USE OF YEAST PRODUCTS IN DAIRY CATTLE RATIONS

by

James Wohlt, Associate Professor
Department of Animal Sciences
Rutgers - The State University
New Brunswick, New Jersey 08903-0231

INTRODUCTION

During the past 50 years various dry yeast products have been marketed through the feed industry and included in livestock and poultry feeds (7,11). Currently there is considerable interest in using "active yeast cultures", because when these products are fed, benefits in animal production are consistently reported. However a shroud of mystery has and continues to be associated with the use of yeast products (10,11); in part, because knowledge on the mode of action or factors associated with yeast that contribute to improvements are limited.

This paper will review the types of yeast products that have been used in the feed industry and in particular discuss the use and value of "active yeast cultures" for the lactating dairy cow. Also, current data will be presented to further define the mode of action with which yeasts improve animal production.

EARLY APPLICATIONS AND IMPROVEMENTS IN YEAST PRODUCTS

Todays wide spread acceptance and increased demand for "active yeast cultures" is a result of the progressive developmental improvement of yeast products over a 50 year marketing period (7,11). As early as the 1940's commercial industries sought on a large scale to dispose of spent medium from fermentors. This waste was high in protein and when fed to livestock and poultry gave a response over and above what could be expected from the waste product's nutrient content. Hence the term "unidentified growth factors" also was attached to these products.

Over the years various terms have been used to describe yeast products "Yeast Feed", "Live Yeast Feed", "Cereal Yeast Feed", "Enzyme Active Yeast", "Live Cell Yeast Culture", "Special Yeast Culture", and "Active Yeast Culture" (7). Rather than relying on spent medium, yeast cultures were introduced and are defined as a "dried product composed of yeast and the media on which it was grown and dried in such a way as to preserve its fermentative capacity. The media must be stated on the label". Although this definition provided yeast cultures an officially-recognized feed ingredient status, it did not quantify or guarantee the viability of the yeast present in the product. Today with an "active yeast culture", a specific strain of yeast in high numbers having a guaranteed viability can be fed to animals. Contrasting this with spent medium for which yeast counts and viability were undefined emphasizes the dramatic progressive development of yeast products for the feed industry.

ACTIVE YEAST CULTURES FOR RUMINANTS

Yeasts have been isolated from rumen contents (15). Although, aerobic strains have been viewed only as transient populations, studies conducted with *Saccharomyces cerevisiae*, a facultative anaerobe, indicate that this organism has some degree of viability and ability to reproduce in the rumen (2). In vitro and in vivo studies have shown that *S. cerevisiae* can influence microbial populations and thus fermentation within the rumen (2,3,6,13).

A majority of the manufacturers include genetically superior strains of *S. cerevisiae* in their "active yeast cultures". Although "active yeast culture" is a source of single cell protein for the ruminant, it is an important source of live yeast cells (numbers vary with product). Through autolysis live yeast cells secrete significant quantities of metabolites including: ethanol, proteins, enzymes, and B-vitamins. Many manufacturers also have included supplemental enzymes and vitamins in addition to the live yeast cells and media. Benefits are thus obtained through the metabolites that yeast secrete and/or their interaction with other rumen microbes.

PRODUCTION RESPONSES BY LACTATING DAIRY COWS

Feeding "active yeast culture" has resulted in significant increases in milk yield (8,9) and fat test (8). But in other studies (1,4,16) no beneficial response occurred. It appears that production is most benefited by "active yeast cultures" during early or the high production phase of lactation when stress is greatest. Data from field trials and recommendations from nutritionists support this concept (14).

Due to the lack of published data in this area, a study was conducted at Rutgers (19) assessing the value of feeding an "active yeast culture" to lactating dairy cows. The study spanned 30 d prepartum through wk 18 of lactation and DM intake, milk yield and composition, nutrient digestibility (DM, CP, NDF, ADF, hemicellulose, cellulose) and N balance were measured. Twenty-four primiparous Holstein cows were divided into 2 groups of 12 cows each, blocking for calving date and Pedigree Type Production Index (420,419+). Ten grams of Biomate Yeast Plus (5×10^9cfu *S. cerevisiae*/g) was top-dressed on each a.m. feeding of corn-silage based diets, thus restricting supplemental yeast to treatment mangers and avoiding diet cross contamination through use of a mixer.

Peak milk yield occurred earlier and was greater when primiparous cows fed a corn silage-based diet were fed the "active yeast culture" (wk 7, 29.5 kg/d vs. wk 11, 28.5 kg/d; treatment X week, $P = .10$; Figure 1). This improvement in milk yield supports data of earlier studies (8,9). The earlier and higher peak milk yield enabled the cows fed yeast to maintain an advantage in milk production over those fed the control diet during wk 8-18 (Figure 1) and average production over wk 1-18 of lactation (27.2 vs. 26.0 kg/d). Cows fed yeast averaged an additional 196 kg of milk during the 126-d study. Milk fat test was high, averaging 3.93%, and did not differ among treatments. Milk protein test averaged 3.17%.

Dry matter intake during wk 4, 3, 2 and 1 prepartum averaged 8.7, 8.7, 8.4, 7.9 and 9.5, 8.9, 8.8, 8.2 kg/d for cows fed the control and yeast-supplemented diets, respectively. The decrease in DM intake normally associated with calving occurred in both groups of cows, but to a lesser extent in those fed supplemental yeast. After calving, diets were offered for ad libitum intake and increases in DM intake tended to be greater in each of the first 6 wk of lactation for cows fed yeast compared to those fed the control diet, averaging 14.9 vs. 13.8 kg/d (treatment X week, $P < .002$; Figure 2). This improved DM intake supports previous data (12) and was an important factor contributing to the earlier and higher peak milk observed in this study for cows fed supplemental yeast.

FACTORS CONTRIBUTING TO PRODUCTION RESPONSES

Digestibility of DM, NDF, ADF and hemicellulose was similar for all cows (Table 1). However, CP and cellulose digestibility tended ($P = .25$) to be improved by yeast supplementation. The improved CP and cellulose digestibility measured during wk 9-10 may reflect differences in digestibility during the first 6 wk of lactation. This, in turn, may have contributed to the greater DM intake by cows fed supplemental yeast during that time period.

Yeast cultures may provide factors stimulatory to rumen cellulolytic and proteolytic bacteria, especially when high-concentrate (>50%) diets are fed (18). Feeding yeast cultures has increased numbers of cellulolytic rumen bacteria (6,17) and improved fiber digestibility (5,17) though not always (1,6). Improvements in digestibility of a specific nutrient with no change in total tract DM digestibility when yeast culture was fed has occurred (5). Williams (18) suggested that yeast cultures may increase ruminal digestion; however, hind-gut fermentation may mask this effect.

The trend for improved CP digestibility in cows fed yeast culture also was expressed in fecal and absorbed N as a percentage of N intake ($P = .28$, $P = .23$). Although supplementation with yeast had no effect on N balance, the similarity in percentages of N intake distributed between milk (25%) and that retained (22%) indicated that N for growth was equal to that used for lactation, representing a stressful situation for the 2-yr old cows.

CONCLUSIONS

At calving DM intake is depressed, but also this is a period of transition as the dairy cow is expected to suddenly consume large amounts of an energy dense ration. Supplemental yeast culture was beneficial in improving DM intake and milk yield. Income from the additional milk (33¢/cow/d) exceeded the material cost of the yeast culture (5¢/cow/d). Additional studies are needed to define the role of yeast and its effect on DM intake and nutrient utilization by the ruminant.

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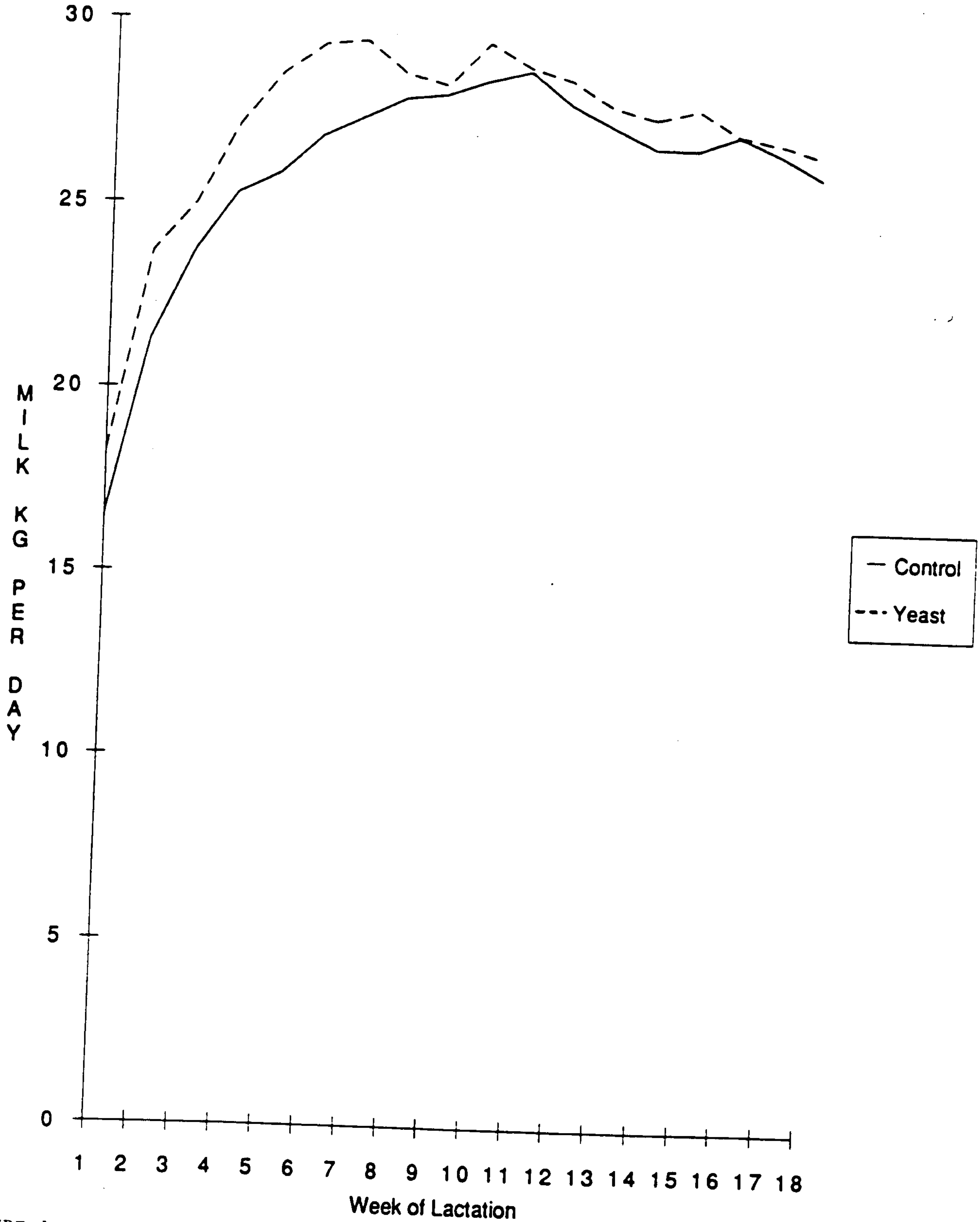

FIGURE 1. Average daily milk production during the first 18 wk of lactation by primiparous Holstein cows fed corn silage-based diets without (control) or supplemented with Biomate Yeast Plus (10 g/d).

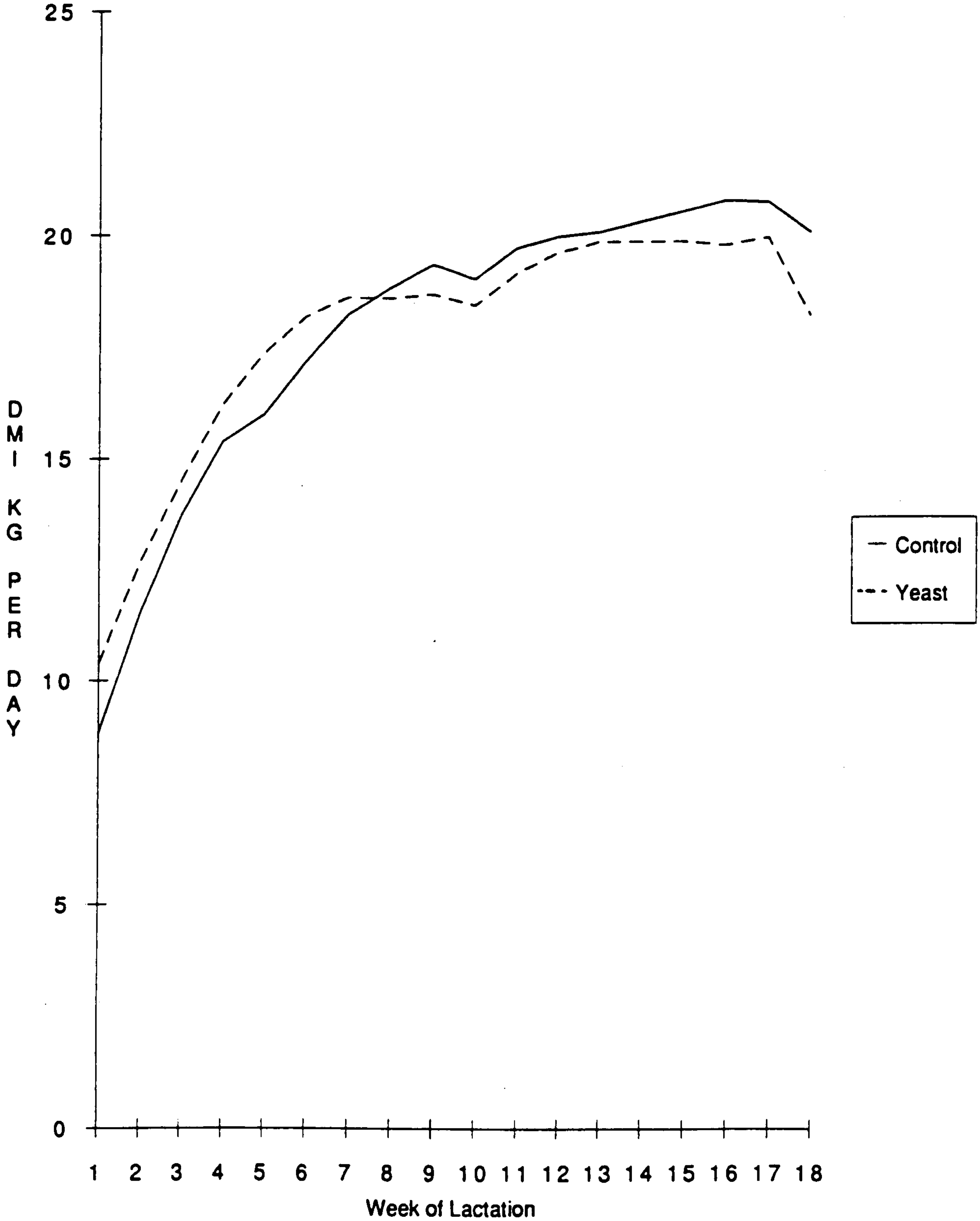

FIGURE 2. Average daily DM intake during the first 18 wk of lactation by primiparous Holstein cows fed corn silage-based diets without (control) or supplemented with Biomate Yeast Plus (10 g/d).

TABLE 1. Average intake, nutrient digestibility and fecal pH of corn silage-based diets without (control) or with supplemental Biomate Yeast Plus (10 g/d) fed to primiparous cows[1].

	Dietary Treatments[1]			
	Control	Yeast	SE	P<
Dry matter, kg/d				
Fed				
Grain	10.7	10.4		
Corn silage	9.0	8.8		
Hay	.8	.8		
Refused	1.3	1.5		
Intake	19.2	18.5		
Nutrient digestibility, %				
DM	72.4	72.8	.6	.68
CP	73.8	75.4	.8	.29
NDF	55.3	55.5	1.2	.94
ADF	48.7	47.7	1.4	.72
Hemicellulose	61.1	61.0	1.3	.96
Cellulose	61.0	66.3	2.1	.23
Fecal pH	7.15	7.20	.13	.84

[1]Twelve primiparous cows assigned to each treatment. Each morning Biomate Yeast Plus (10 g/d) was top dressed on one-half of the daily TMR (corn silage: grain) allotment. A 6-d total fecal and urine collection was performed during wk 9-10 of lactation.