Effects of Yeast Culture (*Saccharomyces cerevisiae*) on Prepartum Intake and Postpartum Intake and Milk Production of Jersey Cows[1]

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ABSTRACT

Yeast cultures (*Saccharomyces cerevisiae*; YC) have been added to diets for dry and lactating dairy cows to attempt to improve ruminal fermentation, potentially increasing dry matter intake (DMI) and milk yield. Jersey cows (14 primigravid and 25 multigravid) were fed total mixed rations prepartum and postpartum that were either supplemented or not supplemented with YC. The YC was a dried product that was top-dressed at 60 g/d for approximately 21 d prepartum and 140 d postpartum. The DMI was increased by YC during both the last 7 d prepartum (9.8 vs. 7.7 kg) and during the first 42 d of lactation (13.7 vs. 11.9 kg). The treatment-by-day interaction was significant for DMI during the first 21 d postpartum, indicating that cows supplemented with YC increased DMI more rapidly than did nonsupplemented cows. A significant treatment-by-day interaction indicated that cows supplemented with YC lost body weight less rapidly postpartum than did nonsupplemented cows. A significant interaction of treatment by day indicated that cows supplemented with YC reached peak milk production more quickly than did nonsupplemented cows. However, total milk produced during the first 140 d of lactation did not differ. Concentrations of fat, protein, lactose, total solids, and urea N in milk, as well as somatic cell count, were not significantly affected by YC. Supplementation of YC increased DMI during the transition period and increased DMI postpartum.

(**Key words:** yeast culture, dry matter intake, prepartum, milk production)

Abbreviation key: C = control, **YC** = yeast culture.

INTRODUCTION

Interest in the use of direct-fed microbials as feed supplements for high producing dairy cows has increased markedly in recent years. A commonly used direct-fed microbial is the yeast *Saccharomyces cerevisiae*. However, research results with cultures of *S. cerevisiae* fed to dairy cattle have varied. Improvements in DMI (13, 14, 15), milk production (4, 6, 14, 15), and milk components (4) have been noted when cows were fed yeast culture (**YC**). In contrast, no differences were found in DMI (4, 5, 6), milk production (5, 6, 9), or milk composition (4, 5, 6, 9) in other studies when cows were fed YC. Piva et al. (4) suggested that several factors affect the response of dairy cows to supplemental YC, such as stage of lactation, type of forage fed, feeding strategy, and the forage-to-concentrate ratio.

Supplemental YC may be most beneficial to dairy cows if it is fed before parturition, a period that is characterized by decreased DMI as parturition approaches, and through peak lactation. Results of the few studies (5, 6, 8, 14, 15) that have fed YC during the transition period varied. Wohlt et al. (15) observed that primiparous Holstein cows fed YC starting 30 d prepartum and continuing through wk 18 of lactation had higher DMI around parturition and greater milk yield through wk 18 of lactation than did control cows. In a similar study, Wohlt et al. (14) found that yeast supplementation during early lactation improved DMI, milk yield, and the digestibility of CP and ADF. However, Robinson (5) found no effect of YC on DMI or milk yield of multiparous Holstein cows. In a subsequent study, Robinson and Garrett (6) observed trends for increased DMI and milk production during early lactation for cows fed YC pre- and postpartum. Soder and Holden (8) found no effects of YC on DMI or milk yield and composition of primiparous and multiparous cows. Consequently, the effects of YC supplementation during the prepartum period and through peak lactation remain controversial and have not been adequately researched. No data are available for effects of YC in Jersey cows. The objectives of this study were to determine the effects of supplementing YC (*S. cerevisiae*) to the diet of primigravid and multigravid Jersey cows for the last 21 d prepartum

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and the first 140 d postpartum on DMI, milk yield, and milk composition.

MATERIALS AND METHODS

Thirty-nine (14 primigravid and 25 multigravid) Jersey cows were assigned to one of two treatments 3 wk before their expected calving date. Within parity group, cows were assigned alternately to treatment according to calving date. Treatments were diets supplemented with YC (*S. cerevisiae*; Diamond V Mills "XP", Cedar Rapids, IA) or not supplemented with YC (control; **C**). Diets (Table 1) were formulated to meet or exceed NRC recommendations (3). Treatments were top-dressed on the TMR at the time of feeding. Prepartum cows were fed TMR ad libitum once daily; for cows on the YC treatment, the TMR was top-dressed with 60 g of YC /d. At calving all cows were abruptly changed to a lactation TMR that was fed ad libitum once daily. Cows continued on either C or YC through 140 d postpartum. The DMI of each animal was measured daily from 21 d before expected calving date until 140 DIM. Samples of the prepartum and postpartum diets were collected weekly, composited monthly, and analyzed for CP, NDF, ADF, Ca, and P (Northeast DHIA, Ithaca, NY). Milk production was recorded daily for each cow until 140 DIM. Milk was sampled weekly (consecutive a.m. and p.m. milkings) and analyzed for fat, CP, lactose, urea N, and SCC (Dairy Lab Services, Inc., Dubuque, IA). The BW of each cow was measured on the same day each week. The same individual assigned a BCS (12) weekly to each cow. Reproductive and health records were maintained for each cow.

Table 1. Ingredient and nutrient composition of diets.

	Diet	
Composition	Prepartum	Postpartum
	(% of DM)	
Ingredient		
Corn silage	47.4	21.7
Alfalfa hay, chopped	28.4	21.6
Shelled corn, ground	16.9	31.2
Soybean meal, 48% CP	5.4	13.1
Soyhulls	. . .	8.7
Meat and bone meal	. . .	2.2
Dicalcium phosphate	. . .	0.5
Sodium chloride	0.3	0.5
Magnesium oxide	. . .	0.25
Limestone	0.9	. . .
Mineral and vitamin mix[1]	0.3	0.25
Anionic salt mixture[2]	0.5	. . .
Chemical		
CP	14.5	17.2
NDF	35.2	30.3
ADF	24.6	20.1
NE_L,[3] Mcal/kg	1.52	1.61
Ca	1.17	0.99
P	0.32	0.42

[1] Mineral and vitamin mix contained 5% Mg, 10% S, 7.5% K, 2% Fe, 3% Zn, 3% Mn, 5000 mg/kg of Cu, 250 mg/kg of I, 40 mg/kg of Co, 150 mg/kg of Se, 2202 IU of vitamin A/g, 661 IU of vitamin D_3/g, 7.7 IU of vitamin E/g.

[2] Anionic salt mixture contained 10% CP, 1% fat, 2.5% Mg, 3.2% S, 0.43% K, 16.5% Cl, 6.6 mg/kg of Se, 110 IU of vitamin A/g, 44 IU of vitamin D/g, 1.3 IU of vitamin E/g, 13.2 mg of nicotinic acid/g.

[3] Calculated according to Northeast DHIA Laboratory.

Energy balance was determined individually for each cow. Milk energy output was calculated from contents of fat, CP, and lactose as suggested by Tyrrell and Reid (10). Energy for maintenance was calculated as $(BW^{0.75}) \times 0.08$ Mcal/kg of BW (3) and energy for change in BW was calculated as –4.92 Mcal/kg of BW loss or 5.12 Mcal/kg of BW gain (3).

Dry matter intake, milk yield, milk composition, and BCS data were analyzed with the following model: treatment, parity, treatment × parity, cow(treatment × parity), time (i.e., day or week), treatment × time, parity × time and treatment × parity × time. Cow(treatment × parity) was used as the error term to test the effect of treatment. Data were analyzed separately for five periods, with the above model, that were deemed a priori to be physiologically important: the entire 21 d of prepartum supplementation; the last 7 d prepartum, during which time DMI normally declines rapidly; the first 21 d postpartum, when cows rapidly increase DMI; the first 42 DIM, when cows are nearing peak milk yield; and the entire 140-d postpartum experimental period. Calculations were conducted by using the general linear models procedure of SAS (7). Health data were analyzed by the Fisher Exact Test (7). Reproduction data were analyzed by the Wilcoxon 2-Sample Test (7). Significance was declared at $P < 0.05$. The interaction of treatment × parity was not significant ($P > 0.10$) for all variables analyzed; consequently, results are presented as least squares means by treatment across parities.

RESULTS AND DISCUSSION

The chemical composition of the TMR (Table 1) met or exceeded NRC recommendations for all nutrients (3). The DMI was 2.1 kg/d higher ($P < 0.01$) during the last 7 d of gestation for cows fed YC (Table 2). Cows fed YC for the last 21 d of gestation tended ($P < 0.10$) to consume more DMI than those fed C. The interaction of treatment × time was not significant ($P > 0.10$) for prepartum DMI. As expected, DMI decreased for cows on both the C and YC treatments as parturition approached. However, cows consuming YC maintained greater DMI as parturition approached. This result is consistent with the observation of Wohlt et al. (15). When initial BW

Table 2. Least squares means for prepartum and postpartum DMI by Jersey cows fed a control (C) diet or the same diet supplemented with yeast culture (YC).

	Treatment			*P*	
DMI	C	YC	Pooled SE	Treatment	Treatment × day
	(kg/d)				
Prepartum					
d –7 to d –1	7.7	9.8	0.6	0.01	0.48
d –20 to d –1	9.5	10.9	0.6	0.10	0.32
Postpartum					
d 1 to d 21	10.2	12.0	0.7	0.07	0.04
d 1 to d 42	11.9	13.7	0.7	0.05	0.43
d 1 to d 140	15.2	16.5	0.6	0.12	0.24

was used as a covariate for DMI, the statistical interpretation did not change; BW was not a significant covariable, indicating that the difference between treatments for prepartum DMI was not attributable to differences in BW of cows.

During the first 42 DIM, cows fed YC consumed 1.6 kg/d more DM ($P < 0.05$) than cows fed C (Table 2). During the first 21 d of lactation, cows supplemented with YC tended ($P < 0.07$) to have greater DMI. The treatment × time interaction was significant ($P < 0.04$) for DMI during the first 21 DIM (Figure 1), indicating that cows supplemented with YC increased DMI more rapidly than did nonsupplemented cows. This observation is consistent with the fact that cows supplemented with YC consumed more DMI during the first 42 DIM. Robinson and Garrett (6) observed similar tendencies for DMI during early lactation. Treatment did not affect ($P > 0.10$) DMI for the first 140 DIM. The lack of significance of the treatment effect on DMI for the first 140 DIM, but improved DMI during the first 42 DMI, suggests that YC supplementation may be most efficacious during the transition period and in early lactation. Arambel and Kent (1) suggested that YC might be best utilized by animals under stress. A possible explanation for this effect is that low DMI does not provide the microbial population with enough soluble growth factors, such as organic acids, B vitamins, and AA. Callaway and Martin (2) suggested that YC provides soluble growth factors that stimulate growth of cellulolytic bacteria and cellulose digestion. However, the mechanism for improved DMI with YC supplementation has not been defined clearly. Researchers have suggested that YC may cause a number of effects in the rumen, including increased pH (13), altered VFA concentrations (13), increased numbers of cellulolytic bacteria (2, 11), and increased rate or extent of ruminal fiber digestion (2). On the basis of these previous results, we propose that YC may increase fiber digestion, which could increase rate of passage and therefore improve DMI.

Mean daily milk yields were not affected ($P > 0.10$) by treatment (Table 3) and averaged 23.2 kg/d during the first 140 DIM for all cows. The treatment × time interaction was significant ($P < 0.01$) for milk yield for d 1 to 140 of lactation (Figure 2), indicating that cows fed YC reached peak milk yield earlier than cows fed C (43 vs. 57 DIM). The earlier peak milk yield for cows fed YC may be a result of the increased DMI during the first 42 DIM. Milk composition was not affected ($P > 0.10$) by treatment (Table 3). Several studies (1, 4, 5, 8, 9) have demonstrated that supplemental YC had no beneficial effect on milk yield or milk composition of dairy cows. Arambel and Kent (1) suggested that lack of a milk fat response in their study indicated that any

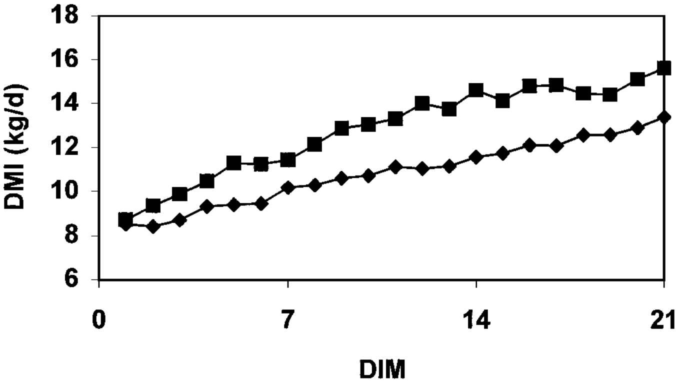

Figure 1. The DMI for the first 21 d of lactation for Jersey cows fed a control diet (◆) or the same diet supplemented with yeast culture (■). The pooled SEM for each mean is 0.7 kg/d.

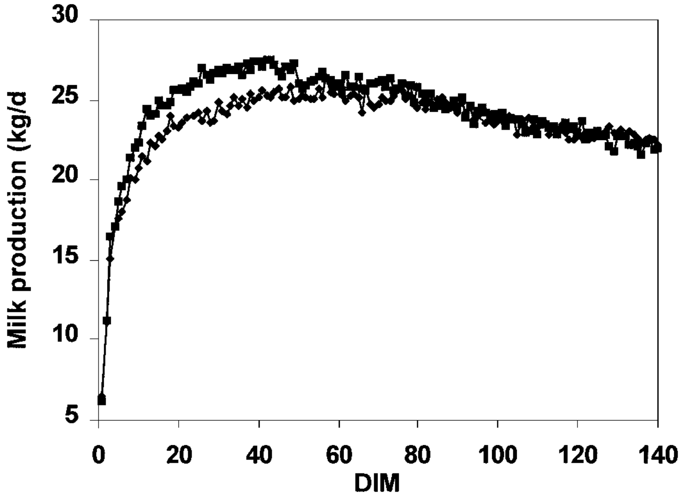

Figure 2. Milk production for the first 140 d of lactation for Jersey cows fed a control diet (◆) or the same diet supplemented with yeast culture (■). The pooled SEM for each mean is 1.0 kg/d.

Table 3. Least squares means for milk yield and milk composition of Jersey cows fed a control (C) diet or the same diet supplemented with yeast culture (YC).

Variable	Treatment C	Treatment YC	Pooled SE	*P* Treatment	*P* Treatment × day
Milk, kg/d					
d 1 to d 21	18.9	20.3	1.1	0.35	0.66
d 1 to d 42	21.3	22.9	1.1	0.31	0.90
d 1 to d 140	22.9	23.5	1.0	0.65	0.01
Fat, %	4.27	4.44	0.11	0.28	0.96
Protein, %	3.64	3.78	0.07	0.15	0.95
Lactose, %	4.93	4.99	0.03	0.19	0.73
Total solids, %	13.57	13.93	0.16	0.10	0.58
MUN, mg/dl	19.52	19.44	0.78	0.94	0.73
SCC, × 1000	311	284	71	0.77	0.67

stimulation of cellulolytic bacteria did not affect milk yield or composition. Those authors (1) speculated that the ADF content of the ration was sufficient to maintain milk fat synthesis, thus potentially negating any treatment effect.

Initial BCS did not differ ($P > 0.10$) between treatments. Supplementation with YC did not affect ($P > 0.10$) prepartum or postpartum BCS or prepartum BW (Table 4). During the postpartum period, cows that consumed the C diet lost 23.4 kg more BW ($P < 0.04$) during the first 42 DIM than did cows that consumed the YC. The difference in BW loss between treatments in the postpartum period may be attributable to the difference in DMI between treatments during the first 42 DIM.

Energy utilization was calculated for cows that were fed either the C diet or the YC diet (Table 5). Treatment did not affect ($P > 0.10$) total NE_L required or estimated NE_L deficit during either the first 21 or 42 d postpartum. The NE_L intake calculated with the estimated NE_L density from feed analyses tended to be greater ($P < 0.07$) for cows that consumed YC during the first 21 DIM and was greater ($P < 0.05$) for cows that consumed YC during the first 42 DIM. The greater NE_L intake was a function of greater DMI during the respective periods.

We estimated NE_L actually supplied from feed by calculating NE_L in milk secreted, maintenance requirements for NE_L, and NE_L actually provided (or required) by changes in BW. The net result of these calculations, apparent NE_L provided by feed, could be used as an indirect indicator of changes in digestible or metabolizable energy supply from the diet. For example, if YC enhanced ruminal fermentation during the transition period, apparent NE_L from feed and NE_L density would be expected to be improved. Estimating body energy changes from BW is likely the least accurate component of these calculations, given the dynamic nature of intake, digestion, and metabolism in transition cows. Increasing DMI, increasing gut fill, and increasing visceral mass likely decrease the accuracy of BW changes in predicting body energy changes. In our study (Table 5), cows fed the C diet mobilized 2.64 Mcal more ($P < 0.05$) NE_L from body stores than cows fed the YC diet during the first 42 DIM, as a result of lower DMI by cows fed C. The supply of NE_L from feed also was increased

Table 4. Body condition score (BCS) and BW of Jersey cows fed a control (C) diet or the same diet supplemented with yeast culture (YC).

Variable	Treatment C	Treatment YC	Pooled SE	*P* Treatment	*P* Treatment × day
BCS					
Initial	3.00	3.13	0.06	0.11	. . .
Prepartum	3.01	3.14	0.06	0.14	0.67
Postpartum	2.48	2.59	0.05	0.12	0.90
BW, kg					
Initial	474.0	470.7	10.6	0.89	. . .
Prepartum[1]	475.1	476.9	2.0	0.54	. . .
Postpartum[1]	396.4	412.1	4.7	0.02	. . .
BW change, kg					
d 1 to d 21	–51.3	–37.0	8.6	0.23	. . .
d 1 to d 42	–55.5	–32.1	8.2	0.04	. . .

[1] Adjusted for covariate of initial BW.

during d 1 to 42, but not from d 1 to 21. However, the calculated NE_L density did not differ significantly between C and YC diets during either period. Similar responses in energy utilization were reported by Robinson and Garrett (6). The disrepancy between NE_L density calculated from feed compostion (Table 1) and NE_L density calculated from energy utilization (Table 5) for d 1 to 21 likely results from inaccuracies of estimating body energy changes from BW during this period. Differences between the two methods of estimating NE_L density were less when data from d 1 to 42 were used.

Treatment did not affect ($P > 0.10$) the occurrence of retained placenta, ketosis, displaced abomasum, milk fever, or mastitis (data not shown). Days to first breeding averaged 74.9 and was not affected by treatment ($P > 0.10$). Treatment also did not affect ($P > 0.10$) services per pregnancy, which averaged 2.1.

Table 5. Energy utilization by Jersey cows fed a control (C) diet or the same diet supplemented with yeast culture (YC).

	Treatment		Pooled	
Variable	C	YC	SE	*P*
	(Mcal/d)			
d 1 to d 21				
NE_L output in milk[1]	15.96	17.31	1.10	0.36
NE_L for maintenance[2]	7.17	7.33	0.12	0.34
Total NE_L required	23.13	24.69	1.12	0.30
Calculated NE_L intake[3]	16.45	19.25	1.11	0.07
NE_L deficit	–6.56	–5.53	0.89	0.38
NE_L from body stores[4]	11.19	8.57	2.04	0.35
Apparent NE_L from feed[5]	11.65	14.55	2.21	0.33
NE_L density[6] (Mcal/kg DMI)	0.91	1.11	0.24	0.53
d 1 to d 42				
NE_L output in milk[1]	17.20	18.60	1.03	0.30
NE_L for maintenance[2]	7.06	7.27	0.12	0.19
Total NE_L required	24.26	25.87	1.06	0.25
Calculated NE_L intake[3]	19.15	22.13	1.10	0.05
NE_L deficit	–5.05	–4.00	0.76	0.30
NE_L from body stores[4]	6.35	3.71	0.97	0.05
Apparent NE_L from feed[5]	17.67	21.32	1.29	0.04
NE_L density[6] (Mcal/kg DMI)	1.36	1.49	0.11	0.38

[1] Calculated from contents of fat, CP, and lactose according to Tyrrell and Reid (9).

[2] Calculated according to NRC (3).

[3] Calculated from DMI and estimated NE_L from feed analyses by Northeast DHIA Laboratory (Ithaca, NY) shown in Table 1.

[4] Calculated from BW change according to NRC (3).

[5] NE_L required for milk plus maintenance minus NE_L from body weight loss.

[6] Apparent NE_L from feed divided by DMI.

CONCLUSIONS

Feeding strategies that help prevent the decline in DMI during the transition period may be beneficial to high producing dairy cows. Supplemental YC improved DMI during the last 7 d of gestation and during the first 42 d of lactation. Supplementation with YC also resulted in cows losing less BW and using less body energy for milk production during early lactation. Although, although cows peaked in milk earlier in lactation, there was no improvement in overall milk production or milk composition with YC supplementation.

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