EFFECT OF DIETARY LIVE YEAST ON MILK YIELD, COMPOSITION AND COAGULATION PROPERTIES IN EARLY LACTATION OF ESTONIAN HOLSTEIN COWS

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ABSTRACT. *A total of 69 Estonian Holstein cows were assigned into treatment groups after calving. Groups were balanced by parity and milk yield of the previous lactation. Milk yield of the cows before the experiment was 30.5 ± 0.86 kg, on average. Treatments were either a control (C) diet or a diet supplemented with live yeast (LY). For 100 days all cows were fed a total mixed ration (TMR), containing 11.9 MJ ME and 173 g CP per kg DM. The cows of the treatment group were fed supplemental pure viable live yeast Levucell SC (CNCM I 1077) 0.5 g/d per cow, premixed with 50 g of chalk. The cows of the control group were fed 50 g chalk without LY.*

Yeast supplementation significantly (P = 0.0082) accelerated the increase in milk yield during early lactation and compared to the pre-experimental period, the cows of the LY group achieved significantly (P=0.0165) higher milk yield than those of the control group. Feeding viable LY had no significant effect on milk composition or coagulation properties.

Keywords: *Estimated Breeding Values (EBV), Estonian Holstein (EH), curd firmness (E_{30}), live yeast (LY), rennet coagulation time (RCT).*

Introduction

Dietary live yeast (LY) is a common feed additive used by commercial dairies in many countries. Interest in the use of direct-fed microbials as feed supplements for high producing dairy cows has increased in recent years. LY has been fed to dairy cows with varied responses. Inclusion of LY to the ration of high-producing dairy cows has been shown to improve dry matter intake (DMI) and milk yield (Wohlt *et al*., 1991; 1998), in some trials also the percentage of milk fat (Wang *et al*., 2001) and milk protein (Putman *et al*., 1997). However, in other studies (Swartz *et al*., 1994; Sode, Holden, 1999) no beneficial response has been found.

Wang *et al*. (2001) have demonstrated that the response of milk yield and milk fat percentage is significant when LY is added to diets with 21% forage neutral detergent fibre (NDF) but not with 17% forage NDF. Erasmus *et al*. (1992) suggest that LY supplementation may alter the amino acid profile of bacterial protein and decrease degradability, but trials of Putman *et al*. (1997) do not confirm these results.

Despite the fact that LY has been fed to cows for some time already and much experimental work has been reported, the mechanism of its effect is not clear yet. Some of the benefits are associated with increased DM intake (Robinson, Garrett, 1999), some with DM and NDF digestion (Wohlt *et al*., 1998), and some with altering ruminal fermentation (Sullivan, Martin, 1999; Miller-Webster *et al*., 2002). Callaway and Martin (1997) have suggested that LY provides soluble growth factors – organic acids, B vitamins, amino acids, *etc*. – that stimulate the growth of ruminal bacteria utilising lactate and digesting cellulose.

As a large portion of milk production is used for cheese manufacturing, good coagulation properties and high milk protein content are important. In the scientific literature, data on the effect of feeding on milk coagulation properties are insufficient and frequently the results are contradictory. A significant effect of feeding on milk coagulation properties has been shown by Kreuzer *et al*. (1996), Ostersen *et al*. (1997), and Lucey and Fox (1992) who have claimed that at a high input feeding level it is possible to improve the coagulation properties of milk.

Our earlier investigations (Kübarsepp *et al*., 2003) revealed that milk coagulation properties began to decline after calving, in the second and third month of lactation, when milk yield is normally high and the energy reserves of the body have been used. The object of this experiment was to study the effect of LY supplementation on cow performance, milk composition and milk coagulation properties at the beginning of lactation.

Materials and methods

Cows, Diets and Experimental Design

A total of 69 Estonian Holstein cows were assigned into treatment groups after calving, balanced by parity and milk yield of the previous lactation (projected milk yield for primiparous cows). An average milk yield of the cows at the beginning of the experiment was 30.5 ± 0.86 kg.

The experiment was carried out from March to July 2004. The animals were housed in a free-stall barn, received either a control (C) diet or a diet supplemented with live yeast (LY) *S. cerevisiae* CNCM I 1077 (10^{10} cfu /per head/day). Diets were fed once daily as a totally mixed ration (TMR) *ad libitum* to ensure approximately 10% orts. The composition of diets between treatments was identical except for the inclusion of supplemental LY (*Levucell SC*) 0.5 g/d per cow (i.e. 10^{10} cfu), premixed with 50 g of chalk (Table 1). The experimental period lasted for 100 days. During the experimental period, DM of TMR included 11.92 MJ/kg metabolisable energy (ME), 173 g crude protein (CP), 98 g metabolisable protein (MP) and 188 g crude fibre (CF).

Table 1. Composition of the diets during the experimental period

Composition	Diet	
	Control	LY
Ingredients	(% of DM)	
Grass silage	21.67	21.67
Maize silage	13.02	13.02
Grass hay	3.47	3.47
Concentrate [1]	41.21	41.21
Rapeseed cake	10.85	10.85
Dried sugar beet chips	6.51	6.51
Rapeseed oil	2.17	2.17
Minerals and vitamins [2]	0.43	0.43
Chalk	0.43	0.22
Salt	0.65	0.65
Levucell SC [3]	–	0.22
Nutrient analysis		
Crude protein	17.34	17.34
Metabolisable protein	9.81	9.81
Crude fibre	18.83	18.83
ME, MJ/kg	11.92	11.92
Ca	0.68	0.68
P	0.52	0.52

[1] Content: barley meal 15%, maize meal 35%, maize gluten feed 25% and sunflower cake 25%.
[2] Content: 100 g/kg Ca; 70 g/kg P; 125 g/kg Mg; 90 g/kg Na; 1,500 mg/kg Fe; 3,000 g/kg Zn, 750 mg/kg Cu; 3,000 mg/kg Mn; 75 mg/kg J; 25 mg/kg Co; 25 mg/kg Se; 500,000 IU of vitamin A/kg; 100,000 IU of vitamin D_3/kg; and 750 mg/kg of vitamin E as tocopherol.
[3] 0.5 g of Levucell SC premixed with 50 g of chalk.

Sampling and Analyses

Cows were milked twice a day: at 4 a.m. and 3 p.m. Milk yield was electronically recorded at each milking. Milk samples were collected from all cows twice a month as an average of two milkings and were preserved with Bronopol®. Milk samples were analysed for fat and protein by infrared analysis (milk analyser System 4000; Foss Electric A/S, Hillerød, Denmark). Milk coagulation properties were determined at 35 ºC using a Formagraph (Foss Electric A/S, Hillerød, Denmark). Chymosin Maxiren 600, diluted 1:100 with distilled water, was added at a rate of 0.2/10 ml milk. The following coagulation parameters were measured: RCT – rennet coagulation time in minutes (time from the addition of rennet to the beginning of coagulation; E_{30} – curd firmness in millimetres (the width of the curve 30 min after the addition of rennet) (Kübarsepp *et al*., 2005).
ECM yield was calculated using the equation suggested by Sjaunja *et al*. (1990):

$$ECM = M \times \mathbf{[}(383MF + 242MP + 783.2) / 3140\mathbf{]}, \text{ where}$$

ECM – energy-corrected milk;
M – milk yield kg;
MF – milk fat content %;
MP – milk protein content %.

Chemical analysis on feeds was performed using generally accepted methods (AOAC, 1990): DM content was determined by heating a sample for 2 hours at 130 ºC to constant weight; protein content was estimated by the Kjeldahl method (N × 6.25) with *Kjeltec auto 1030* analyzer (FOSS Tecator); crude ash was determined after ashing a sample at 550 ºC in a muffle furnace for 6 h; crude fibre was analysed using *Fibretec system*; crude fat content was investigated by petrol ether extraction in a *Soxtec System 1040 Extra Unit*; the concentration of Ca in ash solution was determined by trilonometry; estimation of P was carried out on a flame photometer ПФМ–У4.2 using the yellow complex.

ME concentration in DM was calculated according to the results of Weende analyses, and MP concentration according to the system adopted in Estonia (Kärt *et al*., 2002) and based on the AAT-PBV system used in Finland (Tuori *et al*., 1996). Estimated Breeding Values (EBV) for production traits (milk, protein and fat) were received from the Estonian Animal Recording Centre.

Statistical Analysis

In order to estimate the effect of diet on the milk yield and coagulation parameters considering potential confounding factors the following model was used:

$$y_{ijk} = \mu + R_i + L_j + b_i \text{ x } ebv_{ijk} + c_i \text{ x } dim_{ijk} + d \text{ x } (dim_{ijk})^2 + g_i \text{ x } m_{ijk} + \varepsilon_{ijk}, \text{ where}$$

y_{ijk} – the observed value of studied parameter;
μ – model intercept;
R_i – the treatment effect (i = 1 to 2);
L_j – the effect of parity group (j = 1 to 2);
b_i, c_i and g_i – the regression coefficients modeling the interactions of treatment with EBV (ebv_{ijk}), days in milk (dim_{ijk}) and pre-experimental milk yield (m_{ijk}) respectively;
d – the regression coefficient corresponding to the days in milk squared;
ε_{ijk} – the model error with the first-order autoregressive covariance structure modeling the coherence of values measured on the same cow.

All statistical analyses of the data were implemented with SAS system (SAS Institute, 2004).

Results and discussion

Response of milk yield, composition and coagulation properties to LY supplementation is presented in Table 2.

Table 2. Effect of LY supplementation on milk yield, milk composition and coagulation properties

Trait	Control*	LY*	P-values
Milk yield, kg	36.5 ± 0.36	37.4 ± 0.32	0.0758
ECM, kg	37.3 ± 0.91	38.3 ± 0.76	0.3792
Milk fat, %	4.33 ± 0.086	4.46 ± 0.071	0.2656
Milk protein, %	3.06 ± 0.035	3.12 ± 0.030	0.2077
E_{30}, mm	30.14 ± 1.381	27.82 ± 1.205	0.2044
RCT, min	6.56 ± 0.407	7.18 ± 0.358	0.2505

* results are presented as LSM ± SE showing the joint effect of treatment and treatment specific covariates.

An average milk yield of the LY group was by 0.86 kg higher than that of the control group during the 100 first days of lactation.

In the first 100 days of lactation, the LY group had higher ECM yield due to higher milk yield, and also higher milk fat and protein content although the differences were not statistically significant.

Feeding viable LY had no significant effect on milk coagulation properties. Coagulation properties of the milk from the LY group were poorer than those of the control group. After adding rennet, milk from the control group cows began to coagulate in 6.56 min and that of LY group cows in 7.18 min. The milk from LY group cows formed a softer curd after adding the rennet than the milk of the control group cows did (27.82 mm and 30.14 mm, respectively).

The individual factors of an animal; parity, EBV and days in milk affect milk yield significantly ($P<0.0001$). The interactions of different factors with LY supplementation had different effects on milk yield and composition.

LY supplementation significantly ($P = 0.0082$) accelerated the increase of milk yield of the LY cows at the beginning of lactation. Compared to the pre-experimental period, the cows of the LY group achieved significantly ($P = 0.0165$) higher milk yield than those of the control group (Figure 1). Significant increase in milk yield has also been described by Shaver and Garrett (1997).

In this experiment, diet × EBV interaction with milk yield was not significant (P = 0.3688).

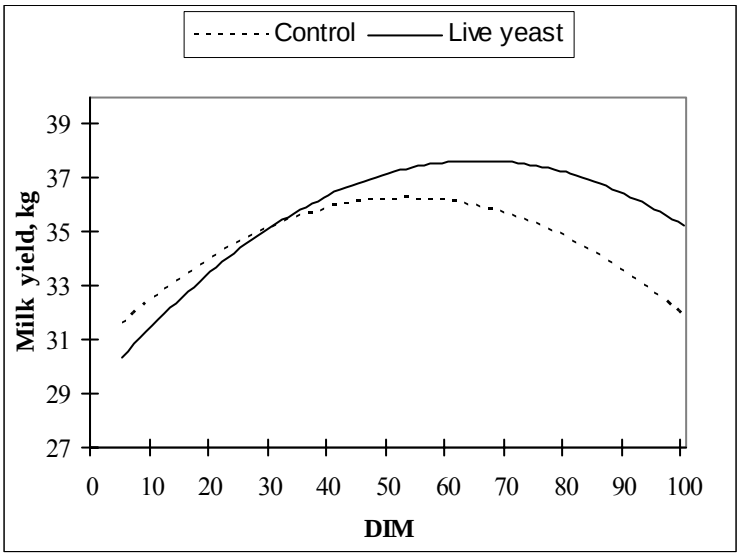

Figure 1. Dynamics of daily milk yield (calculated by the model) for the first 100 lactation days of LY and control group cows

As the P-value of the null model likelihood ratio test was below 0.001, it can be concluded that this model described our experimental results quite precisely. The effect of LY supplementation was not revealed at the beginning of the experiment, this could be resulted from the design of our experiment. The effect of viable LY is primarily through altering microbial metabolism (Miller-Webster *et al*., 2002), thus it is important that LY supplementation begins before calving to affect a response from the beginning of the lactation. This opinion has been confirmed by the results of Dann *et al*. (2000).

In the experiment no statistically significant effect was revealed on milk coagulation properties as well. That finding is in accordance with the data revealed by Piva *et al*. (1993).

Conclusion

In this experiment, LY supplementation to the diets of early lactation cows significantly accelerated the increase in milk yield during early lactation. The cows of the LY group achieved significantly higher milk yield as compared to the pre-experimental period.

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