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Influence of live yeast cells (*Saccharomyces cerevisiae*) supplementation to the diet of fattening lambs on growth performance and rumen bacterial number

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ABSTRACT

A feeding trial was conducted in order to evaluate the effect of live yeast cells (*Saccharomyces cerevisiae*) on the growth performance of lambs. The experiment was performed on thirty-six East - Friesian lambs divided into a control group without live yeast cells (CD = control diet), an experimental group with 1g/day of live yeast cells in the diet (YC1*)* and an experimental group with 0.5 g/day of live yeast cells in the diet (YC0.5*)*. Diet was based on hay and concentrate containing: corn (66.3%), soybean meal (18.7%), bran (6%) and alfalfa meal (4%). No effects were recorded on weight, weight gain and feed conversion ratio. The number of anaerobic and aerobic rumen bacteria was not affected by the treatment. Results demonstrated that 0.5 g/day and 1 g/day of live yeast cells supplementation to finishing lambs fed hay and high energy concentrate does not improve growth performance.

Key words: yeast cells, lambs, hay, concentrate, growth performance

Introduction

The use of *Saccharomyces cerevisiae* as a probiotic, when added to feed in small amounts, began during the 1940's and 1950's (BEESON and PERRY, 1952). Products containing *S. cerevisiae* have been used to improve productivity in ruminants (NEWBOLD, 1996) and present an attractive alternative to chemical growth promoters. Data indicate that supplementation of yeast to the ruminant diet may improve feed intake (ROBINSON and GARRETT, 1999; WILLIAMS et al., 1991), weight gain (SALAMA et al., 2002), digestion (KAMEL et al., 2004; JOUANY et al., 1998; WOHLT et al., 1991), numbers of anaerobic and

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cellulolytic bacteria (MATHIEU et al., 1996; NEWBOLD et al., 1995), ruminal pH value (DOREAU and JOUANY, 1998; JOUANY et al., 1998; MATHIEU et al., 1996), alter the patterns of volatile fatty acids (ARCOS-GARCIA et al., 2000) and influence absorption of some minerals (COLE et al., 1992). However, the results on the use of *S. cerevisiae* in ruminants are contradictory due to the fact that in many cases no influence or opposing results were obtained. One of the most important reasons for such inconsistent results is diet composition (WALLACE, 1994; ZELENAK et al., 1994). Yeasts are most efficient when animals are fed diets overloaded in energy, and thus easily fermented by rumen microorganisms (WILLIAMS et al., 1991), or diets poor in nutrient supply (JOUANY et al., 1998; PLATA et al., 1994).

Over the past few years, there has been increasing interest in comparing the effects of *S. cerevisiae* live cell products to *S. cerevisiae* culture products on ruminal fermentation. Yeast culture is produced by fermenting a selected liquid and cereal grain raw ingredients with baker's yeast (*S. cerevisiae*) and drying the entire culture medium without destroying components associated with the yeast such as B vitamins and other fermentation products. While the yeast culture supplements do contain some viable *S. cerevisiae* cells, the yeast live cell supplements contain higher numbers of yeast with a minimal amount of carrier (LYNCH and MARTIN, 2002).

In fattening lambs, the addition of yeast has shown a positive effect in several studies by increasing gain efficiency, average daily gain and weight gain (WILLIAMS et al., 1987; CAJA et al., 2000; HADDAD and GOUSSOUS, 2004). This trial was designed to investigate the effect of live yeast cells on the production results of East Friesian lambs fed a diet based on hay and concentrate. We were especially interested in the weight, weight gain and rumen microbiology of lambs during fattening period.

Materials and methods

Animals and feed. Thirty-six East Friesian lambs were used in the fattening trial. During pre-treatment (from birth to weaning) the lambs received exactly the same diet. Each group of lambs was randomly assigned to one of three treatments in a completely randomised design. Treatments were: diet without live yeast cells (control diet = CD), diet with 1g/day of live yeast cells (YC1) and diet with 0.5 g/day of live yeast cells (YC0.5). During the treatment lambs were fed *ad libitum* amounts of hay and concentrate. The chemical composition of the ration is provided in detail in Table 1. To attain better blending of the probiotic, live yeast cells were mixed with concentrate and top dressed over the ration. During the experiment each group was kept in a separate pen in a barn. Lambs had *ad libitum* access to feed and water. The study lasted six weeks.

Measurements and analysis. Samples of the concentrate and hay were collected throughout the experimental period for chemical composition analyses. The samples

were ground and analysed for dry matter, crude protein, crude fiber and ash according to AOAC procedures (ANONYM., 1995). The body weights were recorded at birth, weaning and then at the 3rd and 6th week of the trial. The amounts of feed offered and refused were recorded daily and the lambs were maintained at ambient temperature with natural day light. Rumen fluid was obtained using a stomach tube and rumen bacterial numbers were determined using the method described by NEWBOLD et al. (1995). The animals were euthanized at the end of the experiment and processed for carcass yield measurement.

Table 1. Ingredient and chemical composition of the hay and concentrate

Hay	
Chemical (% DM)	
Dry matter	86
Crude protein	12.4
Crude fibre	20.9
Ether extract	2.4
Ash	9.2
Concentrate	
Ingredient (%)	
Corn	66.3
Soybean meal	18.7
Bran	6.0
Premix 1	5.0
Alfalfa meal	4.0
Chemical (% DM)	
Dry matter	88.4
Crude protein	17.0
Crude fibre	4.0
Ether extract	3.8
Ash	4.1

[1]Premix Kuškovit for lambs (Kušić promet, Sv. Ivan Zelina) comprising per kg: vitamin A, 200 000 IU; vitamin D_3, 30 000 IU; vitamin E, 600 mg; Fe, 800 mg; Mn, 800 mg; I, 10 mg; Co, 4 mg; Zn, 800 mg; Se, 6 mg; BHT antioxidant, 2000 mg.

Statistical analysis. All values were analyzed using SAS® software (SAS, 1991). The data were subjected to ANOVA procedures (General Linear Model). Post hoc multiple comparisons were adjusted for p values by using the Tukey-Kramer procedure. Differences were considered at a significance level of $P<0.05$.

Results

Supplementation with live yeast cells did not affect (P>0.05) weight and weight gain among the experimental and control groups (Table 2). All values concerning carcass characteristics also did not differ significantly (P>0.05) among the treatment groups (Table 2). Values did not differ from the respective values recorded in other animals of the herd (not included in the experiment) kept on the experimental farm.

Table 2. Effects of live yeast cells (*Saccharomyces cerevisiae*) on weight, weight gain and carcass characteristics of lambs[1]

	Treatment		
Parameter	CD[2]	YC0.5	YC1
DMI (kg/d)	0.730 ± 0.02	0.689 ± 0.02	0.775 ± 0.03
Live weight (kg), weaning	13.93 ± 2.34	14.32 ± 1.66	13.87 ± 2.73
Live weight (kg), 3rd wk	19.41 ± 2.85	19.82 ± 2.99	19.97 ± 3.32
Live weight (kg), 6th wk	25.48 ± 3.71	26.10 ± 3.60	25.78 ± 4.37
Weight gain (kg), weaning - 3rd wk	5.48 ± 0.78	5.51 ± 0.89	6.10 ± 1.20
Weight gain (kg), 3rd - 6th wk	6.07 ± 0.99	6.24 ± 1.13	5.81 ± 0.88
Weight gain (kg), weaning - 6th wk	11.55 ± 2.13	11.74 ± 2.22	11.91 ± 2.34
Average daily weight gain (kg)	0.275 ± 0.09	0.280 ± 0.09	0.283 ± 0.08
Eviscerated weight (kg), 6th wk	13.30 ± 1.94	13.70 ± 1.81	13.40 ± 2.19
Dressing percentage (%), 6th wk	52.19 ± 0.93	52.49 ± 0.77	51.97 ± 0.99

[1]Values represent means ± SD; [2]CD = control diet; YC0.5 = 0.5 g of live yeast cells per day; YC1 = 1g of live yeast; cells per day

Table 3. Effects of live yeast cells (*Saccharomyces cerevisiae*) on the number of rumen bacteria[1]

Parameter	CD[2]	YC0.5	YC1
Anaerobic bacteria	8.30×10^9	8.74×10^9	1.42×10^{10}
Aerobic bacteria	3.4×10^6	3.8×10^6	2.9×10^6

[1]Values represent means ± SD; [2]CD = control diet; YC0.5 = 0.5 g of live yeast cells per day; YC1 = 1g of live yeast cells per day

The number of rumen anaerobic and aerobic bacteria was not significantly different (P>0.05) (Table 3). Among the isolated rumen bacteria, the most dominant was *Pediococcus* sp.

Discussion

The results on the use of yeast in ruminant animals are contradictory. Most data that show improvement are available for dairy cows (WANG et al., 2001; ROBINSON and

GARRET, 1999; WOHLT et al., 1991) but there are also results that show no improvements in dairy cows (SODER and HOLDEN, 1999; ARAMBEL and KENT, 1990; SWARTZ et al., 1994). Results for small ruminants for milk production are also contradictory. While HADJIPANAYIOTOU et al. (1997) reported no effects on milk yield or composition, ABD EL-GHANI (2004) observed an increase in milk yield and composition.

In our trial we used live yeast cells instead of yeast culture. Nevertheless, LYNCH and MARTIN (2002) compared live yeast cells and yeast culture and found that both S. cerevisiae supplements had similar effects on the mixed ruminal microorganism fermentation.

Although an increase in dry matter intake was observed when yeast was fed to bulls (MUTSVANGWA et al., 1992) and dairy goats (SALAMA et al., 2002) no effect of yeast on dry matter intake was observed in this study. In agreement with our results, other authors also did not find any improvement in dry matter intake after yeast addition to lamb diets (ADAMS et al., 1981; HADDAD and GOUSSOUS, 2004; KAWAS et al., 2007a; KAWAS et al., 2007b; TITI et al., 2008).

Yeast culture supplementation did not affect growth performance, which is consistent with KAWAS et al. (2007b) who reported similar effects of yeast supplementation to finishing lambs. In contrast, HADDAD and GOUSSOUS (2004) observed improved weight gain after supplementing yeast to finishing sheep diets. The reasons behind the different responses to yeast supplementation between our study and those of others are not clear. It is evident that yeast can have beneficial effects on performance under some circumstances, but there seems to be a considerable unexplained variability in response. This could be due to factors such as basal diet, viable cell numbers, the amount of yeast supplemented, type of forage fed, and feeding strategy.

Carcass characteristics were not affected by the addition of yeast to the diets of the lambs. Very little published literature is available concerning the effects of yeast supplementation on carcass characteristics. Recently, KAWAS et al. (2007b) showed that yeast had no effect on hot and chilled carcass weights, or dressing proportions of lambs fed a high grain finishing diet.

Most probably, the lack of any significantly positive effect of live yeast cells supplementation in our study could be related to several factors. Among them diet and the duration of the study were probably the most important. Diet composition is very important in explaining the results of supplementing yeast to ruminants. For example, according to KAWAS et al. (2007b) there is a greater beneficial effect from yeast with forage based diets versus high concentrate diets. SALAMA et al. (2002) explained the lack of positive results in their investigation by the moderately concentrated diet which led to sufficient buffering capacity and cellulolytic activity in the rumen. CHADEMANA and OFFER (1990) emphasized that response to yeast varies particularly according to the different content of readily fermented carbohydrates. Similarly, the relatively ideal conditions in the rumen

in our study may have excluded any positive effects on growth performance. BONILLA et al. (1992) utilized corn stover in high and low protein diets and reported an interaction between levels of protein and yeast, which suggests that, with a low protein level in the diet, yeast improved dry matter intake, whereas with a high protein level, yeast reduced it. In our case, the relative high crude protein content could have prevented the effects of yeast supplementation on growth rate.

The lack of any positive effect could also be explained by the short duration of the experiment. The lambs were slaughtered at 25.87 kg in average because that weight is demanded by the Croatian market. That period was not long enough for differences to reach a significant level.

Conclusion

We concluded that the supplementation of live yeast cells did not achieve a statistically significant beneficial affect on the growth performance of East Friesian lambs fed hay and concentrate. More studies under different feeding conditions and in longer fattening periods are necessary to clarify the effects of live yeast cell supplementation to lamb diets.

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SAŽETAK

Proveden je pokus da bi se utvrdio učinak živih stanica kvasca *Saccharomyces cerevisiae* na proizvodne rezultate janjadi. Pokus je proveden na trideset i šest janjaca istočnofrizijske pasmine podijeljenih u kontrolnu skupinu koja u hrani nije dobivala žive stanice kvasca (CD = kontrolna hrana), pokusnu skupinu s 1 g živih stanica kvasca u obroku (YC1) i pokusnu skupinu s 0,5 g živih stanica kvasca u obroku (YC0,5). Obrok se sastojao od sijena i dodatka koncentrata koji je sadržavao kukuruz (66,3%), sojinu sačmu (18,7%), pšenične posije (6%) i brašno lucerne (4%). Nije utvrđen učinak na težinu, prirast i konverziju hrane. Postupak nije utjecao na broj anaerobnih i aerobnih bakterija. Zaključili smo da žive stanice kvasca nisu poboljšale rast u janjadi hranjene sijenom i koncentratom.

Ključne riječi: žive stanice kvasca, janjad, sijeno, dodatak, proizvodni rezultati