Effects of Using Diatomite and Zeolite in Feed on Rumen Fermentation and Blood Parameters of Cattle

O. Insung [1,2] U. ter Meulen [2] T. Vearasilp [3]

[1]Rajamangala Institute of Technology (RIT) Nakhonsithammarat Campus, Thungsong, Nakhonsithammarat, Thailand.

[2]Insitute of Animal Physiology and Animal Nutrition, Georg-August University of Göttingen, Germany.

[3]Department of Animal Science, Faculty of Agriculture, Chaingmai University, Thailand.

Abstract

A study was conducted to determine the effects of using diatomite and Zeolite in feed on the regulation of ruminal ammonia nitrogen release from urea mixed cassava and on rumen fermentation and blood parameters in cattle. Four crossbred Holstein x Thai- indigenous cattle fitted with permanent rumen fistulae were used. They received alternately 4 different feeds containing 4 different types of ammonia regulators (Control, Diatomite, Zeolite and Diatomite + Zeolite, respectively). Only ruminal ammonia and blood urea nitrogen concentrations measured at 2 hours after feeding increased significantly ($P<0.05$) more in the control group than in the other groups, while at other time periods the concentrations were not different ($P>0.05$) across treatments. In contrast, ruminal pH, blood calcium and blood phosphorus measured at all the different time periods after feeding were not affected by treatment ($P>0.05$).

Introduction

Diatomite or Kieselguhr is a mineral from fossils of shells of diatom. In natural form it can be used as raw material for production of commercial diatomite used as absorbent, additive, coating, conditioner or acoustic or thermal insulator (Edwards, 1991). Diatomite filter aid residue is the residue of diatomite released from factories. This diatomite is used as a filter aid material in factories such as in monosodium glutamate production industry. In Thailand, the released waste product annually accounts for 2,200 tonnes (Ajinomoto, Thailand, co.

Ltd., personal communication). This waste product has an aroma like molasses. It contains crude protein, crude fibre, ether extract, ash and nitrogen free extract (NFE) in the proportions of 5.10, 3.14, 2.03, 47.04 and 42.69 % (DM) respectively (Feed analysis division, 1994). This quality profile has attracted the interest of animal nutritionist who view it as a potential animal feed source. However, before this waste product will be considered to be used as animal feed, especially for the ruminants, it's primary material, the commercial diatomite, should be investigated some functional properties concerning with rumen regulation and blood parameters comparing with Zeolite, a rumen fermentation regulator that has been used for many years.

Materials and Methods

1. Feeds : Four Isonitrogenous diets with 14.80 % crude protein content were formulated according to NRC (1980).The diets contained 4 different types of regulators (Table1).

2. Animals : Four crossbred Holstein x Thai-indigenous heifer fitted with permanent rumen fistulae were used.

3. Experimental design : The animals were used in a 4x4 Latin square design (Steel and Torrie, 1981) with 4 treatments and 4 periods. Each period lasted for 14 days with 13 days for adaptation and 1 day for data collection.

4.Criteria : Rumen fluid was sampled at 0, 2, 4 and 8 hour post feeding for assessment of pH and ammonia concentration. Blood samples were also collected during these times for measurement of blood urea nitrogen (BUN), calcium and phosphorus concentration. The data obtained was analysed using the general linear models procedure (SAS, 1988).

Results and Discussion

1 Ruminal ammonia nitrogen concentration (Table 2)

Ruminal ammonia nitrogen concentration at 2 hours after feeding was significantly different ($P<0.05$) between treatments whereas at other periods it was not different ($P>0.05$). The control group had the highest ammonia nitrogen concentration at 2 hours after feeding. This means therefore that either diatomite or Zeolite contained in ingested feed have evident effect on ruminal ammonia nitrogen regulation especially at short time after feeding.

Table1 Composition of Experimental diets (%DM)

Ingredient	Diets			
	control	Zeolite	Diatomite	Zeolite + Diatomite
Cassava*	73.17	69.02	69.02	69.02
Urea*	1.95	1.84	1.84	1.84
Soybean meal	13.88	13.14	13.14	13.14
Molasses	5	5	5	5
Premix	5	5	5	5
NaCl	1	1	1	1
Zeolite	0	5	0	2.50
Diatomite	0	0	5	2.50
Total	100	100	100	100
% Crude protein (calculated)	14.80	14.80	14.80	14.80
Analysed values				
% Crude protein	14.93	14.68	14.53	14.67
Gross energy (cal/gm)	4,003.23	3,886.22	3,801.26	3,866.14

*Urea mixed cassava had 9.50 % crude protein in every diets

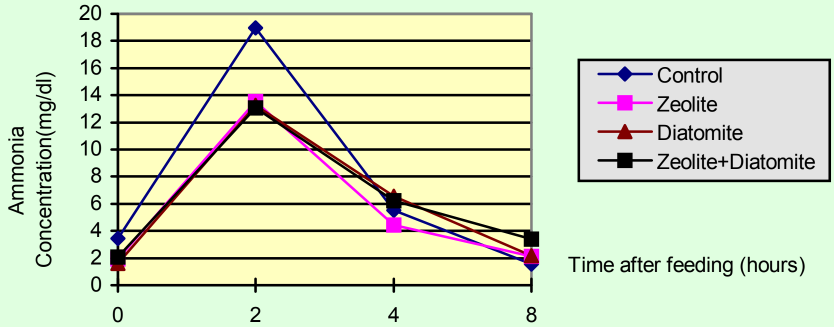

Figure 1. Ruminal ammonia nitrogen concentration at different times after feeding (mg/dl)

2. Blood urea nitrogen (Table 2)

Blood urea nitrogen (BUN) concentration on the control diet were higher than the others treatment groups at 2 hours after feeding (P<0.05). Feed containing diatomite had lower values at 2 and 4 hours after feeding than the others although it was not significant from Zeolite alone. Thus, BUN was reduced by application of regulators. The trends of $NH4^{+}$-Nitrogen in rumen fluid and BUN in blood circulation were similar.

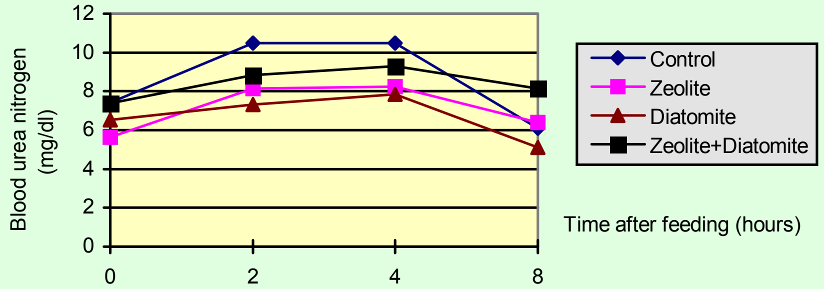

Figure 2 :Blood urea nitrogen at different times after feeding (mg/dl)

3. Ruminal pH (Table 2)

The rumen pH levels from the different groups at different times after feeding were not affected by treatment (P>0.05).

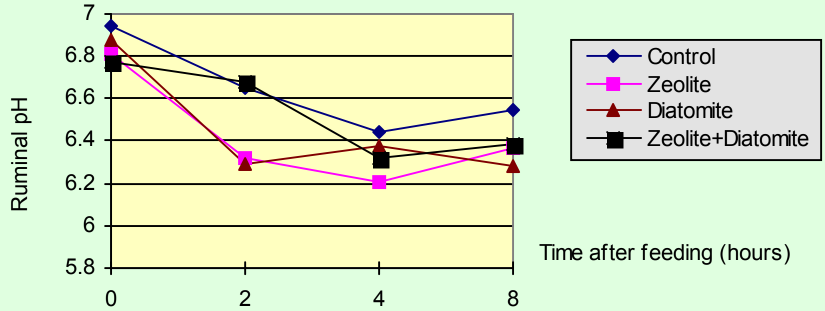

Figure3. Ruminal pH at different times after feeding

4. Blood calcium (Table 2)

The level of blood calcium in the 4 groups were not significantly different (P>0.05) at any time periods after feeding. Blood calcium was not affected by treatments. The level

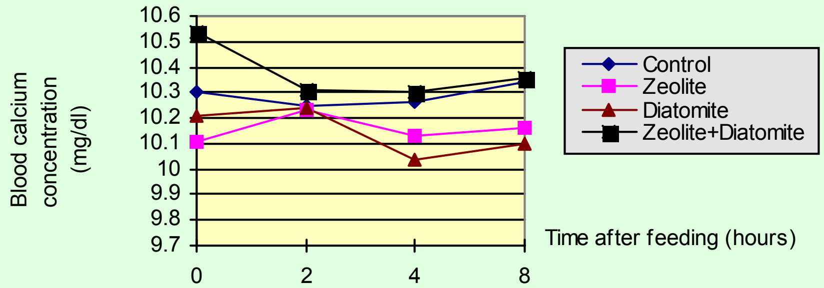

Figure 4. Blood calcium concentration at different times after feeding (mg/dl)

Table 2 : Effects of using diatomite and Zeolite on rumen fermentation and blood parameters of cattle

Items	Regulators				C.V.
	Control	Zeolite	Diatomite	Zeolite + Diatomite	
Rumen pH :					
: 0 hr.	6.94	6.81	6.88	6.77	5.31
: 2 hr	6.65	6.32	6.29	6.68	3.30
: 4 hr	6.44	6.21	6.38	6.32	6.07
: 8 hr	6.55	6.37	6.28	6.39	4.95
Rumen NH_4^+ - Nitrogen (mg/dl)					
: 0 hr.	3.45	1.93	1.59	2.09	71.24
: 2 hr	18.96^{a}	13.54^{b}	13.26^{b}	13.08^{b}	12.51
: 4 hr	5.50	4.45	6.56	6.25	16.57
: 8 hr	1.58	2.10	2.16	3.40	80.09
Blood Urea Nitrogen (mg/ dl)					
: 0 hr	7.43	5.63	6.53	7.40	13.50
: 2 hr	10.47^{A}	8.13^{BC}	7.33^{C}	8.85^{B}	5.17
: 4 hr	10.47	8.23	7.85	9.30	9.09
: 8 hr	6.10	6.38	5.10	8.13	20.66
Blood Calcium : (mg/dl)					
: 0 hr.	10.30	10.11	10.21	10.54	3.56
: 2 hr	10.25	10.23	10.24	10.31	2.67
: 4 hr	10.26	10.13	10.04	10.30	3.39
: 8 hr	10.34	10.16	10.10	10.36	2.57
Blood Phosphorus : (mg/dl)					
: 0 hr	4.69	5.36	5.17	5.21	11.49
: 2 hr	4.64	5.42	5.28	5.61	15.52
: 4 hr	4.44	5.32	4.88	5.32	15.87
: 8 hr	4.43	5.22	5.21	5.70	16.95

Means in the same row followed by different superscripts designated with small letters differ significantly at $P < 0.05$, with those designated by capitals highly significantly at $P < 0.01$.

5. Blood phosphorus (Table 2)

Blood phosphorus levels obtained at any time period after feeding were not significantly ($P > 0.05$) different between treatments. Blood phosphorus was considerably constant throughout the time periods and gave normal values. Blood calcium to phosphorus ratio was 1.57 : 1

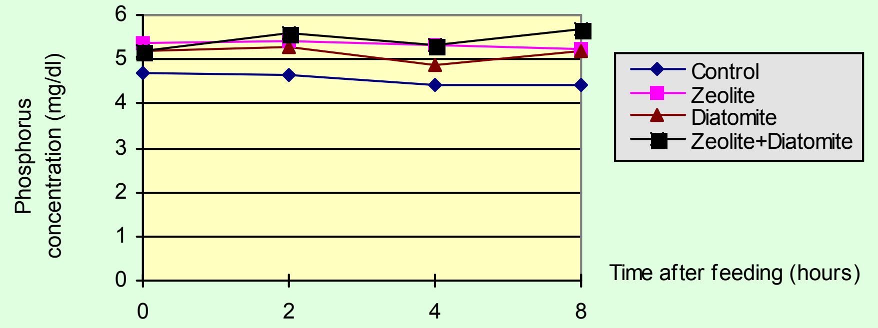

Figure 5. Blood phosphorus concentration at different times after feeding mg/dl)

Conclusion

Diatomite and Zeolite showed evident positive effects on ruminal ammonia and blood urea nitrogen regulation. The increase in rumen ammonia content measured 2 hours after feeding can be lowered if diatomite and/or Zeolite are added to the feed . Since there were no adverse effect found when diatomite and Zeolite were used at 5 % level in cattle feed, it is advisable to include diatomite in the cattle feed.

References

Edwards, A.R. 1991. The Oamaru diatomite. New Zealand geological survey Paleontological Bulletin 64, 260 pp.

Feed analysis division. 1991. Report on feed sample analysis. Department of Animal Science. Kasetsart University. Bangkok, Thailand. 1p.

NRC, 1980. Nutrient Requirements of Beef Cattle (5th.ed.) National Academy Press. Washington, D. C.

SAS, 1988. User's Guide: Statistics. SAS Inst., Inc., Cary, NC.

Steel, R.G.D. and J. H. Torrie. 1981. Principle and Procedures of Statistics A Biometrical Approach 2nd. ed. McGraw-Hill Book Company, Singapore. 633 pp.