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Use of Legume in the Improvement of Silage Quality of Columbus Grass *(Sorghum almum* Parodi)

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Abstract: An experiment was conducted to determine the species of legume that is compatible with Columbus grass for ensilage and to establish the optimum proportion of legume inclusion for better silage preparation. Field grown Columbus grass (*Sorghum almum* Parodi) 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% Columbus grass*;* 80% Columbus grass plus 20% groundnut; 60% Columbus grass plus 40% groundnut; 80% Columbus grass plus 20% Lablab; 60% Columbus grass plus 40% Lablab; 80% Columbus grass plus 20% Centurion and 60% Columbus grass plus 40% Centurion. 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% Columbus 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% Columbus *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 Columbus 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% Columbus grass.

Key words: Grass-legume silage, proximate composition, Semi arid zone, Columbus grass (*Sorghum almum*), Centurion (*Centrocema pascourum*), Lablab bean (*Lablab purpureum*) and Groundnut (*Arachis hypogea*)

INTRODUCTION

A major challenge to ruminant livestock producers in semi arid zone of West Africa is assuring adequate quantity of quality feeds through out the year. The ecological zone has seasonal pattern of rainfall yet hosting over 90% of the cattle and 70% of sheep and goats population (RIM, 1989). 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). These thus, suggest the need for development of feeds conservation strategies during period of abundant supply so as to redistribute the feed supply over the year to meet the requirements of livestock resource.

Among the methods employed in forage conservation is silage. 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. This trial was therefore, conducted to examine the species of legumes that is compatible with Columbus grass for better silage preparation and to determine the optimum level of legume inclusion for better silage from Columbus 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.

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

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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 (Kowal and Knabe, 1972).

Silage preparation: Eighty days-old (80 days post planting) field grown Columbus grass (*Sorghum almum* Parodi) was sampled at soft dough 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 Centurion (*Centrocema pascourum* DC *Benth.*); Lablab bean (*Lablab purpureum* (*L.*)) and Groundnut (*Arachis hypogea* (*L*)). The legume fodder was sampled at 50% 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 materials were chopped to about 2 cm length and were ensilage in open mouthed Kilner jars (Cope BS 910-8, 100 mL) as follows: 100% Columbus grass; 80% Columbus grass plus 20% groundnut; 60% Columbus grass plus 40% groundnut; 80% Columbus grass plus 20% Lablab; 60% Columbus grass plus 40% Lablab; 80% Columbus grass plus 20% Centurion and 60% Columbus grass plus 40% Centurion. Each of the treatment combination was ensilage in the *in vitro* silos and compressed until filled to the brim in three 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 by three independent scorers as described in Table 1. Thereafter, pH in water was determined using digital pH meter. Furthermore, a sub-sample was taken from the prepared silages and oven dried at 60°C for 48 h for proximate analysis.

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.

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

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

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.

RESULTS

Dry matter as fed and silage characteristics: Table 2 presents the pH, dry matter as fed and aroma of silage made from Columbus grass fortified with graded levels of legumes in the semi arid zone. The values of pH obtained were comparable ($p>0.05$) for the silages prepared. The compounded silages were good and acidic with pH varying from 5.33-5.77. From the treatment evaluated, more acidic silage was obtained from the combination of 60% Columbus grass plus 40% groundnut which was followed by the treatments where 80% Columbus grass plus 20% Lablab, 80% Columbus *grass* plus 20% Centurion or 60% Columbus grass plus 40% Centurion.

The data obtained for the dry matter as fed varied significantly ($p<0.05$) from 308.0-508.0 g kg^{-1} succulent silage. Higher fodder was obtained from treatments fortified with lablab compared to the other legumes. Significantly higher ($p<0.05$) dry matter was observed from treatments that had 60% Columbus *grass* plus 40% Lablab. While other variations amongst yield of dry matter of silage as fed due to treatment were significant ($p<0.05$), least value was noted from the treatment that had 60% Columbus grass plus 40% Centurion. Subjective scores for aroma indicated that silage prepared was sweet.

Table 3 showed the proximate composition of silage prepared from Columbus grass enhanced with graded levels of legumes. The values of CP obtained showed significant variations ($p<0.05$) in the primed silages. The compounded silages were good varying from 11.6-14.1% CP. Amongst the treatment examined, significantly ($p<0.5$) higher CP in silages were obtained from the inclusion of 40% of lablab. The least in quality was silage obtained from sole Columbus grass.

Organic matter content (OM) of the silage examined vary significantly ($p<0.5$). The variations were from 45.7-69.1%. Higher ($p<0.05$) OM content were obtained from treatments that had 100% Columbus grass. Despite the fact that other variations due to treatment amongst OM differ significantly ($p<0.5$), least OM content was obtained from the treatment that had 60% Columbus grass plus 40% Centurion.

Table 2: The effect of treatment on pH, Dry matter as fed (g/kg), pH and aroma of Columbus grass Silage fortified with graded levels of legumes

Treatment	pH	Dry matter as fed	Aroma score*
100% Columbus grass (S)	5.5	366.5^{e}	3.0
80% S+ 20% groundnut	5.7	478.0^{b}	3.0
60% S+ 40% groundnut	5.3	438.0^{d}	3.0
80% S+ 20% lablab	5.4	442.0^{c}	4.0
60% S+ 40% lablab	5.7	508.0^{a}	4.0
80% S+ 20% Centurion	5.4	480.0^{b}	3.0
60% S+ 40% Centurion	5.4	308.0^{f}	4.0
L.S.D	2.11	2.11	2.11

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

Table 3: Proximate composition of (%) of Columbus grass (S) fortified with graded levels of legumes

Treatment	CP	OM	EE	ASH	CF	NFE
100% Columbus grass (S)	11.0^{d}	69.1^{a}	17.5^{a}	6.1^{e}	40.0^{a}	25.1^{d}
80% S+ 20% groundnut	14.1^{c}	56.3^{b}	12.4^{b}	6.2^{e}	37.1^{b}	37.1^{a}
60% S+ 40% groundnut	18.1^{a}	49.2^{d}	14.2^{b}	7.8^{c}	36.2^{b}	33.2^{b}
80% S+ 20% lablab	17.6^{b}	52.7^{c}	12.7^{b}	9.2^{bc}	39.5^{a}	28.0^{c}
60% S+ 40% lablab	19.9^{a}	48.8^{d}	14.4^{a}	10.3^{b}	38.4^{a}	36.3^{a}
80% S+ 20% Centurion	12.9^{d}	51.3^{c}	6.6^{c}	13.4^{a}	38.3^{ab}	32.9^{b}
60% S+ 40% Centurion	14.1^{c}	45.7^{e}	7.7^{c}	14.8^{a}	36.2^{b}	33.3^{b}
LSD	2.11	2.11	2.11	2.11	2.11	2.11

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

Ether Extract (EE) presented significant ($p<0.05$) disparity in the concentration of EE of the treatments examined. The disparities were from 6.6-19.4% EE. Higher ($p<0.05$) EE were obtained from treatments that had Columbus grass plus 40% lablab. Albeit, other variations as a result of treatment applied in EE content differ significantly ($p<0.5$), the least concentration was obtained from the treatment that had 80% Columbus grass plus 20% Centurion.

The content of ash obtained showed significant variations ($p<0.05$) in the composite silages. The compounded silages were good varying from 6.2-14.8%. Amongst the treatment examined, inclusion of 40% Centurion resulted in significantly ($p<0.05$.) higher ash content in the resultant silages. The lowest quantity in ash content of the silage was obtained from sole Columbus grass.

Crude fibre content (CF) of the silage examined showed significantly ($p<0.5$) variation. The disparity was from 36.2-40.0%. Higher CF was retrieved from treatments that had 100% Columbus 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% Columbus grass plus 40% groundnut or Centurion.

Concentration of NFE showed significant ($p<0.05$) difference in the treatments evaluated. Treatment that had 80% Columbus grass plus 20% groundnut resulted in higher NFE value. Notwithstanding, other variations as a result of treatment applied in NFE content differ significantly ($p<0.5$). The minimum dry matter content was obtained from the treatment that had sole Columbus grass.

DISCUSSION

Some of the determinants of suitable plant species for use as a silage material include high yield per unit area, nutritional quality at ensiling and quality of the resultant silage (Kallah *et al*., 1997). The treatments evaluated did not manifest any defined trend for dry matter as fed. The higher yield obtained from treatments fortified with lablab relative to the other legumes could be attributed to the robust nature of stem of lablab plant. Ensilage with the legumes produced silages with moderate pH values (Huhnke *et al*., 1997; Yunus *et al*., 2002). Furthermore, Sibanda *et al.* (1997) reported inclusion of legume 450 g kg^{-1} fresh weight raised silage pH. The favorable scores for aroma found in the present study concur with data reported by Kallah *et al*. (1997).

Crude protein (CP) content of the prepared silage was outstanding. Increased in the level of legumes incorporated in the silages resulted to increase in the percent CP, CF, EE, NFE and ash in all the treatments examined. This perhaps suggests the need for inclusion of higher levels of legume to capture the optimum legume requirement for inclusion in Columbus grass silages at soft dough stage of maturity. There are however, contradicting literature reports with regards to level of legume required for exciting the quality of grass silages. While the increasing trend observed in CP was in agreement with several reports (Azim *et al*., 2000; Mustafa *et al*., 2001; Mthiogane *et al*., 2001). Sibanda *et al.* (1997) reiterated that inclusion of 450 g kg^{-1} fresh legume increased the volatile nitrogen and total nitrogen content of grass silages. Contrary, report by Titterton and Maasdorp (1997) recommended 40% proportion of legumes in grass-legume silage.

All the same, earlier reports such as that of Miller (1970) had indicated that mixtures of cereals and legumes are particularly suitable for ensilage: The deficiency of protein in cereal c rop and the absence of carbohydrate in legumes are thus overcome. In mixed Columbus grass-legume silage, Columbus grass provides the fermentable carbohydrate, while the legume improves the protein content of the silages.

While, silages prepared with lablab and centurion had higher crude protein, in addition, lablab contributed more to the content of EE in the silage prepared. This could perhaps mean that lablab is higher in some components of nutritive value relative to others. Conversely, inherent differences in nutrient composition

between and within plant species (McDowll *et al*., 1999) could explanation the variation in CP and EE noted in the present study as a result of legume inclusion in the silages. 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.

CONCLUSION

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

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