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The Effect of Yeast (*Saccharomyces cerevisiae*) on Nutrient Intake, Digestibility and Finishing Performance of Lambs Fed a Diet Based on Dried Molasses Sugar Beet-Pulp

S. Payandeh and F. Kafilzadeh
Department of Animal Science, Faculty of Agriculture, Razi University, Kermanshah, Iran

Abstract: This experiment was conducted to determine the effect of yeast (*Saccharomyces cerevisiae*, SC47) on finishing performance, digestibility, some blood metabolites and carcass characteristics of male lambs fed a diet based on dried Molasses Sugar Beet-Pulp (MSBP). Eighteen Sanjabi male lambs (20.95±2.7 kg initial body weight and 3 month of age) were used in a completely randomized design. Animals were assigned to one of the two dietary treatments (with or without yeast). Digestibility and nitrogen balance experiment was carried out using six mature rams on finishing diet with and without yeast. Serum metabolites were determined in samples taken from lambs at the end of finishing period. Dry matter digestibility of finishing diet was significantly increased by yeast addition. However, yeast did not have any significant effect on apparent digestibility of OM, NDF, CP and energy. Nitrogen retention was also not affected by yeast addition. Yeast resulted in a significant increase in the average daily gain, dry matter and organic matter intake. However, feed conversion ratio was not significantly affected by addition of yeast. The concentration of the serum metabolites including glucose, urea, cholesterol, sodium, potassium, calcium, phosphorous and cratinine were not affected significantly by yeast supplementation, but triglyceride concentrations increased significantly when yeast was fed. Addition of yeast to the diet did not have any significant effect on the carcass characteristics. Results of this study suggest that feeding *saccharomyces cerevisiae* with a diet based on MSBP can improve the performance of fattening lambs without any change in carcass characteristics or cuts.

Key words: *Saccharomyces cerevisiae*, fattening lambs, dried molasses sugar beet-pulp

INTRODUCTION

Beet pulp is a by-product obtained after extracting sugar from sugar beets. It is an excellent and highly palatable feed for ruminants and can be used at high levels as a suitable replacement for cereals especially for barley in ruminants rations. It is considered as energy feed almost similar to cereals which contain at least 85% of the energy value of corn and 95% of energy value of barley (Schroeder, 1999). Partial subsitutionof cereals witrh pectin-rich feed such as sugar beet pulp could prevent ruminal disorders (Livesey and Metcalf, 2003; Bodas *et al*., 2006). Sugar beet pulp is regarded as a fibre source that can be used as a forage replacer in ruminant diets too. However replacing high levels of this by-product with cereals results in a reduction in dry matter intake (Rouzbehan *et al*., 1994). It has been shown that sugar beet pulp increases the numbers and variety of fibre digesting bacteria in rumen, which results in higher digestion of fibre hence, allowing higher use of fibre in ration. The fibre portions in sugar beet pulp are not entirely mature and are made up of a third pectin, a third hemi cellulose and a third cellulose that is well digested by rumen bacteria. The aim of using sugar beet pulp in ruminant diets often is to increase fibre levels without a change in energy. Reports indicate that dried molasses sugar beet pulp can be used from 15 to 40% in ration of growing, finishing, pregnant and dairy sheep successfully, but using high levels of this by-product has been associated with a decrease in performance of animal, especially when level of protein in diet is insufficient (Cooke and Scott, 1995). Feeding yeasts has also been associated with increased digestion of structural carbohydrates (Williams *et al*., 1991). This improvement in digestion structural carbohydrates has been attributed to several factors, such as the increase in cellulolytic and anaerobic bacterial numbers (Wiedmeier *et al*., 1987; Harrison *et al*., 1988), the increase in rumen pH (Arambel *et al*., 1987) and providing suitable conditions for activity of anaerobic bacteria through consumption of extra oxygen in rumen (Newbold *et al*., 1996). However, it has been noted that the responses are

Corresponding Author: F. Kafilzadeh, Department of Animal Science, Faculty of Agriculture, Razi University, Kermanshah, Iran
Tel: +98 831 8324821 Fax: +98 831 8323728

highly variable and apparently influenced by the composition of the diet (Wallace and Newbold, 1993; Rouzbehan *et al*., 1994; Walker, 2000; Kafilzadeh and Paryad, 2005). This experiment was conducted to determine the effects of *Saccharomyces cerevisiae* on digestibility of a finishing ration containing 68% of sugar beet pulp and performance of finishing lambs fed that diet.

MATERIALS AND METHODS

Finishing experiment: Experiment was carried out at experimental farm of faculty of agriculture, Razi University, Kermanshah, Iran in 2006. Eighteen sanjabi male lambs (20.95±2.7 kg average live weight and three months of age) were used in a 2×9 completely randomized design. The lambs were individually penned and before the beginning of the experiment vaccinated against enterotoxaemia and treated for internal and external parasites. The lambs had free access to water and were fed with a TMR containing dried MSBP, alfalfa hay, cracked barley, soybean meal, mineral and vitamin mix and salt (Table 1). Diet was formulated according to NRC (1985) recommendations. The diet of one group of lambs was supplemented with Biosaf (2 g day^{-1} head^{-1}), a live yeast strain of *Saccharomyces cerevisiae* (SC47), while the other group received no yeast (control). Lambs were fed twice daily at 08:00 and 19:00 h at *ad libitum* intake for 90 days followed by a 15 days adaptation period. Diet contained 2.67 Mcal ME kg^{-1} DM and 153 g CP kg^{-1} DM. Feed was offered to allow about 10% refusal. Lambs were weighed at 14 days intervals after 16 h fasting period. Blood samples were taken from jugular veins of lambs at the end of the finishing period to determine serum metabolites. Blood samples were allowed to clot and centrifuged for 15 min at 2500xg, to obtain serum. Serum was stored at -20°C until analysis. At the end of the finishing period, lambs were slaughtered and hot carcass weights, dressing percentage and non-carcass components including head, feet, skin, full and empty stomach, full and empty intestine, spleen, liver, lungs + trachea, heart, kidneys, testicles and abdominal fats were recorded. Carcasses were chilled for 24 h at 3-5°C to measure cold carcass weight. Rib eye muscle area was measured at 12th and 13th ribs (Meat Evaluation Handbook, 1992). Carcass was cut into different sections namely; neck, behind of neck, longissimus dorsi, loin, thighs, hands, breast, flank and fat tail, then percentages of different cuts from the whole carcass was calculated.

Digestibility and nitrogen balance trial: Six mature male lambs (averaging 45.35±3.11 kg) were used in a change over design. Lambs were fed the experimental diet at 1.3×maintenance level (MAFF, 1985) with or without 2 g head^{-1} day^{-1} *S. cerevisiae*. The lambs had free access to water and were fed twice daily at 07:30 and 19:30 h in equal amounts. Yeast was mixed in approximately 50 to 100 g of the experimental diet and was fed to lambs just before feed was offered. A week of adaptation was followed with a week of total faecal and urine collection. Feed and faecal samples were analyzed for DM, OM, N according to AOAC (1997). Urine was also analyzed for N. Neutral detergent fibre (NDF) was determined according to Van Soest *et al*. (1991).

Table 1: Feed composition of the finishing ration used in experiment (g kg^{-1} DM)

Ingredients	Feed (g kg^{-1})
Alfalfa hay	150
Dried molasses sugar beet pulp	680
Cracked barley	40
Soybean meal	115
Mineral and vitamin mix	10
Salt	5
Saccharomyses cerevisiae[a] (added to the diet containing yeast)	2 (g day^{-1} head^{-1})

[a]: 5×10^9 cfu of *S. cerevisiae* g^{-1}

Statistical analysis: Data were analyzed using SPSS Software (2002).

RESULTS

Means of DM, OM, NDF and energy digestibility of finishing ration with and without yeast are presented in Table 2 and those for nitrogen digestibility and retention in Table 3. Dry matter digestibility of finishing ration significantly increased by yeast addition. However, yeast did not have any significant effect on apparent digestibility of OM, NDF and GE. The results also indicate that the addition of yeast to diet had significant effect on the dry matter and organic matter intake expressed both either as g day^{-1} or g kg^{-1} BW$^{0.75}$ (Table 4).

Average daily gain of finishing lambs was significantly affected by yeast supplementation but no effect was found on feed conversion ratio (Table 4). Lambs received diet with *S. cerevisiae* had higher ADG (209 vs. 177 g day^{-1}).

The concentration of the serum metabolites including glucose, urea, cholesterol, sodium, potassium, calcium, phosphorous and cratinine were not affected significantly by yeast supplementation, but triglyceride concentrations increased significantly when yeast was fed (Table 5).

The effect of yeast supplementation on carcass weight and dressing percentage and rib eye muscle area are presented in Table 6. Results of the percentage of different cuts and non-carcass components are presented in Table 7 and 8, respectively. Addition of yeast had no

Table 2: The effect of *S. cerevisiae* on apparent digestibility of dry matter and dry matter components (g kg^{-1} DM) of the finishing diet based on molasses sugar beet-pulp with or without yeast (n = 6)

	Treatments			
Compounds	No yeast	Yeast	Sig	SEM
Dry matter	788.2	803.5	0.04	0.39
Organic matter	808.8	820.3	0.11	0.35
Neutral detergent fiber	665.5	705.8	0.09	1.22
Gross energy	77.49	78.92	0.08	0.41

Table 3: The effect of *S. cerevisiae* on N intake, digestibility and balance in finishing lambs fed a diet based on dried molasses sugar beet pulp with or without yeast (n = 6)

	Treatments			
Items	No yeast	Yeast	Sig	SEM
N intake (g day^{-1})	16.57	16.57	-	-
Fecal N (g day^{-1})	4.53	4.30	0.117	0.072
Urinary N (g day^{-1})	5.00	4.40	0.369	0.315
Nitrogen balance (g day^{-1})	7.02	7.85	0.261	0.353
Apparent N digestibility (g kg^{-1})	726.60	740.50	0.117	0.436
Retained N (%)	42.37	47.38	0.261	2.130

Table 4: The effect of *S. cerevisiae* on performance of finishing lambs fed a diet based on molasses sugar beet pulp with or without yeast (n = 18)

	Treatments			
Animal performance	No yeast	yeast	Sig	SEM
Initial weight	20.880	21.02	0.920	0.63
Final weight (kg)	36.790	39.83	0.183	1.12
Average daily gain (g day^{-1})	177.000	209.00	0.044	8.08
Dry matter intake (g kg^{-1} W$^{0.75}$)	73.290	82.13	0.047	3.90
Organic matter intake (kg day^{-1})	0.866	0.99	0.042	0.03
Feed conversion rate	5.150	5.09	0.416	0.13

Table 5: The effect of *S. cerevisiae* on the level of some metabolites in finishing lambs fed a diet based on dried molasses sugar beet pulp with or without yeast (n = 18)

	Treatments			
Blood metabolites	No yeast	Yeast	Sig	SEM
Glucose (mg dL^{-1})	61.80	63.80	0.77	3.16
Urea (mg dL^{-1})	24.60	29.00	0.19	1.62
Cratinine (mg dL^{-1})	0.66	0.66	1.00	0.02
Calcium (mg dL^{-1})	8.82	8.94	0.64	0.12
Phosphorous (mg dL^{-1})	7.40	7.88	0.71	0.60
Triglyceride (mg dL^{-1})	13.80	17.20	0.01	0.73
Cholesterol (mg dL^{-1})	30.00	34.20	0.23	1.68
Sodium (mmol L^{-1})	212.30	204.69	0.26	3.23
Potassium (mmol L^{-1})	7.54	7.06	0.34	0.24

Table 6: Influence of *S. cerevisiae* on carcass characteristics in finishing lambson a diet based on dried molasses sugar beet pulp with or without yeast (n = 18)

	Treatments			
Carcass trait	No yeast	Yeast	Sig	SEM
Slaughter weight (kg)	40.90	41.40	0.78	0.96
Hot carcass weight (kg)	20.70	20.80	0.94	0.74
Cold carcass weight (kg)	19.90	20.20	0.86	0.74
Dressing percentage (%)	50.49	50.31	0.93	0.98
Rib eye muscle area (cm^2)	13.98	13.46	0.67	0.54

significant on Treatments in current study had no statistically significant different in carcass characteristics including live weight, hot and cold carcass weights, dressing percentage and rib eye muscle area (Table 6).

Table 7: Influence of *S. cerevisiae* on non-carcass components in finishing lambs on a diet based on dried molasses sugar beet pulp with or without yeast (n = 18)

	Treatments			
Parameters (kg)	No yeast	Yeast	Sig	SEM
Head	5.260	5.330	0.75	0.09
Feet	2.670	2.580	0.41	0.05
Skin	14.040	14.450	0.65	0.40
Full stomach	11.200	10.120	0.33	0.51
Empty stomach	2.750	3.070	0.15	0.11
Full intestine	6.650	6.140	0.39	0.27
Empty intestine	3.070	2.900	0.48	0.11
Spleen	0.165	0.140	0.13	0.01
Liver	1.520	1.690	0.17	0.06
Lung + trachea	1.370	1.220	0.31	0.07
Heart	0.384	0.366	0.31	0.01
Kidney	0.311	0.288	0.42	0.01
Abdominal fat	1.029	1.530	0.21	0.19
Fat tail	10.760	9.580	0.45	0.72
Abdominal fat + fat tail	11.790	11.120	0.63	0.69
Testicles	0.355	0.466	0.15	0.08

Table 8: Influence of *S. cerevisiae* on percentages of different cuts of carcass in finishing lambs on a diet based on dried molasses sugar beet pulp with or without yeast (n = 18)

	Treatments			
Parameters (%)	No yeast	Yeast	Sig	SEM
Neck	6.63	6.78	0.78	0.22
Behind of neck	3.05	3.02	0.93	0.19
Longissimus dorsi	4.03	4.50	0.37	0.23
Loin	5.29	5.28	0.93	0.09
Thighs	27.18	26.06	0.27	0.48
Hands	15.63	15.84	0.53	0.15
Breast	10.54	11.24	0.20	0.26
Flank	5.00	5.81	0.20	0.43
Fat tail	22.02	19.57	0.35	1.21

DISCUSSION

Yeast supplementation had significant effect on dry matter and organic matter intakes. Many studies have shown similar results (Philips and Vontugeln, 1985; Dawson *et al*., 1990; Wohlt *et al*., 1991; Cole *et al*., 1992; Erasmus *et al*., 1992; Kung and Muck, 1997) while others have found no change in dry matter intake as the result of yeast addition (Rouzbehan *et al*., 1994; Haddad and Goussous, 2005; Kawas *et al*., 2007a, b) in sheep. Reduced daily feed intakes in dairy cows fed yeast have also been reported (Quinonez *et al*., 1988; Kung *et al*., 1997). Yeast can result in higher intake through an increase in rumen content outflow rate by improving the fermentation in the rumen (Williams *et al*., 1991; Cole *et al*., 1992; Erasmus *et al*., 1992).

Dry matter digestibility of finishing diet significantly increased when *S. cerevisiae* was fed. Kafilzadeh and Paryad (2005) and Haddad and Goussous (2005) reported similar increase in dry matter digestibility due to addition of yeast in fattening lambs. Others found no improvement in dry matter digestibility when yeast was added to the diet of sheep (Arcos-Garcia *et al*., 2000; Kawas *et al*., 2007a). Similar positive results have also been observed with dairy cows fed yeast (Williams *et al*., 1991; Carro *et al*., 1992). Williams *et al*. (1991) and Carro *et al*. (1992) reported that the addition of *S. cerevisiae* increased NDF digestibility in dairy cows. Kafilzadeh and paryad (2005) have also reported that *S. cerevisiae* had significant effect on fiber digestibility in diet containing high levels of sugar cane baggase. In the current study the digestibility of NDF did not increased (p = 0.09) when yeast was added. It has been suggested that increased bacterial flora in the animals fed *S. cerevisiae* is central to the action of yeast in the rumen (Wallace and Newbold, 1992). Arambel *et al*. (1987) reported that addition of yeast to the diet increased the numbers of cellulolytic bacteria and improved digestion of fibre. Increase in the number of cellulolytic bacteria with a wide magnitude has been shown in many studies (Dawson *et al*., 1990; Newbold *et al*., 1995).

Rouzbehan *et al*. (1994) evaluated response of male lambs aged 7-8 months to loose-mix diets containing molassed sugar beet pulp and rolled barley in the ration of 0.8:0.2 and 0.5:0.5 and suggested that addition of yeast to diet in intermediate and highly levels of molasses sugar beet pulp had no effect on the daily gain and daily feed intake. However it is not clear that what percentage of total diet was made up of barely and molasses sugar beet pulp. Addition of yeast in the current study in which dried molasses beet pulp was added to finishing diet at a very high inclusion rate (68% in total diet basis DM) resulted in a higher average daily gain (209 vs. 177 g day^{-1}). These results are in agreement with the findings of Philips and Vontugeln (1985), Kafilzadeh and Paryad (2005) while, Kawas *et al*. (2007b) reported that weight gain of lambs did not change when their diet was supplemented with yeast (p>0.05).

The concentration of the serum metabolites measured were not affected significantly by yeast supplementation, but triglyceride concentrations increased significantly when yeast was added. Nikkhah *et al*. (2004) reported that concentration of glucose, calcium, phosphorous, sodium, cholesterol, triglycerides and total protein in plasma of cows receiving diets with different levels of yeast were not different (p>0.05) while concentration of potassium and magnesium in plasma of cows supplemented with yeast were lower (p<0.05) than those in control group. No reason has been found for such changes however, *Saccharomyces cerevisiae* cell wall has a great binding potential with some cations (especially heavy metals) which could result in lower digestion and absorption of these metals (Walker, 2000). However, Piva *et al*. (1993) reported that yeast addition to diet had no effect on the blood metabolites. Kafilzadeh and Paryad (2005) also showed that yeast addition to diet of finishing lambs didn't affect (p>0.05) serum urea nitrogen and glucose.

Yeast had no effect on carcass characteristics including hot and cold carcass weights, dressing percentage and rib eye muscle area (Table 7). Also, addition of *S. cerevisiae* to diet did not resulted in any significant change in non-carcass components and percentages of different cuts of carcass (Table 7, 8). Similarly, Kawas *et al*. (2007b) reported that addition of yeast culture to diets had no significant effect on cold and hot carcass weights in lambs fed finishing diets. They also reported that yeast addition had no significant effect on the full gastrointestinal tract weight, external fat rib eye muscle area and weight of skin, liver, lungs, testicles or blood. Results of this study showed that supplementation of diet containing high level of molassess sugar beet pulp with yeast can improve live weight gain through increasing feed intake as the result of increasing digestibility of diet.

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