RESEARCH ARTICLE

Digestibility of Nutrients as Influenced by Supplementation of Exogenous Fibrolytic Enzymes in Dry Non-pregnant Cows

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Abstract

The study was planned to evaluate the effect of exogenous fibrolytic enzymes (EFE) supplementation for 56 days @ 240 mg/kg total mixed ration (TMR) on digestibility of dry matter and nutrients in dairy cows. Six dry non-pregnant cows were assigned in each treatment with and without EFE. The digestibility trial of seven days was conducted after 49 days of feeding. Dry matter and nutrients intake of cows was not influenced by EFE. The supplementation of EFE had improved digestibility of dry matter, organic matter, crude fiber, neutral detergent fiber, cellulose ($p < 0.01$), as well as digestibility of nitrogen-free extract and acid detergent fiber, was also higher ($p < 0.05$). The body weight gain of cows was higher on the supplementation of EFE in TMR. The study concluded that feeding exogenous fibrolytic enzymes (240 mg/kg) supplemented TMR improved digestibility of dry matter and nutrients, which was reflected as higher body weight gain in dry non-pregnant Gir and crossbred dairy cows.

Keywords: Cows, Digestibility, Exogenous fibrolytic enzymes, Total mixed ration, Weight gain

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Introduction

The low-quality grasses, crop residues, and agro-industrial by-products are major sources of nutrition to livestock in developing countries. The plant cell walls typically contained 35–50% cellulose, 20–35% hemicellulose and 10-25% lignin on dry mass base (Gemeda *et al.*, 2014). Rumen microbiata digest the plant cell wall components better in comparison to herbivores (Van Soest, 1994; Krause *et al.,* 2003), but only 10 to 35% of energy intake is available as net energy (Varga and Kolver, 1997). The exogenous fibrolytic enzymes (EFE) is a promising tool to enhance the digestibility of fibrous forage. The cellulases and xylanases are the two major enzyme groups that break *β*-1,4 linkages joining sugar molecules of cellulose and xylans of the plant cell wall (Dawson and Tricarico, 1999; Beauchemin *et al.,* 2003). We had hypothesized that supplementation of EFE improves digestibility of nutrients. The current study was therefore aimed to examine the effect of EFE supplementation in TMR on digestibility and weight changes in dry non-pregnant cows.

Materials and methods

The feeding experiment was conducted for 56 days after 7 days adaptive feeding on twelve Gir (*Bos indicus*) and HF x Kankrej (*Bos taurus X Bos indicus*) crossbred dry non-pregnant dairy cows having six cows (3 each Gir and crossbred) in each treatment based on the body weight and age. All the dairy cows were individually fed TMR having compound concentrate mixture 40% and sorghum hay 60% to meet their nutrient needs (ICAR, 1998). Cows were fed TMR without fibrolytic enzyme T_1 (Control), and TMR with exogenous fibrolytic enzyme T2 (Roxozyme GT® contained endo 1,4-β glucanase 800, 1(3), 4-β glucanase 700, and endo 1,4-β xylanase 2700 IU/g procured from M/S, DSM Nutritional Product Pvt. Ltd., Pune, India) @ 240 mg/kg TMR based on the *in vitro* study (Lunagariya *et al.*, 2017). The cows were let loose for exercise for two hours in the morning (9:00 to 11:00 a.m.) and one hour in the afternoon (3:00 to 4:00 p.m.) under controlled conditions, during which they had free access to fresh, clean and wholesome drinking water. The body weight of cows was recorded for two consecutive days every week before feeding and watering. After 49 days of experimental feeding, a digestion trial of seven days was conducted on all the cows to determine the digestibility of nutrients. A proper record of feed consumed, refusal and feces voided by each cow were maintained during the trial period. The quantitative collection of feces of 24 hours period was made. Fifty-gram sample each of TMR, residue and 1/100th part of feces voided was taken in the tray and kept in an oven at 100 ± 2°C for 24 h to estimate dry matter content. The dried samples were pooled over seven days of collection

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Table 1: The proximate composition and fibre fractions of TMR (% on DM basis)

Parameters	*TMR*	*Sorghum hay*	*Concentrate Mixture*
CP	10.27 ± 0.03	6.54 ± 0.10	15.93 ±0.18
EE	2.86 ± 0.16	1.69 ± 0.08	4.59 ± 0.07
CF	24.04 ± 0.61	33.53 ± 0.33	10.69 ± 0.12
NFE	52.06 ± 1.03	49.93 ± 0.25	54.26 ± 0.17
Total Ash	10.77 ± 0.44	8.31 ± 0.12	14.53 ± 0.40
Silica	2.02 ± 0.05	2.73 ± 0.09	0.98 ± 0.02
Calcium	0.96 ± 0.02	0.63 ± 0.02	1.40 ± 0.02
Phosphorus	0.48 ± 0.01	0.26 ± 0.02	0.73 ± 0.02
NDF	52.33 ± 0.31	69.61 ± 0.41	28.03 ± 0.38
ADF	26.66 ± 0.25	36.82 ± 0.10	12.13 ± 0.09
Cellulose	16.62 ± 0.19	18.71 ± 0.26	5.94 ± 0.18
Hemicellulose	25.67 ± 0.23	32.79 ± 0.31	15.90 ± 0.29

TMR = total mixed ration, DM = dry matter, CP = crude protein, EE = ether extract, NFE = nitrogen free extract, NDF= neutral detergent fibre, ADF = acid detergent fibre

Table 2: Dry matter and nutrients intake of cows fed TMR without (T1) and with (T2) EFE

	Treatments	
Particulars	*T1*	*T2*
Dry matter intake kg/d	6.74 ± 0.25	6.76 ± 0.30
Per cent dry matter intake kg/d	1.52 ± 0.04	1.51 ± 0.03
Dry matter intake on metabolic body weight g/W0.75	69.76 ± 0.73	69.38 ± 0.31
Crude protein intake kg/d	0.674 ± 0.02	0.676 ± 0.03
Digestible crude protein intake kg/d	0.391 ± 0.01	0.392 ± 0.02
Total digestible nutrients intake kg/d	3.773 ± 0.14	3.783 ± 0.17

Table 3: Digestibility of dry matter and nutrients of TMR without (T1) and with (T2) EFE fed to cows

	Treatments	
Particulars	*T1*	*T2*
Dry matter	$59.78^{a} \pm 0.18$	$64.12^{b} \pm 0.21$
Organic matter	$63.35^{a} \pm 0.16$	$66.97^{b} \pm 0.48$
Crude protein	64.84 ± 0.56	65.44 ± 0.65
Ether extract	66.15 ± 0.56	67.64 ± 0.30
Crude fibre	$49.32^{a} \pm 0.34$	$54.90^{b} \pm 0.33$
Nitrogen free extract	70.72A ± 0.51	$72.51^{B} \pm 0.30$
Neutral detergent soluble fibre	$57.82^{a} \pm 0.30$	$60.77^{b} \pm 0.58$
Acid detergent soluble fibre	$52.55^{A} \pm 0.65$	$55.39^{B} \pm 0.48$
Cellulose	$56.55^{a} \pm 0.32$	$59.12^{b} \pm 0.32$
Hemicellulose	64.23 ± 0.67	65.58 ± 0.37

A,B & a,b Mean with different superscript in parameter differ significantly ($p < 0.05$ and $p < 0.01$, respectively)

and then ground to pass through 2.0 mm sieve and stored in airtight glass bottles at room temperature for further analysis. The faeces voided were taken 1/100th part with commercial grade sulphuric acid for nitrogen estimation. Samples were analyzed for proximate and fiber fractions as per AOAC (1995) and Van Soest *et al*. (1991), respectively. The experimental data were analyzed as per the methods of Snedecor and Cochran (1994), with the help of the SPSS package programme (SPSS 9.00 software for Windows, SPSS Inc., Chicago, IL).

Table 4: Body weight (kg) of cows during feeding experiment

	Treatments	
Particulars	*T1*	*T2*
Initial Body weight	443.7 ± 28.56	444.3 ± 28.63
Final Body weight	447.7 ± 28.67	454.9 ± 29.64
Gain/loss kg	+ 4.0a ± 1.31	+ 10.6b ± 1.19

[a,b]Means with different superscript in a row differ significantly (p <0.01)

Results and discussion

The chemical composition of total mixed rations (TMR) is given in *Et al*. The nutrients content of TMR was sufficient to meet the nutrient requirement of cows. The dry matter (DM) and nutrients intake (Table 2) of cows were similar in both group, without the effect of EFE supplementation. The supplementation of EFE in TMR of Holstein cows (15 g daily) and Egyptian buffaloes (40 g daily) did not affect/influence significantly the DM and nutrients intake (El-Bordeny *et al*., 2015; Morsy *et al*., 2015). The EFE supplementation to cows' diet and treatment to diet ingredients were also without significant effect on DM and nutrients intake in crossbred cows (Das and Singh. 2011). Similar findings were also observed by Rajamma *et al*. (2014) on intake on metabolic body weight in buffalo bulls.

The supplementation of EFE had significant (p<0.01) effect on digestibility of dry matter (59.78 *vs*. 64.12%), organic matter [OM] (63.35 *vs*. 66.97%), crude fibre (CF) (49.32 *vs*. 54.90%), neutral detergent fibre [NDF] (57.82 *vs*. 60.77%) and cellulose (56.55 *vs*. 59.12%). The digestibility of nitrogen-free extract (NFE) (70.72 *vs*. 72.51%) and acid detergent fibre (ADF) (52.55 vs. 55.39%) was also higher in T_2 in comparison to T_1 (p <0.05; Table 3). Khanh *et al*. (2012) reported higher (p<0.001) digestibility of DM, OM, ADF and NDF on feeding fibrolytic enzymes @ 50 mg/kg DM in TMR in the HF crossbred cows. Similarly higher digestibility of DM, non-structural carbohydrates, NDF and ADF were reported on feeding fibrolytic enzyme @ 40 g/head/day to lactating Egyptian buffaloes (Morsy *et al*., 2015) and @ 40 g/day in TMR to lactating Brown Swiss cows (Gado *et al*., 2009), whereas addition of fibrolytic enzyme through concentrate, TMR, forage (4 g/head/day each) and silage 91.3 g/kg) did not affect the digestibility of DM, CP and NDF in HF cows (Adesogan *et al*., 2007).

The gain in body weight of cows was 4.0 and 10.6 kg in control and enzyme group, respectively, at the end of the experiment and the effect of supplementation of EFE was significant on body weight (Table 4). Supplementation of EFE (14.25 mL/10 kg alfalfa) resulted in higher body weight in Holstein beef cattle (Pejman and Habib, 2012), whereas no effect of EFE supplementation was noted in crossbred cows (Das and Singh, 2011), lactating Murrah buffaloes (Shekhar *et al*., 2010) and lactating cows (Miachieo and Thakur, 2007). The higher digestibility of nutrients in the present experiment has been converted to higher nutrients deposition in the body as revealed by higher weight gain of cows on supplementation of exogenous fibrolytic enzymes.

Conclusion

The supplementation of EFE @ 240 mg/kg 40:60 concentrate: roughage based total mixed ration of dairy cows resulted in improved digestibility of dry matter and nutrients, which reflected as higher body weight changes of cows.

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