Feedstuffs Reprint

Can dry yeast replace buffer in high-yield cow ration?

Dairy nutritionists typically buffer dairy rations to combat acidosis, but an active dry yeast product can be supplemented to improve fiber digestion and further optimize rumen pH in high-yielding cows.

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SODIUM sesquicarbonate and sodium bicarbonate have been shown to have a similar rumen buffering ability (Le Ruyet and Tucker, 1992).

Erdman (1988) concluded that the addition of sodium bicarbonate to low-forage diets increases rumen pH, the acetate-to-propionate ratio and milk fat percentage.

When Solorzano et al. (1989) supplemented 0.71% sodium bicarbonate or 0.65% sodium sesquicarbonate, both dietary buffers tended to equally improve milk fat concentration as well as increase dry matter intake (DMI) and apparent dry matter (DM) and neutral detergent fiber (NDF) digestion. Sodium sesquicarbonate (0.75%) increased milk fat percentage by 0.19 percentage points and raised the 4% fat-corrected milk (FCM) yield by 2.4 kg (Cassida et al., 1988).

Two recent studies conducted in the U.S. under non-heat stress conditions indicated that typical high-production diets — 23-26% forage NDF — may not require an added buffer when active dry yeast (Levucell SC, *Saccharomyces cerevisiae* CNCM I-1077) is supplemented at a rate of 10 x 10^9 colony-forming units (CFU) per cow per day (de Ondarza et al., 2012; de Ondarza et al., 2014).

2012 study

At a 300-cow Vermont dairy, 120 multiparous Holstein cows were supplemented with either active dry yeast (*S. cerevisiae* CNCM I-1077 at 10 x 10^9 CFU per day) or 6 oz. of sodium bicarbonate per cow per day (de Ondarza et al., 2012).

For this side-by-side study, two high-yielding lactating pens were balanced for parity, days in milk (DIM) and pre-trial 3.5% FCM yield. The study was conducted for 11 weeks, with six weeks of diet adaptation and five weeks of data collection. The total mixed ration consisted of corn silage, grass/legume silage, corn meal, whole cottonseed and a commercial grain blend (Table 1).

Daily milk yield of individual cows was recorded, and individual milk components were assessed three times (on weeks 8, 9 and 10). Daily pen DMI was recorded. Rumen pH was measured every five minutes in four cows within each treatment pen during the data collection period.

Results of the 2012 study include:

- Active dry yeast either improved or had no effect on milk yield or milk components (Table 2).
- Milk yield tended ($P = 0.09$) to be 2.1 kg higher for cows fed active dry yeast — 41.9 kg per day for the active dry yeast treatment compared to 39.8 kg per day for the sodium bicarbonate treatment.
- The milk fat percentage was not affected ($P = 0.79$) by treatment, with means of 3.62% for active dry yeast and 3.65% for sodium bicarbonate.
- Milk fat yield was unaffected ($P = 0.30$) by treatment, with means of 1.51 kg per day for active dry yeast versus 1.46 kg per day for sodium bicarbonate.
- Percent milk true protein was similar ($P = 0.34$) for all cows, with means of 2.98% for cows fed active dry yeast and 3.01% for cows fed sodium bicarbonate.
- Milk true protein yield tended ($P = 0.09$) to be higher for cows fed active dry yeast, with means of 1.24 kg and 1.18 kg per day for active dry yeast and sodium bicarbonate, respectively.
- Milk urea nitrogen was not affected ($P = 0.51$) by treatment, with means of 13.05 mg/dL for active dry yeast and 13.33 mg/dL for sodium bicarbonate.
- Daily pen DMI was 26.1 kg per cow per day for active dry yeast and 26.3 kg per cow per day for sodium bicarbonate ($P < 0.05$).

Active dry yeast had a significant positive effect on most rumen pH parameters (Table 3 and Figure). Mean daily pH was higher ($P < 0.0001$) for cows fed active dry yeast — 6.22 for active dry yeast versus 6.03 for sodium bicarbonate.

Minimum daily pH was higher ($P < 0.0001$) for cows fed active dry yeast — 5.54 for active dry yeast compared to 5.34 for sodium bicarbonate. Maximum daily pH was higher ($P < 0.0001$) for cows fed active dry yeast — 6.98 versus 6.81 for active dry yeast and sodium bicarbonate, respectively.

The duration of the day when rumen pH was less than 5.8 (Dohme et al., 2008) was reduced ($P < 0.0001$) for cows fed active dry yeast — 141 minutes per day for active dry yeast versus 378 minutes for sodium bicarbonate. The area under the

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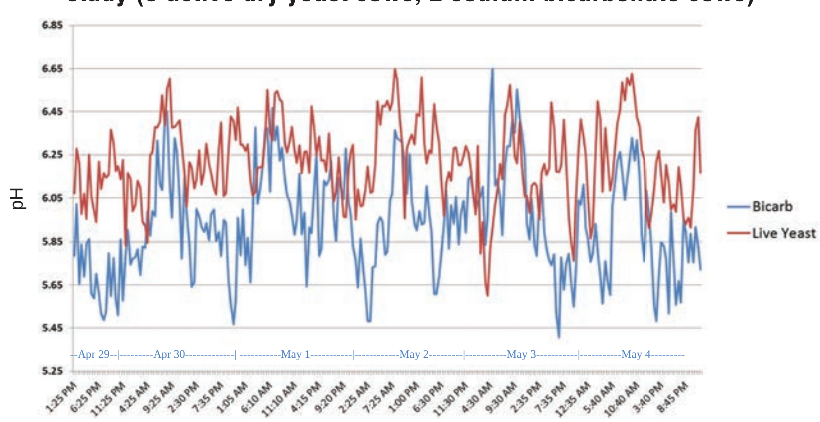
Average ruminal pH fluctuation over 6 days of a 2012 lactating cow study (3 active dry yeast cows; 2 sodium bicarbonate cows)



pH 5.8 curve (pH x minutes per day) was less ($P < 0.0001$) for cows fed active dry yeast — 19.5 for active dry yeast versus 80.1 for sodium bicarbonate.

2014 study

At a 2,000-cow dairy in New York, a study determined the effect of supplementing 10 x 10^9 CFU per day of active dry yeast (*S. cerevisiae* CNCM I-1077) versus 8 oz. of sodium sesquicarbonate per cow per day (0.80% ration DM) on milk yield, milk components and pen DMI (de Ondarza et al., 2014).

For this side-by-side study, four pens of cows (200-230 cows per pen) in a freestall barn were paired as follows: parity 1 and parity 2+, with each pair balanced for DIM, parity and pre-trial milk production prior to beginning the study. One pen per pair received 10 x 10^9 CFU per day of active dry yeast, and one pen per pair received 8 oz. of sodium sesquicarbonate per cow per day (0.80% ration DM).

The study was 16 weeks in length, with 12 weeks of diet adaptation to ensure complete adaptation to the active dry yeast supplement and four weeks of data collection.

The total mixed ration consisted of corn silage, alfalfa/grass haylage, high-moisture ear corn, condensed whey and a commercial feed blend. Parity 1 and parity 2+ diets were similar except that the parity 2+ diet contained 25% brown mid-rib corn silage, and forage NDF was higher — 24.26% versus 23.45% (Table 1).

Milk yield of individual cows was recorded daily. Individual milk components were assessed twice during the data collection period. Only cows remaining in study pens for the entire 16 weeks were included in the analysis (active dry yeast group of 295 cows; sodium sesquicarbonate group of 279 cows). The statistical model for milk yield and components included treatment, DIM category and pair as fixed effects, with cow within pen as random.

Results of the 2014 study include:

- Yields of milk and milk components were excellent throughout the study for both treatments. Daily milk yield was unaffected by treatment, with means of 40.05 kg and 39.82 kg per day for the active dry yeast and sodium sesquicarbonate diets, respectively (Table 4).
- For all cows, weekly average daily milk yields (test day milk yield ± three days) tended ($P = 0.10$) to be higher with the active dry yeast diet — 40.08 kg per day for active dry yeast and 39.13 kg per day for sodium sesquicarbonate (Table 4).
- Weekly average daily milk yields were significantly higher ($P = 0.01$) with the active dry yeast diet in the mature cows, at 42.08 kg per day, than at 40.26 kg per day for the sodium sesquicarbonate diet

1. Diet nutrient analyses

	2012 study	-------2014 study------- Parity 1	Parity 2
CP, % DM	17.74	16.82	16.93
Soluble CP, % CP	35.27	36.58	37.42
Rumen unavailable protein, % CP	37.80	38.58	38.14
Net energy of lactation, Mcal/kg	1.76	1.78	1.80
Acid detergent fiber, % DM	19.75	18.25	18.87
NDF, % DM	32.73	33.68	34.57
Forage NDF, % DM	25.66	23.45	24.26
Lignin, % DM	3.11	2.52	2.30
Non-fiber carbohydrates, % DM	39.82	40.93	40.06
Sugar, % DM	3.59	4.22	4.26
Starch, % DM	27.35	28.18	26.52
Ether extract, % DM	5.34	5.47	5.44

2. Production and component least-square means and standard error (SE) by treatment, 2012 lactating cow study

	-Active dry yeast-		-Sodium bicarb.-		
	Mean	SE	Mean	SE	P-value
Milk, kg/day	41.91	0.86	39.83	0.86	0.09
3.5% FCM, kg/day	42.58	0.89	40.89	0.90	0.18
Fat, %	3.62	0.07	3.65	0.07	0.79
Fat, kg/day	1.51	0.04	1.46	0.04	0.30
Protein, %	2.98	0.02	3.01	0.02	0.34
Protein, kg/day	1.24	0.02	1.18	0.02	0.09
Milk urea nitrogen, mg/dL	13.05	0.30	13.33	0.31	0.51
Somatic cell count x 1,000	80.09	49.16	245.48	49.06	0.02

3. Ruminal pH profile of cows by treatment, 2012 lactating cow study

	-Active dry yeast-		-Sodium bicarb.-		
	Mean	SE	Mean	SE	P-value
Mean daily pH	6.22	0.01	6.03	0.01	<0.0001
Minimum daily pH	5.54	0.01	5.34	0.01	<0.0001
Maximum daily pH	6.98	0.02	6.81	0.02	<0.0001
Daily pH range	1.44	0.03	1.46	0.03	0.58
Ruminal pH below 5.8					
Duration of day, min./day	141	15	378	14	<0.0001
Area, pH x min./day	19.5	4.4	80.1	4.2	<0.0001

4. Production and component least-square means (±SE) by treatment, 2014 lactating cow study

	-----Active dry yeast-----		--Sodium sesq.--			Obser-
	Mean	SE	Mean	SE	P-value	vations
Daily milk, kg/day	40.05	0.32	39.82	0.33	0.62	14,783
Weekly avg. daily milk, kg/day	40.08	0.43	39.13	0.40	0.10	1,057
3.5% FCM, kg/day	42.45	0.53	41.16	0.51	0.08	1051
Fat, %	3.82	0.06	3.86	0.06	0.62	1056
Fat, kg/day	1.54	0.02	1.49	0.02	0.17	1051
True protein, %	3.18	0.02	3.17	0.02	0.71	1056
True protein, kg/day	1.27	0.01	1.23	0.01	0.02	1051
Somatic cell count x 1,000	152.23	40.35	86.89	41.80	0.26	1,056

5. Production and component least-square means (±SE) according to parity by treatment, 2014 lactating cow study

		-Active dry yeast-		--Sodium sesq.--		
	Parity	Mean	SE	Mean	SE	P-value
Weekly avg. daily milk, kg/day						
	1	38.08	0.57	37.99	0.54	0.91
	2+	42.08	0.57	40.26	0.54	0.01
3.5% FCM, kg/day						
	1	39.25	0.65	38.77	0.63	0.56
	2+	45.66	0.64	43.56	0.62	0.01
Fat, kg/day						
	1	1.40	0.03	1.38	0.03	0.51
	2+	1.68	0.03	1.61	0.03	0.08
True protein, kg/day						
	1	1.22	0.02	1.18	0.02	0.10
	2+	1.33	0.02	1.28	0.02	0.02

(Table 5).

- Milk fat percentage was not affected by treatment, with means of 3.82% and 3.86% for active dry yeast and sodium sesquicarbonate, respectively (Table 4).
- Milk fat yield was numerically higher (P = 0.17) for cows supplemented with active dry yeast — 1.54 kg for the active dry yeast diet compared to 1.49 kg for the sodium sesquicarbonate diet (Table 4), especially in the mature cows (P = 0.08; Table 5).
- Yield of 3.5% FCM tended to be 1.29 kg higher for cows supplemented with active dry yeast (P = 0.08) — 42.45 kg per day compared to 41.16 kg per day for sodium sesquicarbonate (Table 4). This difference was significant (P = 0.01) for the mature cows — 45.66 kg per day versus 43.56 kg per day for active dry yeast and sodium sesquicarbonate, respectively (Table 5).
- Milk true protein percentage was not affected by treatment — 3.18% and 3.17% for active dry yeast and sodium sesquicarbonate, respectively (Table 4), although first-lactation animals fed active dry yeast tended (P = 0.08) to produce milk with a higher percentage of milk true protein — 3.19% versus 3.14% for active dry yeast and sodium sesquicarbonate, respectively (Table 5).
- Active dry yeast improved (P = 0.02) milk true protein yield by 0.04 kg per day — 1.27 kg per day for the active dry yeast treatment compared to 1.23 kg per day for the sodium sesquicarbonate treatment (Table 4).
- Overall, DMI tended (P = 0.08) to be higher with active dry yeast supplementation, at 24.89 kg per day versus 24.25 kg per day for the sodium sesquicarbonate supplementation.
- There was no effect of treatment on DMI of first-lactation animals (P = 0.83). Mature cows, however, responded with higher DMI with active dry yeast — 28.24 kg per day versus 26.88 kg per day for sodium sesquicarbonate (P < 0.01).

Discussion

Both studies indicate that yields of milk and milk components are either similar or higher when active dry yeast is supplemented without a rumen buffer in the diet.

In the 2012 study, the improvements in rumen pH with active dry yeast were similar to those seen in previous studies (Thrune et al., 2009; Bach et al., 2007), confirming that active dry yeast reduces the risk of subacute ruminal acidosis.

Previous studies concluded that rumen buffer supplementation prevents milk fat depression when cows are fed a high-concentrate diet (Kennelly et al., 1999; Khorasani and Kennelly, 2001). These trials showed that cows fed a typical high-yielding lactation diet — with 23-26% forage NDF supplemented with active dry yeast and no buffer — perform as well as or better than cows fed solely a rumen buffer.

IMPROVEMENTS in 3.5% FCM with active dry yeast over the buffer-supplemented ration were likely due to a combination of rumen pH control (Bach et al., 2007; Guedes et al., 2008; Moya et al., 2007; Thrune et al., 2007) and enhanced fiber digestibility (Chaucheyras-Durand and Fonty, 2001; Guedes et al., 2008).

Since Moya et al. (2007) reported an increased efficiency of microbial protein synthesis with active dry yeast, it is surmised that in both U.S. studies, an enhanced microbial protein supply with active dry yeast increased milk true protein yield.

With increases in fiber digestion and rumen cellulolytics from dietary active dry yeast (Chaucheyras-Durand and Fonty, 2001; Mosoni et al., 2007), an improvement in DMI would be expected (Oba and Allen, 1999) due to reduced rumen retention time. However, DMI was not improved with active dry yeast in the 2012 study or in the parity 1 animals from the 2014 study. Rather, DMI was increased only in the 2014 study in parity 2+ cows fed a diet containing highly digestible brown mid-rib corn silage.

Implications

Dairy nutritionists typically supplement sodium bicarbonate or sodium sesquicarbonate to combat subacute ruminal acidosis, whereas an active dry yeast product can be supplemented to improve fiber digestion and to further optimize rumen pH in high-yielding cows.

These U.S. studies show that yields of milk and milk components are similar or higher when solely active dry yeast is supplemented without inclusion of sodium bicarbonate or sodium sesquicarbonate. Furthermore, active dry yeast tends to improve 3.5% FCM yield and milk true protein over buffer supplementation, especially in mature cows fed a diet containing highly digestible forage NDF.

Under temperate conditions, typical high-production diets may not require an added buffer when active dry yeast (*S. cerevisiae* CNCM I-1077) is supplemented at a rate of 10 x 10^9 CFU per cow per day.

References

The full list of references for this article can be obtained by emailing tlundeen@feedstuffs.com. ■