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Original article

Physical characteristics, nutritive value and preference of Zebu heifers for ensiled mixtures of corn cob, cassava peel and urea

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In order to improve the feeding quality of corn cob and cassava peel for zebu cattle, a mixture of corn cob-cassava peel was ensiled with 0, 1, 2, and 3% of urea. Physical characteristics, chemical composition and in vitro digestibility of the silage mixtures were determined in a laboratory trial while the preference of cattle for the mixtures was evaluated using twelve Sokoto Gudali heifers in a cafeteria feeding trial. The experimental design adopted was the completely randomized design. Silage colour changed from white to yellow; smell from very pleasant to pungent; and texture from very firm to firm as the level of urea in the silage increased. The pH increased from 3.80 to 6.00 as level of urea in the mixture increased. Crude protein (CP) content of silage increased from 8.50 to 17.52% while acid detergent fibre (ADF) decreased from 34.13 to 30.90% as level of urea in the silage mixture increased. Organic matter digestibility (OMD) varied from 55.44 – 60.45%, and increased with addition of urea. Preference of zebu heifers for corn cob-cassava peel silage varied from 13.81 – 38.87%. Acceptability of silage reduced significantly as level of urea increased. Addition of urea to corn cob-cassava peel silage enhanced CP content and digestibility but physical attributes and acceptability of silage by cattle were adversely affected.

1. Introduction

Inadequate supply of forage during the dry season is a serious constraint to cattle production in most parts of the tropics. During this period forage is scarce and crop residues form the bulk of cattle diets. Although the digestible nutrients in crop residues is generally low, its availability and high fibre content makes it the most practical alternative to forage during the dry season (Abdul et al., 2008). Corn cob and cassava peel are important residues obtained from processing crops in the southwest of Nigeria. Utilization of corn cob by livestock is limited by its high ligno-cellulose contents, low protein and extremely low digestibility (Kategile, 1981; Ibhaze et al., 2014).

Cassava peel is a by-product of cassava root processing which is used extensively as a feedstuff in

Nigeria. It is a valuable source of energy for livestock and fermentable carbohydrate for tropical silage (Asaolu, 1988; Olorunnisomo, 2011). Although cassava peel is high in starch and low in fibre, it is limited as a livestock feed by its low protein content (Onua and Okeke, 1999). Urea is a good source of non-protein nitrogen for ruminants and has been used extensively to supplement low protein diets and improve digestibility of crop residues for ruminants in the tropics (Kunju, 1998; Kertz, 2010). Urea enhances microbial protein synthesis in the rumen and increases protein supply to the animal in the small intestine, thus improving overall nutrition of ruminants on low protein diets (Sundstol and Coxworth, 1984; Sahoo et al., 2009). The ensiled mixture of corn cob, cassava peel and urea is expected to provide a cheap but nutritive feed to cattle during the dry season when forage is scarce.

This study was therefore conducted to evaluate the ensiling quality and nutritive value of corn cob-cassava peel mixture ensiled with graded levels of urea, and preference of cattle fed these mixtures.

2. Materials and Methods

Laboratory analysis and in vitro studies were conducted at the Department of Animal Science, University of Ibadan while preference study was conducted at the Teaching and Research Farm of the same University.

Corn cob (89% DM) and cassava peel (31% DM) were mixed at ratio 20:80 into a homogenous mixture. The mixture was divided into 4 parts and urea was added at 0, 1, 2 and 3% and ensiled for 21 days to form the following treatments:

20% CC + 80% CSP + 0% urea (Urea – 0)
20% CC + 80% CSP + 1% urea (Urea – 1)
20% CC + 80% CSP + 2% urea (Urea – 2)
20% CC + 80% CSP + 3% urea (Urea – 3)

Mixtures were ensiled inside 4L mini silos for laboratory trials and 120L plastic silos for preference trial. Mini silos were opened at 21 days of ensiling and sampled for physical and chemical analysis. Crude protein (CP) and crude fibre (CF) were determined using methods of (AOAC, 2000) while detergent fibres were determined using the method of van Soest et al., (1991). Organic matter digestibility and metabolizable energy of silage was estimated using the in vitro gas production methods of Menke and Steingass (1988). Twelve zebu heifers were used to determine the preference of cattle for the different silages using a cafeteria feeding method. The experimental design adopted was the completely randomized design. The data were subjected to analysis of variance and significant means were separated using the Duncan multiple range tests using the procedure of SAS (1999).

3. Results and Discussion

The physical characteristics and pH of corn cob and cassava peel ensiled with different levels of urea is presented in Table 1. The colour of silages varied from white to yellow. All silages had a speckled brown appearance which resulted from the brownish cassava peel. The colour of the silage changed from white to yellow as the level of urea in the mixture increased. This may be due to ammonia production in the silage with inclusion of urea.

Table 1
Physical characteristics and pH of corncob and cassava peel silage with different levels of urea.

	CC-CSP mixtures*			
Parameters	**Urea-0**	**Urea-1**	**Urea-2**	**Urea-3**
Colour	White with brown speckles	Off-white with brown speckles	Yellowish white with brown speckles	Yellow with brown speckles
Smell	Very Pleasant	Pleasant	Fairly Pleasant	Pungent
Texture	Very firm	Firm	Firm	Firm
pH	3.80	4.90	5.40	6.00

*CC-CSP mixtures consist of 20% corn cob and 80% cassava peel ensiled with 0, 1, 2 and 3% urea

The smell of the silage varied from very pleasant to pungent. Silages with little (Urea-1) or no urea (Urea-0) had a pleasant smell while silage containing 2% urea (Urea-2) had a fairly pleasant smell. Silage containing 3% urea had a poor and pungent smell resulting from production of ammonia. Ammonia production seemed to increase with higher level of urea in the mixture, leading to off-odour and yellow colouration in the silage. All silages had a firm texture due to the high fibre content in the corn cob. The pH varied from 3.80 to 6.00, and increased as level of urea in the mixture increased. This was due to ammonia production from urea which counteracted the effects of lactic acid and other organic acids in the silage. Hill and Leaver (1999) reported that ensiling with urea reduces the conversion of particular sugars to lactic acid. Since acidic conditions are required for stability of stored silage, more soluble carbohydrates should be added to the corn cob-cassava peel mixture when urea levels exceed 1% of the total mixture.

The chemical composition of corn cob-cassava peel mixture ensiled with different levels of urea is presented in Table 2.

Table 2
Effect of urea addition on chemical composition of corn cob and cassava peel silage.

	CC-CSP mixtures*				
Parameters	**Urea-0**	**Urea-1**	**Urea-2**	**Urea-3**	**SEM**
Crude protein	8.50d	11.45c	14.40b	17.52a	0.21
Crude fibre	20.44a	20.24a	19.25b	18.20c	0.32
Neutral detergent fibre	48.41a	46.02b	43.30c	40.60d	0.71
Acid detergent fibre	34.13a	33.05b	32.80c	30.90d	0.53

a,b,c,d: Means within the row with different superscripts are significantly different (P<0.05); *CC-CSP mixtures consist of 20% corn cob and 80% cassava peel ensiled with 0, 1, 2 and 3% urea.

All silages had CP content higher than the minimum of 6 – 7 % required for effective rumen function in ruminant diets (Milford and Haydock, 1965). The CP content of the silages increased as the level of urea increased while the fibre fractions decreased. The increase in CP content of the silages was a direct effect of urea addition which is a source of non-protein nitrogen in ruminant diets (Nguyen et al., 2009). It is also expected that increased N-supply from urea would also lead to increased microbial protein synthesis during the ensiling process. Previous reports have shown that CP content and nutritive value of low quality crop residues improved when treated with urea (Areoghore, 2005; Ramirez et al., 2007).

The decrease in fibre fractions in the silage with addition of urea may have resulted from the solubilization of the hemicellulose in corn cob (Sundstol and Coxwoth, 1984; Abebea et al., 2004). Corn cob consists of cellulose, hemicellulose, and lignin (Chen, 2010). Rodriquez et al., (2002) indicated that ammonia has the ability to dissolve parts of the hemicellulose, releasing phenolic and acetic acids which led to break down of the NDF. These results show that urea addition and ensiling could improve nutritive value of highly fibrous feeds.

The estimated metabolizable energy and organic matter digestibility of corn cob-cassava peel silages are given in Table 3. There was no significant difference (P > 0.05) in metabolizable energy of corn cob-cassava peel mixture ensiled with different levels of urea as predicted by the in vitro gas method used in this study, it is however possible that a different result may be obtained with in vivo studies, since addition of urea is expected to liberate some of the energy bound in the fibre fractions of the crop residues (Rodriquez et al., 2002).

Table 3
Estimated metabolizable energy and organic matter digestibility of corn cob-cassava peel ensiled with urea using in vitro gas method.

	CC-CSP mixtures*				
Parameters	**Urea-0**	**Urea-1**	**Urea-2**	**Urea-3**	**SEM**
Metabolizable energy (MJ/kg DM)	10.50	10.25	10.10	10.02	0.22
Organic matter digestibility (%)	55.44c	60.24a	60.45a	57.20b	1.86

a,b,c: Means within the row with different superscripts are significantly different (P<0.05); *CC-CSP mixtures consist of 20% corn cob and 80% cassava peel ensiled with 0, 1, 2 and 3% urea.

The organic matter digestibility (OMD) of the silage mixtures are also given in Table 3. There were significant differences (P < 0.05) in OMD of ensiled mixtures. Silages ensiled with urea had higher digestibility than silage without urea. Digestibility was highest when urea was added at 2% inclusion. This result shows that addition of urea to corn cob-cassava peel silage improved digestibility of the mixture. Ramirez et al. (2007) also reported improved digestibility with addition of urea to low quality forages.

The preference of zebu heifers for corn cob and cassava peel ensiled with different levels of urea is given in Table 4. There were significant differences in intake and preference of the animals for corn cob-cassava peel silage. Intake and preference of the animals reduced progressively as the level of urea in the mixture increased. This may be due to the pungent smell and bitter taste associated with silage containing urea. Ruminant animals are known to show aversion to increased level of urea in the diet (Kertz, 2010).

Table 4
Preference of zebu heifers for corn cob-cassava peel ensiled with different levels of urea.

	CC-CSP mixtures*				
Parameters	**Urea-0**	**Urea-1**	**Urea-2**	**Urea-3**	**SEM**
Intake (kg, wet basis)	8.50a	6.05b	4.30c	3.02d	0.10
% Preference	38.87a	27.66b	19.66c	13.81d	1.28
Ranking	1st	2nd	3rd	4th	-

a,b,c,d: Means within the row with different superscripts are significantly different (P<0.05); *CC-CSP mixtures consist of 20% corn cob and 80% cassava peel ensiled with 0, 1, 2 and 3% urea.

4. Conclusion

Ensiling corn cob-cassava peel mixture with urea increased crude protein content of silage and reduced fibre contents. Digestibility of silage also increased with addition of urea to the mixture, indicating that livestock performance would be enhanced. Physical attributes and pH of silage were however, adversely affected by addition of urea. Based on our results, physical attributes, chemical composition, digestibility and preference of zebu cattle were optimized when corn cob-cassava peel mixture was ensiled with urea at 1% level of inclusion. At higher levels of urea addition, more soluble carbohydrates should be incorporated into the mixture to ensure proper fermentation and enhance physical attributes and acceptability of the silage mixture. This can be achieved by increasing the proportion of cassava peel in the mixture or incorporating other soluble carbohydrate source like molasses, cassava meal or cereal grains.

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