

# EFFECT OF *SACCHAROMYCES CEREVISIAE* YEAST ON MILK PROTEIN CONTENT AND COMPOSITION AND SERUM MINERAL CONCENTRATIONS IN SHEEP

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## Abstract

The experiment was conducted on 26 nursing Kamieniec ewes from a breeding herd. The animals were divided into two equal groups characterized by the same litter type, age and sex of suckling lambs: I – control and II – experimental. Throughout the 70-day lactation period, both groups were fed identical diets comprising haylage of grasses and legumes, meadow hay and CJ concentrate in daily rations of: 2.80 kg haylage of grasses and legumes, 0.6 kg meadow hay and 0.6 kg CJ concentrate per ewe. Group II animals were fed the CJ concentrate with the addition of Inter Yeast S<sup>®</sup> *Saccharomyces cerevisiae* dried yeast in the amount of 50 g kg<sup>-1</sup> of the concentrate. Milk was sampled during control milking runs on lactation day 28 and 70. The collected samples were analyzed to determine the content of protein, whey protein, casein,  $\alpha_s$ ,  $\beta$  and  $\kappa$  casein fractions. Blood was sampled twice from the jugular vein on lactation day 28 and 70. After separation of serum, the following nutrient concentrations were determined: inorganic phosphorus (P<sub>in</sub>), calcium (Ca) and magnesium (Mg). No significant variations were reported in the percentage share of whey proteins in ewe's milk during the peak and towards the end of lactation. The yeast preparation had no effect on the casein content of milk. Yeast supplementation si-

gnificantly influenced the proportions of casein fractions on lactation day 70. A significant drop in  $\beta$ -casein levels (by 2.32%) with a simultaneous increase in  $\kappa$ -casein concentrations (by 1.86%) were noted in the milk of group II animals. Similar calcium, phosphorus and magnesium concentrations were determined in the blood serum of both animal groups throughout the experiment (on lactation day 28 and 70) and these results were within the reference values.

The results of this study indicate that the inclusion of *Saccharomyces cerevisiae* brewer's yeast into the diet of lactating ewes could enhance the quality of milk proteins.

Key words: ewes, *Saccharomyces cerevisiae*, milk proteins, blood minerals.

## WPLYW PREPARATU DROŹDZY *SACCHAROMYCES CEREVISIAE* NA ZAWARTOŚĆ BIAŁKA I JEGO FRAKCJI W MLEKU ORAZ WSKAŹNIKI MINERALNE W SUROWICY OWIEC

### Abstrakt

Doświadczenie przeprowadzono na 26 maciorkach karmiących owcy kamienieckiej, pochodzących ze stada hodowlanego, podzielonych na 2 równe grupy, analogiczne pod względem wieku oraz typu miotu i płci odchowywanych jagniąt: I – kontrolną, II – doświadczalną. Zwierzęta obu grup otrzymywały podczas 70-dniowej laktacji taki sam zestaw pasz objętościowych: sianokiszonkę z traw i roślin motylkowych, siano łąkowe oraz mieszankę CJ. Dzienna dawka pokarmowa, w przeliczeniu na 1 matkę, obejmowała: 2,80 kg sianokiszonki z traw i roślin motylkowych, siano łąkowe i 0,6 kg mieszanki treściwej CJ. Maciorki z grupy doświadczalnej otrzymywały mieszankę CJ z dodatkiem suszonych drożdży piwowarskich *Saccharomyces cerevisiae* Inter Yeast S<sup>®</sup>, w proporcji 50 g kg<sup>-1</sup> mieszanki. Próby mleka do analiz pobierano podczas doju kontrolnego dwukrotnie, w 28. i 70. dniu laktacji, i określono w nich procentową zawartość: białka, białka serwatkowego i kazein, a także udział frakcji  $\alpha_s$ -,  $\beta$ - i  $\kappa$ -kazeiny w kazeinie całkowitej. Krew do badań pobierano dwukrotnie z żyły jarzmowej, a w otrzymanej surowicy określono koncentrację składników mineralnych: Ca, P<sub>in</sub> i Mg. Dodatek drożdży nie spowodował istotnych zmian w zawartości białka oraz białka serwatki w mleku, zarówno w szczytowej, jak i końcowej fazie laktacji, natomiast wpłynął na kształtowanie się udziału frakcji kazein. Stwierdzono, że w mleku owiec z grupy II nastąpiło istotne obniżenie poziomu  $\beta$ -kazeiny (o 2,32%), a równocześnie wzrost ( $p \leq 0,01$ ) zawartości  $\kappa$ -kazeiny (o 1,86%). Stężenie wskaźników mineralnych surowicy (Ca, P i Mg) pozostawało na zbliżonym poziomie w obydwu grupach owiec zarówno w 28., jak i 70. dniu laktacji i mieściło się w granicach wartości referencyjnych.

Wyniki badań wskazują, że dodatek suszonych drożdży piwowarskich *Saccharomyces cerevisiae* do diety owiec karmiących może mieć wpływ na jakość białka mleka.

Słowa kluczowe: owce, *Saccharomyces cerevisiae*, białka mleka, wskaźniki mineralne krwi.

## INTRODUCTION

Dry extracts of *Saccharomyces cerevisiae* brewer's yeast are a rich source of easily digestible protein (around 43%), B vitamins, minerals, enzymes as well as immunomodulators:  $\beta$ -1,3/1,6-D-glucan (up to 15%) and mannan-oligosaccharides (MOS) (up to 11%). The properties of yeast extracts are deter-

mined by the processing technology. Preparations containing only dead cells demonstrate probiotic properties, whereas extracts that contain live cells show prosymbiotic and symbiotic qualities (GRELA, SEMENIUK 2006). The supplementation of animal diets with yeast improves the feed conversion ratio, body gains, fattening performance, carcass quality, milk yield and lowers disease incidence (DOBICKI et al. 2004, DOBRZYŃSKI et al. 2006, FUCHS et al. 2007, MILEWSKI, SOBIECH 2009). Glucan and mannan, structural components of yeast cell walls, strongly inhibit the growth of pathogenic bacteria, such as *Escherichia coli* and *Klebsiella pneumoniae*, in the gastrointestinal tract. *Saccharomyces cerevisiae* yeast can, therefore, be applied as a natural stimulator in animal nutrition (DOBICKI et al. 2007, GRELA, SEMENIUK 2006, WÓJCIK et al. 2007). The stimulating effect of yeast extracts on lambs was demonstrated by MILEWSKI (2009) and MILEWSKI and SOBIECH (2009). Lambs fed dried yeast were characterized by higher growth rates, improved muscle development and higher humoral immunity parameters (MILEWSKI 2009). A study investigating the milk yield of ewes has demonstrated that yeast significantly improves milk production and increases the dry matter and fat content of milk (MILEWSKI, SOBIECH 2009). To date, no experiments have been conducted to investigate the effect of *Saccharomyces cerevisiae* dried brewer's yeast on the protein composition of ewe's milk.

The objective of this study was to determine the effect of *Saccharomyces cerevisiae* dried yeast on milk protein content and composition and the blood serum concentrations of selected minerals in sheep.

## MATERIAL AND METHODS

The experiment was conducted on 26 nursing Kamieniec ewes from a breeding herd. The animals were divided into two equal groups characterized by the same litter type, age and sex of suckling lambs: I – control and II – experimental. Throughout the 70-day lactation period, both groups were fed identical diets comprising haylage of grasses and legumes, meadow hay and CJ concentrate in daily rations of: 2.80 kg haylage of grasses and legumes, 0.6 kg meadow hay and 0.6 kg CJ concentrate per ewe. Group II animals were fed the CJ concentrate with the addition of Inter Yeast S<sup>®</sup> *Saccharomyces cerevisiae* dried yeast in the amount of 50 g kg<sup>-1</sup> of the concentrate. The quantity of administered feed and leftovers was monitored throughout the experiment. Milk was sampled during control milking runs on lactation day 28 and 70. The animals were milked manually following the administration of oxytocin in accordance with the method described by MILEWSKI and ZABEK (2008). The collected samples were analyzed to determine the content of protein, whey protein, casein,  $\alpha_s$ ,  $\beta$  and  $\kappa$  casein fractions. The percentage content of protein was determined using a Combi

Foss 6000 analyzer. Casein nitrogen and whey protein nitrogen were analyzed by Kiejdahl method. Casein fractions were identified by protein electrophoresis. Milk samples for electrophoretic separation were diluted in the 1:10 ratio. Proteins were separated on 14.5% polyacrylamide gel in the presence of SDS using a Mini-PROTEAN 3-cell system in line with the manufacturer's recommendations (Bio-Rad). The percentage of casein fractions in milk was determined with the application of Bio-Rad Quantity One 4.6 software. Blood was sampled from the jugular vein on lactation day 28 and 70. The following nutrient concentrations were determined in the blood serum: inorganic phosphorus ( $P_{in}$ ) by the phosphomolybdenum reduction assay without deproteinization, calcium (Ca) by the Moorehead and Briggs method involving o-cresolphthalein complexone (CCP), magnesium (Mg) using the Calmagite dye method and the approach proposed by Gindler and Heth and Khayem-Bashi et al. The analyses were performed in an Epoll 200 spectrophotometer using Alpha Diagnostics kits.

The results were verified statistically by the Student's *t*-test with the use of Statistica 10.0 software.

## RESULTS AND DISCUSSION

During the experiment, no differences in feed consumption were reported. Only small quantities of haylage leftovers were observed, suggesting that nutrient uptake levels were similar in both groups. The data presented in Table 1 show comparable protein levels in the milk of both ewe groups, which reached 4.98% in group I and 4.96% in group II on lactation day 28. A higher milk protein content was noted in the experimental group on lactation day 70 (a non-significant difference of 0.45%). No significant variations were reported in the percentage share of whey proteins in ewe's milk during the peak and towards the end of lactation. The yeast preparation

Table 1

Percentage of protein, whey protein and casein in sheep milk

Parameter	Day of lactation	Group I		Group II	
		$\bar{x}$	SD	$\bar{x}$	SD
Protein	28	4.98	0.43	4.96	0.44
	70	5.55	0.88	6.00	0.35
Whey protein	28	0.77	0.04	0.74	0.08
	70	0.96	0.10	0.88	0.12
Casein	28	4.00	0.29	4.07	0.40
	70	4.43	0.64	4.85	0.39

had no effect on the casein content of milk. Yeast supplementation significantly influenced the proportions of casein fractions on lactation day 70 (Figure 1). A significant drop ( $P=0.01$ ) in  $\beta$ -casein levels (by 2.32%) with a simultaneous increase ( $P=0.01$ ) in  $\kappa$ -casein concentrations (by 1.86%) were noted in the milk of group II animals. The protein content of milk noted in this study is consistent with the findings of DOBICKI et al. (2006), PRVA et al. (1993), ROBINSON and GARRETT (1999), and SWARTZ et al. (1994). In the above experiments, the addition of *Saccharomyces cerevisiae* dry brewer's yeast to diets for high-yielding cows had no effect on the protein content of milk. The percentage content of casein fractions in ewe's milk differed from that reported by ONO et al. (1989) – higher  $\beta$ -casein levels and lower  $\beta_s$ -casein concentrations were observed in our study. Caseins are bioactive milk components that affect gastric functions, demonstrate anti-thrombotic and anti-diabetic properties, prevent tooth demineralization and decay (ABD-EL-SALAM et al. 1996). Caseins deliver many health benefits.  $\kappa$ -casein prevents the adhesion of pathogenic bacteria, such as *Streptococcus pneumoniae*, *Haemophilus influenzae* and *Helicobacter pylori*, to gastric mucosal cells. The protective properties of  $\beta$ -casein have been demonstrated in cancer research (NAKAJIMA et al. 1996) and during experimental contaminations with bacteria and endotoxins (NOURSADEGHI et al. 2002). A drop in  $\beta$ -casein levels and an increase in the  $\kappa$ -casein content of milk noted in this study towards the end of the lactation period suggest that the protein composition of ewe's milk can be modified through supplementation with *Saccharomyces cerevisiae* dry brewer's yeast. The results of this study indicate that the use of brewer's yeast enhances the quality of ewe's milk, delivering significant health benefits for suckling lambs. When administered to dairy sheep, brewer's yeast improves the processing suitability of milk. These findings offer a valuable incentive for further research into the use of yeast in animal nutrition.

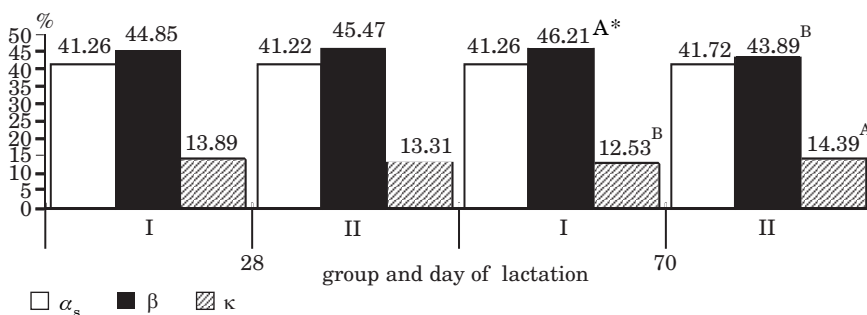


Fig. 1. Percentage content of fractions  $\alpha_s$ -,  $\beta$ - i  $\kappa$ -casein in total casein of sheep milk

\*A, B – difference statistically significant at  $p \leq 0.01$

Table 2

## Concentration of minerals in sheep serum

Parameter	Day of lactation	Group I		Group II	
		$\bar{x}$	SD	$\bar{x}$	SD
Calcium (mmol l <sup>-1</sup> )	28	2.53	0.27	2.76	0.56
	70	2.41	0.29	2.66	0.34
Phosphorus inorganic (mmol l <sup>-1</sup> )	28	1.61	0.41	1.71	0.34
	70	1.68	0.33	1.62	0.46
Magnesium (mmol l <sup>-1</sup> )	28	1.08	0.06	1.11	0.07
	70	1.12	0.11	1.19	0.23

Concentrations of calcium and magnesium in serum of sheep from the experimental group were higher than in the control group throughout the experiment, but these changes were not statistically important. Concentrations of phosphorus in serum of sheep from the experimental group were higher on 28 day of lactation, but decreased on 70 day of lactation and these changes were not statistically important as well (Table 2). These results indicate that yeast has no effect on the content of the bioactive elements studied, as previously demonstrated by GALIP (2006), PAYANDEH and KAFILZADEH (2007) and MILEWSKI and SOBIECH (2009). A decrease in Mg concentrations in the blood serum of cows fed yeast was reported by NIKKHAH et al. (2004), but in the described experiment, feed was supplemented with live yeast cultures. The underlying mechanism has not been fully explained, and it could be attributed to the ability of selected cations to bind across the yeast cell wall, which limits cation absorption from feed (GARCIA et al. 2000).

## CONCLUSIONS

1. The addition of yeast to diets for nursing ewes did not significantly change milk protein content and mineral concentrations in the serum.

2. The supplement improved the proportions of casein fractions in total milk casein.

3. A drop in  $\beta$ -casein levels and a simultaneous increase in the k-casein content of milk was noted towards the end of the lactation period, suggesting that dry brewer's yeast improves the nutritional value of ewe's milk.

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