Effect of fibrolytic enzymes supplementation on rumen fermentation and digestibility in dairy cow fed straw-based diet

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ABSTRACTS: Four Holstein Friesian crossbred cows, with an average initial weight of 460 kg, were used in a 4x4 Latin square design with a 2x2 factorial arrangement. 28-d period to investigate the effects of supplementation level of fibrolytic enzyme (50 mg/kg DM) on rumen fermentation and digestibility in cows fed straw-based total mixed ration (TMR) or fermented total mixed ration (FTMR). The results found that DMI did not affected by fibrolytic enzyme supplementation. However, fibrolytic enzyme supplementation did improve rumen pH and digestibility of nutrients in TMR, but did not observe in FTRM. Under this study, supplementation of fibrolytic enzyme could enhance feed utilization in dairy cows.
Keywords: fibrolytic enzymes, rumen fermentation, total mixed ration (TMR); fermented total mixed ration (FTMR)

Introduction

Attempts to improve feed efficiency in dairy cows by the use of direct-fed fibrolytic enzymes applied to the feed at or only hours before feeding have yielded variable production responses. Feed intake responses have generally been small and inconsistent (Yang et al.,1999; Rode et al., 1999; Vicini et al., 2003) with only occasional significant increases (Lewis et al., 1999). Enzymes have been applied to different portions of the diets including the forage component, the concentrate component, or the complete TMR (total mixed ration) but there have been few direct comparisons about the ratio of roughage in TMR. The fermented total mixed ration (FTMR) is a simple method to potentially improve nutrient utilization and extend the shelf life of the feed. FTMR is made by mixing roughage with concentrate and then fermenting under anaerobic conditions (ie ensiling) in a sealed container for 21 days. In dairy cows, Yuangklang et al. (2004) showed that FTMR increased feed intake and improved nutrient digestion.

Therefore, this study was carried out to determine effect of fibrolytic enzyme supplementation on environment rumen and digestibility of dairy cows fed rice straw-based TMR and FTMR.

Materials and Methods

Four multiparous Holstein Friesian crossbred cows with permanent rumen cannulas, average 460±13 kg on body weight (BW), were randomly assigned to receive dietary treatments in a 2×2 factorial arrangement in a 4×4 Latin square design with four 28-d periods each comprising 21 d for dietary adaptation and 7 d for data collection.

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Animals were individually housed and intensively cared for according to the procedures of the Faculty of Natural Resources, Rajamangala University of Technology Isan, Sakon Nakhon campus.

Dietary treatments were based on type of ration (TMR and FTMR) and supplementation of fibrolytic enzyme (at 0 and 50 mg/kgDM). The combinations of dietary treatments were 1) TMR no added enzyme, 2) TMR added fibrolytic enzyme (ETMR), 3) FTMR no added enzyme and 4) FTMR added fibrolytic enzyme (EFTMR). Fibrolytic enzyme was mixed daily within 1 hr of morning and afternoon feeding. TMR and FTMR were offered twice daily ad libitum, at approximately 07:30 and 16:30 hr. Diets were allowed to have 10% feed refusal. Water and mineral block were available at all times. Ingredients of TMR and FTMR were similar. Both rations were formulated to contain CP, EE, NDF and ADF about 18, 3, 30 and 52 %, respectively.

TMR and FTMR were sampled weekly and analyzed chemical composition in terms of DM, ash, ether extract (EE) and crude protein (CP) (AOAC, 1990), and neutral detergent fiber (NDF) and acid detergent fiber (ADF) (Goering and Van Soest, 1970).

At day 28 of each period, ruminal fluid samples (approximately 500 ml) were collected directly on the rumen at 0, 2, 4, and 6 h post morning feeding through a probe placed in the ventral part of each period. Rumen pH will be determined immediately after sampling using a glass electrode by pH meter and filtered through 4 layers or cheesecloth then divided into 2 portions. One portion: using analysis of NH_3-N by the hypochlorite-phenol procedure of Beecher and Whitton (1978) and second portion: taking 1 ml of rumen fluid and add to 10% formalin solution (1:9 v/v, rumen fluid: 10% formalin) (Galyean, 1989) for measuring microbial population. Rumen fluid will be diluted using autoclave distilled water (121°C for 15 minutes) as a medium by 100, 10 time and counting at 10, 40 ocular objective of microscope for bacteria and protozoa respectively by using a haemocytometer (Boeco).

All data were statistically analyzed as a 2×2 factorial arrangement in a 4×4 Latin square using the SAS, 1996. Significant differences between treatments were determined using Duncan's New Multiple Range Test (DMRT) (Steel and Torrie, 1980).

Results and discussion

The chemical composition such as CP, EE, NDF and ADF of TMR was 17.4, 3.1, 53.9 and 30.3%, respectively and of FTMR was 18.2, 2.8. 52.6 and 31.4%, respectively.

Dry matter intake (DMI) is presented in Table 1. When additional fibrolytic enzyme, DMI of cows was not different among dietary treatments ($P>0.05$).

Digestibility were significantly affected ($P<0.05$) by the adding fibrolytic enzyme on DM, OM, CP, ADF and NDF (**Table 1**). Based on the results found in this experiment, fibrolytic enzyme supplementation did improve digestibility of nutrients in TMR but did not observed in FTMR. This can be explained by the fact that some of nutrients was degraded during silage processing. This result was in accordance with Vasupen et al. (2005, 2006) who revealed that FTMR improved the digestibility of dry matter (DM), organic matter (OM), fiber, and non-structural carbohydrate. In addition, our results were in agreement with Yang

et al. (2000), Rode et al. (1999), Beauchemin et al. (2003), Sutton et al. (2003), and Avellaneda et al. (2009). Measurements of total tract digestibility in dairy cows have generally shown positive responses to fibrolytic enzymes with variable but often significant increases in the digestion of DM, OM, NDF, ADF and N.

Ruminal pH was similar in all treatments on average 6.02, 6.29, 6.27 and 6.29 for TMR, ETMR, FTMR and EFTMR, respectively. However, pH at 4-6 hrs were significantly difference among rations ($P<0.05$). The FTMR was stabilized rumen pH rather than TMR. Moreover, fibrolytic enzyme supplementation in TMR has shown to improve rumen pH. Giraldo et al. (2008) showed that effect of fibrolytic enzyme on ruminal variables was less marked at 24 than at 8 h of incubation. Alis Márquez et al. (2009) also observed that the addition of fibrolytic enzymes with an initial incubation pH 6.2 enhanced in vitro degradation and decreased undegradable fractions, as well as lag phase of alfalfa NDF.

The concentration of NH_3-N in rumen fluid was not difference ($P>0.05$) among dietary treatments. Bacteria population in the rumen had the trend increasing, but protozoa reducing when supplement firolytic enzyme on both TMR and FTMR (**Table 1**). Based on the ration using TMR or FTMR shown that, cattle were fed by TMR, the amount of bacteria and protozoa were lower than FTMR ration. This finding is similar to that reported by Yuangklang et al. (2004) and Vasupen et al. (2006).

Conclusion

In conclusion, supplementation of fibrolytic enzyme could affect rumen fermentation and improve digestibility of nutrients. However, further study should be conducted to provide more information in lactating cows.

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Table 1 Means value for intake and digestion of TMR, FTMR with and without fibrolytic enzyme (enz) on dairy cattle

Items	*Ration*				*SEM*	*P value*		
	TMR	*ETMR*	*FTMR*	*EFTMR*		*R*	*E*	*RxE*
Dry matter intake								
kg/day	10.39	10.40	9.78	10.11	1.01	ns	ns	ns
%BW	2.20	2.22	2.20	2.23	0.16	ns	ns	ns
g/kg $BW^{0.75}$	181	182	174	182	10	ns	ns	ns
Apparent digestion, %								
DM	64.23^{c}	67.82^{a}	66.15^{b}	66.23^{b}	0.29	***	***	***
OM	67.60^{b}	70.89^{a}	70.50^{a}	69.46^{a}	0.39	***	***	***
CP	77.91^{a}	78.80^{a}	74.74^{b}	74.88^{b}	1.04	***	***	***
ADF	29.50^{b}	38.94^{a}	43.61^{a}	42.95^{a}	1.58	***	***	***
NDF	49.63^{b}	55.69^{a}	56.92^{a}	55.13^{a}	2.58	***	***	***
Rumen fermentation								
pH	6.09	5.76	6.20	6.20	0.14	***	***	***
NH_3-N, mg/l	138.13	145.35	138.13	134.73	6.98	ns	ns	ns
Microbial count, cells/ml								
Bacterial, $x10^8$	2.79	3.88	3.89	3.90	0.567	ns	ns	ns
Protozoa, $x10^5$	2.48	1.88	3.08	2.84	0.651	ns	ns	ns

*[a, b]Means in the same row with different superscript differ (p<0.05); *P < 0.05, **P < 0.01, ***P < 0.001; ns, no significant*

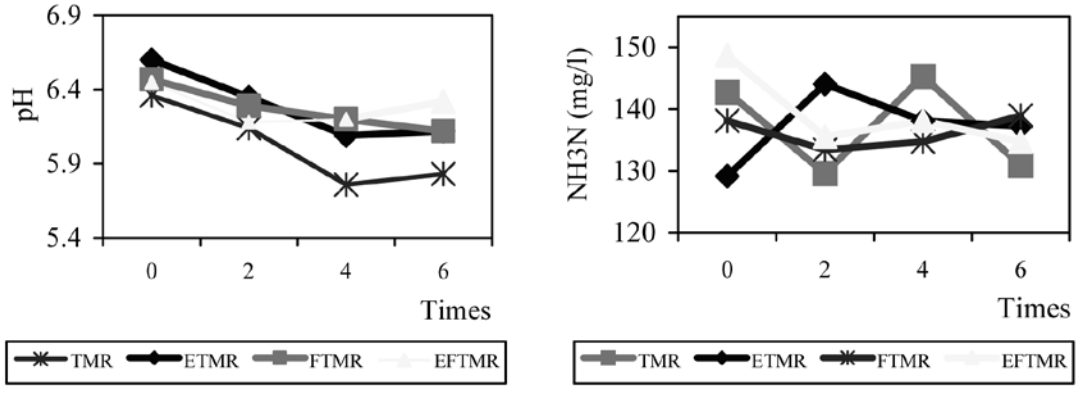

Figure 1 The effect of with and without enzyme supplementation on ruminal pH and NH_3-N rumen fluid