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Research Article

Impact of Feeding Exogenous Fibrolytic Enzymes (EFE) on Digestibility, Rumen Fermentation, Haemobiochemical Profile and Productive Performance in Buffalo Calves

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ABSTRACT

This study was fulfilled to assess the impact of supplementing diets with Exogenous Fibrolytic Enzymes (EFE) in buffalo calves on growth performance criteria, rumen fermentation properties and certain biochemical indices. The total number of 12 buffalo calves of (4-6) months age and 123.3 kg average body weight were assigned into two similar groups (6 animals each): Animals of T1 (control) were fed on basal ration and those of T2 (treated) were fed as T1 plus 12 ml Zymogen liquid (ZL)/100 kg of animal weight per head daily. The study was extended for fifteen weeks. Live body weights were individually recorded biweekly in both group Rumen and blood samples were gathered from each animal in both groups at the finishing of study for determination of rumen fermentations properties and certain blood biochemical indices. Results showed that treated group (T2) recorded significant increase ($P \leq 0.05$) in dry matter intake (DMI), digestion coefficients, average daily gain, total body weight gain and better feed conversion ratio in comparing with control group. Also, treated group recorded significant increase ($P \leq 0.05$) in TVFA's, ammonia concentration and total protozoa count (TPC) in comparing with control group. Blood biochemical analysis in treated group (T2) showed significant increase ($P \leq 0.05$) in total protein, albumin and non-significant decrease in urea, creatinine, triglycerides, AST and ALT levels compared with control group. The results obtained from this study suggested that buffalo calves fed with (EFE) supplemented feed, showed greater daily weight gains, total weight gains and feed conversion rates and rumen fermentation parameters.

Key words: Exogenous Fibrolytic Enzymes (EFE), Buffalo calves, Digestibility, Rumen fermentation, Biochemical profile, Growth performance

INTRODUCTION

In Egypt, agriculturists feed their animals with low quality harvest buildups having high fiber content. Ruminant animals can change over low quality feeds into astounding protein (Satapathy *et al.,* 2018). High fiber substance of feeds keeps the activity of ruminal proteins to the plant cell divider and reduction supplement absorbability. (Elghandour *et al*., 2015; Abdel-Aziz *et al*., 2015; Togtokhbayar *et al*., 2015), Thus to enhance the digestibility, it is important to destruct the linkage between cellulose, hemicellulose and lignin. Buffaloes well known to expand more amount of straw and fodder than that of cattle. However, bad utilization capability of forages by the animal is core restraint in buffalo husbandry. Therefore, there is great want for enhancing the digestibility of the forages in case of buffaloes (Satapathy *et al.,* 2018)

Supplementation of EFE is one of new rumen manipulation biotechnology to improve the quality and digestibility of fibrous forage and enhance production performance of the animals **(**Patel *et al.,* 2015; Rojo *et al.*, 2015; Salem *et al.,* 2015; Valdes *et al.,* 2015; Raju *et al.,* 2016; Deli Nazmín *et al*., 2018**)**. The positive effect of inclusion of EFE to ruminant diets can be summarized as pre consumption effect via, partially digest feed or weaken cell wall barriers that limit microbial digestion in rumen and reduce sugars from feedstuffs before consumption **(**Hristov *et al*., 1996; Raju *et al.,* 2016**)** besides enhance rapid microbial attachment in rumen **(**Forsberg *et al*., 2000**)**. Ruminal effect includes synergistically work with ruminal microbes to improve

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feed digestion besides increase of attachment and numbers of cellobiose and glucose utilizing bacteria in rumen **(**Nsereko *et al*., 2002). Post ruminal benefit of EFE is synergistically work with microbes in small and large intestine (Beauchemin *et al*., 2004**)**.

In recent years, supplementation of ruminant diet with EFE are increased due to cost active tools of enhancing feed efficiency **(**Krause *et al.*, 2003**)**, besides its used not corrosive and or / hazardous, unlike chemical treatment for forages **(**Raju *et al.*, 2016**)**.

Previous studies have reported that use of EFE have a great effect on productivity of cattle **(**Bhasker *et al.*, 2012**)**, buffaloes **(**Gaafar *et al.*, 2010**)**, lambs **(**Salem *et al.*, 2012**)**. The effectiveness of EFE addition depends on many factors such as nature and activity of enzymes, type of ration and level and mode of enzyme supplementation **(**Shekhar *et al.*, 2010).

So, the current study was fulfilled to assess the effect of inclusion of commercial Exogenous Fibrolytic Enzymes cocktail (EFE) Zymogen® on buffalo calves performance, digestibility, rumen fermentation and certain blood biochemical indices.

MATERIALS AND METHODS

This work was allowed in the Experimental Research Station belongs to Faculty of Agriculture, Ain Shams University located in Shalakan village, Qalubia Governorate, Egypt, during the period from February, 2018 to June, 2018.

The experimental animals and rations

Twelve growing buffalo calves of (4-6) month's age and 123.3 kg body weight were assigned into two similar groups (6 animals each). Each group was assigned randomly to feed on one of the following two dietary treatments:

T1: were fed the basal farm ration (NRC, 2001).

T2: were fed the basal farm ration plus 12 ml Zymogen liquid (ZL) /100 kg of animal weight per head daily.

The basal ration consists of concentrate feed mixture (CFM), wheat straw and berseem. The CFM composed of 38% ground maize, 15% soybean meal, 34% wheat bran, 5% rice bran, 3% molasses,1% mineral salts, 2% limestone powder,1% Sodium Bicarbonate and 1% sodium chloride.

All animals were treated for internal and external parasites and vaccinated for common infectious diseases before the experiment started.

Overall means of the initial body weights of the experimental calves in this experiment were 125.6 and 121 Kg for T1 and T2, respectively. The experiment was extended for fifteen weeks. Chemical compositions of feed stuffs are illustrated in Table 1.

Feed additives composition and sources

Zymogen liquid (ZL): This product is a liquid mixture of digestives enzymes, whereas each 1000 ml contains:

Amylase 1500000 BAU (Bacterial Amylase Unit)
Protease 2500000 HUT (Hemoglobin Unit Tyrosine)
Lipase 500000 LU (Lipase Unit)
Cellulase 1000000 CU (Cellulase Unit)
Xylanase 1000000 XU (Xylanase Unit)
Pectinase 2000 Endo-PG (Pectinase Unit) 2000000 PSU
Propylene Glycol 100 ml
Water up to 1000 ml (Wisemed Inc, 2017).

Growth performance parameters

Live body weights were individually recorded at two weeks intervals. The average daily body weight gain was individually calculated. Daily feed intake was measured for each replicate of a treatment by the difference between the daily offered feed and the daily residual one. Feed conversion ratios were obtained by dividing the amount of feed consumption per calf by the corresponding weight gain in a certain stage (two weeks).

Digestibility trial

Through the entire of each study period, digestibility trials were performed for all the experimental buffalo calves using a grab sample method where acid insoluble ash (AIA) was used as an internal marker according to (Schneider and Flatt 1975) for determining the nutrients digestibility. Fecal grab samples were collected handily at 8.0 a.m. and 2.0 p.m. for three successive days from each animal started from the 50th day of the experiment.

Rumen fluid samples

Rumen liquor samples were collected from each animal in each group at the finish of experiment using stomach tube 4 hrs post feeding and filtered through four layers of cheese cloth for estimating of rumen parameters. The pH value was immediately documented using digital pH metter, while samples were stored at -20°C until chemical analysis. Ruminal ammonia nitrogen (NH3-N) concentration was measured according to (Conway 1957), Ruminal total volatile fatty acids (TVFA's) concentration was measured by steam distillation procedure according to (Warner 1964) and total protozol count was estimating according to (Dehorety, 1986) Blood samples Blood samples were collected from each animal in each group at the finish of experiment. The blood samples were collected at three hours post morning feeding.

Blood samples

Blood samples were taken from each animal in each group at the end of experiment. The blood samples were obtained at three hours post morning feeding. A sample of 15 ml of blood per animal was taken from the jugular vein. The blood was taken into a clean dried tube after adding EDTA. The blood plasma was harvested by centrifuging the blood samples soon after collection at 4000 (rpm) for 15 minutes. Blood plasma was transferred into a clean dried tubes vials and then stored in deep freezer at -20ºC for subsequent specific chemical analysis. Blood plasma was determined for total protein (Armstrong and Carr, 1964), albumin (Doumas *et al.,* 1971), urea (March 1965), creatinine (Husdan, 1968). AST, ALT (Reitman and Frankel 1957) and triglyceride (Fassati, 1982). Globulin was calculated by difference.

Analytical methods

The chemical composition of the feedstuffs and feaces were analyzed according to the A.O.A.C (1995) methods to determine moisture, DM, OM, CP, CF, EE and ash contents, while NFE content was calculated by difference.

Statistical analysis

The data were measured according to statistical analysis system (SAS) User s Guide (2001). Separation among means was done by using Duncan multiple tests, (1955).

RESULTS AND DISCUSSION

Dry matter intake

Result were tabulated in Table 2 clearly showed that DMI was increased (P≤0.05) by adding zymogen liquid (ZL) on the basic ration. This result is in good agreement with those obtained by (Thakur *et al*., 2010), who fed Murrah buffalo calves on a basal diet supplemented by EFE. Also, same findings were recorded by (Arif *et al*., 2019) on Nilli Ravi early lactating buffaloes, they tested the effect of adding EFE on ration involved of oat silage and concentrates. They recorded an increase in DM intake with treated groups. In addition, (Gomez-Vazquez *et al*., 2011) on crossbreed steers grazing stargrass plus concentrate and fermented sugar cane supplemented by EFE. They found a positive effects on DM intake. The great impact of enzymes on feed intake may be explained by partly be increase palatability of the diet (Morsy *et al*., 2016; kholif *et al*., 2017).

Nutrients digestibility

Data of digestion coefficients were tabulated in Table (3). Animals of T2 (treated group) showed higher (P≤0.05) digestibility of DM, OM, CP, CF, EE and NFE than those of T1 (control group). The same findings were recorded by (Arif *et al*., 2019) on Nilli Ravi buffaloes, they recorded an improvement (P≤0.05) in all nutrients digestibility coefficients. Also, (Song *et al*., 2018), they found an improvement of EFE supplementation on OM, CP and fiber fraction digestibility of Chinese domesticated black goats. In addition, (Soliman *et al*., 2016) fed Barki sheep on a ration supplemented by prebiotic. They recorded a significant enhancing in all digestibility coefficients. Moreover, (He *et al*., 2015) on Angus cattle recorded an increase of CP and fiber fraction digestibility with diets supplemented by EFE.

Rumen fermentation properties

Rumen fermentation properties (table 4) revealed non-significant increase in pH and significant increase (P≤0.05) in TVFAS, ammonia concentration and total protozoa count (TPC) in EFE supplemented group compared with those in control group.

Rumen pH, NH3-N and VFA concentrations are the important indicators that reflect rumen function and stability of the intra ruminal milieu. In the present study, oral administration of EFE not affect the rumen pH the same finding was recorded by (Yuangklang *et al*., 2013) in buffaloes, (Poonooru *et al*., 2015) in buffalo bulls and (Balci *et al*., 2007) in fattening steers.

Increase ruminal ammonia concentration of the treated group is in agreement with those reported by (Poonooru *et al*., 2015), Bhasker *et al*., 2013), Kholif and Aziz 2014) and Rajamma *et al*., 2014). In contrast, (Gaafar *et al*., 2010) reported that EFE decreased (P<0.01) NH3-N concentration. (Pinos-Rodriguez *et al*., 2008), (Singh and Das 2009) and (Ganai *et al*., 2011) reported no effect of EFE on NH3-N concentration. This variation might be attributed to difference in environmental factors, feed type, feed allocation method, and type of enzyme blend (Sutton *et al*., 2003). Similar results of TVFA were observed in buffalo bulls by (Rajamma *et al*., 2014) and Poonooru *et al*., 2015).

This may be explained by the great availability of fermentable soluble carbohydrates due to increased fibrolytic activity in rumen. Data of table (4) clearly indicated also significant total protozoa increase in treated group compared with control group.

Blood plasma

Data of Table (5) showed significant increase (P≤0.05) in total protein, albumin, while there was non-significant decrease in triglycerides, BUN, AST, ALT and creatinine levels in experimental group compared with those in control group. The values in both groups were within normal physiological ranges (Kaneko *et al*., 1997), the same results were recorded by (Beigh *et al*., 2018) in lambs, (El-Bordeny *et al*., 2015) and (Peters *et al*., 2015) in lactating dairy cows fed rations included with exogenous enzymes. These results may be attributed that EFE supplementation enhance metabolic process as a response to increase apparent nutrients digestibility (table 3). In this connection, (Kumar *et al*., 1980) and (Bush 1991) reported that serum total proteins concentration reflects the nutritional grade of the animal and it has a great link with dietary protein level.

In kidney function attributes, EFE supplemented group had numerically lower levels of urea and creatinine in the blood plasma. The same results were mentioned by (Beigh *et al*., 2018) in lambs, (El-Bordeny *et al*., 2015) in lactating dairy cows and (Turkar and Uppal, 2007); (Javid *et al*., 2008) and (Shekhar *et al*., 2010) in buffaloes. These results might be attributed to efficient utilization of dietary proteins by addition of the feed additive. Lower N wastage by great utilization of generated ammonia in the rumen was characterized in terms of lower blood urea nitrogen (BUN) levels in EFE supplemented group. So, supplementation had no opposing impacts on glomerular filtration, thus safe for renal functioning. These results of non-significant impacts of exogenous enzymes on plasma BUN and creatinine in the present study are in agreement to those obtained by (Rivero and Salem, 2015) for enzyme feeding in sheep.

Table 1: Chemical composition of the experimental feed stuffs (% on DM basis).

Feed stuff	DM	OM	CF	CP	EE	NFE	Ash	AIA**
Berseem	90.94	95.38	30.15	19.64	3.80	41.79	4.62	4.42
Wheat straw	91.73	81.66	51.92	4.15	1.83	23.75	18.34	15.31
CFM*	91.56	96.24	23.60	16.88	2.99	52.76	3.76	5.62

* CFM: Concentrate feed mixture; **AIA: Acid insoluble ash.

Table 2: Effect of EFE supplementation on dry matter intake (kg/h/d).

Period (days)	Treatments	
	T1	T2
0 – 15	4.14±0.65	4.27±1.17
16 – 30	4.12±0.48	4.28±0.77
31 – 45	4.22±0.53	4.40±0.56
46 – 60	4.21±0.32	4.59±1.25
61 – 75	4.35±0.61	4.60±0.80
76 – 90	4.37±0.64	4.71±0.56
91 – 105	4.38±0.52	4.95±1.32
Average	4.26^{B}	4.54^{A}

A and B Means of treatments within the same row with different superscript letters are significantly different (P≤0.05).

Table 3: Effect of EFE supplementation on the nutrients digestibility coefficients of the buffalo calves.

Item	T1	T2
DM	61.48^{B}±1.03	67.34^{A}±0.64
OM	66.43^{B}±1.02	71.08^{A}±0.76
CP	63.33^{B}±0.53	68.89^{A}±0.49
CF	58.76^{B}±1.82	64.40^{A}±0.74
EE	80.12^{B}±1.64	84.39^{A}±0.20
NFE	72.73^{B}±0.92	79.25^{A}±0.62

A and B Means of treatments within the same row with different superscript letters are significantly different (P≤0.05).

Table 4: Effect of EFE supplementation on some rumen fermentation parameters

Item	Treatments	
	G1	G2
PH	6.83	6.93
Total Volatile Fatty Acids (mmol/l)	80.06^{B}	86.97^{A}
Ammonia (mmol/l)	100.37^{B}	106.91^{A}
Total Protozoa Count ($x10^5$/ml)	15.32^{B}	18.22^{A}

A and B Means of treatments within the same row with different superscript letters are significantly different (P≤0.05).

Among the indicators of liver functioning activity, AST and ALT were non significantly decreased in experimental group when compared with those in control group although the values in both the groups were within normal physiological ranges (Kaneko *et al*., 1997). The same data were recorded by (Beigh *et al*., 2018) in lambs, (Rivero *et al*., 2016) in sheep and goat and (El-Bordeny *et al*., 2015) in lactating dairy cows fed diets included with exogenous enzymes. The present values of AST and ALT activity indicate normal activity of the animal hepatic tissues, consequently, EFE application in the present study had no an adverse effect on the liver activity. Moreover, (El-Bordeny *et al*., 2010) stated that supplementation of EFE to buffaloe's rations had not any major adverse influence on blood parameters.

Regarding to the level of triglycerides in experimental group showed non-significant decrease although the values in both the groups were within normal physiological ranges in buffalo calves (Kaneko *et al*., 1997) The same results were recorded by (Beigh *et al*., 2018) in lambs and (Morsy *et al*., 2016) in Egyptian buffaloes.

Body weight and growth performance criteria

Data of Table (6) showed higher significant (P≤0.05) total gain and daily gain values in treated group (T2) than control (T1).

Table 5: Effect of EFE supplementation on selected serum biochemical parameters.

Item	Treatments	
	G1	G2
Total protein (g /dl)	5.85^{B}	6.24^{A}
Albumin (g /dl)	1.90^{B}	2.26^{A}
Globulin (g /dl)	3.95	3.98
Urea (mg /dl)	28.31	27.88
Creatinine (g /dl)	1.33	1.31
Triglyceride (mg/dl)	36.92	38.39
AST (unit /L)	33.62	32.08
ALT (unit /L)	31.47	30.42

A and B Means of treatments within the same row with different superscript letters are significantly different (P≤0.05).

Table 6: Effect of EFE supplementation on changes of body weights and daily gain (kg/h/d)

Item	Treatments	
	T1	T2
Animal weight		
Initial weight	125.60±15.40	121.00±25.53
Final weight	187.80±18.70	202.33±32.92
Total gain	$62.20±3.52^{B}$	$81.33±7.54^{A}$
Days	Average daily gain (kg/h/day)	
0 – 15	0.574±0.09	0.711±0.17
16 – 30	0.571±0.07	0.711±0.09
31 – 45	0.569±0.10	0.689±0.06
46 – 60	0.544±0.05	0.800±0.15
61 – 75	0.572±0.12	0.800±0.10
76 – 90	0.586±0.11	0.822±0.06
91 – 105	0.679±0.14	0.889±0.16
Average	0.586^{B}	0.775^{A}

A and B Means of treatments within the same row with different superscript letters are significantly different (P≤0.05).

Table 7: Effect of EFE supplementation on dry matter conversion (kg DM/ kg gain)

Item	Treatments	
Days	T1	T2
0 – 15	7.47±0.81	6.02±0.52
16 – 30	7.50±0.76	6.01±0.66
31 – 45	8.11±1.28	6.49±1.07
46 – 60	8.01±0.48	5.59±0.48
61 – 75	8.72±1.57	5.72±0.47
76 – 90	8.34±1.12	5.72±0.54
91 – 105	7.23±0.89	5.43±0.59
Average	7.91^{A}	5.85^{B}

A and B Means of treatments within the same row with different superscript letters are significantly different (P≤0.05).

This may be explained by, 1) Zymogen liquid may be having a stimulating effect on the rumen proper functions and digestion. 2) The higher digestibility that was recorded particularly for group T2 supplemented by (ZL) (table 3), which led to increase the absorbed nutrients from small intestine, consequently increase body weight gain. 3) Increased protein anabolism due to higher protein digestibility which led to higher blood plasma total protein and albumin concentration, which resulted an increase in protein biosynthesis in these group.

(Gomez-Vazquez *et al*., 2011) and (He *et al*., 2015) stated that supplements of EFE improved daily body weight gain. The present results agree also with those obtained by (Thakur *et al*., 2010) on Murrah buffalo calves, (Sudipta Ghosh and Ram Kumar Mehla 2012) on Holstein cross calves and (Soliman *et al*., 2016) on Barki sheep.

Feed conversion (kg DM/ kg gain)

Results of Table (7) showed better DM conversion ($P \leq 0.05$) for group supplemented by ZL (T2) than the control group (T1). This may be attributed to 1) Zymogen liquid may be having a stimulating effect on the rumen proper functions and digestion. 2) The higher digestibility that was recorded particularly for group supplemented by (ZL) T2 (table 3), which led to increase the absorbed nutrients from small intestine, consequently led to more body weight gain (table 6). 3) Increased protein anabolism due to higher protein digestibility which led to higher blood plasma total protein and albumin concentration (table 5), which resulted an increase in protein biosynthesis in this group.

These results are agree with those reported by (Gomez-Vazquez *et al*., 2011) on crossbreed (Brahman x Brown Swiss) steers, they fed steers on concentrate, sugarcane fermented and supplemented by EFE. They reported a significant improvement on feed conversion ratio. In addition, (Sudipta Ghosh and Ram Kumar Mehla 2012) on Holstein cross calves recorded an improvement on feed conversion efficiency for calves fed ration supplemented by prebiotic than the control group. Same results are also obtained by (Soliman *et al*., 2016) on Barki sheep fed ration supplanted by prebiotic.

Conclusions

The obtained results from this study suggested that buffalo calves fed with Exogenous Fibrolytic Enzymes (EFE) supplemented feed, showed better daily weight gains, total weight gains, feed conversion rates and rumen fermentation parameters. Therefore, inclusion complete diets for growing buffalo calves with EFE cocktail provided nutrients more than the recommended requirements with no opposing effects on plasma lipid parameters and resulted in normal hepato-renal activity signifying in-feed supplementation of EFE for successfully raising buffalo calves intensively.

REFERENCES

AOAC, 1995. Official Methods of Analysis. 15th ed. Association of Official Analytical Chemists. Arlongton, Virginiall USA.

Abdel-Aziz NA, AZM Salem, MM El-Adawy, LM Camacho, AE Kholif, MMY Elghandour and BE Borhami, 2015. Biological treatments as a mean to improve feed utilization in agriculture animals-An overview. J Integ Agric, 14: 534-43.

Arif M, AA Al-Sagheer, AZM Salem, ME Abd El- Hack, AA Aswlume, M Akhtar, 2019. Influence of exogenous fibrolytic enzymes on milk production efficiency and nutrient utilization in early lactating buffaloes fed diets with two proportions of oat silage to concentrate ratios. J Livestock Sci 219: 29-34.

Armstrong WD and CW Carr, 1964. Physiological chemistry 3rd ed. P, 75. Burges Publishing Co. Minneapolis, Minnesota.

Balci F, S Dikmen, H Gencoglu, A Orman, II Turkmen and H Biricik, 2007. The effect of fibrolytic exogenous enzyme on fattening performance of steers. Bulgarian J Vet Med, 10: 113−118.

Beauchemin KA, D Colombatto, DP Morgavi, WZ Yang and LM Rode, 2004. Mode of action of exogenous cell wall degrading enzymes for ruminants. Canadian J Anim Sci, 84: 13-22.

Beigh YA, AM Ganai, HA Ahmad, DM Mir, MA Bhat and S Muzamil, 2018. Blood metabolic profile of lambs fed complete diet supplemented with exogenous fibrolytic enzymes cocktail. J Anim Health Prod, 6: 96-102.

Bhasker TV, D Nagalakshmi and DS Rao, 2012. Exogenous Fibrolytic Enzyme Cocktail for Improvement of Nutrient Utilization from Sorghum Stover in Cattle. Indian J Dairy Sci, 65: 324-328.

Bhasker TV, D Nagalakshmi and S Rao, 2013. Development of appropriate fibrolytic enzyme combination for maize stover and its effect on rumen fermentation in sheep. Asian Austr J Anim Sci, 26: 945-951.

Bush BM, 1991. Interpretation of Laboratory Results for Small Animal Clinicians. Oxford Blackwell Scientific Publications, London.

Conway EJ, 1957. Microdiffusion analysis and volumetric errors., 2nd Ed., London Crosby Lock wood and Son. Lt.

Dehority BA, 1986. Rumen ciliates Fauna of Brazilian cattle: occurrence of several ciliates new to the rumen including Cycloposthid: Parantidinium africanum. J Eukaryotic Microbiol, 33: 416-421.

Deli Nazmín Tirado-González, LA Miranda-Romero, A Ruíz-Flores, SE Medina-Cuéllar, R Ramírez-Valverde and G Tirado-Estrada, 2018 Meta-analysis: effects of exogenous fibrolytic enzymes in ruminant diets, J Appl Anim Res, 46: 771-783 .

Doumas B, W Wabson and H Biggs, 1971. Albumin standards and measurementof serum with bromocresol green. Clin Chem Acta, 31:87.

Duncan David B, 1955. Multiple range and multiple F test. Biometric, 11: 1-42.

El-Bordeny NE, AA Abedo, HM El-Sayed, EN Daoud, HS Soliman and AEM Mahmoud, 2015. Effect of Exogenous Fibrolytic Enzyme Application on Productive Response of Dairy Cows at Different Lactation Stages. Asian J Anim Vet Adv 10: 226-236.

El-Bordeny NE, HM Gado, SM Kholif, AA Abedo and TA Morsy, 2010. Influence of exogenous enzyme on dairy buffaloes performance. Proceedings of the 61th Annual Meeting on EAAP, August 23-27, 2010, Herklion, Greece, pp: 1-228.

Elghandour MMY, AZM Salem, JS Martínez Castañeda, LM Camacho, AE Kholif and JC Vázquez Chagoyán, 2015. Direct-fed microbes: A tool for improving the utilization of low quality roughages in ruminants. J Integr Agric, 14: 526–33.

Fassati P and L Principe, 1982. Measurement triglyceride. Clin Chem, 28: 2077.

Forsberg C, E Forano and A Chesson, 2000. Microbial adherence to the plant cell wall and enzymatic hydrolysis. In: P.B. Cronje (ed) Ruminant Physiology: Digestion Metabolism, Growth and Reproduction. CABI Publishing, Walling ford, UK. pp: 79-97.

Gaafar HMA, EM Abdel Raouf and KFA El Reidy, 2010. Effect of Fibrolytic Enzyme Supplementation and

Fiber Content of Total Mixed Ration on Productive Performance of Lactating Buffaloes. Slovak J Anim Sci, 43: 147-153.

Ganai AM, T Sharma, RK Dhuria, 2011. Influence of exogenous fibrolytic enzymes on in vitro fermentation of bajra straw in goats. Vet Prac, 12: 138-141.

Gomez-Vazquez A, GD Mendoza, E Aranda, J Perez, A Hernadez, JM Pinos-Rodriguez, 2011. Influence of fibrolytic enzymes on growth performance and digestion in steers grazing stargrass and supplemented with fermented sugarcane. J Appl Anim Res, 39: 77-79.

He ZX, ND Walker, TA McAllister, WZ Yang, 2015. Effect of wheat dried distillers grains with solubles and fibrolytic enzymes on ruminal fermentation digestibility, growth performance, and feeding behavior of beef cattle. J Anim Sci, 93: 1218-1228.

Hristov AN, LM Rode, KA Beauchemin and Wuerfel, 1996. Effect of commercial enzyme preparation on barley silage *in vitro* and *in sacco* dry matter degradability. J Anim Sci, 74: 273.

Husdan H, 1968. Chemical determination of creatinine with depproteinization. Clin Chem, 14: 222.

Javid A, M Nisha, M Sarwar and M Asif, 2008. Ruminal characteristics, blood pH, blood urea nitrogen and nitrogen balance in Nili-ravi buffalo bulls fed diets containing various levels of ruminally degradable protein. Asian Austr J Anim Sci, 21: 51.

Kaneko JJ, JW Harvey and ML Bruss, 1997. Clinical Biochemistry of Domestic Animals, 5th edn. Academic Press, San Diego, California, USA.

Kholif AE, MM Abdoa, UY Aneleb, MM El-Sayed and TA Morsy, 2017. Saccharomyces cerevisiae does not work synergistically with exogenous enzymes to enhance feed utilization, ruminal fermentation and lactational performance of Nubian goats. Livestock Sci, 206: 17-23.

Kholif AM and HA Aziz, 2014. Influence of feeding cellulytic enzymes on performance, digestibility and ruminal fermentation in goats. Anim Nutr Feed Technol, 14: 121-136.

Krause DO, ST Denman, RI Mackie, M Morrison, AL Rae, GT Attwood and CS McSweeney, 2003. Opportunities to improve fiber degradation in the rumen: Microbiology, ecology, and genomics. FEMS Microbiol Rev, 27: 663- 693.

Kumar N, UB Singh and DN Verma, 1980. Effect of different levels of dietry protein and energy on growth of male buffalo calves. Ind J Anim Sci, 15: 513-517.

Morsy TA, AE Kholif, SM Kholif, AM Kholif, X Sun, and AZM Salem, 2016. Effects of two enzyme feed additives on digestion and milk production in lactating Egyptian buffaloes. Annal Anim Sci, 16: 209-222.

Nsereko VL, KA Beauchemin, DP Morgavi, LM Rode, AF Furtado, TA McAllister, AD Iwassa, WZ Yang and Y Wang, 2002. Effect of fibrolytic enzyme preparation from *Trichoderma Longibrachiatum* on the rumen microbial population of dairy cows. Canadian J Microbiol 48: 14-20.

NRC (National Research Council) 2001. Nutrient Requirements of Cattle. National Academy Press, Washington, DC, USA.114 Pp.

Patel BC, RS Oza, VR Desai and RS Gupta, 2015. Effect of Fibrolytic Enzyme on nutrient utilization and rumen fermentation pattern in sheep. J Anim Res, 5: 807-811.

Peters A, U Meyer and S Danicke, 2015. Effect of exogenous fibrolytic enzymes on performance and blood profile in early and mid-lactation Holstein cows. Anim Nutr, 1: 229- 238.

Pinos-Rodriguez JM, R Moreno, SS Gonzalez, PH Robinson, G Mendoza and G Alvarez, 2008. Effects of exogenous fibrolytic enzymes on ruminal fermentation and digestibility of total mixed rations fed to lambs. Anim Feed Sci Technol, 142: 210-219.

Rajamma K, D Srinivas Kumar, E Raghava Rao and DN Nath, 2014. Effect of fibrolytic enzymes supplementation on rumen fermentation of buffalo bulls fed total mixed rations. Int J Agric Sci Vet Med, 2: 106-113.

Raju J, PR Reddy, AN Reddy, A Ramadevi and PP Reddy, 2016. Recent trends in supplementation of Exogenous Fibrolytic Enzymes in ruminant nutrition A Review. Indian J Nat Sci, 7: 1170-11708.

Reitman S and S Frankel, 1957. Calorimetric method for the determination of serum glutamic- oxaloacetic and glutamic- pyruvate transeaminase. An J Clin Path, 28: 56.

Rojo R, AE Kholif, AZM Salem, MMY Elghandour, NE Odongo, RM De Oca, N Rivero and MU Alonso, 2015. Influence of cellulase addition to dairy goat diets on digestion and fermentation, milk production and fatty acid content. J Agric Sci, 153: 1514-1523.

Rivero N, AZM Salem, 2015. Biochemical parameters in sheep fed diet in presence of mixed Salix babylonica extract and exogenous enzyme as feed additives. Indian J Anim Sci, 85: 189-194.

SAS, 2001. Statistical Analysis System guide: Version 8.2th. Institute Inc. Cary. Nc. USA.

Satapathy D, T Dutta, and A Chatterjee, 2018. Application and Limitations of Exogenous Fibrolytic Enzymes in Animal Nutrition. Int J Livestock Res, 8: 21-34.

Salem AZM, AA Hassan, MS Khalil, HM Gado, H Alsersy and J Simbaya, 2012. Effects of Sun Drying and Exogenous Enzymes on Nutrients Intake, Digestibility and Nitrogen Utilization in Sheep Fed Atriplex Halimus Foliages. Anim Feed Sci Technol, 171: 128-135.

Salem AZ, H Alsersy, LM Camacho, MM El-Adawy, MMY Elghandour, AE Kholif, NRivero, MU Alonso, and A Zaragoza, 2015. Feed intake, nutrient digestibility, nitrogen utilization, and ruminal fermentation activities in sheep fed Atriplex halimus ensiledwith three developed enzyme cocktails. 60: 185–194.

Schneider BH and PW Flatt, 1975. The evaluation of Feeds Through Digestibility Experiments The University of Georgia Press Athens, 30602.

Shekhar C, ST Sudarshan, SK Shelke, 2010. Effect of exogenous fibrolytic enzymes supplementation on milk production and nutrient utilization in Murrah buffaloes. Trop Anim Health prod, 42: 1465-1470.

Singh KK and MM Das, 2009. Effect of fibrolytic enzyme treated wheat straw on rumen fermentation and nutrient utilization in calves. Indian Vet J, 86: 380-382.

Soliman SM, AM El-Shinnawy and AM El-Morsy, 2016. Effect of Probiotic or Prebiotic Supplementation on the Productive Performance of Barki Lambs. J Anim Poult Prod, Mansoura Univ, 7: 369- 376.

Song SD, GJ Chen, CH Guo, KQ Rao, YH Gao, ZL Peng, ZF Zhang, X Bai, Y Wang, BX Wang, ZH Chen, XS Fu, WL Zhu, 2018. Effects of exogenous fibrolytic enzyme supplementation to diets with different NFC/NDF ratios on the growth performance, nutrient digestibility and ruminal fermentation in Chinese domesticated black goats. 236: 170-177.

Sudipta Ghosh and Ram Kumar Mehla, 2012. Influence of dietary supplementation of prebiotics (mannanoligosaccharide) on the performance of crossbred calves. Trop Anim Health Pro, 44: 617–622.

Sutton JD, RH Fipps, DE Beever, GF Humphrics, JI Vicini, DL Hard, 2003. Effect of method of application of a fibrolytic enzyme product on digestive process and milk production in Holstein Friesian cows. J Dairy Sci, 86: 546-556.

Thakur SS, MP Verma, B Ali, SK Shelke and SK Tomar, 2010. Effect of exogenous fibrolytic enzymes supplementation on growth and nutrient utilization in Murrah buffalo calves. Indian J Anim Sci, 80: 1217-1219.

Togtokhbayar N, MA Cerrillo, GB Rodríguez, MMY Elghandour, AZM Salem, C Urankhaich, S Jigjidpurev, NE Odongo and AE Kholif, 2015. Effect of exogenous xylanase on rumen in vitro gas production and degradability of wheat straw. Anim Sci J, 86: 765–71.

Turkar S and SK Uppal, 2007. Blood Biochemical and Ruminal liquor profile in Buffaloes (*Bubalus bubalis*) Showing omasal impaction. Vet Res Communication, 31: 967-975.

Valdes KI, AZM Salem, S Lopez, MU Alonso, N Rivero, MMY Elghandour, IADomínguez, MG Ronquillo and AE Kholif, 2015. Influence of exogenous enzymes in presence of Salix babylonica extract on digestibility, microbial protein synthesis and performance of lambs fed maize silage. J Agric Sci 153: 732-742.

Warner ACI, 1964. Production of volatile fatty acids in the rumen: methods of measurements. Nutr Abst Rev, 34: 339.

Wisemed Inc. 2017. http://www.wisegroupusa.com, Indianapolis, In USA 46260.

Yuangklang C, K Vasupen, S Bureenok, S Wongsuthavas, AC Beynen and V Vorlaphim, 2013. Effect of roughage sources and fibrolytic enzyme supplementation on nutrient digestion and rumen fermentation in buffaloes. Buffalo Bull, 32: 993-997.