and preservatives at ensiling of Alfafa in bunker silo. *Journal of Dairy Science*. 66: 1057-1068.
16. Sodeinde, F. G., Akinlade, J. A., Aderinola, O. A, Amao, S. R., Alalade, J.A., Adesokan, A. T., (2009). Effect of poultry manure on proximate composition and in-vitro Gas production of *Panicum maximum* cv T 58 in the Derived Savanna Zone of Nigeria. *Pakistan Journal of Nutrition* 8 (8): 1262-1265, 2009 ISSN 1680-5194.
17. Schlegel, A. J. (1992) Effect of composted manure on soil chemical properties and nitrogen use by grain sorghum. *Journal of production Agriculture* 5: 153-157.
18. Minson, D.T. (1981). Nutritional differences between tropical and temperate pastures In: Grazing animals. Disciplinary approach. World Animal Science volume 34, Elsevier, Amsterdam, Netherlands. Pp 143-157.
19. National Research Council (NRC) (2001). Nutrient requirements of dairy cattle. 7th edition, National Academic Press. Washington, DC.
20. Vanbelle, M. and Bertin, G. (1985). L' ensilage. aspect biologiques nouveaux. Universite de Louvain, Faculte des Sciences Agronomiques, Place Croix du Sud, 3 Louvaun La Neuve, 1348, Belgium.
21. Babayemi, O. J. (2009). Silage quality, dry matter intake and digestibility by west African dwarf sheep of Guinea grass (*Panicum maximum* cv Ntchisi) harvested at 4 and 12 weeks regrowths. *African Journal of Biotechnology* 8 (16): 3983-3988.
22. Jusoh, S. B. (2005). Effects of sheep manure and application on the production of dwarf napier grass (*Pennisetum purpureum* cv MOTT) MSc. Thesis Faculty of Agriculture, Universiti of Putra, Malaysia 139pp.
23. McDonald, P., Henderson, A. R., and Heron, S. J. E. (1991).The Biochemistry of silage 2nd Ed. Marlow, UK: Chalcombe Publication.
24. Mustapha, A. F. and Seguin, P. (2003). Effects of stage of maturity on ensiling characteristics and ruminal nutrient degradability of oat. Archives of Animal Nutrition, 57(5): 346-358.
25. Schingoethe, D. J. (2004). Distiller grains for cattle. South Dakota State University

Extension Service Extra ExEx 4022 South Dakota, USA.

26. Aganga, A. A., Omphile, U. J., Thema, T. and Baitshotlh, J. C. (2005). Chemical composition of Napier grasses at different stages of growth and Napier grasses silage with additives. *Journal of Biological science* 5(4): 493-496.

27. Wolf, D., and Boberfeld, W. Opitz von. (2003). Effects of nitrogen fertilization and date of utilization on the quality and yield of tall fescue in winter. *Journal Agronomy Crop Science* 189, 47-53.