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Ensiling Quality of Gamba Fortified with Tropical Legumes and its Preference by Rabbits

[1]I.R. Muhammad, [2]M.I. Abdu, [3]G.T. Iyeghe-Erakpotobor and [1]K.A. Sulaiman
[1]Department of Animal Science, Faculty of Agriculture, Bayero University, Kano, Nigeria
[2]Department of Animal Science, Kano University of Science and Technology, Wudil
[3]National Animal Production Research Institute, Ahmadu Bello University, Shika Zaria, Nigeria

Abstract: An experiment was conducted to determine the species of legume that is compatible with gamba grass for ensilage and to establish the optimum proportion of legume inclusion for better silage preparation. Field grown Gamba grass (*Andropogon gayanus*) was sampled at soft dough stage and fortified with legumes forage from Centurion (*Centrocema pascourum* L.); Lablab bean (*Lablab purpureum* L.) and Groundnut (*Arachis hypogea* L). The treatments were 100% Gamba grass; 80% Gamba grass plus 20% groundnut; 60% Gamba grass plus 40% groundnut; 80% Gamba grass plus 20% Lablab; 60% Gamba grass plus 40% Lablab; 80% Gamba grass plus 20% mucuna and 60% Gamba grass plus 40% mucuna. Each of the treatment combination was ensilage using *in vitro* silos, kept at room temperature of 26°C for 21 days incubation period. Thereafter, pH and proximate composition were examined. The results obtained showed the compounded silages were good and moderately acidic with pH varying from 5.33-5.77. Higher acidic value was obtained from silage prepared of 60% Gamba grass plus 40% groundnut. Dry matter as fed varied significantly ($p<0.05$) from 308.0-508.0 g kg^{-1} succulent silage. Significantly higher ($p<0.05$) dry matter as fed was observed from treatments that had 60% Gamba grass plus 40% Lablab. Significantly higher CP was obtained from the inclusion of 40% of lablab. Organic Matter content (OM) of the silage vary significantly ($p<0.5$) from 45.7-69.1%. Ether Extract (EE) varied ($p<0.05$) from 6.6-19.4% with the higher values obtained from Gamba grass plus 40% lablab. The content of ash obtained showed significant variations ($p<0.05$) in the composed silages. Higher OM and CF content were obtained from treatments that had 100% Gamba grass. Rabbits however showed preference for sole ensilage gamba grass to fortified ensilage materials.

Key words: Grass-legume silage, proximate composition, semi arid zone, gamba grass (*Andropogon gayanus*) Mucuna (*Mucuna ripens* DC Benth.), Lablab bean (*Lablab purpureum* (L.)), stylo (*Stylosanthes hamata* (L.)) rabbit, preference

INTRODUCTION

The Semi arid and sub humid zones have seasonal pattern of rainfall yet hosting over 90% of the cattle and 70% of sheep and goats population (RIMS, 1992). There is sporadic year-round shortage in the supply of pasture both in quantity and quality despite of the abundant supply of feeds during the late rainy season. Furthermore, there are increasing indices towards intensification of livestock, for example, in Nigeria (Muhammad *et al*., 2007). A foremost contest to ruminant livestock producers in semi arid zone of West Africa is ensuring supply of sufficient quantity of quality feeds through out the year. One of the conventional approaches is silage as a feed conservation strategy in which feed is conserved during period of abundant supply so as to redistribute the supply over the year to meet the requirements of livestock resource. One of the major advantages of silage is that surplus forage can be conserved during the growing season at a time when hay making is mired by humid condition. Silage in a silo is secured from the hazard of combustion. Its production is not a common practice among the majority of the livestock producers in semi arid zone but a viable option of succulent feed conservation for use in the dry season. The contribution of legume to improving the ensiling quality had been noted (Sibanda *et al*., 1997; Titterton and Maasdorp, 1997). This trial was therefore, conducted to examine the species of legumes that is compatible with gamba grass for better silage preparation and to determine the optimum level of legume inclusion for better silage from gamba grass. It is hoped that the data generated will be used by livestock farmers in the region for conservation of high quality feed as silage.

Corresponding Author: I.R. Muhammad, Department of Animal Science, Faculty of Agriculture, Bayero University, Kano, Nigeria

MATERIALS AND METHODS

Experimental site: The experiment was conducted at Kano (11°59'N and 8°26'E) in the Semi arid zone at an altitude of 460 m above sea level. The climate of the study area is characterized by discrete wet and dry seasons. The mean annual rain fall vary from 600-1000 mm (KNARDA, 2001). The location has about 4-8 months of dry season with maximum and minimum temperatures of 33 and 15.2°C, respectively. The temperature goes as low as 10°C during harmattan. The environment is conducive to different species of livestock production (cattle, sheep, goats, rabbits, donkeys, horses and poultry). It is also favored with abundance of grassland for grazing by animals and free from tsetse fly infestation. Cereal crops grown in the region includes millet, sorghum, maize, cowpea, groundnuts, soybean, sesame. Commercial agricultural products include grains of pulses and cereals; horticulture crops and livestock.

Trial one: Silage preparation: One hundred days-old (100 days post planting) field grown gamba grass (*Andropogon gayanus*) was sampled at full bloom stage. The pasture had 95% inflorescence, 79.8% fresh leaf and about 19.8% brown senescence leaves below the mid stem. Intact whole plants were cut using a sickle 5 cm from the ground level. Legumes used in the study were mucuna (*Mucuna ripens* DC Benth.); Lablab bean (*Lablab purpureum* (L.)) and Stylo (*Stylosanthes hamata* (L.)). The legume fodder was sampled at flowering/early pod stage with 90% of the leaves fresh and green. Each of the legumes was harvested 5 cm from the ground level using sickle. The harvested m aterials were chopped to about 2 cm length and were ensilage in open mouthed Kilner jars (Cope BS 910-8, 100 mL) as follows: 100% gamba grass; 80% gamba grass plus 20% mucuna; 60% gamba grass plus 40% mucuna; 80% gamba grass plus 20% lablab; 60% gamba grass plus 40% lablab; 80% gamba grass plus 20% stylo and 60% gamba grass plus 40% stylo. Each of the treatment combination was ensilage in the *in vitro* silos and compressed until filled to the brim in 3 replicates. The lids were greased before screwed back tightly to provide anaerobic environment suitable for fermentation. The silos were kept at room temperature of 26°C for 21 days incubation period in the laboratory. Following 21days fermentation, the content of the silos were visually examined and scored for colour. Each jar was then open, the content from the first 5 cm of the silos were scooped off to safe guide against possible contamination by the grease used as air sealant, a pair of forceps was used to fetch samples from the middle of the bottles and the content scored for aroma on a subjective score of 1-4×3 independent scorers as described in Table 1. Thereafter, pH in water was determined using digital pH m. Furthermore, a sub-sample was taken from the prepared silages and oven dried at 60°C for 48 h for proximate analysis.

Table 1: Description of colour and aroma rating used as indices of silage quality

Rating	Colour	Aroma
1	Dark or deep brown	Putrid or rancid
2	Light brown	Pleasant
3	Pale yellow	Sweet
4	Yellowish green	Very sweet

Chemical and data analysis: The dried silage samples from each replicate of the treatments were ground to pass 1 mm screen using a Tecator Cyclotec 1093 sample mill. Proximate analysis was done to determine Nitrogen (N) for crude protein determination (N×6.25), Crude Fibre (CF), Ether Extract (EE), Nitrogen Free Extract (NFE) and ash according to AOAC (1999). Organic matter was calculated as the difference between DM and ash. Neutral Detergent Fibre (NDF) and Acid detergent fibre ADF were analysed according to procedures outlined by AOAC (1999).

The data collected were analysed as complete randomise design of General Linear Models of GenStat (2005). Differences between means were considered significant at probability level of 0.05.

Trial two: Preference by rabbits: Eight matured rabbits of 2.1±00 kg were caged in a fully walled house with 2 open windows for cross ventilation. The pen was cleaned daily. The rabbits were fasted over night. Twenty one centimetre diameter plastic feeders were labeled and 50 g of each of the treatments was weighed and placed into the labeled feeders. The rabbits were allowed access to the feed for 30 min in the morning from 10:00-10:30 am daily. Following withdrawal of silage, the rabbits were routinely fed 100 g concentrate and roughage *ad libitum*. This was repeated consecutively for 3 days within the week. Rabbit were rested for 4 days and the preference trial repeated again for another consecutive 3 days with corresponds 4 days of rest over 6 weeks. On each trial day, ort of silage offered was weighed and the preference intake was determined by difference.

RESULTS

Dry matter as fed and silage characteristics: Table 2 presents the pH, dry matter as fed and aroma of silage made from gamba grass fortified with graded levels of legumes in the semi arid zone. The values of pH obtained were not significantly different ($p>0.05$) for the silages prepared. The compounded silages were slightly acidic

Table 2: The effect of treatment on pH, dry matter as fed (g kg^{-1}), pH and aroma of Columbus grass Silage fortified with graded levels of legumes

Treatment	pH	DM as fed (g kg^{-1})	MC (%)	Aroma score*
100% Gamba grass (G)	6.10	600.00	40.00	3
80% G + 20% lablab	5.30	606.70	39.30	3
80% G + 20% mucuna	5.50	646.70	35.30	3
80% G + 20% Stylo	5.20	516.70	48.30	3
60% G + 40% lablab	5.60	500.00	50.00	3
60% G + 40% mucuna	5.20	530.00	47.00	3
60% G + 40% Stylo	5.50	493.30	50.70	3
LSD	2.34	203.32	30.43	-

Means with different letters superscripts within column differ significantly ($p<0.05\%$); * Aroma scores are described in Table 1

Table 3: Chemical composition of (%) of Gamba grass fortified with graded levels of tropical legumes

Treatment	DM	CP	EE	Ash	CF	NDF	ADF	HEM
100% Gamba grass (G)	98.10	6.20b	2.20	4.50	53.1ab	77.1cd	42.80a	17.80e
80% G + 20% lablab	98.20	7.0ab	3.10	5.20	49.30b	71.20d	58.10c	13.5bc
80% G + 20% mucuna	98.30	7.2ab	2.40	5.60	50.90c	74.80e	53.40d	21.7cd
80% G + 20% Stylo	98.50	7.6ab	2.30	5.40	52.40a	72.80a	57.7ab	15.5ab
60% G + 40% lablab	98.20	8.3ab	2.60	5.60	50.50b	71.3cd	55.90a	21.60e
60% G + 40% mucuna	97.20	9.30a	3.10	4.30	48.7ab	70.0ab	57.3bc	14.40a
60% G + 40% Stylo	98.50	7.7ab	2.50	5.10	45.30a	60.2cd	51.40a	13.9de
LSD	2.77	2.77	2.77	2.77	2.770	2.770	2.770	2.770

Means with different letters within column differ significantly ($p<0.05$)

Table 4: Chemical composition of (%) of Gamba grass silage prepared with 20 and 40% tropical legume

Treatment	DM	CP	EE	Ash	CF	NDF	ADF	HEM
100% Gamba grass (G)	98.10	6.20	2.20	4.50	52.20a	77.1a	55.90	21.5a
80% G + 20% legume	98.30	7.30	2.60	5.40	50.9ab	72.9a	56.40	16.9b
60% G + 40% legume	98.00	8.10	2.80	5.40	48.20b	67.20	50.50	17.1b
LSD	2.10	2.10	2.10	2.10	2.100	2.10	2.10	2.10

Means with different letters within column differ significantly ($p<0.05$)

with pH varying from 5.5-6.1. From the treatment evaluated, more acidic silage was obtained from the combinations with 40% legume. Treatments with 40% mucuna or stylo were more acidic while 100% gamba had the least.

The data obtained for the dry matter as fed varied significantly ($p<0.05$) from 493.3-646.7g kg^{-1} succulent silage. Higher dry matter as fed was obtained from sole gamba and treatments fortified with lower percentage of legumes compared to higher level of legume inclusion. Moisture content differed significantly ($p<0.05$) amongst treatments varying between 35.3-50.7%. Higher moisture content was obtained from silages made with 40% legume inclusion. Subjective scores for aroma indicated that silage prepared was sweet.

Chemical composition of resultant silages: Table 3 presents the chemical composition of silage prepared from Gamba grass enhanced with graded levels of 3 tropical legumes. The values of CP obtained showed significant variations ($p<0.05$) in the primed silages. The compounded silages had 6.2-9.3 %CP. Amongst the treatment examined, significantly ($p<0.5$.) higher CP in the silages were obtained from the inclusion of 40% of mucuna. The least in quality was silage obtained from sole gamba grass. Values obtained for ether extract and ash did not show any significant difference ($p>0.05$) due to the species or levels of legumes included. Crude Fibre content (CF) of the silage examined showed significantly ($p<0.5$) differences. The values vary from 45.3-53.1%. Higher CF was obtained from treatments that had 100% gamba grass ($p<0.05$). Despite the fact that other variations due to treatment amongst CF differ significantly ($p<0.5$), least CF content was obtained from the treatment that had 60% gamba grass plus 40% Stylo. The values of NDF obtained showed significant variations ($p<0.05$) in the fortified silages. The produced silages were good varying from 60.2-77.1% NDF. Amongst the treatment examined, significantly ($p<0.5$) higher NDF in silages were obtained from gamba grass alone. The least in NDF was silage obtained from 40% stylo inclusion. The values of ADF obtained differed significantly ($p<0.05$) amongst the prepared silages. The produced silages varied from 42.8-57.7% ADF. While higher ADF in silages were obtained from gamba grass alone, the least ADF was obtained from 40% stylo inclusion. The prepared silages varied from 13.9-21.7% HEM. Significantly ($p<0.05$) higher HEM (21.7%) in silages were obtained from gamba grass alone, the least HEM was obtained from 40% stylo inclusion. Irrespective of legume species, comparison of chemicals composition of silage prepared with 20 or 40% legume inclusion as shown in Table 4 revealed the content of DM, CP, EE, ash and ADF were statistically similar ($p>0.05$). With the exception of ADF, silages

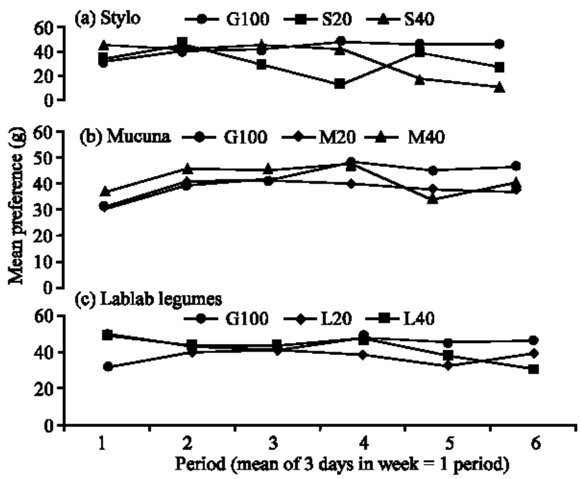

Fig. 1a-c: Trend of preference by rabbits offered gamba grass silage alone or fortified with graded proportion

prepared with 40% legume had higher values of CP, EE and ash. Significant differences ($p<0.05$) manifested in CF, NDF and hemicellulose. While sole gamba silage had significantly higher values of CF, NDF and hemicellulose, lower values were obtained from silages made with 40% legume inclusion. Furthermore, with the exception of NDF, the differences in values of indices of silage quality were similar for 20 and 40% levels of legume inclusion.

Study two: Preference study: It can be seen from Fig. 1a that preference for sole gamba was higher and presented a consistently increasing trend. Trend of preference for gamba ensilage with stylo either with 20 or 40% level had fluctuating trends. Comparatively, in Fig. 1b, treatment with sole gamba had the least initial preference which increased steadily and remained higher by the end of the trial period. The trend of silage preference by rabbit for gamba alone or ensilage with mucuna presented a similar trend but lower than preference observed in gamba at the end of the trial period. Figure 1c presents the trend of silage preference by rabbit, which indicated at the on set of the trial higher preference was observed for 80% gamba plus 20% lablab and 60% gamba plus 40% lablab. Subsequently, a drop was noted in their preference, which rose slightly and got to the peak at period 4 followed by a small drop to the end of the trial.

DISCUSSION

Silage production is a convention forage conservation method, which requires the use of high yield forage species per unit area. Miller (1970) had indicated that mixtures of cereals and legumes are particularly suitable for ensilage: the deficiency of protein in cereal crop and the absence of carbohydrate in legumes are thus overcome. In mixed gamba grass-legume silage, gamba grass provides the fermentable carbohydrate, while the various legumes improve the protein component of the silages.

The treatments evaluated did not manifest any defined trend for dry matter as fed. However, higher yield were obtained from treatments fortified with 20% relative to 40% legumes, which is attributed to the apparently higher component of gamba grass. Ensilage with the legumes produced silages with moderate pH values (Huhnke *et al*., 1997; Kallah *et al*., 1997; Yunus *et al*., 2002; Muhammad *et al*., 2008). The favorable scores for aroma found in the present study concur with data reported by Kallah *et al*. (1997) and Muhammad *et al*. (2008).

Crude Protein (CP) content of the fortified silage was moderate. Increased in the level of legumes in the silages resulted to increases in the CP% and EE with corresponding decline in CF, NDF, ADF and hemicellulose in all the treatments examined. This suggests that inclusion of 40% legume improved the ensiling quality of gamba grass at full bloom stage of maturity. The increasing trend observed in CP was in agreement with several reports (Azim *et al*., 2000; Mustafa *et al*., 2001; Mthiogane *et al*., 2001; Muhammad *et al*., 2008). Also Muhammad *et al*. (2008) recommended 40% proportion of legumes in *Sorghum almum*-legume silage.

Silages prepared with mucuna proved superior with higher content of CP and EE. Inherent differences in nutrient composition between and within plant species had been noted to course variation in nutrient content of plant, which could explain the variations noted in silages from different legume species with same level of inclusion. While crude protein values realize for sole silages compare well with data reported by Kallah *et al*. (1997), higher values were obtained from the legume fortified silages (Muhammad *et al*., 2008).

Mayland *et al*. (2000) reported that grazing animals prefer some plants to others. These choices are likely related to physical and chemical factors such as energy-dense carbohydrates contained in plants. Paradoxically, findings of the present study showed that rabbits had higher preference for sole grass silages relative to silages made with legumes despite the fact that silages prepared with legumes (20-40% inclusion) had higher content of CP and EE with corresponding lower CF, NDF, ADF and hemicellulose. This finding was in agreement with recent data reported by Iyeghe-Erakpotobor and Muhammad (2008) in which they noted relative lower intake of fresh grass-legume mixture in rabbits. Literature reports indicate a lot of composed evidence that ruminants can take some time to adapt to eating legume forages in the field, while they readily eat grasses. Furthermore, tropical legumes are known to contain some anti-nutritional factors that could interfere with livestock nutrition in terms of reduced palatability, digestibility or even be of toxic to the animals (Robbins *et al*., 1998; Kaitho *et al*., 1998; Iyeghe-Erakpotobor and Muhammad, 2008). The inclusion of legume and the inherent tannin content could explain the lower preference of silages fortified with legumes by the rabbits. However, amongst the improved silages, mucuna was more preferred. Iyeghe-Erakpobotor *et al.* (2008) had observed preference in the eating habit of rabbits fed mixture of varieties of tropical grasses and legumes.

CONCLUSION

The use of legume in preparation of gamba grass silages has beneficial advantage to silage quality. Data from the present study revealed that the composite silage made from 60% gamba grass plus 40% lablab resulted in silage with higher CP and thus, recommended for large scale silage production in the semi arid zone. Rabbits will however, prefer sole gamba grass silage.

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