IJAS Iranian Journal of Applied Animal Science

# Use of Yeast Culture in the TMR of Dairy Holstein Cows

Research Article

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Received on: 29 Jun 2011
Revised on: 18 Aug 2011
Accepted on: 20 Aug 2011
Online Published on: Mar 2012

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Online version is available on: www.ijas.ir

## ABSTRACT

The aim of this study was to determine the effect of yeast culture (*Saccharomyces cerevisiae* SC 47) addition in the diet of dairy cows on their rumen fermentation and milk production. Animals received a diet TMR based on good maize silage with a higher dry matter content (14 kg), 14 kg of lucerne-grass haylage, 5 kg of crushed ears of maize, 5 kg of beet pulp silage, 3 kg of crimped wheat, 2 kg of meadow hay, and 7.0 kg feed mixture. The yeast culture (5 g/day) was added to the mixture. The supplementation of yeast culture showed a positive effect on ruminal volatile fatty acids (VFA) production by the experimental group of Holstein cows in comparison with the control, higher production ($P< 0.05$) on sampling days 30 and 60 (114±25.44 vs. 125±26.49, and 146±32.47 vs. 149±36.64, respectively). The average concentration of ammonia was higher by cows in the control group, and the difference vs. the treated group was significant. The difference in the number of protozoa of cows in the control and experimental groups was significantly ($P<0.01$) different (353±6.97 vs. 386±3.91 ths/1 mL of rumen fluid). Average daily fat corrected milk (FCM) milk production was higher in the experimental group (38±3.33 vs. 33±1.64).

KEY WORDS cows, milk production, rumen fermentation, yeast culture.

## INTRODUCTION

The effect of yeast action on animals was well documented in the last twenty years namely in dairy cows (Dawson, 1999). The response of cows to the administration of yeast is relatively changeable and ranged from 2% to 30%. The response of animals to the addition of yeast cultures into feeding diets also depends on the treatment of animals and on their feeding regimes. Apart from this, it is also necessary to point out great individual differences between animals in the groups. According to Doreau and Jouany (1998), yeasts reduce the size of variability in dairy cows fed with higher amounts of cereals.

The beneficial influence of yeasts on the production efficiency of animals can be explained also by the fact that after their application, the animals show increased fodder intake and improved digestibility of nutrients (Erasmus *et al.* 1992). Lyons (1997) inform that the capacity of yeast to produce glutamic acid may enhance the palatability of feeds for ruminants. The tight relation that exists in the rumen between microbes participating in the micro-structure of the bacterial population is responsible for the fact that even these low amounts of stimulators are sufficient for bacteria connected with the yeast. The stimulation of the growth of bacteria and their activities causes a more intensive decomposition of cell walls in higher plants, which finally results in the generally increased fodder intake. Together with the improved digestibility, which is usually observed under these circumstances, the animals receive more nutrients and their production efficiency is increasing. Moreover, yeast

has a positive influence on the prevention of acidosis and may stimulate the immunological system of the animal organism (Maekawa *et al*. 2002). Finally yet importantly, the yeast cell walls are characterized by a certain affinity to toxins and thus reduce the risk of the development of toxicosis. All these factors together serve to explain the positive effects of yeast on ruminants. Many works (Alshaikh *et al.* 2002) document the favorable effects of yeast cultures not only on the rumen environment of dairy cows itself but also on the improved microbial activity because they facilitate digestion of fiber, reduce lactate accumulation, suppress oxygen concentration in the rumen fluid and enhance utilization of starch in the ration. Similarly, Sullivan and Martin (1999) inform that the yeast culture of *Saccharomyces cerevisiae* in the diet of dairy cows increases the utilization of lactate and hence improves cellulose digestion. Some yeast strains have a higher capacity of utilizing lactate or they stimulate the utilization of lactates by the bacteria of propionic fermentation (Strohlein, 2003). Doreau and Jouany (1998) recorded that yeast reduce the daily fluctuation of pH value and mitigate individual differences between various individuals. In one of our earlier studies (Dolezal *et al.* 2005) we observed a similar situation. We found out that with the increasing concentration of yeast in the diet of dairy cows, the rumen fluid shows not only an increasing total content of fat corrected milk (VFA) an increasing percentage share of propionic and acetic acids, a decreasing amount of ammonia but also an increasing total count of bacteria and infusorians in the rumen. Similar conclusions were reported by Strohlein (2003) and Kamra *et al*. (2002). Zhang *et al*. (2000) and Strohlein (2003) claim furthermore that the supplementation of yeast *Saccharomyces cerevisiae* into the feeding ration of lactating dairy cows improves milk production and the content of milk components (Erasmus *et al*. 1992).

A number of works point out the favorable influence of yeast on the production efficiency of dairy cows (milk production increased by 7-10%, milk protein content increased by 0.1-0.2%, milk fat production increased by 0.1-0.2%, daily gain increased by 5-10% and lower loss of good condition. In some experiments, the milk production efficiency increased by 1.4-1.8 liters.

## MATERIALS AND METHODS

The experiment included 12 dairy cows of Holstein breed, which were divided into 2 equal groups with respect to productivity, order of lactation and live weight. The experimental period lasted 120 days. The cows were kept at loose and fed 3-times daily the same ration with the experimental group of animals receiving in the production feeding ration mixture supplemented by yeast culture Biosaf® (*Saccharomyces cerevisiae*-SC 47).

The additive was supplemented at feed ration on the level of 5 g per animal per day. The control group of cows did not receive any yeast supplementation. The chemical composition and nutritional value of the total mixed ration (TMR) are presented in Table 1.

**Table 1** Composition and nutritional value of the total mixed ration (TMR)

| Ingredients | Amount |
|---|---|
| Lucerne-grass silage (kg) | 14 |
| Corn silage with higher DM (kg) | 14 |
| Ears maize silage (kg) | 5 |
| Beet pulp silage (kg) | 5 |
| Meadow hay (kg) | 2 |
| Concentrate mixture (kg) | 7 |
| Crimped wheat (kg) | 3 |
| Mineral mixture (MKP) (kg) | 0.14 |
| Nutrients | |
| Dry matter (DM) (%) | 44.84 |
| Crude protein (CP) (%) | 16.95 |
| Rumen protein degradability (RDP) (%) | 61.24 |
| Fat (%) | 2.82 |
| Crude fiber (%) | 18.72 |
| Acid detergent fiber (ADF) (%) | 20.89 |
| Neutral detergent fiber (NDF) (%) | 31.57 |
| Nitrogen free extractives (NFE) (%) | 53.27 |
| Starch (%) | 30.42 |
| Starch degradability (%) | 70.25 |
| Metabolisable energy (ME) (MJ.kg $DM^{-1}$) | 11.79 |
| Netto energy for lactation (NEL) (MJ.kg DM-1 ) | 6.78 |
| Composition of mineral mixture (in 1 kg of product) | |
| Ca (g) | 150 |
| P (g) | 60 |
| Na (g) | 90 |
| Mg (g) | 80 |
| Fe (mg) | 2000 |
| Cu (mg) | 1500 |
| Mn (mg) | 7000 |
| Zn (mg) | 7000 |
| Se (mg) | 30 |
| I (mg) | 110 |
| Co (mg) | 25 |
| Vitamine A (International Units) (ths.) | 1000 |
| Vitamine $D_3$ (International Units) (ths.) | 100 |
| Vitamine E (mg) | 3000 |

The intake of TMR was *ad libitum*. Residual fodder was removed after each feeding. The cows were milked in a milking shed 2-times daily. Samples of rumen fluids were taken from the cows of both groups by using oesophageal probe by a method described by Hofirek and Dvorak (2002) within 3 hours after feeding in the fourth month of the experiment as a response to feeding diet.

Rumen fluid was analyzed for the total content of volatile fatty acids (VFA), relative % share of acetic, propionic and butyric acids, pH value, abundance of infusorians and ammonia content. VFAs were measured by the method of gas chromatography (Dolezal *et al*. 2005) and the ammonia content was ascertained by the AOAC method (2005). The total content of infusorians was established according to a method described by Hofirek and Dvorak (2002). Results were statistically analyzed using the multi-factor analysis of variance (Snedecor and Cochran, 1989). The values were compared with reference values according to Vrzgula *et al.* (1990).

## RESULTS AND DISCUSSION

Results of the effect of yeast culture SC-47 supplementation on the biochemical indicators of rumen fermentation in cows are presented in Table 2 and Figures 1 and 2 and they are compared with those recorded in cows of the control group. The achieved results show that the pH value of experimental cows is within the reference range and after 30 and 60 days it is lower (6.26±0.3 and 6.29±0.01, respectively) than that recorded in the control group after 30 (6.47±0.02) and 60 days (6.40±0.06), respectively.

It followed out from analyzing the effect of yeast culture on milk production efficiency (Table 3) and on the content of milk components that the highest milk production efficiency was found in the cows of experimental group (48.7±4.54 L) as compared with the cows in the control group (44.43±4.98 L) on day 112 of lactation. The trend to higher milk yield in the cows of experimental group persisted also in later sampling terms. Cows of the experimental group achieved milk production higher compared with cows of the control group.

The milk of cows in the experimental group (Table 3) also showed a higher milk fat content in individual months (3.6±0.71%, 3.45±0.51% and 3.76±0.19% respectively) as compared with the milk of cows in the control group (2.93±0.5%, 3.13±0.59%, 3.34±0.4% respectively). The results indicate that the addition of yeast culture had a positive effect on the milk production efficiency of cows in the experimental group. The effect was demonstrated on the increase of milk fat and protein contents in cows of the experimental group. All differences were statistically significant (P<0.05) and in favor of the experimental group. In our experimental surfy (Table 2), we did not succeed to prove the conclusions of other authors (Kamra *et al*. 2002) about the increased and stabilized rumen fluid pH through the supplementation of yeast. On the opposite, our results rather correspond to findings reported by similarly did not Kung *et al*. (1997); Putnam *et al*. (1997) and Garg *et al*. (2000) who prove any profound stabilizing effect on pH and other products of fermentation.

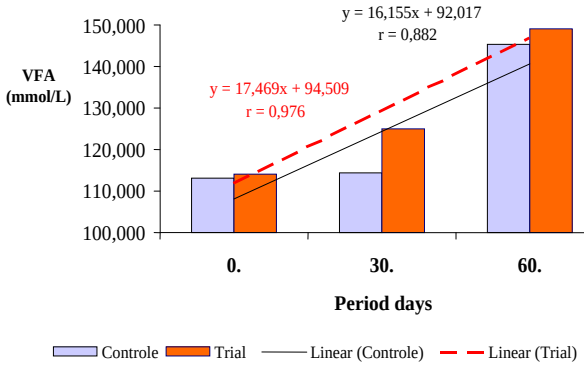


**Figure 1** The effect of yeast culture on the rumen VFA (volatile fatty acid) production

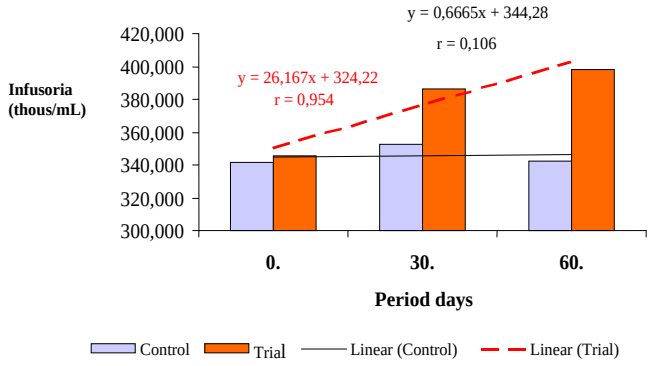


**Figure 2** The effect of yeast culture on the ruminal infusoria content

The achieved results of yeast culture effect on VFA production showed that the yeast culture supplementation led to increased (P<0.05) VFA production (125.00±26.49 mmol/L after 30 days and 149.00±36.64 mmol/L after 60 days respectively) as compared with cows in the control group (114.0±25.44 mmol/L after 30 days and 146.00±32.47 mmol/L after 60 days respectively). A significant increase was detected in both sampling terms. The achieved results agree with the findings of other authors (Pestevsek *et al*. 1998 and Kamra *et al*. 2002).

The supplementation of yeast in conditions of our experiment resulted in a better concentration of ammonia (8.045±0.18 mmol/L, 7.92±0.072 mmol/L and 7.69±0.13 mmol/L respectively) as compared with cows in the control

**Table 2** Average biochemical parameters of rumen fluid of cows in experimental and control groups

| Group | Day of collection | PH | VFA (mmol/L) | $NH_3$ (mmol/L) | Infusoria (thous/mL) |
|---|---|---|---|---|---|
| Control | 0 | 6.49±0.04 | 113±25.38 | 8.95±0.03 | 341±6.53 |
| | 30 | 6.47±0.02 | 114±25.44$^{a}$ | 8.46±0.32$^{a}$ | 353±6.97$^{A}$ |
| | 60 | 6.40±0.06 | 146±32.47$^{b}$ | 8.15±0.16$^{b}$ | 343±4.77$^{B}$ |
| Experimental | 0 | 6.62±0.03 | 114±24.84 | 8.05±0.18 | 346±9.90 |
| | 30 | 6.26±0.03 | 125±26.49$^{c}$ | 7.92±0.07$^{c}$ | 386±3.91$^{C}$ |
| | 60 | 6.29±0.01 | 149±36.64$^{d}$ | 7.69±0.13$^{d}$ | 398±6.51$^{D}$ |
| Reference value | | 6.2-6.8 | 80-120 | 6.00-16.00 | 300-500 |

VFA: volatile fatty acids.
The means within the same column that have different letters a, b, c, d and A, B, C, D are different (P<0.05 and P<0.01 respectively).

**Table 3** Milk yield and content of milk components

| Group | Lactation (days) | Milk yield (L) | FCM (kg) | Fat (%) | Fat (kg) | Milk Protein (%) | Milk Protein (kg) |
|---|---|---|---|---|---|---|---|
| Control | 305 | 11344±1155 | 10164±500$^{a}$ | 3.17±0.63 | 353±40.89$^{a}$ | 3.15±0.24 | 357±41.22 |
| Experimental | | 11647±1314 | 11714±1016b | 3.75±0.30 | 433±33.92$^{b}$ | 3.27±0.24 | 378±36.85 |
| Group | | Milk yield (L/day) | FCM (kg/day) | - | - | - | - |
| Control | | 37±3.79 | 33±1.64$^{a}$ | - | - | - | - |
| Experimental | | 38±4.31 | 38±3.33$^{b}$ | - | - | - | - |

FCM: fat corrected milk.
The means within the same column that have different letters a, b are significantly different (P<0.05).

group (8.95±0.034 mmol/liter, resp. 8.46±0.32 mmol/L and 8.15±0.16 mmol/L respectively). Differences in the ammonia content between the two groups of cows were significant (P<0.05). Our results corroborate the findings of Kamra *et al*. (2002); Alshaikh *et al*. (2002). Similarly, Strohlein (2003) confirmed the reduced ammonia content in the rumen fluid of cows after the addition of yeast. On the other hand, Putnam *et al*. (1997) did not observe any significant effect of supplemented yeast on the content of ammonia in the rumen fluid while Newbold *et al*. (1990) demonstrated even its increased level. The effect of yeast culture supplementation on the content of rumen infusorians is analyzed in Figure 2. The achieved results show clearly that the yeast concentration used in the feeding diet significantly (P<0.01) stimulated the metabolic activity of infusorians in the rumen, which showed in their increased (P<0.01) abundance (346.00±9.90 thous./mL, 386±3.91 thous./mL and 398 thous.±6.51 thous./mL respectively).

Following out of these results is an unambiguously significant link between the yeast culture supplementation and the number of infusorians in 1 mL of rumen fluid. By contrast, other studies (Erasmus *et al*. 1992 and Putnam *et al*. 1997) demonstrated that the counts of rumen microorganisms and infusorians were not affected by the addition of yeast or that their counts even decreased.

Also, Kamra *et al*. (2002) concluded that the addition of yeast culture did not affect the number of infusorians in the rumen fluid. Values detected in our experiment are in a good agreement with the conclusions of other authors (Strzetelski *et al*. 1996; Alshaikh *et al*. 2002). The positive effect of yeast culture on milk production was further cofirmed by Dawson and Tricario (2002), Kung *et al*. (1996);

Sinclair *et al*. (2006). Also, Roth *et al*. (2007) concluded that the supplementation of live yeast to the feed ration resulted in the increased milk FCM by 1.7 kg as compared with dairy cows of the control group. On the other hand, Alshaikh *et al*. (2002) and Cooke *et al*. (2007) did not observe any positive influence of supplemented yeast on milk productivity efficiency. Similarly, Zhang *et al*. (2000) reported the increased milk production efficiency, production of milk, protein, lactose and dry matter in cows receiving the *Saccharomyces cerevisiae* supplement in the diet by 7.1% (2.01 kg), 20.2% (175.6 g), 8.6% (68.4 g), 7.9% (104.3 g) and 11% (361.4 g) as compared with the control groups.

## CONCLUSION

The aim of this work was to review the influence of the addition of yeast culture *Saccharomyces cerevisiae* (SC-47) in the total mixed ration with higher starch content on rumen fermentation and milk production in the puerperal period dairy cattle. The yeast culture significantly ($P<0.05$) influenced the production of VFA in rumen as compared with the control group. The addition of yeast culture decreased the content of ammonia in comparison with the control group. The cows of the experimental group were diagnosed the higher counts of infusorians for all donations as compared with the cows in the control group. The significant difference was high ($P<0.01$). Compared with the control group, the cows of experimental group had higher average daily yield (38±4.31 kg) and FCM production (38±3.33 kg).

## ACKNOWLEDGEMENT

We are thankful to the Ministry of Education, Youth and Sports of the Czech Republic, for their financial support to the Project Research Plan No. MSM 6215648905 “Biological and technological aspects of sustainability of controlled ecosystems and their adaptability to climate change“.

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