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EFFECT OF *SACCHAROMYCES CEREVISIAE* SUPPLEMENTATION ON HEALTH AND PERFORMANCE OF DAIRY COWS DURING TRANSITION AND EARLY LACTATION PERIOD

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Abstract: Data concerning the effect of probiotics supplementation on many parameters concurrently at the same cows are lacking. Therefore, the objective of this experiment was to investigate the effects of *Saccharomyces cerevisiae* feeding on rumen, blood and milk parameters together in high-producing dairy cattle during the transition and early lactation period. Sixteen clinically healthy Holstein cows were divided into 2 groups: a control group of 6 cows and a probiotics-fed group of 10 cows. Rumen fluid and blood samples were collected 21 days before the expected calving as well as 7, 15, 30, 45 and 60 days-in-milk (DIM). Milk yield for each animal was recorded every 2 weeks. Individual milk samples were collected 15, 30, 45 and 60 DIM. Ruminal pH and rumen ammonia nitrogen were significantly lower, whereas total volatile fatty acids were significantly higher in yeast-fed animals compared with controls throughout the study. Serum concentrations of total proteins and globulins were higher, while albumins were lower in the yeast-treated group. Serum glucose levels were significantly higher in yeast-supplemented animals. Serum triglycerides, high density lipoproteins, and low density lipoproteins concentrations were lower, with cholesterol being significantly lower in the treated group. Milk production and milk fat percentage were higher, whereas milk protein percentage and somatic cell count were decreased in yeast-supplemented cows throughout the study. These results suggest that supplementation of *S. cerevisiae* to dairy cows rations during transition and early lactation period improve their health and milk production parameters.

Key words: blood biochemical parameters, cows, *Saccharomyces cerevisiae*

Introduction

The transition period of a dairy cow is defined as the change from the pregnant, non-lactating state to the non-pregnant, lactating state; it lasts from 3 weeks pre-partum until 3 weeks postpartum (*Goff and Horst, 1997*). It is characterised by numerous changes in physiological, metabolic and endocrine status to accommodate parturition and lactogenesis (*Grummer, 1995*). If nutritional management does not meet these challenges, the transition cow is at high risk of developing a wide range of health problems soon before and, mainly, after parturition *(Bell, 1995)*, like milk fever, fatty liver, ketosis, retained placenta, displaced abomasum, and suppressed immune function (*Goff and Horst, 1997*).

Probiotics are beneficial for animals, affecting their health and production by various mechanisms that are not yet fully understood *(Shriver-Munsch, 2011)*. Feeding yeast (*Saccharomyces cerevisiae*) or its fermentation products during the transition period may counteract some of those challenges by improving appetite, nutrient utilisation and immune function *(Shriver-Munsch, 2011).* Yeast culture used as a dietary supplement for dairy cattle is thought to improve rumen function, and hence milk production and feed efficiency, by stimulating selective growth of rumen bacteria species (*Harrison et al., 1988*).

Inclusion of *S. cerevisiae* in ruminants' diets has been shown to alter the molar proportion of ruminal volatile fatty acids (VFAs) (*Newblod et al., 1990; Dawson, 1993*), reduce rumen ammonia concentration, increase the number of ruminal bacteria and protozoa and alter the flow of the nitrogen (N) fraction to the duodenum (*Dawson, 1993; Williams et al., 1991*). Furthermore, a study by *Kumar et al. (1994)* showed that supplementation of yeast culture as a growth promoter for buffalo calves resulted in increased rumen pH, total bacteria and protozoa culture counts, total VFAs, total N and microbial protein, with reduced rumen ammonia N concentration and improved digestion of cellulose and dry matter (DM) intake. Other researchers have reported that live yeast and yeast culture supplementation may increase feed intake and milk production of dairy cows (*Robinson and Garrett, 1999; Dann et al., 2000*).

However, each published study has investigated the effect of *S. cerevisiae* feeding to dairy cows selectively on a few parameters (either milk yield or milk composition, or either blood biochemical or ruminal parameters) and, therefore, data concerning its effect on many of the parameters together are lacking. The objective of the present study was to investigate the effect of feeding *S. cerevisiae* concurrently on rumen parameters, blood biochemical parameters, milk production,

and milk composition in high-producing dairy cows during the transition and the early lactation period.

Materials and methods

Probiotics (live yeast)

For the study, *Saccharomyces cerevisiae* live yeast culture (Levucell SC 20®, Lallemond co., France) was used as feed-additive. Each gram of Levucell SC 20® provided 20×10^9 CFU/g of *S. cerevisiae* (CNCM 1-1077).

Experimental design, feeding and management

The present study was carried out in a private farm in Ihnasia city, Beni-Suef governorate in Egypt. Sixteen clinically healthy Holstein cows aged 4-5 years old, with an average body weight of 530±22 kg (mean±SE) were used. The animals were randomly allocated into 2 groups that were similar according to parity, body weight and previous mean total milk yield. The first (group A) was consisted of 6 animals, fed on a diet without yeast supplementation and kept as a control group. The second (group B) was consisted of 10 cows, fed on the same diet as group A plus daily in-feed inclusion of 0.5 g/animal of live yeast culture (*Levucell SC 20*®).

Table 1. Ration composition: Ingredient composition (%) of close-up dry period and early lactation diets on a dry matter (DM) basis.

Ingredients (%)	Close-up dry period diet	Early lactation diet
Corn silage	59.35	50.71
Yellow corn (grain)	12.55	19.39
Soya bean meal	12.10	14.17
Beet pulp	10.27	7.46
Alfa-alfa hay	4.57	5.97
Rumen-protected fat	0.00	0.82
Sodium bicarbonate	0.00	0.48
Monocalcium phosphate	0.11	0.36
Sodium chloride	0.09	0.24
Magnesium oxide	0.00	0.12
Mineral mix[a]	0.09	0.12
Vitamin mix[b]	0.05	0.06
Calcium carbonate	0.00	0.05
Calcium chloride	0.27	0.00
Magnesium sulphate	0.55	0.00

[a] Copper sulphate 2800 mg/kg, cobalt carbonate 300 mg/kg, sodium selenite 25 mg/kg, ferrous carbonate 750 mg/kg, magnesium oxide 250 mg/kg, potassium iodide 100 mg/kg and zinc oxide 150 mg/kg.

[b] Vit. A 10,000 IU/kg, vit. D 1,000 IU/kg and vit. E 20 mg/kg.

The animals were housed in a clean and spacious open yard. Cows were milked by an automated milking machine three times daily and fed on a total mixed ration to meet the recommendations of the National Research Council (*NRC, 2001*).They were accustomed to 2 diets, the close-up dry period diet (fed 3 weeks before expected calving up to the day of parturition) and the early lactation diet (fed from parturition up to 60 days-in-milk - DIM). The ingredients and nutrient composition of the 2 diets are shown in Tables 1 and 2.

Table 2. Ration composition: Chemical composition of close-up dry period and early lactation diets on a dry matter (DM) basis.

Chemical composition	Close-up dry period diet	Early lactation diet
NEL[1] (MJ/kg DM)	6.987	7.238
Crude protein (%)	13.9	14.9
Crude fat (%)	2.74	2.82
Crude fiber (%)	18.5	16.5
NDF[2] (%)	39.0	34.4
ADF[3] (%)	23.2	20.7
Calcium (%)	0.43	0.46
Phosphorus (%)	0.44	0.50
Sodium (%)	0.08	0.26
Magnesium (%)	0.21	0.27
Copper (mg/kg DM)	11.4	11.2
Zinc (mg/kg DM)	24.4	25.2

[1] Net Energy for Lactation; [2] Neutral Detergent Fiber; [3] Acid Detergent Fiber

Samplings and analyses

Rumen and blood samples were collected at the commencement of the experiment (21 days before the expected calving date), as well as 7, 15, 30, 45 and 60 DIM. All animals were clinically examined before each sampling.

Rumen fluid

Rumen fluid was collected from all animals using stomach tubing, 4 hours after the morning feeding. At each sampling 100 mL of rumen fluid were collected into a clean, dry flask. Ruminal pH was immediately measured using a portable digital pH meter (350 portable pH meter, JENWAY, Essex, UK). Rumen fluid samples were kept frozen (-20˚C) for analysis. Rumen ammonia nitrogen concentration was determined according to the method proposed by *Conway*

(1974) and total VFAs samples were assayed by steam distillation, according to the method described by *Abou-Akkada and El-Shazly (1964)*.

Blood samples

Blood samples were collected by jugular venipuncture, 2 hours after the morning feeding**.** Samples were centrifuged at 4000 rpm for 15 min to obtain blood sera, which were stored at -20ºC until analysis.

Serum was tested for total proteins (TP) and albumins (ALB) according to *Doumos et al*. (1971), and then serum globulins (GLOB) were calculated. Serum glucose levels were estimated according to *Trinder (1969*). Concentrations of serum total cholesterol, triglycerides, high density lipoproteins (HDL) and low density lipoproteins (LDL) were measured using commercial kits (SPECTRUM DIAGNOSTICS, Obour City, Egypt).

Milk samples

Milk yield of each animal was recorded every 2 weeks. Individual milk samples of each animal were collected for analysis at 15, 30, 45 and 60 DIM. Fat percentage, protein percentage and somatic cell count (SCC) were measured at Animal Reproduction Research Institute using MilkoScan analyser (FOSS ANA MilkoScan FT 120, GERBER INSTRUMENTS, Effretikon, Switzerland), according to the method proposed by *Zecconi et al. (2002)*.

Statistical analysis

Data were statistically analysed using SAS computer software (*SAS, 1985*). The general linear model function was used for analysis of variance (ANOVA). Statistically significant differences between treatment means were measured by least significant difference and means were considered different at ($P < 0.05$) and at ($P < 0.01$).

Results

All 16 animals remained clinically healthy during the whole experimental period. There was not any statistically significant difference between any of the investigated parameters at the commencement of the experiment (21 days before the expected calving) between experimental groups.

Rumen fluid parameters for control and *S. cerevisiae*-fed animals are shown in Table 3. Ruminal pH was significantly lower at 15 ($P<0.05$), 45 ($P<0.01$) and 60 ($P<0.05$) DIM in yeast-fed animals compared to control ones. The levels of

rumen ammonia nitrogen in yeast-treated cows were significantly lower than controls at 15 ($P<0.05$), 30 ($P<0.01$) and 45 ($P<0.01$) DIM. Total VFAs concentrations were significantly higher in treated animals compared to the control cows throughout the experiment.

Table 3. Effect of feeding *S. cerevisiae* during transition and early lactation period on rumen fluid parameters of Holstein dairy cows.

Groups	Rumen fluid parameters	Days from parturition					
		-21d	+ 7d	+ 15d	+ 30d	+ 45d	+ 60d
A (Control cows)	pH	6.86±0.20	7.30±0.15	7.22±0.16**	7.28±0.28	7.3±0.14*	7.38±0.13**
	Ammonia nitrogen (mg/mL)	15.16±0.81	14.0±1.98	15.96±2.9**	16.52±1.53*	16.8±1.98*	13.16±0.76
	Total VFAs[1] (mg/mL)	2.36±0.25	2.4±0.17**	3.1±0.34*	2.16±0.26*	2.04±0.22**	2.16±0.35**
B (Yeast-fed cows)	pH	6.84±0.18	7.21±0.31	7.01±0.15**	7.16±0.34	6.95±0.19*	7.02±0.26**
	Ammonia nitrogen (mg/mL)	14.84±1.18	12.72±1.76	13.1±1.91**	12.9±1.94*	12.9±2.03*	11.48±1.72
	Total VFAs (mg/mL)	2.36±0.21	2.71±0.27**	4.09±0.2*	2.8±0.38*	2.5±0.39**	2.6±0.37**

[1]Volatile Fatty Acids; * Significantly different *(P<0.01);* **Significantly different *(P<0.05)*

As shown in Table 4, serum TP concentrations tended ($P>0.05$) to be higher in the yeast-supplemented group B than those in the control group A, except for the 45th DIM where they were lower. On the contrary, serum ALB values showed a non-significant ($P>0.05$) reduction in the yeast-supplemented group compared with control ones throughout the study. GLOB concentrations tended ($P>0.05$) to be higher in the yeast-supplemented group, except for the 60th DIM where a significant difference ($P<0.01$) was noted.

Table 4. Effect of feeding *S. cerevisiae* during transition and early lactation period on blood serum parameters of Holstein dairy cows.

Groups	Parameters	Days from parturition					
		-21d	+7d	+15d	+30d	+45d	+60d
A (Control cows)	Total proteins (g/L)	70.1±10.12	70. 4±7.3	77.3±10. 4	79.2±12.5	82.0±8.8	82.6±3.3
	Albumins (g/L)	39.5±1.4	40. 1±2.1	41.1±4.1	42.9±4.7	42.9±5.1	41.5±5.1
	Globulins (g/L)	31.5±3.9	30. 3±4.0	36.2±7.8	36.3±5.1	39.1±7.6	41.1±4.5[3]
	Glucose (mmol/L)	3.73±0.37	3.74±0.37	3.76±0.35	3.70±0.14[3]	3.56±0.21[3]	3.72±0.19[3]
	Triglycerides(mmol/L)	0.31±0.05	0.36±0.04	0.33±0.04	0.39±0.03	0.35±0.06	0.26±0.05[4]
	HDL[1] (mmol/L)	2.02±0.24	2.26±0.34	2.64±0.46	2.51±0.35	3.2±0.33[**]	3.40±0.4
	LDL[2] (mmol/L)	0.76±0.17	0.71± 0.11	0.9± 0.1	0.88 ± 0.13	0.84 ± 0.22	0.81± 0.13
	Total cholesterol(mmol/L)	2.51±0.32	2.46±0.31	3.45±0.35	3.95±0.61[3]	4.1±0.31[*]	4.44±0.53[4]
B (Yeast-fed cows)	Total proteins (g/L)	71.4±7.0	72.0±5.5	77.4±8.1	80. 5±11.0	80. 2±11.9	85.9±5.7
	Albumins (g/L)	38.5±4.5	38.3±5.3	39.4±3.6	38.3±6.0	40. 2±4.5	38.9±4.5
	Globulins (g/L)	32.9±4.5	33.7±6.7	38.0±7.3	42.2±11.1	40.0±10. 6	47.0±5.8[3]
	Glucose(mmol/L)	3.72±0.42	3.75±0.14	3.82±0.28	3.93±0.15[3]	3.89±0.27[3]	3.99±0.11[3]
	Triglycerides(mmol/L)	0.31±0.08	0.36±0.07	0.28±0.04	0.39±0.03	0.33±0.06	0.21±0.03[4]
	HDL (mmol/L)	1.92±0.27	2.02±0.27	2.63±0.39	2.21±0.50	2.42±0.54[4]	2.91±0.56
	LDL (mmol/L)	0.66± 0.11	0.71± 0.1	0.74± 0.18	0.74± 0.11	0.75± 0.17	0.80± 0.20
	Total cholesterol(mmol/L)	2.52±0.51	2.23±0.43	3.34±0.42	2.85±0.35[3]	3.04±0.50[3]	3.55±0.71[4]

[1]High Density Lipoproteins; [2] Low Density Lipoproteins; [3] Significantly different *(P<0.01);* [4]Significantly different *(P<0.05)*

Serum glucose levels were significantly higher (P<0.01) in yeast-supplemented animals than controls at 30, 45 and 60 DIM. Concerning the effects of probiotics upon serum lipids, a significant reduction (P<0.05) in the levels of triglycerides was evident at 60 DIM in *S. cerevisiae*-supplemented group. HDL levels were significantly lower (P<0.05) in yeast-fed group at 45 DIM, while for LDL no significant differences were observed between 2 groups during the whole study period. Furthermore, a significant reduction was found for serum cholesterol concentrations in the yeast-fed group compared to the control group at 30 (P<0.01), 45 (P<0.01) and 60 (P<0.05) DIM.

Regarding milk production and milk parameters (Table 5), the results revealed that milk yield was higher in yeast-supplemented group, but it was significantly higher (P<0.01) only at 60 DIM. Milk fat percentage was higher (P>0.05) in yeast-fed group throughout the study. In contrast, a significant reduction (P<0.01) was evident for milk protein percentage at 45 and 60 DIM in

yeast-fed animals. Similarly, SCC was lower in this group, but significantly lower (P<0.01) at 15 DIM.

Table 5. Effect of feeding *S. cerevisiae* during the transition and early lactation periods on milk production and milk parameters of Holstein dairy cows.

Groups	Parameters	Days-in-milk			
		+15d	+30d	+45d	+60d
Group A (Control cows)	Milk yield (kg)	28.86 ±2.35	27.18 ±3.08	29.00 ±2.15	28.42 ±2.51**
	Milk fat %	3.66±0.16	3.73±0.92	3.52±0.52	3.86±0.45
	Milk protein %	2.57±0.30	2.61±0.30	2.78±0.08*	3.02±0.26*
	Somatic cell counts (10^3/mL)	84.00±17.28*	66.0±24.53	41.25±16.46	66.5±18.78
Group B (Yeast-fed cows)	Milk yield (kg)	29.61±2.88	29.56±4.24	31.79±3.17	31.03±2.05**
	Milk fat %	3.67±0.83	3.85±0.95	3.95±0.54	4.11±0.44
	Milk protein %	2.78±0.22	2.43±0.06	2.41±0.12*	2.44±0.07*
	Somatic cell counts (10^3/mL)	58.5±16.22*	46.37±14.09	34.75±15.21	54.5±17.56

* Significantly different *(P<0.01);* ** Significantly different *(P<0.05)*

Discussion

The results showed that rumen pH was lower in yeast-fed animals compared to controls. These results are in accordance with those found by other workers *(Herrick,1971; Khattab et al., 2003).* The reduction in the rumen pH of yeast-fed animals may be attributed to the increase in the concentration of VFAs production *(Hristov et al., 2001; Ghorbanietal., 2002)* and/or the increase in lactate synthesis in probiotics-supplemented animals *(Benjamin 1990).* The fact that the total VFAs concentration in our study were higher in the yeast-fed group throughout the experimental period is supportive for the hypothesis of *Hristov et al. (2001)* and *Ghorbani et al. (2002).* The present results concerning total VFAs are consistent with those obtained by previous *studies (Windschtil, 1991; 1998; Agarwal et al., 2002; Abd El-Tawab, 2007).* The increase of total VFAs concentrations in yeast-supplemented animals may be attributed to decreased methane production and consequent reduction of energy loss, providing thus additional energy for VFAs synthesis *(Williams and Newbold, 1990).*

Concentrations of rumen ammonia nitrogen were significantly lower in the yeast-treated animals. This is in agreement with previously published results *(Harrison et al., 1988; Carro et al., 1992; Erasmus et al., 1992).* The reduction of rumen ammonia nitrogen in yeast-supplemented animals may be attributed to the incorporation of ammonia into microbial proteins rather than a decrease in protein degradation *(Williams and Newbold, 1990),* or it may be due to an inhibitory effect on proteolysis, amino acid production, or ruminal urease activity *(Khattab et al., 2003).*

Concentrations of serum TP and GLOB were non-significantly higher in yeast-supplemented group. Similar results were obtained by other researchers *(Abd El-Tawab, 2007; Helal and Abdel-Rahman, 2010).* The elevation in the levels of serum TP in probiotics-treated animals may be attributed to the fact that yeast supplementation stimulates the rumen microbial protein synthesis, so it elevates the populations and the activity of cellulolytic bacteria in rumen, consequently enhancing the fiber digestion, lactate utilization in the rumen and increase flow of microbial protein from the rumen to duodenum (*Guedes et al., 2008*). Moreover, the elevated levels of GLOB in the *S. cerevisiae*-fed group may be due to the increase of net globulins, as a result of the increase in gamma globulins caused by Kupffer cell proliferation and an increase in the number of plasma cells in the bone marrow *(Benjamin, 1984)*. This hypothesis is supported by other researchers *(Buts et al., 1990),* who found that oral administration of *S. cerevisiae* to growing rats significantly increased IgA and secretory components of immunoglobulins.

Serum ALB values were not significantly different between the 2 groups, although a slight reduction was observed in the yeast-supplemented group. This reduction might be attributed to the increased milk production of these animals *(Benjamin, 1984; Helal and Abdel-Rahman, 2010).* Results of milk production in the present study favour this hypothesis.

The finding that serum glucose levels were significantly higher in yeast-supplemented animals is in agreement with the results of other studies *(Abd El-Tawab, 2007; Kawas et al., 2007; Stanislaw and Przemyslaw, 2009).*The glucose increase in yeast-treated animals may be attributed to increased gluconeogenesis, which raises blood glucose levels in ruminants (*Huntington and Eisemann, 1988*).This explanation is supported by *Antunovic et al. (2005),*who recorded low glucose levels in probiotics-treated lambs after inhibition of gluconeogenesis by insulin, which inhibits phosphorylase and gluconeogenic enzymes. It is worth mentioning that propionate is the major precursor for gluconeogenesis in ruminants and thus increments of rumen propionate production result in an increase of hepatic glucose production *(Reynolds et al., 2003; Stein et al., 2006).* The higher propionic acid production is the cause of the increased glucose levels in *S. cerevisiae*-fed cows *(Nisbet and Martin, 1991).* Several studies demonstrated that feeding *S. cerevisiae* increased the production of acetate, propionate, and total VFA in dairy cows *(Nisbet and Martin, 1991; Piva et al., 1993; Miller-Webster et al., 2002).* Total VFAs were significantly higher for yeast-fed cows in our experiment and this could explain the recorded higher glucose levels in yeast-treated cows.

Serum triglycerides, HDL, LDL and cholesterol were lower in the yeast-fed group compared with the control one. This reduction may be due to an increase in lipid metabolism and utilisation by the cows because of their increased milk production *(Stein et al., 2006)*, which was the case for the group of the yeast-supplemented cows in our study. Moreover, the reduction in cholesterol level could be attributed to the inhibition of the cholesterol synthesis or the direct assimilation

of cholesterols *(Zacconi et al., 1992).* The lipid profile estimated in the current study is in harmony with that reported by other researchers *(Taranto et al., 1998; Begely et al., 2006).*

The higher milk yield recorded for the yeast-supplemented cows in our experiment has also been observed by other workers and may be attributed to an increase in DM intake *(Robinson and Garrett, 1999, Jounay, 2006),* a greater flow of microbial protein and amino acids to the duodenum (*Erasmus et al., 1992*), and the fact that yeast supplementation may act as a source of vitamin B complex *(Abdel-Khalek, 2003; Helal and Abdel-Rahman, 2010).* However, some other researchers *(Erdman and Sharma, 1989; Arambel and Kent, 1990; Kung et al., 1997)* have not found probiotic administration to increase the milk production in cows.

The results for milk fat percentage in the present study are in agreement with those recorded by others *(Oetzel et al., 2007; Hanafy et al., 2009; Metha et al., 2011).* The increase in milk fat percentage in yeast-supplemented animals may be attributed to the increment in total bacterial populations and cellulolytic micro-organisms in the rumen, which improve fiber digestibility and fermentation and, consequently, increase milk fat content *(Doreau and Jounay, 1998; Wang, 2001; Chaucheyras-Daurant et al., 2008).*

Milk protein content increases after probiotic administration according to some researchers *(Abdel-Khalek, 2003; Helal and Abdel-Rahman, 2010)* and decreases according to others *(Lehloenya, et al., 2008).* In the present experiment, a reduction of milk protein percentage was recorded after the first 15 DIM for yeast-fed cows. This reduction could be interpreted on the base of dilution effect of the higher milk production in yeast-fed cows *(Lehloenya et al., 2008).* On the other side, milk protein percentage was higher in yeast-treated cows at 15 DIM. These findings show that the effect of probiotics on milk protein concentration needs further investigation.

SCC in yeast-fed cows was lower compared with that of controls. These results are in agreement with other studies *(Stein et al., 2006; Sretenović et al., 2008).*The reduction of SCC in yeast-treated cows may be attributed to a better health status of their udder *(Sretenović et al., 2008)* or may be due to an improvement of the immune status of the yeast-supplemented cows, as a result of the increase in IgA and secretory components of immunoglobulins *(Buts et al., 1990).* The increased values of globulins recorded in the yeast-treated group in our experiment could support this hypothesis.

Conclusion

Feeding *S. cerevisiae* to dairy cows during the close-up dry and the early lactation period significantly reduced rumen pH and rumen ammonia nitrogen, while significantly increased rumen total VFAs content. Serum glucose was

significantly increased in the yeast-supplemented animals. Serum concentrations of total proteins and globulins were higher, while albumins were lower in the yeast-treated group. Serum lipids were significantly reduced in the yeast-fed group, except for LDL. Finally, milk production and milk fat percentage were higher, whereas milk protein percentage and SCC were lower in the *S. cerevisiae*-supplemented cows throughout the experiment.

CONFLICT OF INTEREST STATEMENT

The authors have nothing to disclose.

Uticaj dodatka *Saccharomyces cerevisiae* u ishrani na zdravlje i proizvodnju krava tokom perioda tranzicije i početka laktacije

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Rezime

Podaci koji bi se odnosili na uticaj suplementacije probiotika na više parametara istovremeno na istim grlima nedostaju u literaturi. Stoga je cilj ovog eksperimenta bio da se ispita uticaj *Saccharomices cerevisiae* u obroku/hrani na parametre rumena, krvi i mleka zajedno u visoko-proizvodnim mlečnim govedima tokom tranzicije i početkom laktacije. Šesnaest klinički zdravih holštajn krava je podeljeno u 2 grupe: kontrolna grupa od 6 krava i grupa od 10 krava hranjenih probiotikom u obroku. Buražna tečnost i uzorci krvi su sakupljeni 21 dan pre očekivanog teljenja, kao i 7, 15, 30, 45 i 60 dana tokom laktacije (days in milk - DIM). Prinos mleka za svaku životinju zabeležen je svake 2 nedelje. Pojedinačni uzorci mleka su prikupljeni 15, 30, 45 i 60 DIM. pH buraga i buražni amonijačni azot su bili značajno niži, dok su ukupne isparljive masne kiseline bile značajno veće kod životinja hranjenih kvascem u poređenju sa kontrolama kroz celu studiju. Serumske koncentracije ukupnih proteina i globulina bile su više, dok su koncentracije albumina bile niže u grupi sa kvascem. Serumski nivoi glukoze bili su značajno viši kod životinja sa dodatkom kvasca. Trigliceridi u serumu, koncentracije lipoproteina visoke i niske gustine bile su niže, sa holesterolom koji je bio znatno niži u tretiranoj grupi. Proizvodnja mleka i procent mlečne masti bili su viši, dok je sadržaj proteina mleka i somatskih ćelija bio niži u krava hranjenih sa dodatkom kvasca kroz celu studiju. Ovi rezultati ukazuju na to da dodatak *S.*

cerevisiae u obrocima muznih krava tokom tranzicije i rane laktacije poboljšava njihovo zdravlje i parametre proizvodnje mleka.

References

ABD EL-TAWAB M.M. (2007): Clinico-laboratory evaluation of probiotics applications in buffalo calves. MVSc Thesis, Fac of Vet Med Beni-Suef University, Egypt.

ABDEL-KHALEK A.E. (2003): Productive and reproductive performance of primiparous and multiparous Friesian cows fed rations supplemented with yeast culture (Yea-Sacc 1026). Egypt J Nutr Feed 4:1095-1105.

ABOU-AKKAD A.R., EL-SHZLY K. (1964): Effect of absence of ciliate protozoa from the rumen microbial activity and growth of lambs. Appl Microbiol 12:, 384.

AGARWAL N., KAMARA D.N., CHAUDHARY L.C., PATHAK N.N. (2002): Microbial status and rumen enzyme profile of cross-bred calves fed on different microbial feed additives. Lett Appl Microbiol 34:329-366.

ANTUNOVIC Z., SPERANDA M., LIKER B., SERIC V., SENCIC V., DOMACINOVIC M., SPERANDA T. (2005): Influence of feeding the probiotic pioneer PDFM® to growing lambs on performances and blood composition. Acta Vet (Beog) 55: 287-300.

ARAMBEL M.J., KENT B.A. (1990): Effect of yeast culture on nutrient digestibility and milk yield response in early to mid-lactation dairy cows. J Dairy Sci 73, 1560–1563.

BEGLEY M., HILL C., GAHAN C.G.M. (2006): Bile salt hydrolase activity in probiotics. Appl Environm Microbiol 72:1729-1738.

BELL A.W. (1995): Regulation of organic nutrient metabolism during transition from late pregnancy to early lactation J Anim Sci 73:2804-2819.

BENJAMIN M.M. (1990): Outline of Veterinary Clinical Pathology.. The Iowa state University Press, Ames, Iowa, USA.

BUTS J.P., BERNASCONI P., VALRMAN J.P., DIVE C. (1990): Stimulation of secretory IgA and secretory component of immunoglobulins in small intestine of rats treated with Saccharomyces boulardi. Dig Dis Sci 35:251-256.

CARRO M.D., LEBZIEN P., ROHT K. (1992): Influence of yeast culture on the in vitro fermentation (rusitech) of diet containing variable proportions of concentration. Anim Feed Sci Technol 37:209-220.

CHAUCHEYRAS-DURAND F., WALKER N., BACH A. (2008): Effects of active dry yeast on the rumen microbial ecosystem: past, present and future. Anim Feed Sci Technol 145:5–26.

CON-WAY E.J. (1974): Micro-diffusion analysis and volumetric errors. 9th Ed. London Crosby-Cock Wood and Son Ltd

DANN H.M., DRACKLEY J.K., MCCOY G.C., HUTJENS M.F., GARRETT J.E. (2000): Effects of yeast culture (*Saccharomyces cerevisiae*) on prepartum intake and postpartum intake and milk production of Jersey cows. J Dairy Sci 83:123–127.

DAWSON K.A. (1993): Biotechnology in the feed industry, Proceedings of Alltech's 9th Annual Symposium, T P Lyons Ed Alltech's Technical Puplications pp: 269.

DOREAU M., JOUANY J.P. (1998): Effects of a Saccharomyces cerevisiae culture on nutrient digestion in lactating dairy cows. J. Dairy Sci 81:3214-3221.

DOUMOS B.T., WATSON W.A., BIGGS H.G. (1971): Albumin standers and measurements of serum albumin with bromocresol green. Clin Chim Acta 31:87–96.

ERASMUS LJ, BOTHA P.M., KISTNER A. (1992): Effects of yeast culture supplement on production, rumen fermentation, and duodenal nitrogen flow in dairy cows. J Dairy Sci 75:3056.

ERDMAN R.A, SHARMA B.K. (1989) Effect of yeast culture and sodium bicarbonate on milk yield and composition in dairy cows. J Dairy Sci 72:1929-1932.

GHORBANI G.R., MORGAVI D.P., BEAUCHEMIN K.A., LEEDLE J.A.Z. (2002): Effects of bacterial direct-fed microbials on ruminal fermentation, blood variables, and the microbial populations of feedlot cattle. J Anim Sci 80:1977–1985.

GOFF J.P., HORST R.L. (1997): Physiological changes at parturition and their relationship to metabolic disorders. J Dairy Sci 80:1260-1268.

GRUMMER R.R. (1995): Impact of changes in organic nutrient metabolism on feeding the transition dairy cow. J Anim Sci 73:2820-283.

GUEDES C.M., GONCALVES D., RODRIGUES M.A.M., DIAS-DA-SILVA A. (2008): Effects of a Saccharomyces cerevisiae yeast on ruminal fermentation and fiber degradation of maize silages in cows. Anim Feed Sci Technol 145:27- 40.

HANAFY M.A., ALI M.A., ABD EL-GAWAD M.H., FARGHALY M.S., EL-BANNA H.M. (2009): Improving productive efficacy of lactating buffaloes fed whole corn silage. Amer-Euras J Agric Environm Sci 5:838-842.

HARRISON G.A., HEMKEN R.W., DAWSON K.A., HARMON R.J., BARKER K.B. (1998): Influence of addition of yeast culture supplement to diets of lactating cows on ruminal fermentation and microbial populations. J Dairy Sci 71:2967-2975.

HELAL F.I.S., ABDEL-RAHMAN K.A. (2010): Productive performance of lactating ewes fed diets supplementing with dry yeast and/or bentonite as feed additives. World J Agric Sci 6:489-498.

HERRICK J.B. (1971): Therapeutic nutrition using lactobacillus species. Vet Med S Anim Clin Nutr 67:1249.

HRISTOV A.N., IVAN M., RODE L.M., MCALLISTER T.A. (2001): Fermentation characteristics and ruminal ciliate protozoal populations in cattle fed medium- or high-concentrate barley-based diets. J Anim Sci 79:515–524.
HUNTINGTON G.B., EISEMANN I.H. (1988): Regulation of nutrient supply by gut and liver tissue. J Anim Sci 66 (Suppl. 3):35-48.
JOUANY J.P. (2006) Optimizing rumen functions in the close-up transition period and early lactation to drive dry matter intake and energy balance in cows. Anim Reprod Sci 96:250–264.
KAWAS J.R., GARCIA-CASTILLO R., GARZA-CAZARES F., FIMBRES DURAZO H., OLIVARES-SAENZ E., HERNANDEZ-VIDAL G., LU C.D. (2007): Effects of sodium bicarbonate and yeast on productive performance and carcass characteristics of light weight fed finishing diets. Small Rumin Res 67:157-163.
KHATTAB H.M., SALEM F.A., SAYEDA M.M., NAGH H.M. (2003): Effect of Yea-Sacc, Lacto-Sacc supplementation and energy level on performance, rumen activity, some rumen activity, some blood constituents and carcass traits in growing sheep. Egypt J Nutr Feed 4:981-989.
KUMAR U., SAREEN V.K., SINGH S. (1994): Effect of Saccharomyces cerevisiae yeast culture on ruminal metabolism in buffalo calves given a high concentrate diet. Anim Prod 59: 209.
KUNG L., KRECK E.M., TUNG R.S., HESSION A.O., SHPHERD A.C., COHEN M.A., SWAIN H.E., LEEDLE J.A.Z. (1997): Effect of a live yeast culture and enzymes on in vitro ruminal fermentation and milk production. J Dairy Sci 80:2045-2051.
LEHLOENYA K.V., STEIN D.R., ALLEN D.T., SELK G.E., JONES D.A., ALEMAN M.M., REHBERGER T.G., MERTZ K.J., SPICER LJ (2008): Effects of feeding yeast and propionibacteria to dairy cows on milk yield and components, and reproduction. J Anim Physiol Anim Nutr 92:190-202.
METHA W., KISSADA B., CHAMNANWIT P., ANUSORN C. (2011): Effects of alternative protein sources on rumen microbes and productivity of dairy cows. Maejo Intern J Sci Technol 5:13-23.
MILLER-WEBSTER T., HOOVER W.H., HOLT M., NOCEK J.E. (2002) Influence of yeast culture on ruminal metabolism in continuous culture. J Dairy Sci 85:2009-2014.
NATIONAL RESEARCH COUNCIL (NRC) (2001) Nutrient requirements of dairy cattle. Nat Acad Sci Washington Dc USA.
NEWBOLD C.J., WILLIAMS P.E.V., MCKAIN N., WALKER A., WALLACE R.J. (1990) The effect of yeast culture on yeast numbers and fermentation in the rumen of sheep. Proc Nutr Soc 49:474.
NISBET D.J., MARTINE S.A. (1991): The effect of S. cereviciae culture on lactate utilization by the ruminal bacterium Selenomonas ruminatium. J Anim Sci 69:4628-4633.

OETZEL G.R., EMERY K.M., KAUTZ W.P., NOCEK J.E. (2007): Direct-fed microbial supplementation and health and performance of pre- and postpartum dairy cattle: a field trial. J Dairy Sci 90: 2058–2068.
PIVA G., BELLADONNA S., FUSCONI G., SICBALDI F. (1993): Effects of yeast on dairy cow performance, ruminal fermentation, blood components and milk manufacturing properties. J Dairy Sci 76:2717–2722.
REYNOLDS C.K., AIKMAN P.C., LUPOLI B., HUMPHRIES D.J., BEEVER D.E. (2003): Splanchnic metabolism of dairy cows during the transition from late gestation through early lactation. J. Dairy Sci 86:1201-1217.
ROBINSON P.H., GARRETT J.E. (1999) Effect of yeast culture (Saccharomyces cerevisiae) on adaptation of cows to postpartum diets and on locational performance. J Anim Sci 77:988-999.
ROMAN M., SHARMA D.D. (1998) In vitro evaluation of different probiotic as feed supplement. Ind. J. Dairy Sci., 51:357-362.
SAS (1985) User's Guide: Statistics, Version 5 Ed SAS Inst Inc Cary NC.
SHRIVER-MUNSCH C.M. (2011): Effect of feeding various dosages of Saccharomyces cerevisiae fermentation product on health, reproduction, and costs in multiparous dairy cows. MVSc Oregon State University.
SRETENOVIC LJ., PETROVIC M.P., ALEKSIC S., PANTELIC V., KATIC V., BOGDANOVIC V., BESKOROVAJNI R. (2008): Influence of yeast, probiotics and enzymes in rations on dairy cows performances during transition. Biotechnol Anim Husb 24:33-43.
STANISLAW M., PRZEMYSLAW S. (2009): Effect of dietary supplementation with Saccharomyces cervisiae dried yeast on milk yield, blood biochemical and hematological indices in ewes. Bull Vet Ins Pulawy 53:753-758.
STEIN D.R., ALLEN D.T., PERRY E.B., BRUNER J.C., GATES K.W., RENBERGER T.G., MERTZ K., JONES D., SPICER LJ. (2006): Effects of feeding propionibacteria to dairy cows on milk yield, milk components, and reproduction. J Dairy Sci 89:111-125.
TARANTO M.P., MEDICI M., PERDIGON G., RUIZ HOLGADO A.P., VALDEZ G.F. (1998): Evidence for hypocholesterolemic effect of *Lactobacillus reuteri* in hypocholesterolemic mice. J Dairy Sci 81:2336-2340.
TRINTER P. (1969): Rapid colorimetric method for determination of blood glucose. Ann Clin Biochem 6:24-27.
WANG Z., EASTRIDGE M., QUI X. (2001): Effects of forae neutral detergent fiber and yeast culture on performance of cows during early lactation. J Dairy Sci 84:204-212.
WILLIAMS P.E.V., NEWBOLD C.J. (1990): Rumen probiosis: the effect of novel microorganisms on rumen fermentation and ruminant productivity. In: Recent Advances in Animal Nutrition pp. 211-227 Butterworth London UK.
WILLIAMS P.E.V., TAIT C.A.G., INNES G.M., NEWBOLD C.J.(1991): Effects of the inclusion of yeast culture (Saccharomyces cerevisiae plus growth medium)

in the diet of dairy cows on milk yield and forage degradation and fermentation patterns in the rumen of steers. J Anim Sci 69:3016-3026.
WINDSCHTIL P.M. (1991): Effect of probiotic supplementation on growth rate, rumen metabolism and nutrient digestibility in Holstein heifer calves. AJAS 4:341-351.
ZACCONI C., BOTTAZZI V., REBECCHI A., BOSI E., SARRA P.G., TAGLIAFERI L. (1992): Serum cholesterol levels in axenic mice colonized with *Enterococcus faecium* and *Lactobacillus acidophilus*. Microbiologica 15: 413-418.
ZECCONI A., CASIRANI G., BINDA E., PICCININI R. (2002): The importance to assess the effect of voluntary milking system on teat tissues, intramammary infections and somatic cell counts. Dept Anim Path-infect Dis Lab university of Milan Delaval Hygiene Technology center Imaugal Symposium.

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