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Yeast cells as a feed supplement for cattle 3. New yeast preparations for cows in the first period of lactation

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ABSTRACT

A study was conducted on 28 cows between the third week preceding and fourteenth week after calving. The cows were divided into 4 groups of 7. The animals in the control group (C) were fed a basic ration consisting of maize and beet top silage, meadow hay, soyabean oilmeal, concentrate for extra milk production and mineral mixtures according to the INRA system. This ration was supplemented for the experimental groups with Yea-Sacc preparation (Y) or with preparations containing baker's yeast *Saccharomyces cerevisiae* G1 produced according to a cell-engineering method (X) or *Saccharomyces carlsbergensis* brewery strain SK-1 (S).

Average milk production during the experimental period in the respective groups was, in kg: 26.7 – C; 28.2 – X and S; 27.7 – Y; the milk-fat content: 4.05; 4.01; 3.99 and 4.29% and protein content, 3.01; 2.98; 3.09 and 3.15%. The persistence of milk yield after the peak of lactation was greater in cows receiving a yeast supplement than in the cows of the control group.

KEY WORDS: yeast preparation, lactating cows, milk yield

INTRODUCTION

The results of numerous experiments and practical trials on dairy cows have shown that supplementing the diet with Yea-Sacc preparation containing

Saccharomyces cerevisiae 1026 produced by Alltech Biotechnology Center stimulates milk yield and improves milk composition (Dildey, 1988; Williams, 1989; Wohlt et al., 1991; Wallace and Newbold, 1992; Cooley, 1993; Skórko-Sajko et al., 1993). Recent studies have concentrated on new yeast strains and fungi that increase the effects of ruminant nutrition (Fondevila et al., 1990; Williams and Newbold, 1990; Moore and Headon, 1992; Wallace and Newbold, 1992; Dawson, 1993). Strzetelski et al. (1995a,b) obtained yeast preparations containing different strains of *Saccharomyces carlsbergensis* yeast and demonstrated their suitability for feeding calves and fattening bulls.

The aim of the present experiment was to assess the effectiveness of new yeast supplements containing *Saccharomyces cerevisiae* G1 and *Saccharomyces carlsbergensis* SK-1 in dairy cow nutrition.

MATERIAL AND METHODS

Animals and experimental design

The experiment was carried out on 28 Black-and-White Lowland cows divided into 4 groups of 7 animals allotted to the groups by the analog method at 3 weeks before calving, taking into account maximum milk yield at the peak of the previous lactation, number of lactations (2 to 4) and 30 to 70% of hf blood proportion. Allocation to the groups was completed within 2 months.

The cows were fed individually at a controlled feed intake. The concentrate mixture consisted of (%): ground barley, 35; wheat bran, 15; ground triticale, 13; soyabean oilmeal, 21; dehydrated whole barley crop with undersown lucerne, 10; meat-and-bone meal, 2; mineral mixture[1], 4. Daily rations were established according to the INRA (IZ, 1993) using INRAtion 2.03 software (1993). The cows were given maize silage, beet top silage, meadow hay, soyabean oilmeal and concentrate mixture. Rations for experimental groups were supplemented with 10 g/cow/day of the respective yeast preparation. During the 3 weeks before calving up to day 6 after calving, the cows received rations according their maximal milk production during the preceding lactation, afterwards the rations were corrected according to predicted maximal milk yield calculated after calving (IZ, 1993).

[1] – mineral mixture composition (%): 12.5 $CaHPO_4 \cdot 2H_2O$; limestone, 12.5; premix B, 12.5; commercial mineral mixture MMB, 62.5.
1 kg of mineral mixture contained, g: P – 46, Ca – 156, Na – 80, Mg – 29, Zn – 3.42, Cu – 0.98, Co – 0.02, Mn – 2.54, Fe – 0.325, J – 0.012

The cows of the control group (C) were fed a basal diet without yeast supplement. Rations for the experimental groups were supplemented with Yea-Sacc preparation containing *Saccharomyces cerevisiae* 1026 (Y) or one of two of own yeast supplements containing *Saccharomyces carlsbergensis* brewery strain SK-1 (S) or baker's yeast *Saccharomyces cerevisiae* strain G-1 (X). The feeding trial was terminated after 14 weeks of lactation. Daily milk yield and fat and protein content in 3-day bulked samples were determined.

Yeast supplements

Yea-Sacc supplement was obtained from Alltech Biotechnology Center Agency in Warsaw. Agar cultures of *Saccharomyces carlsbergensis* SK-1 and *Saccharomys cerevisiae* G1 were obtained from the Institute of Biotechnology of the Agriculture and Food Industry in Warsaw. The yeast inoculum was incubated for 48 h at 30^{0}C. The pure laboratory culture was obtained by initial cultivation on YPG followed by cultivation on diluted 1:10 molasses wort supplemented with minerals. The period of incubation in both cases was 24 h at 30^{0}C. Cultivation of yeast was carried out at first on a laboratory scale in a 4.5 l fermenter (Chemap Type LF7) and afterwards in a 100 l macro fermenter (New Brunswick) for 16 h in both cases. The carbon and energy source for yeast was molasses wort containing 50% of polarimetrically determined sugar. The wort was supplemented with 98 g ammonium sulphate, 13.6 g dibasic ammonium phosphate and 5.6 g magnesium sulphate. Cultivation was carried out at 30^{0}C, pH = 5.2 and pO_2 = 5 to 10%. Dry yeast preparations were obtained by spinning yeast wort and drying of the biomass by fluidization, except the preparation for group X, which was dried by fluidization of the biomass mixed with barley bran (1:0.75) as a carrier.

Analysis and calculations

The density of yeast cultures administered to animals was determined in a Burker chamber by counting the number of yeast cells in samples fixed in formalin-glicerol and expressed as the number of cells per gram of preparation.

Proximate analysis of feed samples was carried out using conventional methods (AOAC, 1975). The nutritive value of feeds was estimated according to the INRA system (1988) using Polish computer software INWAR 1.0 (1993). Fat and protein content in milk was determined using Milko-Scan 133B equipment.

The obtained data were subjected to variance analysis with multiple range test using Statgraphics Plus 6.0 software (1992).

RESULTS

Average yeast culture density (n x 10^6 cells/g) was 85, 107 and 517 in groups Y, S and X, respectively. Nutrients content in feeds and feeding value of the diet are given in the Table 1. Feed intake in animals of the control group (C) was slightly less (about 3%) and of group Y more (about 2%) than in the groups S and X, however, these differences were not significant ($P > 0.05$). Average daily feed intake for all animals was (kg/day): maize silage – 23.7; beet top silage – 5.0; meadow hay – 3.6; soyabean oilmeal – 0.8 and concentrate mixture – 8.0 (Table 1). Daily intake of nutrients in cows of group C was: 16.8 kg DM; 2816 g CP; 1709 g PDI (PDIE – PDIN = –54) and 14.3 UFL. There were no significant differences between the groups in nutrients and feed intake ($P > 0.05$), although supplementing diets with a yeast preparation slightly increased nutrients intake, on average by: DM, 3%; CP, 4%; PDI, 1.5 and UFL, 3.

TABLE 1

Composition of feeds and nutrients content

Feed	DM	Ash	CP	CF	Fat
Barley ground	88.02	2.12	10.91	4.14	2.43
Wheat bran	86.24	3.30	13.60	5.37	4.33
Triticale ground	86.83	2.61	13.30	3.16	1.77
Soyabean oilmeal	87.99	6.66	43.08	7.17	2.35
Whole barley crop dehydrated with undersown lucerne	90.14	5.78	12.21	19.22	3.36
Meat-and-bone meal	93.80	28.20	38.60	–	24.50
Concentrate mixture[1]	87.80	4.12	18.63	6.08	3.05
Maize silage[2]	22.95	1.48	1.89	5.09	1.35
Beet top silage[3]	19.26	3.47	2.84	4.31	1.08
Meadow hay[4]	84.33	4.65	12.68	29.36	1.98

in 1 kg DM according to INRA system (1988):
[1] – 128 g PDI (PDIE – PDIN = –16), 1.08 UFL
[2] – 51 g PDI (PDIE – PDIN = 10), 0.89 UFL
[3] – 83 g PDI (PDIE – PDIN = –7), 0.58 UFL
[4] – 87 g PDI (PDIE – PDIN = –7), 0.73 UFL

Milk yield in the cows of the experimental groups was 5, 6 and 4% higher in group X, S and Y, respectively, than in the control group, however, these differences were not statistically significant (Table 2). The persistence of milk yield after the peak of lactation in the control group was lower (77%) than in the experimental groups: 85% in groups X and S, 90.5% in group Y (Figure 1).

TABLE 2

Milk yield and composition

Item	Group				
	C	X	S	Y	SE
Milk yield, kg/day					
initial[1]	19.46	20.85	21.23	20.79	1.94
final[2]	23.46	27.20	26.60	25.32	4.88
average	26.72	28.18	28.22	27.71	3.77
FCM	26.92	28.15	28.06	28.75	3.44
Milk fat, %	4.05	4.01	3.99	4.28	0.30
Milk protein, %	3.01	2.98	3.09	3.15	0.20

[1] – average of first day lactation
[2] – average of 14-th week lactation

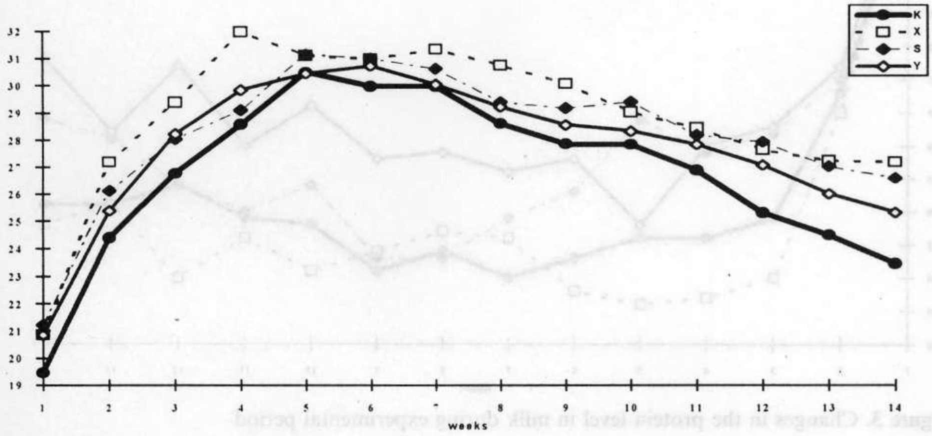

Figure 1. Changes in the daily milk production during experimental period

Milk fat and protein contents in group Y were slightly, but not significantly, higher during the entire experimental period than in the remaining groups (Figures 2 and 3). Supplementing the basal diet with yeast did not affect nutrients utilization ($P > 0.05$), however, the cows of the control group needed somewhat (3%) more nutrients for production of 1 kg milk (0.63 kg DM, 105 g CP, 64 g PDI and 0.53 UFL) than animals of the experimental groups. All cows used about 0.32 kg concentrate, including compensating mixture, for 1 kg milk produced.

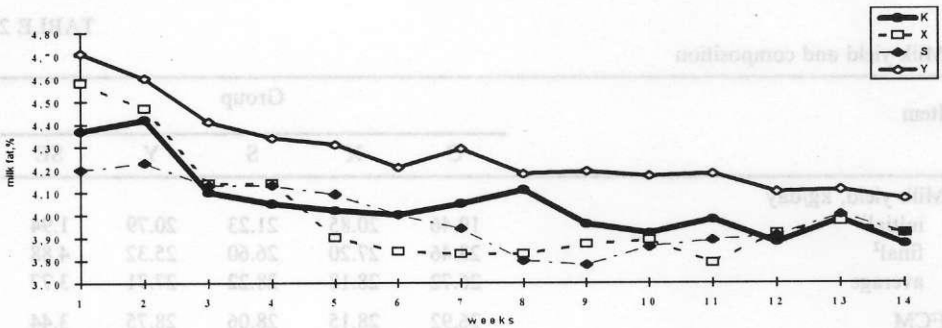

Figure 2. Changes in the fat level in milk during experimental period

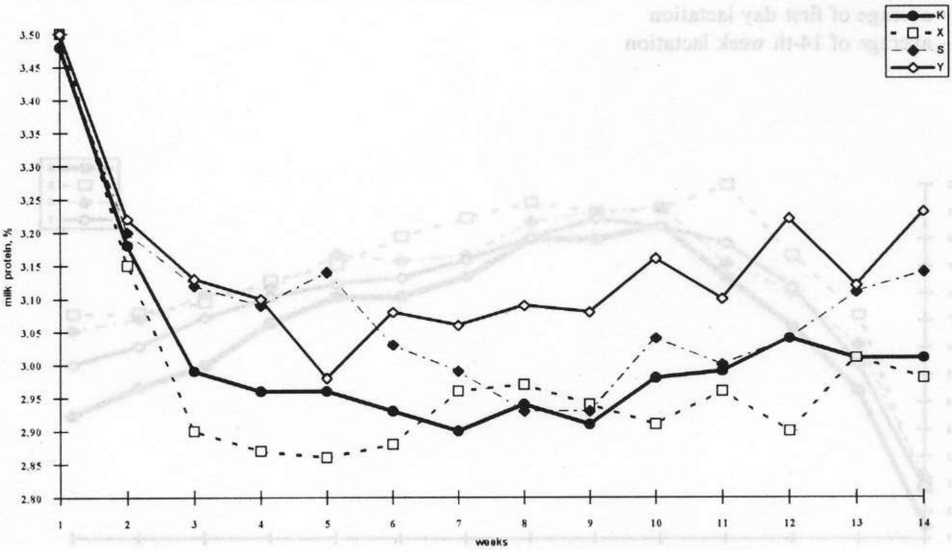

Figure 3. Changes in the protein level in milk during experimental period

DISCUSSION

Results obtained in this experiment confirmed the finding of other authors that Yea-Sacc stimulates milk yield in cows (Dildey, 1988; Harris and Lobo, 1988; Williams, 1989; Harris and Webb, 1990; Williams and Newbold, 1990; Wallace and Newbold, 1992; Skórko-Sajko et al., 1993). One of the interesting results is that supplementing diets for cows with *Saccharomyces carlsbergensis* SK-1 affected not only milk production but also tended to increase protein and decrease fat content in milk. May be this supplement, similarly as *Saccharomyces* *cerevisiae* 1026 present in Yea-Sacc, can lead to increased protein and amino acid delivery and advantageous changes in amino acid profile in protein reaching the duodenum (Erasmus, 1991; Erasmus et al., 1992).

The increased fat content in milk in the group receiving the Yea-Sacc supplement could result from a change in the rumen fermentation pattern that increased acetic acid production (Harrison et al., 1988). In our earlier studies on digestion in the rumen (Strzetelski et al., 1995b), a high ratio of C_2:C_3 (4.4) was found in bulls fed diets supplemented with Yea-Sacc. Williams et al. (1991) and Piva et al. (1993) found a similar increase of the C_2:C_3 ratio in the rumen of dairy cows and increased fat content in milk after supplementing the diet with the Yea-Sacc preparation.

The higher milk yield after supplementing diets with yeast preparations was probably caused by higher DM intake compared with the control group (Williams and Newbold, 1990; Wohlt et al., 1991). The advantageous effect of yeast preparation on milk production, which was marked during all periods of the experiment, could also be a result of a better established fermentation pattern in the rumen compared with that in control animals (Harrison et al., 1988; Adams et al., 1995). This conclusion is supported by the higher persistence of milk yield after peak of lactation in our experiment.

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STRESZCZENIE

Zastosowanie drożdży jako dodatku paszowego w żywieniu bydła.
3. Nowe preparaty drożdżowe dla krów w pierwszym okresie laktacji

Wpływ dodatków preparatów drożdżowych na efekty produkcyjne badano na 28 krowach rasy ncb podzielonych na 4 grupy po 7 sztuk w każdej. Doświadczenie trwało od 3 tygodnia przed wycieleniem do 14 tygodnia po wycieleniu. Grupa kontrolna (C) otrzmywała dawkę podstawową bez preparatu natomiast do dawek dla grup doświadczalnych dodawano preparat Yea-Saac (Y) lub preparaty wyprodukowane według własnej technologii zawierające drożdże piekarnicze *Saccharomyces cerevisiae* G1 otrzymane metodą inżynierii komórkowej (X) bądź *Saccharomyces carlsbergensis* szczepu piwowarskiego SK-1 (S).

Średnia produkcja mleka w ciągu całego doświadczenia wynosiła, kg: 26,7 – C; 28,2 – X i S; 27,7 – Y, zawartość tłuszczu w mleku wynosiła odpowiednio: 4,05; 4,01; 3,99 i 4,28%, a białka – 3,01; 2,98; 3,09 i 3,15%. U krów otrzymujących dodatki preparatów wytrwałość produkcji mleka po szczycie laktacji była większa niż w grupie kontrolnej.