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CHEMICAL COMPOSITION AND DIGESTION KINETICS OF UREA-MOLASSES TREATED WHEAT STRAW ENSILED WITH FIBROLYTIC ENZYME IN RUMINALLY CANNULATED BUFFALO BULLS

A. U. Rehman[1], M. U. Nisa[2]; A. Shazad[2]; M. Sarwar[2]; O. A Khan[2] and M. Sharif[2]

[1]Department of Animal Science, University College of Agriculture, University of Sargodha [2]Institute of Animal Nutrition and Feed Technology, University of Agriculture Faisalabad, Faisalabad, Punjab, Pakistan
Corresponding author email: linknisa@gmail.com

ABSTRACT

Experiment was conducted to evaluate the effect of increasing fibrolytic enzyme level on nutrient composition and digestion kinetics of urea treated wheat straw (WS). Wheat straw was treated with 4% urea and 6% molasses and was ensiled with 0 (E0), 1 (E1), 2 (E2) and 3 (E3) g of enzyme /Kg of dry matter (DM). Enzyme mixture was dissolved in water and sprayed on WS. Then after an hour of enzyme treatment, molasses and urea were dissolved in water and sprayed on enzyme-treated WS. Wheat straw was ensiled in 36 laboratory silos under Completely Randomized Design for twenty one days. Application of enzymes on ensiled WS did not affect (P>0.05) DM, crude protein, true protein, neutral detergent fiber (NDF) and acid detergent fiber (ADF) contents. Enzyme treatment did not affect (P>0.05) the pH of the ensiled WS. Digestion kinetics of DM, NDF and ADF also remained unaltered (P>0.05) across all the treatments. On the basis of results it is concluded that enzyme did not affect the nutrient profile of WS because of alkaline pH due to rapid production of ammonia in the silo.

Key words: fibrolytic enzyme, digestion kinetics, wheat straw

INTRODUCTION

Wheat straw is abundantly available by-product. However, its low protein, high fiber contents and low digestibility limit its use in ruminant nutrition (Abo-Eid *et al.*, 2007). Nutritive value of WS can be improved by adding different chemicals and feed additives. Fibrolytic enzymes as feed additive at the time of forge ensilation results in conversion of fiber contents of the forage into fermentable sugars by using microbes to produce lactic acid (McDonald *et al.*, 1991). Fibrolytic enzymes used in animal feeds are the products of batch fermentation of bacterial and fungal origin (Pendleton, 2000 and Cowan, 1994). Ensilation of urea-treated WS with fiber degrading enzymes may result in improved ammonia fixation and reduced fiber contents of the ensiled WS. Keeping in view, the study was planned to examine the nutrient composition and digestion kinetics of urea-treated WS ensiled with varying level of fibrolytic enzymes.

MATERIALS AND METHODS

Wheat straw was ground through a Wiley mill (2 mm screen) for chemical analyses. Commercial cellulase+hemicellulase mixture of enzymes (Allzyme®, an *Aspergillus nigar* product by Alltech) was used as an inoculant to ensiled WS. Wheat straw was treated with 4% urea and 6% molasses and was ensiled with 0 (E0), 1 (E1), 2 (E2) and 3 (E3) g of enzyme /Kg of dry matter (DM). Enzyme mixture was dissolved in water for spraying on WS. Then molasses and urea was dissolved in water and sprayed on enzyme-treated WS. Amount of water used was sufficient to attain 50% moisture in WS. The treated WS was ensiled in 36 (3 for each enzyme level) laboratory silos. These silos were pressed and sealed to achieve the anaerobic conditions for 21 days at room temperature. After 21 days the sample from each silo were collected and analyzed to determine pH and OM, DM, TP, CP, NDF and ADF contents.

For digestion kinetics, four ruminally cannulated buffalo bulls (400±20 Kg) were used in 4×4 Latin square design to evaluate the fibrolytic enzyme treated ensiled WS. Nylon bags measuring 10×23 cm with an average pore size of 50 µm were used and incubated in the rumen for 0, 1, 2, 4, 6, 10, 16, 24, 36, 48 and 96 h, in reverse order and removed all at the same time (Sarwar *et al*., 2004). The bags were washed and dried in a forced air oven at 55°C. The lag time was calculated according to method described by Mertens and Loften (1980) by using formula. *Lag time = ln (100) – Intercept / Rate of digestion.* The dry matter, OM, CP NDF and ADF were determined by AOAC 1990 .The collected data was subjected to analysis of variance technique using multivariate analysis in General Linear Model option of SPSS 17.0 (SPSS Inc., Chicago, IL, USA). In case of significance (P<0.05) Duncan's New Multiple Range Test was applied to separate the means.

RESULTS AND DISCUSSION

Nutrient composition: Dry matter, CP, TP, NDF and ADF were not influenced (P>0.05) by varying enzyme levels on urea treated ensiled WS (Table.4.1). Adolga-Bessa *et al*. (1999) also reported similar findings for urea-treated whole crop wheat ensiled with enzyme mixture. Enzymes have more effect on immature plants as compared to mature plants (Van Vuuren *et al*., 1989). Unaltered nutrient contents of urea treated WS ensiled with fibrolytic enzyme might be due to mature crystalline fiber. Another plausible reason might be the rapid production of ammonia due to urea treated WS (Sarwar *et al*., 2004) which reflected in alkaline pH of silos that might have restrained the enzyme activity (Vicini *et al*., 2003) for the conversion of fiber into reducing sugars by lactic acid microbes (Kozelov *et al.*, 2008). As enzyme used in present study was of fungal origin and most the fungal enzymes work optimally at pH from 4-6 (Muzakhar *et al*., 1998). Similarly, increasing enzyme level did not affect (P>0.05) overall pH of ensiled WS (Chart.4.2). During 21 days of ensilation, pH of all silos remained alkaline due to rapid production of ammonia resulted in lower enzymes activity which ultimately reduced conversion of fiber into reducing sugars (Kung *et al.*, 2003) and causes unaltered pH.

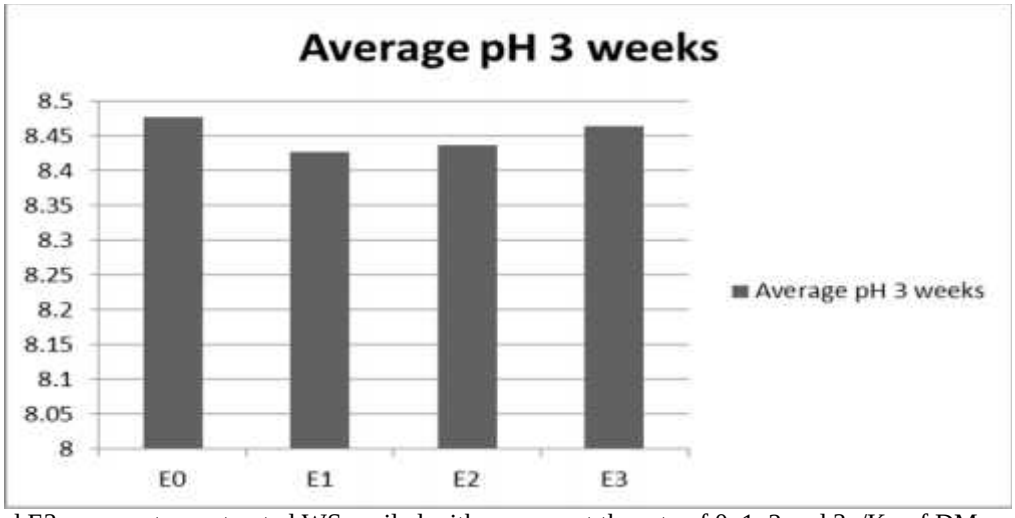
Digestion kinetics: Increasing enzyme level did not influence (P>0.05) digestion kinetics of DM, CP, NDF and ADF (Table 4.3;).Unaltered nutrients digestibility, rate and extent of digestion are not supported by the findings of Hussain (2009) who reported higher *in-situ* digestibility, extent and rate of digestion and lower lag time for DM and NDF of Berseem fodder+ WS diet treated with exogenous enzyme mixture. Application of exogenous fibrolytic enzymes convert the fiber into reducing sugars which help the microbes to get attached to their substrate through chemotaxis (Newbold, 1997) resulting in higher digestibility. But the production of reducing sugars is dependent upon fiber composition of the forage. Nadeau *et al*. (2000) reported lower production of reducing sugars for forage with higher lignin contents in response to enzyme treatment. Thus no effect of enzyme application on digestion kinetics of WS might be related to inability of enzymes to hydrolyze the complex structure of the WS fiber.

Table.4.1.Nutrient composition of ensiled wheat straw after 21 days of ensilation

Items (g/ Kg)	Treatments[1]				SE
	E0	E1	E2	E3	
Dry matter	498.3	495.7	498	497.3	3.6
Organic matter	890.6	894.6	891.7	889.6	3.7
Crude protein	90.4	89	90.4	90.4	0.7
True protein	45.2	45.6	46.7	47.4	0.9
Neutral detergent fiber	755.7	755	751.3	748.3	2.4
Acid detergent fiber	488.3	493	493.7	487.3	2.4

[1]E0, E1, E2 and E3 represent urea-treated wheat straw ensiled with enzyme at the rate of 0, 1, 2 and 3g/Kg of dry matter, respectively. SE= Standard error.

Chart. 4.2 Overall pH of ensiled wheat straw with increasing enzyme levels



E0, E1, E2 and E3 represent urea-treated WS ensiled with enzyme at the rate of 0, 1, 2 and 3g/Kg of DM, respectively.

Table.4.3 Effect of increasing level of enzyme application on DM, CP, NDF and ADF digestion kinetics of ensiled WS in cannulated bulls.

Items	Treatments[1]				SE
	E0	E1	E2	E3	
DM					
Digestibility[2] (%)	52.1	52.3	51.5	51.8	0.41
Extent of digestion[2] (%)	62.7	61.9	61.6	62.5	0.56
Lag time (h)	3.16	3.17	3.16	3.15	0.01
Digestion rate (%/h)	4.7	4.74	4.72	4.75	<0.001
CP					
Digestibility[2] (%)	56.1	55	55.5	56.4	0.41
Extent of digestion[2] (%)	64	64.5	64.9	65	0.29
Lag time (h)	0.76	0.77	0.76	0.77	0.009
Digestion rate (%/h)	4.67	4.65	4.63	4.67	<0.001
NDF					
Digestibility[2] (%)	48.5	48.1	48.2	49.1	0.31
Extent of digestion[2] (%)	59.2	59.1	60.1	59.6	0.34
Lag time (h)	3.24	3.24	3.25	3.27	0.02
Digestion rate (%/h)	4.56	4.62	4.59	4.61	<0.001
ADF					
Digestibility[2] (%)	43.6	42.8	43.4	43.8	0.55
Extent of digestion[2] (%)	53.2	53	52.7	53.2	0.46
Lag time (h)	3.77	3.74	3.76	3.76	0.01
Digestion rate (%/h)	4.62	4.67	4.7	4.67	<0.001

[1]E0, E1, E2 and E3 represent urea-treated WS ensiled with enzyme at the rate of 0, 1, 2 and 3g/Kg of DM, respectively. [2]Digestibility and extent of digestion were determined after 48 and 96 hours of ruminal incubation, respectively.SE= Standard error.

Conclusions: Enzyme treatment at the time of ensilation of urea-treated WS has no effect on its chemical composition and digestion kinetics.

REFERENCES

Abo-Eid, H.A., M.A. El-Ashry, M.M. Khorshed and M.F. El-Sayes (2007). Effect of biological treatment of some crop residues on their nutritive value: 1- Effect of biological treatment on recovery rate, chemical composition and in situ disappearance. Egyp. J. Nut. Feeds. 10(2): 493-508.

Adogla-Bessa, T., E. Owen and A.T. Adesogan (1999). Ensiling whole crop wheat with Cellulase+hemicellulase based enzymes: 3. Comparing effects of urea or enzyme treatment on forage composition and stability. Anim. Feed Sci. Tech. 82: 51-61.

AOAC. (1990). Association of Official Analytical Chemists International. Official Methods of Analysis, 15th Ed. Arlington, VA, USA.

Cowan, W.D. (1994). Factors affecting the manufacture, distribution, application and overall quality of enzymes in poultry feeds. In Joint Proc. 2nd Int. Round table on Anim.

Hussain, A. (2009). Impact of exogenous fibrolytic enzymes on digestibility and digestion kinetics of berseem plus wheat straw in *Nili-Ravi* buffalo bulls. M.Sc. Thesis, University of Agriculture Faisalabad, Pakistan.

Kung, Jr L., M.R. Stokes and C.J. Lin (2003). Silage additives, in Silage Science and Technology, ed. by Buxton DR, Muck RE and Harrison JH. American Society of Agronomy, Madison, WI. Pp. 305-360.

McDonald, P., A.R. Henderson and S.J.E. Heron (1991). The Biochemistry of Silage. Chalcombe Publications, London, UK. pp. 340.

Mertens, D.R. and J.R. Loften (1980). The effect of starch on forage fiber digestion kinetics *in vitro*. J. Dairy Sci. 63:1437-1446.

Muzakhar, K., H. Hayashii, T. Kawaguchi, J. Sumitani and M. Arai (1998). Purification and properties of α-L-arabinofuranosidase and endo-β-D-1,4-galactanase from Aspergillus niger KF-267 which liquefied the Okara. MIE Bioforum, Genetics, Biochemistry and Ecology of Cellulose Degradation. Suzuka, Japan. pp. 133.

Nadeau, E.M.G., D.R. Buxton, J.R. Russell, M.J. Allison and J.W. Young (2000). Enzyme, bacterial inoculant, and formic acid effects on silage composition of orchard grass and Alfalfa. J. Dairy Sci. 83:1487-1502.

Newbold, J. (1997). Proposed mechanisms for enzymes as modifiers of ruminal fermentation. In Proc. 8th Annual Florida Ruminant Nutrition Symposium, Gainesville, Florida. Pp. 146-159.

Pendleton, B. (2000). The regulatory environment. In Direct-Fed Microbial, Enzyme and Forage Additive Compendium. S. Muirhea, ed. The Miller Publishing Co., Minnetonka, MN. pp 49.

Sarwar, M., M.A. Khan and M. Nisa (2004). Effect of organic acids or fermentable carbohydrates on digestibility and nitrogen utilization of urea treated wheat straw in buffalo bulls. Aust. J. Agric. Res. 55:235-240.

Van Vuuren, A.M., K. Bergsma, F. Frol-Kramer and J.A.C. Van Beers (1989). Effects of addition of cell wall degrading enzymes on the chemical composition and the *in sacco* degradation of grass silage. Grass Forage Sci. 44 (2): 223-230.

Vicini, J.L., H.G. Bateman, M.K. Bhat, J.H. Clark, R.A. Erdman, R.H. Phipps, M.E. Van Amburgh, G.F. Hartnell, R.L. Hintz and D.L. Hard. (2003). Effect of feeding supplemental fibrolytic enzymes or soluble sugars with malic acid on milk production. J. Dairy Sci. 86:576-585.