Indian Journal of Animal Sciences **88** (7): 857–859, July 2018/Short communication

Fibrolytic enzyme supplementation improves lactation performance of Awassi ewes fed a high forage diet

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Received: 17 October 2017; Accepted: 31 December 2017

Key words: Awassi ewes, Fibrolytic enzyme, Lactation performance, Nutrient digestibility, Nutrient intake

Exogenous enzymes (EE) have been extensively used as feed additives in livestock to improve feed efficiency due to beneficial effects on ruminal fermentation. EE have been shown to improve nutrient digestibility, N balance and growth rate in lambs (Titi and Tabbaa 2004), and feed intake and milk production in dairy cows (Gado *et al.* 2009). However, other researchers reported no effects of adding fibrolytic enzymes to diets of dairy cows (Ortiz-Rodea *et al.* 2013). The controversial results among different studies could be related to the differences in diets (high roughage vs. high concentrate), forage source, type of enzyme, dose level, and/ or level of production. Objective of the present study was to evaluate the effect of fibrolytic enzyme supplementation on performance of lactating Awassi ewes.

All experimental procedures were approved by Jordan University of Science and Technology Institutional Animal Care and Use Committee. Twenty four ewes [62.5±2.51 kg initial body weight (BW) and 4±1 year old] were randomly assigned to two groups of 12 ewes; a control diet group (CON) and a diet supplemented with fibrolytic enzymes at a rate 0.3% of dietary dry matter (DM) diet (ENZ; Table 1). Following weaning (60 days postpartum), all ewes were housed in individual feeding pens (1.5 m × 0.75 m) and offered the corresponding diet as an *ad lib.* totally mixed ration for 1 week adaptation period. Thereafter, corresponding diets and water was continued to be offered *ad lib*. over a 7-week period during which ewes were weighed biweekly. Weights were recorded before the morning feeding. Refusals were collected daily at 0800 h, weighed and sampled for chemical analysis; and replaced by a fresh supply of the diet. The daily amount offered was increased throughout the experiment so that there was 10–15% of refusal present on the next day. Diets were formulated according to NRC (2007) requirements for lactating ewes to be isonitrogenous [crude protein (CP) = 14.5%]. At the end of the study, 6 randomly-chosen ewes (3 ewes from each group) were housed individually in digestibility crates (1.05 m × 0.80 m) to evaluate the nutrient digestibility as described in Obeidat (2017). During the second week of the experiment, and weekly thereafter, ewes were hand-milked to evaluate milk yield and composition as described by Obeidat *et al.* (2014). Data were analyzed using the Proc Mixed procedure of SAS (2000). Model included treatment, week, and their interaction as fixed effects and animal within treatment was incorporated in the model as a random effect as described by Obeidat *et al.* (2014).

Intake of DM and CP was similar between the two diets (Table 2). On the other hand, NDF and ADF intakes were greater in ENZ than in CON ewes. The experiment was designed with more NDF and ADF content in the ENZ group compared to the CON group. It would have been expected, then, that DM intake in ENZ group would be lower than that of the CON group. Contrary to this, the increment in fibre content did not decrease DM intake in the ENZ group. Because DM intake was similar between the two groups, it can be speculated that EE has a positive effect on intake as the level of the fibre did not limit intake

Table 1. Ingredients and chemical composition of experimental diets

	Diets[1]	
	CON	ENZ
Ingredients (%)		
Barley	41.0	18.0
Soybean meal	15.0	17.0
Wheat bran	12.0	13.0
Wheat straw	30.0	50.0
Salt	1.0	0.8
Limestone	0.9	0.8
Mineral vitamin premix	0.1	0.1
Fibrolytic enzyme[2]	0.0	0.3
Chemical composition (%)		
DM	91.0	92.0
CP	14.6	14.2
NDF	39.1	48.9
ADF	22.9	32.2

[1]Diets were a control diet (CON) or a diet supplemented with fibrolytic enzyme (ENZ). [2]Enzyme composed of cellulase, xylanase, β-glucanase and amylase.

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in the ENZ group. A plausible explanation for the observed improvement in fibre intake in ewes receiving EE in the current study is that the EE increased the availability of fibre particles for digestion and, as a result, increased particle passage rate and lowered retention time in the rumen. Salem *et al.* (2012) found that adding 10 g/head/d of EE mixture (ZADO) increased nutrient intake in sheep fed *Atriplex halimus* foliages. Furthermore, when these enzyme mixtures were given to dairy cows at 40 g/head/d, feed intake was improved by 11.5% (Gado *et al.* 2009).

Initial and final BW was similar between the two groups; whereas ENZ ewes tended to lose more weight than CON ewes (Table 2). Similar results were reported earlier by Kung *et al.* (2002) who found that body weight, average daily gain and feed efficiency were not affected by enzyme treatment over a 12-week period, as their DM intake was unaffected. However, the tendency of losing more weight in the ENZ group could be due to the fact that this group produced more milk compared to the control. This reduction in the weight was not significant and did not impact BW.

Digestibilities of DM, CP, NDF and ADF were greater (P≤0.05) in ENZ ewes compared to the CON ewes (Table 2). Improving nutrient digestibility would be expected to enhance productivity and provide adequate energy and protein supply. In the current study, digestibilities of DM, CP, NDF and ADF improved in ewes supplemented with fibrolytic enzyme compared to the CON ewes. Similar results were reported earlier in dairy cows (Rode *et al.* 1999).

The improvement in nutrient digestibility with ENZ diets may be attributed to reduction in particle size and increase in ruminal fermentation (Gado *et al.* 2009). Stimulation of microorganisms' activity in the rumen may be improved by reducing ammonia nitrogen concentration in ruminal fluid through combining microbial protein with ammonia nitrogen (Gado *et al.* 2006). The increased NDF digestibility may be due to the ability of supplemented enzymes to degrade lignocellulotic bonds in the fibre part (Bassuny *et al.* 2003), which can reduce rumen fill over time, and subsequently increased voluntary feed intake.

Milk production was greater (P<0.05) for the ewes supplemented with enzyme compared to the control group (Table 3). Milk SNF and fat contents were greater (P≤0.05) in the ENZ than CON group. However, milk protein content did not differ (P=0.15) between the two groups. Solid–not-fat yield tended to be greater (P=0.08) for the ENZ group than the CON group. Fat yield was greater (P=0.004) in ENZ ewes compared to CON ewes, while the yield of protein was not affected by enzyme supplementation. In agreement with our study, Zheng *et al.* (2000) reported significant increase in milk production in dairy cows fed on ENZ-supplied diets. Authors explained their results by the increase in available nutrients for milk production among ewes fed enzyme-supplemented diets. On the other hand, Sutton *et al.* (2003) reported that using ENZ in feeding dairy cattle produced no significant increases in milk yield. Lewis *et al.* (1999) found that yield of milk protein and fat was greater in cows receiving enzyme treated diets, due to the increased milk production without affecting milk composition. The increased milk fat and SNF yields in ewes fed ENZ may be due to an increase in feed digestibility, and subsequently an increase in availability of energy for milk fat and SNF production. One another plausible explanation for the increase fat content could be related to the greater fibre content in the enzyme group compared to the control group, which associated with increasing fatty acids resulting in higher milk fat content. As volatile fatty acids are considered the main energy precursor in ruminants, supplying up to 80% of the daily requirements, the improvement in nutrient digestibility, and subsequently improved utilization of nutrients, induces better energy allocation, and as a result, better performance. Therefore, the improve in the utilization of nutrients could suggest a better efficiency of diets, which in turn enhance the quality of the produced milk as noted in the current study.

Table 2. Nutrient intake (g/d), body weight changes (kg) and digestibility (%) of lactating Awassi ewes fed diets containing fibrolytic enzyme

	Diets[1]		SEM	P-value
	CON	ENZ		
Intake				
DM	1110	1089	34.9	0.68
CP	182	172	3.7	0.10
NDF	384	511	14.85	< 0.0001
ADF	271	364	7.1	< 0.0001
Body weight				
Initial BW	61.8	63.2	2.54	0.70
Final BW	60.3	60.5	2.48	0.94
BW change	–1.50	–2.67	0.467	0.09
Digestibility				
DM	74.2	81.4	1.90	< 0.05
CP	84.8	88.9	1.28	= 0.05
NDF	57.8	74.8	3.58	< 0.05
ADF	72.3	83.9	2.05	< 0.05

[1]Diets were a control diet (CON) or a diet supplemented with fibrolytic enzyme (ENZ).

Table 3. Milk production and composition of lactating Awassi ewes fed diets containing fibrolytic enzyme.

	Diets[1]		SEM	P value
	CON	ENZ		
Milk production (g/d)	1115	1293	61.5	0.05
Milk composition (%)				
SNF	10.77	11.40	0.206	0.04
Fat	6.63	7.75	0.176	0.0002
CP	3.91	3.69	0.104	0.15
Milk yield (g/d)				
SNF	123.6	145.3	8.38	0.08
Fat	76.3	97.9	4.77	0.004
CP	44.8	47.0	3.03	0.62

[1]Diets were a control diet (CON) or a diet supplemented with fibrolytic enzyme (ENZ).

SUMMARY

Objective of the present study was to evaluate the effect fibrolytic enzyme supplementation on performance of nursing Awassi ewes. Twenty four ewes [62.5±2.51 kg initial body weight (BW) and 4±1 year old] were randomly assigned to two groups, a control group (CON) and a group supplemented with fibrolytic enzymes at a rate 0.3% of dietary dry matter (ENZ). Ewes were individually housed and performance was recorded over a 7-week period. Intake of neutral and acid detergent fibre was greater in ENZ compared to CON ewes. Final BW tended to be lower for the ENZ than the CON group. Nutrients digestibilities were higher for the ENZ compared to the CON. Milk production was greater for the ENZ than the CON. Milk fat and solid–not-fat contents were greater for the ENZ compared to the CON. In summary, lactation performance improved in ewes supplemented with fibrolytic enzymes and was profitable of lactating ewes. The use of fibrolytic enzymes in lactating diets containing considerable levels of fibre is a beneficial practice and may improve the utilization of low quality forage in areas where these forages are abundant.

ACKNOWLEDGEMENTS

The author wish to thank the Deanship of Scientific Research JUST for the financial support of this project (129/2016).

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