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Effects of Live Yeast *Saccharomyces cerevisiae* on Fermentation Parameters and Microbial Populations of Rumen, Total Tract Digestibility of Diet Nutrients and on the *in situ* Degradability of Alfalfa Hay in Iranian Chall Sheep

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Abstract: The effects of live yeast *Saccharomyces cerevisiae* (LYSC, strain *Sc* 47) on rumen fermentation and microbial populations, digestibility of nutrients, degradability of alfalfa hay and on the performances of sheep were investigated in two experiments. In both experiments, animals in treatment groups were received 0, 2.5, 5 and 7.5 g of LYSC per sheep per day and were defined as control, 2.5, 5.0 and 7.5 g LYSC treatment groups, respectively. In the first experiment, four fistulated Chall sheep (49±0.5 kg BW) were kept in individual metabolic crates under a 4×4 Latin square design and fed a Total Mixed Ration (TMR) containing of barely (48%), wheat bran (16%), shelled corn (5%), mineral-vitamin mix (1%) and of alfalfa hay (30%). In the second experiment, 28 sheep (48±0.5 kg BW) were assigned into four treatment groups under a complete randomized design and fed a TMR containing of barely (60%), wheat bran (7%), cottonseed meal (2%), mineral-vitamin mix (1%) and of alfalfa hay (15%) and wheat straw (15%). The highest and the lowest ruminal pH values ($p<0.01$) were recorded for sheep in 2.5 g LYSC and control groups, respectively. At 3 h post-feeding, the total VFA of rumen fluid was increased ($p<0.01$) from 91.26 to 103.34 mmol L^{-1} in control vs. 2.5 g LYSC groups. The ruminal NH3-N of sheep was decreased ($p<0.01$) from 159.63 to 128.90 mg L^{-1} in control vs. 2.5 g LYSC groups. Bacterial populations of rumen fluids were differed from 14 to 43% in treatment groups although the differences were not significant. Compared to the other groups, voluntary feed intake was higher ($p<0.01$) in 5.0 g LYSC group and this was ended to an inappropriate feed to gain ratio in this group. It can be concluded that the use of LYSC at a level of 2.5 g per sheep per day could improve the ruminal fermentation and resulted in a relatively better performances in Chall sheep.

Key words: Chall sheep, live yeast, rumen fermentation, diet digestibility, performance

INTRODUCTION

Direct-fed microbial (DFM) additives which contained useful microorganisms such as bacteria and fungi and their spent growth medium have been introduced to feed industry during the last decades (Wiedmeier *et al*., 1987; Gray and Ryan, 1988; Williams, 1989; Wallace and Newbold, 1992; Fiems *et al*., 1993; Durand-Chaucheyras *et al*., 1998; Yang *et al*., 2004). Among different commercial DFM products, yeast cultures (YC, especially *Saccharomyces cerevisiae* (Sc)), were more commonly used in the diets of cattle, sheep and goats (Mutsvangwa *et al*., 1992; Angeles *et al*., 1998; Doreau and Jouany, 1998; Arcos-Garcia *et al*., 2000; Abd El-Ghani, 2004; Haddad and Goussous, 2005). According to the definition of Auclair (2000), yeasts are eukaryotic microorganisms and their properties are completely different from those of bacteria which are prokaryotic microorganisms.

Inconsistent results were reported with the use of YC as feed additives in ruminants (Fiems *et al*., 1993; Chiquette, 1995; El-Hassan *et al*., 1996; Durand-Chaucheyras *et al*., 1998). The yeast strains (Newbold *et al*., 1995), their different commercial products (Wallace and Newbold, 1992) and the dosages used in ruminant diets (Corona *et al*., 1999; Haddad and Goussous, 2005) were reported to influence the performance of animals. Inclusion of different strains of *Sc* and bacteria in ruminant rations has been shown to alter the molar proportions of rumen volatile fatty acids (Beharka *et al*., 1991; Yang *et al*., 2004) and to increase the nutrient digestibility of nutrients (Wiedmeier *et al*., 1987). The number of rumen bacteria (Chiquette, 1995) and the amount of ruminal ammonia nitrogen in dairy and beef cattle (Chiquette, 1995; Wallace and Newbold, 1992) were also reported to be increased due to yeast supplementation in diets. In contrast, Cole *et al*. (1992) reported that YC supplementation in the ration of stressed

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feeder calves had no significant effect on their performances. Moreover, Arcos-Garcia *et al.* (2000) reported that the digestibility of nutrients or the ruminal fermentation parameters were not affected by YC supplementation in sheep diets.

Although reasonable research works has been conducted worldwide reporting the effects of YC utilization on the rumen fermentation parameters and the performance of ruminants; but, little information has been published showing the effects of YC addition in diets on the performance of farm animals in Iran (Rezaeian, 2004). It is while; various YC was introduced to Iranian farmers during these years and more researches were needed to be investigated in this regard. Based on these considerations, the present study was conducted to investigate the effects of different levels of live yeast *Saccharomyces cerevisiae* (LYSC) supplementation in diets on the fermentation parameters (pH, total volatile fatty acids (VFA) and ammonia nitrogen (NH3-N) and microbial populations (bacteria and protozoa) of rumen in Chall sheep. The total tract digestibility of ration nutrients, the *in situ* degradability of alfalfa hay and the performances of sheep fed with LYSC supplemented diets were also investigated.

MATERIALS AND METHODS

Experiment 1

Animals and diets: Four rumen fistulated Chall sheep (49±0.5 kg BW) were assigned in a 4×4 Latin square design to investigate the effects of LYSC supplementation in diets on their performances. Animals were housed in individual metabolic pens with free access to water. The same total mixed ration (TMR) was offered to sheep in all treatment groups (Table 1), but LYSC was used at levels of 0, 2.5, 5, or 7.5 g per sheep per day and their relative treatments were defined as control, 2.5, 5.0 and 7.5 g LYSC groups, respectively. The probiotic used in this trial was *Saccharomyces cerevisiae* (Biosaf® strain *Sc* 47) and contained 1×10^{10} colony-forming units (CFU) per gram of product. The amount of LYSC for sheep in each treatment group was top-dressed on their morning meals. For each experimental duration, based on Latin square designs, animals in treatment groups were fed their relative LYSC supplemented TMR *ad libitum* for 10 days adaptation period and then a restricted ration, at a level of 90% of that fed *ad libitum*, was offered twice daily at 8:00 and 16:00 for 14 days in which samples were collected on individual sheep during this latter period as fallows.

Table 1: The ingredients, chemical composition and the energy content of diets used in two experiments[1]

Items	Experiment 1	Experiment 2
Ingredients (DM bases)		
Alfalfa hay (%)	30.00	15.00
Barely grain (%)	48.00	60.00
Wheat bran (%)	16.00	7.00
Wheat straw (%)	-	15.00
Shelled corn (%)	5.00	-
Cottonseed meal (%)	-	2.00
Mineral-vitamin mix (%)[2]	1.00	1.00
Chemical composition (g kg^{-1} DM)		
Crude protein	121	117
Effective rumen degradable protein[3]	83.1	86.8
Digestible undegradable protein[3]	61.0	32.7
Neutral detergent fiber	289	320
Acid detergent fiber	139	163
Calcium	7.0	7.9
Phosphorus	5.3	6.7
Energy content (MJ kg^{-1} DM)[3]		
Metabolisable energy	11.61	9.18
Fermentable metabolisable energy	10.72	10.67

[1] The live yeast *Saccharomyces cerevisae* (LYSC) was top-dressed on the morning feed meals at 8.00 at levels of zero (control), 2.5, 5.0 and 7.5 g per sheep per day, respectively, in treatment groups. [2] Contained of, vitamin A 50000 IU kg^{-1}; vitamin D_3 1000 IU kg^{-1}; vitamin E 100 IU kg^{-1}; Ca 195 g kg^{-1}; P 90 g kg^{-1}; Mg 3 g kg^{-1}; Na 55 g kg^{-1}; Zn 3 g kg^{-1}; Fe 3 g kg^{-1}; Mn 3 g kg^{-1}; Cu 0.28 g kg^{-1}; I 0.1 g kg^{-1} and Se 1 mg kg^{-1} of mix, [3] Calculated based on AFRC (1993)

Rumen fluid samples: Rumen fluid samples were collected at 0 h and at 3 and 6 h after morning feedings. The pH of the samples was measured immediately after the sampling times and then a 50 mL of rumen fluid from each animal was strained through four layers of cheesecloth. A 2.5 mL of $HgCl_2$ (20 g L^{-1}) was added to each of ruminal fluid samples and then stored at -20°C for further analysis. The total VFA and the NH3-N of the samples were assayed using the methods of Kroman (1967) and Conway *et al.* (1962), respectively.

Ruminal fluid samples from sheep in treatment groups were also used to count microbial populations mixing 5 mL ruminal fluid with 5 mL of 10% formaldehyde (V/V) in a 0.9% salt solution. The samples were stored at 10°C for estimating the protozoal populations using a hemocytometer (Dehority, 1984). The total bacterial numbers of rumen fluid samples were also enumerated by the Most Probable Number (MPN) procedure described by Dehority *et al.* (1989).

Alfalfa nutrients degradability: The *in situ* disappearance of Dry Matter (DM), Crude Protein (CP), Neutral Detergent Fiber (NDF) and Acid Detergent Fiber (ADF) of alfalfa hay were measured by incubation of 5 g ground (through a 1mm screen) alfalfa samples in polyester bags. Duplicate bags were incubated for 8, 16, 24, 48, 72 and 96 h. After removal from the rumen, bags were rinsed for approximately 2 min in cold water until no colour was appeared in the rinse water and then machine-

Table 2: The effects of live yeast *Saccharomyces cerevisae* (LYSC) on the pH, total VFA, NH_3-N and the microbial populations of ruminal fluid in Chall sheep[1]

Items	Sampling times (h)	Treatment groups[2] Control	2.5 g LYSC	5.0 g LYSC	7.5 g LYSC	SEM[3]
Ruminal pH	0	6.57^{c}	6.87^{a}	6.93^{a}	6.70^{b}	0.035
	3	5.88^{c}	6.25^{a}	6.23^{a}	6.09^{b}	0.033
	6	6.12^{c}	6.45^{a}	6.35^{b}	6.27^{b}	0.024
Ruminal total VFA (mmol L^{-1})	0	72.41^{b}	78.66^{a}	75.74^{ab}	74.62^{ab}	1.293
	3	91.26^{b}	103.34^{a}	95.30^{b}	92.34^{b}	1.612
	6	83.65^{b}	92.90^{a}	85.70^{b}	85.43^{b}	1.074
Ruminal NH_3-N (mg L^{-1})	0	93.15^{ab}	78.62^{c}	83.79^{bc}	87.41^{ab}	1.701
	3	159.63^{a}	128.90^{d}	137.69^{c}	147.75^{b}	2.263
	6	109.75^{a}	87.15^{c}	98.11^{b}	100.00^{b}	2.422
Microbial populations						
Total bacteria (organisms $\times 10^{10}$ mL^{-1})		2.57	3.70	3.62	2.80	0.490
Total protozoa (organisms $\times 10^{5}$ mL^{-1})		5.63	6.10	6.44	5.80	0.521

[1]The LYSC was top-dressed on the morning feed meals at 8.00 at levels of zero (control), 2.5, 5.0 and 7.5 g per sheep per day, respectively. [2]Means with different superscript letter(s) on the same row differ significantly ($p<0.05$). [3]SEM = Standard error of mean

washed (2×5 min) in cold water (Ørskov *et al*., 1980). The dry matter losses of samples were determined after they were dried at 60°C. The CP content of dried samples was determined by macro-Kjeldahl technique (AOAC, 1990). The NDF and ADF content of samples were also assayed by the procedures described by Van Soest (1994). Data from *in situ* DM, NDF and ADF disappearances of alfalfa hay samples were adjusted using the exponential equation described by Ørskov and McDonald (1979) and their degradability characteristics were also calculated.

Diets total tract digestibility: The total tract digestibility of diet nutrients was also measured by total faeces collections for 7 consecutive days. A representative sample of homogenized and weighed faeces was taken each day and dried at 60°C for 24 h. The nutrient contents (CP, NDF and ADF) of feed and faeces samples were measured using the above mentioned procedures and their digestibility were calculated.

Experiment 2: In this experiment, 28 Chall sheep with an average BW of 48±0.5 kg were used. Sheep were randomly assigned into four treatment groups (7 sheep in each group) so that the initial average BW of them in each group was similar. The ingredients and the chemical composition of TMR used in this experiment are shown in Table 1. Sheep were fed a TMR *ad libitum* for 11 days adaptation and 10 days voluntary feed intake measurement periods. Treatment groups were the same as that described for sheep in experiment 1. The weighed diets for each sheep in different groups were offered in two equal portions at 8:00 and 16:00 daily. The amounts of LYSC for each sheep per day were top-dressed on their related rations once daily immediately after morning feedings. Sheep were weighed at the beginning and end of the experimental period.

Statistical analysis: Data were analyzed using GLM procedure of SAS statistical analyzer software (SAS Institute, 1997). Results were reported based on the mean values for observations in treatment groups with their related Standard Error of Mean (SEM). The significant group differences in observations were compared by Duncan's Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Ruminal pH: At 0 h, the ruminal pH of treatment groups was higher ($p<0.01$) compared to that of control group (Table 2). Afterwards, pH values were dropped at 3 h post-feeding due to the highly fermentable carbohydrate contents of rations consumed by sheep in all groups. However, sheep fed LYSC supplemented diets had higher rumen pH values which was continued until 6 h post-feeding showing that the use of LYSC in sheep rations resulted into reasonably more stable pH values and probably more appropriate ruminal activities in these group of sheep compared to that in control group. In this regard, Mutsvangwa *et al*. (1992) reported that pH was reflected by the rate of fermentation of carbohydrate of diets and the total VFA absorption and buffering conditions of rumen of bulls utilized yeast culture supplemented diets. In addition, Erasmus *et al*. (1992) and Abd El-Ghani (2004) reported that ruminal pH of dairy cows and goats were, respectively, increased by YC utilization. They suggested that this could be due to the lowered lactic acid concentrations through enhancement of activity of lactate fermenting bacteria such as *Selenomonas ruminantium* and *Megasphaera elsdenii* in the rumen of animals fed YC contained diets. In contrast, it was reported that ruminal pH of sheep was dropped when YC was used in corn stover (Angeles *et al*., 1998; Corona *et al*., 1999) or sugar cane tops (Arcos-Garcia *et al*., 2000) contained diets. It is while;

Enjalbert *et al.* (1999) noted that ruminal pH was not affected when YC was supplemented to the corn silage based ration of non-lactating dairy cows.

Ruminal total VFA: At 3 and 6 h post-feedings, total VFA of rumen fluid samples in treatment groups were higher ($p<0.01$) than that in control group (Table 2). This was in agreement with the results of Enjalbert *et al.* (1999), Arcos-Garcia *et al.* (2000), El-Waziry *et al.* (2000) and Abd El-Ghani (2004) who reported much higher rumen VFA for animals fed with YC supplemented rations than that in their counterpart groups. Carro *et al.* (1992) reported that in high grain rations, YC utilization increased ruminal total VFA concentrations, but it was not affected by YC when medium or low grain contained rations were used. In contrast, Angeles *et al.* (1998) and Corona *et al.* (1999) reported that diet YC supplementation had no significant effect on the ruminal total VFA of sheep. The elevation of VFA which was not accompanied by any decrease in pH in this experiment is comparable to the findings of Gray and Ryan (1988). Increased ammonia concentrations which can offset the expected fall in pH have been attributed for these findings. The increased in total VFA observed in this experiment was probably related to the higher rumen microbial activities (Erasmus *et al.*, 1992) due to the use of LYSC in rations since YC provides soluble growth factors such as organic acids, B vitamins and amino acids for ruminal microbes which may stimulate their growth and activities.

Ruminal NH3-N: The concentration of ruminal NH3-N in treatment groups was increased ($p<0.01$) at 3 h post-feeding compared to that at 0 h, but it was decreased ($p<0.01$) steadily until 6 h of feeding (Table 2). In agreement with these findings, Van-Soest (1994) reported that the peak rumen ammonia concentration occurred two to four hours post-feeding. The addition of LYSC in rations decreased ($p<0.01$) the rumen NH3-N from 159 mg L^{-1} for sheep in control group to that of 128 mg L^{-1} for sheep in 2.5 g LYSC group at 3 h post-feeding. In this regard, Enjalbert *et al.* (1999) also reported that supplementation of rations with YC decreased rumen ammonia from 148.5 to 103.1 mg L^{-1} three hours post-feeding. Erasmus *et al.* (1992), El-Waziry *et al.* (2000), Alshaikh *et al.* (2002) and Abd El-Ghani (2004) have also reported that YC usage in diets decreased the ruminal ammonia concentrations. It is while; Williams and Newbold (1990) found that YC usage in rations of dairy cows increased their rumen ammonia concentration. However, the declined concentration of ammonia in the rumen appears to be the result of increased incorporation of ammonia into microbial protein production and might be the direct result of the ruminal stimulated microbial activities.

Rumen microbial populations: Compared to the bacterial populations in the rumens of sheep in control group (Table 2), LYSC usage in rations increased rumen bacterial populations by 14 to 43% in 7.5, 5.0 and 2.5 g LYSC sheep groups, but the differences were not statistically significant. This might be due to the high variations existed between sheep groups for the most probable number procedure used for counting the bacterial populations and also due to the logarithmic conversions for normalization of data (Nagaraja *et al.*, 1997). However, Newbold *et al.* (1998) and El-Hassan *et al.* (1996) reported that YC supplementation significantly increased the number of total bacteria and the cellulolytic bacteria in rumen. In addition, Callaway and Martin (1997) suggested that soluble materials present in yeast cultures are involved in the stimulated growth of bacteria. In the case of rumen protozoa, the results reported in Table 2 are in agreement with the findings of Angeles *et al.* (1998) and Corona *et al.* (1999) who suggested that YC supplementation had no effect on the total number of rumen protozoa in sheep. Although the *Entodiniomorph* and *Holotrich* groups of rumen protozoa populations were not enumerated separately in the present study and it is not clear if one or both groups of protozoa were influenced by the yeast additive; but, it could be concluded that LYSC supplementation in diet (particularly at a level of 2.5 g LYSC per sheep per day, Table 2) tended to alter the rumen fermentation parameters in favorite of rumen protozoa populations.

Degradability of alfalfa hay nutrients: The use of LYSC in sheep rations had no significant effect on the degradability of DM, CP, NDF and ADF of alfalfa at different incubation times (Fig. 1). Also the coefficients of degradability (i.e., a, b and c) did not affected by treatment groups (Table 3). In this regard, Williams *et al.* (1991), Enjalbert *et al.* (1999) and Arcos-Garcia *et al.* (2000) reported that DM degradability of forages was not affected by yeast culture. Yang *et al.* (2004) reported that YC had no significant effect on the degradability of forage CP. In addition, Doreau and Jouany (1998) and Arcos-Garcia *et al.* (2000) reported that YC supplementation had no effect on the NDF and ADF degradability of forages. Williams *et al.* (1991) demonstrated that the initial rate of degradation, rather than the potential degradability of the feedstuffs were affected in their study. Erasmus *et al.* (1992) reported that the use of YC increased ruminal DM degradability of wheat straw after 12 and 24 h of incubation. They suggested that inconsistency in results with yeast cultures in degradability of forage nutrients could be due to differences in the maturity of forages.

Digestibility of diet nutrients: The total tract digestibility of DM of rations was not affected by LYSC utilization in

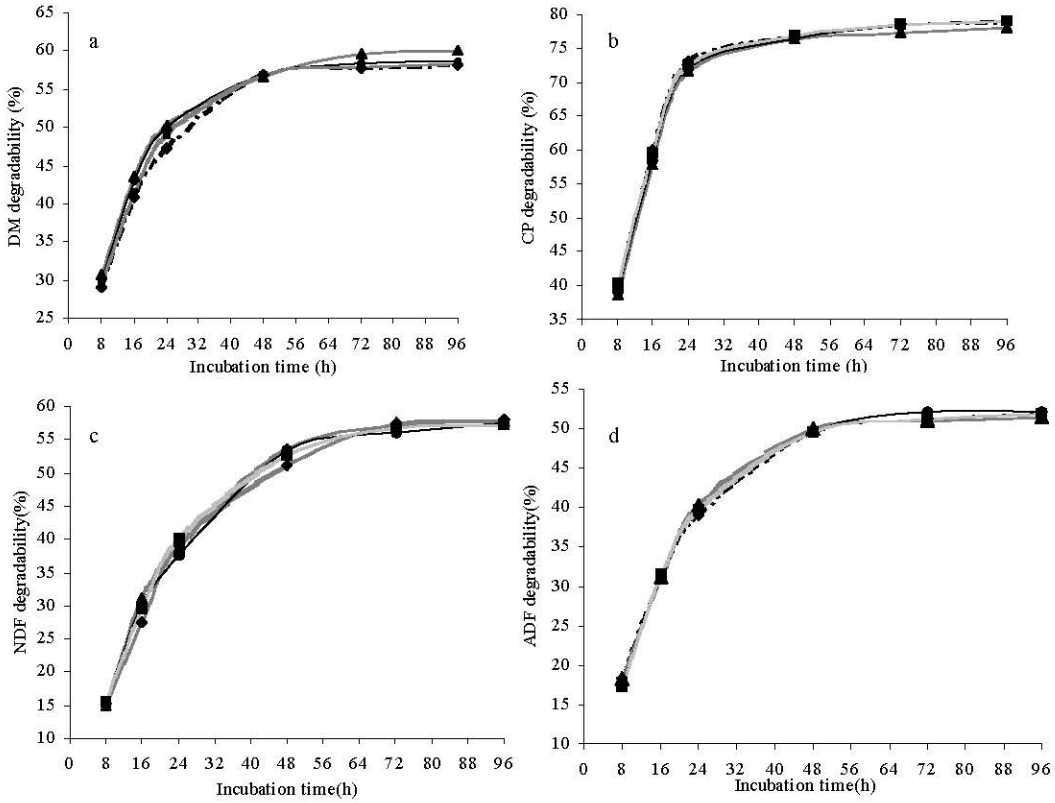

Fig. 1: The effects of live yeast *Saccharomyces cerevisae* (LYSC) on the degradability of dry matter (DM), Crude Protein (CP), Neutral Detergent Fiber (NDF) and Acid Detergent Fiber (ADF) content of alfalfa hay. Symbols in a, b, c and d curves are defined as: ---◆---, ---▲---, —◆— and ···■··· for sheep in control, 2.5, 5.0 and 7.5 g LYSC treatment groups, respectively

Table 3: The effects of live yeast *Saccharomyces cerevisae* (LYSC) on the degradability characteristics of dry matter, crude protein, neutral detergent fiber and the acid detergent fiber of alfalfa hay[1]

	Treatment groups[2]				
Degradability characteristics	Control	2.5 g LYSC	5.0 g LYSC	7.5 g LYSC	SEM[3]
Dry matter (%)					
a	18.50	18.47	18.39	18.50	0.400
b	41.10	39.79	40.11	39.94	0.341
c	6.50	6.90	6.83	6.70	0.022
Crude protein (%)					
a	16.78	16.75	16.74	16.64	0.250
b	61.85	61.03	61.74	61.94	0.132
c	10.35	9.72	9.61	9.86	0.038
Acid detergent fiber (%)					
a	2.14	2.15	2.15	2.13	0.085
b	49.14	49.43	49.64	48.84	0.098
c	6.28	6.33	6.30	6.48	0.028
Neutral detergent fiber (%)					
a	4.22	4.23	4.23	4.23	0.071
b	54.85	54.29	54.54	54.94	0.098
c	4.87	5.05	4.85	5.04	0.027

[1]The LYSC was top-dressed on the morning feed meals at 8.00 at levels of zero (control), 2.5, 5.0 and 7.5 g per sheep per day, respectively. [2] The differences between the means in the same row for all parameters were not statistically significant ($p>0.05$). [3] SEM = Standard error of mean

sheep but the CP, NDF and ADF digestibility of rations were significantly ($p<0.05$) increased (Table 4). In this regard, Arambel and Kent (1990) and Angeles *et al.* (1998) reported that the addition of YC in rations had no effect on the CP, NDF and ADF digestibility of rations in dairy cattle and sheep, respectively. Abd El-Ghani (2004) reported that CP and DM digestibility were not affected by supplementation of *Saccharomyces cerevisiae* in

Table 4: The effects of live yeast *Saccharomyces cerevisae* (LYSC) on the total tract digestibility of diet nutrients and the performances of Chall sheep[1]

	Treatment groups[2]				
Items	Control	2.5 g LYSC	5.0 g LYSC	7.5 g LYSC	SEM[3]
Digestibility of diet components (%)					
Dry matter	66.88	70.55	68.84	67.74	1.281
Crude protein	69.98^{b}	73.22^{ab}	74.02^{a}	71.31^{ab}	1.312
Neutral detergent fiber	64.45	65.09	64.51	62.84	1.431
Acid detergent fiber	51.32^{ab}	49.53^{a}	53.13^{b}	51.82^{ab}	0.622
Sheep performances					
Average daily gain (g/day)	223.80	228.57	257.14	247.61	0.221
Voluntary feed intake (kg/day)	1.41^{a}	1.42^{a}	1.57^{b}	1.38^{a}	0.021
Feed-to-gain ratio	6.39	6.48	6.60	5.86	0.533

[1] The LYSC was top-dressed on the morning feed meals at 8:00 at levels of zero (control), 2.5, 5.0 and 7.5 g per sheep per day, respectively, in treatment groups. [2] Means with different superscript letters on the same row differ significantly ($p<0.05$). [3] SEM = Standard error of mean

rations of Zaraibi goats. Furthermore, Angeles *et al.* (1998), Doreau and Jouany (1998), Corona *et al.* (1999) and Arcos-Garcia *et al.* (2000) found that the apparent digestibility of DM, CP, NDF and ADF of sheep and dairy cattle rations was not affected by yeast cultures supplementation. However, the results obtained in this study are in agreement with the findings of Fayed (2001) who reported that the digestibility of nutrients in goats fed with yeast supplemented diet was higher than that in control animals. The improvement of nutrients digestion might be attributed to the relative increase in the population of rumen cellulolytic bacteria due to yeast supplementation (Williams, 1989).

Sheep performances: Live yeast *Saccharomyces cerevisiae* increased ($p<0.05$) the voluntary feed intake of sheep but the feed-to-gain ratio and the average daily gain were not affected (Table 4). Compared to the other groups, sheep in 5.0 g LYSC group consumed higher ($p<0.01$) amount of feed during the experimental period. In agreement with these results, others reported that *Saccharomyces cerevisiae* increased feed intake of sheep (Arcos-Garcia *et al*., 2000) and dairy cattle (Dann *et al*., 2000). However, it was reported that, in spite of higher dry matter intake in animals fed with YC, the feed-to-milk ratio in dairy goats (Abd El-Ghani, 2004) and the feed-to-gain ratio in lambs (Haddad and Goussous, 2005) were not affected by yeast cultures. In contrast, Angeles *et al.* (1998) and Arambel and Kent (1990) reported that YC had no effect on the feed intake of sheep and dairy cattle, respectively. It might be thought that the increased ruminal turnover rates in sheep fed with LYSC have been the most probable reason of higher feed intake in these groups compared to that in control group, but it was observed only in sheep of 5.0 g LYSC group and the voluntary feed intakes in other two treatment groups were similar to that in control group. However, it should be noted that the period of intake measurements was short in this study and further experiments with longer periods are needed to elucidate the above mentioned findings.

CONCLUSIONS

The use of LYSC in the rations was ended to a more stable ruminal pH values in sheep. The DM digestibility of rations was not affected by LYSC supplementation but the digestibility of nutrients was significantly affected by use of LYSC in diets. The voluntary feed intake of sheep in 5.0 g LYSC group was higher than that in their counterpart groups. This ended to an inappropriate feed to gain ratio in 5.0 g LYSC group compared to that in other two groups. In some cases, with increase in the amount of LYSC usage in rations, the directions of variations were unexpected and the reasons were not clear to us. In general speaking, it seems that the addition of 2.5 g of LYSC per sheep per day into reasonably high concentrate contained diets could be more appropriate for the pH stability in the rumen and probably the improvement of ruminal activities in Iranian Chall sheep.

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