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The influence of live yeast cells (*Saccharomyces cerevisiae*) on the performance of grazing dairy sheep in late lactation

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ABSTRACT

A feeding trial was conducted in order to evaluate the influence of live yeast cells (*Saccharomyces cerevisiae*) on milk production and composition, and on blood parameters in late lactation. The experiment was performed on forty Croatian crossbred dairy sheep divided into a control group without live yeast cells (CD = control diet) and the experimental group with live yeast cells in the diet (YC = diet with *Saccharomyces cerevisiae)*. The diet was based on pasture and concentrate containing corn (66.3%), soybean meal (18.7%), bran (6%) and alfalfa meal (4%). Supplementation with live yeast cells significantly increased the total milk yield in the 23rd week ($P<0.5$) and in the 27th week ($P<0.5$). Morning milk yield was also significantly increased in that period. All other values concerning milk yield did not differ significantly between treatment groups. The average amount of milk during the experimental period was higher in the YC group than in the CD group (604.60 ± 83.21 and 630.28 ± 92.34, for control and yeast-supplemented group, respectively) but without any significant difference ($P>0.5$). The chemical composition of the milk was not influenced by the treatments with the exception of milk fat that was significantly higher in YC group. Blood parameters were not affected by the treatment. We conclude that supplementation with live yeast cells, under the conditions of our experiment, had no statistically significant beneficial effects on the performance of dairy ewes during late lactation. High concentrate diet, the stage of lactation and high temperatures may have decreased the response to live yeast cells.

Key words: live yeast cells, sheep, milk yield, milk composition, blood parameters

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Introduction

The use of *Saccharomyces cerevisiae* as a probiotic, when added to feed in small amounts, began during 1940s and 1950s (BEESON and PERRY, 1952). Products containing *S. cerevisiae* have been used to improve daily gain and milk production in ruminants (WALLACE, 1994). The increasing concern regarding the use of antibiotics has led to even greater interest in probiotics as feed additives.

Various models have been designed to explain the effects of yeast in the rumen (NEWBOLD et al., 1996). Data indicate that supplementation of yeast in the ruminant diet may improve feed intake (ROBINSON and GARRETT, 1999; WILLIAMS et al., 1991), milk production (ABD EL-GHANI, 2004; WANG et al., 2001), weight gain (SALAMA et al., 2002), digestion (KAMEL et al., 2004; JOUANY et al., 1998; WOHLT et al., 1991), numbers of anaerobic and 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), and alter the patterns of volatile fatty acids (ARCOS-GARCIA et al., 2000).

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. The yeast culture is produced by fermenting selected liquid and cereal grain raw ingredients with bakers 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 amounts of yeast with a minimal amount of carrier**.** Live yeast cells and yeast culture have similar effects on ruminal fermentation (LYNCH and MARTIN, 2002)

This trial was designed to investigate the effect of live yeast cells on milk yield and composition of Croatian dairy sheep (MIKULEC et al., 1997; MIKULEC et al., 2000) fed a diet based on pasture and concentrate. We were especially interested in their influence on the lactation curve during late lactation due to the fact that a possible increase in milk production could lead to prolonged lactation.

Materials and methods

Animals and feed. Forty Croatian crossbred dairy sheep (¾ East Friesian, ¼ Croatian autochthonous breed, Istrian sheep) were used in the lactation trial starting from week 20 to 28 of lactation. All animals were multiparous, aged 2.5 ± 0.2 years on average. The ewes were milked twice daily (at 05.00 h and 17.00 h) in a double 24 stall, parallel milking parlour. Ewes were selected from 347 Croatian crossbred dairy sheep.

During pre-treatment (first 20 weeks of lactation) the ewes received exactly the same diet. Sheep were divided into two groups at the 20th week of lactation according to parity,

milk yield and body condition score, recorded in previous and current lactations. During the experiment each group was kept in separate pens and separate paddocks between morning and evening milking. The ewes grazed rotationally in a mixed grass pasture and received 1kg of concentrate during the pre-treatment and treatment period. The chemical composition of the ration is provided in detail in Table 1.

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

Pasture	
Chemical (% DM)	
Crude protein	11.8
Crude fiber	31.6
NDF	51.5
Etherextract	5.1
Ash	10.2
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 fiber	4.0
NDF	17.9
Ether extract	3.8
Ash	4.1

[1]Premix Kuškovit for ewes (Kušić promet, Sv. Ivan Zelina) comprising per kg: vitamin A, 200000 IU; vitamin D_3, 30000 IU; vitamin E, 500 mg; Fe, 800 mg; Mn, 800 mg; I, 10 mg; Co, 4 mg; Zn, 1000 mg; Se, 6 mg; Mg, 2000 mg; BHT antioxidant, 1000 mg.

Each group of ewes was randomly assigned to one of the dietary treatments: diet without live yeast cells (control diet = CD), and diet with live yeast cells (supplemented with *S. cerevisiae* = YC). Live yeast cells (Biosaf®, Lesaffre Feed Additives, France) were fed to the YC group during morning milking in the amount of 1g/ head/ day. To attain better blending of the probiotic, live yeast cells were mixed with the concentrate.

Measurements and analysis. Samples of the supplement and pasture 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 (ANON., 1995). The milk yield of each sheep was recorded biweekly

during pre-treatment and then weekly during the treatment period by using recording jars in the milking parlour. Milk samples for composition analysis were taken twice a week until the end of the experiment. The samples were analysed for fat, protein, dry matter and lactose using a near infrared spectrophotometer (Milcoscan FT 120).

Blood was sampled weekly prior to morning feeding from the jugular vein into heparinized centrifuge tubes and centrifuged. Plasma was stored at -20ºC until analysis for its components according to metabolic profile (PAYNE et al., 1970).

Statistical analysis. The PROC MIXED for repeated measurements of SAS was used for the analysis of variance (SAS, 1985). The statistical model contained the effects of treatment, parity, week as the repeated measure, and the first order interaction of these effects. Differences were considered at a significance level of ($P<0.5$).

Results

Supplementation with live yeast cells significantly increased total milk yield in the 23rd week ($P<0.5$) and in the 27th week ($P<0.5$) (Fig. 1). Morning milk yield was also significantly increased in that period. All other values concerning milk yield did not differ significantly between the treatment groups (Tab. 2). The average amount of milk during the experimental period was higher in the YC group than in the CD group (604.60 ± 83.21 and 630.28 ± 92.34, for control and yeast-supplemented group, respectively) but without significant difference ($P>0.5$).

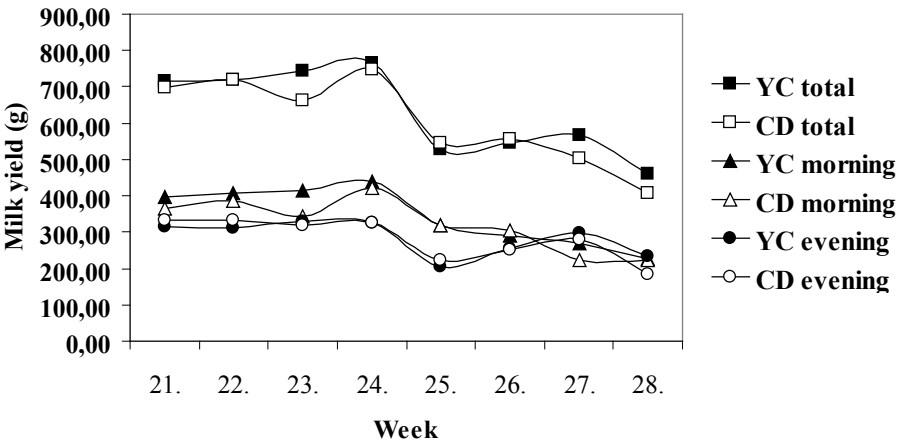

Fig. 1. Influence of yeast supplementation on milk yield during experimental period.

Table 2. Influence of yeast supplementation on average milk yield and composition from 20th to 28th week of lactation[1]

Parameter	CD[2]	YC	Significance
Milk yield (g/day)	604.60 ± 83.21	630.28 ± 92.34	NS[3]
FCM$^{6.5}$ (g/day)[4]	722.31 ± 95.35	740.81 ± 85.41	NS
FPCM$^{6.5;5.8}$ (g/day)	717.29 ± 93.71	734.06 ± 91.03	NS
Milk composition			
Fat (%)	8.01 ± 1.62	8.83 ± 1.42	*
Protein (%)	5.95 ± 0.54	6.14 ± 0.95	NS
Lactose (%)	4.45 ± 0.32	4.36 ± 0.36	NS
Dry matter (%)	19.42 ± 2.09	20.36 ± 2.13	NS
Milk urea nitrogen (mg/%)	24.17 ± 6.97	25.06 ± 10.99	NS

[1]Values represent means ± standard deviation; [2]CD = control diet; YC = diet supplemented with *Saccharomyces cerevisiae;* [3]NS = non significant; significant at * P<0.05; [4]FCM$^{6.5}$ = fat corrected milk (6.5% milk fat); FPCM$^{6.5; 5.8}$ fat and protein corrected milk (6.5% milk fat and 5.8% milk protein) (PULINA and NUDDA, 2005)

The chemical composition of the milk was not influenced by the treatments, with the exception of milk fat, that was significantly higher in the YC group (Table 2). Values of milk yield and composition did not differ from the respective values recorded in other animals of the herd (not included in the experiment) kept on the experimental farm.

No significant difference was recorded in blood components between the CD and YC groups (Table 3).

Table 3. Influence of yeast supplementation on blood plasma components from 20th to 28th week of lactation[1]

Item	CD[2]	YC	Significance
Glucose (mmol/L)	3.09 ± 0.39	3.10 ± 0.31	NS[3]
Cholesterol (mmol/L)	2.15 ± 0.32	2.01 ± 0.31	NS
Urea (mmol/L)	7.50 ± 1.51	8.01 ± 1.65	NS
Ca (mmol/L)	2.33 ± 0.16	2.23 ± 0.15	NS
P (mmol/L)	1.68 ± 0.22	1.70 ± 0.28	NS
Total protein (g/L)	68.75 ± 2.12	70.30 ± 2.30	NS
Albumin (g/L)	30.36 ± 2.11	30.80 ± 2.01	NS

[1]Values represent mean ± SD; [2]CD = control diet; YC = diet supplemented with *Saccharomyces cerevisiae;* [3]NS = non significant;

Discussion

In our study, the inclusion of live yeast cells in the diet showed a positive effect in the 23rd and 27th week of lactation (Fig. 1). Between these periods milk yield was affected by a decrease in feed intake because of extreme temperatures, with consequential milk yield decrease. Although results from SCHINGOETHE et al. (2004) suggest that the yeast culture can improve the feed efficiency of heat-stressed dairy cows in middle lactation, this did not happen in our trial. Animals kept on pasture will always be strongly influenced by weather conditions. In-field studies are less accurate than those in laboratories or institutes but are very important for the application of theories. A similar in-field study was performed by SWARTZ et al. (1994) and they found that yeast supplementation was not beneficial for any production parameters on seven dairy farms.

Total milk yield and the lactation curve for the period of late lactation was not significantly influenced by live yeast cells. Nevertheless, the results on the use of yeasts in dairy animals were contradictory. Most data for milk yield improvement are available for dairy cows (WANG et al., 2001; ROBINSON and GARRET, 1999; WOHLT et al., 1991) but there are also results that showed no improvements (SODER and HOLDEN, 1999; ARAMBEL and KENT, 1990; SWARTZ et al., 1994). Results on small ruminants were 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. Results concerning fermentation processes in ewes are also contradictory, but the most consistent finding is an increase in the total number of bacteria (NEWBOLD et al., 1996), which could lead to better performance of dairy ewes.

Diet composition is very important in explaining the results of supplementing yeast to ruminants. Yeasts are most efficient when animals are fed diets overloaded in energy, and thus easily fermented by rumen microorganism (WILLIAMS et al., 1991; ZELENAK et al., 1994), or diets poor in nutrient supply (JOUANY et al., 1998; PLATA et al., 1994). SALAMA et al. (2002) explained a lack of positive results with a moderate amount of concentrate in diet, which led to sufficient buffering capacity and cellulolytic activity in the rumen. These relatively ideal conditions in the rumen could exclude the positive affects on milk yield in our trial.

Another important aspect is the period of lactation. Results from HARRIS and LOBO (1988) suggested that the response to the inclusion of yeast was greater in early as opposed to mid or late lactation. Lower response to yeast in middle and late lactation could be a reason why the average milk yield in our experiment did not reach statistical significance, although there was a tendency of improvement for the YC group.

The chemical composition of milk showed an increase of milk fat content, which is in agreement with the results of WANG et al. (2001). On the contrary, according to PIVA et al. (1993) a common result of yeast supplementation is only a slight (non significant)

increase in milk fat content. Several other authors even found no influence of yeast on milk fat content (ARAMBEL and KENT, 1990; ERASMUS et al., 2005). These results could be explained by differences in diet composition, because fat concentration is normally positively correlated with the concentration of NDF in the diet.

We did not find any difference in blood parameters, which is consistent with previous data in calves (LESMEISTER et al., 2004) and in dairy cows (PIVA et al., 1993; DOREAU and JOUANY, 1998).

Conclusion

We concluded that supplementation of live yeast cells did not achieve a statistically significant beneficial effect on the milk yield of Croatian crossbred dairy sheep, fed on pasture and concentrate in late lactation. Most probably, the lack of a significantly positive influence from live yeast supplementation in our study was related to several factors, including diet, stage of lactation and in field conditions. Nevertheless, the trial showed several periods of significant increase in milk yield and milk fat content during the experiment. More studies under different feeding conditions and in earlier stages of lactation are necessary to clarify The influence of live yeast cell supplementation to the diets of grazing dairy ewes.

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MAŠEK, T., Ž. MIKULEC, H. VALPOTIĆ, L. KUŠĆE, N. MIKULEC, N. ANTUNAC: Učinak živih stanica kvasca (*Saccharomyces cerevisiae*) na proizvodne rezultate pašno držanih, mliječnih ovaca tijekom kasne laktacije. Vet. arhiv 78, 95-104, 2008.

SAŽETAK

Proveden je hranidbeni pokus kako bi se procijenio učinak živih stanica kvasca (*Saccharomyces cerevisiae*) na proizvodnju i sastav mlijeka te krvne pokazatelje u kasnoj laktaciji. Pokus je proveden na 40 ovaca hrvatske oplemenjene mliječne pasmine koje su bile podijeljene u kontrolnu skupinu bez živih stanica kvasca (CD = kontrolna hrana) i pokusnu sa živim stanicama kvasca u hrani (YC = hrana sa *Saccharomyces cerevisiae*). Obrok je zasnovan na paši i koncentratnom dodatku koji se sastojao od kukuruza (66,3%), sojine sačme (18,7%), stočnog brašna (6%) i brašna lucerne (4%). Dodatak živih stanica kvasca značajno je povećao dnevnu količinu mlijeka u 23. tjednu ($P<0,5$) i 27. tjednu ($P<0,5$). Jutarnja količina mlijeka također je bila značajno viša u tom razdoblju. Sve ostale vrijednosti vezane uz količinu mlijeka nisu se značajno razlikovale. Prosječna količina mlijeka tijekom pokusnog razdoblja bila je viša u YC skupini nego u CD skupini (604,60 ± 83,21 i 630,28 ± 92,34, za kontrolnu i pokusnu skupinu), ali razlika nije bila statistički značajna ($P>0,5$). Postupci nisu utjecali na kemijski sastav mlijeka s izuzetkom mliječne masti koja je bila značajno viša u pokusnoj skupini. Krvni se pokazatelji nisu razlikovali između skupina. Zaključili smo da, u uvjetima našeg pokusa, dodavanje živih stanica kvasca nije imalo statistički značajan utjecaj na proizvodne rezultate mliječnih ovaca tijekom kasne laktacije. Učinak je vjerojatno bio smanjen zbog veće količine koncentrata u obroku, stadija laktacije i visokih temperatura.

Ključne riječi: žive stanice kvasca, ovce, mlijeko, krvni pokazatelji