EFFECT OF ENSILED CASSAVA PEEL AS REPLACEMENT FOR CONCENTRATE ON RUMINAL FERMENTATION IN RUMEN-FISTULATED COWS

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Abstract- Ensiled cassava peel (ECP) was made prior to commencing the experiment. Three Holstein Friesian Crossbred (>75% HF) dairy cows were assigned to one of 3 treatments in a 3 x 3 Latin squares design. Dietary treatments were: 4 kg/cow/d pelleted concentrate (control), 3.2 kg/cow/d pelleted plus 0.8 kg/cow/d (20% replacement) ensiled cassava peel and 2.4 kg/cow/d plus 1.6 kg/cow/d (40% replacement). Feed offered and feed refused were measured and recorded daily during the experimental periods. On the last day of each experimental period (d 21), ruminal fluid samples were collected from each fistulated non-lactating cow at 0, 3 and 6 h after the morning feeding. The pH of rumen fluid were immediately determined at the time of sampling by pH meter. VFAs and ammonia N determination were performed by GC and Kjeldahl analysis respectively. The rumen pH of 40% ECP cows was significantly higher (P=0.01) than control and 20% ECP cows at 3 h after feeding while the rumen pH of 20% ECP cows was higher (P=0.01) than 40% ECP cows but did not differ from the control cows at 6 h after feeding. The molar proportion of acetic, propionic and butyric acids; and the proportion of acetic acid to propionic acid were unaffected by dietary treatments at all h after feeding. It can be concluded that ECP can replace concentrate up to 40% without any harmful effect to the cows.

Index Terms- Aspergillus Oryzae, Saccharomyces Cerreviseae, Ensiled Cassava Peel, Ruminal Fermentation.

I. INTRODUCTION

Ruminal fermentation is important for ruminant animals since the end products of fermentation can be used for their maintenance and production. Ruminal microbial fermentation process yields volatile fatty acids, ammonia-N, methane, carbon dioxide and microbial protein. The end-products of fermentation such as VFA are absorbed across the rumen wall and used for energy and protein synthesis. The outflow of microbial biomass and VFA from the rumen influences the nutritional status of the animal as well as the efficiency of nutrient utilization. Many factors affect end-product of fermentation including type and amount of feeds, roughage: concentrate ratio, etc. Ruminal fermentation characteristics were largely unaffected by the source of dietary carbohydrate, with similar ruminal pH and volatile fatty acid and ammonia concentrations for the first 6 h after the morning feeding [1].

Saccharomyces cerevisiae, have been used in animal diets for several decades and are considered sources high quality proteins and B-complex vitamins, selenium and zinc [2]. In addition, dietary yeast can be used as a ruminant feed because the yeast cell contained useful nutrients for ruminant feed especially with high lysine composition (8.0 g/100 g of protein) [3]. Supplementing diets with yeast (*S. cerevisiae*) increased milk production of dairy cows and weight gain of growing cattle [4]. Production responses attributed to yeast are usually related to stimulation of cellulolytic and lactate-utilizing bacteria in the rumen, increased fiber digestion and increased flow of microbial protein from the rumen [5].

Utilization of local feed especially fermentation of cassava peels by pure culture *S. cerevisiae* could increase its protein content from 2.4% in non fermented cassava to 14.1% in fermented products [6]. The fermented cassava flour with *S. cerevisiae* enhanced the protein level (from 4.4% to 10.9%) and decreased the amount of cyanide content [7]. Furthermore, reference [8] reported that cassava chip can be nutritionally improved with *S. cerevisiae* called yeast fermented-cassava chip (YEFECAP) and could be used for animal feeding. Reference [9] found that feeding diets containing yeast fermented cassava peel and pulp resulted in higher ruminal pH, ammonia-N and blood urea nitrogen. The aim of the present study was to determine the effect of ensiled cassava peel as replacement for concentrate on ruminal fermentation in rumen fistulated cows.

II. MATERIALS AND METHODS

Preparation of ensiled cassava peel

Ten drums of each 80 kg of wet cassava peel taken from cassava flour factory were put into each 150 L plastic drum. Water was added to make 70% moisture content, according to the calculation. Each drum was then streamed through drilled hose placed at the bottom of the drum. The hose was attached to stream pipe connected to boiler. The cassava peel was allowed to stream for 4 h and then left to cool down at room temperature. After cooling down, 320

ml of 3.25 x 10^6 cells/ml of *A. oryzae* were inoculated in each drum, thoroughly mixed and then left at room temperature. All drums were incubated for 3 days. After 3 days, *S. cerreviseae* were inoculated and urea was added. Drums were left at room temperature for 7 days. After 7 days, ensiled cassava peel was removed, sun-dried for 4 days and stored for further utilization. The concentration of ammonia-N in the rumen fluid was unaffected ($p>0.05$) by the dietary treatments.

Management of rumen fistulated cows

Three Holstein Friesian Crossbred (>75% HF) dairy cows housed in individual pen (3 x 3 m^2) were assigned to one of 3 treatments in a 3 x 3 Latin squares design. The experiment comprised 3 periods, with 21 d in each period, 14 d for adaptation to the diets followed by 7 d for ruminal sample collection. Dietary treatments were: 4 kg/cow/d pelleted concentrate (control), 3.2 kg/cow/d pelleted plus 0.8 kg/cow/d (20% replacement) ensiled cassava peel and 2.4 kg/cow/d plus 1.6 kg/cow/d (40% replacement).

Diets offered as 4 kg/cow/d of concentrate containing 21% CP plus ensiled cassava peel according to treatments and 6 kg/cow/d of rice straw, divided into 2 equal meal at 0800 and 1600 h together with *ad libitum* clean water. Feed offered and feed refused were measured and recorded daily during the experimental periods. The DM content (48 h at 60°C) of the rice straw for individual cows was determined daily to calculate DMI. The samples were ground through a 1 mm screen for chemical analysis. The DM of rice straw and concentrate were determined by oven drying at 105 °C to a constant weight. The samples were analyzed for CP, ether extract (EE), ash [10], NDF, ADF, and ADL [11].

Ruminal fermentation

To evaluate ruminal fermentation, on the last day of each experimental period (d 21), ruminal fluid samples were collected from each fistulated non-lactating cow at 0, 3 and 6 h after the morning feeding. The pH of rumen fluid were immediately determined at the time of sampling by pH meter. For VFAs and ammonia N determination, 36 ml of rumen fluid was put into 50 ml centrifuge tube containing 4 ml of 1M H_2SO_4, then centrifuged at 1895 rpm for 15 min. Supernatants were collected and put into 25 ml test tube, then capped and stored at -20 °C until analysis. Analysis of acetic, propionic and butyric acids used GC (Hewlett Packard GC system HP6890, USA, 19091N-113 INNOWAX , Length (meters) 30, I.D. (mm) 0.32 WIDEBORE, Film (um) 0.25). Ammonia N concentration was determined by Kjeldahl analysis [10].

III. STATISTICAL ANALYSIS

Measurements of intake, pH, ammonia N, and VFAs were analyzed by ANOVA using the Statistical Analysis System [12]. Differences between treatment means were statistically compared using Least Significant Differences.

IV. RESULTS AND DISCUSSION

Chemical composition of feeds and feed intakes

Concentrate and ECP contained similar CP (23.0 vs 21.8%) while rice straw was low in CP (1.3%) (Table 1). Therefore, the protein content of the ration would not be affected by the replacement of ECP for concentrate. Other chemical compositions were in the range commonly reported [13]. The total daily DM, CP and NE intakes (Table 2) were similar in all treatment groups.

Table 1. Chemical composition of cassava peel, concentrate and rice straw (Mean±SD)

	ECP	21% CP concentrate	Rice straw
% dry matter (DM)	94.32±0.01	92.17±0.01	92.08±0.01
		% of DM	
Crude protein (CP)	23.02±0.24	21.83±0.09	1.34±0.02
Crude fat	2.65±0.03	4.94±0.25	1.54±0.11
Ash	13.73±0.15	12.45±0.12	15.84±0.24
Crude fiber	18.95±0.23	15.72±0.12	34.92±0.21
NDF	54.33±0.04	36.58±0.08	73.58±0.04
ADF	45.39±0.14	21.89±0.21	59.16±0.15
ADL	9.38±0.02	6.21±0.04	10.44±0.03
NDIN	0.35±0.02	0.96±0.01	0.15±0.01
ADIN	0.18±0.01	0.21±0.01	0.16±0.01
TDN_{1X}; %	45.50	65.45	37.76
DE_P; Mcal/kg DM	2.36	2.67	1.89
ME_P; Mcal/kg DM	1.94	2.25	1.46
NE_{LP}; Mcal/kg DM	1.17	1.39	0.84

ECP = ensiled cassava peel; NDF = neutral detergent fiber; ADF = acid detergent fiber; ADL = acid detergent lignin; NDIN = neutral detergent insoluble nitrogen; ADIN = acid detergent insoluble nitrogen.

[1] TDN_{1x} (%) = tdNFC + tdCP = (tdFA x 25.25) + tdNDF – 7)

DE_{1x} = ((tdNFC/100) x 4.2) + ((tdNDF/100) x 4.2) x ((tdCP/100) x 5.6 + ((FA/100) x 9.4) – 0.3

[2] DE_P (Mcal/kg) = ((TDN_{1x} – ((0.18 x TDN_{1x}) – 10.3)) x Intake)/ TDN_{1x}) x DE_{1x}

[3] ME_P (Mcal/kg) = (1.01 x (DE_P) – 0.45) + (0.0046 x (EE-3))

[4] NE_{LP} (Mcal/kg) = (0.703 x ME_P) – 0.19 , (EE>3 %)

[4] NE_{LP} (Mcal/kg) = (0.703 x ME_P) – 0.19) + ((0.097 x ME_P)/97) x (EE-30), (EE>3%)

Table 2. Effect of ensiled cassava peel as replacement for concentrate on feed intake.

Intake	Control	20%ECP	40%ECP
DM (kg)			
Ensiled cassava peel	0.00	0.75	1.50
Concentrate	3.68	2.94	2.21
Rice straw	5.52	5.52	5.52
Total	9.20	9.22	9.23
CP (g/d)			
Ensiled cassava peel	0.00	173	346
Concentrate	803	643	482
Rice straw	74	74	74
Total	877	890	902
NE (Mcal/d)			
Ensiled cassava peel	0.00	0.82	1.64
Concentrate	5.35	4.28	3.21
Rice straw	5.05	5.05	5.05
Total	11.90	11.65	11.40

ECP = ensiled cassava peel; NE = net energy

Rumen fermentation characteristics

The pH in the rumen fluid at 0, 3 and 6 h after feeding (Table 3) ranged from 6.54 to 6.83 and was affected by diets at 3 and 6 h after feeding. At 0 h, the rumen pH were similar, however, the rumen pH of 40% ECP cows was significantly higher (P=0.01) than control and 20% ECP cows at 3 h after feeding while the rumen pH of 20% ECP cows was higher (P=0.01) than 40% ECP cows but did not differ from the control cows at 6 h after feeding. The higher pH in the rumen fluid of ECP cows reflected the urea residue in ECP products. However, the rumen pH in all treatments were within the range of 5.80 – 7.00 below which the rumen function might be negatively affected [14].

The concentration of ammonia-N in the rumen fluid was unaffected (p>0.05) by the dietary treatments (Table 3). Ammonia-N is the product of ruminal fermentation of dietary CP, microbial protein and non-protein nitrogen. Variation in ammonia-N concentration is dependent on level of feeding, solubility of dietary protein, available carbohydrate and frequency of feeding [15]. Reference [16] suggested that optimum ammonia-N concentration promoting highest microbial growth and DM degradability was between 50 and 80 mg/L. The present study found lower values at 0 and 6 h after feeding and within the normal range at 3 h after feeding when compared to [16].

Table 3. Effect of ensiled cassava peel as replacement for concentrate on pH, ammonia nitrogen (NH_3-N) and blood urea nitrogen (BUN) at various h after feeding.

h	Control	20%ECP	40%ECP	SEM	P-value
pH					
Hour 0	6.83	6.82	6.74	0.03	0.15
Hour 3	6.54^{b}	6.56^{b}	6.65^{a}	0.01	0.01
Hour 6	6.78^{ab}	6.80^{a}	6.69^{b}	0.01	0.01
NH_3-N	…….(mg/l)……				
Hour 0	38.19	39.43	42.17	1.42	0.78
Hour 3	50.19	48.47	53.31	1.57	0.43
Hour 6	39.42	31.88	36.53	2.53	0.69

SEM = standard error of the mean, ECP = ensiled cassava peel

^{a,b} Means within a row with different superscripts are significantly different (P<0.05).

Volatile fatty acids (VFAs) are the end-products of carbohydrate fermentation in the rumen. The molar proportion of acetic, propionic and butyric acids; and the proportion of acetic acid to propionic acid were unaffected by dietary treatments at all h after feeding (Table 4). Similar result was also reported by [9] when cows were supplemented with yeast fermented cassava.

Table 4. Effect of ensiled cassava peel as replacement for concentrate on volatile fatty acids (VFAs) content in the rumen.

h after feeding	Control	20%ECP	40%ECP	SEM	P-value
Acetate	…….(mol/100mol)…….				
Hour 0	66.27	73.18	68.93	0.87	0.39
Hour 3	65.68	70.59	68.91	1.02	0.42
Hour 6	64.80	69.27	69.89	1.62	0.49
Propionate	…….(mol/100mol)…….				
Hour 0	24.59	16.03	19.40	0.88	0.28
Hour 3	25.78	18.42	18.75	0.94	0.31
Hour 6	23.60	18.89	19.59	0.94	0.56
Butyrate	…….(mol/100mol)…….				
Hour 0	9.14	10.79	11.67	0.31	0.12
Hour 3	8.54	11.32	12.33	0.30	0.10
Hour 6	11.52	11.84	10.52	0.44	0.42
C2:C3					
Hour 0	2.7	4.6	3.6	0.10	0.09
Hour 3	2.6	3.9	3.7	0.16	0.30
Hour 6	2.8	3.7	3.6	0.11	0.23

SEM = standard error of the mean; ECP = ensiled cassava peel

CONCLUSION

Based on the results of the current study, replacing concentrate by 20 and 40% ECP had no effect on feed intake, ruminal concentrations of ammonia-N, total and individual volatile fatty acids, however, ruminal pH was increased by ECP. Farmers can replace concentrate by ensiled cassava peel up to 40% in order to reduce the feed cost.

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