EFFECT OF CASSAVA ROOTS AND LEAVES INCLUSION ON THE QUALITY OF NAPIER GRASS SILAGE

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ABSTRACT

A laboratory experiment was carried out at KARI Mtwapa to determine the effect of substituting maize bran with fresh or dried cassava chips and substituting gliricidia with cassava leaves on the quality of Napier grass silage. The treatments consisted of two factors, energy supplement (maize bran, dry and fresh cassava chips) and protein supplement (none, gliricidia and cassava leaves), that were combined in a factorial arrangement to provide nine feed mixtures. The nine mixtures each weighing 3.5kg were ensiled in polythene tubes and kept in a dark place in the laboratory. Samples were drawn from the tubes at 6, 12 and 24 weeks after ensiling. The silage samples were stored in the freezer and nutrient analyses done for all treatments. An assessment of the aroma and colour was also carried out. There was no significant ($P<0.05$) difference in colour or aroma between the treatments and they were all rated acceptable by panellists. The CP and Ca increased significantly ($P<0.05$) by over 28% and 58%, respectively, on inclusion of a protein source. However, substitution of gliricidia with cassava leaves had no significant ($P>0.05$) effect on the CP and Ca contents of the silage. The use of cassava leaves for silage making led to a significant ($P<0.05$) increase in the P content of the silage (44%) but gliricidia had no effect on this parameter. Protein supplementation significantly ($P<0.05$) lowered the NDF from 674 to 623 and 633 g kg^{-1}DM when gliricidia or cassava leaves were added to the silage respectively. Use of dry cassava chips in the silage lowered ($P<0.05$) the NDF to, correspondingly, 620 compared to 651 and 659 g kg^{-1}DM for maize bran, and fresh cassava roots respectively. Inclusion of fresh cassava chips significantly raised the Ca content (7.7) of the silage compared to the silage whose energy source was maize bran (5.6) and dry cassava chips (6.3 g kg^{-1}DM) . It was concluded that both cassava roots and leaves can be used to make silage to increase dry season feed security.

Key words: silage, cassava, gliricidia, energy, protein, Napier grass

INTRODUCTION

Quality and availability of livestock feed is one of the most important challenges in livestock feeding. Farmers in coastal Kenya mainly depend on forages to feed their livestock (Muinga *et al.*, 1999a, Ramadhan *et al.,* 2008). Forage production depends on rainfall and farmers are therefore faced with low feed availability during the dry season. Coastal Kenya has a bimodal rainfall pattern with the long rainy season in March to June and short rains season in October to December. The latter season is often unreliable. The rainy seasons are associated with high dry matter production and animals are fed on a variety of feeds, including weeds from the arable land while the planted forages are spared for the dry season (Muinga *et al.*, 1999a).

During the short dry period in July to September, crop residues like maize stover are also available for the animals. The main challenge in livestock feeding is experienced in December to March, especially when the short rains fail. To address this problem, the silage technology was adapted for coastal Kenya to enable farmers make use of forages that grow in the region. Farmers in the region are encouraged to grow Napier grass in leucaena or gliricidia alleys (Mureithi *et al*., 1996). Forage growth during the wet season is vigorous and the excess can be ensiled for later use. Since molasses, the recommended source of carbohydrate in silage making, is not readily available in coastal Kenya, a technology was developed and recommended to farmers where maize bran is used as its replacement (Muinga *et al*., 1999b).

In an effort to increase food production in coastal Kenya, past research based at KARI Mtwapa recommended cassava varieties that are high yielding and tolerant to cassava diseases and pests (Gethi *et al.,* 2011). These varieties are already

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being grown by farmers in 46 one-acre plots for multiplication and sale to other farmers in various counties. Adoption of the varieties is expected to increase cassava yield from less than 10 to 50-70 t ha^{-1} of fresh roots. Due to the increase in yield, some of the roots and leaves are expected to be available for livestock feeding. A limited number of studies, for example Marjuki *et al.* (2008), and Pinho *et al*. (2004) reported the nutritive value and use of cassava leaf silage for livestock feeding. Hardly any reports are available on ensiling Napier grass in combination with cassava roots and leaves.

A laboratory experiment was therefore carried out to determine the effect of substituting maize bran with fresh or dried cassava chips and substituting gliricidia with cassava leaves in the conventional Napier grass/ gliricidia/ maize bran silage. Use of cassava chips as a carbohydrates source would reduce dependency on maize bran or molasses which is not within reach of most farmers due to the high price. Molasses is also hardly available in the region. Napier grass forage productivity peaks and coincides with cassava root harvesting in April/May. Determination of the suitability of substituting maize bran with cassava chips and gliricidia with cassava leaves would give farmers some additional sources of energy and protein for silage preparation.

MATERIALS AND METHOD

The study was carried out at KARI Mtwapa (3° 5'S and 39° 44'E). Napier grass and gliricidia were harvested from fodder plots at the Centre. The Napier grass re-growth was about six weeks old and one metre high. Gliricidia leaves and stems less than 5mm diameter were used. The cassava roots were harvested from an existing crop of Tajirika variety which was about 12 months old. The forages were harvested and wilted for one day before ensiling. They were chopped with a laboratory guillotine to pieces of about 2-4 cm. The cassava roots were harvested, washed and chopped with a manual chipper to about 50 mm. Half the chips were dried to a moisture content of 10.5% under direct sunlight and the rest were used fresh (70% moisture). Maize bran was purchased from a local maize miller. Three and a half kilograms of silage on as is basis were made as per the proportions recommended by Mambo *et al.* (undated leaflet) for Napier grass/ gliricidia/ maize bran silage. The material was ensiled in double polythene tubes measuring 20 x 100 cm. The mixture was hand compacted to expel air from the bags and immediately sealed using rubber bands. Nine different silage mixtures were made by supplementing Napier grass with different energy (maize bran, fresh cassava chips, dry cassava chips) and protein (None, gliricidia, cassava leaves) sources as follows:

1. 150 g Maize bran (MB) + no protein supplement (None)
2. MB + 670 g Gliricidia (G)
3. MB + 670 g Cassava leaves (CL)
4. 450 g Fresh cassava chips (FCC) + None
5. FCC + G
6. FCC + CL
7. 150 g Dry cassava chips (DCC) + None
8. DCC + G
9. DCC + CL

Treatments 1, 4 and 7 were mixed with 3.35 kg Napier grass while the remaining treatments had 2.68 kg Napier grass. Each mixture was replicated three times. Sampling was done at 6, 12, and 24 weeks after ensiling the material, during which the polythene tubes were opened for the shortest time possible and then re-sealed. The final sampling date represented the four months dry season and an allowance for forage re-growth after the onset of rains. Samples were manually sub-divided into two parts using the quartering method. One part was dried in the oven at 105°C to constant weight to determine dry matter (DM) content while the second one was frozen immediately at -20°C for determination of crude protein (CP), Neutral detergent fibre (NDF), Calcium (Ca) and phosphorous (P). Part of the frozen sample was analysed in the laboratory (AOAC, 1990). The remaining sample was used for aroma and colour acceptability which was done by six panellists with livestock feeding experience. A three point ordinal scale for colour ranging from 1 = very good (brownish), 2 = good (grey) and 3 = bad (blackish) was used. Similarly the aroma was scored 1 = very aromatic, 2 = aromatic and 3 = bad (rotten aroma). Analyses of variance was carried out to evaluate for the effect of energy source, protein source, date of sampling and their interactions using the GLM procedure of SAS (2003).

RESULTS

The crude protein in cassava roots was low (17 and 22 g kg^{-1}DM for fresh and dry cassava, respectively). The gliricidia CP was 136 g/kg DM. The CP value for cassava leaves (108 g/kg DM) and the composition of the other feeds are as shown in Table 1.

There was no significant date of sampling effect on the quality of silage and the three time data sets were averaged per treatment and included in the analyses. There was no interaction between energy and protein and consequently only the energy and protein effects are discussed and reported in Tables 2 and 3.

Aroma and colour of silage can be used by the stockman to rate the quality of silage before it is fed to livestock. Good silage tends to retain the green colour of the forages while a black colour is a sign of poor fermentation and therefore poor quality silage.

None of the mixtures was rated bad (3) for colour and aroma. All the different mixtures were rated acceptable by the panellists for aroma and colour, which can be used as an indication of acceptability by the animals. Cassava and gliricidia leaves increased the CP and Ca content of silage by over 28 and 58%, respectively, but these two protein supplements did not differ significantly on their effect on the two parameters. This confirmed reports from other studies (Muinga *et al.,* 1999b) that showed that inclusion of gliricidia forage in Napier grass based silage increased the CP content from 75

TABLE I - NUTRIENT COMPOSITION (G/KG DM) AND DM (%) OF FEED INGREDIENTS USED TO MAKE THE SILAGE

Feed	CP	NDF	Calcium	Phosphorous	DM
Napier grass	37	765	0.4	0.6	26.0
Gliricidia leaves	136	339	4.6	1.3	29.7
Cassava leaves	108	407	3.2	0.9	25.2
Maize bran	53	440	0.7	2.6	89.5
Dry cassava chips	22	400	0.7	0.4	87.4
Fresh cassava chips	17	487	1.1	0.1	33.3

TABLE II -THE EFFECT OF SUBSTITUTING GLIRICIDIA WITH CASSAVA LEAVES ON NUTRIENT COMPOSITION AROMA AND COLOUR OF NAPIER GRASS BASED SILAGE

Protein source	Colour	Aroma	Crude protein	NDF	Calcium	Phosphorous
	---- (Scores) ----		-------------------- (g/ kg^{-} DM) ----------------------			
None	1.7	1.9	46	674	4.6	0.9
Gliricidia	1.9	2.1	59	623	7.1	0.8
Cassava leaves	2.1	2.1	69	633	7.9	1.3
LSD (P<0.05)	0.14	0.15	13.1	25.2	0.92	0.23

DISCUSSION

The CP for the fresh and dry cassava chips reported (17-22 g kg^{-1}DM) in this study was similar to 19 g kg^{-1}DM for peeled cassava reported earlier at KARI Mtwapa (Muinga, 1992). The CP for gliricidia (108 g/kg DM) was lower than that reported in earlier studies by Juma *et al.* (2005) and Abdulrazak *et al.* (2006) which was 230 and 210 g/kg DM, respectively. The values reported in the current study are lower than expected and can only be used for comparison of the treatments but not to show absolute values.

TABLE III - THE EFFECT OF SUBSTITUTING MAIZE BRAN WITH FRESH OR DRIED CASSAVA ON NUTRIENT COMPOSITION, AROMA AND COLOUR OF NAPIER GRASS BASED SILAGE

Energy source	Colour	Aroma	Crude protein	NDF	Calcium	Phosphorous
	------- (Scores) ------		-------------------- (g/kg DM) -------------------			
Maize bran	1.8	2.0	49	651	5.6	1.5
Fresh cassava chips	2.0	2.2	63	659	7.7	0.8
Dry cassava chips	1.9	2.0	60	620	6.3	0.6
LSD (P<0.05)	0.14	0.15	13.1	25.2	0.92	0.23

for Napier grass silage to 131 g/kg DM (32% increase) for Napier grass ensiled together with gliricidia forage. Protein supplementation with either gliricidia or cassava leaves led to a significant decrease in NDF. However, there was no difference between the NDF of silage made from either of the protein supplements. The use of cassava leaves for silage making led to a significant ($P<0.05$) increase in the P content of the silage (44%) but gliricidia had no effect on this parameter.

Cassava chips significantly increased the CP content of the silage in comparison with the maize bran based silage. Silage made from dry cassava chips had significantly ($P<0.05$) lower NDF than that made from fresh cassava chips, and maize bran. However, there was no difference between the latter two. Inclusion of fresh cassava chips in silage significantly ($P<0.05$) increased the content of Ca compared to maize bran and dry cassava chips. Inclusion of either dry or fresh cassava chips produced silage that had significantly ($P<0.05$) lower P content than that for silage containing maize bran.

Supplementation of the Napier grass based silage with protein (gliricidia or cassava leaves) had a clear effect on the quality of silage through an increase in CP and a decrease in NDF values. Similarly, inclusion of gliricidia or cassava leaves which were high in Ca compared to Napier grass and maize bran, led to an increase in the Ca content of silage. In contrast, inclusion of maize bran which had higher CP (53 g/kg) than fresh (17 g/kg) and dry (22 g/kg) cassava chips did not lead to an increase in silage CP. This may have been due to the low nutrient concentration in the energy supplements and the low amounts used in the mixtures.

The high yielding cassava varieties released to farmers were selected for their low hydrocyanic (HCN) potential of less than 4 (Weru *et al.*, 2007). Ensiling is likely to lower the HCN and there is need to confirm this. The organic acid profile gives an indication of the fermentation quality of silage. However, this was not determined in this study due to equipment limitations.

CONCLUSION

From the results of this study, it can be concluded that fresh or dry cassava chips and leaves can be included in Napier grass based silage without compromising on the quality. The silage stored well for up to 24 weeks, and can therefore, contribute to increased feed security in the region.

RECOMMENDATION

Livestock feeding studies should be carried out to verify the results from this laboratory work. The studies should establish the organic acids in the silage and the effect of ensiling on the nutrient composition and the hydrocyanic potential.

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