Short communication: Responses to supplemental *Saccharomyces cerevisiae* fermentation product and triticale grain in dairy cows grazing high-quality pasture in early lactation

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ABSTRACT

Supplementing cows grazing highly digestible pasture with a *Saccharomyces cerevisiae* fermentation product (SCFP) was hypothesized to increase dry matter (DM) intake and milk production. Sixty multiparous dairy cows were fed 3 kg of crushed triticale DM/cow per day for 23 ± 4.4 d before calving. Half of the cows received SCFP (60 g/d; Diamond V Original XP; Diamond V Mills, Inc., Cedar Rapids, IA). Cows in both treatment groups were randomly allocated at calving to 1 of 2 amounts (3 or 6 kg of DM/d) of triticale feeding with or without 60 g of SCFP/day ($n = 15/\text{treatment}$) until 84 days in milk. The amount of pasture harvested (kg of DM/cow per day) and milk yield (kg/cow per day) were not affected by SCFP. Milk protein content and yield were greater in cows receiving 6 kg of crushed triticale DM/d. Plasma nonesterified fatty acids and β -hydroxybutyrate concentrations were not affected by SCFP supplementation, but were lower in cows fed 6 kg of crushed triticale DM/d than those fed 3 kg of DM/d. Supplementation with SCFP increased milk lactose content without affecting milk production under the conditions investigated.

Key words: yeast culture, milk composition, pasture, transition cow

Short Communication

Saccharomyces cerevisiae fermentation products (SCFP) have been reported to improve rumen stability and increase milk production (Rabiee et al., 2008), primarily by increasing rumen pH and VFA concentrations, while decreasing lactic acid concentrations (Erasmus et al., 1992; Piva et al., 1993). In some studies, SCFP also improved DMI, milk production, and

feed conversion efficiency (kg of ECM/kg of feed DM; Schingoethe, et al., 2004; Rabiee et al., 2008).

However, very little information exists on the response of cows grazing highly digestible spring pasture to SCFP supplementation; spring pasture is often in excess of 80% DM digestibility, with low concentrations of ADF (<20% of DM; Roche et al., 2009) and estimated effective NDF. As a result, cows grazing high-quality pasture in spring have a low mean rumen pH (<5.8; Kolver and de Veth, 2002), which is further exacerbated when starch-based supplements are offered (Wales and Doyle, 2003).

Although de Veth and Kolver (2001) reported little effect of altering mean rumen pH in the 5.8 to 6.6 range on either microbial protein synthesis or NDF digestibility when pH was held constant through the day, Wales et al. (2004) reported a negative effect of low mean rumen pH (about 5.6) on OM, NDF, and ADF digestibility, when pH was allowed to fluctuate as it would normally in grazing animals. These results indicate that productivity gains are likely from either increasing rumen pH or decreasing the diurnal variation in rumen pH in grazing dairy cows. Despite this, attempts to raise pH and decrease the diurnal variation in pH through supplementation with coarse fiber supplements have been unsuccessful (Wales and Doyle, 2003).

Another possible avenue for promoting rumen stability could be through the use of an SCFP. The objective of this study was to determine if supplementing cows with an SCFP would improve milk production and DMI in cows grazing highly digestible spring pasture and supplemented with either moderate or high levels of cereal grain.

Seventy-four multiparous dairy cows were fed 3 kg of crushed triticale DM/cow per day for 23 ± 4.4 d before calving. Half of the cows also received a SCFP (60 g/d; Diamond V Original XP Yeast Culture; Diamond V Mills, Inc., Cedar Rapids, IA) top-dressed on their grain; the remainder received the same supplement without SCFP. The first 30 cows to calve in each treat-

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ment were randomly allocated to one of 2 supplement feeding levels: cows received either 3 or 6 kg of crushed triticale DM/d with or without SCFP inclusion (60 g/cow per day) in a 2×2 factorial arrangement ($n = 15$ cows/treatment). Treatments were balanced for milk production in the first 100 d of the previous lactation ($2,490 \pm 492$ kg), BW (553 ± 61 kg), BCS (4.6 ± 0.62 ; 1 to 8 scale), age (5.3 ± 2.70 yr), and predicted calving date (July 31, 2008 ± 1.7 d). Treatments continued until 84 DIM.

Cows were rotationally grazed as one herd. Pastures were predominantly perennial ryegrass (*Lolium perenne* L.; 80%) and were of high quality throughout the experiment (CP = $22.3 \pm 2.10\%$ of DM; OM digestibility in the DM (DOMD) = $75.8 \pm 2.09\%$ of DM; NDF = $42.0 \pm 3.57\%$ of DM; ME = 12.4 ± 0.41 MJ/kg of DM). Cows received their allocation of triticale twice daily during milking (CP = $14.5 \pm 0.42\%$ of DM; ADF = $3.8 \pm 0.38\%$ of DM; DOMD = $86.1 \pm 0.53\%$ of DM; ME = 13.3 ± 0.07 MJ ME/kg of DM). *Saccharomyces cerevisiae* fermentation product (60 g/cow per day) was added to the grain at the a.m. milking.

Pasture yield pre- and post-grazing were recorded on 3 d each week using a calibrated rising plate meter (I. K. J. & M. A. Englund, Werribee, Victoria, Australia). To calibrate the rising plate meter, compressed pasture heights were measured inside 0.2 m^2 quadrants placed randomly within the pasture allocations to be grazed the following day and those grazed during the previous 24 h; pasture within the quadrants was cut to ground level. Pasture samples were washed to remove soil contamination and dried at 100°C to constant weight (approximately 72 h). These data were used to develop a regression equation relating pasture height to pasture mass:

$$\text{Pasture mass} = 213.7 \times \text{pasture height} + 582.3;$$

$$\text{adjusted } r^2 = 0.76; P < 0.001.$$

All cows grazed as one herd. Pasture DMI was not measured. Instead, on 2 occasions during the experiment (wk 5 to 7 and wk 9 to 11), pasture harvested/cow was estimated by splitting the cows into the 4 individual treatment groups, and using a calibrated rising plate meter to measure the difference between pre- and post-grazing pasture mass every day (kg of pasture DM/ha per day); the resulting pasture mass was multiplied by the paddock area (kg of DM/d) and divided by the number of cows in the pasture to give mean pasture harvested/cow (kg of DM/cow per day). During the measurement period, treatment herds were strip grazed within the same paddock, and their position within the paddock rotated every 3 d to ensure

no herd was unduly affected by position in the paddock. Back-grazing outside the pasture allocation was prevented. Pasture was grazed to a height of >6 cm for each of the treatment groups, ensuring that cows had unlimited access to high-quality pasture.

Cows were milked twice per day. Milk yield was measured once per week, and fat, protein, and lactose concentrations of milk determined by Milkoscan (Foss Electric, Hillerød, Denmark) and SCC was measured on a Fossomatic (Foss Electric) on individual p.m. and a.m. aliquot samples collected on one day each week by a National Association of Testing Authorities certified laboratory. Body weight was determined every week at approximately 0900 h. First milking colostrum was collected, the specific gravity measured, and a subsample analyzed for IgG concentration by radial immunodiffusion (Pritchett et al. 1991).

Blood samples were collected by coccygeal venipuncture into an evacuated blood tube containing K_3EDTA pre- and post-calving (d -7 , -4 , -3 , -2 , -1 , 0 , 1 , 2 , 3 , 4 , and 7). Blood samples were then collected at biweekly intervals post-calving. Plasma was harvested ($1,120 \times g$; 10 min; 4°C) and analyzed for NEFA (colorimetric method, NEFA C kit from Wako Diagnostics, Richmond, VA; Cat. No. 279-75401) and BHBA (BHBA dehydrogenase assay, Ranbut kit from Randox Laboratories, Paramatta, NSW, Australia) concentrations on an AU400 analyzer (Olympus, Tokyo, Japan) at 37°C . The inter- and intra-assay CV was $<2.6\%$ for all assays.

Data were analyzed using a mixed-modeling framework in Genstat 11.1. Treatment factors relating to SCFP inclusion (control and SCFP), supplement feeding level (3 and 6 kg of triticale DM), and their interaction were modeled as fixed effects, and repeated measures on individual cows incorporated into the model by providing a cow-level random effect. Additional covariates considered were week of observation, calving date, and milk yield in the first 100 d of the previous lactation. Blood and SCC data were log-transformed before analysis to stabilize variances, using an offset value of 0.01. Pasture harvested/cow and measurements related to pasture mass were analyzed using day of grazing as the experimental unit.

The effect of treatment on pasture harvested/day, milk production and composition, and colostrum yield and quality are presented in Table 1. Supplementation of SCFP did not affect estimated pasture harvested/day or milk yield, although lactose percent was increased ($P < 0.05$) in SCFP-supplemented cows. Considerable evidence exists that cows grazing highly digestible pasture exhibit what would be regarded as suboptimal pH in TMR-fed cows (Kolver and deVeth, 2002), and that this problem is exacerbated by supplementation with cereal grain-based concentrates (Wales

Table 1. Effects of *Saccharomyces cerevisiae* fermentation product and triticale supplementation on the performance of grazing dairy cows^{1,2}

Item	SCFP		Triticale		SED ³	P-value		
	No	Yes	3 kg of DM	6 kg of DM		SCFP	C	SCFP × C
Pasture harvested								
wk 5 to 7	9.3	9.4	10.7	8.0	0.61	0.88	<0.001	0.89
wk 9 to 11	11.9	11.7	12.2	11.4	0.50	0.66	0.13	0.90
Yield								
Milk	29.6	29.8	29.1	30.3	1.08	0.84	0.28	0.36
Fat	1.09	1.11	1.10	1.11	0.037	0.57	0.80	0.54
Protein	0.96	0.97	0.92	1.00	0.039	0.70	<0.05	0.68
Lactose	1.48	1.50	1.46	1.52	0.057	0.64	0.24	0.42
Composition								
Fat	3.72	3.78	3.83	3.67	0.103	0.54	0.15	0.77
Protein	3.23	3.27	3.19	3.31	0.056	0.49	<0.05	0.32
Lactose	4.98	5.05	5.01	5.02	0.036	0.04	0.87	0.57
SCC ⁴	10.8	11.0	10.7	11.1	0.28	0.60	0.21	0.87
	(49.0)	(59.9)	(44.4)	(66.2)				
BW	509	513	509	513	14.4	0.77	0.80	0.95
Colostrum								
Yield	7.4	6.5	—	—	1.19	0.49	—	—
SG	1,050	1,053	—	—	3.0	0.26	—	—
IgG × 10 ³	118	134	—	—	24.9	0.53	—	—

¹Amount of pasture harvested (kg of DM/cow per day), milk and milk component yield (kg/cow per day), milk composition (%), BW (kg), colostrum yield at first milking (kg/cow), colostrum specific gravity (SG), colostrum IgG concentration (μg/mL), and plasma BHBA and NEFA concentrations³ (mmol/L).

²Cows were offered either 3 or 6 kg of crushed triticale (C) DM/cow per day for 12 wk postpartum. Crushed triticale offered to half of the cows was fortified with 60 g/cow per day of *Saccharomyces cerevisiae* fermentation product (SCFP).

³Standard error of the difference.

⁴Data (× 10³ cells/mL) were log-transformed before analysis. Back-transformed means are presented in parentheses.

and Doyle, 2003). Although rumen parameters were not investigated in the study reported here, the quality of pasture on offer would be expected to result in a mean rumen pH of less than 6.0 (Kolwer and de Veth, 2002). Providing supplements reported to stabilize the rumen environment, such as SCFP, would, therefore, be expected to decrease any malaise associated with such a subacute rumen acidosis, which could result in an increase in DMI and milk production.

Despite these inferred changes in rumen pH, SCFP did not affect pasture harvested/cow per day, although one cannot discount the indirect assessment of DMI as a possible contributor to this lack of effect. Nonetheless, treatment effect on milk production was limited to an increase in milk lactose percent. Although not a major effect, per se, this change in milk lactose content with SCFP supplementation may still reflect a rumen-stabilizing effect of SCFP. Increases in rumen propionate have been observed in studies when SCFP was fed (Harrison et al., 1988; Yoon et al., 1997) and Callaway and Martin (1997) reported that SCFP stimulates the growth of ruminal bacteria that utilize lactic acid, thereby increasing propionate production. The measured increase in milk lactose in the present study may reflect greater glucose availability, a result, potentially, of greater propionate availability for gluconeogenesis (Van Soest, 1994). Although the SCFP did not affect

either milk yield or yield of milk components in early lactating cows grazing moderate- to high-quality pasture and supplemented with reasonably high levels of triticale, milk yield in wk 2 of lactation was greater (2.0 kg/d; $P < 0.05$) in SCFP cows, possibly implying a more rapid rise to peak milk production. This is consistent with the results of Dann et al. (2000), who reported no difference in cumulative milk production in cows supplemented with SCFP, but an accelerated rise to peak milk. Further research is required on legume-dominant or more digestible temperate grass pastures to determine if pasture quality influences response to SCFP and whether the effect on milk yield can be extended beyond wk 2 of lactation.

On average, blood plasma concentrations of NEFA and BHBA were not affected by feeding SCFP (Figure 1), although cows supplemented with SCFP had lower NEFA concentrations 1 d before calving and tended to be lower 1 d after calving. In addition, a tendency existed for plasma BHBA to be lower when cows were supplemented with SCFP 28 DIM, with the treatment separation becoming noticeable 2 to 3 wk earlier. Dann et al. (2000) reported that supplemental SCFP improved DMI during the last 7 d of gestation and during the first 42 d of lactation. Supplementation with SCFP also resulted in cows losing less BW and using less body energy for milk production during early

Figure 1. Effect of *Saccharomyces cerevisiae* fermentation product (0 g/cow per day ◆ or 60 g/cow per day ■) pre- and postpartum during the first 12 wk of lactation on plasma BHBA (A) and NEFA (B) concentration. Vertical bars represent the standard error of the means.

lactation. The NEFA and BHBA data presented here are consistent with the earlier results and suggest that further research is required to determine if, and in what situations, SCFP supplementation improves the dietary transition through parturition on very high-quality pasture diets. Yield of colostrum during the first milking postpartum was not affected by SCFP supplementation prepartum. Similarly, the specific gravity of colostrum and IgG concentration were not affected by SCFP inclusion in the prepartum diet.

Milk production responses to concentrates in grazing dairy cows have been comprehensively reviewed elsewhere (Stockdale, 2000; Bargo et al., 2003) and will not

be extensively discussed here; however, it is noteworthy that responses in the present study (0.4 kg of milk/kg of DM) were less than the published average (1 kg of milk/kg of DM). This difference probably reflects the timing of the current study (i.e., in spring). Stockdale (2000) highlighted a lower milk production response to concentrate supplementation (−0.54 kg of milk/kg of concentrate DM) in spring than later in the season.

Plasma BHBA and NEFA concentrations were marginally less ($P < 0.01$) in cows offered 6 kg of triticale DM/d compared with those fed 3 kg of DM/d (BHBA: 0.55 and 0.62 mmol/L; NEFA: 0.42 and 0.49 mmol/L, respectively). The effect of diet on NEFA likely reflects

a positive effect on lipogenesis (McNamara, 1989) and is consistent with BCS profiles presented by Roche et al. (2006) in grazing cows. The diet effect on BHBA was also expected. The inverse association between propionate and ketogenesis is long known, with Schultz et al. (1949) and Van Soest and Allen (1959) reporting decreases in blood ketone bodies with propionate supplementation and Roche et al. (2010) highlighting decreased BHBA concentrations in cows supplemented with concentrates, even though energy balance and BCS were not affected by diet.

In conclusion, supplementing SCFP to cows grazing high-quality fresh pasture and receiving triticale supplementation increased milk lactose concentration without affecting milk production, colostrum quality, or metabolic measures of energy status.

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