Effect of Feeding *Aspergillus oryzae* Fermentation Extract or *Aspergillus oryzae* plus Yeast Culture plus Mineral and Vitamin Supplement on Performance of Holstein Cows During a Complete Lactation

R. O. KELLEMS, A. LAGERSTEDT, and M. V. WALLENTINE
Department of Animal Science
Brigham Young University
Provo, UT 84602

ABSTRACT

The addition of *Aspergillus oryzae* fermentation extract (Amaferm®) increased milk flow and mean 3.5% FCM production during the latter stages of the full lactation trial compared with the control group and the *Aspergillus oryzae* fermentation extract plus yeast culture plus mineral-vitamin supplement (VitaFerm®) group. Based on the differences observed when FCM production was determined for the cows at various stages of lactation, Amaferm apparently had its greatest effect during the early stages of the lactation cycle and subsequent milk production was likely a result of higher initial production. The response difference observed between the Amaferm and VitaFerm treatments could have resulted from the additional minerals provided by the VitaFerm compared with the Amaferm and control groups.
(Key words: *Aspergillus oryzae* fermentation extract, fungal additive, lactation)

INTRODUCTION

Recent advances in understanding rumen microbial digestion processes have stimulated interest in the use of microbial additives for increasing or altering the digestive efficiency of ruminant animals. *Aspergillus oryzae* fermentation extract is one such preparation that has been shown to alter rumen VFA production (1); to alter the digestion of DM, fiber, and CP (8); and to increase milk production (3, 4, 5, 7) in lactating cows.

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The objective of this research trial was to determine the effect of supplementation of a common basal ration with *Aspergillus oryzae* fermentation extract (Amaferm®) with or without yeast culture plus mineral and vitamin mix (VitaFerm®) (Amaferm® and VitaFerm®, Biozyme Enterprises, Inc., 1231 Alabama St., St. Joseph, MO 64504-0428) on subsequent milk production and reproduction performance over a complete lactation cycle.

MATERIALS AND METHODS

Pretrial Period

Early lactation Holstein cows (n = 210) were fed a common total mixed ration consisting of (kg/d per cow): 7.7, corn earlage; 24.9, alfalfa silage; 5.9, rolled barley; 1.8 CP-mineral-vitamin supplement and 3.2, whole cottonseed during the 14-day pretrial period. Individual cow's milk production and composition were monitored four times during the pretrial period with composite samples collected at the 0600-, 1400-, and 2200-h milkings (one-third from each milking). Based on the results obtained from the pretrial period, 150 high-producing, early lactation Holstein cows were blocked according to 3.5% FCM, days in milk, and lactation number and allocated randomly to one of three treatment groups of 50 cows each. Averages and ranges for the parameters by which cows were allotted are given in Table 1 for the respective groups. Groups were placed in pens equipped with free stalls.

Trial Period

During the test period cows were group-fed and received the following rations: 1) basal; 2) *Aspergillus oryzae* fermentation extract (Amaferm), basal plus 3 g of Amaferm; and 3)

TABLE 1. Characteristics of treatment groups at initiation of Amaferm and VitaFerm trial.

Item	Average	SD[1]	Range
Days in milk			
Control	104.9	32.7	39 to 171
Amaferm	107.6	33.2	43 to 173
VitaFerm	106.4	32.7	39 to 154
Lactation number			
Control	2.46	1.46	1 to 6
Amaferm	2.48	1.49	1 to 6
VitaFerm	2.54	1.54	1 to 6
3.5% FCM kg/d			
Control	32.8	6.1	21.7 to 49.2
Amaferm	33.1	6.3	20.2 to 47.5
VitaFerm	33.1	6.0	18.2 to 46.1

[1]Based on 48 observations per group.

Aspergillus oryzae fermentation extract plus yeast culture plus mineral and vitamin mix (VitaFerm), basal plus 90 g of VitaFerm. Each group, including the control group, received .9 kg of ground corn/cow per d, to which the Amaferm and VitaFerm were added for the respective groups. The cows were fed a TMR as a group three times daily (feed was available when they returned from milking parlor) with one-third of the ration and supplement being fed at each feeding. The TMR was mixed and fed using a Harsh mixer truck.

Two rations were fed during the course of the trial period with ration 1 being fed for the first 83 d (October 28, 1986 to January 18, 1987) of the trial, and ration 2 being fed during the remaining 170 d (January 19, 1987 to July 7, 1987) of the trial. The composition of the rations fed is shown in Table 2. The amount of each of the feedstuffs fed to each pen was weighed to the nearest 4.5 kg and recorded at the time of each feeding. The amount of concentrate was held constant, but when more feed was required, the amount of alfalfa silage was increased to allow cows to satisfy their appetites.

Milk production was monitored using the Surge Infarmation Milk Manager Model 36001 milking station and the 36000 measuring bottle.

TABLE 2. Composition of rations for the Amaferm and VitaFerm trial.

Composition	Control	Amaferm	VitaFerm
Ration 1	(kg/d per cow)		
Alfalfa, silage	24.9	24.9	24.9
Corn earlage	7.3	7.3	7.3
Barley, rolled	5.4	5.4	5.4
Whole cottonseed	2.8	2.8	2.8
Supplement			
CP-Mineral-vitamin[1]	1.7	1.7	1.7
Corn, ground	.9	.9	.9
Amaferm, g	. . .	3	. . .
VitaFerm, g	. . .	. . .	90
Nutrients, %			
DM	52.2	52.2	52.2
CP	18.4	18.4	18.4
NE, Mcal/kg	1.68	1.68	1.68
Ca	.76	.76	.76
P	.5	.5	.5
Mg	.34	.34	.34
ADF	19	19	19
Ration 2			
Alfalfa, silage	22.2	22.2	22.2
Corn silage	8.2	8.2	8.2
Supplement,			
Corn-Mineral-vitamin[1]	1.5	1.5	1.5
Barley, rolled	7.9	7.9	7.9
Whole cottonseed	1.8	1.8	1.8
Corn, ground	.9	.9	.9
Amaferm, g	. . .	3	. . .
VitaFerm, g	. . .	. . .	90
Nutrient, %			
DM	53.1	53.1	53.1
CP	17	17	17
NE, Mcal/kg	1.63	1.63	1.63
Ca	.76	.76	.76
P	.46	.46	.46
Mg	.32	.32	.32
ADF	19.7	19.7	19.7

[1]Supplement specification: CP, 32.7%; NE_l, 1.14 Mcal/kg; Ca, 3.4%; P, 2.0%; salt, 3.5%; Mg, 1.5% and NPN, .36%. Supplement composition (kg/metric ton): animal-vegetable fat blend, 50; cane molasses, 25; brewers grains, 86; cottonseed meal (41% CP), 324; meat and bone meal (50% CP), 150; soybean meal (44%) CP, 149.5; urea (47% N), 8; limestone, 22.5; magnesium oxide (54%), 20; monodicalcium phosphate (21%), 39; plain salt, 37.5; sodium bicarbonate, 75; trace-mineral premix[2], 13.5%.

[2]Trace-mineral premix ingredients: calcite, magnesium oxide, wheat midds, zinc oxide, iron carbonate, manganous oxide, sulfur, copper oxide, vitamin A supplement, sodium selenite, calcium iodate, dl-α-tocopherol acetate, d-activated animal sterol (source of vitamin D_3), cobalt carbonate. Analysis: Mg, 5.6%; Zn, 4.8%; Fe, 2.6%; Mn, 1.92%; S, 2%; Cu, .8%; Co, .35%; I, .12%; vitamin A, 1,270 KIU/kg; vitamin D, 180 KIU/kg; vitamin E, 180 IU/kg; Se, 18 mg/kg.

TABLE 3. Feed component consumption for Amaferm and VitaFerm trial.

Feeding period	Alfalfa silage	Earlage corn	Supplement[1]	Rolled barley	Whole cottonseed	Ground corn	Corn silage
	(kg/d)						
First							
Control	8.7	4.1	1.6	4.8	2.6	.8	0
Amaferm	8.7	4.1	1.6	4.8	2.6	.8	0
VitaFerm	8.5	4.0	1.6	4.9	2.6	.8	0
Second							
Control	6.9	0	1.3	6.9	1.8	.9	2.9
Amaferm	6.9	0	1.3	6.9	1.8	.9	2.9
VitaFerm	6.8	0	1.3	6.9	1.8	.8	2.9

[1]CP-Mineral-vitamin supplement specification: CP, 32.7%; NE_l, 1.14 Mcal/kg; Ca, 3.4%; P, 2.0% salt, 3.5%; Mg, 1.5% and NPN, .36%. Supplement composition (kg/metric ton): animal-vegetable fat blend, 50; cane molasses, 25; brewers grains, 86; cottonseed meal (41% CP), 324; meat and bone meal (50% CP), 150; soybean meal (44% CP), 149.5; urea (47% N), 8; limestone, 22.5; magnesium oxide (54%), 20; monodicalcium phosphate (21%), 39; plain salt, 37.5; sodium bicarbonate, 75, trace-mineral premix, 13.5%.

Individual cow's milk production was determined twice weekly and individual cow's milk composition was determined every 2 wk during the trial. One person was required to be in the milking parlor during each shift (0600, 1400, and 2200 h) to record the individual cow's milk production and collect the composite milk sample (one-third collected from each shift). The treatment effects on milk production, FCM production, and composition during the trial were determined. The effect on FCM production during various stages of lactation was assessed to determine if DIM affected response of cows to the various treatments.

Rectal temperature readings were monitored in three different ambient temperature ranges: 1) 20°C or above, 2) 0 to 20°C, and 3) less than 0°C to determine if the treatments affected the body temperature of the cows. Days to first heat and number of services per conception were monitored for the trial groups.

The experiment was a randomized complete block design with cows randomly assigned to the diet treatment groups. Cows were blocked based on their DIM, lactation number, and pretrial FCM production. Data were analyzed using SAS (6) routines, and treatment means were determined using Duncan's multiple range test. Differences were determined at the $P<.05$ level.

The 3.5% FCM production data were statistically analyzed using pretrial FCM production as a covariant to adjust for pretrial differences in cows compared with subsequent milk production.

RESULTS AND DISCUSSION

Feed Consumption

Feed consumption based on pen averages was computed for the trial period (rations 1 and 2) using the daily group feeding records. The average forage, concentrate, and total feed consumption per cow on a DM basis for the entire trial period were: 7.5, 13.8, 21.3; 7.5, 13.8, 21.3; 7.4, 13.8, and 21.2 kg/d, respectively for the control, Amaferm, and VitaFerm groups. Average weekly DM consumption per cow of forage, concentrate, and total feed, when ration 1 was fed, was 8.7, 13.9, 22.6; 8.7, 13.9, 22.6; and 8.5, 13.9, and 22.4 kg/d, respectively for control, Amaferm, and VitaFerm groups. Average weekly DM consumption per cow of forage, concentrate, and total feed, when ration 2 was fed, was 6.9, 13.8, 20.7; 6.9, 13.8, 20.7; and 6.8, 13.7, and 20.5 kg/d, respectively for control, Amaferm, and VitaFerm groups. The average DM consumption for the individual feedstuffs is summarized in Table 3. The average weekly (7 d) consumption for the forage, concentrate, and total feed for the trial periods is shown in Figure 1 when rations 1 and 2 were fed. No differences ($P>.05$) were observed in feed consumption between treatment or period. Therefore, any differences in milk production should be results of treatment effects and not of feed consumption.

Milk Production and Composition

Average milk production per cow for the complete lactation, based on biweekly observa-

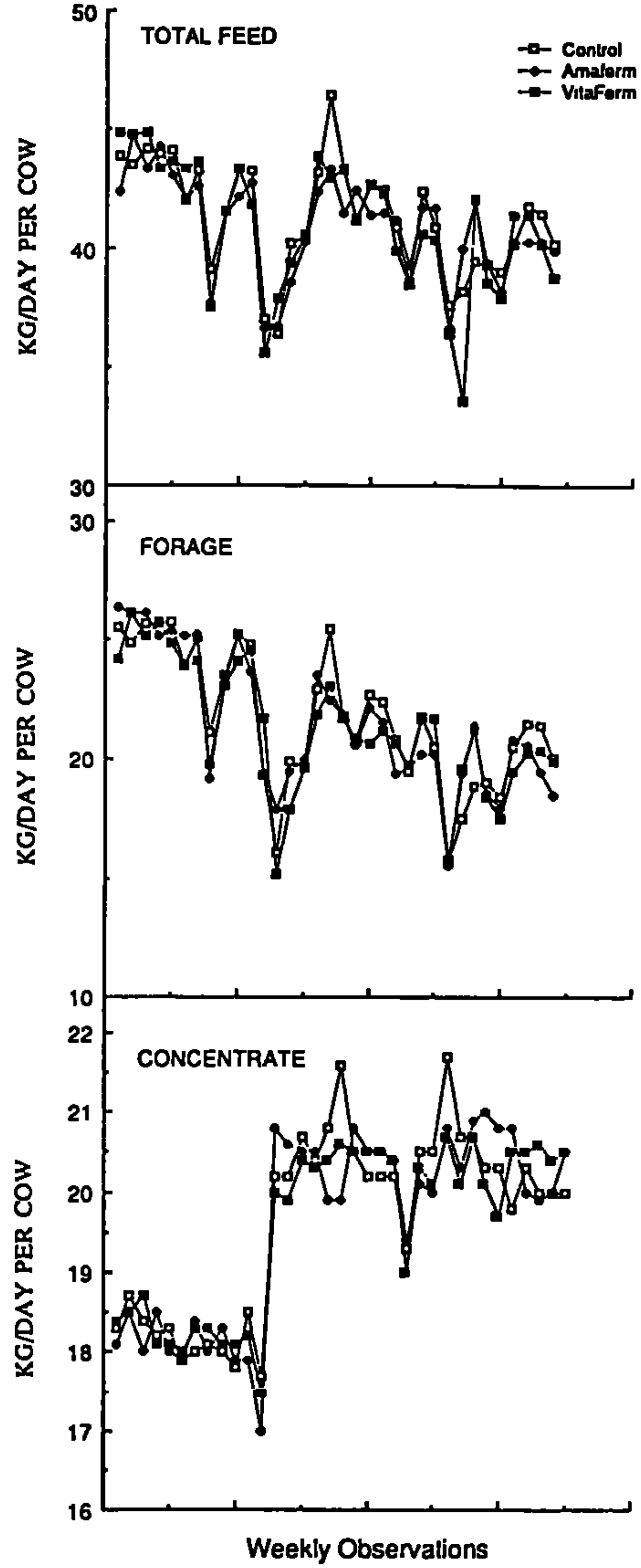

Figure 1. Feed consumption for Amaferm and VitaFerm trial.

tions, was 26.0, 27.7, and 26.6 kg/d for control, Amaferm, and VitaFerm groups, respectively. A numerical increase in the average milk production was observed for the Amaferm group

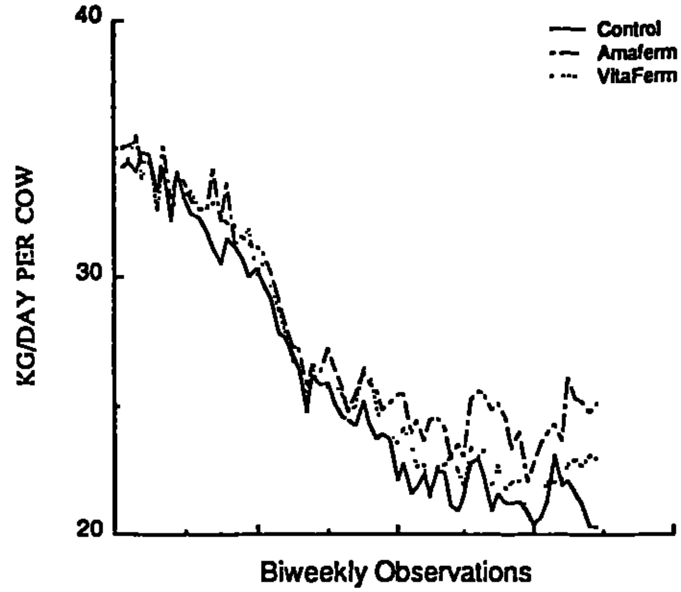

Figure 2. Milk production for the Amaferm and VitaFerm trials.

compared with the control and VitaFerm groups, but this increase was not significant when averaged across the complete trial. When evaluated on a weekly basis, starting from wk 18 and continuing to the termination of the trial, milk production was higher for the Amaferm group (24.49 kg/d per cow) than for the VitaFerm (23.04 kg/d per cow) and control (22.22 kg/d per cow) groups. There was a nonsignificant increase for the VitaFerm group during a similar period of time. Milk production data for the treated groups based on biweekly observations are shown in Figure 2.

Average fat content of milk for the trial was 3.73, 3.68, and 3.72% for the control, Amaferm, and VitaFerm groups, respectively. No differences (P>.10) in milk fat production by treatment were observed. Monthly milk fat percentage by treatment is shown in Figure 3.

Average 3.5% FCM (kg/d per cow) was 27.5, 28.8, and 27.5% for the control, Amaferm, and VitaFerm groups, respectively. The FCM increased numerically for the Amaferm versus the control and VitaFerm groups when the FCM was pooled and analyzed across time, but this difference was not significant. The FCM production was higher for the Amaferm versus the control and VitaFerm groups, starting at wk 18 to the end of the trial as shown in Figure 4.

The adjusted FCM production (kg/d per cow) was 33.4, 34.1, and 33.2%, respectively,

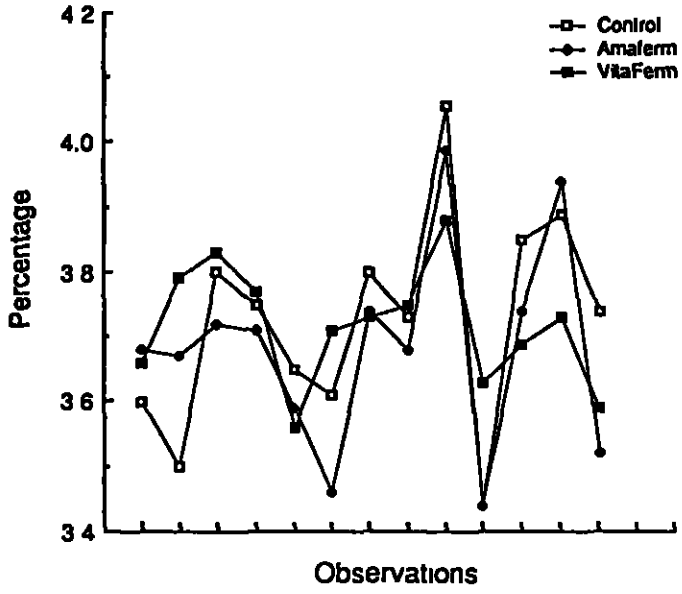

Figure 3. Milk fat percentage for the Amaferm and VitaFerm trials

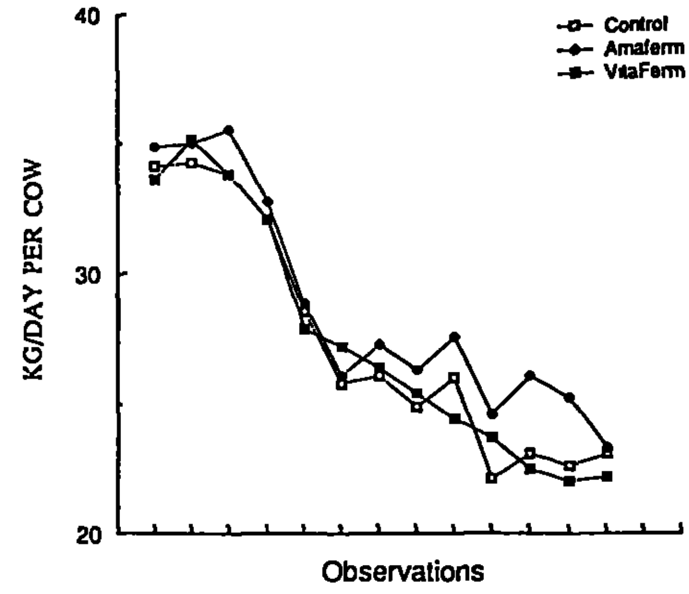

Figure 4 Fat-corrected milk (3.5%) for the Amaferm and VitaFerm trials.

for the control, Amaferm, and VitaFerm groups. A numerical, but not significant, increase was observed for the Amaferm group compared with the control and VitaFerm groups.

The FCM production adjusted for pretrial production was evaluated based on the number of days in milk at the start of the trial to determine if cows in the varying stages of their lactation responded differently to the treatments; results are shown in Figure 5. Most response differences were observed between treatment groups that were either in early or late stages of their lactation.

Initial BW and final BW are shown in Table 4. No differences in average BW changes during the trial period were observed.

The cows were scored for condition using a modification of the procedure developed by Edmonson (2) in which a 10-point scale was used instead of a 5-point scale. Cows were scored at the start of the trial and when dried; the results are summarized in Table 4. There were no differences in changes in condition score observed between the groups. All cows gained body condition during the course of the trial and were in satisfactory condition when dried.

Average rectal temperatures for cows were evaluated when maximum ambient temperatures were 0, 0 to 30, and above 30°C (Table 4). Control cows had higher rectal temperatures than cows receiving Amaferm or VitaFerm when the ambient temperatures were below °C. The Amaferm cows had lower rectal temperatures than the VitaFerm cows, but not the control cows, when the maximum ambient temperatures ranged from 12.8 to 28.9°C. When the maximum ambient temperature was above 30°C, the Amaferm cows had higher rectal temperatures than the control or VitaFerm cows, which were found not to be different. These results agree with previous research con-

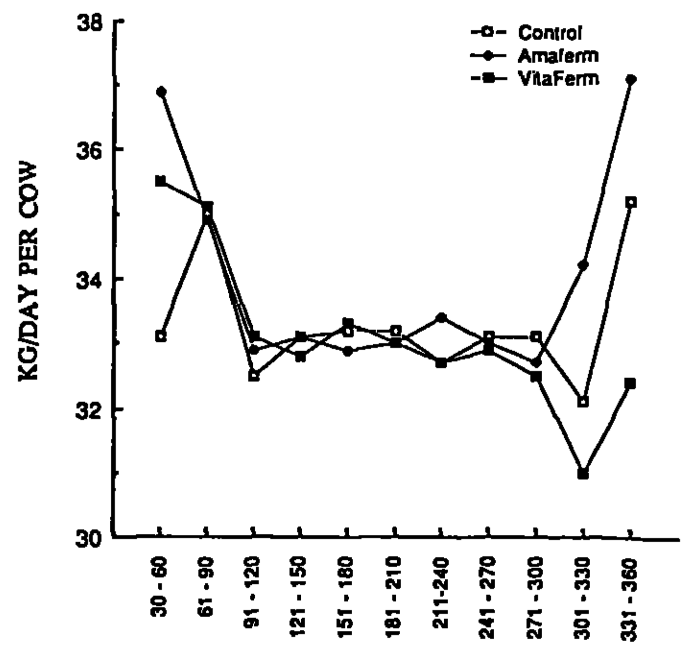

Figure 5. Adjusted 3.5% FCM response of cows with different days in milk to Amaferm and VitaFerm.

TABLE 4. Body weight of cows (kg), body condition scores, rectal temperatures, and reproduction performance of lactating Holstein cows fed Amaferm and VitaFerm.

	Control	Amaferm	VitaFerm	SEM
	(kg)			
Body weight of cows				
Initial	610	597	601	12
At time of drying	726	697	703	14
Change in BW	+116	+100	+102	7
Body condition scores of cows[1]				
Initial	5.2	5.3	5.1	.1
At time of drying	7.4	7.0	6.9	.1
Change during trial period	+2.2	+1.7	+1.8	.1
Average and range of rectal temperatures	Maximum daily ambient temperatures, °C			
−1.5 (−5 to 0)	38.56[a]	38.44[b]	38.50[b]	.02
21.9 (12.8 to 28.9)	38.67[ab]	38.61[a]	38.72[b]	.02
39.8 (32.2 to 43.3)	39.22[a]	39.39[b]	39.22[a]	.02
Reproductive performance				
Number of days to conception	109.9	116.8	122.8	4.2
Number of services per conception	2.0	2.1	2.2	.1
Days to first service	78.9	81.7	80.5	1.4

[a,b]Means with different superscripts differ ($P<.05$).

[1]Condition scores were based on a scale of 1 to 10 with 1 being extremely thin and 10 being obese [modification of (2)].

ducted at our station (7), which showed that Amaferm increased rectal temperatures when ambient temperatures were above 30°C.

Reproductive performance summarized in Table 4 was not different between groups for days to first service, days to conception, and number of services per conception.

CONCLUSION

Amaferm increased milk flow and FCM production during the latter stages of the trial compared with the control and VitaFerm groups. Based on FCM differences observed at various stages of lactation, Amaferm apparently had its greatest effect during the early stages of the lactation cycle and subsequent higher milk production was a result of higher initial production, which was reflected in increased persistency. The response difference observed between the Amaferm and VitaFerm possibly could be explained by the fact that the control ration included minerals, and the additional minerals in the VitaFerm did not result in a positive interaction which in turn caused depressed production. The Amaferm and VitaFerm-treated cows had higher rectal temperatures when ambient temperatures were less than 0°C, and the Amaferm cows had elevated rectal temperatures when ambient temperatures were higher than 32°C. The other parameters measured such as feed consumption, reproduction performance, body condition scores, or BW changes were not affected by the Amaferm or VitaFerm.

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