Agricultural Journal 8 (6): 295-298, 2013
ISSN: 1816-9155

Silage Characteristics, Nutritive Value and Preference of Zebu Cows for Moringa Leaf Ensiled with Different Levels of Cassava Peel

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Abstract: In this study, Moringa Leaf (ML) was ensiled with increasing levels of Cassava Peel (CSP). Silage characteristics, chemical composition and *in vitro* digestibility of the silage mixtures were determined in the laboratory while preference of zebu cows for the mixtures were determined using six non-lactating Sokoto Gudali heifers. Treatments consist of the following ML-CSP mixtures: 80:20, 60:40, 40:60 and 20:80. All the mixtures formed good silage and pH reduced from 4.22-3.74 while colour varied from pale to light green, as proportion of cassava peel in the silage mixture increased. All silages had firm texture with pleasant and slightly alcoholic smell. Dry Matter (DM) content and Nitrogen Free Extract (NFE) of silage increased as proportion of cassava peel in the mixture increased while Crude Protein (CP) and Crude Fibre (CF) reduced. DM, NFE, CP and CF varied from 24.5-30.9, 53.0-66.7, 18.2-8.2 and 13.9-11.7%, respectively. Organic matter digestibility was 69.0, 69.1, 71.5 and 70.2% while percent preference by zebu heifers was14.2, 30.8, 34.9 and 20.1% for 80:20, 60:40, 40:60 and 20:80 ML-CSP silage mixture, respectively. These results revealed that addition of cassava peel to moringa leaf enhanced the silage properties, digestibility and acceptability of moringa leaf silage by Sokoto Gudali heifers.

Key words: Moringa silage, chemical composition, digestibility, acceptability, Sokoto Gudali heifers

INTRODUCTION

Silage-making has great potential to solve seasonal shortage of feed for ruminants in Nigeria by preserving excess forage produced during the wet season for use at the dry period. However, nutritive value of silage prepared from tropical grasses and agricultural wastes is often limited by their low protein content (Gallaher and Pitman, 2001). *Moringa oleifera* has high protein leaves, high mineral content and high yield potential (Aregheore, 2002; Foidl *et al*., 2001) and can be exploited for feeding dairy animals during the dry season when forage is scarce. On a well managed field, moringa can yield a high biomass of 20 ton ha^{-1} of dry matter with crude protein content above 20% (Akinbamijo *et al*., 2004).

Low levels of fermentable carbohydrates in moringa leaf may, however limit its use as a silage material, hence there is need to mix with highly fermentable carbohydrates to enhance its silage value. Cassava peel is a common agricultural by-product of gari processing in the Southwest of Nigeria that contains high levels of fermentable carbohydrate. It is available throughout the year and constitutes an important supplement to ruminant animals when dried or a nuisance to the environment when left to rot in open spaces during the wet season. Ensiling moringa together with cassava peel presents an opportunity to preserve their nutrients and enhance their feeding value for ruminants during the dry season. *Moringa oleifera* leaf with its high protein content, complements cassava peel which has low protein (5-6%) while high starch cassava peel provides the mixture with fermentable carbohydrate and energy (Onua and Okeke, 1999).

This study aims to estimate the silage quality, nutritive value and preference of Sokoto Gudali heifers (a zebu breed) for moringa foliage ensiled with increasing levels of cassava peel.

MATERIALS AND METHODS

Location: The experiment was conducted at the dairy unit of the Teaching and Research Farm, University of Ibadan. University of Ibadan falls within latitudes 7°15' and 7°30'N and longitudes 3°45' and 4°0'E.

Silage preparation, chemical analysis and quality assessment: Fresh cassava peel was collected from a gari processing unit in Ibadan while moringa leaves were harvested from a plot within the University of Ibadan. Both materials were chopped to a particle size of 2-3 cm

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using an automated chopper. Weighed quantities of each material were mixed in proportions indicated below and packed in triplicates into 4 L plastic silos for silage analysis and 120 L plastic drums for acceptability study. Silages were compacted manually, sealed with polythene sheets and pressed with sand bags to exclude air from the silage. Mini silos were opened at 21 days to determine pH, physical characteristics (colour, smell and texture) and proximate composition using the general procedures by AOAC (2005). Dry matter content was determined using a forced draught oven at 65°C, correcting values for the loss of volatile compounds by multiplying with the factor of 1.056 (Fox and Fenderson, 1978). Detergent fibre components were determined according to methods by Van Soest *et al.* (1991). Organic matter digestibility and metabolizable energy of dried and ground silage samples were estimated in the laboratory using the *in vitro* gas methods by Menke and Steingass (1988).

Preference study: About 6 non-lactating Sokoto Gudali heifers weighing between 210 and 254 kg were used for the preference trial. Animals were treated against internal and external parasites using ivermectin and housed in one group inside a pen. The silages (20 kg each on a wet basis) were offered in various troughs in the pen for a period of 12 days. Fresh water was offered free choice on a daily basis. Silage intake was measured 4 h after it was offered by deducting remnants but animals were allowed to eat the remnant silage for the rest of the day. The Coefficient of Preference (COP) was calculated, as the ratio of individual silage intake to the average intake of all silages. Preference was calculated as the ratio of individual intake to total intake multiplied by 100. Silage was regarded as acceptable when the COP was greater than unity while ranking was based on percentage of preference.

Statistical analysis: All data obtained were subjected to analysis of variance and significant means were separated by Duncan's multiple range tests using the SAS (1995) procedures. The treaments were as follows:

- 80% moringa leaves+20% cassava peels (ML-CSP 80:20)
- 60% moringa leaves+40% cassava peels (ML-CSP 60:40)
- 40% moringa leaves+60% cassava peels (ML-CSP 40:60)
- 20% moringa leaves+80% cassava peels (ML-CSP 20:80)

RESULTS AND DISCUSSION

The physical characteristics of moringa-cassava silages are shown in Table 1. All the mixtures formed good silage. The pH reduced from 4.22-3.74 as proportion of cassava peel in the silage mixture increased showing that cassava peel improved fermentation in moringa leaf silage. This trend was also observed when cassava peel was ensiled with elephant grass and legume forages (Olorunnisomo, 2011; Olorunnisomo and Fayomi, 2012). The pH of these silages was within acceptable range for good silage in the tropics (Bilal, 2009, Nhan *et al.*, 2009). Colour of silages varied from pale green to light green as proportion of cassava peel increased in the mixture. The lighter colour is indicative of improved fermentation. All the silages had a pleasant and slightly alcoholic smell typical of fermented cassava which is relished by ruminants in Nigeria. All the silages were firm in texture although ML-CSP 80:20 which had the least content of cassava peel was slightly wet when touched.

Chemical composition of moringa-cassava peel silage is presented in Table 2. Except for ether extract, there were significant differences ($p<0.05$) in the chemical constituents of the different silage mixtures. Dry matter content and Nitrogen Free Extract (NFE) of silage increased as proportion of cassava peel in the mixture increased while crude protein, fibre fractions and ash reduced. The increased level of NFE and reduced crude protein in the silage mixture with high proportion of cassava peel indicates that addition of cassava peel to moringa leaf silage improved energy concentration at the expense of protein concentration in the silage. The minimum protein content recommended for ruminant diets is 10-12% (ARC, 1980), hence animals fed moringa leaf silage with high proportion of cassava peel (80% of the mixture) may need extra protein supplementation. The crude fibre level in the moringa silage is generally low compared with conventional ruminant forage. This may have a negative impact on normal rumen function of the cow and fat content of the milk when offered as a basal diet, hence dairy cows fed moringa leaf silage should be grazed or fed additional roughage. The ash content of silage mixture with high proportion of moringa leaf was higher compared to those with high cassava peel content. This is largely a reflection of the high mineral content reported for moringa leaf (Asaolu *et al.*, 2010). This indicates that moringa silage may serve as a good source of minerals in ruminant diets.

The Metabolizable Energy (ME) and Organic Matter Digestibility (OMD) of moringa leaf ensiled with varying levels of cassava peel is presented in Table 3. Values for ME and OMD varied significantly ($p<0.05$) between the different silage mixtures while values for Short Chain Fatty Acids (SCFA) did not differ significantly ($p>0.05$) between the various mixtures. The ME of moringa-cassava peel silage increased as proportion of cassava peel in the mixture increased. Chemical composition of silage mixtures

Table 1: Silage characteristics of moringa leaves ensiled with varying levels of cassava peels

	Moringa-cassava peel mixtures			
Parameters	80:20	60:40	40:60	20:80
pH	4.22	4.05	3.92	3.74
Colour	Pale green with some brown and white speckles	Olive green with brown and white speckles	Light olive green with brown and white speckles	Light green with brown and white speckles
Odour	Pleasant with slight alcoholic smell	Pleasant with alcoholic smell	Pleasant with alcoholic smell	Pleasant with strong alcoholic smell
Texture	Firm and slightly wet	Firm	Very firm	Very firm

Table 2: Proximate and detergent fibre composition (% dry matter) of moringa leaves ensiled with cassava peel

	ML-CSP				
Parameters	80:20	60:40	40:60	20:80	SEM
Dry matter (% of wet material)	24.48^{d}	26.18^{c}	28.66^{b}	30.95^{a}	0.30
Crude protein	18.24^{a}	15.88^{b}	11.52^{c}	8.16^{d}	2.25
Ether extract	6.15	5.55	5.50	5.30	0.18
Crude fibre	13.85^{a}	13.16^{a}	12.41^{ab}	11.71^{b}	0.16
Ash	10.86^{a}	9.79^{b}	8.70^{c}	6.02^{d}	0.07
Nitrogen free extract	53.04^{d}	56.37^{c}	61.12^{b}	66.67^{a}	0.64
Neutral detergent fibre	42.86^{a}	41.55^{b}	39.68^{c}	38.25^{d}	0.99
Acid detergent fibre	16.96^{a}	16.57^{a}	15.42^{b}	14.24^{c}	0.61
Acid detergent lignin	2.42^{a}	2.32^{a}	1.99^{b}	1.32^{c}	0.25

Table 3: Metabolizable energy and *in vitro* organic matter digestibility of moringa leaf ensiled with cassava peel

	ML-CSP				
Parameters	80:20	60:40	40:60	20:80	SEM
Metabolizable energy (MJ kg^{-1} DM)	10.24^{c}	10.81^{b}	10.85^{b}	11.02^{a}	0.12
Organic matter digestibility (%)	68.98^{c}	69.12^{c}	71.46^{a}	70.19^{b}	2.25
SCFA (µ mol)	1.14	1.17	1.28	1.29	0.02

$^{a-d}$Means with same superscripts within the row are not significantly different ($p>0.05$); ML = Moringa Leaf; CSP = Cassava Peel

reveal that NFE values, also increased with increasing level of cassava peel in the mixture. Since, ME and NFE represents the utilizable energy fraction of the diet, this result indicates that addition of cassava peel to moringa leaf silage improved energy concentration and utilization in the silage. This is consistent with the observation by Oliveira (2008) who reported improved nutrient utilization in elephant grass ensiled with increasing levels of cassava meal. The *in vitro* digestibility of the silage mixtures is given in Table 3. The result indicates that digestibility of the silage mixtures improved with increasing level of cassava peel in the mixture which corresponds with higher available energy in the silage diets. This trend points to the primary influence of available energy on digestibility of ruminant diets. In this study, digestibility peaked at the 40:60 moringa-cassava peel mixtures. This probably represents the optimum protein energy ratio in the silage mixtures, leading to optimum conditions for rumen microbes and improved digestibility. A similar observation was made when sweet potato foliage and root were mixed in different proportions for sheep. Nutritive value was optimized when the foliage and root were mixed in equal proportions (Olorunnisomo, 2008).

Table 4: Preference of Sokoto Gudali cows for ensiled moringa leaf with cassava peel

	ML-CSP				
Parameters	80:20	60:40	40:60	20:80	SEM
Intake (kg, wet basis)	3.78^{d}	8.18^{b}	9.26^{a}	5.35^{c}	0.18
Coefficient of preference	0.57^{d}	1.23^{b}	1.39^{a}	0.81^{c}	0.07
Preference (%)	14.23^{d}	30.79^{b}	34.85^{a}	20.14^{c}	1.86
Ranking	4th	2nd	1st	3rd	-

$^{a-d}$Means with same superscripts within the row are not significantly different ($p>0.05$); ML = Moringa Leaf, CSP = Cassava Peel

Preference of Sokoto Gudali cows for moringa leaf ensiled with different proportions of cassava peel is shown in Table 4. There were significant differences ($p<0.05$) in Coefficient of Preference (COP) and % preference of the cows for the various silage mixtures. The COP measures preference for forages by ruminants, as the ratio of individual forage intake to the mean intake of all the forages offered. When values are = 1 or greater, the forage is considered to be acceptable to the animals but when values are <1, the forage is considered to be unacceptable. Percent preference on the other hand measures intake of individual forage as a percentage of total forage intake.

Preference indices show that cattle prefer silage mixtures with almost equal proportions of moringa leaf and cassava peel. The COP values show that the 60:40 and 40:60 moringa-cassava peel mixtures were more acceptable to cows than either 80:20 or 20:80 mixtures. The low COP for 80:20 moringa-cassava peel silage suggests that these cows were averse to diets with very high proportion of moringa leaf. This is corroborated by the observation of one of the researchers that these cows generally avoid moringa when grazing on grass-dominated pastures. Based on % preference, the order of preference by cattle in this study was 40:60>60:40>20:80>80:20 moringa-cassava peel silage. This trend indicates that addition of cassava peel to moringa forage greatly enhanced its acceptability by cattle.

CONCLUSION

Based on the results, it is concluded that addition of cassava peel to moringa leaf improved silage properties, energy concentration, digestibility and acceptability of moringa leaf silage by zebu cows.

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