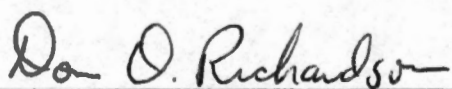
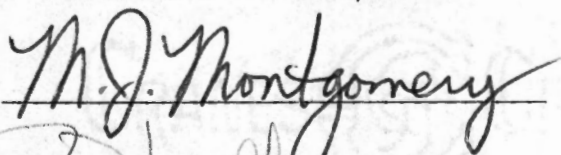
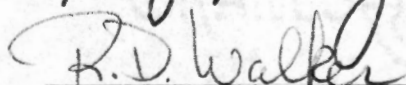


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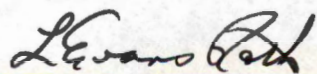
I am submitting herewith a thesis written by Martha Joyce Cunningham entitled "A Comparison of Dry Treatment and Teat Sealing as Mechanisms for Reducing New Mastitis Infections During the Dry Period." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Animal Science.


Don O. Richardson, Major Professor

We have read this thesis
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A COMPARISON OF DRY TREATMENT AND TEAT SEALING AS MECHANISMS
FOR REDUCING NEW MASTITIS INFECTIONS DURING THE DRY PERIOD

A Thesis
Presented for the
Master of Science
Degree
The University of Tennessee, Knoxville

Martha Joyce Cunningham

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ABSTRACT

The primary objectives of this study were to resubstantiate the importance and effectiveness of dry cow therapy and to compare dry treatment and teat sealing as mechanisms for reducing the incidence of new mastitis infections and for eliminating existing infections during the dry period.

Data used in this study were obtained from quarter samples from 71 cows at The University of Tennessee, Knoxville dairy herd. This data included bacterial analysis of each sample taken at two different test periods, one prior to drying off and the second within 10 days after freshening.

The cows were assigned to four treatment groups. Group 1 received no treatment and served as the control group. Group 2 cows received the teat sealant. Group 3 cows were infused with a commercial dry cow treatment and in the fourth group, cows were dipped in the teat sealant in addition to the dry cow therapy. Since the teat sealant was not designed for the dry period, cows were resealed every two weeks. (It was also not a germicide so an iodine teat dip was used under the sealant.)

The change in infection status between the two sampling periods was the primary response measurement.

The use of dry cow treatment was found to be very effective in eliminating existing infections of Staphylococcus aureus and Streptococci and preventing the incidence of new infections. The

results of this study reinforce the use of dry cow therapy as a form of mastitis control but do not provide a basis for the recommendation of the use of teat sealants. It should be realized that the sealant used in this study was not designed for use in the dry period and a more effective sealant could be developed in the future.

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CHAPTER I

INTRODUCTION

The first step in any mastitis control program is to recognize the seriousness of the disease and the consequence of its economic and health effects. Mastitis control programs, as such, have evolved over time so that teat dipping and dry cow treatment are now recognized as very important aspects of preventive treatments.

It was early in the 1950's that dry cow therapy was first implemented. Initially it was used to clear existing infections and was found to have little effect on the incidence of new infections. Since the first use of dry treatments, much work has been conducted to develop preparations which both eliminate existing infections and prevent the incidence of new infections.

Now, as many dairymen realize the effects mastitis has on production and thus their income, they have become more interested in and demanding of mastitis preparations which effectively control mastitis.

The specific purposes of this study were:

1. To confirm the importance and effectiveness of dry cow treatment.
2. To evaluate the possible use of teat sealants and compare dry cow treatment and teat sealing as mechanisms for prevention of mastitis and elimination of existing infections during the dry period.

CHAPTER II

REVIEW OF LITERATURE

Mastitis has long been known to be one of the major herd health problems in dairy herds. Although complete control or prevention is not feasible at this time, much can be done to keep this health problem at a manageable level.

I. ETIOLOGY OF MASTITIS

The complexities that forestall elimination of the mastitis problems are that the disease itself is a manifestation of several interrelated systems. These systems are each quite complex in their own right. The disease itself is evidenced when a susceptible cow is confronted or challenged by a pathogen capable of creating an infection.

Dodd et al. (6) found that cows often show stability in infection status in that infected cows tend to remain infected and vice versa. Furthermore, they stated that only 40 percent of the infections are normally detected by the milkman as clinical mastitis, thus making it more important to develop an effective control program.

Factors Affecting Susceptibility to Infection

The individual cow's susceptibility is highly variable and is influenced by the proper functioning of milking equipment, the diligence of the milker in hygiene, and attaching and removing the milking unit. In addition, bruises and other injuries to the udder as well as the adequacy of bedding and housing facilities necessary to maintain the cows in a clean state are all important factors (3).

The ability of organisms to establish an udder infection or disease is related to the cow's general resistance. A severe pathogen such as Staphylococcus aureus may become established in a more resistant cow, however, bacteria such as Corynebacterium bovis and Staphylococcus epidermidis do not normally result in disease, but may be a factor if resistance is very low (16).

Several researchers have studied the changes in the udder and its susceptibility to infection during the dry period. Neave et al. (24), in a study with small numbers, used six cows. In this study two quarters of each cow's udder were dried off, then all teats were immersed twice a day in Streptococcal and Staphylococcal suspensions. In this study only unmilked quarters became infected, seven with S. aureus and three with Streptococcus. This led the authors to the conclusion that udders are more susceptible to infection during the dry period.

Later, a larger experiment was reported by Thomas et al. (36) using the same procedures. In this study 16 cows were included and handled in the same manner as the previous study. Of the 32 dry quarters, a total of 22 became infected while only 3 of the 32 quarters being milked became infected. The researchers felt that the primary cause for the differences in susceptibility was that the bacteria may be flushed from the gland during milking.

Cousins et al. (4) dipped the teats of 18 cows daily for one or two weeks in a mix of Streptococcus dysgalactiae and Streptococcus uberis at the start, middle, or end of the dry period. Teat sinuses were sampled and those that showed no bacteria infection were infused

with Streptococci. Of the nine quarters infected after dipping, eight became infected early and one in the middle of the dry period. Of the 38 quarters which were infused, 36 developed new infections. This research suggested that differences in rates of new infection may be due to the differences in ease with which bacteria can penetrate the teat canal.

Pathogenicity of Various Organisms

Approximately 90 to 95 percent of all cases of mastitis are caused by Staphylococcal and Streptococcal bacteria (28). Staphylococcus aureus is generally considered the most serious as it is able to secrete toxins which enable the organisms to penetrate the duct walls of the udder and create barriers, thus becoming less accessible to drugs. S. aureus is also capable of developing a resistance to some antibiotics. For these reasons, the control of S. aureus should be of great concern to the dairyman (3).

McDonald (16) also discussed the roles of different Gram-positive cocci as mastitis-causing pathogens. He stated that S. aureus rarely attacks healthy skin, but the eroded skin on the teat is highly susceptible. S. aureus is capable of living for extended periods on the skin which aids in making it difficult to eliminate. Another species of pathogenic bacteria, Streptococcus agalactiae, is highly contagious, but is generally considered less serious because it only exists in the mammary gland and is easily eradicated through the use of penicillin. There are other strains of Streptococci which are also pathogenic and more hardy than S. agalactiae, but are also more easily detected by the dairyman.

A study examining the survival of S. aureus on the teat and teat orifices of cows in the dry period was conducted by Smith and Coetzee (34) to reveal possible susceptibility to S. aureus during the dry period. They used 18 cows and infected nine of the cows by the infusion of S. aureus in one or more quarters, the other nine were left uninfected. Skin swabs taken two or three weeks after drying off were analyzed for bacterial presence and when compared to earlier swabs, showed a reduction in skin contamination. S. aureus was found on infected orifices each time samples were taken. The survival of S. aureus on the orifices of the uninfected cows was found to be the same as the survival on the skin, but longer on orifices of infected cows.

II. FARM MANAGEMENT PRACTICES

It is important for the farmer to incorporate some form of mastitis control into the management process. Jarrett (14) felt that the first step in any control program is the realization that mastitis is both an economic and a disease problem.

The association between management practices and bulk milk tank somatic cell counts was examined by Hoare et al. (12). Using 115 herds they found that 80 percent of the farms used dry cow therapy. Those treating all cows showed consistently lower somatic cell counts than the other herds.

Hayward and Webster (10) reported a study with one herd of 83 cows. They infused all cows with 100 mg Rifamycin per quarter immediately following the final milking. The results of this study

showed that the percentage of quarters having a positive California Mastitis Test was reduced from 70 percent to 20 percent at freshening when compared to the previous lactation.

Methods of milk cessation have also been studied. Natzke, Everett, and Bray (19) compared intermittent milking to abrupt cessation. They used a total of 9,254 quarters on 36 farms in which 80 percent of the cows were dry treated. In both the controls and treated cows, higher rate of cure and fewer new infections were found in those cows dried by intermittent milking.

There have been studies to demonstrate the effects of dry cow treatment on milk production. Merch and Jacob (18) found substantial differences in milk yield between the 250 cows treated and the 250 cows used as untreated controls in three herds. The mean difference showed a milk-yield gain of 0.63 kg per cow daily in the treated group.

Dry Cow Therapy Programs

According to Philpot (27), there are several reasons for treating cows at the start of the dry period. These are salable milk is not contaminated, it allows for regeneration of damaged tissue, new infections may be prevented and it reduces the number of clinical cases at the beginning of the next lactation. Philpot also found a basis for treating all cows for subclinical mastitis at this time because those subclinical quarters not treated may act as a constant source of reinfection.

Since the first use of dry cow therapy, much work has been done to determine the effectiveness of dry cow treatment as a means of

mastitis control. A lot of these studies (7, 32, and 35) involve comparisons of different antibiotic preparations. These papers do not show much difference between the preparations, however, all show a difference between the untreated controls and those cows receiving some form of dry cow therapy. These studies all showed a decrease in new infection rate and an overall improvement in herd health among the treated cows.

Four trials were conducted by Pearson and Wright (25) to evaluate the effects of dry cow treatment on S. aureus and Streptococci. In the first trial there were 584 quarters in six herds, 351 of the quarters served as the untreated controls. One herd was used in the second trial and all infected quarters received treatment. In these trials 75 percent of the S. aureus and all of the Streptococci were eliminated from treated cows. The third trial used 121 cows, all of these cows were treated and the infection rate was reduced from 26 to 13.3 percent. In the final trial there were 72 cows. All the right quarters were treated and the left quarters served as untreated controls. In this study there was a 5 percent reduction on the treated side and a 1.6 percent reduction on the untreated side. These researchers recommend the use of dry cow treatment but in addition to, not in place of, routine management and machine maintenance.

Another experiment, by Janovics and Armitage (13), also examined the effects of dry cow treatments on Staphylococcus mastitis. They used three large commercial herds and evaluated cows before and after dry treatment. The results showed a significant reduction of the incidence of Staphylococcus infections in the next lactation.

Several other researchers have studied incidence and control of mastitis during the dry period (21, 26, and 38). In these studies cows were assigned to either control or treatment groups and sampled both before and after the dry period. The results indicated that dry cow treatments are an effective means of control and that it is important to treat all quarters in order to prevent the spread of mastitis.

In additional studies, different preparations of dry treatments were compared (2, 5, and 11). The results of these reports indicated little difference between the effectiveness of various preparations.

Selective Treatment

There has been debate in the past over whether it is best and more economical to treat all or only certain cows. Serieys and Roguinsky (33) ran comparative tests using dry cow therapy for some or all cows in the herd. Three experimental groups were formed. These were: control, all treated, and selective treatment. Infection status was determined by the presence of bacteria. The number of infections at drying off were compared to infections at calving. Seventy-five percent of the new infections were in cows which had been identified as infected at drying off. They felt selective treatment could be used and could thus save money by treating fewer cows. However, that still left 25 percent of the new infections in cows which were not treated at drying off using selective treatment.

In another study, Rindsig et al. (29) used 232 cows alternately assigned to complete or selective dry cow therapy. In the selective group cows were treated based on either a history of mastitis,

California Mastitis Test score of +2 or +3, or somatic cell counts above 500,000 cells/ml. In the complete treatment group, 85.4 percent of the infections were cleared and 88.2 percent cleared in the selective group. The incidence of mastitis following the dry period was also lower in the complete therapy group. They found selective treatment to be just as effective in eliminating existing infections but the researchers advocated the use of complete therapy in situations where new infections during the dry period are a problem.

A later report by Rindsig et al. (30) compared the effectiveness of different methods of identifying those cows to be treated in a selective therapy program. They used the California Mastitis Test, bacteria analysis of quarter samples and somatic cell counts. By using the bacteria analysis to determine infection status, the researchers found that the cell counts correctly identified 53 percent of the infected cows for treatment, however 25 percent of the uninfected cows would have also been treated. By using a CMT score of +2 or +3, 89 percent of the infected cows were treated. However, 56 percent of the uninfected cows were also treated. They felt that when using selective treatment, the use of CMT gave a more accurate identification of infected cows.

At the USDA Experiment Station at Beltsville, Maryland, Schultze et al. (31) showed that if only cows with a clinical history of mastitis were treated at drying off, 63 percent of those quarters infected and which would become infected during the dry period would receive treatment.

III. THE USE OF TEAT SEALANTS

Very little work has been done using a teat end seal either during the lactation or the dry period.

Farnsworth (8) reported a study using an acrylic latex film which acted as a physical barrier until the next milking. The dip was studied with respect to its effect on intramammary infection rates in four dairy herds. Infections were determined by bacterial analysis and somatic cell counts. Rates of new infections in treated quarters were compared with rates in the control quarters on the same cow. There was a significant reduction of S. aureus, S. epidermidis, and coliform mastitis but not the Streptococci pathogens. They found the dip to be very effective in prevention of coliforms but less effective on other organisms than a disinfectant-type teat dip. However, the use of an iodine teat dip under the latex dip was found to be effective.

In Ireland, Meaney (16) has conducted studies using a dry period teat seal. He used 31 non-infected and 14 infected cows in a series of three experiments. All teats in experiments one and two were exposed to a bacterial culture each week during the dry period. In experiment one, two teats of each of 14 infection-free cows were infused with the sealer and all others served as untreated controls. There were new infections in 1 percent of the sealed quarters and 32 percent of the controls. In experiment two, sealer and antibiotics were used with similar results. In the last experiment, infected cows were infused with the teat seal and antibiotic. Seventy-eight percent of the infections were eliminated during the dry period. Meaney's

work indicated that a teat seal can protect the quarter from infection during the dry period.

IV. SUMMARY

There are differences of opinion among the researchers as to whether it is better to treat all cows or use a selective method of dry cow treatment. Regardless of whether a study indicates selective or complete treatment, the general concensus is that dry cow therapy is important for mastitis control and has the two-fold purpose of eliminating existing infections and protecting the udder from new infections. Work also indicates that therapy is especially helpful in controlling the incidence of S. aureus. Little work has been conducted in regard to the use of teat sealants during the dry period but the research does seem to indicate that the development of teat seals may be an effective means to improve mastitis control programs.

CHAPTER III

MATERIALS AND METHODS

Data utilized in this analysis were collected over a seven-month period (August 1979 to March 1980) from 71 cows (54 Holstein and 17 Jersey cows) in The University of Tennessee, Knoxville dairy herd.

Experimental Design

The cows used in this experiment were first grouped by breed and parity levels in an attempt to remove breed and age effects. Within a breed and parity level cows were randomly assigned to the treatment groups. The cows were assigned to treatment groups before bacterial analysis, therefore the cows were assigned irrespective of infection status.

Group 1 was designated as a control group and did not receive treatment beyond a commercial iodine teat dip at final milking. In Group 2, in addition to a commercial iodine teat dip at last milking, the cows' teats were all dipped in a latex teat sealant immediately after the iodine dip had dried. Cows in Group 3 were infused with a commercial intramammary infusion made of a synthetic penicillin in peanut oil immediately after final milking. The teats were then dipped with the same commercial iodine dip. Group 4 animals were treated with both the intramammary infusions and the latex teat sealant, in addition to the commercial iodine teat dip.

As the teat sealant used did not contain a germicide, it was always preceded by dipping the teats in a commercial iodine teat dip.

The sealant was white in color while wet then dried clear. It was applied in the same manner as a conventional teat dip. To avoid contamination before the sealant had gelled, the cows were confined in a lot and not allowed to lie down for approximately 30 minutes after the dip was applied. Cows which were dipped with the sealant, groups 2 and 4, were subjected to a teat seal procedure as described every two weeks.

Data Collection

Within the week prior to drying-off, milk samples were collected aseptically from each quarter of each cow. This involved washing and drying each teat and then scrubbing the teat ends with sterile gauze pads saturated with 70 percent ethanol until no visible dirt was on the gauze. Prior to collecting the milk, the teat canal was stripped three times; the next eight streams were then collected in a sterile collection bottle. Samples were cultured on blood agar plates using a 0.01 ml inoculating loop and putting all quarter samples from an individual cow in separate quadrants of one plate. The plates were examined daily for at least 72 hours for bacterial growth. Cows were sampled a second time within ten days post-partum. These samples were also assayed to determine infection status.

All bacterial growth was subjected to further analysis to identify the organisms present. Bacterial growth was identified by first using gram stains to determine cell morphology. Gram-positive cocci were subjected to a catalase test to distinguish between Streptococci and Staphylococci. All Staphylococci were further subjected to a coagulase test to separate S. aureus from S. epidermidis.

Streptococci were subjected to a CAMP test to identify any incidence of S. agalactiae or Group B Streptococci.

The results of the bacteria analysis were used to determine the infection status of the individual quarters. The two test periods were compared to determine any changes in bacteria present in order to identify new infections and which infections were cleared during the dry period. For the purposes of this study, infection was defined as the presence of at least three colonies of a specific pathogen (i.e., 300 colonies/ml).

All calculations and statistical analyses were done with the aid of the IBM 360/65 data processing system of The University of Tennessee Computing Center. In the analysis the infection levels were examined first considering only S. aureus and then again including any Streptococci.

CHAPTER IV

RESULTS AND DISCUSSION

Information on the infection status of 71 dairy cows from The University of Tennessee, Knoxville dairy herd was collected to evaluate the effectiveness of a teat sealant administered with and without dry cow therapy as a mechanism for reducing new and existing infection.

There was some attrition of research animals during the course of the study. Initially 76 cows were distributed evenly among the four treatment groups. At the completion of the trial, usable data existed for 14, 19, 20, and 18 cows in the four treatment groups. The reduction in the control group occurred because one cow was removed from the study due to an alteration in the treatment schedule, one cow aborted, two cows died of milk fever before the second sampling, and one cow was sold after the groups were assigned. There were four cows utilized in this study which were three quartered cows, two of these were in the control group and two in the dry treatment group.

The incidence of quarters infected by various organisms is presented in Table I. The cows were assigned to treatments prior to the availability of the results of the culturing procedures. Cows assigned to the various treatments appear to differ somewhat in both initial level of infection and the types of organisms responsible. S. aureus was found to be the most prevalent pathogen. Treatments 3 and 4 appeared to have a much lower incidence of S. aureus at freshening than did groups 1 and 2. In this table, in addition to

S. aureus and Streptococci, S. epidermidis and Corynebacterium are included. Since S. epidermidis and Corynebacterium are not normally considered pathogenic, only infection by S. aureus and Streptococci will be considered as true infection for the remainder of the analysis. There was only one confirmed case of S. agalactiae in this study and that was in the control group in the first sampling period.

At the planning stage it was thought that parity and breed might be factors that would affect the distribution of infections. Table II presents the distribution of infections from both the pre-treatment and post treatment cultures. Surprisingly, the first parity group had higher infection levels in the pretreatment cultures in that 63 percent of cows and 31 percent of quarters were infected in the first parity group and comparable values were 48 and 21 for the multiple parity group. No differences in the post treatment cultures were observed. Breed differences, however, were pronounced—Jerseys' infection incidences were distinctly lower than Holsteins. These values were 29 percent of cows and 12 percent of quarters for the Jersey versus 61 percent and 29 percent for Holstein in the pretreatment cultures. The differences were not as wide but still distinct for the post treatment cultures in that 24 percent of Jersey cows and 10 percent of Jersey quarters were infected while 44 and 22 percent of cows and quarters were infected in the Holstein herd.

The preliminary analyses of the incidence of infection by S. aureus are presented in Table III for the pretreatment cultures, and Table IV contains the post treatment cultures. Data presented in Table III does not indicate any differences among the treatments in the incidence of infection observed from pretreatment cultures. This

TABLE II. INCIDENCE OF INFECTION AS AFFECTED BY BREED AND AGE

	Pretreatment				Post Treatment			
	Uninfected		Infected		Uninfected		Infected	
	Cows	Qtrs.	Cows	Qtrs.	Cows	Qtrs.	Cows	Qtrs.
<u>By Breed</u>								
Holstein	21	151	33	62	30	167	24	46
Jersey	12	59	5	8	13	60	4	8
<u>By Parity</u>								
1st Parity	10	73	17	33	16	86	11	20
2nd & Later	23	127	21	37	27	141	17	33

TABLE III. CHI-SQUARE ANALYSIS OF PRETREATMENT INCIDENCE
OF INFECTION BY S. AUREUS

Results of Pretreatment Culture	Treatment				
	1	2	3	4	
Negative	42	57	66	51	Observed
	41.7	58.6	60.2	55.5	Expected
	0.0	0.0	0.6	0.4	Cell Chi-square
Positive	12	19	12	21	Observed
	12.3	17.4	17.8	16.5	Expected
	0.0	0.2	1.9	1.3	Cell Chi-square
Total Chi-square	4.306				
Probability of a Greater Chi-square	0.203				

TABLE IV. CHI-SQUARE ANALYSIS OF POST TREATMENT INCIDENCE
OF INFECTION BY S. AUREUS

Results of Post Treatment Culture	Treatment				
	1	2	3	4	
Negative	39	60	74	61	Observed
	45.1	63.5	65.2	60.2	Expected
	0.8	0.2	1.2	0.0	Cell Chi-square
Positive	15	16	4	11	Observed
	8.9	12.5	12.8	11.8	Expected
	4.2	1.0	6.1	0.1	Cell Chi-square
Total Chi-square	13.574				
Probability of a Greater Chi-square	0.0035				

result was desirable in that it indicated an equal initial distribution of infection with S. aureus. In the post treatment results (Table IV) a difference exists among treatments, particularly between the control and dry cow therapy groups. There were more infections at freshening in the control group than expected and fewer in the dry cow treatment group. The data presented in Tables V and VI are the results when both S. aureus and Streptococci are included. These results indicate that there may have been a difference among the pretreatment cultures due to an uneven initial distribution of Streptococci infections among the treatments. In Table VI the treatments are different among the post treatment cultures, once more the greatest differences are between the control and dry cow treatment groups.

This analysis did not take into consideration the suspected effects of age and breed and it assumes that the probability of infection in each quarter of a cow is independent of infection status of other quarters.

To avoid the necessity of making these assumptions, the change in infection status from the pretreatment to the post treatment sampling period was used to ascertain new infections and situations where infection was cleared. Individual cows that cleared an existing infection but became reinfected cannot be distinguished from continuous infections. These results are presented in Table VII for S. aureus and Table VIII for S. aureus and Streptococci. The differences in new infections between those groups receiving a commercial dry cow treatment and the remaining groups were pronounced.

TABLE V. CHI-SQUARE ANALYSIS OF PRETREATMENT INCIDENCE
OF INFECTION BY S. AUREUS AND STREPTOCOCCI

Results of Pretreatment Culture	Treatment				
	1	2	3	4	
Negative	39	56	66	49	Observed
	40.5	57.0	58.5	54.0	Expected
	0.1	0.0	1.0	0.5	Cell Chi-square
Positive	15	20	12	23	Observed
	13.5	19.0	19.5	18.0	Expected
	0.2	0.1	2.9	1.4	Cell Chi-square
Total Chi-square	5.990				
Probability of a Greater Chi-square	0.1121				

TABLE VI. CHI-SQUARE ANALYSIS OF POST TREATMENT INCIDENCE
OF INFECTION BY S. AUREUS AND STREPTOCOCCI

Results of Post Treatment Culture	Treatment				
	1	2	3	4	
Negative	35	58	73	61	Observed
	43.8	61.6	63.2	58.4	Expected
	1.8	0.2	1.5	0.1	Cell Chi-square
Positive	19	18	5	11	Observed
	10.2	14.4	14.8	13.6	Expected
	7.5	0.9	6.5	0.5	Cell Chi-square
Total Chi-square	19.010				
Probability of a Greater Chi-square	0.0003				

TABLE VII. TOTAL INFECTION SCORES OF S. AUREUS

Treatment Group	No. Cows	No. Qtrs.	Frequency of Infection Status							
			None		Cleared		New		Both	
			No.	%	No.	%	No.	%	No.	%
1	14	54	33	61.11	6	11.11	9	16.67	6	11.11
2	19	76	49	64.47	11	14.47	8	10.53	8	10.53
3	20	78	65	83.33	9	11.54	1	1.28	3	3.85
4	18	72	46	63.89	15	20.83	5	6.94	6	8.33

TABLE VIII. TOTAL INFECTION SCORES OF S. AUREUS AND STREPTOCOCCI

Treatment Group	No. Cows	No. Qtrs.	Frequency of Infection Status							
			None		Cleared		New		Both	
			No.	%	No.	%	No.	%	No.	%
1	14	54	28	51.85	7	12.96	11	20.37	8	14.82
2	19	76	47	61.84	11	14.47	9	11.84	9	11.84
3	20	78	64	82.05	9	11.54	2	2.56	3	3.85
4	18	72	44	61.11	17	23.61	5	6.94	6	8.33

Tables IX and X present a chi-square analysis for infection status by treatment groups. These tables reinforce the previous tables and demonstrate that the subcells where the dry cow treatment appeared had the large cell chi-squares.

In order to include breed and parity effects in the model used to determine the differences that exist among the effectiveness of the various treatments, the analysis suggested by Koch et al. (14) was employed. This analysis used linear models techniques to remove the effects of the various classes of effects that one includes in the model. This permits the researcher to build models for categorical data similar to techniques used for data with continuous distributions. The analyses presented in this thesis are based on the following three models:

Model I

$$\text{Infection Response} = \text{Breed Effect} + \text{Parity Effect} + \text{Treatment Effect} + \text{Residual Effect.}$$

Model II

$$\text{Infection Response} = \text{Breed Effect} + \text{Parity Effect} + \text{Active Treatment Effect} + \text{Residual.}$$

Model III

$$\text{Infection Response} = \text{Breed Effect} + \text{Parity Effect} + \text{Sealant} + \text{Dry Treatment} + \text{Residual.}$$

In the above models, the infection response was either the total number of infected quarters per cow or the difference in number of infected quarters per cow between the post treatment and pretreatment cultures. The first model contrasted all treatments, the second model

TABLE IX. CHI-SQUARE TABLE OF INFECTION BY TREATMENT FOR S. AUREUS

Infection	Treatment				
	1	2	3	4	
None	33	49	65	46	Observed
	37.5	50.9	59.0	45.6	Expected
	0.5	0.1	0.6	0.0	Cell Chi-square
Cleared	6	11	9	15	Observed
	7.7	12.2	7.7	13.5	Expected
	0.4	0.1	0.2	0.2	Cell Chi-square
New	0	8	1	5	Observed
	4.5	6.1	7.0	5.4	Expected
	4.6	0.6	5.2	0.0	Cell Chi-square
Both	6	8	3	6	Observed
	4.3	6.8	4.3	7.5	Expected
	0.7	0.2	0.4	0.3	Cell Chi-square
Total Chi-square	18.925				
Probability of a Greater Chi-square	0.0258				

TABLE X. CHI-SQUARE TABLE OF INFECTION BY TREATMENT
FOR S. AUREUS AND STREPTOCOCCI

Infection	Treatment				
	1	2	3	4	
None	28	47	64	44	Observed
	34.0	48.8	57.5	42.7	Expected
	1.1	0.1	0.7	0.0	Cell Chi-square
Cleared	7	11	9	17	Observed
	9.2	12.6	7.5	14.5	Expected
	0.6	0.2	0.3	0.4	Cell Chi-square
New	11	9	2	5	Observed
	5.0	7.2	8.5	6.3	Expected
	1.1	0.4	5.0	0.3	Cell Chi-square
Both	8	9	3	6	Observed
	5.6	7.4	4.5	8.5	Expected
	1.1	0.3	0.5	0.8	Cell Chi-square
Total Chi-square	25.254				
Probability of a Greater Chi-square	0.0024				

compared all active treatments with the control group (Treatment 1) and the third model divided the four treatments into a contrast involving sealants and another involving the commercial dry treatment.

Tables XI and XII represent the different response levels among the cows by treatments. These tables present the number of quarters affected per cow and the number of cows in each category. The first part of the table is for pretreatment cultures, the second part is for post treatment cultures and the third part is for change in number of infected quarters per cow. In both tables the control group has more cows with new infections as evidenced by the increased frequency of cows with a positive value. Table XI represents data pertaining only to S. aureus, Table XII includes data pertaining to S. aureus and Streptococci.

The analysis of the pretreatment infection status is presented in Table XIII. Parity effects were present in all models. Residual effects were also significant and suggest that the model was not complete. The addition of interaction terms to the model did improve the degree of "fit," however, this lack of "fit" was only a problem in the pretreatment data so interactions were not included in the other analyses.

Table XIV presents the analysis of the post treatment infection status. The results at this time indicate little difference due to breed and age. The difference between active treatments as compared to the control group and the dry treatment versus no dry treatment do approach significance in these tables and suggest that there was a difference between the treatments. Breed may be confounded with

TABLE XI. NO. COWS AND NO. QUARTERS PER COW INFECTED
WITH S. AUREUS BY TREATMENT GROUPS

Treatment Group	Pre Treatment					Totals
	No. of Infected Qtrs. per Cow					
	0	1	2	3	4	
	(No. of Cows)					
1	7	3	3	1	0	14
2	9	3	5	2	0	19
3	13	3	3	1	0	20
4	<u>7</u>	<u>3</u>	<u>6</u>	<u>2</u>	<u>0</u>	<u>18</u>
Totals	36	12	17	6	0	71

Treatment Group	Post Treatment					Totals
	No. of Infected Qtrs. per Cow					
	0	1	2	3	4	
	(No. of Cows)					
1	4	6	3	1	0	14
2	12	2	2	2	1	19
3	17	2	1	0	0	20
4	<u>11</u>	<u>5</u>	<u>0</u>	<u>2</u>	<u>0</u>	<u>18</u>
Totals	44	15	6	5	1	71

Treatment Group	Change in Number of Infected Qtrs. per Cow							Totals
	No. of Infected Qtrs. per Cow							
	-3	-2	-1	0	1	2	3	
	(No. of Cows)							
1	1	0	3	4	3	3	0	14
2	1	2	2	10	3	0	1	19
3	1	1	3	15	0	0	0	20
4	<u>1</u>	<u>4</u>	<u>4</u>	<u>6</u>	<u>2</u>	<u>0</u>	<u>1</u>	<u>18</u>
Totals	4	7	12	35	8	3	2	71

TABLE XII. NO. COWS AND NO. QUARTERS PER COW INFECTED
BY TREATMENT GROUP

Treatment Group	Pre Treatment					Totals
	No. of Infected Qtrs. per Cow					
	0	1	2	3	4	
	(No. of Cows)					
1	6	3	3	2	0	14
2	8	4	5	2	0	19
3	13	3	3	1	0	20
4	<u>6</u>	<u>3</u>	<u>7</u>	<u>2</u>	<u>0</u>	<u>18</u>
Totals	33	13	18	7	0	71

Treatment Group	Post Treatment					Totals
	No. of Infected Qtrs. per Cow					
	0	1	2	3	4	
	(No. of Cows)					
1	4	3	5	2	0	14
2	12	1	2	3	1	19
3	16	3	1	0	0	20
4	<u>11</u>	<u>5</u>	<u>0</u>	<u>2</u>	<u>0</u>	<u>18</u>
Totals	43	12	3	7	1	71

Treatment Group	Change in Number of Infected Qtrs. per Cow							Totals
	No. of Infected Qtrs. per Cow							
	-3	-2	-1	0	1	2	3	
	(No. of Cows)							
1	1	2	0	4	3	4	0	14
2	1	2	2	10	2	1	1	19
3	1	1	3	14	1	0	0	20
4	<u>1</u>	<u>5</u>	<u>4</u>	<u>5</u>	<u>2</u>	<u>0</u>	<u>1</u>	<u>18</u>
Totals	4	10	9	33	8	5	2	71

TABLE XIII. ANALYSIS OF VARIANCE OF PRETREATMENT NUMBER OF
QTRS. INFECTED PER COW OF S. AUREUS

Model: Pretreatment = Breed + Parity + Treatment + Residual.

<u>Source</u>	<u>DF</u>	<u>Chi-Square</u>	<u>Probability</u>
Intercept	1	59.40	0.0001
Breed	1	0.48	0.4883
Parity	1	33.69	0.0001
Treatment	3	1.94	0.5858
Residual	10	28.52	0.0015

Model: Pretreatment = Breed + Parity + Active Treatment + Residual.

<u>Source</u>	<u>DF</u>	<u>Chi-Square</u>	<u>Probability</u>
Intercept	1	83.31	0.0001
Breed	1	0.61	0.4341
Parity	1	33.97	0.0001
Active Treatments	1	0.35	0.5533
Residual	4	30.75	0.0001

Model: Pretreatment = Breed + Parity + Seal + Dry + Residual.

<u>Source</u>	<u>DF</u>	<u>Chi-Square</u>	<u>Probability</u>
Intercept	1	63.16	0.0001
Breed	1	0.60	0.4396
Parity	1	33.18	0.0001
Seal	1	0.47	0.4934
Dry	1	0.00	0.9994
Residual	11	29.96	0.0016

TABLE XIV. ANALYSIS OF VARIANCE OF POST TREATMENT NUMBER
OF QTRS. INFECTED PER COW OF S. AUREUS

Model: Post Treatment = Breed + Parity + Treatment + Residual.

<u>Source</u>	<u>DF</u>	<u>Chi-Square</u>	<u>Probability</u>
Intercept	1	40.93	0.0001
Breed	0	0.00	1.0000
Parity	1	0.18	0.6708
Treatment	3	3.51	0.3198
Residual	11	-3.91	1.0000

Model: Post Treatment = Breed + Parity + Active Treatment + Residual.

<u>Source</u>	<u>DF</u>	<u>Chi-Square</u>	<u>Probability</u>
Intercept	1	14.77	0.0001
Breed	1	0.01	0.0103
Parity	1	0.08	0.7746
Active Treatments	1	3.56	0.0591
Residual	4	-2.17	1.0000

Model: Post Treatment = Breed + Parity + Seal + Dry + Residual.

<u>Source</u>	<u>DF</u>	<u>Chi-Square</u>	<u>Probability</u>
Intercept	1	40.73	0.0001
Breed	0	0.00	1.0000
Parity	1	0.53	0.4655
Seal	1	0.12	0.7275
Dry	1	3.04	0.0814
Residual	12	-3.44	1.0000

treatment in two of the models in that 0 degrees of freedom were allocated to breed.

Table XV presents the change in infected quarters of post minus pretreatment infection status. In Model I the difference among treatments approaches significance ($.05 < p < .10$). Model II suggests that active treatments were different from the control. The third model indicates that the differences were due to the use of the dry treatment.

Tables XIII, XIV and XV considered infections by S. aureus while Tables XVI, XVII and XVIII included infections by both S. aureus and Streptococci. The results presented in these tables are similar to that in the preceding tables.

The data indicates that the use of dry cow treatment is an effective means of mastitis control. These results are in agreement with most researchers as to the use of dry cow therapy in controlling S. aureus and Streptococci infections. Since few of the infections displayed any clinical symptoms of mastitis, according to farm records, this indicates the advisability of treating all cows at drying off. The data reveals fewer new infections and a higher elimination rate when the cows are dry treated. It should be noted that any treatment performed better than the control, however, in comparison involving both sealants and dry therapy, there was no advantage in using both.

In order for a control program to be useful to the dairyman it must not only be effective but it must be relatively simple and easy to apply or he will not follow the program. Many dairymen place

TABLE XV. ANALYSIS OF VARIANCE OF CHANGE IN NUMBER OF
QTRS. INFECTED PER COW OF S. AUREUS

Model: Change = Breed + Parity + Treatment + Residual.

<u>Source</u>	<u>DF</u>	<u>Chi-Square</u>	<u>Probability</u>
Intercept	1	5.11	0.0237
Breed	1	0.75	0.3878
Parity	1	0.59	0.4407
Treatment	3	7.48	0.0580
Residual	4	5.01	0.8372

Model: Change = Breed + Parity + Active Treatment + Residual.

<u>Source</u>	<u>DF</u>	<u>Chi-Square</u>	<u>Probability</u>
Intercept	1	0.17	0.6783
Breed	1	0.01	0.9268
Parity	1	0.74	0.3902
Active Treatments	1	5.33	0.0209
Residual	4	5.01	0.2864

Model: Change = Breed + Parity + Seal + Dry + Residual.

<u>Source</u>	<u>DF</u>	<u>Chi-Square</u>	<u>Probability</u>
Intercept	1	4.74	0.0294
Breed	1	0.27	0.6061
Parity	1	0.49	0.4841
Seal	1	2.09	0.1481
Dry	1	5.13	0.0235
Residual	11	6.86	0.8104

TABLE XVI. ANALYSIS OF VARIANCE OF PRETREATMENT NUMBER OF QTRS. INFECTED PER COW OF S. AUREUS AND STREPTOCOCCI

Model: Pretreatment = Breed + Parity + Treatment + Residual.

<u>Source</u>	<u>DF</u>	<u>Chi-Square</u>	<u>Probability</u>
Intercept	1	49.91	0.0001
Breed	1	1.89	0.1690
Parity	1	10.67	0.0011
Treatment	3	7.36	0.0613
Residual	10	18.95	0.0409

Model: Pretreatment = Breed + Parity + Active Treatment + Residual.

<u>Source</u>	<u>DF</u>	<u>Chi-Square</u>	<u>Probability</u>
Intercept	1	97.05	0.0001
Breed	1	7.09	0.0078
Parity	1	11.30	0.0008
Active Treatments	1	5.58	0.0181
Residual	4	15.50	0.0038

Model: Pretreatment = Breed + Parity + Seal + Dry + Residual.

<u>Source</u>	<u>DF</u>	<u>Chi-Square</u>	<u>Probability</u>
Intercept	1	59.92	0.0001
Breed	1	0.82	0.3660
Parity	1	12.59	0.0004
Seal	1	0.04	0.8455
Dry	1	1.68	0.1954
Residual	11	24.63	0.0103

TABLE XVII. ANALYSIS OF VARIANCE OF POST TREATMENT NUMBER OF QTRS.
INFECTED PER COW OF S. AUREUS AND STREPTOCOCCI

Model: Post Treatment = Breed + Parity + Treatment + Residual.

<u>Source</u>	<u>DF</u>	<u>Chi-Square</u>	<u>Probability</u>
Intercept	1	34.99	0.0001
Breed	1	1.91	0.1668
Parity	1	0.01	0.9347
Treatment	3	2.64	0.4508
Residual	10	-3.55	1.0000

Model: Post Treatment = Breed + Parity + Active Treatment + Residual.

<u>Source</u>	<u>DF</u>	<u>Chi-Square</u>	<u>Probability</u>
Intercept	1	58.82	0.0001
Breed	1	0.02	0.8865
Parity	1	0.21	0.6444
Active Treatments	1	7.63	0.0057
Residual	4	0.85	0.9313

Model: Post Treatment = Breed + Parity + Seal + Dry + Residual.

<u>Source</u>	<u>DF</u>	<u>Chi-Square</u>	<u>Probability</u>
Intercept	1	38.82	0.0001
Breed	1	2.15	0.1425
Parity	1	0.01	0.9132
Seal	1	0.30	0.5833
Dry	1	2.54	0.1113
Residual	11	-3.55	1.0000

TABLE XVIII. ANALYSIS OF VARIANCE OF CHANGE IN NUMBERS OF QTRS. INFECTED PER COW OF S. AUREUS AND STREPTOCOCCI

Model: Change = Breed + Parity + Treatment + Residual.

<u>Source</u>	<u>DF</u>	<u>Chi-Square</u>	<u>Probability</u>
Intercept	1	1.81	0.1782
Breed	1	0.01	0.9413
Parity	1	0.36	0.5497
Treatment	3	7.32	0.0624
Residual	10	6.35	0.7852

Model: Change = Breed + Parity + Active Treatment + Residual.

<u>Source</u>	<u>DF</u>	<u>Chi-Square</u>	<u>Probability</u>
Intercept	1	0.09	0.7697
Breed	1	0.42	0.5149
Parity	1	0.90	0.3425
Active Treatment	1	5.86	0.0155
Residual	4	3.70	0.4487

Model: Change = Breed + Parity + Seal + Dry + Residual.

<u>Source</u>	<u>DF</u>	<u>Chi-Square</u>	<u>Probability</u>
Intercept	1	1.80	0.1795
Breed	1	0.02	0.8892
Parity	1	0.26	0.6131
Seal	1	3.00	0.0835
Dry	1	5.06	0.0245
Residual	11	6.94	0.8040

their cows in lots or pastures away from the main barns for the duration of the dry period. The sealant used in this study was not designed to last throughout the dry period, requiring resealing at least every two weeks. This length of time was derived by checking the cows constantly at the start of the study to determine how long the seal remained; therefore, this type of sealant would not be practical.

In regards to the use of a teat sealant, these results should be considered cautiously. The sealant used was not designed for the dry period and was not a germicide, thus it had to be continuously replaced. A sealant specifically designed for the dry period could be developed, and this experiment should be repeated if this occurs.

CHAPTER V

SUMMARY

The primary objectives of this study were to resubstantiate the importance and effectiveness of dry cow therapy and to compare dry treatment and teat sealing as mechanisms for reducing the incidence of new mastitis infections and for eliminating existing infections during the dry period.

Data used in this study were obtained from quarter samples from 71 cows at The University of Tennessee, Knoxville dairy herd. This data included bacterial analysis of each sample taken at two different test periods, one prior to drying off and the second within 10 days after freshening.

The cows were assigned to four treatment groups. Group 1 received no treatment and served as the control group. Group 2 cows received the teat sealant. Group 3 cows were infused with a commercial dry cow treatment and in the fourth group, cows were dipped in the teat sealant in addition to the dry cow therapy. Since the teat sealant was not designed for the dry period, cows were resealed every two weeks. (It was also not a germicide so an iodine teat dip was used under the sealant.)

The change in infection status between the two sampling periods was the primary response measurement.

The use of dry cow treatment was found to be very effective in eliminating existing infections of Staphylococcus aureus and Streptococci and preventing the incidence of new infections. The

results of this study reinforce the use of dry cow therapy as a form of mastitis control but do not provide a basis for the recommendation of the use of teat sealants. It should be realized that the sealant used in this study was not designed for use in the dry period and a more effective sealant could be developed in the future.



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VITA

Martha Joyce Cunningham was born in Blount County, Tennessee, on May 29, 1958. Upon graduation from Porter High School in 1976, she enrolled in The University of Tennessee, Knoxville Animal Science department and received a Bachelor of Science degree in Animal Science in December 1979.

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As an undergraduate she was a member of Phi Eta Sigma Freshman Honorary Society, a Little Sister for FarmHouse Fraternity, involved in the Dairy Club, and served as treasurer for the Block & Bridle Club, Roundup Queen, and received the B&B Outstanding Senior Award.

As a graduate student she continued activities in the Dairy Club and Block & Bridle Club and remained active in the fraternity sister organization. In addition, she gained membership into Gamma Sigma Delta Honorary Society.