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Effects of addition of a live yeast product on dairy cattle performance

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ABSTRACT

Live yeast products (LYPs) increase nutrient utilization and milk yield. The purpose of this trial was to determine if a LYP administered at 3 g/cow/d at a commercial dairy increased milk production. Cows were milked twice daily and given LYP in the total mixed ration in an OFF, ON, OFF, ON, OFF design where each ON or OFF period lasted 45 days and LYP was added during ON periods. Only data from cows with at least one Dairy Herd Improvement Association milk test each period were used in the data analyses ($n = 1903$). Statistics were performed using the Mixed procedure of SAS (SAS. 2015. SAS/STAT User's Guide: Version 9.4. Cary, NC: SAS Institute Inc.) with treatment nested within period and covariates: parity, days in milk, pen and corresponding production value in the previous control period. Overall, daily milk yield (32.3 and 33.0 kg, $P = .0014$) and milk protein (1.04 and 1.08 kg, $P = .0006$; 3.25% and 3.31%, $P = .0021$) for control and LYP, respectively, were greater for cows fed LYP. Therefore milk yield and milk protein yield and percentage increased with supplementation of LYP.

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Live yeast; dairy cow performance; large commercial herd

1. Introduction

Meta-analyses (Desnoyers et al. 2009; de Ondarza et al. 2010b; Poppy et al. 2012) and research studies (Moallem et al. 2009; Evans et al. 2012; AlZahal et al. 2014) have concluded that supplementation of live yeast to dairy cattle yields inconsistent results. Common benefits to feeding yeast products (YP) are increases in milk, milk protein yield, fibre digestion and stabilization of rumen pH (Wohlt et al. 1998; Chaucheyras-Durand et al. 2008; Meller et al. 2014). These results may vary because the influence of YP on rumen function decreases with decreasing level of concentrate and dry matter intake (DMI) (Gurbuz 2007; Desnoyers et al. 2009), with later stages of lactation (Shaver & Garrett 1997; Moallem et al. 2009), with other feed additives (sodium bicarbonate; Swartz et al. 1994; Marden et al. 2008; Ferraretto et al. 2012) and with differences in management (Bach et al. 2007; Chaucheyras-Durand et al. 2008; AlZahal et al. 2014; DeVries & Chevaux 2014).

Responses to feeding YP to commercial herds have been inconsistent (Swartz et al. 1994; Shaver & Garrett 1997; de Ondarza et al. 2010b). Most commercial herds supplement yeast to all cows, not just transition cows, are kept in large free-stall pens and have variability in daily nutrient supply and feed availability (Bach et al. 2007; Gurbuz 2009; Rossow & Aly 2013). For example, differences in social behaviour in large pens may impact feeding behaviour making it difficult to detect a difference when feeding YP. Sorting behaviour, frequency and timing of daily feedings are altered by YP (Bach et al. 2007; DeVries & Chevaux 2014). But, if these feeding changes do not affect cow performance, a commercial dairy may not be able to detect a benefit to feeding an YP. Therefore



YP must be tested under commercial herd conditions to assess their effectiveness. The purpose of this study was to evaluate the effects of supplementation of a live yeast product (LYP) on milk yield and milk components on a large commercial dairy. Milk yield and Milk component production from all milking cow pens were compared over five 45-day periods alternating no LYP supplementation periods ($n = 3$) with LYP supplementation periods ($n = 2$).

2. Materials and methods

2.1. Animals and treatments

Animals participating in this study were handled in accordance with guidelines outlined by the 'Guide for Care and Use of Agricultural Animals in Research and Teaching' (3rd ed. 2010 Federation of Animal Science Societies, Champagne, IL). The field trial was conducted from July 2013 to March 2014 on a commercial dairy with 6700 lactating Holstein dairy cows located in the Central California region. Cows were housed in free-stall barns with access to open exercise pens, milked and fed twice daily.

All lactating cows were fed LYP in an OFF-ON-OFF-ON-OFF study design sequence where OFF corresponded to all cows not fed a yeast product and ON to all cows fed LYP. Each period was 45 days and OFF periods contained one Dairy Herd Improvement Association (DHIA) test date and ON periods contained two DHIA test dates. The LYP was fed at the rate of 3 g/d, giving each cow approximately 60 billion cfu of live yeast per day incorporated into a premix manufactured by JD Heiskell Co. (Pixley, CA USA) which was added to a total mixed ration (TMR) fed at the rate of 0.23 kg/cow/d.

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Milk yield, percentages of fat and protein, and somatic cell counts were measured monthly by DHIA for a total of eight tests, four of which were during LYP supplementation (Table 1). Milk samples were analysed each month by infrared analysis (Southern Counties DHIA Laboratory, Shafter, CA USA). Pen DMI was estimated from daily pen feed delivery weights from the mixer wagon and recorded using the Feed-Watch feed management software (Valley Agricultural Software, Tulare, CA USA) for each pen. Pen DMI was corrected for residual feed which were weighed every other day and recorded using Feed Watch. Total corrected DMI was divided by numbers of cows in the pen that day to estimate individual cow DMI and to account for differences in numbers of cows per pen from day to day.

Nutrient compositions of the TMR (Table 2) were calculated based on nutrient profiles of individual feeds in NRC Nutrient Requirements of Dairy Cattle (NRC 1989, 2001) and TMR ingredients fed (FeedWatch v.8.0, Valley Agricultural Software Inc., Tulare, CA USA). Ingredients in the TMR did not change over the course of the trial but proportions of ingredients changed due to variations in forage quality. Dry matter content of forages was measured twice a month using a Digital Moisture Balance (CSC Scientific Company Inc., Fairfax, VA USA). Four diets fed to a total of 22 pens of cows were included in the OFF-ON study design: fresh cow, milk cow, first lactation and pregnant cow (Table 2). Cows were moved into and out of pens according to herd protocol during the study.

2.2. Statistical analyses

There were 1903 cows that completed all five periods of the study and had at least one DHIA test during each period of the trial. Statistical analyses of DMI, milk yield and composition was performed using the Mixed procedure of SAS (SAS Institute Inc., Cary, NC v.9.4 2015) with period nested within treatment, and fixed effects pen, days in milk (DIM), parity and previous control period milk yield or composition. Nesting period within treatment was included in the model to account for changes in milk production due to differences among pens and increasing DIM as the trial progressed. There were no differences in least square means of parity and mean previous mature equivalent (ME305) milk.

3. Results and discussion

Only data from cows that were present in all five periods of the trial with at least one milk test in each period were retained in the dataset. This was done to avoid seasonality of milk production that is often observed in long, multi-season commercial dairy herd trials. As a result, total cows in the study declined by 114, mean DIM increased by 192 days and mean parity remained the same over the 225-day trial (Table 1).

Four diets were fed during the trial depending on parity and DIM (Table 2). Similar ingredients were used in all four diets resulting in small deviations in estimated nutrient contents and so variability in nutrient quality of feeds was not included in the ingredient nutrient profiles. Differences in nutrient content of the diets are solely due to changes in ingredient proportions. Variability in ingredient compositions especially for

Table 1. Trial design, cow characteristics and performance during the 225-day trial.

Item	Period 1	Period 2	Period 3	Period 4	Period 5	SE
Treatment	Control	LYP ³	Control	LYP ³	Control	
Dates of period ¹	15/7/2013–31/8/2013	1/9/2013–15/10/2013	16/10/2013–30/11/2013	1/12/2013–15/1/2014	16/1/2014–3/3/2014	
Milk test dates	14/8/2013	11/9/2013–9/10/2013	13/11/2013	11/12/2013–15/1/2014	12/2/2014–12/3/2014	
Total cows on study	2017	2016	1998	1971	1903	
Mean parity ²	1.85	1.84	1.83	1.83	1.84	0.030
Mean DIM ^{2,3}	106 ^e	143 ^a	193 ^c	238 ^b	298 ^a	2.0
DMI ² , kg cow/d	23.1 ^c	24.4 ^b	24.1 ^b	24.2 ^b	26.0 ^a	0.33
Mean previous ME305 milk ² , kg	11,991	11,991	11,991	11,992	11,993	68
Milk yield ² , kg/d	32.7 ^a	32.5 ^a	32.6 ^a	33.5 ^a	31.5 ^b	0.64
3.5% FCM ² , kg/d	33.9 ^a	33.2 ^a	32.9 ^a	33.6 ^a	32.1 ^b	0.55
Milk fat ² , %	3.78 ^a	3.68 ^{ab}	3.61 ^{bc}	3.53 ^c	3.65 ^b	0.058
Milk fat ² , kg/d	1.22 ^a	1.18 ^b	1.17 ^b	1.17 ^b	1.13 ^c	0.020
Milk protein ² , %	3.19 ^c	3.21 ^c	3.33 ^b	3.40 ^a	3.23 ^c	0.027
Milk protein ² , kg/d	1.02 ^c	1.02 ^c	1.08 ^b	1.14 ^a	1.02 ^c	0.018

¹Each period lasted 45 days.

²Least square mean days in milk (DIM), dry matter intake (DMI), mature equivalent 305 day milk (ME305), fat corrected milk (FCM) with differing letters (abcde), within a row are different ($P < .05$).

³Mean DIM is calculated according to milk test date and dates of period refer to days of no supplementation of LYP or days of supplementation of LYP. Therefore mean DIM are not 45 days apart for each period.

⁴LYP is live yeast product added to diets at the rate of 3 g/cow/d.

Table 2. Ingredients and calculated nutrient compositions of diets used in the study (% of DM).

Item	Fresh cow 7–50 DIM	CV ^a	Milk Cow 14–300 DIM	CV	Milk heifer 14–300 DIM	CV	Pregnant cow 100–350 DIM	CV
Number of pens	4		7		4		7	
Ingredient composition								
Alfalfa	19	22	15	10	17	8.0	16.2	11
Corn silage	13	35	7.9	22	9.1	23	9.5	31
Milo silage	5.9	48	4.1	45	4.1	44	5.6	54
Almond hulls	6.7	28	14	10	12	16	11.6	14
Rolled corn	23	5.1	19	7.8	20	8.4	21	9.4
Dried distillers grains	4.8	28	5.7	11	4.5	27	5.4	7.5
Carrots	0.081	65	0.55	26	0.076	30	0.087	36
Whey	3.9	28	5.4	7.7	5.8	19	6.4	9.8
Premix ^b	27	8.1	29	5.4	28	4.8	26	3.6
Wheat straw	0.79		0.83		0.80		0.75	
Canola meal	7.8		8.2		7.9		7.4	
Mill run	9.2		9.7		9.3		8.7	
Cottonseed	4.4		4.6		4.5		4.2	
Molasses blend	2.4		2.9		2.4		2.2	
Calcium carbonate	0.79		0.83		0.80		0.75	
Vitamin and mineral mix	0.78		0.82		0.79		0.74	
Nutrient composition ^c								
DM ^d	74	7.5	76	4.0	75	4.2	75	4.7
CP	16	12	15	4.7	15	5.2	15	3.8
ADF	18	22	18	5.3	18	5.4	18	6.6
NDF	29	20	28	4.3	29	5.1	28	5.9
Lignin	4.2	22	5.0	6.4	4.7	7.2	4.6	9.2
Ash	7.1	19	7.2	6.5	7.1	7.2	7.1	6.1
Fat	4.2	7.7	4.2	2.6	4.2	3.4	4.2	1.8

^aCV is coefficient of variation calculated from changes in diets formulated by the nutritionists approximately every two weeks from data in the feed management software, FeedWatch V 7.0.

^bPremix ingredient composition was fixed therefore CV reflects differences in amount of Premix fed.

^cCalculated nutrient values based on NRC Nutrient Requirements of Dairy Cattle 1989 and 2001 nutrient composition of feeds tables except DM.

^dDry matter content of forages was measured twice a month using a Digital Moisture Balance (CSC Scientific Company Inc., Fairfax, VA USA).

forages and byproducts (carrots and almond hulls) was high (Table 2). However, this was a relatively long trial (225 days) and the high variability reflects decisions to exchange milo silage for corn silage and the seasonal availability of byproducts such as carrots and almond hulls.

Milk yield, and milk protein yield and percentage increased during LYP supplementation periods (Table 3), implying that supplementation with LYP is beneficial in later lactation (238 DIM). Milk production levels (Table 1) were maintained in periods 1 through 4 and declined to their lowest levels in period 5 (Control). These results agree with a meta-analysis by de Ondarza et al. (2010b) which showed an increase in 3.5% fat corrected milk (FCM) at all DIM for cows supplemented with LYP but did not report results for milk fat or milk protein. Other studies have shown an increase in milk yield with LYP supplementation but not milk protein or milk fat yields. For instance, Evans et al. (2012) also observed increases in milk yield, but changes in milk fat and protein yields were

inconclusive in 14 trials with commercial dairy herds supplementing cows greater than 150 DIM with LYP. In this study, milk protein yield and percentage increased over time but milk fat percentage declined with LYP supplementation. However, the decline in milk fat percentage with LYP supplementation was due to an increase in milk yield and essentially constant milk fat yield with LYP supplementation. Therefore supplementation of LYP did not affect milk fat yield. DMI was not different in periods 2–4 and was lowest during the first period when 3.5% FCM was greatest, and greatest during the last period when milk yield was lowest. Since cows were in late lactation (298 days) in the last period, milk yield would be expected to be lower and greater DMI may be supporting fetal growth and body weight gain in addition to milk production. Overall, DMI was not different between treatments.

Yields of 3.5% FCM were higher in period 1 (control) than in period 2 (LYP). On average cows were less than 150 DIM in these two periods and milk test dates were at 10 days and approximately 30 days into the LYP supplementation periods. Therefore 10 days of feeding LYP may not be long enough to cause changes in the rumen that would impact milk protein and fat yields. Underlying mechanisms for the action of LYP on rumen metabolism are maintaining the reducing potential in the rumen (stabilizing rumen pH), increasing populations of cellulolytic microbes (increasing fibre digestibility), utilizing starch and sugars to help lower the rate of lactic acid production (help prevent rumen acidosis) and releasing vitamins and growth factors to stimulate bacterial growth (Krizova et al. 2011; de Ondarza et al. 2010a; Pinloche et al. 2013). However, due to the lack of consistent results in milk fat and protein yields

Table 3. Performance of lactating dairy cows fed diets supplemented with 0 or 3 g/d of live yeast product (LYP) in sequential 45 days periods of OFF, ON, OFF, ON, OFF of LYP supplement.

Item	Control diet	LYP diet	SE ^a	P value
Milk, kg/d	32.3	33.0	0.41	.0014
3.5% FCM ^a , kg/d	33.0	33.4	0.35	.0057
Milk fat, %	3.68	3.61	0.037	.048
Milk fat, kg/d	1.17	1.17	0.012	.85
Milk protein, %	3.25	3.31	0.017	.0021
Milk protein, kg/d	1.04	1.08	0.011	.0006
DMI ^a , kg cow/d	24.4	24.3	0.21	.56
SCC ^a , ×1000 cells	138	154	27	.94

^aSE is standard error; FCM is fat corrected milk; DMI is dry matter intake; SCC is somatic cell count.

with LYP supplementation, a longer exposure period may be needed to observe the benefits of feeding LYP (Meller et al. 2014; de Ondarza et al. 2010a).

Meta-analyses (Desnoyers et al. 2009; de Ondarza et al. 2010b; Poppy et al. 2012) reveal that when responses to YP supplementation are observed, they fall within a consistent range. Results from this study are consistent with meta-analyses results. For example, in this study, milk yield and 3.5% FCM increased during the ON periods (feeding LYP) by 0.7 and 0.4 kg/d, respectively, and milk protein yield and percentage increased by 0.04 kg/d and 0.06%, respectively (Table 3). These results are similar to those from meta-analyses with estimated mean responses of 0.5–2 milk yield (kg/d), 0–0.06 protein yield (kg/d) and 0–0.02 protein (%).

Variability between control and LYP means were also similar to variability associated with other studies feeding LYP to commercial herds. Examples of commercial herd studies are Shaver and Garrett (1997) with 585 cows from 11 commercial herds at 140 DIM on average, Swartz et al. (1994) with 306 cows from 7 commercial herds at 0–120 DIM and de Ondarza et al. (2010a) with 341 cows from 1 commercial herd at 146 DIM on average. The standard deviation (SD) associated with milk production from the commercial herds were 4.8, 16 and 5.2 kg milk yield, 0.48%, 0.42%, and 2% for milk fat and 0.24%, 0.21% and 0.5% for milk protein from Shaver and Garrett (1997), Swartz et al. (1994) and de Ondarza et al. (2010a), respectively. Standard deviations from 52, 14 and 16 YP studies in three meta-analyses summarized by Desnoyers et al. (2009), de Ondarza et al. (2010b) and Poppy et al. (2012–milk only), respectively, included SD 1.6, 6.5 and 2.0 kg milk yield, 0.14, 0.34% milk fat and 0.070, 0.16% for milk protein. Milk yield (kg), fat and protein percentage SD from this study were 6.6 kg, 0.60% and 0.28%, respectively, and were within ranges from the commercial herds. Therefore variability in milk production is generally greater in commercial herds than meta-analyses combining small research studies.

Because variability in milk yield is generally larger in commercial herds than in smaller, well-controlled studies, benefits of feeding LYP may not be detectable on a commercial dairy. Day to day feeding, variability in nutrients supplied, cow movement between pens and social interactions between cows in large pens (stress) may impact milk yield more than LYP supplementation. Since many of the proposed benefits of feeding yeast result in a more stable rumen pH and rumen environment, LYP may mitigate some of the effects of inconsistent feeding and stress on the rumen environment. Therefore while there may not be a difference in milk, milk protein or milk fat yields with LYP supplementation, milk production may be more consistent. To determine the effect of LYP supplementation on milk production, results of small, well-controlled research studies need to be confirmed with studies using commercial herds.

4. Conclusion

Previous data have shown the addition of LYP promotes the growth of cellulolytic bacteria populations by reducing oxygen concentration, buffering ruminal fluid and increasing ruminal lactic acid-utilizing bacteria. In this study, supplementation of LYP increased milk yield and milk protein yield and

percentage without a significant increase in feed consumption. Therefore greater milk and milk protein yields are probably a result of improved rumen function with feeding LYP.

Disclosure statement

No potential conflict of interest was reported by the authors.

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