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Effect of BioYeast® on Milk Yield and Related Responses in a Commercial California Dairy Herd

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Saccharomyces cerevisiae is marketed as a yeast culture which contains both viable yeast cells and a dried preparation of the media in which those cells were grown. Results of numerous studies with yeast cultures added to dairy rations are inconsistent. There were significant increases in dry matter intake, milk production, milk fat percentage, and milk protein percentage in some, but not all, trials. The cause of the variable response is undetermined, but may be related to the variety of yeast strains contained in different preparations.

Recently, a yeast culture (BioYeast® Procreatin-7®, SAF Products, Minneapolis, MN) has been introduced to the California dairy industry. Research regarding this yeast product in California dairy feeding systems has not been conducted. The purpose of this study was to examine the effects of feeding BioYeast® Procreatin-7® on milk production, milk composition and body weight parameters in a commercial dairy herd in California.

PROTOCOL

Two pens of Holstein cows, each totaling approximately 175 cows, were utilized. Pens were similar in parity and days in milk. The trial commenced July 22, 1998 with two 5-week treatment periods timed to allow completion of the study before significant alterations in the rations occurred for the fall/winter-feeding period.

For each 5-week period, trial pens were alternated between control (no yeast) and (BioYeast®) treatment. Both groups were fed a total mixed ration composed of alfalfa hay, greenchop alfalfa, corn silage, distillers grains, wheat millrun, beet pulp, rolled corn, whole cottonseed, canola meal, carrots, grain mix, molasses and dry mineral. The chemical composition of the feedstuffs is in Table 1. In addition to the TMR, both groups were fed a separate mixture in the AM and PM which was composed of ground hay, corn silage, carrots, and a grain mix which facilitated cow lock-up in self-locking stanchions. For the BioYeast® group, this mixture supplied 56 grams per cow per day of BioYeast® Farm Pak which provided four grams of Procretin-7® yeast per day (i.e., 60 billion live cells of yeast).

Table 1. Analysis of feedstuffs offered during BioYeast® feeding trial.[1]

Ingredient	DM	CP	ADF	NDF	ASH	NSC
	------------------------- % (DM basis) -------------------------					
Alfalfa hay	89.2	22.8	29.1	42.2	11.7	20.5
Chopped alfalfa	90.0	19.6	37.4	49.9	9.6	18.0
Greenchop alfalfa	24.1	19.3	35.6	50.6	13.4	13.8
Corn silage	29.3	8.4	30.8	53.0	5.1	30.6
Lock-up mix with yeast	52.6	19.3	21.3	31.7	9.9	36.1
Lock-up mix without yeast	54.5	20.5	22.5	34.1	11.0	31.4
Distillers grains	89.2	28.8	19.0	50.5	4.9	12.9
Wheat millrun	89.3	20.4	12.3	40.3	5.4	31.0
Beet pulp	91.4	13.0	27.2	45.0	7.7	31.5
Rolled corn	86.7	9.7	3.4	11.7	0.6	75.0
Whole cottonseed	95.8	23.0	45.6	60.8	3.8	9.5
Canola meal	90.9	42.1	18.4	30.7	7.8	16.5
Carrots	10.6	12.2	19.0	22.2	12.5	50.3
Grain mix	88.3	19.0	18.9	32.1	8.3	37.7
Mineral	7.5	35.2	-	-	76.8	-

[1] Values shown are pooled from periods 1 and 2.

Cows were milked twice daily and housed in an open drylot with shades provided. Milk yield was recorded daily with composition for all cows determined at the end of each 5-week treatment period. Milk composition was determined by Tulare DHIA (Tulare, CA) by infrared methods for fat, protein, lactose, and solids-not-fat. Feeds offered were sampled biweekly and stored at -5^{0}C until analyzed. Cows were scored initially and at the end of each 5-week treatment period for body condition using a five-point scale (1 = thin to 5 = obese).

On the same occasions as body condition scoring, cows were taped over the withers to estimate body weight and assigned body locomotion scores on a five-point scale (1 = normal to 5 = severely lame). Respiration rates per minute were measured biweekly by counting breaths per 15 s and multiplying by 4. Feed intake was estimated as a group by recording feed offered the last week of each treatment period and then measuring the final week's orts.

Ambient temperature recordings were obtained at the California Irrigation Management Information System located in Tulare County. The dairy was located approximately 5 km from the weather station.

Parameters of milk production and composition were statistically analyzed in two ways. First, as a 2x2 Latin Square to determine the effect of 'treatment' and 'pen' utilizing pen means during the final week of each period as the experimental unit. The 'pen' x 'treatment' interaction was the error term. Second, as a completely randomized design using individual cow means during the final week of each period with period and treatment as main effects. Only cows that completed both experimental periods were included in this latter analysis. Body status was analyzed solely in a 2x2 Latin Square design.

The approach of utilizing pen as the experimental unit offers the advantage of holding the experimental unit constant relative to time since cows are entering and leaving the pen weekly relative to performance and/or days in milk. Since pen is the experimental unit relative to body parameters (not all cows were assessed in each period) and feed intake, this approach can be used for all response parameters. In contrast, this approach has the disadvantage that some cows in each pen were not on the diet for the full five-week experimental period.

Thus, quantitative changes in any response parameter between treatments may under-represent the full effect of a treatment influence. In addition, the use of the interaction term as the error term means that as inherent differences between pens increase (i.e., the differences in the pools of cows within pen differ between pens) it will be more difficult to detect significant differences between pens. Conversely, these two characteristics of the design provide a very high degree of confidence in any treatment differences that are observed.

The nutritional status of the diets, relative to the nutrient requirements of the cows, was evaluated using an experimental metabolic model (SHIELD 7.4). The mean performance and feed intake data for each treatment were used for the evaluation.

RESULTS

Weekly averages of maximum and minimum ambient temperatures for the trial were 33.8 and 17.7^{0}C respectively (Table 2). All maxima exceeded the thermo-neutral zone for dairy cows. As the composition and intake of the rations were virtually identical between treatments, only the mean diet composition and intake values are presented in Tables 3 and 4. The composition of the rations was calculated based upon the feed mix-sheet records provided by the dairy producer and the DM content of the feedstuffs as analyzed. The composition values of the overall ration in Tables 3 and 4 are calculated from the intake of the various feedstuffs fed at different times of the day in different mixes in different physical locations as well as their chemical composition as analyzed.

The rations contained only 34.4% forage on a DM basis with a 30.3% grain component and 9.8% whole cottonseed. By-products of plant origin made up the bulk of the balance of the ration. Estimated feed intake levels of 25.2 kg/d of DM were considered to be excellent for cows at this stage of lactation.

Table 2. Mean weekly ambient temperatures and relative humidities.

	Ambient Temperature		Relative Humidity	
	Maximum	Minimum	Maximum	Minimum
Trial Week	--------- ^{o}C ----------		-------- (%) -------	
1	35.6	20.0	91	37
2	33.9	18.9	93	40
3	38.3	17.8	97	32
4	37.8	20.6	91	31
5	32.2	15.0	95	32
6	35.0	16.7	93	32
7	35.6	21.7	93	39
8	32.2	16.7	92	35
9	32.2	16.1	94	35
10	25.6	13.3	95	45

Table 3. Ingredient and composition of the rations, as well as feed intake[1].

	Composition (% of DM intake)	Intake (kg/d)
Corn silage	10.07	2.53
Alfalfa hay (extra-premium)	6.55	1.65
Alfalfa hay (premium)	9.81	2.47
Green chop alfalfa	7.92	2.00
Beet pulp	4.65	1.17
Cull carrots	2.29	0.58
Corn distillers grains	5.45	1.37
Wheat millrun)	4.55	1.15
Steam-flaked corn	30.31	7.64
Canola meal	2.79	0.70
Whole cottonseed	9.79	2.47
Masonex (20% fat)	2.50	0.63
Sodium bicarbonate	0.46	0.12
Mineral premix	2.85	0.72

Table 4. Chemical composition of the rations and intake of chemical components[1].

	Composition	Intake
Dry matter (% of as fed)	56.3	25.20
	--------- % of DM	--------
Fat	4.5	1.13
NDF	33.0	8.31
Non-Fiber carbohydrate	37.6	9.47
Protein		
Total	15.73	3.96
Soluble	5.54	1.40
Bound	0.69	0.17
Macro-minerals		
Calcium	0.79	0.199
Phosphorous	0.47	0.118
Potassium	1.60	0.403
Magnesium	0.28	0.071
Sulfur	0.39	0.098
Sodium	0.36	0.091
Chloride	0.46	0.116
Micro-minerals	ppm of DM	g/d
Iron	267.3	6.7
Manganese	99.8	2.5
Zinc	74.1	1.9
Copper	2.3	0.058

[1]There were no differences in ration composition or intake between treatments.

Using pen as the experimental model, cows supplemented with BioYeast® produced numerically more milk, fat-corrected milk, and milk components (Table 5). In addition, changes in body parameters were improved (BW) or numerically improved (BCS and BLS) when cows were supplemented with the yeast product. Examining only cows that completed both periods (Table 6) showed that cows fed BioYeast® produced significantly more milk fat, protein, and SNF and FCM. Other parameters were not significantly different between treatments.

Respiration rates taken from approximately 60 cows per pen three times per experimental period were 83.4 and 79.4 beats/minute for control and BioYeast® groups, respectively ($P < 0.01$).

Table 5. Effect of BioYeast® on milk production and body parameters[1].

	Control	BioYeast®	*P* Value	SEM
Days in Milk	268	268	1.00	13
Yield (kg/d)				
Milk	29.34	29.71	0.47	0.24
Fat	1.03	1.05	0.69	0.03
Protein	1.00	1.00	0.85	0.03
SNF	2.61	2.64	0.80	0.06
Fat-corrected-milk	25.78	26.34	0.27	0.76
Milk Composition				
Fat (%)	3.52	3.55	0.92	0.13
Protein (%)	3.39	3.38	0.92	0.06
SNF (%)	8.90	8.89	0.97	0.13
Somatic cell count (cells/ml)	447,000	418,000	0.51	21
Body Weight				
Mean (kg)	657.8	667.3	0.57	8.3
Change (kg/d)	-0.31	0.29	0.05	0.03
Body Condition[2]				
Mean (units)	2.89	3.07	0.29	0.06
Change (units/28 d)	-0.11	0.02	0.58	0.11
Body Locomotion[3]				
Mean (units)	1.34	1.26	0.42	0.05
Change (units/28 d)	0.12	-0.15	0.29	0.09

[1]Based upon pen as the experimental unit.
[2]Scored on a 1 to 5 scale where 1 is emaciated and 5 is obese.
[3]Scored on a 1 to 5 scale where 1 is normal locomotion and 5 is severely lame.

DISCUSSION

It is clear from the published literature that yeast supplements have the potential to increase production of absorbable nutrients from rumen fermentation, due to enhanced microbial growth in the rumen and/or enhanced microbial flow from the rumen. However merely because a dietary manipulation has the potential to enhance feed intake and/or animal performance does not mean that such an enhancement will actually occur under a particular feeding situation. In order to capture the potential, it is essential that nutrients be available from the diet to support it. Thus it is critical that results of studies that impose a nutritional modification as an experimental treatment be evaluated in this context. We have chosen to evaluate the nutritional status of the rations, relative to the observed performance of the cows, using an experimental metabolic model called SHIELD.

Table 5. Effect of BIOyeast® on milk yield and composition for cows completing both experimental periods.

	Control	BioYeast®	*P* value	SEM
Cows	251	251	-	-
Milk (kg/d)	28.1	28.7	0.36	0.09
Fat (%)	3.49	3.59	0.14	0.05
(kg/d)	1.01	1.09	0.03	0.03
Protein (%)	3.39	3.40	0.62	0.02
(kg/d)	0.96	1.02	0.03	0.02
Solids-not-fat (%)	8.90	8.91	0.93	0.03
(kg/d)	2.56	2.70	0.05	0.05
3.5% Fat-corrected-milk (kg/d)	28.8	30.7	0.02	0.60
Somatic cell count (cells/ml)	359,000	364,000	0.92	36

Evaluation of the diets, relative to the observed performance of the cows, suggests that cows on both groups were gaining approximately 1.35 kg/d of gross body weight. In addition, the feed intake of 25.2 kg/d of DM was very close to the maximum potential DM intake that was calculated from intake of structural fiber corrected for characteristics of the diet, environment and parity of the cows. Thus there seems to have been little, if any, capability of the cows to respond to any dietary manipulation with enhanced DM intake.

The amount of protein consumed, as well as its fractions, was closely matched to its requirements as predicted by SHIELD. Cows on both treatments were provided with about 99.5% of their calculated requirement for absorbable protein, indicating that this was a possible nutritional limitation to increased milk production, but with no indication of deficiencies of any absorbable amino acid. However the tight control of delivery of degraded intake protein (DIP) relative to calculated requirements, specifically the insoluble fraction, suggests that rumen microbial growth may have been slightly depressed, versus its potential, on both diets and clearly left no capability for quantitatively enhanced microbial growth due to the inclusion of the yeast product in the ration. Thus any rumen benefits of the yeast product would likely have been limited to enhanced efficiency of microbial growth.

CONCLUSIONS

Late lactation dairy cows producing about 30 kg of milk per day responded to inclusion of a yeast product in the diet with modest numerical increases in output of milk and milk components, as well higher BW gain and numerically improved BCS and BLS. Evaluation of the rations fed to the cows, in relationship to the performance achieved, suggests that cows on both treatments had little or no capability to respond to the yeast inclusion with enhanced DM intake. In addition, tight supplies of insoluble DIP relatie to calculated requirements are likely to have slightly depressed rumen microbial growth on both treatments, and eliminated the possibility of a quantitative enhancement of rumen microbial growth due to the inclusion of the yeast product in the diet. In the context of these nutritional limitations, the consistent numerical improvement in the performance of the cows provided with the yeast supplement is notable, and may reflect an improved efficiency of rumen microbial growth.

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