PRODUCTIVE PERFORMANCE OF LACTATING COWS FED RATONS SUPPLEMENTED WITH FIBROZYME

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ABSTRACT

Twenty-four lactating Friesian cows averaged 482 ± 9 kg live body weight (LBW) at the 2nd to 4th parities from 7 to 18 weeks postpartum (after the peak milk production) were used in this study. Cows were randomly divided into four similar groups (6 cows each) according to milk production, parity and LBW. Cow groups were assigned to be fed one the following experimental rations:- LR0: low roughage level (40% roughage (R) + 60% concentrate mixture, CM); LRF: LR0 + Fibrozyme; HR0: high roughage level (60% R + 40% CM); HRF: HR0+ Fibrozyme. Roughages were consists of corn silage, berseem hay and rice straw by 50, 25 and 25 % (on DM basis), respectively. Fibrozyme was supplemented (10 g/h/d) to ground CM just prior to the morning feeding. Results indicated that, most of nutrient digestibility and nutritive values were improved ($P<0.05$) by Fibrozyme supplementation in both LRF and HRF compared to LR0 and HR0. No significant differences were observed among all tested rations for ruminal pH values, while NH_3-N concentration decreased ($P<0.05$) for HR0 compared to LR0. Both total VFA and propionic acid concentrations increased ($P<0.05$) for LRF and HRF compared to LR0 and HR0. Higher acetic acid, but lower ($P<0.05$) propionic acid percentage was observed for HR0 than LR0. Serum glucose concentration was higher ($P<0.05$) for LRF and HRF than LR0 and HR0. Also, it was higher ($P<0.05$) for LR0 than HR0. Fibrozyme supplementation improved ($P<0.05$) both actual and FCM yields by 12.96 and 10.72%, respectively for cows fed LRF compared to those fed LR0 and improved by 13.37 and 11.88% for HRF compared to HR0. Also, this yields increased by 8.70 and 6.07% for LR0 compared to HR0. Most of milk component yields were higher ($P<0.05$) for cows fed both LRF and HRF than those fed LR0 and HR0. Feed cost as LE/ kg FCM decreased by 8.00 and 8.14% for cows fed both LRF and HRF compared to those fed LR0 and HR0, respectively. Moreover, it decreased by 14.00% for cows fed HR0 compared to those fed LR0. Economic return as LE/h/d increased by 24.32 and 22.21% for cows fed LRF and HRF compared to those fed LR0 and HR0, respectively. Moreover, it increased by 15.34% for cows fed HR0 compared to those fed LR0.

***Key words**: roughage, fibrolytic enzymes, Fibrozyme, digestibility, dairy cows.*

INTRODUCTION

In the different regions of the world, forages are used as a unique of feed source for ruminants due to their abundance and low cost. However, their - availability and quality are not constant throughout the year. Moreover, the digestion of forages in the rumen is relatively slow and incomplete, limiting animal performance and increasing feed cost of livestock production. Tropical forages are particular have limited energy value and its cell wall contents are rich in lignin, silica and cutin that limiting carbohydrates fermentation and therefore the VFA' s production and microbial mass in the rumen (Domenguez Bello and Escobar, 1997).

Recent studies indicated that, adding fibrolytic enzymes to ruminant diets improved nutrient digestibility (Kung et al., 2000 and Murillo et al., 2000), growth rate (Ali, 2006) and milk production (Rode et al., 1999 and Zheng et al., 2000). Moreover, fibrolytic enzymes were more effective when added to either concentrate or roughage portion of diets in early lactation period. These enzymes increased milk yield by 6 to 16 % in lactating dairy cows (Lewis et al., 1999 and Yang et al., 2000). Furthermore, enzyme application was more effective with lower forage to concentrate ratio (38:62) than higher ratios (55:45, 57:43 and 60:40). Therefore, the effect of the dietary component to which the enzyme is added may depend on the forage to concentrate ratio and the uniformity of enzyme application to these components (Adesogan, 2005).

Moreover, Beauchemin et al. (2003) indicated that, using fibrolytic enzymes lead to improve both of forage utilization and productive efficiency of ruminants. As well as, adding enzymes to high-concentrate diets was more consistent results than with high-roughage diets. Who also found that, improvement in animal performance due to enzyme additives could be attributed mainly to improvements in ruminal fiber digestion resulting an increase of digestible energy intake.

Ruminal pH plays an important role in fiber digestion. Because the growth of ruminal fiber digesting bacteria is strictly limited at pH less than 6.00 (Russell and Wilson, 1996), we hypothesize that the relative magnitude of the benefit to enzyme supplementation is a least partially dependent on ruminal pH (Murillo et al., 2000).

The objective of the present study was to investigate the effect of fibrolytic enzyme (Fibrozyme) supplementation to rations containing different roughage levels on performance of dairy Friesian cows. Nutrients digestibility, rumen fermentation and blood constituents were also studied.

MATERIALS AND METHODS

This experiment was carried out in a private farm belong to Abu-Elmatamer, El-Behera Governorate. Twenty-four lactating Friesian cows averaged 482 ± 9 kg LBW at the 2nd to 4th parities from 7 to 18 weeks postpartum (after the peak milk production) were used in this study. Cows were randomly assigned in equal numbers to four similar groups (6 cows each) according to milk production, parity and LBW. Animal groups were fed on one of the following rations:- LR0: low roughage level without Fibrozyme (40% roughage (R) + 60% concentrate mixture, CM); LRF: LR0 + Fibrozyme; HR0: high roughage level without Fibrozyme (60% R + 40% CM); HRF: HR0 + Fibrozyme. Roughages were consists of corn silage (whole plants, CS), berseem hay (BH) and rice straw (RS) by 50, 25 and 25 % (on DM basis), respectively. The CM was composed of undicorticated cottonseed meal 30%, wheat bran 35%, rice bran 4%, yellow corn 25%, molasses 3%, common salt 1% and limestone 2%.

Fibrolytic enzyme (Fibrozyme) is a nutritional supplement was supplemented (10 g/h/d) to ground CM just prior to the morning feeding. It contains rumen-protected fiber degrading enzymes designed to maximize forage utilization in ruminants. Fibrozyme ingredients are *Aspergillus Niger* and *Trchodema longibrachiatum* fermentation extracts and fermentation soluble. Also, it contains 20% crude protein, 8% ash and 100 U xylanase /g (International Free Trade Co., Cairo, Egypt). The CM was offered to animals twice daily at 7.00 a.m. and 16.00 p.m., while roughages were offered at 8.00 a.m. and 18.00 p.m. Fresh water was available at all times. Cows were fed according to NRC (1989) allowances for dairy cattle. Feeding allowance was adjusted biweekly according to LBW change and milk production.

Individual morning and evening actual milk yield was recorded daily and fat corrected milk (FCM) yield was calculated using the daily actual milk yield and percentage of milk fat during the experimental period (12 weeks). Composite milk samples from consecutive morning and evening milkings for each cow were taken biweekly, it was mixed in proportion to milk yield and analyzed for fat, protein, lactose, solid not fat (SNF) and total solids (TS) contents by Milk-O- Scan, 133 B.

At the last week of the experimental period, three animals from each group were used in a digestibility trial using acid insoluble ash (AIA) as internal marker (Van Keulen and Young, 1977) to evaluate the different tested rations. Samples of both feed and feces were analyzed according to AOAC (1990). Fiber fractions were estimated by method of Goering and Van Soest (1970).

Rumen liquor samples were collected from the same animals used in the digestibility trials at 3 hrs post morning feeding using a rubber stomach tube. Rumen pH was determined directly using Beckman pH meter, while 1 ml. saturated mercuric chloride solution was added to each sample for stopping the microbial activity and then filtrated through a double layer of cheesecloth and stored in polyethylene bottles in freezer (-20°C) until analysis. Concentration of VFA's was determined using the method of Warner (1964). Moreover, the strained ruminal fluid samples were prepared for individuals volatile fatty acids by high-pressure liquid chromatography (HPLC) according to Bush et al. (1979). Concentration of NH_3-N was assayed according to AOAC (1990).

Blood samples were taken from the jugular vein into clean centrifuge tubes at the same time of rumen liquor collection, allowed to clot and centrifuged at 3500 r.p.m. for 15 minutes to obtain the serum, then it was stored in the freezer at -20°C until analysis. Total proteins, albumin, glucose, urea, GOT and GPT concentrations were estimated according to Varley (1976). While, globulin concentration was obtained by subtracting the albumin form serum total proteins.

The data were statistically analyzed using General Linear Models Procedure adapted by SPSS (1997) for one-way analysis of variance and means were differentiated using Duncan's multiple range test.

RESULTS AND DISCUSSION

1. Chemical composition

Chemical composition of the different feed ingredients and tested rations is shown in Table 1. Results indicated that, OM, EE and ash contents were nearly similar for all tested rations. However, CF and its fractions (NDF, ADF, ADL, hemicellulose and cellulose) increased, while both CP and NFE contents were decreased with increasing roughage level in HR0 and HRF compared to low roughage rations (LR0& LRF). These results take the same trend that was observed by many authors (Murillo et al., 2000; Saleh, 2001; Omer et al., 2005; Saleh, 2005 and Ali, 2006) with rations containing different roughage levels. Differences in chemical composition of tested rations due to the changes in nutrient contents of feed ingredients. Generally, chemical composition of roughages is depends on many factors such as plant age, soil type, fertilizers, crop harvesting systems and others. Fibrozyme supplementation did not affect all nutrient contents of tested rations that containing either low or high roughage level. These results are in harmony with those reported by Kung et al (2000) and Murillo et al (2000) when they added fibrolytic enzymes to lactating cow rations.

Table (1): Mean values of chemical composition of feed ingredients and tested rations fed to lactating cows during the experimental period (on DM basis).

Item	Feed ingredients*				Tested rations (calculated)			
	CM	CS	BH	RS	LR0	LRF	HR0	HRF
DM, %	90.53	30.79	89.95	90.25	65.82	65.49	56.30	56.88
DM composition, %								
OM	91.95	92.26	87.34	83.22	90.58	90.65	90.13	90.08
CP	15.88	8.60	13.38	3.69	12.90	12.94	11.48	11.50
CF	10.54	27.77	30.78	33.43	18.44	18.38	22.10	22.11
EE	3.26	2.86	2.28	1.72	2.92	2.92	2.77	2.76
NFE	62.27	53.03	40.90	44.38	56.32	56.41	53.78	53.71
Ash	8.05	7.74	12.66	16.78	9.42	9.35	9.87	9.92
GE, Mcal/kg DM**	4.23	4.11	3.95	3.60	4.11	4.11	4.06	4.06
Fiber fractions, %* **								
NDF	29.72	62.73	55.11	75.17	43.63	43.50	50.22	50.15
ADF	16.98	35.60	42.25	53.17	27.11	26.96	31.61	31.65
ADL	4.25	5.04	7.59	5.18	4.86	4.84	5.10	5.10
Hemicellulose	12.74	27.13	12.86	22.00	16.52	16.54	18.61	18.50
Cellulose	12.73	30.56	34.66	47.99	22.25	22.12	26.51	26.55

***CM**: Concentrate mixture, **CS**: Corn silage, **BH**: Berseem hay, **RS**: Rice straw.
LR0: Low roughage ration without Fibrozyme (40% R + 60% CM), **LRF**: LR0 + Fibrozyme (10 g /h/d), HR0: High roughage ration without Fibrozyme (60% R+ 40% CM), **HRF**: HR0 + Fibrozyme (10 g /h/d). ****GE** (Mcal/kg DM) = CP x 5.65 + CF x 4.15 + EE x 9.40 + NFE x 4.15 (Blaxter, 1968). *****NDF**: Neutral detergent fiber (Cellulose + Hemicellulose + lignin), **ADF**: Acid detergent fiber (Lignin + cellulose), **ADL**: Acid detergent lignin (Lignin), **Hemicellulose** = NDF- ADF, **Cellulose** = ADF - ADL.

2. Digestibility and nutritive values

Most of nutrients digestibility was significantly (P<0.05) increased by Fibrozyme supplementation in both LRF and HRF compared to LR0 and HR0 (Table 2). Furthermore, these improvements were more pronounced with LRF especially CF, NDF and ADF digestibility, which improved by 22.9, 17.3 and 17.6%, respectively compared to LR0. Whereas, with HRF the corresponding values were 10.0, 8.4 and 8.6% compared to HR0. These results are in accordance with those reported by many workers (Rode et al., 1999; Kung et al., 2000; Beauchmin et al., 2003 and Sutton et al., 2003) when they supplemented fibrolytic enzymes to lactating cow rations containing different roughage levels. Murillo et al

(2000) found that, supplementation of Fibrozyme to cattle diets containing 33% forage increased ruminal NDF and ADF digestion by 10 and 43%, respectively. While, it did not significantly affect fiber digestion with diets containing 66% forage. Moreover, Adsogan (2005) indicated that enzyme application to concentrate proportion was more effective with lower forage diet (38%) than those containing from 55 to 60% forage. Also, the response to exogenous fibrolytic enzymes depends on forage quality, feeding level, time of action on the substrate and ruminal pH (Pinos et al, 2000).

Table (2): Mean values of nutrients digestibility and nutritive values of the tested rations fed to lactating cows during the experimental period.

Item	Tested rations				±SE
	LR0	LRF	HR0	HRF	
Digestibility, %					
DM	65.30^{a}	69.43^{b}	70.92^{b}	73.65^{c}	0.97
OM	72.36^{b}	75.88^{c}	69.12^{a}	71.87^{b}	0.77
CP	71.39^{b}	77.11^{c}	68.13^{a}	73.22^{b}	1.03
EE	74.41	75.82	72.70	74.02	0.66
NFE	75.26	77.52	73.97	75.60	0.60
CF	47.15^{a}	57.96^{b}	57.21^{b}	62.93^{c}	1.77
NDF	50.19^{a}	58.86^{b}	62.27^{b}	67.51^{c}	1.97
ADF	45.76^{a}	53.82^{b}	59.02^{b}	64.12^{c}	2.11
Nutritive values					
TDN, %	65.18^{a}	69.34^{b}	64.77^{a}	67.53^{ab}	0.68
ME, Mcal/kg DM*	2.35^{a}	2.49^{b}	2.33^{a}	2.43^{ab}	0.02
DCP, %	9.21^{c}	9.98^{d}	7.82^{a}	8.42^{b}	0.25

^{a,b,c,d} Means in the same row with different superscripts differ significantly at ($p<0.05$).
*ME, Mcal / kg DM = (TDN x 3.6) /100 (Church and Pond, 1982).

Additionally, treating feeds with enzymes just prior to feeding may improve digestibility via a number of different mechanisms including direct hydrolysis, enhanced microbial attachment, changes in gut viscosity, complementary actions with ruminal enzymes, changes in site of digestion, improvement in palatability and changes in patterns of feed consumption (Kung et al., 2000). In the present study, the nutritive values (TDN, ME and DCP) were significantly ($P<0.05$) higher for LRF than LR0. While, DCP value was increased ($P<0.05$), but TDN and ME values did not significantly differ for HRF compared to HR0. Higher nutritive values of rations supplemented with Fibrozyme may be attributed to the positive effect of enzyme on the most of nutrients digestibility (Beauchmin et al., 2003 and Sutton et al., 2003). Also, in our study DM, CF, NDF and ADF digestibility was higher (P<0.05), while both OM and CP digestibilities were lower (P<0.05) for HR0 than LR0. However, roughage level did not affect neither EE nor NFE digestibility. Higher nutritive values of LR0 compared to HR0 might be attributed to the higher digestibility coefficient of most nutrients in LR0. These results are in agreement with those observed by Murillo et al. (2000); Al-Dabeeb and Ahmed (2002), Omer et al. (2005), who found that, the nutritive value was improved with increasing concentrate ratio in the different ruminant rations.

3. Fermentation in the rumen

Results of fermentation in the rumen indicated that, no significant differences were observed in ruminal pH values among the tested rations (Table 3). Neither Fibrozyme supplementation nor roughage levels had any effect on ruminal pH values. These results are in agreement with those reported by many authors (Lewis et al., 1996; Krause et al., 1998; Pinos et al, 2002 and Sutton et al, 2003) with sheep, steers and lactating cows. Bowman et al (2002) indicated that, adding fibrolytic enzymes had no effect on rumen pH likely due to the increase saliva production, which attributed to enzyme applying may have been a physiological response to increased fermentation products within the rumen. In the current study, increasing roughage level in HR0 lead to a slight increase of ruminal pH value compared to LR0. These results are consistent with previous studies (Zinn and Plascencia, 1996 and Murillo et al, 2000).

Moreover, Fibrozyme supplementation had no significant effect on NH_3-N concentration with both LR and HR rations, though these values were numerically lower in treated rations (LRF& HRF) than those untreated (LR0&HR0) These results are in accordance with findings of Pinos et al (2002), who indicated that, ammonia-N was decreased by 4% for sheep fed diet treated with fibrolytic enzymes compared to those fed control. Moreover, Sutton et al (2003) found that ruminal NH_3-N concentration was not significantly different among treatments, although cows fed enzyme treatments tended to have greater ruminal NH_3-N than control. In general, with HR0 concentration of NH_3-N was decreased (P<0.05) compared to LR0. These results are supported by previous studies (Al-Dabeeb and Ahmed, 2002 and Saleh, 2005).

Ruminal VFA's concentrations were significantly (P<0.05) higher for Fibrozyme treatments (LRF&HRF) than those of untreated (LR0&HR0). These results are in harmony with those recorded by Lewis et al. (1996), Al-Dabeeb and Ahmed (2002) and Ali (2006), when they added fibrolytic enzymes or probiotic to steers and sheep rations. In the present study, higher VFA' s concentration with treated rations may be attributed to improving most of nutrients digestibility compared to those untreated. Colombatto et al (2003) indicated that, enzymes enhanced the fermentation of cellulose and zylan by a combination of pre and post incubation effects (i. e., an increase in the release of reducing sugars during the pretreatment phase and increase of hydrolytic activity of the liquid and solid fractions of ruminal fluid, which was reflected in higher fermentation rate. Generally, in the current study VFA' s concentrations increased (P<0.05) with increasing concentrate level in the tested rations. These results are in agreement with those reported by Saleh (2001 & 2005). The changes of VFA' s may be depending on the ration type, chemical composition, nutrient digestibility and its nutritive value.

Table (3): Mean values of rumen liquor parameters of lactating cows fed the tested rations during the experimental period.

Item	Tested rations				±SE
	LR0	LRF	HR0	HRF	
pH	6.12	6.08	6.36	6.32	0.05
NH_3- N, mg/100 ml	15.29[b]	14.88[b]	13.41[a]	12.81[a]	0.36
VFA's, mM/100 ml	12.84[b]	13.96[c]	10.91[a]	12.47[b]	0.34
VFA's proportions, %					
Acetic acid (A)	58.15[a]	57.29[a]	62.12[b]	61.27[b]	0.66
Propionic acid (P)	24.27[c]	25.86[d]	21.13[a]	22.96[b]	0.54
A/P ratio	2.40[b]	2.21[a]	2.94[d]	2.67[c]	0.02
Butyric acid	12.48	11.66	11.37	10.85	0.35

[a,b,c,d] Means in the same row with different superscripts differ significantly at (p< 0.05)

Regarding molar proportions of VFA' s (Table, 3), propionic acid percentage increased, while A/ P ratio decreased (P<0.05) for cows fed treated rations (LRF&HRF) compared to those fed untreated (LR0& HR0). Whereas both acetic and butyric acids unaffected by adding enzyme. These results were nearly similar with findings of Krause et al. (1998), Kung et al. (2000) and Sutton et al. (2003). Moreover, Murillo et al. (2000) indicated that Fibrozyme supplementation led to increase propionate, but decreased butyrate, while did not affect on acetate percentage in bulls. Meanwhile, Yang et al (2002) found that, fibrolytic enzymes supplementation did not affect total VFA concentration, but increased acetate and reduced the propionate percentage in lactating cows. In the present study, higher (P<0.05) acetic acid percentage and acetic/propionic (A/P) ratio, while lower (P<0.05) propionic acid percentage was observed with HR0 than LR0. Conversely, LR0 showed higher (P<0.05) propionic acid percentage than HR0. However, no significant differences were observed among treatments for butyric acid percentage. The same trend was observed by Lewis et al (1996), Kung et al (2000) and Sutton et al (2003), with steers and lactating cows. In general, the changes in molar proportions of VFA's indicates a potential increase in ruminal OM, CP, CF, NDF and ADF digestibility. Moreover, the differences between our results and other published data (Yang et al, 2002) could be attributed to the differences in the roughage level and quantities and types of fibrolytic enzymes supplemented to these rations.

4. Blood constituents

Data of blood constituents (Table 4) indicated that, all these values except for glucose were not significantly affected by feeding the tested rations. However, LRF and HRF treatments showed higher ($P<0.05$) glucose concentration than both LR0 and HR0. Moreover, serum glucose was higher ($P<0.05$) for LR0 than HR0. These results were nearly similar with those recorded by Bendary et al. (2000) and Hassan et al. (2005) with dairy cows. Generally, the blood constituent values measured in the present study were within the normal range for dairy cows as recorded by Reece (1991). In the current study, increase of glucose concentration with LRF, HRF and LR0 may be due the improvements of nutrients digestibility especially CF, NDF and ADF and increase of ruminal propionic acid percentage for these rations (Tables 2&3). Perry and Cecava (1995) found that most of absorbed propionic acid is converted to glucose by the liver. Also, propionic acid is a precursor for about 80% of glucose synthesized by the liver with amino acids and lactic acid that are minor substrates for glucose synthesis.

Table (4): Mean values of blood serum constituents for lactating cows fed the tested rations during the experimental period.

Item	Tested rations				±SE
	LR0	LRF	HR0	HRF	
Serum proteins, g/dl	7.85	8.12	7.59	7.80	0.10
Albumin, g/dl	4.63	4.78	4.56	4.66	0.10
Globulin, g/dl	3.22	3.34	3.03	3.14	0.05
Glucose, mg/dl	72.77^{b}	79.52^{c}	67.74^{a}	71.86^{b}	0.42
Urea, mg/dl	34.57	35.09	33.33	33.94	0.29
GOT, U/L	42.84	43.15	43.07	43.31	0.32
GPT, U/L	13.42	13.85	12.96	13.31	0.22

^{a,b,c} Means in the same row with different superscripts differ significantly at ($p<0.05$).

5. Milk yield and composition

As shown in Table 5, both of actual and FCM yields were significantly (P<0.05) higher for cow groups fed rations supplemented with Fibrozyme (LRF&HRF) than those fed unsupplemented (LR0&HR0). It was noticed that cows fed LRF produced 1.75 kg/d (12.96%) and 1.33 kg/d (10.72%) more actual and FCM yields, respectively than those fed LR0. However, with HRF the corresponding yields increased by 1.66 kg/d (13.37%) and 1.39 kg/d (11.88%) compared to those fed HR0. Although milk production (actual &FCM) was not significantly affected by roughage level, cows fed LR0 produced 1.08 (8.70%) and 0.71 kg/d (6.07%) more actual and FCM yields, respectively than those fed HR0. In general, supplementation of Fibrozyme to either LR or HR ration improved (P<0.05) both actual and FCM yields. Increasing milk production has been observed in many studies (Lewis et al., 1999; Rode et al.; 1999; Yang et al., 2000 and Zheng et al., 2000), who reported that supplementation of fibrolytic enzymes to dairy cow rations containing different roughage levels improved milk production by 6-16%. This response may be attributed to improved nutrients digestion after enzymes supplementation (Kung et al, 2000 and Beauchemin et al., 2003).

Milk composition was not significantly affected by either Fibrozyme supplementation or roughage level among the tested rations (Table 5). Milk fat content tended to decrease slightly for cows fed both of LRF and HRF compared to those fed LR0 and HR0. Meanwhile, animal group fed HR0 showed a slight increase of most milk components compared to that fed LR0. These results were supported by findings of Kung et al (2000) and Sutton et al. (2003). Increasing ruminal propionic acid and blood serum glucose may have stimulated insulin release. The net effect would be to depress milk fat synthesis by increasing adipose tissue lipogenesis. Also, increase of fiber digestion due to enzymes supplement reduced the effective NDF content of the diet, indicating more fiber may be needed to maintain a high milk fat content when enzymes supplemented to diets (Rode et al., 1999).

Cow groups fed either LRF or HRF produced higher values (P<0.05) of most milk component yields than those fed LR0 and HR0. These results illustrated that although Fibrozyme did not significantly affect milk composition, the milk component yields were improved (P<0.05) in treated groups compared to those untreated. This is attributed to increase of milk production for treated groups. However, there are no significant differences between cow groups fed LR0 and those fed HR0, while the later one showed a slight decrease in all milk component yields. This may due to the decrease of milk production for cow groups fed HR0 than those fed LR0. These results were nearly similar with those reported by Kung et al (2000), Zheng et al. (2000) and Sutton et al. (2003), when they added fibrolitic enzymes to dairy cows rations containing 50 - 65% roughage.

Table (5): Mean milk yield and composition for lactating cows fed the tested rations during the experimental period.

Item	Tested rations				±SE
	LR0	LRF	HR0	HRF	
Milk yield, kg/h/d					
Actual	13.50^{ab}	15.25^{c}	12.42^{a}	14.08^{bc}	0.29
4% FCM	12.41^{ab}	13.74^{c}	11.70^{a}	13.09^{bc}	0.25
Milk composition, %					
Fat	3.46^{ab}	3.34^{a}	3.53^{b}	3.49^{ab}	0.04
Protein	3.21	3.18	3.16	3.31	0.04
Lactose	4.53	4.56	4.65	4.69	0.03
SNF	8.43	8.45	8.53	8.72	0.07
TS	11.89	11.79	12.13	12.25	0.11
Milk component yields, kg/h/d					
Fat	0.468^{ab}	0.510^{b}	0.448^{a}	0.498^{ab}	0.01
Protein	0.432^{ab}	0.487^{b}	0.393^{a}	0.467^{b}	0.01
Lactose	0.613^{ab}	0.693^{c}	0.578^{a}	0.660^{b}	0.01
SNF	1.137^{ab}	1.288^{c}	1.060^{a}	1.228^{bc}	0.03
TS	1.602^{ab}	1.798^{c}	1.512^{a}	1.727^{bc}	0.04

^{a,b,c} Means in the same row with different superscripts differ significantly at ($p<0.05$).

6. Feed intake, feed conversion and economic return

Data presented in Table 6 cleared that, cows fed the different tested rations consumed nearly similar amounts of DM. However, those fed treated rations (LRF&HRF) showed more TDN and DCP intakes than those fed untreated (LR0&HR0). As well as, cows fed LR0 consumed slightly higher TDN and DCP than those fed HR0. This attributed to both of Fibrozyme and higher concentrate level improved OM, CP, EE, and NFE digestion and nutritive values (Table 2). These results are in agreement with Schingthe et al. (1999) and Zheng et al. (2000) findings, who indicated that DMI was similar for dairy cows fed diets either treated with fibrolytic enzymes or containing different roughage levels.

Regarding feed conversion expressed as DM, TDN and DCP required to produce one kg FCM, results indicated that cow groups fed

LRF and HRF were better than those fed LR0 and HR0. Furthermore, with LR0 both DM and TDN efficiency values were better, but DCP efficiency was lower than HR0. In general, the fluctuation of feed conversion among the tested groups reflected in the differences of DM, TDN and DCP intakes and FCM production. These results are in harmony with those reported by Rode et al. (1999) and Schingthe et al. (1999), who found that feed conversion as DMI/FCM was improved for dairy cows fed diets treated with fibrolytic enzymes or those fed low roughage diets.

Table (6): Mean values of feed intake, feed conversion and economic return for lactating cows fed the tested rations during the experimental period.

Item	Tested rations			
	LR0	LRF	HR0	HRF
Feed intake, kg DM /h/d				
From CM	7.83	7.84	5.25	5.26
From CS	2.54	2.59	4.10	3.97
From BH	1.39	1.35	1.84	1.89
From RS	1.41	1.35	1.90	1.93
Roughage %, as DM	40.55	40.29	59.89	59.69
Total feed intake, kg/h/d				
From DM	13.17	13.13	13.09	13.05
From TDN	8.58	9.10	8.48	8.81
From DCP	1.21	1.31	1.02	1.10
Milk yield, kg/h/d				
Actual	13.50	15.25	12.42	14.08
4% FCM	12.41	13.74	11.70	13.09
Feed conversion, kg/kg 4% FCM				
DM	1.061	0.956	1.119	0.997
TDN	0.691	0.662	0.725	0.673
DCP	0.098	0.095	0.087	0.084
Feed cost and economic return*				
Total feed cost, LE/h/d	12.41	12.70	10.08	10.37
Feed cost/ kg FCM, LE	1.00	0.92	0.86	0.79
Price of FCM yield, LE/h/d	20.10	22.26	18.95	21.21
Economic return, LE/h/d	7.69	9.56	8.87	10.84
Economic return, LE/kg FCM	0.62	0.70	0.76	0.83

*Price list of one ton of CM, CS, BH, RS and FCM were, 1200, 120, 650, 90 and 1620 L.E., respectively and Fibrozyme 30 L.E./ kg (based on 2006 prices).

Economic return (LE/h/d) = price of FCM yield - total feed cost.

Feed cost as LE/kg FCM (Table 6) decreased by 8.00% and 8.14% for cows fed rations supplemented with Fibrozyme (LRF&HRF) compared to those fed unsupplemented (LR0&HR0), respectively. Moreover, it decreased by 14.00% for animals fed HR0 compared to those fed LR0. However, economic return as LE/h/d increased by 24.32 and 22.21%, also as LE/kg FCM, it increased by 12.90 and 9.21% for cows fed LRF and HRF compared to those fed LR0 and HR0, respectively. Furthermore, these increased by 15.34 and 22.58%, respectively for cows fed HR0 compared to those fed LR0. In general, the decrease of feed cost and increase of economic return by Fibrozyme supplementation was attributed to the improvement of milk production in these groups. Moreover, the same effect was observed when cow groups fed high roughage might due to the decrease of roughage prices compared to concentrate mixture. These results are in harmony with those reported by Schingthe et al. (1999), who found that income over feed cost increased by 6.5-13.2% and 19.8% for dairy cows fed diets treated with fibrolytic enzymes and those fed high roughage ration compared to untreated and low roughage ration, respectively.

CONCLUSION

From the results obtained it could be concluded that, supplementation of fibrolytic enzyme (Fibrozyme) to concentrate mixture at level 10 g/h/d just prior to feeding in lactating cow rations containing either 40 or 60% roughage lead to increasing most of nutrient digestibilities especially CF and its fractions, this led to improve milk production, decreasing feed cost and increasing economic return. Thereby, it could be recommended adding fibrolytic enzymes to cow rations that containing either low or high roughage level.

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الملخص العربى

الأداء الإنتاجى للأبقار الحلابة المغذاة على علائق مدعمة بالفيبروزيم

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استخدم فى هذه الدراسة ٢٤ بقرة فريزيان حلابة متوسط وزنها ٤٨٢ ± ٩ كجم ما بين الموسم الثانى والرابع بداية من الأسبوع السابع وحتى الأسبوع الثامن عشر بعد الولادة (١٢ أسبوع) لدراسة الأداء الإنتاجى للأبقار الحلابة المغذاة على علائق معاملة بالإنزيم المحلل للألياف (الفيبروزيم) مع مستويات مختلفة من الأعلاف المالئة والتى تتكون من سيلاج الذرة بالكيزان و دريس البرسيم و قش الأرز بنسبة ٥٠، ٢٥، ٢٥٪ على التوالى (على أساس المادة الجافة). حيث غذيت الأبقار على العلائق الآتية:-

ع١: ٤٠٪ أعلاف مالئة +٦٠٪ مخلوط أعلاف مركزة.

ع٢: ٤٠٪ أعلاف مالئة +٦٠٪ مخلوط أعلاف مركزة+ فيبروزيم.

ع٣: ٦٠٪ أعلاف مالئة +٤٠٪ مخلوط أعلاف مركزة.

ع٤: ٦٠٪ أعلاف مالئة +٤٠٪ مخلوط أعلاف مركزة+ فيبروزيم.

كان الفيبروزيم يضاف للمخلوط المركز المجروش بمعدل ١٠ جم/رأس يوميا قبل التغذية الصباحية مباشرة.

وقد أظهرت الدراسة النتائج الآتية:-

١- تحسنت معظم معاملات هضم المركبات الغذائية والقيمة الغذائية معنويا (٥٪) بإضافة الفيبروزيم للعلائق ع٢،ع٤ مقارنة بالعلائق غير المعاملة (ع١،ع٣)، كما تحسنت معاملات هضم المادة الجافة و الألياف الخام و مكوناتها للعليقة ع٣ العالية المحتوى من الأعلاف المالئة مقارنة بالعليقة ع١ المنخفضة المحتوى.

٢- لم تكن هناك اختلافات معنوية فى درجة حموضة سائل الكرش بين المجموعات المختلفة، بينما انخفض تركيز نيتروجين الأمونيا معنويا (٥٪) فى الحيوانات المغذاة على العليقة ع٣ مقارنة بالعليقة ع١، بينما ازداد تركيز كل من الأحماض الدهنية الطيارة الكلية وحمض البروبيونيك معنويا (٥٪) بإضافة الفيبروزيم فى العلائق ع٢،ع٤ مقارنة بالعلائق غير المعاملة (ع١،ع٣)، كما لوحظ ارتفاع نسبة حمض الخليك و انخفاض نسبة حمض البروبيونيك معنويا (٥٪) فى الحيوانات المغذاة على العليقة ع٣ مقارنة بالعليقة ع١.

٣- ازداد تركيز جلوكوز الدم معنويا (٥٪) فى الأبقار المغذاة على العلائق المعاملة بالفيبروزيم مقارنة بالعلائق غير المعاملة، كما ازداد تركيز الجلوكوز معنويا (٥٪) فى سيرم دم الحيوانات المغذاة على العليقة ع١ مقارنة بالعليقة ع٣.

٤- أدت إضافة الفيبروزيم إلى تحسن إنتاج اللبن اليومى الفعلى واللبن المعدل الدهن (٤٪ دهن) بنسبة ١٢,٩٦، ١٠,٧٢٪ على التوالى بالنسبة للأبقار المغذاة على العليقة ع٢

مقارنة بالأخرى المغذاة على العليقة ع١، كما تحسن هذا الإنتاج بنسبة ١٣,٣٧، ١١,٨٨٪ للأبقار المغذاة على العليقة ع٤ مقارنة بالعليقة ع٣، كما تحسن أيضا إنتاج اللبن بنسبة ٨,٧٠، ٦,٠٧ ٪ للحيوانات المغذاة على العليقة ع١ المنخفضة المحتوى من الأعلاف المالئة مقارنة بالأخرى المغذاة على العليقة ع٣ العالية المحتوى.

٥- تحسن الإنتاج اليومى لمعظم مكونات اللبن معنويا (٥٪) للحيوانات المغذاة على العلائق المعاملة بالفيبروزيم مقارنة بالأخرى المغذاة على العلائق غير المعاملة.

٦- لم تتأثر كمية المادة الجافة المأكولة يوميا سواء بإضافة الإنزيم أو بمستوى الأعلاف المالئة بالنسبة لجميع المعاملات، بينما استهلكت الحيوانات المغذاة على العلائق المعاملة كمية أكثر من كل من مجموع المركبات الغذائية المهضومة و البروتين الخام المهضوم مقارنة بالعلائق غير المعاملة.

٧- انخفضت تكلفة الغذاء (جنيه/كجم لبن معدل الدهن) بنسبة ٨,٠٠ ، ٨,١٤ ٪ للأبقار المغذاة على العلائق ع٢،ع٤ المعاملة بالإنزيم مقارنة بالعلائق ع١،ع٣ غير المعاملة على التوالى، كما انخفضت هذه التكلفة بنسبة ١٤,٠٠٪ للحيوانات المغذاة على العليقة عالية المحتوى من الأعلاف المالئة (ع٣) مقارنة بالعليقة ع١ المنخفضة المحتوى.

٨- ازداد العائد الاقتصادى مقدرا بالجنيه/رأس/ يوميا بنسبة ٢٤,٣٢، ٢٢,٢١٪ كما ازداد هذا العائد مقدرا بالجنيه/كجم لبن معدل الدهن بنسبة ١٢,٩٠ ، ٩,٢١ ٪ للأبقار المغذاة على العلائق المعاملة بالإنزيم (ع٢،ع٤) مقارنة بالأخرى غير المعاملة (ع١،ع٣) على التوالى، كما ازداد كل منهما بنسبة ١٥,٣٤ ، ٢٢,٥٨٪ للأبقار المغذاة على العليقة عالية المحتوى من الأعلاف المالئة (ع٣) مقارنة بالعليقة ع١ المنخفضة المحتوى.

من هذه الدراسة نستنتج أن إضافة الإنزيم المحلل للألياف (الفيبروزيم) بمعدل ١٠ جم/رأس/ يوميا لعلائق الأبقار الحلابة سواء المحتوية على ٤٠٪ أو ٦٠٪ أعلاف مالئة أدت إلى تحسن معظم معاملات هضم المركبات الغذائية خصوصا الألياف الخام و مكوناتها والذى أدى إلى تحسن إنتاج اللبن و انخفاض تكلفة الغذاء و زيادة العائد الاقتصادى. لذا يوصى بإضافة الإنزيمات المحللة للألياف إلى علائق الأبقار الحلابة بصفة عامة.