EFFECT OF SUBSTITUTING MAIZE GRAIN WITH COBS TREATED WITH COMBINATIONS OF UREA AND WOOD ASH ON CHEMICAL COMPOSITION AND *IN SACCO* DEGRADABILITY

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ABSTRACT

An experiment was conducted to determine the effect of substituting maize grain with maize cobs treated with 25% urea plus 75% wood ash (WA) on chemical composition and *in sacco* degradability. Maize grain was substituted with graded levels of 25U75WA in the dietary ingredients and the treatments were: 100M = 100% maize grain, 66M34C = 66% maize grain plus 34% treated maize cobs, 34M66C = 34% maize grain plus 66% treated maize cobs and 100C = 100% treated maize cobs. Samples were analyzed for dry matter (DM), organic matter (OM), ash, crude protein (CP), neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL); they were incubated *in sacco* for 6, 12, 24, 48 and 72 hrs and their DM degradation kinetics described using the equation $y = a + b (1- e^{-ct})$. Results indicated that as maize grain is substituted with treated maize cobs, NDF, ADF and ADL also increased, however only the neutral detergent soluble (NDS) for treatment 100C was reduced. At 72 hrs of incubation, treatment 34M66C had the highest DM degradation, rapidly soluble fraction 'a' and potential degradability 'a+b'. It was concluded that maize cobs treated with combinations of urea and WA could substitute 66% of maize grain in ruminant diets.
Key word: Maize cob, maize grain, in sacco, urea, wood ash.

INTRODUCTION

Domestic ash left after burning of wood for cooking is alkaline, can improve the digestibility of crop residues the same way as urea and is available at household level at no cost to the farmer. Most researches have centered investigations on use of either urea (Sundstol and Coxworth, 1984; Preston, 1985; Chenost, 1995) or wood ash (Adebowale *et al*., 1991; Ramirez *et al.,* 1992., Solomon *et al*., 2012) as source of crop residue treatments but not their combinations. The combination is expected to reduce cost of treatment, improve digestibility at the same time incorporating both nitrogen present in urea and minerals from ash into the crop residue. After maize harvest and shelling of the grains, the cobs are left in the homestead as waste and in some cases burnt. Meanwhile livestock compete with man for grain, therefore there is need to conserve grains for human consumption by either partially or completely replacing it with urea-wood ash treated maize cobs which are rich in energy, nitrogen and minerals (Chenost, 1995; Solomon *et al.,*2012). The objectives of this study was to determine the effect of substituting maize grain with cobs treated with combinations of urea and wood ash on chemical composition and *in sacco* degradability.

MATERIAL AND METHODS

Location of Study, Sample Collection and Treatment

The study was conducted at the Botswana University of Agriculture and Natural Resources, Content Farm located 10 Km north of Gaborone in South Eastern Botswana. Maize cobs treated with a combination of 25% urea and 75% WA were used to substitute graded level of maize grain in a complete diet as shown in Table 1.

Laboratory Analysis

Dry matter (DM, ID number 930.15) for all samples were determined by drying in forced air oven at 60^{o} C for 24 hr. Organic matter (OM, ID number 942.05) and ash were obtained by difference in weight after ignition at 550^{o} C in a muffle furnace (Muffle Furnace Size 3, Gallenkamp, UK). The

NDF, ADF and ADL were determined with ANKOM fiber analyzer (Ankom Technology Corporation, Fairport, NY, USA) according to the procedure of Van Soest *et al*, (1991). In the analysis of NDF, sodium sulphite and alpha amylase were also added. Nitrogen was determined by the Kjeldahl method (ID number 955.04) according to AOAC (1999) and CP determined as N*6.25 (ID number 954.01).

IN SACCO DEGRADABILITY

The *in sacco* DM degradability analysis for the various treatments was carried out according to the procedure of Mehrez and Orskov (1977). Various samples were milled through a 3mm sieve and 2g weighed into nylon bags (pore size 20µ) in duplicates. These were then incubated for 6, 12, 24, 48 and 72 hours in two fistulated steers (5 treatments × 5 time periods × 2 fistulated steers). The procedure was repeated three times and means for each incubation used as replicates. The steers were fed commercial concentrate combined with crushed maize cobs for 5 days to get rumen microbes adapted to the feed. After removal, the nylon bags were thoroughly washed with cold running water until no further coloured liquid could be extruded, followed by drying at 60 ^{0}C for 48 hours. The dry matter losses for each incubation time were then determined according to the formula proposed by Osuji *et al.* (1993)

The DM degradation data were then fitted to the exponential equation $\mathbf{P= a + b (1 –e^{-ct})}$ (Orskov and McDonald, 1979): where P = DM disappearance in rumen at time't', a = the rapidly soluble fraction, b = the insoluble but fermentable fraction, c = the constant rate of degradation of 'b' (% per hour), a + b = Potential degradability. ed = a + bc/ (c + k) where k = the ruminal passage rate assumed at 3%$^-$h.

STATISTICAL ANALYSIS

I*n sacco* degradability constants were generated with Non Linear Model (NLIN) SAS programme using the code of Osuji *et al*. (1993) and effects of treatment carried out using GLM procedure of SAS (2002) and means separated using Duncan's multiple range test (Steel and Torrie, 1984).

Results

Table 1: Ingredients and chemical composition (g/kg) of experimental diet

	Types of treatment				
Ingredients (%)	100M	66M34C	34M66C	100C	
Maize cob	0	15	30	45	
Maize grain	45	30	15	0	
Lucerne	39	36	32.5	29.5	
Wheat bran	10	10	10	10	
Sun Flower Cake	5	8	11.5	14.5	
Salt	0.5	0.5	0.5	0.5	
DCP	0.5	0.5	0.5	0.5	
Chemical composition (g/kg)					SD±
DM	945.0	950.0	950.0	955.0	4.630
ASH	82.01	100.0	107.9	175.4	38.68
OM	918.0	900.0	892.1	824.6	38.68
CP	134.3	131.0	133.5	133.5	3.740
NDF	470.0	470.0	480.0	570.0	54.97
ADF	160.0	220.0	250.0	360.0	78.51
ADL	53.20	63.20	85.20	114.4	28.61
HC	310.0	250.0	230.0	210.0	53.45
NDS	530.0	530.0	520.0	430.0	54.97
ME MJ/kg	18.94	19.19	19.28	17.24	0.938

DM= dry matter, OM=organic matter, CP=crude protein, NDF=neutral detergent fibre, ADF=acid detergent fibre, ADL=acid detergent lignin, HC=hemicellulose, NDS=neutral detergent soluble, ME=metabolizable energy, DCP= Di calcium phosphate. 100M= 100% maize, 66M34C=66% maize 34% treated maize cobs, 34M66C=34% maize

66% treated maize cobs, 100= 100% treated maize cobs.

Ingredients and chemical composition of experimental diet are shown in Table 1. It was observed that the NDF, ADF and ADL of the experimental diets increased as the maize was substituted with urea-wood ash treated maize cobs; however, treatment 100C had the lowest NDS. The result indicated that treatment 33M66C had the highest DM degradation at all the time intervals (Table 2), while the highest 'a', 'a+b' and 'ed' were also recorded for treatment 33M66C (Table 3)

Table 2: *In sacco* degradation (%) characteristics of experimental diets

Time of incubation (hr)	Types of treatment					
	100M	66M34C	34M66C	100C	SE	P value
6	27.21[b]	27.85[b]	32.59[a]	26.16[b]	0.9723	0.0124
12	30.15[b]	31.17[b]	35.91[a]	29.49[b]	0.9725	0.0126
24	37.67[b]	39.01[b]	41.96[a]	36.53[b]	0.8064	0.0161
48	41.25[c]	42.51[b]	46.31[a]	40.26[c]	0.8778	0.0004
72	61.96[b]	60.72[b]	67.35[a]	55.50[c]	1.633	0.0045

100M= 100% maize, 66M34C=66%maize 34% treated maize cobs, 34M66C=34% maize 66% treated maize cobs, 100= 100% treated maize cobs

Table 3: *In sacco* degradation (%) parameters of experimental diets

Parameters	Types of treatment					
	100M	66M34C	34M66C	100C	SE	P value
a	27.72[b]	27.50[b]	30.76[a]	26.14[b]	0.7015	0.0523
b	52.86[ab]	52.35[ab]	55.06[a]	51.47[b]	0.6015	0.1597
c	0.0093	0.0097	0.0094	0.0079	0.0005	0.6605
a+b	80.58[b]	79.85[b]	85.82[a]	77.61[b]	1.172	0.0064
ed	40.23[b]	40.31[b]	43.88[a]	36.91[c]	0.9586	0.0083

100M= 100% maize, 66M34C=66%maize 34% treated maize cobs, 34M66C=34% maize 66% treated maize cobs, 100= 100% treated maize cobs, a= rapidly soluble fraction, b= insoluble but fermentable fraction, c= degradation rate/h, a+b= potential degradability, ed= effective degradability.

DISCUSSION

It was observed that the more the substitutions of maize grain with treated maize cobs, the more the ash content of the feed. The high amount of ash in the feed may supply more minerals to the animals and rumen microbes (Imbeah, 1999). However the substitution also led to increase in NDF, ADF and ADL and reduction in NDS of treatment 100C. The higher NDS content of treatments 100M, 66M34C and 34M66C could be attributed to their maize contents that were mostly cell soluble compared to treatment 100C that was characterized by higher contents of NDF, ADF and ADL which can negatively affect digestibility. Various authors have also reported increases in NDF, ADF and ADL contents of feeds when energy source is substituted with maize cobs (Khan *et al*., 2006; Wanapat *et al*., 2012). The reason for the high NDF and ADF contents of treatment 100C based diet was because of its high crude fibre content.

At 72 hours of *in sacco* degradability, treatment 34M66C had the highest percent degradability probably because it had better colonization and attachment by rumen microbes due to its low maize grain contents compared to treatments 100M and 34M66C. When diets have high grain contents, they are fermented rapidly by rumen microbes to VFAs which leads to a drop in rumen pH. A drop in rumen pH depresses the activities of rumen microbes thereby impacting negatively on digestibility of fibrous materials. However, the impact of low pH may not be significant under *in sacco* condition due to dilution resulting from entry and exit of other particles surrounding the nylon bags. The fact that treatment 34M66C had the highest degradation (%) after 72 hours of incubation and highest potential degradability 'a+b,' implied that it was superior to the other treatments in terms of digestibility. Carro *et al*. (1991) reported that the fraction that would be degraded when samples were incubated indefinitely in the rumen was the potential degradability and did not indicate the *in vivo* condition. Khazaal *et al.* (1995) reported that potential degradability of feed pointed to the quality of feed because it was associated with the degradability of feed. Therefore, feeds with higher 'a+b' fractions may degrade faster than those with lower 'a+b' fractions.

CONCLUSION

It was therefore concluded that 66% of maize cobs could replace maize grain in ruminants' diets.

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