Influences of Starch to Fiber Ratio in Total Mixed Rations on Rumen Fermentation and Ruminal Dry Matter and Organic Matter Degradability of Fiber Source in the Dairy Cows

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Introduction

•Starch is a source of carbohydrate obtained mostly from cereal grain and root crop as well as by- products of these sources. On a chemical basis, starch is comprised of glucose molecules linked together by α-1,4 glygosidic linkage.

•Feeding the ruminant with high level of starch reduced the ruminal pH and may cause rumenitis and parakeratosis (Ørskov, 1986)

•Fiber is a main fraction of the plant cell wall contained mostly of carbohydrates. The most predominant component of fiber are cellulose hemicelluloses and lignin

•To prevent the severe adverse effect of ruminal starch fermentation, providing the ruminant with optimum fiber content in the offered feed is must be taken into the considerations.

•. The purpose of this experiment was to study the influence of ratio of starch to fiber in total mixed ration on ruminal pH redox potential(*Eh)* and on ruminal dry matter and organic matter degradation parameters of ensiled Napier grass used as fiber source of the TMR.

Materials and Methods

Experiment1: Rumen fermentation study

Four Holstein x Thai-indigenous cross bred cows fitted with permanent ruminal fistula were allocated in a 2 x 2 factorial arrangement in a 4 x 4 Latin Square design to receive 4 different experimental feeds contained with 2 different starch source (cassava chip VS ground corn) and two different ratio of starch to fiber (high starch low fiber diets VS High fiber low starch diets)(Table 1). The rumen fluid was taken every two hours from 0 to 8 hours post feeding for the pH and the *Eh* measurements

Ensiled Napier grass as a source of fiber in Total mixed ration

Rouhage source

Concentrate source

Total mixed ration

Rumen fistulated cows for fluid collection and pH and Eh measurement

Experiment2: Ruminal dry matter and organic matter degradation parameters study

Dry ensiled Napier grass was grind through a 1 mm screen for use as the sample for ruminal dry matter and organic matter degradation parameters study.

Bag preparation

Weighing

Tied

Put into the nest

Warming at 39°C

Put into the rumen

Taking off

Washing

Owen dry

Desiccation and weighing

Curve fitting and generate data

Table1: Feed ingredients and calculated values of four total mixed rations used for the experimentations (% DM basis)

Ingredients	Starch sources			
	Cassava		Ground Corn	
	High starch	High fiber	High starch	High fiber
Cassava ship	33.25	10.00	0	0
Ground corn	0	0	38.25	11.45
Soybean meal	17.00	15.00	13.00	15.50
Molasses	3.50	3.00	3.50	3.50
Vitamin-mineral premixed	0.50	0.50	0.50	0.50
Dicalcium phosphate	1.00	1.00	1.00	1.00
NaCl	1.00	1.00	1.00	1.00
Ground sulfur	1.00	1.00	1.00	1.00
Urea	1.00	1.50	1.00	1.25
Palm oil	1.00	1.00	1.00	1.00
Ensiled Napier grass	40.75	66.00	39.75	65.00
Calculated Value (%DM basis)				
Crude Protein	12.00	12.08	12.21	12.12
Metabolizable energy (kcal/kg)	2607	2408	2698	2424
Ca	0.65	0.71	0.57	0.70
P	0.47	0.49	0.41	0.48
Starch	48.64	28.86	43.77	28.06
NDF	32.36	43.30	29.24	41.92
% Starch in Total mixed ration	60	40	60	40
% NDF in Total mixed ration	40	60	40	60

Results and Discussion

Table 2: Influences of source of starch and ratio of starch to fiber in total mixed rations on change of pH and oxidation reduction potential (*Eh*) of ruminal fluid of the dairy cattle

Hour after feeding (hr)	pH							
	Energy sources (A)			Ratio of starch to fiber (B)				
	Cassava chip	Ground corn	P>F	60:40 (HSLF)	40:60 (LSHF)	P>F	SEM	A*B
0	7.08	6.92	0.15	7.01	6.99	0.81	0.07	0.09
2	6.93	6.90	0.61	6.87	6.96	0.22	0.04	0.04
4	6.73	6.86	0.32	6.72	6.87	0.29	0.09	0.14
6	6.82	6.95	0.20	6.79	6.97	0.10	0.06	0.18
8	6.84	7.04	0.15	6.86	7.02	0.24	0.09	0.12
	Eh (mV)							
0	-30.56	-31.94	0.79	-34.69	-27.81	0.21	3.55	0.43
2	-38.31	-40.25	0.64	-41.75	-36.81	0.25	2.75	0.05
4	-49.44	-42.06	0.35	-50.25	-41.25	0.27	5.18	0.15
6	-44.86	-37.03	0.18	-46.00	-35.94	0.10	3.66	0.16
8	-39.94	-32.94	0.16	-38.94	-33.94	0.30	3.12	0.07

SEM = Stand error of the mean

mV = Millivolt

Table 3: Influences of source of starch and ratio of starch to fiber in total mixed ration on the ruminal degradation parameters of dry matter and organic matter of ensiled Napier grass used as the principal fiber source in total mixed ration (%)

parameter	Dry matter					
	Energy sources(A)		Ratio of Starch to Fiber % (B)		SEM	A*B
	Cassava chip	Ground corn	60:40	40:60		
a	20.21[b]	22.72[a]	22.29	20.65	0.69	0.84
b	63.31	63.14	60.07[b]	66.38[a]	1.52	0.08
c (fr/hr)	0.027	0.024	0.028[a]	0.023[b]	0.00	0.07
ed1	56.59	56.24	56.84	55.99	0.45	0.53
ed2	42.50	42.44	43.28	41.66	0.59	0.20
ed3	36.36	36.64	37.28	35.73	0.64	0.23
PTDG	83.90	85.87	82.26[b]	87.51[a]	0.08	0.03
lag time(hr)	0.09	0.18	0.02	0.25	1.32	0.71
	Organic matter					
a	15.04[B]	18.96[A]	16.31	17.70	0.735	0.46
b	67.35	64.87	64.62	67.59	1.516	0.17
c (fr/hr)	0.027	0.025	0.029[a]	0.023[b]	0.001	0.07
ed1	54.21	54.10	54.43	53.89	0.505	0.88
ed2	39.15	40.03	39.98	39.20	0.494	0.52
ed3	32.44	34.06	33.50	33.00	0.514	0.67
PTDG	82.39	83.83	80.93	85.29	1.434	0.08
lag time(hr)	0.44	0.34	0.55	0.24	0.190	0.66

Degradation constants derived from the Ørskov and McDonald (1979) equation P = a+b(1-e^{-ct}) where P is degradability at time 't'; 'a', the rapidly soluble fraction; 'b', the potentially degradability of dry matter with in time 't', be degraded; 'c', the degradation rate of the 'b' fraction, PTDG = Potential degradability (a+b). Effective degradation in the rumen at 0.02, 0.05 and 0.08 fraction/hour passage rate is represented by ed1, ed2 and ed3 respectively and is calculated by using the Excel Application Programs for processing feed degradability data written by Chen (1995).

[a, b]= Means in the same row of the same factor with different superscript differ significantly (P<0.05)

[A, B]= Means in the same row of the same factor with different superscript differ significantly (P<0.01)

SEM = Stand Error of Mean

1. Both the effect of starch sources and starch to fiber ratios did not affect to the rumen pH and the *E*h value in every collection periods.
2. The pH value obtained from this work range from 6.72 to 7.08 which is classified as an optimum pH for rumen fermentation.
3. The *E*h value range from -30.50 to – 50.25 mV which is lower than the previous result reported by Marden, *et al.* (2005) with the value ranged from -73.5 to -266.8 mV.
4. The lower reducing power of the *E*h Value derived from this research work might ground on the fact that measuring of the *E*h value was done in the aerobic condition. The rumen fluid was allow to contact with oxygen for short time, the reducing power was therefore lower than that of other reports.
5. Higher level of starch in TMR affects the potential degradability of the dry matter of Napier grass which is used as fiber source in the TMR.

Conclusions

The influences of sources of starch and ratios of starch to fiber in total mixed ration had a very little impact on both the rumen fermentation and the ruminal dry matter and organic matter degradability.

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