

**THE EFFECTS OF METAPHYLAXIS AND MILK REPLACER ADDITIVES ON
HEALTH AND GROWTH OF NEONATAL HOLSTEIN BULL CALVES**

A Thesis

by

KENTON SCOTT HOLLOWAY

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

May 2009

Major Subject: Dairy Science

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ABSTRACT

The Effects of Metaphylaxis and Milk Replacer Additives on Health and Growth of

Neonatal Holstein Bull Calves. (May 2009)

Kenton Scott Holloway, B.S., Texas A&M University

Chair of Advisory Committee: Dr. Michael A. Tomaszewski

A study evaluating effects of metaphylaxis and milk replacer additives on health and growth was conducted with Holstein bull calves ($n = 52$; mean BW = 42.28 ± 3 kg) < 7 d of age. Calves were randomly assigned to receive tilmicosin phosphate (TIL), ceftiofur crystalline free acid (CEF), or saline (CON). All calves received a commercial milk replacer powder (25% CP, 20% fat), and within metaphylaxis treatment, were randomly assigned to receive milk replacer with: 1) 4 g/d for 7 d and then 2 g/d for the next 14 d of an egg-based additive (PR); 2) 2 g/d of 96% betaine (BE); 3) both PR and BE (BP); or 4) no additives (NA). Calves were housed in individual fiberglass hutches with ad libitum access to a commercial calf starter and water. Body weight was recorded twice weekly and fecal scores (1=firm, 4=watery) were recorded daily for 54 d. Number of treatments per calf for scours, incidence of respiratory symptoms, and febrile events were recorded on a daily basis, and the cumulative incidence of each response was used as an index of morbidity. All data were analyzed as a completely randomized design with a 3 X 4 factorial treatment arrangement. Neither metaphylaxis, additives, nor their interaction affected ADG ($P>0.60$); overall, calves gained .45 kg/d. Fecal scores were reduced by 39%

for CEF compared to CON ($P < 0.01$), but were not affected by additives.

Metaphylaxis influenced neither the incidence of fever ($P > 0.3$), or respiratory symptoms ($P > 0.2$), nor were they reduced by additives. Overall, calves were treated an average of only 0.39 times for respiratory symptoms and 0.66 times for fever.

Scours were not influenced by metaphylaxis ($P > 0.6$), additives ($P > 0.5$), nor their interaction ($P > 0.8$). Other than fecal score, metaphylaxis did not enhance productivity or reduce morbidity in this study, but disease challenge may have been mild. Feed additives influenced neither measures of health and performance nor did the metaphylaxis and feed additive interaction.

ACKNOWLEDGEMENTS

I would like to thank my committee chair, Dr. Michael Tomaszewski, and my committee members, Dr. Glenn Holub, Dr. Jason Sawyer, Dr. David Anderson, and Dr. Danny Klinefelter, for their guidance and support throughout the course of this research.

Also a thank you goes to my colleagues, faculty, and staff for their help and support during my time at Texas A&M Univeristy.

Finally, I would like to thank my family, friends, and my fiancé for their love, support, and encouragement during my career in graduate school.

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1. INTRODUCTION

The dairy business is a rapidly growing, dynamic industry. There are approximately 125.6 million cows used for milk production in the world. In the United States, the average dairy herd size is 121.5 milk cows, which has increased from 93.8 milk cows in 2001 and has more than doubled the average of 53.9 milk cows in 1991 (USDA, 2007). Along with this increase comes the addition the number of calves being born on a daily basis. Calf management has been a topic of concern and frustration among dairy producers for years, whether the situation is raising calves on a small or large scale dairy farm or calf ranch. The question still arises today: what methods need to be implemented to properly raise calves?

Dairy producers raise and condition their calves to serve as heifer replacements, veal, bulls for reproduction, or steers for beef production. Recent attention has turned the focus to programs that properly raise calves from pre-weaning to post-weaning. Drackley (2000), indicated that the pre-weaning phase is an opportune time to optimize genetic growth based on the results of studies that have shown that current calf programs compromise the potential of dairy calves during this most important time. The ideal time to most efficiently optimize calf growth is during the first 2 months of life (Chester-Jones et al., 2004).

The practice of using metaphylaxis (mass medication) is common in the beef Industry for management of highly stressed, newly shipped cattle. The addition of a milk

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replacer additive is also used throughout the dairy industry. Could these practices prove beneficial in neonatal dairy calves when they have the highest potential for illness? This study focused on using a metaphylactic and a milk replacer additive in neonatal Holstein bull calves. Factors such as morbidity, mortality, body weight (BW), fecal score, average daily gain (ADG), and number of treatments for scours, respiratory symptoms, and febrile events were evaluated.

2. LITERATURE REVIEW

Calf raising has not only been a challenge for the dairy industry, but for the beef industry as well. Various studies have been conducted trying to determine the proper approach to raising calves. The most critical time in a calf's life is shortly after birth. During this time it is important that the calf receives colostrums, which is a milk source high in nutrients essential to increase the calf's metabolism and stimulate the digestive system. Most importantly, it is the only source of immunoglobulins (antibodies) that provide passive immune protection that is essential for keeping the calf healthy. Antibodies are absorbed in the gastrointestinal tract during the first 24 hours of life and provide the basis of the calf's immune system for the first 3-6 months of age. According to Heinrichs and Jones (2003), the composition of colostrum decreases after the first two or three milkings. They stated that there is a window period of time where the calf is at greater risk of illness when colostrum quality decreases and the time the calf's immune system is fully functional independently of the dam's immune status. If the calf does not receive adequate passive transfer of immunity when required then this risk increases even more. This high risk period is estimated to be between days 3 and 16 of life. Ideally, it would be beneficial to eliminate this period of high risk.

2.1 Metaphylaxis

The practice of using mass medication, also known as metaphylaxis, is frequently used in the beef industry. A metaphylactic agent (typically an antibiotic) can be used as both a prophylactic and a therapeutic. The term prophylaxis indicates that the drug is used as a preventative therapy while therapeutic describes its use in the treatment of a

disease. Generally, metaphylaxis is used to manage newly received, highly stressed cattle. When cattle are being shipped and processed, their stress levels increase allowing cattle to become highly susceptible to diseases. Additionally, being commingled with cattle from various locations increases the likelihood of being exposed to a pathogen for which they have no immunity. The use of metaphylaxis helps reduce the incidence of diseases, primarily Bovine Respiratory Disease (BRD), especially for cattle not properly vaccinated. The use of metaphylactic therapy in the dairy industry is uncommon, especially in neonatal calves. There has been very little research done in the area of metaphylactic therapy in neonatal calves, including Holstein bull calves that could potentially be used in beef production.

In the beef industry, research using metaphylactic therapy and even prophylactic therapy has proven to reduce the incidences of diseases in cattle, improve performance and gain, and reduce morbidity (Booker et al., 2006; Galyean et al., 1995; Guthrie et al., 2004). In a study conducted by Galyean et al. (1995), tilimicosin phosphate was used as a metaphylactic agent. The results showed that few or no cattle had to be treated for BRD. In a similar study conducted by McCoy et al. (1994), results showed that the use of tilimicosin decreased morbidity in calves from 16.1% in control calves to 5.9% in calves receiving the treatment. Lofgreen (1983) conducted a study using oxytetracycline and sulfadimethoxine as a means of metaphylaxis. His results showed a reduction in treatments for morbidity with oxytetracycline by 21% and 20% for calves treated with sulfadimethoxine. Similar results were discovered in a study conducted by Turgeon (1996), where a selected group of newly received feedlot cattle were given a

metaphylactic treatment of tilmicosin. Results showed that a single dose of tilmicosin vs. a control without antibiotics reduced morbidity from 53.1% in the control group to 29.9% in the antibiotic group. The same decrease was seen in mortality from 1.97% to 0.57%. Booker et al. (2006) discovered similar results with the use of ceftiofur crystalline free acid. The ceftiofur crystalline free acid group had significantly lower mortality and chronicity rates with significantly higher average daily gain.

Parameters that are measured frequently in both the dairy and beef industries are feed intake and average daily gain. Many factors, such as stress and poor health, inhibit an animal from reaching their full potential in these areas. When these aspects are suppressed, this potentially affects the final product a producer is trying to achieve, as well as increases the cost of production. With the use of metaphylaxis to help alleviate stress and increase health, feed intake and average daily gain can also improve. In a study conducted by Lofgreen (1983), results showed that metaphylaxis significantly ($P < .05$) increased feed intake and average daily gain when compared to the non-metaphylactic control group. Feed intake increased from 4.48 kg/day in the non-metaphylactic group to 4.65 kg/day in the metaphylactic group. Average daily gain was 1.11 kg/d in the metaphylactic group and .99 kg/d in the non-metaphylactic group. There was also a positive influence on feed efficiency. Cusack (2004) found similar results when looking at the use of tilmicosin and oxytetracycline. Calves treated with tilmicosin ($P < 0.05$) had a significantly higher average daily gain (1.67 kg/animal/d) versus animals treated with oxytetracycline (1.59 kg/animal/d) and non-antibiotic (1.59 kg/animal/d).

Bovine respiratory disease syndrome (BRD) or pneumonia is a major disease that affects both dairy and beef neonatal calves. In a study by Ose and Tonkinson (1988), tilmicosin was used as a therapeutic treatment to treat male Holstein calves diagnosed with neonatal calf pneumonia. The study evaluated three dosage levels. Treatment was significantly ($P < 0.05$) effective at all dosage levels in reducing body temperature, mortality, and the incidence and severity of clinical signs. In another study conducted by Laven and Andrews (1991), tilmicosin and oxytetracycline were used to treat cases of acute pneumonia. All treated calves recovered from the disease, but tilmicosin had a greater reduction in cases and required fewer second treatments compared to oxytetracycline. Groups treated with tilmicosin had reduced rectal temperature and respiratory rate compared to those treated with oxytetracycline.

Another study (Berge et al., 2005) was conducted with 1-day old dairy bull calves that would eventually be used in beef production. Calves were treated for diseases that were a result of failure of passive transfer of immunity. They were treated with ceftiofur hydrochloride, Penicillin G procaine, or tilmicosin. Treatments with these antibiotics showed reduction in mortality and morbidity, compared to non-antibiotic treatments.

There is endless research demonstrating that the various antibiotics used in prophylactic, therapeutic, or metaphylactic situations prevent or reduce the incidence and severity of disease in high risk cattle. With these practices, many aspects of cattle production have benefited, ranging from decreased mortality to increased average daily gain. Implementing metaphylactic therapy for dairy calves could boost the overall health

and performance during the pre-weaning phase and may extend to the finishing stage of production. This protocol would be used to help raise heifers that will eventually be replacement heifers for the milking herd and bulls that will be used for beef production. Reducing factors that can prohibit proper health and performance could potentially improve the quality of cattle in the dairy industry.

2.2 Milk Replacer

Milk replacer is widely used in the dairy industry to feed pre-weaned calves. Since the dam is used for milk production, the calf cannot be kept with the mother during the production phase and must be fed independently. Therefore, the cow's milk is replaced with a powdered milk replacer. The crude protein (CP) percentage in milk replacer varies from 16-28% based on research from past studies (Blome et al., 2003; Bartlett et al., 2006). According to the National Research Council (NRC, 2001) calves weighing 50 kg require approximately 84 g of CP a day, which can be obtained from a combination of milk replacer and calf starter grain ration.

Studies have concluded that increasing CP in milk replacer will increase feed efficiency and average daily gain (Blome et al., 2003; Bartlett et al., 2006). In a study conducted by Blome et al. (2003), results indicated that as CP percentage in milk replacer increased, so did body weight and average daily gain. Bartlett et al. (2006) conducted a study using different levels of CP at two feeding rates. The study concluded that increasing the concentration of protein and increasing the feeding rate increased average daily gain and feed to gain ratio. Therefore, increasing crude protein in milk

replacer has a positive influence in the health, growth, and overall performance of calves.

2.3 Milk Replacer Additives

There are many opinions about what extra nutritional additives need to be supplemented into milk replacer. Two such additives are Protimax® and Betaine 96%. Protimax® (43% CP, 30% CF) is composed of pasteurized hyper-immunized dried egg which also contains antibodies and other nutrients. It is labeled to increase the effectiveness of the neonatal immune system. Betaine 96% is a trimethylglycine compound that aids in feed efficiency and aids in the reduction of the incidence of scours. Betaine is a methylating form of choline and can replace choline in rations.

3. RESEARCH METHODOLOGY

3.1 Project Overview

The project consisted of 52 newborn Holstein bull calves, < 7 days of age. The duration of the trial was 8 weeks (56 days) and was conducted during the summer months of June-September in south Texas.

The calves came from dairies in the Panhandle of Texas and Eastern New Mexico. Certain criteria must have been met in order for the calves to qualify for the study: 1) they must have markings of the Holstein breed, 2) they must have been born within a couple of days of each other, 3) they must have been given colostrum no later than two hours after birth and 4) weigh greater than 45 kg.

Upon arrival at the research site, the calves were 3-4 days old and were processed immediately. Processing included measuring body weight, measuring blood serum IgG (Immunoglobulin) levels and TSP (Total Serum Protein) to determine level of passive transfer of immunity. They were then assigned an experimental protocol stratified on body weight, IgG, and TSP levels. The calves were allowed a 2-day adaptation period receiving 4 liters of milk replacer (Land O' Lakes Maxi Care 25% crude protein, 20% crude fat), 2 liters in the morning and 2 liters in the evening. Each calf received 0.45 kg per calf per day of milk replacer for the first 9 days and then 1.1% of body weight adjusted weekly for each treatment group's mean body weight. They received water and an 18% CP calf starter (Calf Nibblers, HiPro, Comanche, TX) ad libitum. They were individually housed in hutches (CalfTel) 3 meters apart to prevent contact. After the adaptation period, each calf received its assigned protocol. An additional 7-way

clostridium vaccine (Agri-labs, Schering-Plough Animal Health Corp., Union, NJ) was administered subcutaneously on day 10 to prevent *Clostridial* species diseases (chauvoei, septicum, novyi, sordellii, perfringens Types C & D).

The project used two antibiotics: tilmicosin (TIL) and ceftiofur crystalline free acid (CEF). The calves were divided up into three separate groups. One group (n=14) received the tilmicosin antibiotic (Micotil ®),(Elanco Animal Health, Indianapolis, IN), (10 mg CE/kg, 1.5 mL/100 lbs) administered subcutaneously in the neck, another group (n=17) received the ceftiofur crystalline free acid antibiotic (Excede ®),(Pfizer Animal Health, New York, NY), (6.6 mg CE/kg, 1.5 mL/100 lbs) administered subcutaneously in the posterior base of the ear, and the final group (n=13) received saline solution (CON),(1.5mL) administered subcutaneously in the neck to serve as the control. The antibiotics were administered on day two of the study, one day prior to the beginning of the nutritional additive treatments.

The calves were fed every twelve hours, 0600 and 1800 h. Each calf received a total of 4 liters of milk replacer a day in a bottle with a nipple, 2 liters in the morning and 2 liters in the evening. Milk replacer was prepared by adding the powder to water at 43°C and mixing with an electric mixer. Calves received an animal feed supplement treatment additionally added to the milk replacer. The two products are Protimax ® (43% CP, 30% CF), (Trouw Nutrition, Highland,IL) and Betaine 96%. Each was be added to the milk replacer at the time of mixing. The calves were broken up into four treatment groups using the two products. One treatment (n=10) consisted of adding 4 g per day of Protimax ® for 7 days which was reduced to 2 g per day for the next 14 days

(PR); a second treatment (n=11) consisted of 2 g per day of Betaine 96% added from day 3 thru 54 (BE); a third treatment (n=12) included 4 g of Protimax ® daily for 7 days and 2 g daily for the next 14 days, and 2 g per day of Betaine 96% added daily for days 3 thru 54 (BP); a fourth treatment (n=11) served as the control only receiving milk replacer with no additional supplement (NA).

Fecal score was recorded daily after the 0600 feeding but observed after each feeding to determine if the calf was scouring. Body weight was recorded twice a week, Tuesdays at 1800 h and Saturdays at 0600 h. Calf starter refusals were weighed daily at 1800 h and water intake was recorded daily at 0600 h. ADG was calculated by subtracting the beginning BW from the end BW and then dividing by the number of days in the study (54 d).

Mortality was defined as a calf dying or leaving the study due to a severe disease or illness. Morbidity was calves treated for a disease or illness. During each feeding period, each calf was inspected for possible illnesses requiring immediate attention. Fecal score was recorded using a numbering system from 1-4 (1 = formed, hard; 2 = pudding- like consistency; 3 = pancake batter like consistency; 4 = mixture of watery liquid and solids). If a calf recorded a fecal score of 4 or the feces was liquid, the calf was scored with a yes for scouring and a treatment of Re-Sorb® (Pfizer Animal Health, Exton, PA), an electrolyte, was administered in 2 l of water. Calves with a fecal score of 1-3 were recorded with no treatment for that day. Calves with an abnormal respiration rate were administered subcutaneously 3 cc of florfenicol (Nuflor®, Intervet, Schering-Plough Animal Health Corp., Summit, NJ) and were recorded as a treatment. Calves

with rectal temperature > 103.5 °F were administered orally 1 cc of flunixin meglumine (Banamine®, Intervet, Schering-Plough Animal Health Corp., Summit, NJ) and were recorded as a treatment.

The calves were weaned on day 54 of the study, at which time data recording ended. From this point a 2-day weaning period was imposed in which they received 2 liters of milk replacer once a day.

3.2 Data Analysis

All data was recorded and entered into a spreadsheet program (Excel, Microsoft Corp., Redmond, WA, 2003). Data was analyzed as a completely randomized design with a 3 X 4 factorial treatment arrangement using an analytical software program (SAS System for Windows, 9.1, SAS Institute Inc., Cary, NC, 2002-2003). Least Square Means for BW and fecal score were evaluated using PROC MIXED for Repeated Measures with metaphylactic, milk replacer additive, and metaphylactic by milk replacer additive interaction serving in the model.

$$Y_{ijklm} = \mu + D_i + T_j + A_k + TD_{ij} + AD_{ik} + TA_{jk} + CT_{jl} + e_{ijklm}$$

Where: μ is the overall population mean, D is the effect of day as a continuous variable (i=1-54), T is the effect of milk replacer additive (j=1,2,3,4), A is the effect of metaphylactic (k=1,2,3), TD is the effect of milk replacer additive with day, AD is the effect of metaphylactic with day, TA is the effect of milk replacer additive with metaphylactic, CA is the effect of lth calf (l=1,,44) within kth treatments, and e is the random error term.

ADG and number of treatments for scours, respiratory symptoms, and febrile events were analyzed using PROC MIXED with metaphylactic, milk replacer additive, and metaphylactic by milk replacer additive as the model.

$$Y_{ijkl} = \mu + T_i + A_j + TA_{ij} + e_{ijkl}$$

Where: μ is the overall population mean, T is the effect of milk replacer additive (j=1,2,3,4), A is the effect of metaphylactic (k=1,2,3), TA is the effect of milk replacer additive with metaphylactic, and e is the random error term.

4. RESULTS

At the conclusion of the 54 day study, 44 of the 52 calves remained. The 8 calves removed from the study were removed due to extreme cases of morbidity with five of the calves eventually reaching mortality. Metaphylaxis, additives, and interactions showed no effect on BW, ADG, or reduction in number of treatments for scours, respiratory symptoms, or febrile events. Fecal score was not affected by additives ($P>0.18$), nor interaction (>0.14), but was reduced by metaphylaxis ($P<0.01$) as shown in the Least Square Means Tables 1, 2, and 3.

Variables	Micotil	Excede	Control	P-value
BW (kg)	47.59 ± 1.57	47.99 ± 1.41	48.99 ± 1.55	0.8042
ADG (kg)	0.44 ± 0.04	0.41 ± 0.03	0.46 ± 0.04	0.5903
Fecal Score	2.00 ± 0.04 ^b	1.86 ± 0.04 ^a	2.03 ± 0.04 ^b	0.0061
Number of Treatments for Scours	7.22 ± 1.18	5.89 ± 1.06	7.42 ± 1.24	0.5787
Number of Treatments for Respiratory Symptoms	0.41±0.15	0.17±0.14	0.50±0.16	0.2632
Number of Treatments for Febrile Events	0.27 ± 0.30	0.83 ± 0.26	0.52 ± 0.31	0.3634

^{a,b} Means without a common superscript were significantly different ($P<0.01$).

Variables	PR	BE	NA	BP	P-value
BW (kg)	47.52 ±1.77	47.61±1.72	47.66±1.80	48.42±1.69	0.9809
ADG (kg)	0.41±0.04	0.44±0.04	0.45±0.04	0.47±0.04	0.7198
Fecal Score	1.97±0.05	1.99±0.04	2.01±0.05	1.88±0.04	0.1860
Number of Treatments for Scours	6.47±1.44	7.93±1.29	7.13±1.35	5.83±1.26	0.6923
Number of Treatments for Respiratory Symptoms	0.69±0.19	0.47±0.17	0.17±0.18	0.11±0.17	0.0931
Number of Treatments for Febrile Events	0.33±0.36	0.69±0.32	0.58±0.34	0.56±0.32	0.9047

Variables	Micotil				Excede				Control				P-value
	PR	BE	NA	BP	PR	BE	NA	BP	PR	BE	NA	BP	
BW (kg)	48.50 ± 2.74	49.07 ± 2.45	45.07 ± 3.85	46.26 ± 3.15	45.25 ± 3.15	46.17 ± 3.15	49.17 ± 2.45	49.67 ± 2.25	48.80 ± 3.15	47.60 ± 3.15	48.75 ± 2.74	49.32 ± 3.15	0.8088
ADG (kg)	00.45 ± .06	00.46 ± .05	00.37 ± .09	00.49 ± .07	00.37 ± .07	00.36 ± .07	00.44 ± .05	00.49 ± .05	00.40 ± .07	00.48 ± .07	00.53 ± .06	00.43 ± .07	0.6348
Fecal Score	1.94 ± .07	1.94 ± .06	2.17 ± .09	1.96 ± .08	1.84 ± .08	1.94 ± .08	1.88 ± .06	1.72 ± .06	2.12 ± .08	2.04 ± .08	1.97 ± .07	1.97 ± .08	0.1427
Number of Treatments for Scours	5.75 ± 2.08	7.80 ± 1.86	8.00 ± 2.94	7.33 ± 2.40	4.67 ± 2.40	9.00 ± 2.40	6.40 ± 1.86	3.50 ± 1.70	9.00 ± 2.94	7.00 ± 2.40	7.00 ± 2.08	6.67 ± 2.40	0.8118
Number of Treatments for Respiratory Symptoms	0.75 ± 0.27	0.40 ± 0.24	0.50 ± 0.38	-3.67 E-16 ± 0.31	0.33 ± 0.31	0.33 ± 0.31	-5.54 E-17 ± 0.24	5.86 E-17 ± 0.22	1.00 ± 0.39	0.67 ± 0.31	7.71 E-17 ± 0.27	0.32 ± 0.31	0.8198
Number of Treatments for Febrile Events	0.00 ± 0.52	0.40 ± 0.46	3.33 E-16 ± 0.73	0.67 ± 0.60	1.00 ± 0.60	1.00 ± 0.60	1.00 ± 0.46	0.33 ± 0.42	2.59 E-16 ± 0.73	0.67 ± 0.60	0.75 ± 0.52	0.67 ± 0.60	0.8522

4.1 Metaphylaxis

Metaphylaxis showed no effect on BW ($P>0.8$) and ADG ($P>0.6$). There was an increase in body weight throughout the study between the three groups as seen in Figure 1. Figure 2 shows an overall BW average of 48.17 kg between TIL (47.59 kg), CEF (47.92 kg), and CON (48.97 kg) groups.

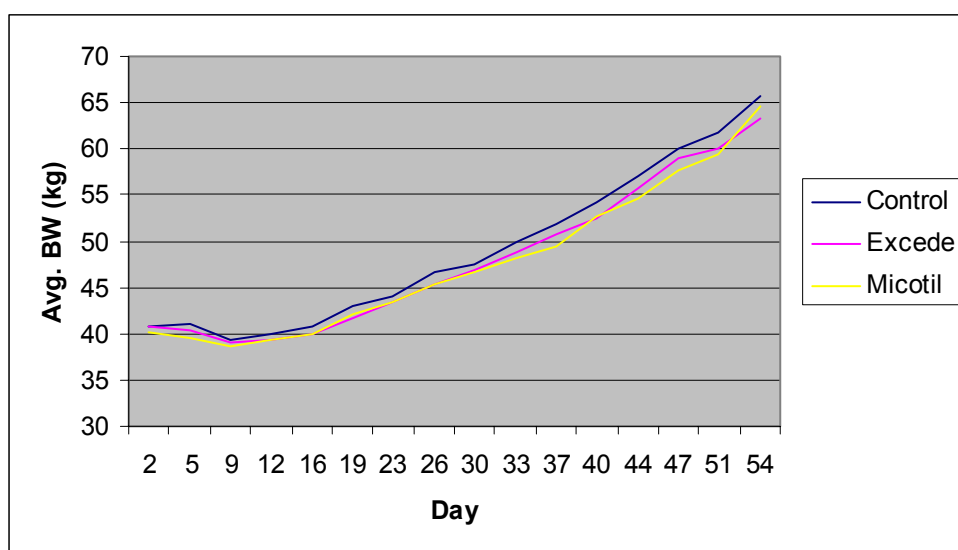


Figure 1. Average BW for days 1-54 for metaphylactic groups.

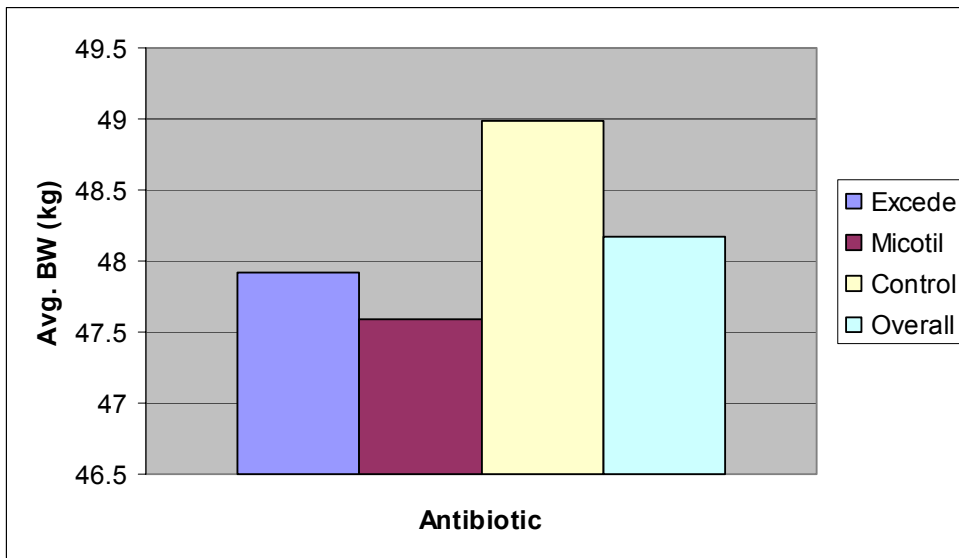


Figure 2. Average BW for metaphylactic groups.

Overall, calves gained 0.45 kg/d with TIL averaging 0.44 kg/d, CEF 0.41 kg/d, and CON 0.46 kg/d as shown in Figure 3.

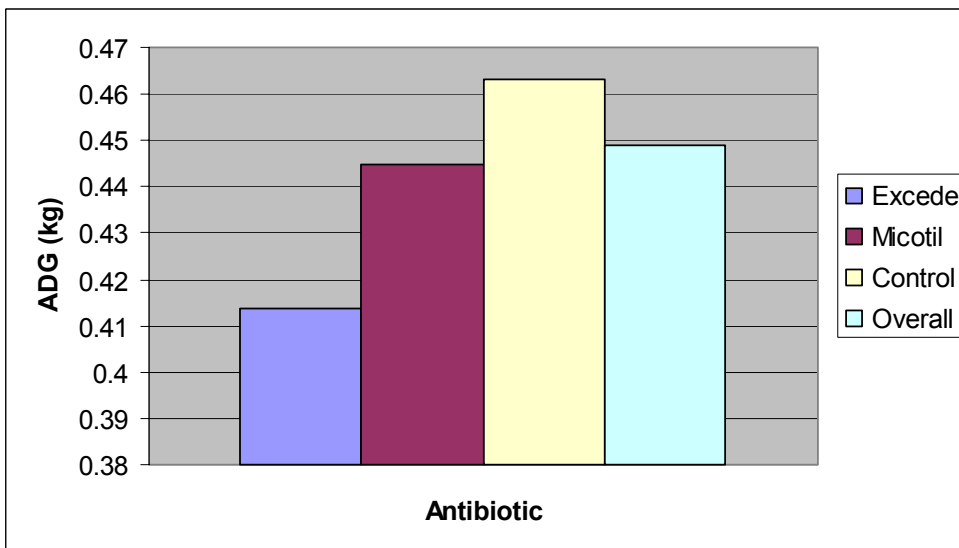


Figure 3. ADG for metaphylactic groups.

Fecal score dramatically increased from d 1 to 6, then declined. This event could have resulted from stress, environmental changes, or change from whole milk to milk replacer in the diet (Figure 4). Fecal score was reduced by CEF compared to TIL ($P<.01$) and CON ($P<.01$). Overall, CEF reduced fecal score by 39%. The average fecal score for CEF was 1.86 compared to 2.00 (TIL) and 2.03 (CON) (Figure 5).

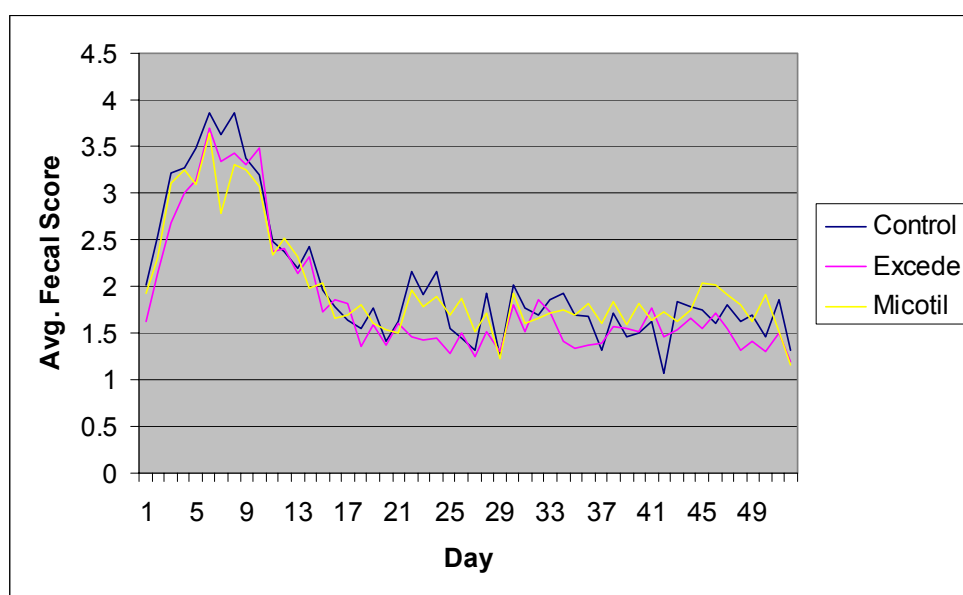


Figure 4. Average fecal score for days 1-54 for metaphylactic groups.

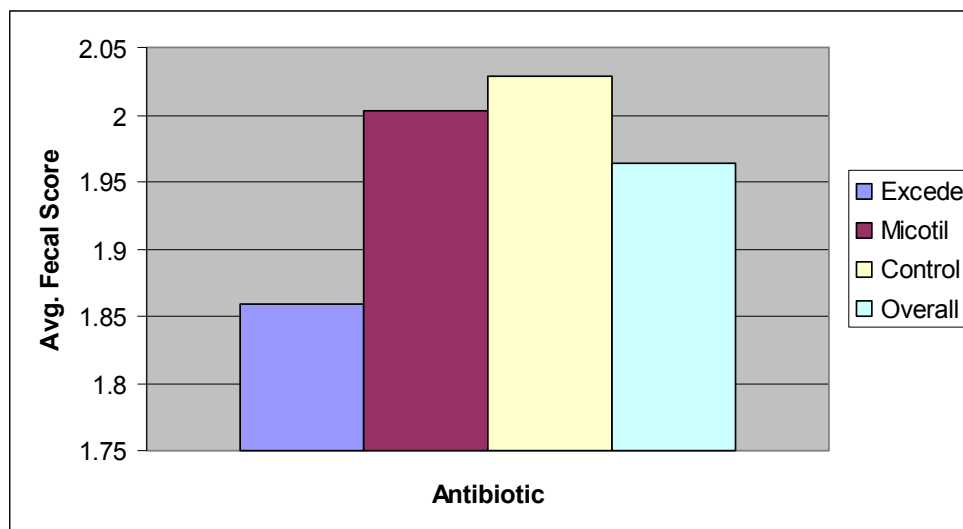


Figure 5. Average fecal score for metaphylactic groups.

There was not a significant difference obtained by metaphylaxis on number of treatments for scours ($P>0.6$), respiratory symptoms ($P>0.2$), or febrile events ($P>0.3$). Overall, calves were treated 6.84 times for scours across the metaphylactic groups. Calves in the TIL group were treated an average of 7.22 times, 5.89 times for the CEF group, and 7.42 times for the CON group (Figure 6). Treatments for respiratory symptoms were the lowest for the CEF group (0.17 treatments), while TIL had 0.41 treatments and CON had 0.5 treatments (Figure 7). Febrile events had the highest average number of treatments in the CEF group (0.83 treatments), with an overall average of 0.54 treatments across the groups (Figure 8).

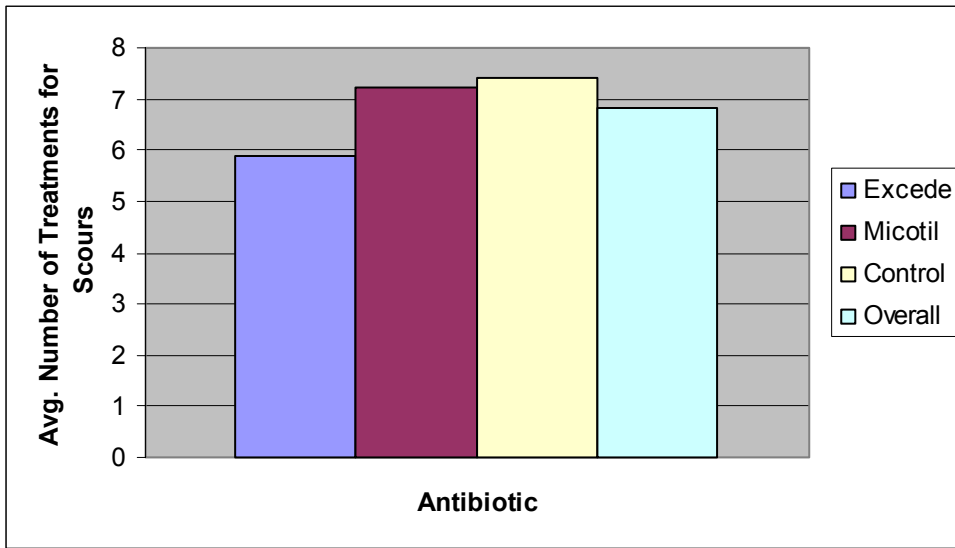


Figure 6. Average number of treatments for scours in metaphylactic groups.

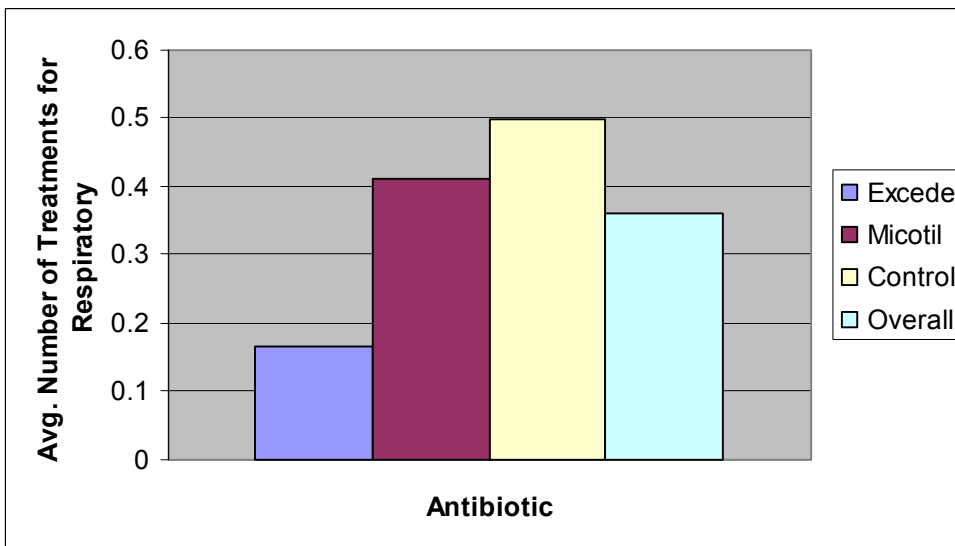


Figure 7. Average number of treatments for respiratory symptoms in metaphylactic groups.

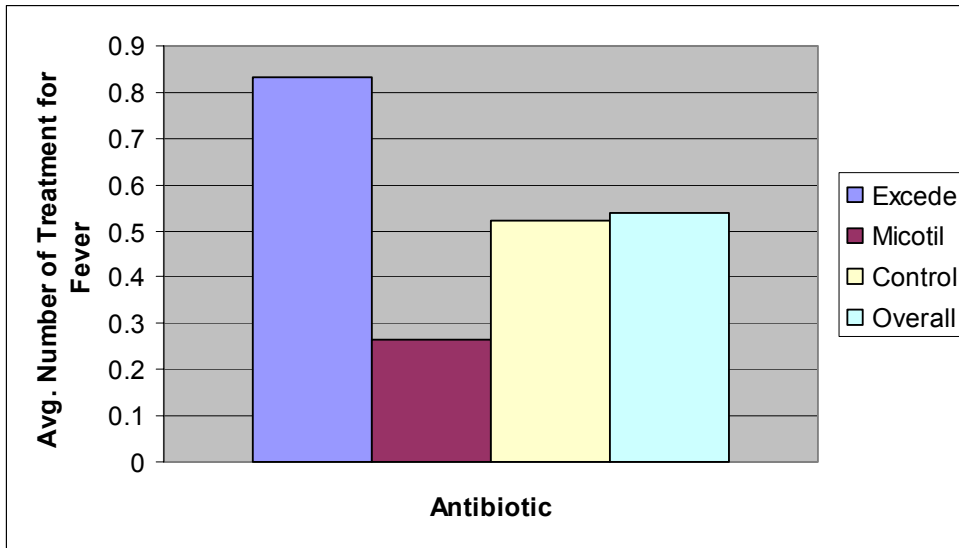


Figure 8. Average number of treatments for febrile events in metaphylactic groups.

4.2 Milk Replacer Additives

The addition of additives to the milk replacer had no effect on BW ($P>0.98$), ADG ($P>0.7$), fecal score ($P>0.18$), or the reduction in the number of treatments for scours ($P>0.69$), respiratory symptoms ($P>0.09$), and febrile events ($P>0.9$) (Table 2). Figure 9 shows BW ranged from 47.52 kg (PR) to 48.42 kg (BP), with an increase throughout the study between the four groups shown in Figure 10. The ADG across treatments was 0.44 kg/d, with PR the lowest (0.41 kg/d) and BP the highest (0.47 kg/d) (Figure 11).

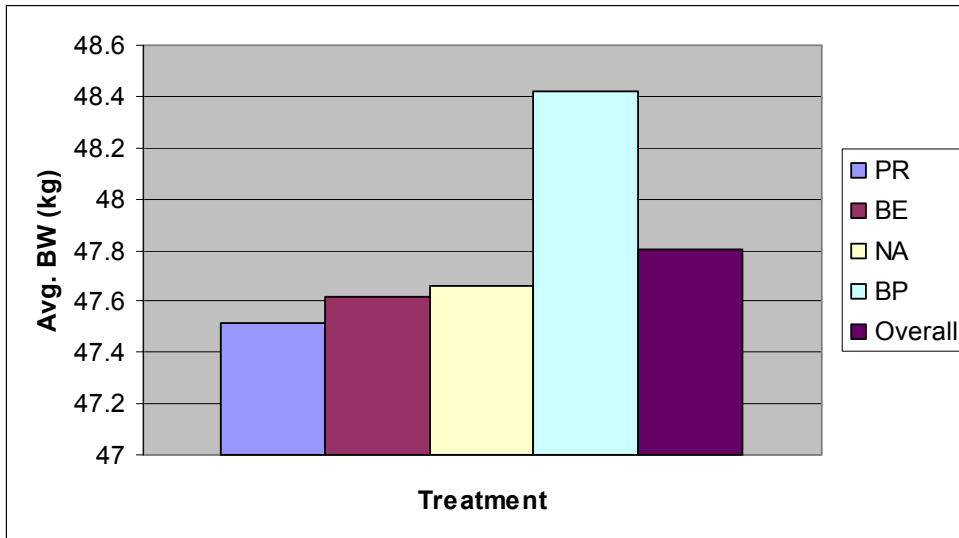


Figure 9. Average BW for milk replacer additive groups.

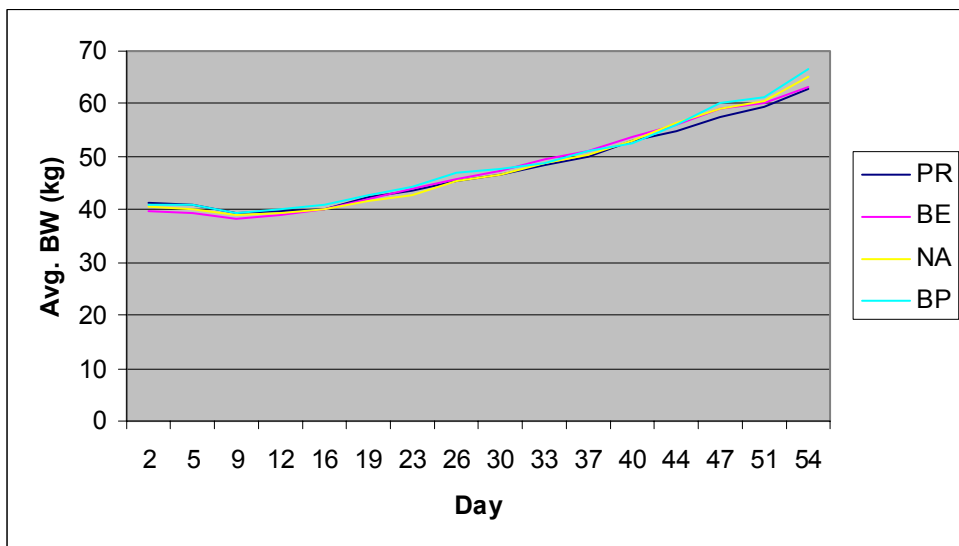


Figure 10. Average BW for days 1-54 for milk replacer additive groups.

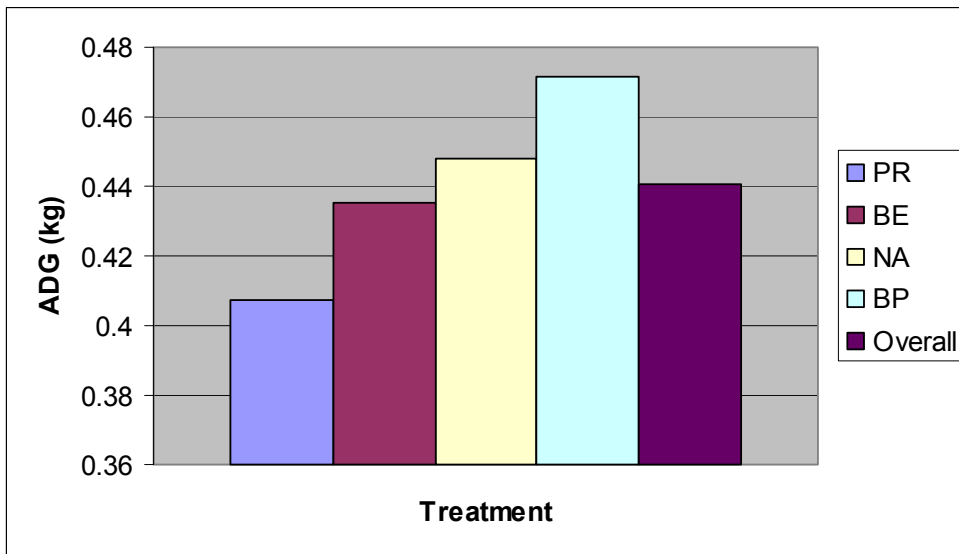


Figure 11. ADG for milk replacer additive groups.

Again, the same trend is seen in the milk replacer additive groups as was seen with the metaphylactic groups (Figure 12). The overall average fecal score for additives was 1.96, with BP having the lowest score (1.88) as shown in Figure 13.

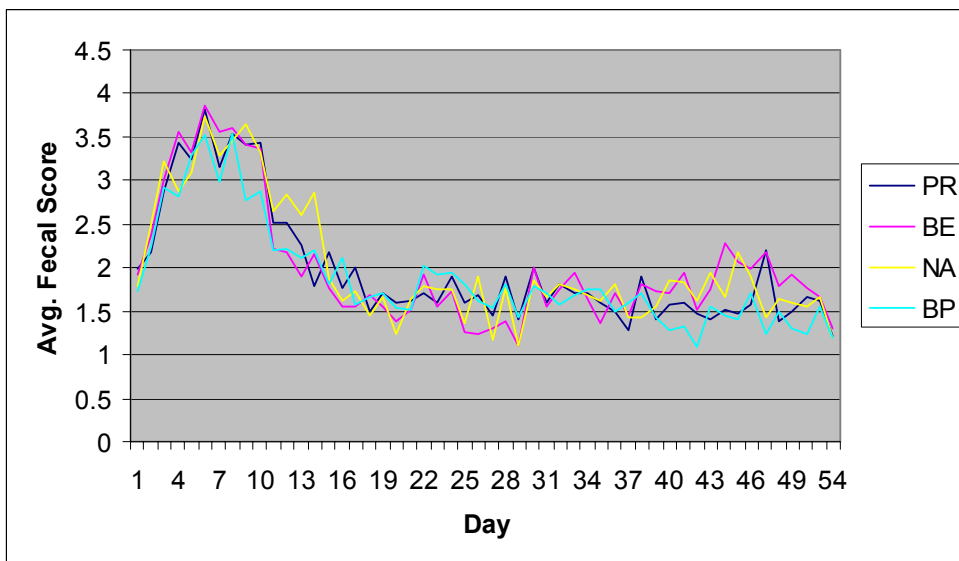


Figure 12. Average fecal score for days 1-54 for milk replacer additive groups.

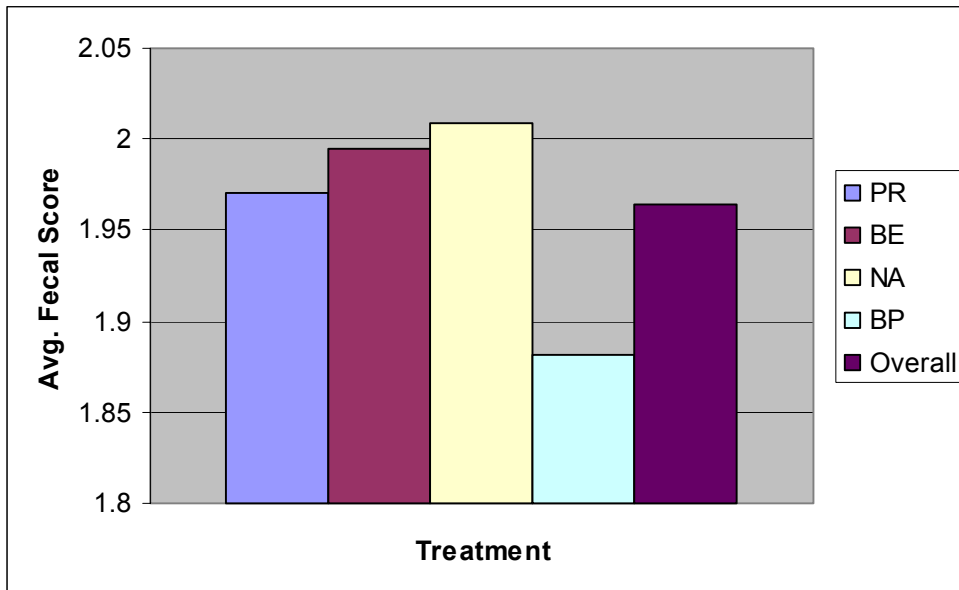


Figure 13. Average fecal score for milk replacer additive groups.

Average number of treatments for respiratory symptoms ranged from 0.70 (PR) to 0.11 (BP), with an overall average of 0.36 (Figure 14). Scours had an overall average of 6.84 (Figure 15) and an average of 0.54 for febrile events (Figure 16).

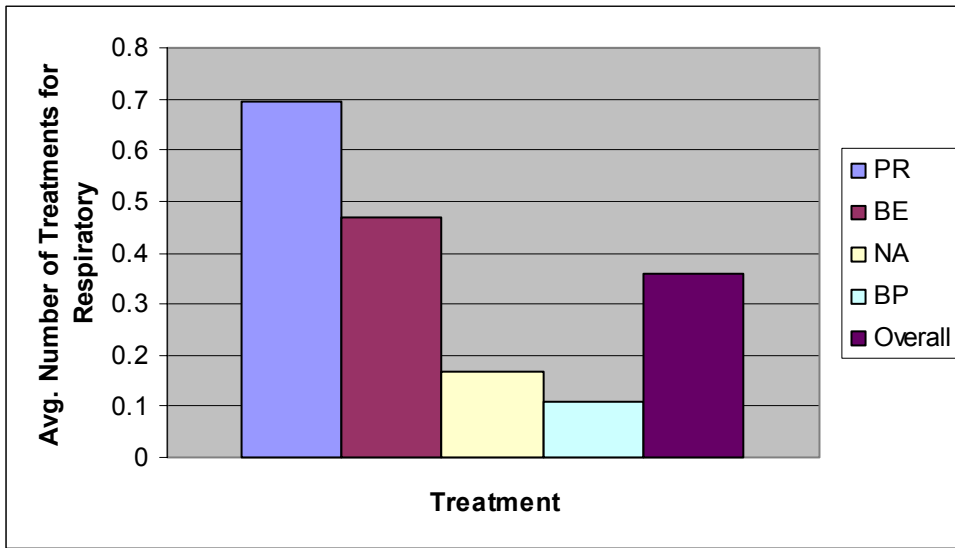


Figure 14. Average number of treatments for respiratory symptoms for milk replacer additive groups.

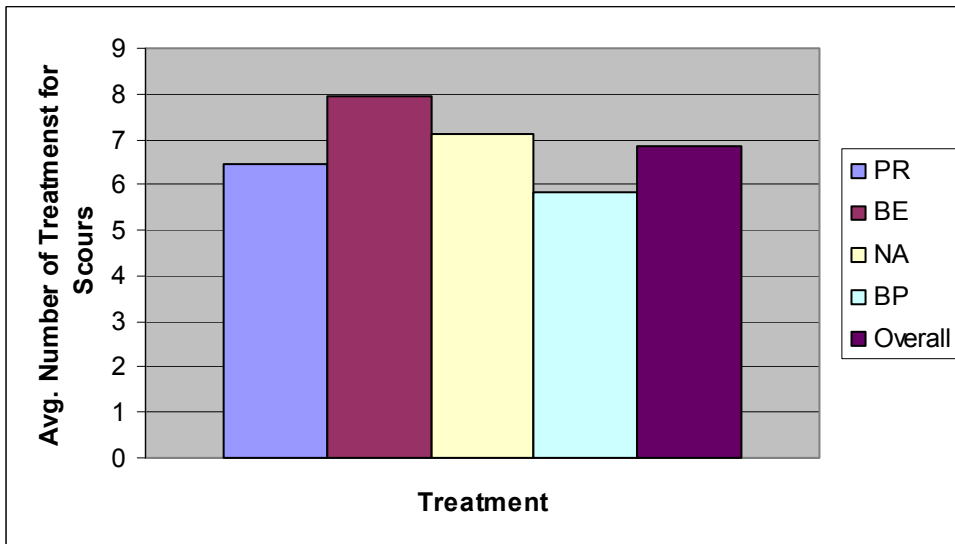


Figure 15. Average number of treatments for scours for milk replacer additive groups.

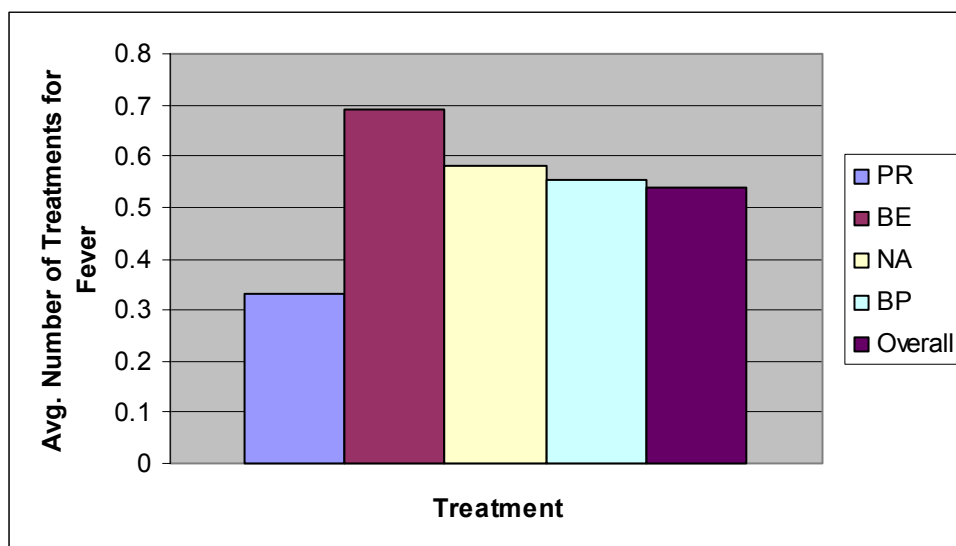


Figure 16. Average number of treatments for febrile events for milk replacer additive groups.

4.3 Metaphylaxis and Milk Replacer Additive Interaction

The interaction of metaphylaxis and milk replacer additive had no effect on the tested variables. Figures 17-34. refer to the metaphylactic with milk replacer for variables studied. CEF ranged in BW from 45.25 kg (PR) to 49.67 kg (BP). TIL ranged from 45.07 kg (NA) to 49.07 kg (BE), while CON ranged from 47.6 kg (BE) to 49.32 kg (BP). ADG ranged from .36 kg/d (CEF/BE) to .54 kg/d (CON/NA). Fecal score recorded the highest score at 2.17 (TIL/NA) and the lowest at 1.72 (CEF/BP). CEF with treatment BE and CON with treatment PR had the same number of treatments for scours (9), as well as CON with BE and CON with NA (7). CEF with BP recorded the lowest number of treatments (3.5). CON with PR had the highest number of treatments for respiratory symptoms (1), while CEF with PR, CEF with BE, and CON with BR each averaged .33 treatments. Three groups averaged 1 treatment for febrile events (CEF/PR, CEF/BE,

CEF/NA) and three groups averaged .67 treatments (TIL/BP, CON/BE, CON/BP), while TIL with PR had 0 treatments.

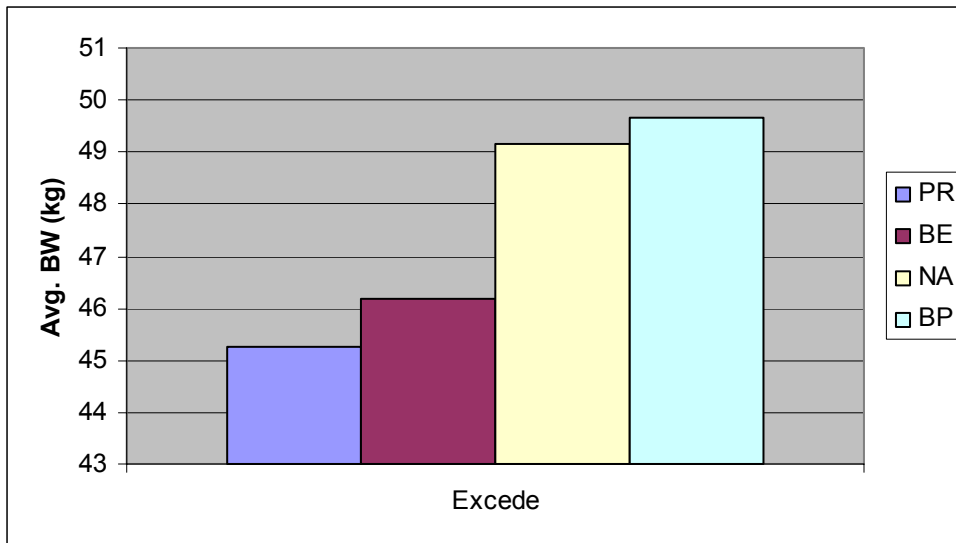


Figure 17. Average BW for metaphylactic CEF (Excede®) with milk replacer additive.

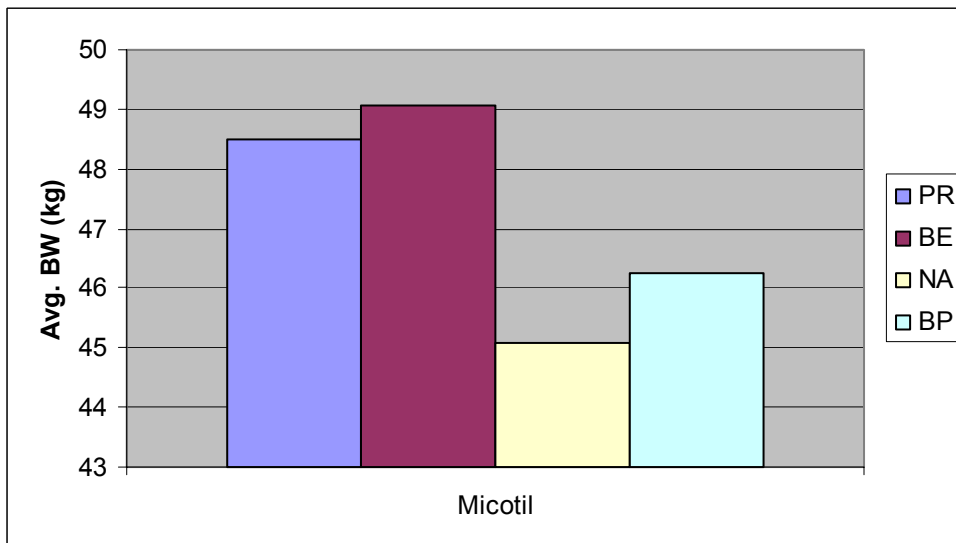


Figure 18. Average BW for metaphylactic TIL (Micotil®) with milk replacer additive.

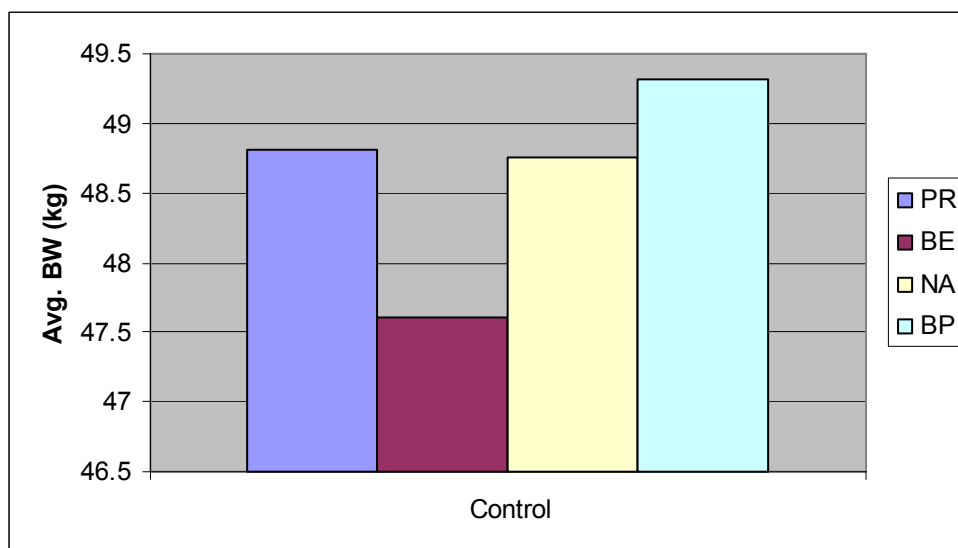


Figure 19. Average BW for metaphylactic CON (Saline) with milk replacer additive.

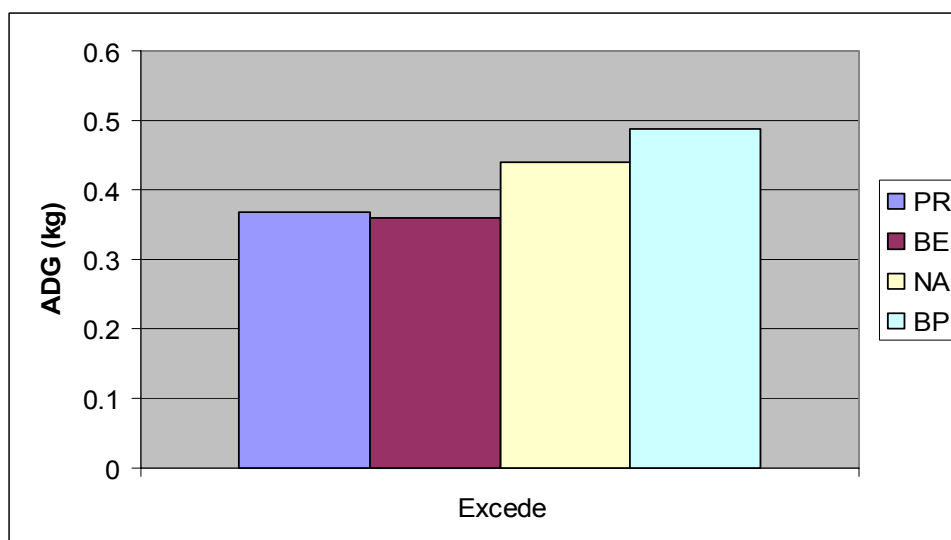


Figure 20. ADG for metaphylactic CEF (Excede®) with milk replacer additive.

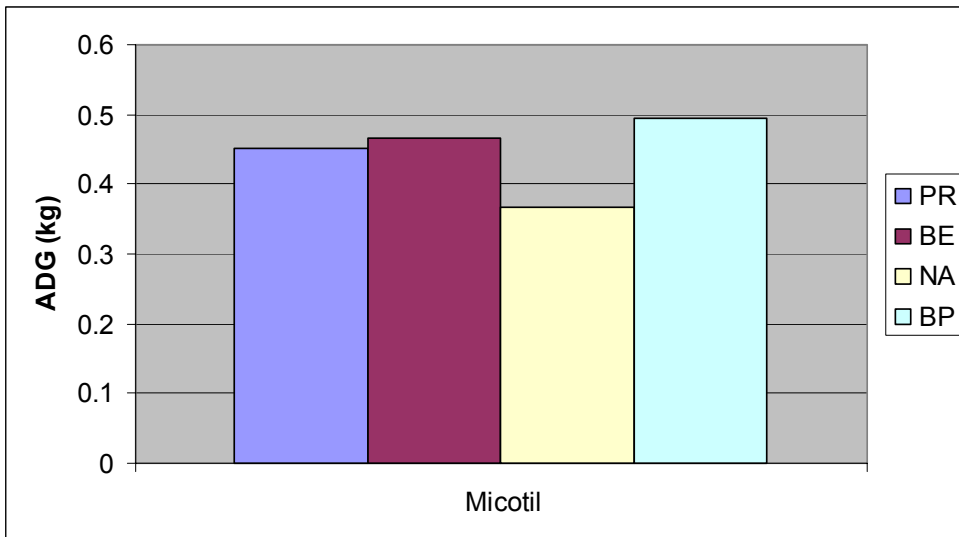


Figure 21. ADG for metaphylactic TIL (Micotil®) with milk replacer additive.

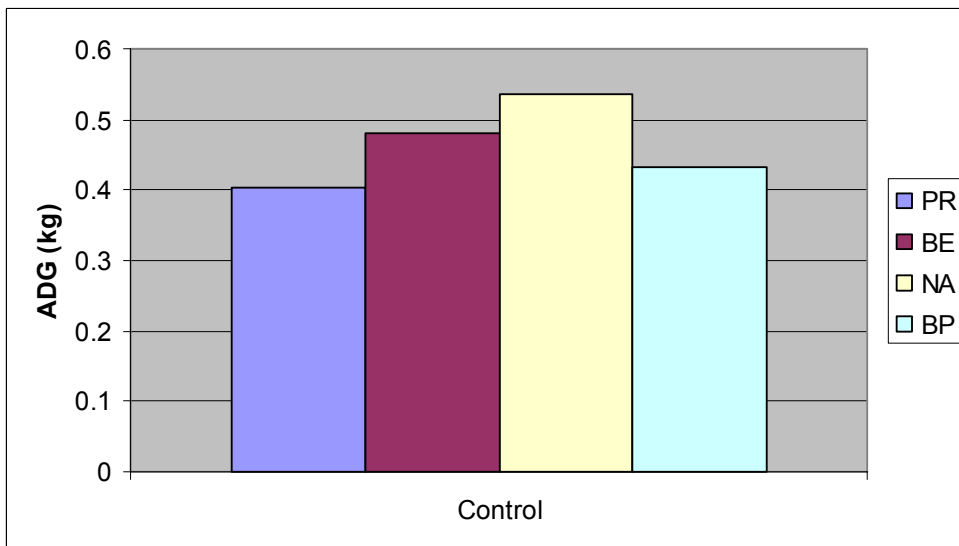


Figure 22. ADG for metaphylactic CON (Saline) with milk replacer additive.

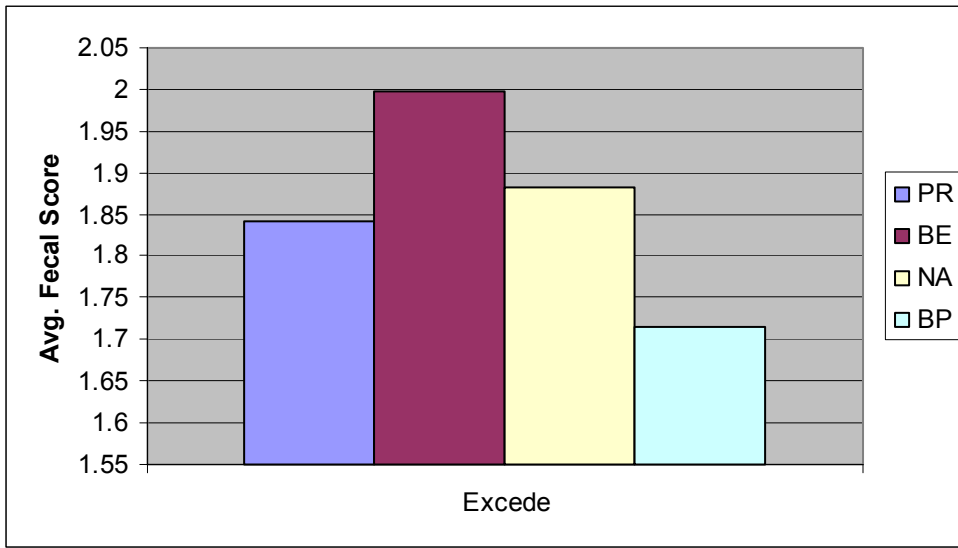


Figure 23. Average fecal score for metaphylactic CEF (Excede®) with milk replacer additive.

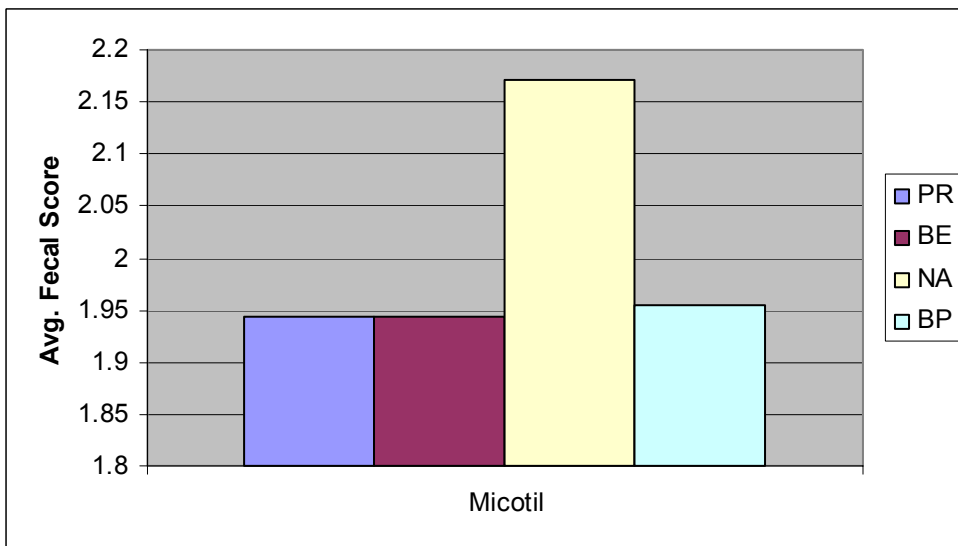


Figure 24. Average fecal score for metaphylactic TIL (Micotil®) with milk replacer additive.

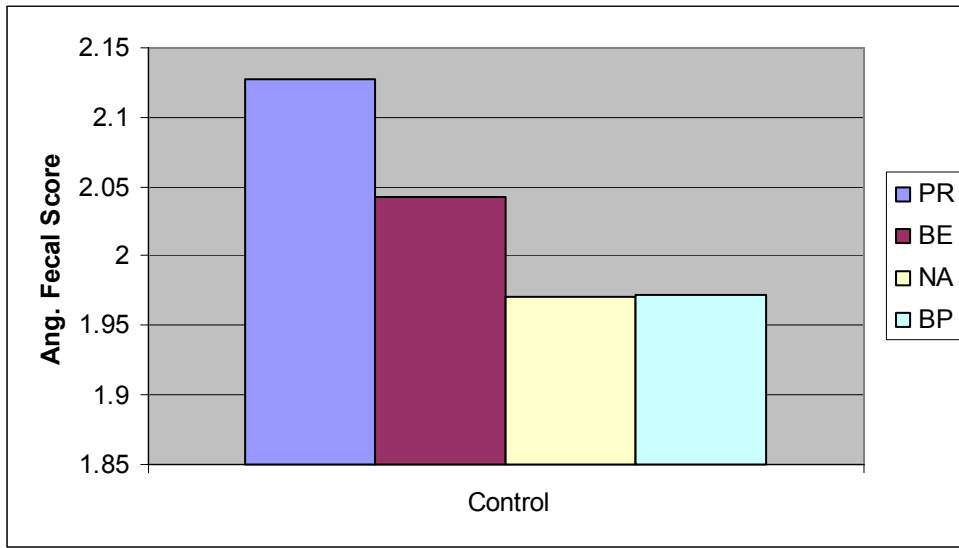


Figure 25. Average fecal score for metaphylactic CON (Saline) with milk replacer additive.

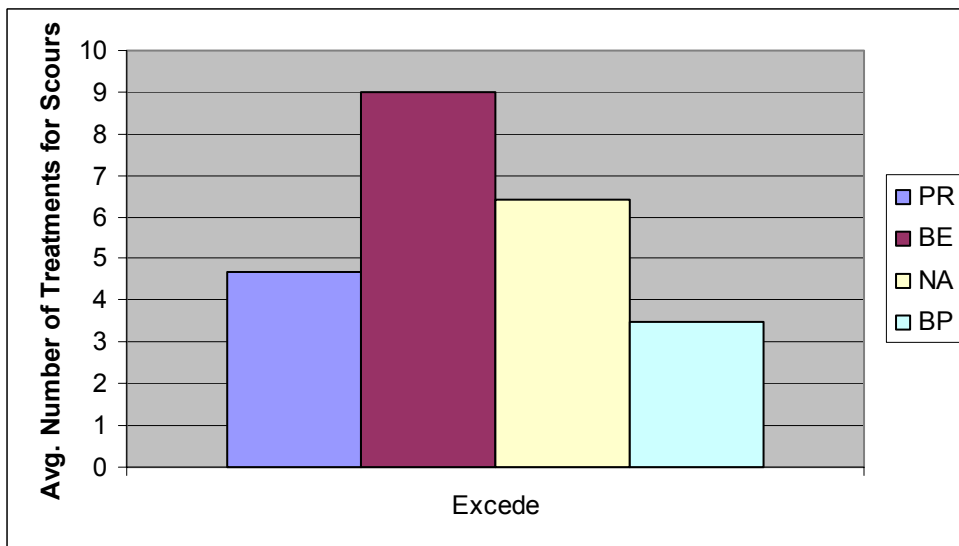


Figure 26. Average number of treatments for scours for metaphylactic CEF (Excede®) with milk replacer additive

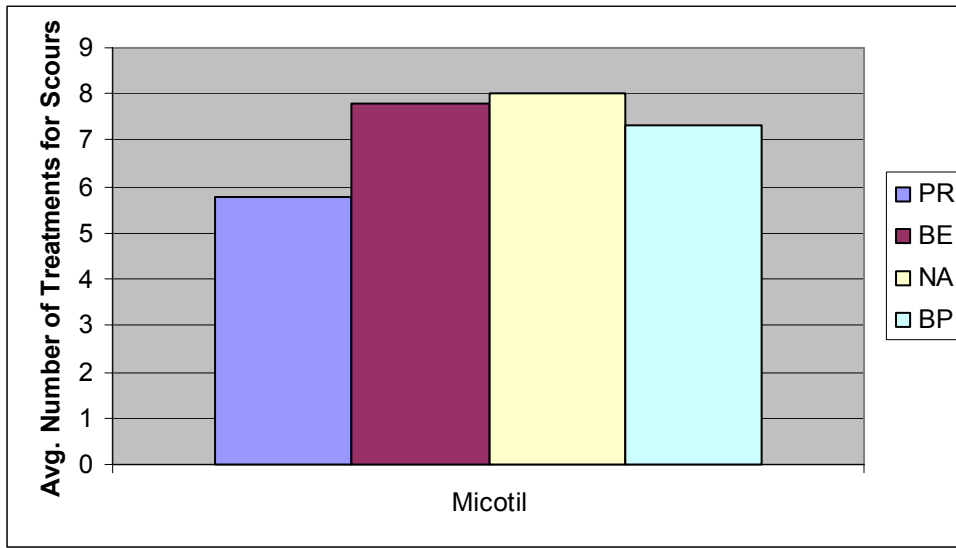


Figure 27. Average number of treatments for scours for metaphylactic TIL (Micotil®) with milk replacer additive.

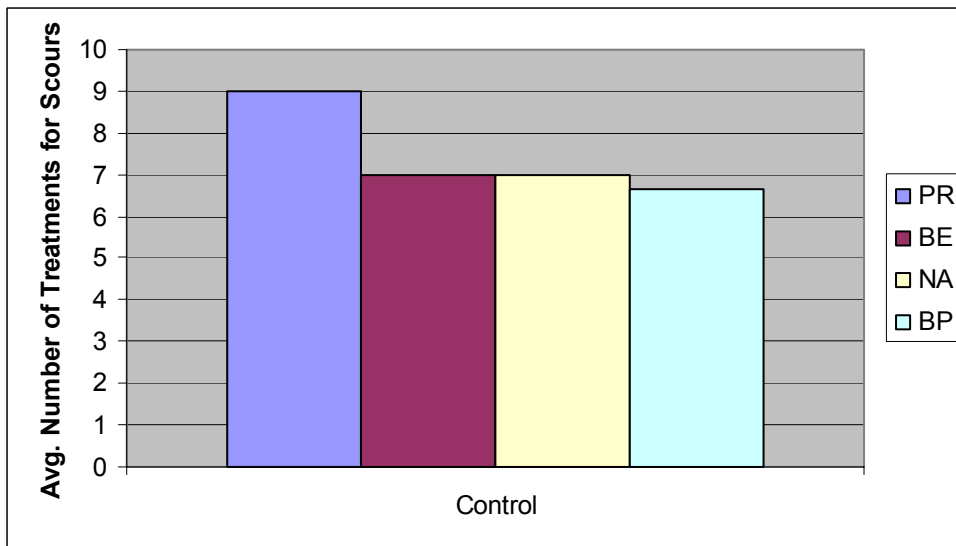


Figure 28. Average number of treatments for scours for metaphylactic CON (Saline) with milk replacer additive.

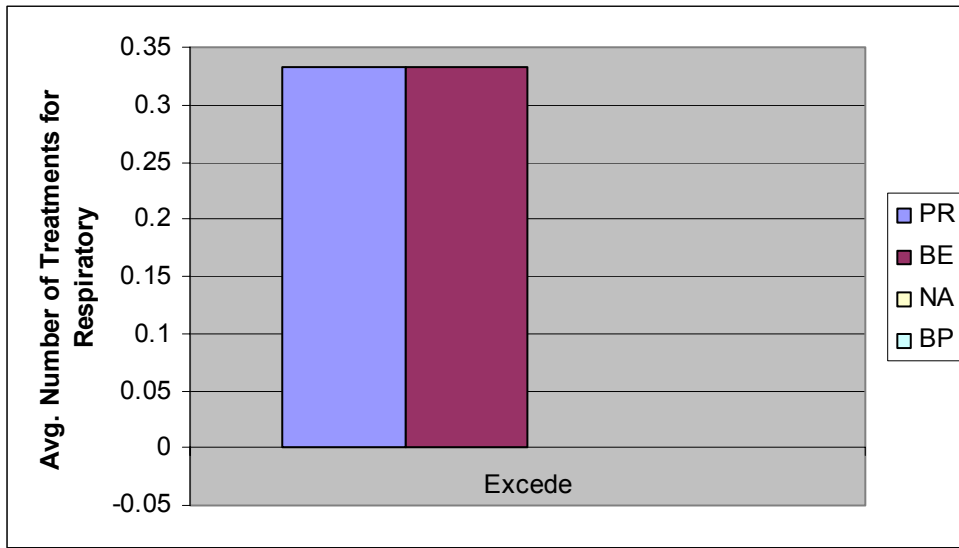


Figure 29. Average number of treatments for respiratory symptoms for metaphylactic CEF (Excede®) with milk replacer additive.

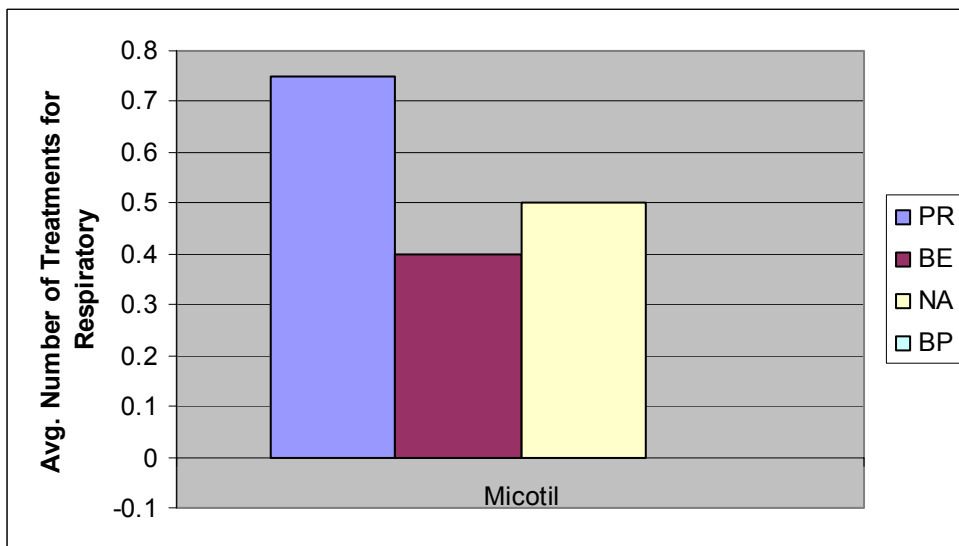


Figure 30. Average number of treatments for respiratory symptoms for metaphylactic TIL (Micotil®) with milk replacer additive.

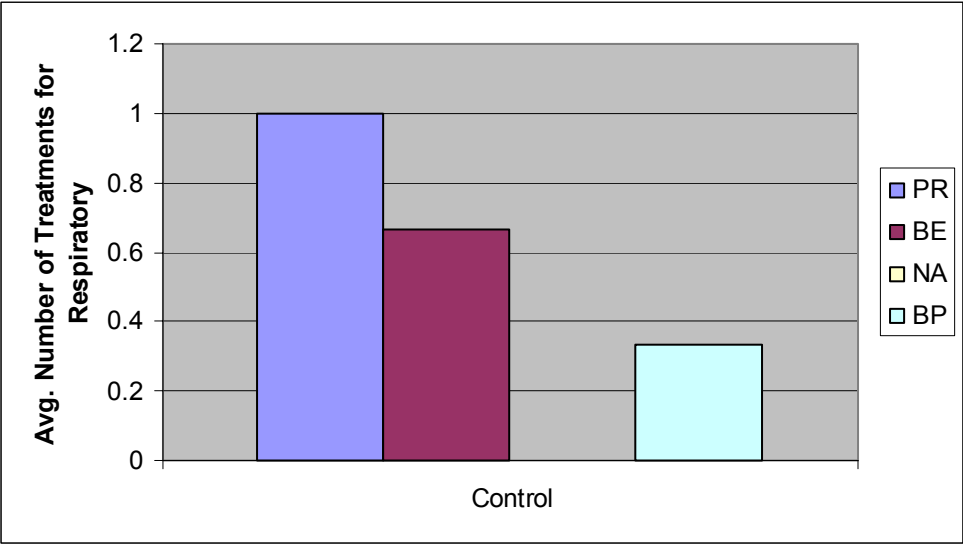


Figure 31. Average number of treatments for respiratory symptoms for metaphylactic CON (Saline) with milk replacer additive.

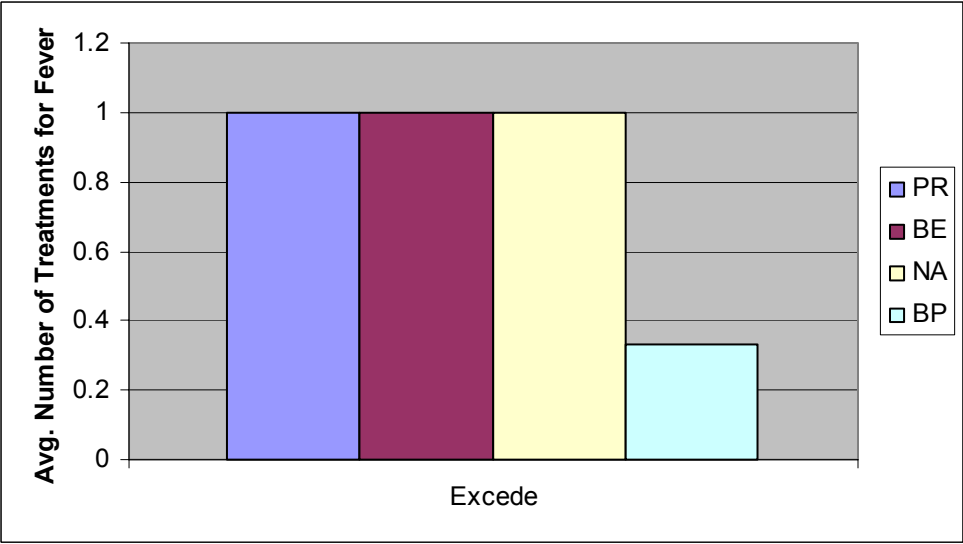


Figure 32. Average number of treatments for febrile events for metaphylactic CEF (Excede®) with milk replacer additive.

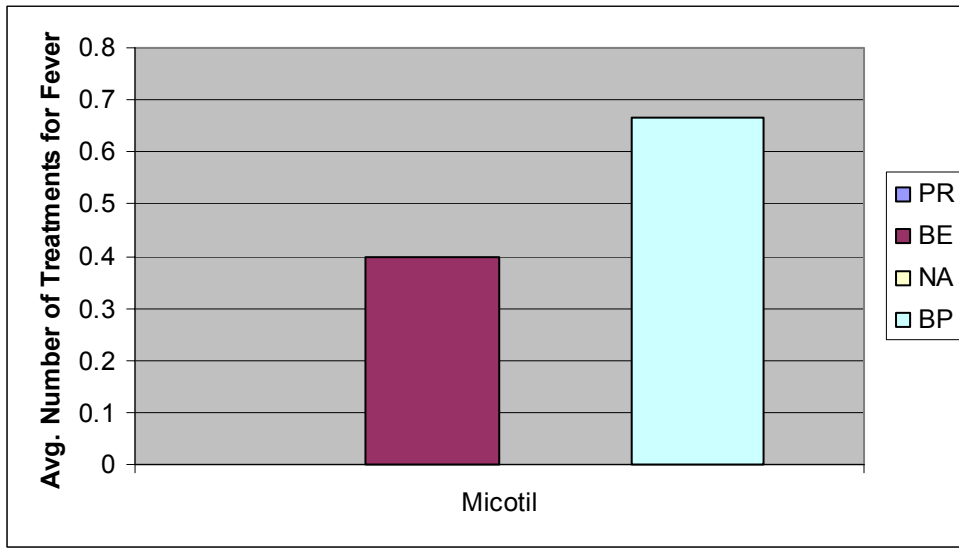


Figure 33. Average number of treatments for febrile events for metaphylactic TIL (Micotil®) with milk replacer additive.

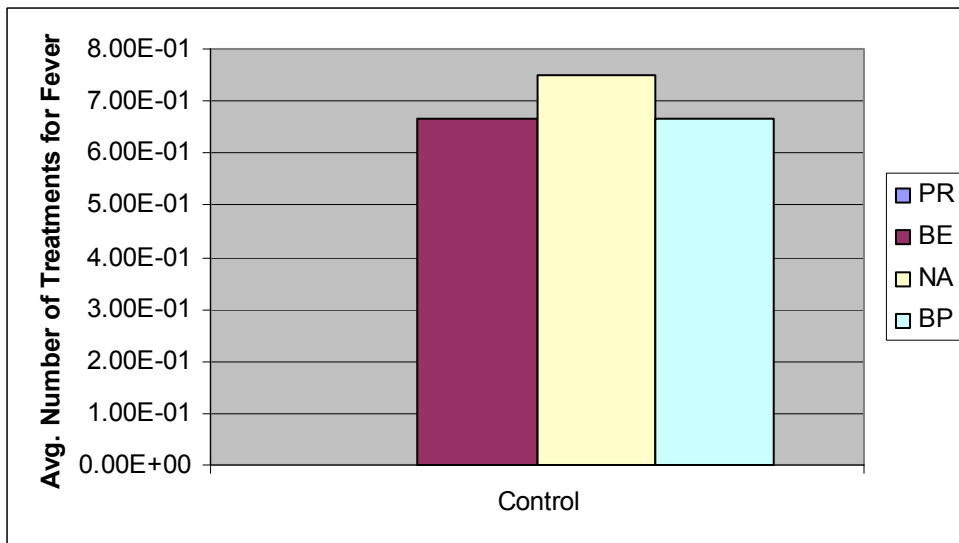


Figure 34. Average number of treatments for febrile events for metaphylactic CON (Saline) with milk replacer additive.

5. DISCUSSION

Previous research has shown that implementing metaphylactic treatment has a positive impact on the production of cattle by decreasing the incidence and severity of disease and therefore has a positive correlation to average daily gain and body weight. In these models, however, the test groups were being treated or exposed to a disease challenge or a known disease was present in the test situation (Booker et al., 2006; Galyean et al., 1995; Guthrie et al., 2004). A mild disease challenge in this study may account for the results showing no significant difference between the antibiotic test groups.

Furthermore, calves included in this study were required to receive sufficient colostrum intake within the first 12 hours of life to ensure adequate passive transfer (APT) of immunity. If proper management practices were implemented in the immediate post-natal period and the calf received antibodies from the dam, it was protected from the diseases that the dam had acquired immunity to. Given that the calves in the study had adequate passive immunity, they would have been less susceptible to disease and therefore antibiotics would have no effect on the calves.

Vaccinations administered to non-lactating cows build immunity and pass the antibodies on to the calf through the colostrum. Therefore, if the dams of the calves studied in this project were in a vaccination program and thereby prevented certain diseases in the calves, they would have a decreased incidence of disease from the pathogens associated with their vaccination protocol. Conversely, antibodies for rotavirus, coronavirus, cryptosporidia and *Salmonella* sp. are not commonly passed on to

the calf from the dam through colostrum, therefore allowing the calf to be susceptible to these diseases which are viral in nature (Donovan, 1998; Smith et al., 1980; Archambault et al., 1989; Harp et al., 1989). However, because morbidity was low and equal throughout groups, it is likely that these pathogens had a mild to no occurrence in this study.

Other explanations for incidence of scours are possible and include noninfectious scours and stress. These causes of scours and their subsequent treatment have no correlation with antibiotic treatment. Therefore, it is possible for a calf to develop scours and need treatment independent of metaphylactic treatment status. Fecal score was the only factor significantly affected in this study. CEF treated calves had a firmer stool on average than those in the control and TIL groups. This is most likely due to a reduction in the number of subclinical pathogens for diseases causing diarrhea by metaphylactic treatment with CEF. However, this result may be detrimental to the overall health of the calves as calves fed milk replacer do not normally have a firm, formed stool. Fecal score exhibited an increase in the first few days of the study which could have been caused by stress (traveling, change in feed) or environmental changes. The change occurred in all groups and declined at the same time in all groups, revealing changes not to be associated with a metaphylactic, milk replacer additive, or both.

Protimax® and Betaine 96% had no affect on the subjects. This result could have been due to the fact the calves had the necessary requirements to maintain health and proper growth. Colostrum could have provided the necessary requirements that

Protimax® claims to provide, while betaine requirements could have been met through milk replacer and calf starter.

There was no difference in BW, fecal score, ADG, or number of therapeutic treatments between the different milk additive groups. Both milk additives were designed to target specific disease or metabolic challenges in cattle. Our test subjects were likely not in need of such supplementation or was in need of little supplementation, therefore, no response was expected.

6. CONCLUSION

Results show that the use of TIL or CEF as a metaphylactic has no effect on health and growth of neonatal calves, nor does the addition of a milk replacer additive. However, the use of CEF has shown to reduce fecal score. Further research needs to be done to determine the effects of using a metaphylactic and milk replacer additives in calf management. It is likely that mild cases of disease caused the lack of response in the subjects. In order to determine an accurate response, disease should be challenged in a further study.

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