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DAIRY DAY 2003

Report of Progress 919

FOREWORD

Members of the Dairy Commodity Group of the Department of Animal Sciences and Industry are pleased to present this Report of Progress, 2003. Dairying continues to be a viable business and contributes significantly to the agricultural economy of Kansas. In 2002, dairy farms accounted for 2.9% or $232 million of all Kansas farm receipts, ranking 7th overall among all Kansas farm commodities. Annual milk production per cow increased 12.7% from 2001 to 2002, moving Kansas from #22 ranking in 2001 to #8 in ranking in 2002 among the 50 states. Wide variation exists in productivity per cow, as indicated by the production-testing program (Heart of America Dairy Herd Improvement Association [DHIA]). More than 116,000 cows were enrolled in the DHI program from Kansas, Nebraska, Oklahoma, Arkansas, North Dakota, and South Dakota beginning January 1, 2003. A comparison of Kansas DHIA cows with all those in the Heart of America DHIA program for the year 2002 is illustrated in the table below.

Comparison of Heart of America Cows with Kansas Cows - 2002

Item	HOA	KS
No. of herds	906	308
No. of cows/herd	129	137
Milk, lb	20,086	20,930
Fat, lb	743	754
Protein, lb	623	633
IOFC*, $	1,424	1,376
Milk price, $	12.16	11.97

*IOFC = income over feed costs

Most of this success occurs because of better management of what is measured in monthly DHI records. Continued emphasis should be placed on furthering the DHI program and encouraging use of its records in making management decisions. In addition, use of superior, proven sires in artificial insemination (AI) programs shows average predicted transmitting ability (PTA) for milk of all 325 Holstein AI bulls in service (August, 2003) to be +1,566 lb (range of +283 to +3,061 lb). Emphasis on use of superior genetics through more use of AI sires is warranted.

The excellent functioning of the Dairy Teaching and Research Center (DTRC) is due to the special dedication of our staff. It has served us well since 1977. Our milk production with 205 cows has improved considerably according to our last test day in September (83 lb). Our rolling herd average for milk was 27,902 lb, with 1,037 lb of fat, and 872 lb of protein.

We acknowledge the dedication of our current DTRC staff: Michael V. Scheffel (manager), Donald L. Thiemann, Daniel J. Umsheid, William P. Jackson, Charlotte Boger, Glen Farrell, and Katie Strisler. Special thanks to Irene Vanderwerff, Cheryl K. Armendariz and a host of graduate and undergraduate students for their technical assistance in our laboratories and at the DTRC.

Each dollar spent for research yields a 30 to 50% return in practical application. Research is not only tedious and painstakingly slow but expensive. Those interested in supporting dairy research are encouraged to consider participation in the Livestock and Meat Industry Foundation (LMIF), a philanthropic organization dedicated to furthering academic and research pursuits by the Department of Animal Sciences and Industry (more details about the LMIF are found at the end of this publication).

J.S. Stevenson, Editor
2003 Dairy Day Report of Progress

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FRESH COW HEALTH ISSUES

Jerry D. Olson*[1]*, DVM, MS, DACT

Summary

The post-calving period is a critical time in a cow's life. The first few weeks post-calving pose the highest risk period for a number of diseases including milk fever, mastitis, metritis, pneumonia, retained fetal membranes, ketosis, and displaced abomasum. Post-calving diseases adversely affect dry matter intake, peak milk production, and reproductive performance, in addition to increasing the risk of involuntary culling and death. Consequences of disease can be costly. The ideal strategy is to minimize losses associated with disease by preventing their occurrence. However, even with the best management practices in place, it is impossible to prevent all post-calving diseases. For cows that develop post-calving diseases, the challenge is to minimize losses by developing a strategy to identify them as early as possible, implementing effective treatment protocols, evaluating effectiveness of those protocols, and tracking incidence so preventive practices can be re-evaluated when the incidence exceeds a threshold level for an individual disease. A "fresh cow program" is an effective approach to systematically managing post-calving disease by close daily observation of cows during the first 10 to 14 days after calving. By conducting a brief, but systematic physical examination, including monitoring body temperature, disease can be identified as soon as possible and treatment protocols implemented. This approach minimizes losses associated with post-calving disease.

(Key Words: Fresh Cows, Health, Disease)

Fresh Cow Monitoring Program

The first requirement for a successful fresh cow program is facilities that allow quick and easy examination of individual cows. Such facilities are dedicated to cows that have recently freshened and have sufficient space for the number of cows that freshen during a 3-week period. Stocking rate for this pen should never exceed 90% of the number of feeding spaces, especially if fresh heifers and cows are commingled. Fresh cows are the most sensitive to consequences of over-crowding, and one of the most common consequences of over-stocking is an increase in the incidence of displaced abomasums. Self-locking stanchions are critical to facilitate quick and easy access to the cows for examination. In addition to improving labor efficiency, it is important to minimize the amount of time cows are confined to the lock-ins for examination.

Systematic Examination of Fresh Cows

Veterinarians are a great resource in designing monitoring programs and assisting in training personnel to implement these programs. A key component is daily monitoring

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of fresh cows for fevers. The most common disease of fresh cows is metritis. Fresh cows, especially those that have retained fetal membranes, are at high risk for developing metritis. If cows with metritis are not identified early and treated effectively, metritis can cause cows to go "off-feed" and potentially develop secondary problems such as ketosis and displaced abomasums (DA's).

Electronic thermometers are extremely helpful in improving efficiency. They allow for quick and accurate monitoring of body temperatures, especially when large numbers of fresh cows must be examined. The temperature of a fresh cow can be accurately obtained within 15 to 20 seconds with an electronic thermometer.

The 20 seconds spent "temping" a cow can be put to productive use by observing it for signs of post-calving diseases. Coordinate the exam by first having someone walk in front of the cows to identify those that aren't eating and "flag" them so the person taking temperatures knows that these cows need to be examined more closely.

The person taking the temperature should have a mental check-list for an examination. Observe the cow for carriage of the ears. Failure to carry the ears erect is an indication that the cow is not feeling well and likely has some disease process. Observe the rate and character of respiration. An increase in respiratory rate can be an indication of heat stress, fever, or pneumonia. When a cow has an increased respiratory rate, she should be examined further to determine its likely cause. Each cow should be observed for the presence of vaginal discharge. If there is discharge, it should be noted for character and odor. Foul smelling vaginal discharge is an indication of metritis. The udder should be observed for swelling and asymmetry. Asymmetrical swelling is an indication of mastitis, and cows should be examined closely to determine if clinical mastitis is present. The cow should be observed for rumen fill. Lack of rumen fill indicates the cow is "off-feed," and space between the last rib and rumen may indicate a DA. Cows that are off-feed, but have normal temperatures, should have their urine checked for ketones.

If a cow has a fever, the cause of the fever should be determined. The primary causes of fevers in fresh cows are metritis, mastitis, and pneumonia. All observations must be evaluated and used to derive a diagnosis. Once a diagnosis has been made, the next step is to assign a treatment protocol.

Treatment Protocols

Treatment protocols need to be developed in consultation with your veterinarian. Your veterinarian understands treatment alternatives, guidelines set forth in the Animal Medical Drug Use Clarification Act (AMDUCA), and the needs of your dairy. Treatment protocols should use products with label indications for a specific disease before products are used in an extra-label manner. Treatment protocols that outline a consistent course of therapy for a specific disease are important for several reasons: It is difficult to evaluate treatment protocols that are inconsistent from cow to cow. If two or more people are involved in the treatment of fresh cows, and if there aren't specific treatment protocols for a disease, it will be impossible for cows to receive a consistent course of therapy. Once a cow is enrolled in treatment, it is important that she complete that therapy, even if someone has a day off and another person is responsible for continuing treatment. This means that some form of record is available to indicate her treatment protocol and the number of days she has been treated.

Metritis, the most common disease of post-calving cows, is a bacterial infection of the uterus. Excenel® is an antibiotic that has a label indication for the treatment of metritis and has been demonstrated to be effective in field trials. Excenel® has a zero-hour milk withholding, so the cow does not need to be moved a hospital string to prevent antibiotic residue in the bulk milk. Intrauterine therapy of cows with metritis once was a common treatment. However, its use has declined in the dairy industry because of uterine abscesses and peritonitis frequently observed following improper treatment technique.

Record Systems

Record systems are variable, but they should fulfill the needs of the dairy. Some of the goals of a record system include identifying cows that are being treated, means of tracking the course of therapy, a system for evaluating the response to a treatment regimen, means of assuring appropriate withholding times for milk and slaughter (when cows have been treated with drugs requiring milk and slaughter withholding times), and means of determining the incidence of fresh-cow disease. The record systems for tracking individual cow treatments can consist of colored chalk marks on the back of the cow indicating the treatment status, paper records on a clipboard, electronic records on a Personal Digital Assistants (PDA)/Palm Pilots and/or electronic dairy management programs on computers in the fresh cow pen.

In addition to tracking the treatment of individual cows, record data should be summarized each month to assess the incidence of fresh-cow disease. The minimum for monitoring post-calving diseases should be a "quick and dirty" estimation of the incidence of a disease. This can be done by dividing the number of cases of post-calving disease by the number of cows that freshened in the past month. These numbers become the basis for establishing a benchmark for the incidence of post-calving disease in the dairy. This information can be used to inform your veterinarian and nutritionist on the status of the fresh cow program. The number of cows that either die or are culled in the first 60 days of lactation should be tracked. It is currently estimated that 25% of the cows that leave the herds do so in the first 60 days of lactation. This number tells us there is an opportunity to improve transition cow management and fresh cows programs as an industry.

Table 1. Post-Calving Health Disorders on Dry Matter Intake (DMI) and Milk Production

	Health Problem			
	None	One*	RP/MET**	DA/KET***
No. of cows	22	24	10	13
DMI, lb/day	39.2	30.6	30.6	27.3
Milk, lb/day	57.9	55.7	55.0	73.7
305-ME milk, lb	20,780	19,738	19,622	18,901
Wt. loss, lbs	74.8	103.4	85.8	118.8

*Experienced at least one adverse health event.
**Retained fetal membranes and metritis.
***Displaced abomasums and ketosis.
Adapted from presentations by Dr. Dick Wallace, University of Illinois.

LEPTOSPIROSIS: A NEW PERSPECTIVE ON AN OLD DISEASE

Jerry D. Olson, DVM, MS, DACT

Summary

Disease causing Leptospira can be placed in one of two broad categories for common domesticated mammals: They are either host-adapted or incidental strains. The four incidental serovars of *Leptospira* that are pathogenic to cattle are: *L. pomona*, *L. grippotyphosa*, *L. canicola* and *L. icterhemmorhagiae*. They are transmitted to cattle from other carrier animals that act as hosts for these strains. The strains are found in chronically infected rats, dogs, deer, or even pigs and are transmitted to cattle though urine-contaminated water. When the incidental strains of *Leptospira* are introduced into an unvaccinated, susceptible herd of cattle, they commonly cause an outbreak of abortions in the mid- to late-term pregnant cows. Commercial five-way Leptospiral vaccines are effective in preventing the abortion storms associated with the incidental strains of *Leptospira*, but ineffective to the most common serovar found in cattle (hardjo-bovis). Pfizer Animal Health recently received USDA approval to market the first effective *L. hardjo* vaccine, known as Spirovac®, in the United States.

(Key Words: Lepto hardjo, Health)

Background

The host-adapted strain for cattle in the United States is *Leptospira borgpetersenii* serovar hardjo (Type: hardjo-bovis), commonly referred to as *L. hardjo*. The primary source of *L. hardjo-bovis* for uninfected cattle is the urine of chronically infected cattle. Once cattle are infected, they may shed the organism in the urine for weeks or years. The primary manifestation of hardjo-bovis in cattle is a mild disease characterized primarily by low conception rates, but may cause embryonic deaths, abortions, and stillbirths.

The first report indicating that the current five-way leptospiral vaccines were ineffective in providing protection against infections from *L. hardjo* was published by Bolin in 1989. Bolin had three groups of experimental animals: 1) an unvaccinated control group, 2) a group of cows that was vaccinated once, and 3) a group of cows that was vaccinated twice. All three experimental groups of cattle were bred after control or treatment vaccinations, and at midgestation they were experimentally challenged with a virulent strain of *L. hardjo*. All control cows and 13 of 16 vaccinated cows became infected and shed *L. hardjo* in the urine. The percentage of urine specimens that contained *Leptospira* organisms was reduced in the experimental groups of vaccinated cattle compared to controls (79% vs. 11%, respectively). The calves from these cows were sacrificed after birth and *Leptospira* organisms were identified in the kidneys of 17 of 19 of the calves from control and vaccinated cows. The authors concluded the

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current five-way vaccines failed to prevent renal-shedding of *L. hardjo* in the urine of the cows and failed to prevent fetal infection with the organism in the fetal kidneys.

In a later study Bolin demonstrated that vaccination with *L. hardjo* vaccine altered the serological response to the disease so the titers of *L. hardjo*-challenged cattle that were vaccinated were no different than that of non-challenged vaccinated cattle. Nonvaccinated cattle that were challenged with *L. hardjo* developed titers that were diagnostic of *L. hardjo* infections. The conclusion was that the vaccine not only provided little to no protection to cattle for the prevention of renal infection of dams or fetal infection, but it made serological diagnosis of *L. hardjo*, the traditional method for diagnosing the disease, impossible. The only positive factor about the existing vaccines with respect to *L. hardjo* is that they may reduce the duration of renal shedding in cows. It was not until state-supported diagnostic laboratories began to offer fluorescent antibody and PCR tests for identification of the organism in cattle urine in the late 1990s that disease diagnosis became practical.

Recent Findings

A recent survey was conducted to determine the incidence of *L. hardjo* infections in U.S. dairy herds. Eleven herds were selected in each of four regions of the country: Southeast, Midwest, Northwest, and West. Of the 44 herds in the survey, 57% were infected with *L. hardjo*, the most common form of *Leptospira* in dairy cattle. Within herds that were positive of *L. hardjo*, it is estimated that 30% of the cows were infected.

Low conception rates in dairy herds can be caused by numerous factors. When a dairy herd experiences low conception rates, *L. hardjo* should be considered in the differential diagnosis. Urine samples should be collected and sent to a diagnostic laboratory familiar with performing either the fluorescent antibody or PCR tests that allow identification of the organism in urine. Another characteristic observed in herds with endemic *L. hardjo* is a lower pregnancy rate in first-lactation cows in the majority of estrous cycles after the end of the voluntary waiting period when compared to second or greater lactating cows. Normally first lactation cows are more fertile and have greater pregnancy rates than older cows.

Pfizer Animal Health recently received USDA approval to market in the United States the first effective *L. hardjo* vaccine, known as Spirovac®. The vaccine has been available to dairy producers in other areas of the world for several years. Immunizing dairy animals consists of initial administration of two doses of vaccine 4 to 6 weeks apart, followed by annual vaccination. Some producers have chosen to vaccinate cows as they go through the dry period, whereas others have chosen to vaccinate the entire herd at one time. Initial reports from herds that have been diagnosed with *L. hardjo* and have been vaccinated look promising.

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DEVELOPING AND USING MONITORING PROGRAMS FOR FRESH COWS

***M.J. Brouk, J.F. Smith, and J.P. Harner*[1]**

Summary

Metabolic disorders and related health problems are a significant problem on dairy farms, resulting in increased culling and decreased profitability for producers. Early detection and treatment of disorders and disease is critical in minimizing losses and increasing probability of cow recovery. Fresh cow monitoring systems that evaluate several key factors – general appearance, body temperature, intake or appetite, rumen motility, milk production, and milk or urine concentrations of ketones – are necessary for early detection of disorders and disease. Most of these problems occur within the first 3 weeks of lactation, with most occurring during the first 10 days. Developing and implementing of fresh cow monitoring systems and early treatment should increase profitability of dairy enterprises by reducing the negative effects of metabolic disorders and forced early culling.

(Key Words: Health, Calving, Metabolic Disorders)

Introduction

Metabolic disorders during the first 3 weeks of lactation are major health and production issues for dairy producers. These disorders include dystocia, ketosis, displaced abomasums, and milk fever. In addition, retained placenta and uterine infections are also major problems during early lactation. Disorders and infections cost $150 to $300 per occurrence and can result in the death or early culling of affected cows. Early detection and aggressive treatment can reverse the effects and prevent a cascade of additional disorders.

Monitoring System Components

Early detection of metabolic disease is the goal of any monitoring system. Several key factors – general appearance, body temperature, intake or appetite, rumen motility, milk production, and milk or urine concentrations of ketones – are used in effective monitoring. The number of variables determines the system's complexity. Many systems include only general appearance, body temperature, and appetite. More complex systems also include milk production, rumen motility, and urine ketones. In general, the more information gathered and processed, the greater the possibility of detecting affected cows.

Cows developing metabolic disease often display a change in general appearance. Those appearing dull or lethargic obviously display signs of a disorder or disease. The critical question is how is this observed or detected on the farm. Effective monitoring includes at least daily observation of the fresh cow (less than 10 days in milk) for general appearance. This is usually done immediately after the morning milking. It is helpful if the same per-

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son does this each day or written observations from the previous day are available for the observer. It is also easier if all fresh cows are located in a single pen, facilitating more careful observation of each.

Body temperature during the first 10 days in lactation should be a critical part of an effective monitoring system. There is considerable cow-to-cow variation in normal body temperature. Environmental temperature also can affect body temperature. Thus, taking temperatures at the same time each day and having the previous day's information available will make this data easier to interpret. Body temperature is generally measured with a rectal thermometer. Electronic thermometers speed this process, but the value obtained is only as accurate as the operator. Most electronic thermometers require 15 to 20 seconds to equilibrate. Thus, the probe must be in the rectum at least that long. In addition, the rectum may contain air, which affects the temperature reading. Generally a rectal temperature below 100°F or above 103°F indicates there may be a problem. However, individual cows and environmental temperature, especially heat stress, can change the normal range of expected body temperatures. Monitoring body temperatures early in the morning and having previous data available improves interpretation.

Body temperature is generally monitored for the first 10 days after calving. Cows with a normal body temperature for at least the last 3 consecutive days and at least 10 days in milk are eligible to be removed from daily monitoring. Thus, if a cow displays a normal body temperature on days 8, 9, and 10 of lactation, she is eligible to be moved to another pen. Cows not displaying a normal body temperature on days 8, 9, and 10 of lactation should not be moved until they display at least 3 consecutive days of normal body temperature.

A system of chalk marks is often used to alert farm workers to the cow's temperature status. A green mark may signify normal body temperature and a red mark an abnormal temperature. Marks corresponding to the first 5 days in milk are recorded on the left thurl and those for days 6 through 10 are recorded on the right thurl. Cows requiring more than 10 days in the fresh pen may have additional marks placed on the loin.

Intake of fresh cows may be the most important factor in preventing metabolic disease. Cows that consume adequate amounts of a properly balanced diet are less likely to develop metabolic disorders. Fresh pens should offer at least 28 inches of bunk space per cow and pen dry matter intakes should be about 40 to 45 lb per cow per day. However, averages do not reveal the whole story. Appetites of individual cows in the fresh pen should be monitored daily. Cows should approach the bunk when feed is added and consume an adequate meal. Headlocks at the feed bunk can be a great asset in monitoring appetite of individual cows. If cows fail to come to the bunk and lock-up or they lock-up but do not consume adequate feed in a 30-minute period, potential problems may exist, and further examination may be necessary. Most monitoring programs include evaluation of appetite during the morning feeding.

Rumen motility is an indication of digestive tract function. Cows with metabolic disorders generally have decreased appetites and fewer than normal rumen contractions. If the rumen is contracting less than once per minute, a problem likely exists. Other factors may have already alerted the producer of a problem. However, severity of the problem is greater when rumen contractions have decreased below a critical level.

Some farms may have the ability to monitor daily milk production on individual cows. For cows in their second and greater lactation, one should expect a 10% increase in milk production per day during the first 14 days in milk. For cows in their first lactation, the expectation might be an 8% increase in milk production per day during the first 18 days. Other producers expect older cows to be producing at least 99 lb of milk by 20 days in milk (or 70 lb for 2-year-olds). Cows not meeting these criteria should be further evaluated. Using milk production information allows continual tracking of cows after they leave the fresh pen. Monitoring milk production allows early detection of problems that may develop in the transition from the fresh pen to a general lactation pen.

Milk or urine ketones can be monitored for early detection of ketosis or to confirm if a cow has ketosis. Most producers do not test each fresh cow for ketosis. Cows appearing sick or having an abnormal body temperature may be tested. During a severe outbreak, every fresh cow may be tested to ensure early treatment. Early effective treatment for ketosis is important for improving recovery.

Putting the Pieces Together

Developing a fresh cow monitoring program is important to the success of any dairy farm. Determine what factors to evaluate, what treatments should be used for each situation, and implement the plan. Your herd veterinarian should be included in developing monitoring strategies and treatment protocols.

Many farms effectively evaluate fresh cows each morning. Each morning, fresh cows are locked in headlocks at the feed bunk as they return from the milking parlor, where fresh feed is offered. Fifteen to 20 minutes after milking, farm personnel begin evaluating each cow. First, determine which cows did not lock-up. Cows that returned to the pen and went to a stall to lie down may be in the early stages of a metabolic disorder and should be moved to the feed line for further evaluation. Each cow is evaluated for body temperature, general appearance, and appetite. A daily record is noted for each cow. This evaluation procedure may take 1 to 2 minutes per cow. If observations indicate that further evaluation or treatment is needed, additional time may be required. Completing this evaluation will detect most of the metabolic problems associated with fresh cows and facilitate early application of effective treatments. Farms with the capability to monitor daily milk production also should evaluate this information along with daily visual observations of each fresh cow.

COW COMFORT THROUGH THE TRANSITION PERIOD

J.F. Smith, J.P. Harner[1], and M.J. Brouk

Summary

Managing transition cows is a significant problem on dairy farms. The issues include nutritional considerations, stocking rates, metabolic disorders, heat stress, and access to feed and water. Often management of transition cows is limited to nutritional considerations. Facilities, grouping strategies, stocking rates, heat stress, and access to feed and water also have a dramatic impact on milk production, herd health, culling rates, and reproductive efficiency. Often nutritional benefits can be negated by not managing cow comfort issues. Producers can improve profitability by managing those variables.

(Key Words: Housing, Transition Cows, Comfort)

Introduction

Often too little emphasis is put on housing and management of transition cows. For optimal cow health and milk production, a well-designed special needs facility for transition cows is essential, because transition from pregnancy to lactation represents the period of greatest challenge to the cow's health and productivity. Most of the metabolic and infectious diseases the cow will experience occur during the first weeks of lactation.

Onset of milk yield during early lactation outpaces the cow's ability to increase intake of nutrients, placing her in negative balance for vital nutrients such as energy, protein, and calcium. Cows failing this metabolic challenge can develop milk fever, ketosis, and displaced abomasum. Hormonal changes associated with calving suppress the immune system and increase susceptibility to infectious diseases such as mastitis and Salmonellosis. Negative energy balance and environmental stresses can have an additive effect on immune cells and further suppress resistance to infection. To reduce disease and improve productivity, strategies must be designed to maximize feed intake and reduce stress. Stress can take many forms, but generally results in increased cortisol secretion, which tends to reduce immune cell function.

Grouping Strategies and Building Requirements

The size and number of cow groups in a dairy are critical planning factors. Factors affecting the number and types of groups are largely associated with parlor size, maximizing cow comfort, feeding strategies, reproduction, and increasing labor efficiency. Lactating cows fit one of seven classifications: 1) healthy lactating 2-year-olds; 2) healthy multiple-lactation cows; 3) fresh cows with non-sellable milk (0 to 2 days postpartum); 4)

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fresh cows with sellable milk (3 to 16 days postpartum); 5) fresh 2-year-olds with sellable milk (3 to 16 days postpartum); 6) sick cows with non-sellable milk; and 7) high risk cows with sellable milk. The cows in classifications 3 to 7 are typically housed in the special needs area, along with close-up cows and heifers.

Table 1 provides recommended groups, group sizes, and typical housing requirements for cows, 2-year-olds, and calves. Group sizes are increased to account for fluctuations in the number of calvings of cows and heifers. If pens are only sized for average numbers, there will be a considerable time when the special needs facilities are overstocked.

Selection of Cow Housing

In a freestall dairy, cows and heifers in the special needs facilities are housed in either free stalls or loose housing. Advantages and disadvantages exist for each housing system. Loose housing maximizes cow comfort, but requires additional space, bedding material, and labor to maintain a sanitary environment. This is particularly true when organic bedding is used. Free stalls reduce labor costs of maintaining the resting area. Some cows may be intimidated by free stalls and may choose not to use them. Options that can be used for different groups of cows are listed in Table 1.

Stocking Density

Due to the nature of calving cycles, overstocking of close-up cows and fresh cows often occurs. The dilemma faced is whether one can afford to build facilities to handle the maximum number of cows that will be in the close-up and fresh pen. These two groups of cows should never be overcrowded. Field experience indicates that they should be stocked at less than 100% of available feedline space.

Access to Feed and Water

Keeping cows eating and drinking through the transition period is critical. Sufficient feed and water must be provided in all housing areas. Often feed and water are not provided in calving pens with the logic that cows will only be in the maternity pen long enough to calve, so providing water and feed is not necessary. This short period of time often varies from 4 to 12 hours. Many producers are moving to a group calving situation to make it easier to provide feed and water for these cows.

Managing Heat Stress

The first groups of cows that should be cooled on the dairy include close-up dry cows, maternity cows, fresh cows, and sick cows. Emphasis is often put on cooling healthy, lactating cows. However, if a smooth transition is not made from the dry period to lactation, cows are put at a huge disadvantage, both from the standpoint of milk production and reproduction. Providing fans does little to reduce heat stress. Feedline soakers also should be provided.

Table 1. Housing Requirements for Dairy Cattle

Group	Average time in facility	% of lactating herd	Housing systems
Close-up cows	21 days	6%	Free stalls or loose housing
Close-up heifers	21 days	3%	Free stalls or loose housing
Maternity cows	Calving	1%	Loose housing
Fresh cows	2 days	1%	Free stalls or loose housing non-sellable milk
Fresh mature cows	14 days	3.5%	Free stalls
Fresh 2-year olds	14 days	1.5%	Free stalls
Mastitis and sick cows	N/A	2%	Free stalls or loose housing non-sellable milk
High risk sellable milk	N/A	2-6%	Free stalls or loose housing
Cull and dry cows	N/A	1.5%	Loose housing
Calf housing	24 hours		Hutches or small pens

EFFECT OF SOAKING AND MISTING ON RESPIRATION RATE, BODY SURFACE TEMPERATURE, AND BODY TEMPERATURE OF HEAT STRESSED DAIRY CATTLE

M.J. Brouk, J.P Harner[1], J.F. Smith, A.K. Hammond, W.F. Miller, and A.F. Park

Summary

Reducing heat stress is a key issue for dairy producers. Use of feedline soaking and supplemental airflow effectively reduces heat stress and increases milk production and profitability. High-pressure misting allows water to evaporate in the air, reduces air temperature, and increases relative humidity. Misting also soaks the skin of cattle, resulting in additional cooling as water evaporates from skin surfaces, similar to the cooling effect of feedline soaking. Impact of soaking frequency (5-, 10-, or 15-minute intervals) was compared to continuous high-pressure misting. Cows cooled with either system had lower respiration rates, body surface temperatures, and internal body temperatures than controls**.** Soaking cattle every 5 minutes or 5-minute soaking plus high-pressure misting produced similar body temperatures, but lower (P<0.01) than those when soaking occurred every 10 or 15 minutes. Skin surface temperatures from the thurl, shoulder, and rear udder were less when cattle were cooled with high-pressure misting. Cattle cooled with high-pressure misting became soaked, thus the cooling effect is the combination of cooler air and water evaporation from the skin. These results indicate that either frequent soaking (every 5 minutes) or continuous high-pressure misting that soaks the skin could be equally effective in reducing heat stress in dairy cattle.

(Key Words: Cow Comfort, Cow Cooling, Environment)

Introduction

Heat stress significantly reduces milk production, reproductive efficiency, and profitability of dairy farms. Several Kansas State University studies have shown the benefits of utilizing feedline soaking and supplemental airflow (fans) at the feedline and over free stalls. These benefits include decreased respiration rates, decreased body temperatures, decreased skin surface temperatures, and increased milk production. Correct system designs can increase profitability for Kansas' dairy producers.

Effective cow cooling occurs when body heat is efficiently transferred from the skin to the environment. Cow soaking and supplemental airflow increase heat transfer from the cow to the environment through water evaporation from the skin and hair. Decreasing air temperature with evaporative cooling also can reduce heat stress. However, air is a poorer conductor of heat than water. High-pressure misting systems combine the benefits of

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evaporative air cooling and skin soaking. The objective of this study was to evaluate the effects of increased soaking frequency and high pressure misting on respiration rate, body surface temperature, and internal body temperature of heat-stressed dairy cattle.

Procedures

Ten lactating Holstein cows, five primiparous and five older cows, were arranged in a replicated 5×5 Latin square design. Treatments were control (C), a low-pressure soaking cycle every 5 (F + 5), 10 (F + 10), or 15 (F + 15) minutes, plus continuous high-pressure misting (F + HP). The soaking and misting treatments also received supplemental airflow (650-690 feet/minute). Cows were housed in free-stall barns and milked twice daily. During testing, cows were moved to a tie-stall barn for 2 hours starting at 1 p.m. during 5 days of intense heat stress. During the testing periods, respiration rates were determined every 5 minutes by visual observation. Body surface temperature of three sites (shoulder, thurl, and rear udder) were measured with an infrared thermometer and recorded at 5-minute intervals. Body temperature was recorded with a data logger and vaginal probe every 1 minute, and averaged over 5-minute intervals for statistical analyses. Cooling treatments were initiated following three 5-minute intervals.

Results and Discussion

Stall temperature and thermal-humidity index (THI) were lower ($P<0.01$) and relative humidity (RH) greater ($P<0.01$) when high-pressure misting was used (Figures 1, 2, and 3). The rise in THI observed at time period 4 on the F + HP treatment resulted from increased RH before the water from the misting system evaporated and lowered the air temperature. Respiration rates (Figure 4) were lower ($P<0.01$) for the cooled cows than those of controls. Average respiration rates during the final three observation periods differed ($P<0.01$) for all treatments (115.1, 90.0, 81.5, 66.7, and 60.0 breaths/minute for C, F + 15, F + 10, F + HP and F + 5, respectively). Shoulder skin surface temperatures followed similar patterns, except values for F + HP were lower ($P<0.01$) than F + 5. This is a reflection of the combination of skin soaking and reduced air temperature associated with the F + HP treatment. Surface skin temperatures of the rear udder and thurl followed similar patterns (Figures 6 and 7). Body temperature (Figure 8) was lower ($P<0.01$) for cooled cows than for controls. Cows cooled with the F + HP and F + 5 treatments did not differ ($P>0.05$) and were lower ($P<0.01$) than either F + 15 or F + 10, which differed ($P<0.01$) from each other.

High-pressure misting reduced stall temperature and THI while increasing RH, resulting in lower skin surface temperatures than soaking the cows every 5 minutes. Previous Kansas State University studies showed advantages for soaking cows more frequently (every 5 versus every 10 or 15 minutes). Results of this study indicate that continuous high-pressure misting might be more effective in reducing skin surface temperatures if the skin becomes soaked, rather than soaking every 5 minutes. However, continuous high-pressure misting offered no advantage for reducing body temperature. Thus, either frequent soaking (every 5 minutes) or continuous high-pressure misting that soaks the skin could be equally effective in reducing heat stress in dairy cattle.

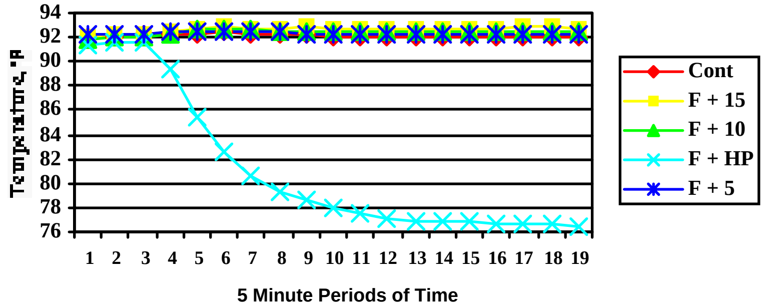

Figure 1. Stall Temperature During Cooling Treatments.

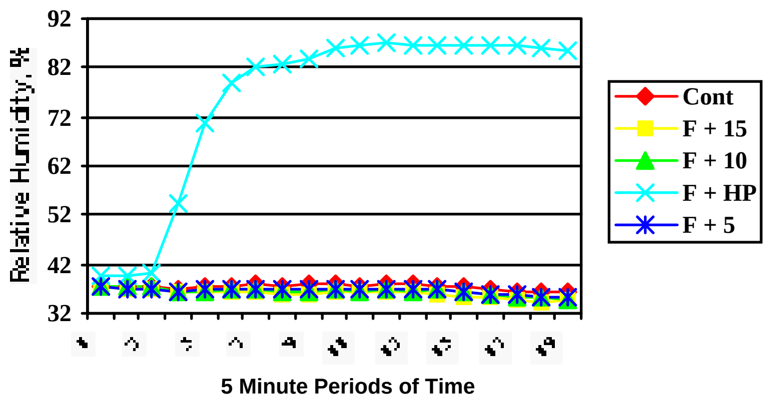

Figure 2. Stall Relative Humidity During Cooling Treatments.

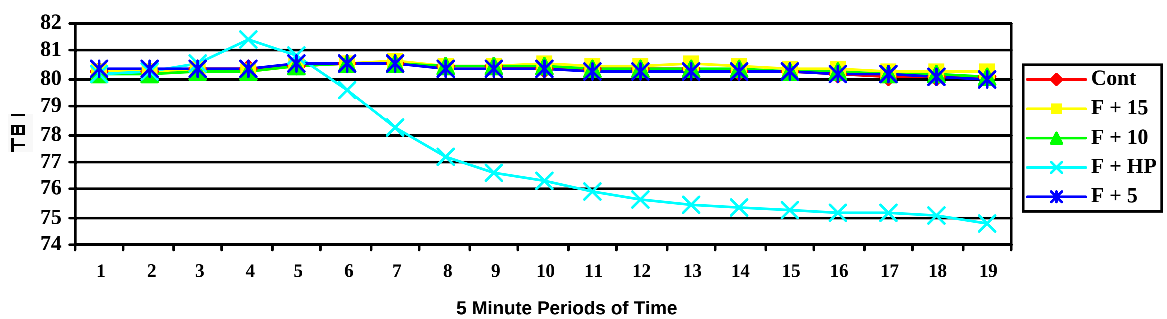

Figure 3. Stall THI During Cooling Treatments.

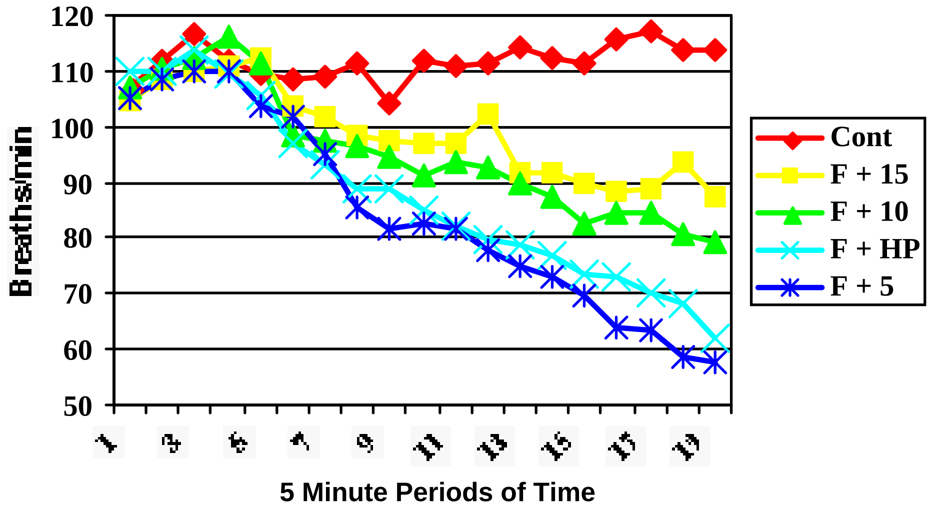

Figure 4. Respiration Rates of Dairy Cows During Cooling Treatments.

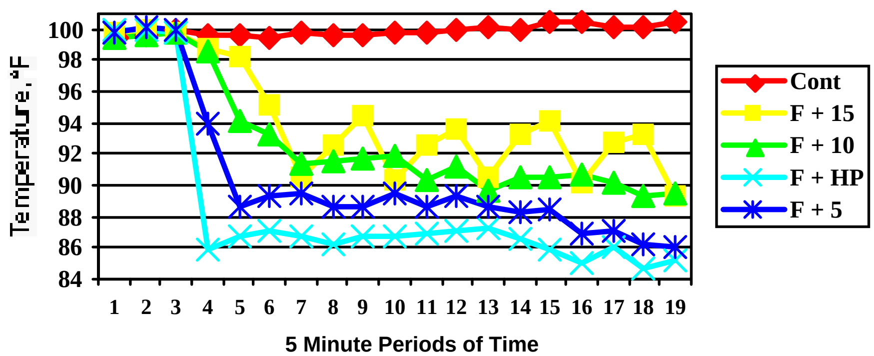

Figure 5. Shoulder Skin Surface Temperatures of Dairy Cows During Cooling Treatments.

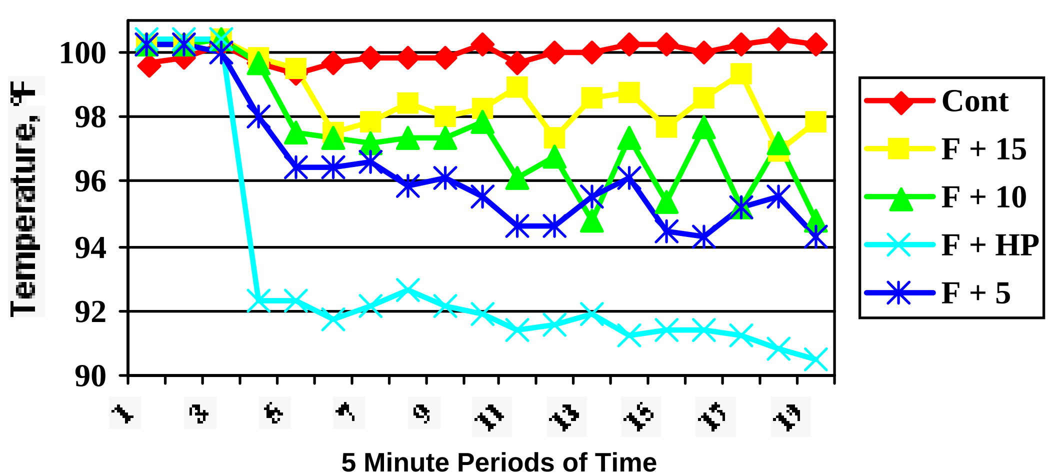

Figure 6. Thurl Skin Surface Temperatures of Dairy Cows During Cooling Treatments.

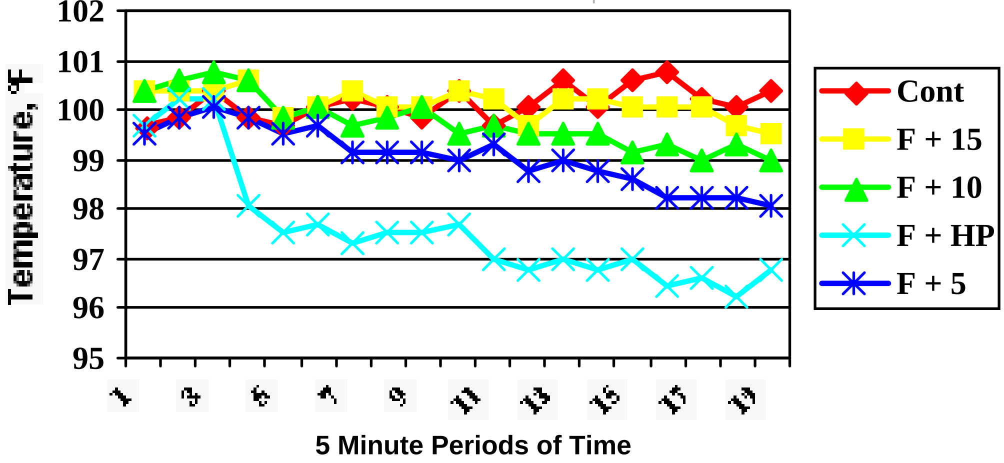

Figure 7. **Rear Udder Skin Surface Temperature of Dairy Cows During Cooling Treatments.**

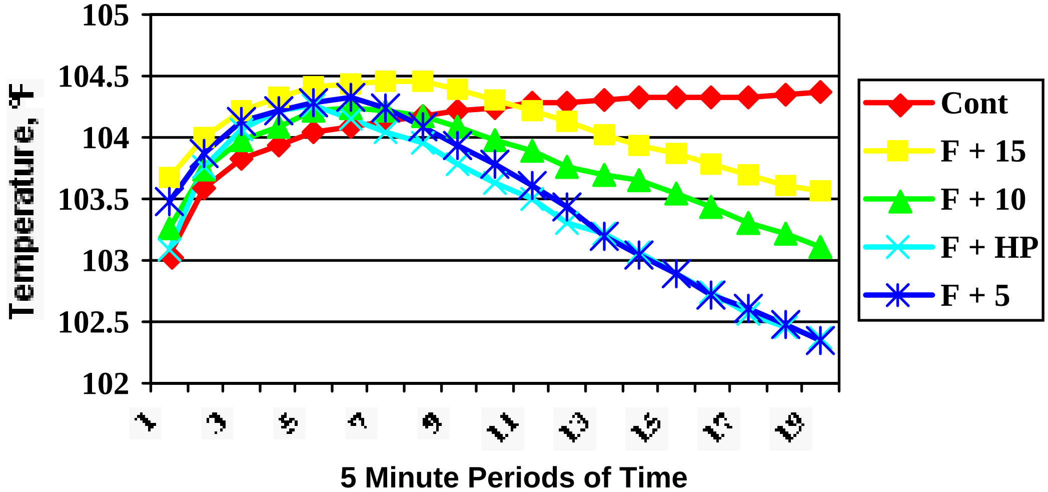

Figure 8. Body Temperature of Dairy Cattle Under Different Cooling Treatments.

SMALL-SIZED MILK PROCESSING PLANT CONSIDERATIONS

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Summary

Milk is widely considered one of the world's most valuable foods. As a raw material, it is available in various forms, and is found in an ever-increasing variety of nutritional products. Milk is a complex biological fluid consisting of the following components: water (87.4%), sugar or lactose (4.8%), fat (3.7%), protein (3.4%), minerals (0.7%), as well as minute amounts of vitamins. This document presents the standards, process needs, and labeling requirements of pasteurized fluid milk for the state of Kansas.

(Key Words: Raw Milk Standards, Processed Milk Standards, Processed Milk Equipment)

Raw and Pasteurized Milk Standards

The federal Food and Drug Administration (FDA) and Pasteurized Milk Ordinance (PMO) are resources for the published standards for raw and pasteurized milk that every milk producer and processor must know and follow in manufacturing fluid milk. Chemical, bacteriological, temperature, and sanitation criteria set for fluid milk are shown in Table 1. Each of the preceding attributes is described briefly below.

Antibiotics

All raw milk must be screened for presence of antibiotics before any process schedule, and all raw milk that is confirmed positive for the presence of antibiotics must be destroyed in accordance with federal guidelines. Drug-residue tests, such as those to detect the presence of beta-lactam drugs, must be performed at the processing site before accepting raw milk into the premises.

Bacteria

As bacterial types and counts are indicators of animal health, sanitation practices, and previous temperature history, raw and pasteurized milk (for fluid consumption) has maximum bacteria counts established for quality assessment. For pasteurized milk, standards exist for the standard plate count (or total plate count), often abbreviated as SPC, and coliform counts. For raw milk, a standard only exists for the SPC. The SPC estimates the total number of aerobic bacteria present in the milk sample. Lower limits are mandated for pasteurized products, compared to raw milk. Milk processors may establish standards that are stricter than federal mandates. Stricter standards are especially important for milk products with extended shelf life.

Coliform counts are an index of the level of sanitation and water quality used throughout milk handling and processing. Presence of a significant number of coliform bacteria in milk indicates unsanitary conditions and practices during raw milk production or milk processing and packaging.

Composition

Pasteurized milk, according to the Code of Federal Regulations (CFR), shall contain not less than 8.25% milk-solids-not-fat and not less than 3.25% milk fat. Typically a producer may receive premiums for milk that contains greater amounts of some components (e.g., milk fat and protein).

Somatic Cell Count

Somatic cell counts (SCC) are used as a measure of milk quality. High levels of SCC in raw milk indicate abnormal or reduced quality milk that may be caused by mastitis. Milk producers normally rely on SCC to help ensure a quality product. Thus SCC are monitored to assure compliance with federal and state milk quality standards.

Temperature

Raw milk temperature before processing should never exceed 45°F, excepting for specific conditions that are described in the PMO. Once milk is pasteurized, temperatures are not to exceed 45°F during storage and distribution. Microbial growth is directly related to temperature, as well as most enzymatic reactions. To preserve and maintain milk quality, activities of microbial growth and enzymatic reactions must be minimized.

Milk Microbiology

Raw milk is virtually sterile when it leaves the udder. Beyond this stage of milk production, microbial contamination generally occurs from two main sources: the udder and the surfaces of milk handling and storage equipment. Cow health, hygiene, and environment, as well as the cleaning and sanitizing practices, influence the number and type of microorganisms found in raw milk. Equally important are storage temperature and time that may allow microbial contaminants to multiply and increase in numbers. Typical types of microorganisms found in milk include pathogens (those that can cause disease), coliforms, lactic acid bacteria (those that efficiently use lactose as a sugar source), and psychrotrophic bacteria (those that can grow at 32 to 50°F).

The degree of cleanliness of the milking system probably influences the total bulk milk bacteria count as much, if not more, than any other factor. Cleaning is done to remove residual soil from the equipment, and a subsequent sanitizer cycle will reduce microbial loads to very low levels if done properly. However, if cleaning and sanitizing procedures are not optimized or efficient, microorganisms can grow on the residual soil on the surfaces and be available to "contaminate" other milk as it passes over these dirty or contaminated surfaces. Minimizing these microbial reservoirs prevents bacteria from growing to significant levels in the bulk tank during the storage period on the farm or the dairy plant. The longer the milk is held before processing, the greater the chance that psychrotrophs will increase in numbers. However, milk produced under ideal conditions usually has an initial psychrotroph population of less than 10% of the total bulk tank count (SPC). Under conditions of poor cooling (temperatures greater than 45°F), most bacteria are able to grow rapidly in raw milk. Depending upon the temperature, some bacteria may double in number every 30 minutes.

Milk Processing Basics

Processing of fluid milk involves the primary steps of separation, pasteurization, homogenization, packaging, and distribution. A flow diagram of fluid milk processing is shown in Figure 1. Each step will be briefly discussed.

Upon arrival at the plant, raw milk is tested to ensure that regulatory and company quality standards are met. Once the milk has been "accepted" i.e., normally free of antibiotics, contains the minimum fat and solids contents, has no off-flavors and odors, and falls within the appropriate acidity range, it is transferred into a raw milk storage tank. It must be processed within 72 hours of arrival at the plant.

The next process step is separation, where continuous flow centrifugation separates the fat phase (cream) from the nonfat phase (skim). The cream and skim fractions are recombined or the separator is adjusted to produce a "milk stream" that meets the desired milk fat content, i.e., whole, reduced/low fat and nonfat milks (Table 2).

After milk fat is adjusted to its desired fat percentage, milk is pasteurized, a process that combines heat and time to inactivate all pathogenic bacteria. Batch pasteurization is allowed if all federal and state requirements are met. Most of these requirements address equipment design and operation to ensure that heat and hold functions occur properly. A batch pasteurizer consists of a jacketed vat surrounded by either circulating water, steam, or heating coils. The milk is heated to 145°F and held at that temperature for a minimum of 30 minutes. A cutaway picture of a batch pasteurizer is depicted in Figure 2. If milk is batch pasteurized, it must be cooled quickly to maintain quality. However, the most commonly used pasteurization method in the United States is the high temperature short time (HTST) process. HTST pasteurization is a continuous, enclosed system capable of heating milk to a minimum of 161°F and holding it for a minimum of 15 seconds. Within the same system, milk is cooled relatively quickly (45 to 90 seconds) to below 40°F. The HTST is shown in Figure 3.

If milk is batch pasteurized, homogenization occurs after pasteurization. However in most HTST systems, homogenization is a component of the HTST, as raw or pasteurized milk can be pumped directly to the homogenizer and then back to the HTST without exposure to outside influences, thus reducing the risk of microbial contamination. Homogenization is a pressure treatment that reduces diameters of milk fat globules to sizes so small that fat globules no longer coalesce (i.e., cream) to a noticeable extent during normal refrigerated storage.

In either pasteurization process one of the last process steps is to fill containers with pasteurized milk. In most cases, milk will be pumped into a "filling machine" where cooled, pasteurized milk is packaged into cartons, sealed, and code-dated. The packaged milk should be stored at 38°F or lower until shipment to retail or wholesale stores. A wide variety of fillers and containers can be selected to package milk; however, the bottom line selection criteria should be based on safety and consumer needs. The container must protect the product from undesirable contamination and chemical reactions, and should meet consumer demands (e.g., re-closable, size, weight, etc.). Provided the appropriate package is selected, high quality milk should be acceptable for up to 14 days when maintained at cold temperatures throughout distribution and storage. This 14-day period is known as shelf life.

Shelf life is an important indicator of the quality of milk processing. Even when pasteurized milk has been heated to a minimum of 161°F for 15 seconds (or 145°F for 30 minutes for equivalent bacteria kill), and subsequently packaged under clean and sanitized conditions, some bacteria survive pasteurization. These bacteria can cause milk spoilage in about 14 days, despite refrigeration. Pasteurized milk should be stored at 34 to 38°F. Under ideal refrigeration, most containers of pasteurized milk will remain fresh 2 to 5 days after the labeled sell-by date. Once opened, milk should be consumed as soon as possible for best quality and taste.

In the United States, most pasteurized milk is fortified with vitamin D, and reduced/lowfat and nonfat milk is fortified with vitamins A and D. If vitamins are added, their quantities must meet federal guidelines for vitamin A content (not less than 2000 I.U./quart) and

Vitamin D content (not less than 400 I.U./quart). This may be considered an additional process step, depending on how and when vitamins are added.

Milk Processing Equipment

In order to process milk properly, all equipment and utensils used during processing, storing, and pumping must meet specific standards that are outlined in the PMO. For example, all multi-use containers, equipment, and utensils used in milk handling, storage, or transportation should be made of smooth, nonabsorbent, corrosion-resistant, nontoxic materials; constructed for easy cleaning; and kept in good repair at all times. Common materials that meet these requirements are stainless steel; equally corrosion-resistant, nontoxic metal; heat-resistant glass or plastic; and rubber. All of these materials are relatively inert, and resistant to scoring, chipping, and distorting under normal use.

Milk Labeling

Labeling is an important part of food production, especially for milk, because the label provides information for consumer choice. Milk labeling is regulated by the FDA, and milk and milk products must comply with labeling and nomenclature requirements set in the CFR and the Nutrition Labeling and Education Act (NLEA) of 1990. Two main issues of concern exist for the fluid milk packaging in the United States: 1) Principal Display Panel, and 2) Nutritional Facts. For further information about labeling requirements, CFR Title 21 reviews the requirements for specific food products, including fluid milk products. An example of nutritional labeling for Kansas State University's 2% reduced fat milk is shown in Figure 4. The label is intended to help consumers make choices and provide essential data concerning nutrient content.

Table 1. Chemical, Bacteriological, and Temperature Standards for Raw and Pasteurized Milk Adapted From the Pasteurized Milk Ordinance (PMO) for Grade "A" Compliance[1]

Attribute	Raw Milk Standard	Pasteurized Milk Standard
Antibiotic presence	No positive results on drug residue detection methods prescribed in the PMO	No positive results on drug residue detection methods prescribed in the PMO
Bacteria Counts		
Standard Plate Count	Individual producer milk must not exceed 100,000 CFU/ml before commingling with milk. Not to exceed 300,000 CFU/ml as commingled milk prior to pasteurization	≤ 20,000 CFU/ml
Coliform	Not applicable	≤ 10 CFU/ml
Composition		
Fat		3.25 %
Solids not Fat		8.25 %
Somatic Cell Counts	Individual producer milk must not exceed 750,000 CFU/ml	
Temperature	Cooled to 45°F or less within 2 hours after milking, provided that the blend temperature after the first and subsequent milking does not exceed 50°F	Cooled and maintained to 45°F or less

[1]Anon. 1999. Grade "A" Pasteurized Milk Ordinance. U.S. Public Health Service, p #19.

Table 2. Federal Standards for the Fat and Solids-Non-Fat Contents of Pasteurized Milk[1]

Product	Fat content (%)	Solids-nonfat(%)
Whole milk	3.25	8.25
Reduced fat or 2% milk	2.0	8.25
Low fat or 1% milk	1.0	8.25
Fat free or Skim milk	Less than 0.5	8.25

[1]U.S. Food and Drug Administration, 2003.

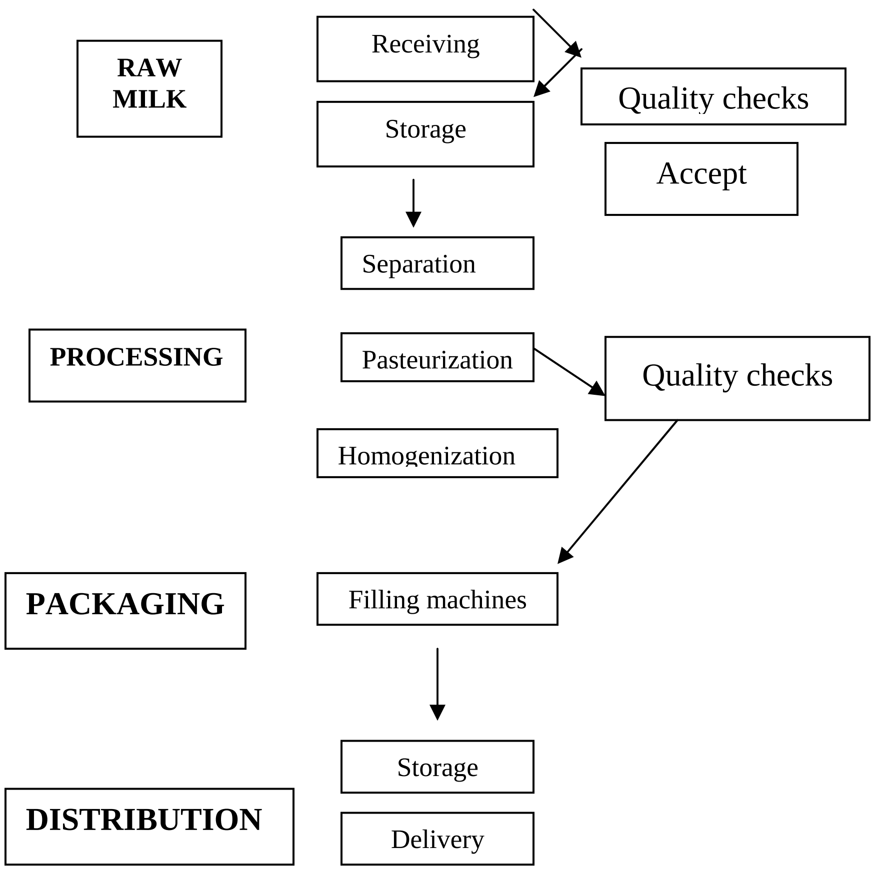


Figure 1. **Milk Processing Flow Diagram**.
(adapted from: http://www.foodsci.uoguelph.ca/dairyedu/fluid.html)

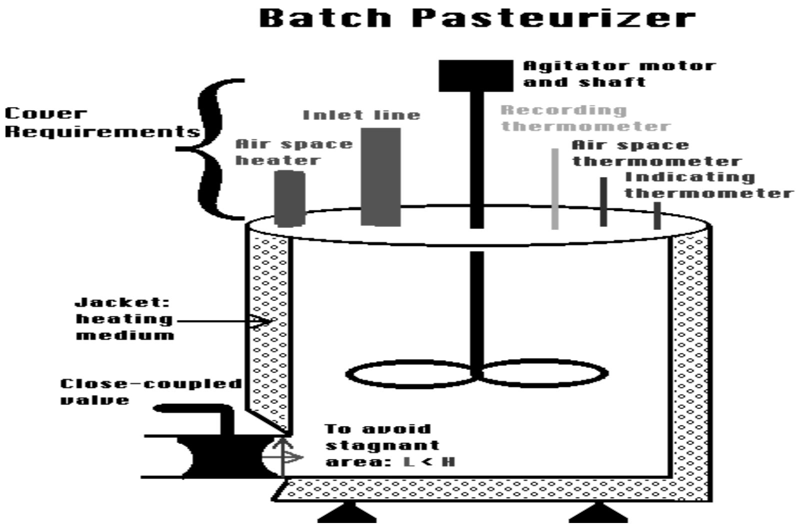
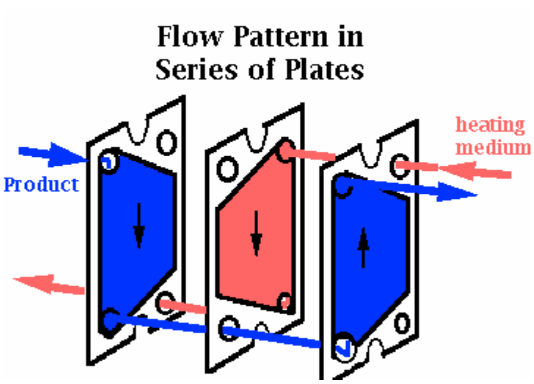


Figure 2. Batch Pasteurizer.
(http://www.foodsci.uoguelph.ca/dairyedu/pasteurization.html).



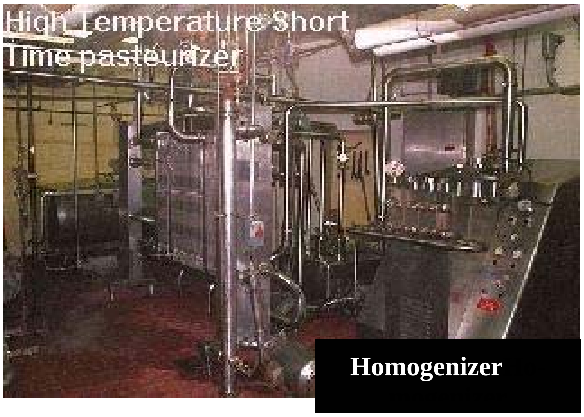


Figure 3. High Temperature Short Time Pasteurizer.
(http://www.state.ct.us/doag/regsinsp/dairy.htm)

Kansas State University, Manhattan, KS

Figure 4. Nutritional Labeling of Kansas State University's 2% Reduced Fat Milk.

EFFECT OF TWO NEW TEAT DIP PREPARATIONS ON TEAT CONDITION, SOMATIC CELL COUNT, AND INCIDENCE OF MASTITIS UNDER NATURAL EXPOSURE

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M.V. Scheffel, and E.C. Titgemeyer

Summary

Application of an iodophor teat dip before and after milking is a common practice in the dairy industry as an effective method of preventing mastitis by reducing microbial populations at the teat end. Overall effectiveness of a teat dip is a function of its ability to reduce the microbial population and maintain a pliable teat skin condition. The objective of this study was to evaluate a new conditioning component in iodophor teat dips containing either 0.5% or 1.0% iodine. Two experiments were conducted during late winter (133 cows) and during summer (104 cows) to evaluate two new iodophor teat dips developed by KO Manufacturing, Inc., Springfield, Mo. The two teat dips contain a nontraditional conditioning agent designed to sustain the lipid bilayer of the teat skin and improve skin condition. Dinerin (0.5% iodine) was equally effective as Westfalia-Surge Derma-Kote during the winter study in preventing new mammary infections based on the number of new clinical cases of mastitis and somatic cell counts. Teat and teat end condition were similarly maintained by both teat dips during the winter study. Two Dinerin teat dips, 0.5% and 1.0% iodine, were compared to Westfalia-Surge Teat-Kote 10-3 (0.5% iodine) during the summer. The Dinerin 0.5% iodine dip was most effective in preventing new cases of clinical mastitis. Teat and teat end conditions were maintained similarly by all three dips. Somatic cell counts were similar among treatments when cows that developed clinical mastitis were deleted from the analysis. The numbers of clinical mastitis cases were 5, 0, and 6 for cows dipped with Westfalia-Surge Teat-Kote 10-3, Dinerin 0.5% iodine, and Dinerin 1.0% iodine, respectively.

(Key Words: Teat Dips, Mastitis, Somatic Cells)

Introduction

According to the National Mastitis Council, the estimated annual mastitis loss to the dairy industry exceeds $1.7 billion in the United States. Measures recommended by the council to prevent mastitis include dipping teats after milking with iodophor teat dips to reduce microbial populations at the teat-end. Iodophor teat dips can dry the skin and cause chapping, resulting in discomfort to the cow, reduced milk letdown, and increased in intramammary infection. Teat end callosity and roughness have been reported to have a direct relationship with clinical mastitis. Teat dips containing 1.0% iodine effectively reduce microbial populations, but may cause chapping of the skin, depending on the type and amount of conditioner included in the formulation. Reducing the iodine content, combined with an effective conditioner, should reduce teat chapping, but may not reduce the teat-end microbial population sufficiently to prevent intramammary infections. A new teat dip (Dinerin, from KO Manufacturing, Inc., Springfield, Mo.) that contains a blend of glycerin and natural lipids as the conditioning ingredients was developed recently. This conditioner is designed to help sustain the skin's lipid bilayer by filling gaps and replacing unhealthy skin. The purpose of this study was to evaluate the conditioning effectiveness of Dinerin relative to that of a standard teat dip that contains glycerin as the conditioning agent.

Procedures

Two experiments were conducted during a 60-day period of late winter (133 cows) and during a 90-day period of summer (104 cows) to evaluate two new iodophor teat dips. In the winter study, cows were paired on parity, milk yield, somatic cell count, and previous cases of clinical mastitis. Cows within pairs were allotted randomly to treatment. Pretreatment milk yield, milk components, somatic cell count, teat-end scores, and teat condition were determined and used in covariate analysis. Treatments during the winter study include Westfalia-Surge Derma-Kote (0.5% iodine) and Dinerin (0.5% iodine dip from KO Manufacturing, Inc., Springfield, Mo.). In the summer study, cows were blocked (three cows per block) as in the winter study and assigned randomly to three treatments: 1) Westfalia-Surge Teat-Kote 10-3 (1.0% iodine), Dinerin (0.5% iodine), and Dinerin (1.0% iodine).

Daily milk yield was recorded, and weekly milk samples (a.m./p.m. composite) were collected for content analysis of fat, protein, lactose, somatic cells, and milk urea nitrogen by the Heart of America DHI laboratory, Manhattan, Kan. Teat ends were scored at the beginning and end of each experiment, and incidences of chapping and clinical mastitis were recorded throughout. Teat condition was evaluated at the beginning and end of each experiment.

Results and Discussion

Yield and composition of milk for the winter and summer experiments are summarized in Tables 1 and 2, respectively. These measures were included to demonstrate that high milk-producing cows were assigned to treatments and would be sensitive to mammary gland insults, resulting in decreased milk yields. Milk and energy-corrected milk yields were similar across treatments for both studies. Differences in milk yield were not expected because too few cows were assigned to treatments to detect differences in yield and because those cows that were diagnosed with clinical mastitis were deleted from the summary of traits in Tables 1 and 2.

During the winter study, two cows treated with Westfalia-Surge Derma-Kote and three cows treated with Dinerin WinterGuard exhibited clinical mastitis. Numbers of clinical mastitis cases during the summer study were 5, 0, and 6 for Westfalia-Surge Teat-Kote 10-3, Dinerin 0.5%, and Dinerin 1.0%, respectively. Absence of clinical cases in the cows treated with Dinerin 0.5% suggests that the Dinerin 1.0% iodine product may have been too harsh compared to the Dinerin 0.5% iodine product, regardless of the conditioner used.

Treatment effects on somatic cell count (SCC) are summarized in Tables 3 and 4. Results were analyzed several ways because of the impact one or two cows might have on treatment outcomes. Regardless of analysis for sorting technique, all treatments seemed to be equally effective in maintaining similar SCC during both winter and summer. Somatic cell counts listed in Tables 3 and 4 do not include those for cows with clinical mastitis during the study.

The effect of treatments on teat and teat end condition is shown in Table 5. Teat dips had no negative effects on teat or teat end conditions during the winter or summer. Results for the summer study are not shown because they were similar to data collected during the winter.

Conclusion

The teat dips used in this study were equally effective in maintaining teat condition and somatic cell count. The Dinerin 0.5% dip appeared to reduce the incidence of clinical mastitis during the summer study. Additional work with larger numbers of cows is needed to confirm these findings.

Table 1. Effect of Teat Dips on Milk Yield and Composition of Milk (Winter Study)

	Primiparous		Multiparous		*P* value		
Item[1]	Derma-Kote	Dinerin	Derma-Kote	Din-erin	Treatment	Parity	TxP
No. of cows	23	25	44	41			
Milk, lb/day	90.0	95.3	90.2	91.5	0.90	0.19	0.17
ECM, lb/day	90.9	90.9	90.0	93.7	0.68	0.59	0.30
Fat, %	3.64	3.46	3.40	3.53	0.05	0.32	0.05
Protein, %	3.09	3.20	3.14	3.13	0.15	0.65	0.01
Lactose, %	4.95	5.00	4.95	4.94	0.32	0.10	0.07
SNF, %	8.97	9.17	8.99	9.02	0.66	0.04	0.01
MUN, mg/dL	16.23	16.48	16.73	16.66	0.03	0.05	0.37
Fat, lb/day	1.44	1.38	1.41	1.50	0.33	0.32	0.11
Protein, lb/day	1.26	1.38	1.28	1.29	0.54	0.16	0.01
Lactose, lb/day	2.03	2.17	2.04	2.06	0.67	0.12	0.08

[1]Values have been adjusted for covariates (parity, previous milk yield, somatic cell count, and previous case of mastitis).

Table 2. Effect of Teat Dips on Milk Yield and Composition of Milk (Summer Study)

	Primiparous			Multiparous			*P* value		
Item[1]	Teat-Kote 10-3	Dinerin-0.5%	Dinerin-1.0%	Teat-Kote 10-3	Dinerin-0.5%	Dinerin-1.0%	Treat-ment	Parity	TxP
No. of cows	15	16	13	19	21	20			
Milk, lb/day	81.2	80.5	84.5	81.0	77.4	82.7	0.51	0.20	0.66
ECM, lb/day	82.1	82.5	85.1	79.6	78.3	83.6	0.02	0.07	0.78
Fat, %	3.62	3.72	3.50	3.41	3.48	3.56	0.98	0.07	0.18
Protein, %	3.15	3.10	3.15	3.14	3.17	3.15	0.05	0.28	0.17
Lactose, %	4.99	4.93	4.99	4.90	4.93	4.93	0.03	0.01	0.17
SNF, %	9.08	8.95	9.05	8.96	9.03	9.01	0.01	0.44	0.02
MUN, mg/dL	17.61	16.66	17.27	16.75	16.72	17.31	0.13	0.33	0.25
Fat, lb/day	2.88	2.97	2.93	2.71	2.75	2.93	0.06	0.08	0.46
Protein, lb/day	2.53	2.49	2.64	2.51	2.42	3.92	0.27	0.28	0.95
Lactose, lb/day	4.05	3.98	4.22	3.98	3.83	4.09	0.09	0.12	0.92

[1]Values have been adjusted for covariates (parity, previous milk yield, somatic cell count, and previous cases of mastitis).

Table 3. Effect of Teat Dips on Somatic Cell Counts (Winter Study)

	Primiparous		Multiparous		*P* value		
Item[1]	Derma-Kote	Dinerin	Derma-Kote	Dinerin	Treat-ment	Parity	TxP
No. of cows	23	25	45	43			
SCC × 100[a]	79	123	250	355	0.39	0.02	0.72
No. of cows	23	25	44	41			
SCC × 100[b]	49	58	122	135	0.59	0.01	0.92
No. of cows	52	62	44	41			
SCC × 100[c]	52	62	126	138	0.60	0.01	0.94

[1]Values have been adjusted for covariates (parity, previous milk yield, somatic cell count, and previous cases of mastitis).

[a]All SCC values used in analysis.

[b]Values above 800,000 SCC removed.

[c]Values above 998,000 SCC removed.

Table 4. Effect of Teat Dips on Somatic Cell Counts (Summer Study)

	Primiparous			Multiparous			*P* value		
Item[1]	Teat-Kote 10-3	Dinerin-0.5%	Dinerin-1.0%	Teat-Kote 10-3	Dinerin-0.5%	Dinerin-1.0%	Treat-ment	Parity	TxP
No. of cows	15	16	13	19	21	20			
SCC × 100[a]	293	274	585	428	322	221	0.67	0.54	0.09
No. of cows	15	16	13	19	21	20			
SCC × 100[b]	115	74	124	215	168	139	0.43	0.02	0.44
No. of cows	15	16	13	19	21	20			
SCC × 100[c]	123	69	132	226	198	191	0.59	0.01	0.70

[1]Values have been adjusted for covariates (parity, previous milk yield, somatic cell count, and previous cases of mastitis).

[a]All SCC values used in analysis: SCC x treatment, SCC x parity, and SCC x treatment x parity interaction..

[b]Values above 800,000 SCC removed: SCC x treatment, and SCC x treatment x parity interaction.

[c]Values above 998,000 SCC removed: SCC x treatment, SCC x treatment x parity interaction.

Table 5. Effect of Teat Dips on Teat Condition and Teat Ends (Winter Study)

	Primiparous		Multiparous		*P* value		
Item[1]	Derma-Kote	Dinerin	Derma-Kote	Dinerin	Treat-ment	Parity	TxP
No. of cows	21	26	45	46			
Left front teat	1.81	2.04	2.04	1.97	0.51	0.54	0.23
Right front teat	1.73	2.07	1.93	1.91	0.19	0.87	0.15
Left rear teat	1.39	1.57	1.59	1.56	0.46	0.36	0.33
Right rear teat	1.42	1.78	1.69	1.56	0.28	0.82	0.03
Left front end	2.59	2.45	2.75	2.812	0.63	0.01	0.21
Right front end	2.63	2.59	2.86	2.82	0.64	0.01	0.95
Left rear end	2.27	2.33	2.55	2.53	0.83	0.01	0.62
Right rear end	2.48	2.33	2.52	2.49	0.36	0.29	0.56

[1]Values have been adjusted for covariates (parity, previous milk yield, somatic cell count, and previous cases of mastitis).

CLINICAL MASTITIS PERCEPTIONS OF KANSAS DAIRY PRODUCERS

***J.R. Roberson*[1]**

Summary

Mastitis is considered the most costly disease in the U.S. dairy industry. Treatment of clinical mastitis is the major reason for antibiotic contamination of products on U.S. dairy farms. A survey of 183 dairy producers was conducted to determine their perceptions regarding clinical mastitis treatments and what constituted their treatment regimens. Results indicated that 33% of dairy producers used a coliform vaccine, 10% used a *Staphylococcus aureus* vaccine, and 38% did no prestripping before milking cows. Obtaining a clinical cure (restoration of normal milk) was considered the most important aspect of mastitis treatment success (110/183; 60%) compared to bacteriological cure (absence of bacterial pathogen), somatic cell count cure (cells count back to near normal concentrations), milk production (back to near pre-mastitis levels), and udder firmness (back to near normal firmness). Average treatment success for mastitis reported by the 183 producers was 70%, with a range of 10 to 100%. Seventy-three (92%) producers listed "off-feed" as a good measure of the severity of clinical mastitis, followed closely by general appearance (91%). Appearance of udder and milk, droopy ears, appearance of the eyes, and low milk production were other popular methods used to determine the severity of clinical mastitis. Dairy producers believed that 5.3 days (range of 1 to 45 days) passed between first recognition of a clinical case until normal milk was restored. Only 34% of producers utilized rectal temperatures as a diagnostic tool for mastitis. Many treatments used were extra-label and some were potentially illegal. However, the results presented demonstrate a wide diversity of products used and a general lack of consensus of what is considered efficacious mastitis treatment. In addition, drug dosages and duration of therapy varied considerably. Greater education on proper dosages, durations, and potential efficacy of treatments should be beneficial. A clear need exists for conducting efficacy studies to help establish necessary and justified treatments for clinical mastitis.

(Key Words: Milking Routines, Mastitis Survey, Mastitis Therapies)

Introduction

Although mastitis is considered the most costly disease in the U.S. dairy industry and treatment is the major reason for antibiotic contamination of dairy products, few published, peer-reviewed studies that document effective antibiotic therapies are available. Despite the lack of efficacy data, dairy producers and veterinarians desire to treat cases of clinical mastitis, sometimes with extra-label or illegal antibiotic therapies. A prior message on American Association of Bovine Practitioners (AABP-L) reported the use of gentamicin, enrofloxacin, and florfenicol for

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treatment of clinical mastitis; tilmicosin and florfenicol were administered to cows entering the non-lactating period (March 1997). None of the aforementioned antibiotics is approved for use in lactating dairy cows, and use of enrofloxacin is illegal. This extra-label use of antibiotics for clinical mastitis illustrates the frustration and lack of faith dairy producers and veterinarians have with approved mastitis treatment products. Research documenting the most effective methods of treating clinical mastitis would benefit producers, veterinarians, and consumers by determining economical treatments and decreasing the risk of antibiotic residues in consumer milk products.

In the early 1990s, two intramammary antibiotic preparations were compared to oxytocin for treatment of mild clinical mastitis in three California dairies. No significant differences in clinical or bacteriological cures were reported among the 254 cases studied. Most mastitis researchers generally agree that antibiotic therapy with approved intramammary preparations for mastitis caused by gram-negative pathogens is of little value. Further, antibiotic therapy against gram-positive organisms also may be ineffective to produce clinical recovery. Anti-inflammatory therapy has not been shown to alter recovery rates.

Few controlled studies have been published regarding efficacy of non-antibiotic mastitis therapies. Frequent milk-out (FMO), a common therapy for clinical mastitis, was found to be ineffective when compared to nontreated controls. Fluid therapy (intravenous, oral, and hypertonic) is considered vital for cases of acute clinical mastitis, yet little research has been performed. Calcium therapy has been recommended for gram-negative mastitis. Little applied and practical research has been conducted to aid the producer and veterinarian in treating or managing mastitis.

The primary objective of this observational study was to document dairy producer perceptions about clinical mastitis treatment and what constituted their treatment regimens. A questionnaire was administered regarding treatment methods and the expected outcomes.

Experimental Procedures

A list of Kansas dairy herds was obtained from the 2001 Kansas Dairy Producer Directory. An effort was made to administer the questionnaire to 25% of dairy producers within any given county. Dairy producers were contacted by telephone, the project was described, and producers were asked if they would be willing to participate. If agreeable, a time was set to administer the questionnaire. The questionnaire was administered in person by the author.

Results and Discussion

One hundred eighty-three dairy producers were surveyed. Only two were not available at the time of appointment. The first questionnaire was administered in December 2001 and the last was August 2003. The rolling herd average for milk, according to producer estimates, was 18,733 lb, with a range of 3,660 to 28,000. The average estimated rolling herd somatic cell count (SCC) was 318,000 cells/mL, with a range of 75,000 to 729,000. Twenty-one herds (11.5%) milk at least a portion of their cows more than twice daily. Average number of cows (both lactating and dry) per herd was 345, with a range of 9 to 7,000.

Thirty-three percent of producers use a coliform vaccine, but only 10% of producers use a *Staphylococcus aureus* vaccine. Two producers reported using an autogenous streptococcus vaccine.

Thirty-eight percent of producers reported that pre-stripping was not a routine milking procedure in their herds, suggesting that mild cases of clinical mastitis would not be identified. Twelve percent reported forestripping some of the time, whereas the remaining 50% routinely performed forestripping. Among those using forestripping, only 7 of 91 (7.6%) strip the milk on objects other than the parlor floor or gutter. Only three reported using a strip cup.

Producers were asked to rank clinical cure (normal milk), bacteriological cure (absence of bacterial pathogen), SCC cure (cell count back to near normal levels), milk production (back to near pre-mastitis levels), and udder firmness (back to near normal firmness) in order of importance to mastitis treatment success. Obtaining a clinical cure was considered the most important aspect of treatment success (110/183). Thirty-four producers considered getting the udder back to normal firmness most important, 17 (9.3%) considered lowering the SCC most important, 12 (6.6%) considered a bacteriologic cure most important, and 10 (5.5%) considered milk production most important to evaluate treatment success. The factor considered least important was bacteriologic cure (71/183; 38.8%); whereas only 8 (4.4%) producers considered clinical cure least important. The average treatment success reported by the 183 producers was 70% with a range of 10 to 100%.

Producers were asked how many days passed between recognition of the clinical case to normal milk. The average number of days was 5.3, with a range of 1 to 45. Likewise producers were asked the number of days until a bacteriologic cure. The average number of days was 10.7, with a range of immediate cure (2 producers) to never cured (12 producers). Average days reported to near normal SCC, milk production, and udder were 16.8, 9.8, and 10.2, respectively.

Seventy-nine producers were queried concerning methods used to determine severity of clinical mastitis. Seventy-three (92%) producers listed "off-feed" as a good measure of severity, followed closely by general appearance (91%). Appearance of udder and milk, droopy ears, appearance of the eyes, and low milk production were the other major methods used to determine the severity of clinical mastitis. Only 27 (34%) producers used rectal temperatures, and the average critical rectal temperature was 102.8°F, with a range of 100 to 104. Other methods listed as aids to determine severity were diarrhea, respiratory signs, kicking or touchy, entering the parlor out of order, dehydrated, slobbering, not cleaning nose, isolated, and walking stiffly.

Five typical cases of clinical mastitis were described to dairy producers (chronic, mild, moderate, severe, and non-responding), and they were asked how each case would be managed. Only data on the chronic, mild, and moderate cases are reported herein.

Chronic Mastitis

Chronic cases consisted of excellent milking cows that were 4 to 5 months pregnant displaying milk clots from a single quarter. These cows had episodes of clinical mastitis every 1 to 2 months, and each clinical phase lasted 1 to 2 weeks regardless of management or treatment. These cows were not clinically ill or had firm or hard udders. Thirty-eight percent of producers used antibiotics in an extra-label manner, with only 4.4% using antibiotics according to label directions. Eight percent used no drugs, but would take extra care to strip out the clots, 4.4% used no treatment of any kind, 14% used only oxytocin for chronic cases, and one producer removed teats from the offending quarter.

Intramammary treatment. Approximately 31% of producers reported using intramammary antibiotics to treat chronic cases. Of the 56 herds that used a product intramammary, 38% use a cephapirin product (Today® or Cefa-Lak®), 21% used pirlimycin (Pirsue®), and < 4% of producers used other labeled intramammary antibiotics. One producer used a veterinarian-mixed product, one used vinegar, and one used a neomycin/dexamethasone mixture. Five producers reported using two different intramammary products in some combination on chronic mastitis.

SystemicTreatment-Antibiotics. Eighteen percent (33/183) of producers reported using systemic antibiotics to treat chronic cases. Eleven producers used penicillin either intramuscularly or subcutaneously on chronic cases, with daily dosages ranging from 20 to 50 mL as a one-time treatment or until clots were resolved. Fifteen producers use a ceftiofur product (Naxcel® or Excenel®), most often following label directions. Other products listed were oxytetracycline, a custom, veterinarian-mixed product, and LS-50.

Systemic Treatment-Anti-Inflammatory. Four of the 183 producers reported using an anti-inflammatory drug for chronic mastitis cases. Products used were intramammary and external dimethyl sulfoxide (DMSO), aspirin (orally), dexamethasone intramammary, and a combination of dexamethasone and intramuscular injections of Banamine®.

Miscellaneous Treatments. Other products and procedures used included: vitamins A, B, D, and E, hyperimmune serums, whey products, Tramisol®, mint or oil products, hydrotherapy, and energy or stress boluses.

Mild Clinical Mastitis

A mild case was indicated when a cow had clots in one quarter, but no evidence of systemic illness or firmness of the affected quarter. This would be the very first case of clinical mastitis observed in the cow. Sixty-four percent of producers used antibiotics in an extra-label manner, whereas 13% reported using antibiotics according to label directions. One producer did not use any drugs, but would take extra care to strip out the clots, 11% used no treatment of any kind, and 8% use only oxytocin on mild cases.

Intramammary Treatment. Approximately 62% of producers used intramammary antibiotics to treat mild cases. Of the 113 producers who used intramammary products, 49% used a cephapirin product (Today® or Cefa-Lak®), 27% used pirlimycin (Pirsue®), about 7% used amoxicillin, 4% each used either novobiocin/penicillin or cloxicillin, 3% used penicillin with or without a steroid, 2% used ampicillin, and one producer each used a homebrew, dry-cow antibiotic, gentamicin with dexamethasone, and neomycin with dexamethasone. Two producers used two different intramammary products in sequence.

Systemic Treatment-Antibiotics. Thirty-two percent (58/183) of producers reported using systemic antibiotics to treat mild cases. Twenty-five producers used ceftiofur (Naxcel® or Excenel®), 19 producers used penicillin or a penicillin-like antibiotic, five used a tetracycline antibiotic, and six producers used a veterinarian mix, spectinomycin-lincomycin (LS-50), Micotil®, or Albon® (sulfadimethoxine).

Systemic Treatment-Anti-Inflammatory. Only 3 of the 183 producers reported using an anti-inflammatory drug for mild cases.

Miscellaneous Treatments. Sixty-five producers reported using various other products. Fifty-one producers used oxytocin once or for the rest of the lactation, mostly premilking, at doses ranging from 0.5 to 5 mL. Four producers routinely used vitamins or nutritional supplements. Four producers used a hyperimmune serum product. Two producers routinely used ointments, and one used a teat cannula.

Moderate Clinical Mastitis

The moderate case was described as a cow with clots in one quarter that was slightly firm and warm. This cow had a temperature of 104.5ºF, but was not off-feed or dehydrated. Clinical mastitis had not previously occurred in this quarter.

Fluid Therapy. Five percent of producers would administer some type of fluid therapy (hypertonic saline, dextrose, 3 to 5 gallons of water orally, or an oral drench mixture consisting of beer, rumen fluid, water, and propylene glycol).

Intramammary Treatment. Seventy percent of producers would use intramammary antibiotics and three producers relied on their veterinarians to treat the cow with moderate clinical mastitis. Of the 128 herds that used a product intramammary, 52% used a cephapirin product (Today® or Cefa-Lak®), 20% used pirlimycin (Pirsue®), about 6% used amoxicillin, 4% used novobiocin/penicillin, and 2% used cloxicillin. Four producers used a single intramammary product without a preference. Nine producers routinely used a combination of intramammary products (five used two intramammary labeled products either one after the other or at the same time; two used a veterinary mix and an approved intramammary product; one used spectinomycin and Today®, and one used a dry cow product followed by Pirsue®). Ten producers used other combinations or dry cow intramammary antibiotics (five used penicillin and a steroid; two used a dry-cow intramammary antibiotic, one used penicillin-vitamin mix, one used a neomycin-dexamethasone mix, and one used a gentamicin-dexamethasone mix).

Systemic Treatment-Antibiotics. Five producers relied on their veterinarian to treat their cows with moderate clinical mastitis. Sixty-three percent (112/178) of producers reported using systemic antibiotics to treat moderate cases. Producers reported using penicillin (23%), ceftiofur (19%), tetracycline products (9%), a combination of antibiotics (4%: penicillin and tetracycline, sulfa-containing drugs or ceftiofur, erythromycin and tetracycline, ceftiofur and Albon®), ampicillin (2%), vet mixes (2%), sulfa products (2%), LS-50 (<1%), Micotil® (<1%), and one producer had no preference. Dosages for penicillin ranged from 10 to 75 ml. Dosages for ceftiofur ranged from 10 to 30 mL. Dosages for tetracycline products ranged from 20 to 110 mL.

Systemic Treatment-Anti-Inflammatory. Nearly 75% of producers do not use anti-inflammatory products to treat cows with moderate clinical mastitis. Banamine® was routinely used by 12% of producers, with doses ranging from 10 to 25 mL. A steroid was used by 8% of producers, with dosages ranging from 1 to 110 ml. Five producers used aspirin as their sole anti-inflammatory drug. Four producers used a combination of anti-inflammatory drugs, and two producers had no specific preference.

Miscellaneous Treatments. Forty-two percent of producers (75/178) that treated their own moderate cases of clinical mastitis used other forms of treatment. Oxytocin was used by 60 producers, 12 used some form of mint oil externally, 10 used vitamins or nutritional supplements, five used hyperimmune serum, one used DMSO, one used cold water hydrotherapy, one used an antihistamine, and one used Tramisol®.

Conclusions

The purpose of this study was to neither support nor condemn treatments for clinical mastitis used by Kansas dairy producers. Many of the treatments used are extra-label and some were potentially illegal. However, the results presented demonstrate a wide diversity of products used and a general lack of consensus of what is considered effective mastitis treatment. In addition, drug dosages and duration of therapy varied considerably. Greater education on proper dosages, durations, and potential efficacy of treatments should be beneficial.

Although the producers generally did not have a severity scoring scheme, the amount of treatment seemed to increase with increasing severity of mastitis. Producer-reported treatment success rates were not different for those who used intramammary antibiotics compared to those who did not. A clear need exists to conduct efficacy studies to help establish necessary and justified treatments producers can use for clinical mastitis.

TRANSITION COW NUTRITION AND MANAGEMENT

J.E. Shirley

Summary

Dairy cows are generally provided with a 60-day dry period. The first part of the dry period is called the “far-off dry period” beginning at dry off and continuing until 21 days before projected calving date. The second part of the dry period is called the “close-up dry period” beginning at 21 days before projected calving date and ending at parturition. Diets formulated for far-off dry cows are generally high in forage and are designed to support body maintenance and fetal growth. Rumen function and microbial populations adjust to these diets by the end of the far-off period and require a period of adaptation before switching to a high-energy lactation diet. Thus, a close-up diet should not be formulated as an entity unto itself, but as a bridge between a low and high-energy diet, retaining some characteristics of both the far-off and lactation diets. The ultimate success of a transition cow nutrition and management program is a lactation characterized by high milk and yields of its component and an absence of ruminal, metabolic, mammary gland, and reproductive disorders. Therefore, close-up diets should encourage ruminal adaptation to subsequent lactation diets, prevent metabolic disorders, and minimize tissue mobilization prior to parturition. Rumen bacteria, protozoa, and fungi are sensitive to new diet ingredients and the amount of substrate available (dry matter intake). Thus, adequate time should be allocated to exposure to the close-up diet before parturition. Our studies indicate that cows should be offered a close-up diet that contains 13.5 to 14.5% crude protein and 35% nonfiber carbohydrate for approximately 28 days before parturition.

(Key Words: Close-up Diets, Transition Cows)

Introduction

The primary purpose of a close-up diet is to initiate ruminal changes beneficial to the cow after parturition, when her nutritional demands dramatically increase. The far-off dry cow diet is generally high in neutral detergent fiber (NDF), moderate to low in nonfiber carbohydrate (NFC), and low in crude protein, whereas the lactation diet is relatively low in NDF, high in NFC, and high in crude protein. The close-up diet serves as a bridge between far-off and lactation diets. Thus, the primary changes in formulation should be in type of carbohydrate and, possibly, level of crude protein. The most appropriate changes are not clearly understood, but a recent study indicates that the NFC content of the close-up diet should be above 32% of dry matter.

Experiments (49 diets) from 10 universities were recently used to evaluate animal and feed factors that affect dry matter intake during the prefresh transition period and demonstrated that dietary NDF accounted for 15.3% of the variation in dry matter intake of Holstein cows. Dietary NDF was negatively related, whereas NFC was positively related to dry matter intake. We would expect dry matter digestibility to increase as NDF is replaced with NFC, but a point is reached when the rumen environment becomes compromised. Confounded with the issue of the most appropriate dietary NDF to NFC ratio is the digestibility of the NDF fraction. Recent research indicates that highly fermentable nonforage fiber sources offer a means of stimulating intake in the prefresh cow by increasing rate of passage through the rumen. We were able to improve dry matter intake by replacing a portion of the alfalfa hay, corn silage, and corn grain with either wet corn gluten feed or a soyhull-corn steep liquor blend in diets fed to cows during early lactation. The advantage of highly fermentable nonforage fiber sources is the increase in nutrient delivery to the cow without increased risk of acidosis.

The basic question left unanswered in the literature is how rumen microbes react to diet changes dictated by the two-tier dry cow feeding programs. This presentation will discuss ruminal adaptation to changes in diet and dry matter intake during the transition from far-off to close-up dry periods through early lactation and some factors to consider regarding carbohydrate fractions when formulating close-up diets.

Composition of Far-Off, Close-Up and Lactation Diets

Successful formulations in our program for far-off, close-up, and lactation diets are shown in Table 1 and their chemical compositions in Table 2. These diets were offered as a total mixed ration (TMR) and fed for ad libitum intake. The major component changes between the far-off and close-up diet were the introduction of alfalfa hay, decreases in prairie hay and corn grain, and increases in corn silage and soybean meal. These changes increased crude protein and NFC, met NE_L requirements, and decreased NDF as a percentage of total diet dry matter.

Table 3 provides a different perspective of these diets. Total carbohydrates decrease as cows change from a far-off to a lactation diet. A major shift in carbohydrate fractions occurs, NDF decreases, and NFC increases. Starch (percent of dry matter) is only slightly higher in the close-up compared to far-off diet, but significantly greater in the lactation diet. The amount of corn grain was reduced in the close-up compared to the far-off diet because the amount of corn silage increased. Starch values were obtained by chemical analyses of TMR samples.

A comparison of TMR particle size using the Penn State Particle Separator is shown in Table 4. The particle size is slightly less in the close-up compared to the far-off diet; the major change in particle size occurs in the lactation diet.

General Comments About Close-Up Diets

Properly formulated close-up diets can reduce incidences of postpartum metabolic problems and prepare the rumen for lactation diets. However, it is not a magic formula that can cure problems created by overly fat cows and low quality or improperly formulated lactation diets. In our view, cows should enter the close-up pen at a body condition score of 2.75 to 3.0 and gain 0.25 points before calving. To accomplish this, cows should enter the close-up pen approximately 28 days before expected calving date to ensure that they are exposed to the close-up diet for a minimum of 14, but hopefully 21 days. We found that body condition score at the beginning of the close-up period (day 31 prepartum) was negatively related to prepartum and postpartum dry matter intake (first 90 days) and milk yield during the first 90 days of lactation but not significantly related to complete lactation milk yield. These findings support the concept that fatter cows eat less than thinner cows and indicate that energy gained from fat mobilization during early lactation does not offset the decrease in dry matter intake experienced by fatter cows in support of milk production. Others also have reported a negative relationship between body condition score and prepartum dry matter intake.

The 2001 Dairy NRC recommends that close-up diets contain 0.73 Mcal NE_L/lb of dry matter. The close-up diet presented in Table 2 contained 0.71 Mcal NE_L/lb of dry matter based on the summation of values from individual feedstuffs and 0.74 NE_L/lb dry matter based on NRC (2001). A significant portion of the NE_L in our close-up diet is due to the crude protein content (15.6% dry matter), so the recommended NE_L can be achieved without a substantial increase in rapidly fermentable carbohydrate.

Conclusions

The primary purpose of a close-up diet is to initiate ruminal changes beneficial to the cow after parturition, when her nutritional demands dramatically increase. Rumen bacteria, protozoa, and fungi are sensitive to new diet ingredients and the amount of substrate available. Thus, adequate time should be allocated to close-up diet exposure before expected parturition. Altering the type and physical form of the carbohydrate fraction can vary diet energy value. Close-up diets containing 35% NFC and 14.5% crude protein should stimulate fermentation sufficiently to prepare the rumen for the lactation diet. Properly formulated close-up diets can reduce, but cannot completely solve, the problem of overly fat cows and low quality feedstuffs.

Table 1. Diet Ingredients (% of Dry Matter)

	Diets		
Item	Far-off	Close-up	Lactation
Alfalfa hay	—	15.0	30.0
Prairie hay	48.4	20.0	—
Corn silage	19.8	30.0	15.0
Corn grain	22.4	18.7	32.0
Whole cottonseed	—	—	9.3
Fishmeal	—	—	1.3
Expeller soybean meal	—	9.4	3.3
48% soybean meal	8.4	4.4	4.4
Wet corn gluten feed	—	—	—
Molasses	—	—	1.0
Limestone	0.06	0.60	1.36
Dicalcium phosphate	0.40	0.74	0.88
Sodium bicarbonate	—	—	0.75
Trace mineral salt[1]	0.34	0.50	0.32
Magnesium oxide	—	0.50	0.21
Vitamin A, D, E[2]	0.11	0.12	0.13
Sodium selenite premix[3]	0.02	0.04	0.01

Adapted from Park et al. (2001).

[1]Composition: not less than 95.5% NaCl, 0.24% Mn, 0.24% Fe, 0.05% Mg, 0.032% Cu, 0.032% Zn, 0.007% I, and 0.004% Co.

[2]Contributed 4,912 IU of vitamin A, 2,358 IU of vitamin D, and 24 IU of vitamin E per kg diet DM.

[3]Contributed 0.06 mg Se per kg diet DM.

Table 2. Chemical Characteristics of Diets

	Diets		
Item	Far-off	Close-up	Lactation
DM, %	74.5	70.3	75.0
CP, %	11.5	15.6	18.4
Soluble protein, % of CP	25.2	25.2	31.3
RDP, % of DM[1]	7.3	10.3	11.7
RUP, % of DM[1]	4.2	5.3	6.7
ADF, %	25.2	22.0	18.2
NDF, %	42.9	34.4	27.0
Nonfiber carbohydrate, %[2]	35.2	39.1	40.4
NE_L, Mcal/lb[3]	0.70	0.74	0.73
Ether extract, %	3.8	3.5	5.6
Ash, %	6.7	7.4	8.4
TDN, %	67.0	69.1	72.3
Calcium, %	0.5	0.8	1.5
Phosphorus, %	0.4	0.5	0.7
Magnesium, %	0.2	0.4	0.3
Potassium, %	1.2	1.5	1.5
Sodium, %	0.1	0.2	0.3
Sulfur, %	0.1	0.2	0.2

Adapted from Park et al. (2001).

[1]Based on feed analysis from Dairy Herd Improvement Forage Testing Laboratory, Ithaca, N.Y.

[2]Calculated based on DHI formula represented by 100 - [(crude protein + (NDF – NDICP) + ether extract + ash)].

[3]Calculated based on NRC (2001). Estimates of NE_L values from summation of individual ingredients (0.66, 0.71, and 0.77 for the far-off, close-up, and lactation diets, respectively).

Table 3. Carbohydrate Fractions in Dry and Lactating Cow Diets

	Diets		
Item	Far-off	Close-up	Lactation
Crude protein, % of DM	11.5	15.6	18.4
Ether extract, % of DM	3.8	3.5	5.6
Ash, % of DM	6.7	7.4	8.4
Carbohydrates, % of DM	78	73.5	67.6
NDF, % of CHD	55	47	40
DFC, % of CHD	45	53	60
Starch, % of DM	11.9	12.2	17.8

Table 4. Particle Size Characteristics of Diets

	Diets		
Total mixed ration particle size, %[1]	Far-off	Close-up	Lactation
> 19 mm	34.1 ± 12.6	32.2 ± 11.8	11.1 ± 4.6
8 to 19 mm	20.1 ± 01.3	19.1 ± 05.2	24.9 ± 3.3
<8 mm	45.8 ± 12.9	51.1 ± 08.0	63.9 ± 3.4

[1]Particle size determined by the Penn State Particle Separator (Lammers et al., 1996), as-fed basis; mean ± SD.

COMPARISON OF THREE FRESH COW FEEDING PROGRAMS

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Summary

We evaluated the impact on performance of top dressing a based total mixed ration (TMR) with long-stem alfalfa hay with or without additional dry-rolled corn to the lactating cow diet during the first 5 days postpartum. The three dietary treatments and numbers of cows assigned to each diet were: 1) total mixed ration (TMR; n = 19); 2) TMR + long-stem alfalfa hay (TMR + A; n= 20); and 3) TMR + long-stemmed alfalfa hay + dry-rolled corn (TMR + A + C; n = 20). Top dressing the lactating TMR with long-stem alfalfa hay with or without dry-rolled corn did not reduce the incidence of metabolic disorders in early lactating cows. Six cows, two on each diet, were treated for displaced abomasums. Cows consuming only the TMR lost slightly more body weight during the first 30 days after calving compared to cows fed the other diets. Milk and energy corrected milk (ECM) yields were similar among diets. Fat, protein, and urea nitrogen content in milk were not different among dietary treatments. Lactose content in milk was greater for cows consuming TMR + A than those consuming TMR or TMR + A + C. Concentrations of glucose and urea nitrogen in plasma were not affected by treatment during the initial 5 days of lactation. Concentrations of glucose and urea nitrogen on days 2 and 3 were less for multiparous cows consuming TMR than for multiparous cows consuming TMR + A. Rumen contractions during the first 5 days of lactation were not different among diets. Top dressing the lactating TMR with long-stem alfalfa hay with or without dry-rolled corn was not beneficial in this study. On a dry matter basis, the lactating TMR contained 22% chopped alfalfa hay, 10% corn silage, 20% wet corn gluten feed, 9% whole fuzzy cottonseed, 7.1% expeller soybean meal, 27.4% ground shelled corn, 1.2% molasses, 1.3% Menhaden fishmeal, and 2.0% mineral-vitamin premix. Cows fed diets containing corn silage as the predominant fiber source may respond differently.

(Key Words: Transition Cows, Alfalfa, Dry-rolled Corn)

Introduction

The most problematic time in the life of a dairy cow is the first 2 weeks after calving. Metabolic adjustments to the demands of the mammary system must occur, and the rumen must adjust to an energy dense diet. Close-up diets partially adapt rumen microorganisms and epithelium to the lactating diet, but rumen adaptation is driven by diet changes and the normal postpartum increase in feed intake required to support the increasing demands of the mammary gland. In most cases, energy intake is less than energy expenditure in early lactation. The metabolic adaptation to this negative energy balance is fat mobilization from adipose tissue. Mobilized fat is processed by the liver and serves as a source of energy and milk fat precursor. Fatty liver and ketosis occurs when the rate of fat uptake exceeds the liver's ability to process it. One of the rate limiting steps in fat processing by the liver is availability of glucose.

During the dry period the dairy cow is fed a diet containing high levels of neutral detergent fiber (NDF), and rumen environment is altered with respect to microbial populations and absorptive capacity of the ruminal epithelium. Decreased feed intake typically observed immediately before parturition reduces rumen fill and likely diminishes the rumen mat. A rapid change from a high fiber, low starch close-up diet to a low fiber, high starch lactating diet may contribute to subacute ruminal acidosis. Ruminal acidosis has a negative impact on dry matter intake and exaggerates the negative energy balance normally observed early postpartum. Reduced dry matter intake lessens the amount of glucose precursors available to the liver for fatty acid oxidation and could result in fatty liver and ketosis. We hypothesized that the addition of long-stem alfalfa hay would increase rumen fill, moderate rumen pH, and improve intake during transition from the close-up to the lactating diet. However, additional hay reduces the concentration of rumen-available starch in the diet and could decrease the supply of gluconeogenic substrate. Thus, additional corn grain was offered in one of the diets in addition to being top dressed with long-stem alfalfa hay to maintain dietary starch concentration.

Procedures

Before calving, each cow was offered 20 lb daily of the lactating cow total mixed ration (TMR) with free choice prairie hay and water. Thirty-three multiparous and 27 primiparous Holstein cows were utilized in a randomized block design. Cows were blocked by calving date and parity before parturition, housed in group pens, and assigned randomly to one of three dietary treatments: 1) lactating TMR (TMR; n = 19); 2) TMR + 3 lb of long-stem alfalfa hay (TMR + A; n = 20); and 3) TMR + 3 lb of long-stem alfalfa hay + 3 lb of dry-rolled corn (TMR = AC; n = 20). Ingredient and chemical composition of the lactating TMR is shown in Table 1. Each identical pen consisted of commingled primiparous and multiparous cows fed one of the experimental diets. The TMR was mixed and offered thrice daily for ad libitum intake during the initial 5 days of lactation. Long-stem alfalfa hay was top-dressed at the 6 a.m. feeding of the TMR for diet TMR + A and TMR + A + C. Dry-rolled corn was offered individually to cows consuming TMR + A + C diet before the noon feeding of TMR. On day 6 of lactation following dietary treatments, cows were relocated and commingled with the remainder of the herd and offered the basal TMR for ad libitum intake.

Cows were milked twice daily and individual milk weights recorded at each milking. Milk samples were collected weekly for subsequent analysis of fat, protein, lactose, somatic cells (SCC), and urea nitrogen (MUN) by Heart of America DHI, Manhattan, Kan. Plasma was harvested from the coccygeal vein and frozen until analyzed for NEFA and glucose content.

Results and Discussion

Addition of 3 lb of top-dressed long-stem alfalfa hay increased dietary alfalfa hay (% of dry matter) from 22% to 25.8% and 24.8% for TMR + A and TMR +A + C, respectively. Dry-rolled corn constituted 27% of diet dry matter in TMR + A + C versus 29% in the control diet. Initial body weights (BW) and body condition scores (BCS) are summarized in Table 2. The BCS were greater from primiparous cows than for multiparous cows. Loss in BW and BCS during the first 30 days postpartum was slightly greater for cows consuming only the TMR. Daily dry matter intake per cow receiving TMR, TMR + A, and TMR + A + C diets was estimated to by 37.8, 32.3, and 33.4 lb, respectively.

Lactation Performance. Multiparous cows produced more milk and EMC than primiparous cows (Table 2), but differences among dietary treatments were not detected. Concentrations of fat, protein, and solids-not-fat in milk were similar across diets, but concentrations of lactose were greater in cows consuming diet TMR + A than for those consuming the basal TMR or diet TMR + A + C.

Milk urea nitrogen and somatic cell count (SCC) did not differ among dietary treatments. Clinical ketosis was indicated when the beta-hydroxy butyric acid (BHBA) concentrations in milk were >1,000 μmol L^{-1}. Concentration of BHBA in the milk of primiparous cows did not differ among treatments and increased in all cows, regardless of dietary treatment, from day 1 to day 5. Milk from multiparous cows consuming diet A contained more BHBA than milk from cows consuming TMR, but was not different from the TMR + A + C diet. Concentrations of BHBA were similar on days 1, 3, 4, and 5 among treatments for multiparous cows (Figures 1 and 2).

Plasma Constituents. Top dressed long-stem alfalfa hay with or without dry-rolled corn did not alter blood concentrations of nonesterified fatty acids (NEFA) in primiparous cows (Figure 3), but top dressed long-stem alfalfa hay increased blood NEFAs in multiparous cows on days 2 and 3, compared to cows consuming TMR, and on day 2 compared to cows consuming TMR + A + C (Figure 4). Glucose concentration in plasma indicated similar responses to treatments between parity groups. Primiparous cows had greater plasma glucose than multiparous cows on days 1, 2, 3, and 5 (Figure 5). The basal TMR top dressed with alfalfa hay increased plasma glucose on day 4 in primiparous cows compared to those offered only the TMR, but not in those offered TMR + A + C (Figure 5). Plasma glucose concentrations were greater in multiparous cows offered TMR on the first day of lactation compared to those offered TMR + A + C, but no differences were observed among dietary treatments during days 2 through 5 of lactation (Figure 6). Rumen contractions in early lactating dairy cows provide an indication of rumen function. Rumen contractions were similar among diets (Figure 7) and were greater for multiparous than for primiparous cows.

Health Disorders. Incidences of health disorders are summarized in Table 3. Two primiparous cows consuming the basal TMR diet were diagnosed with displaced abomasums (DA) on the 19th and 30th days of lactation. Each cow also was diagnosed with metritis, which can contribute to the occurrence of DA's. Primiparous cows consuming diets TMR + A or TMR + A + C had one incidence of DA on days 10 and 11, respectively. The DA's in these two heifers likely resulted from reduced intake and lack of rumen fill, but relocation of 2-year-old cows on day 6 also may have contributed to its occurrence. Multiparous cows consuming the TMR had no incidences of DA during this study. Multiparous cows consuming diet

TMR + A had two DA's, one on day 9 and the other on day 10. One of these cows also experienced a retained placenta. One multiparous cow consuming diet TMR + A + C was diagnosed with a DA on the 16th day of lactation without other complications. Although commingling of cows might influence the incidence of DA's, inclusion of long-stem alfalfa hay did not reduce the incidence of DA because two primiparous and two multiparous cows receiving diets TMR + A and TMR + A + C developed DA's without other complications associated with the transition.

Ketosis has a profound negative effect on milk production in lactating dairy cattle. Losses in milk yield for a 305-day lactation can exceed 1,200 lb. In the present study, no cows were diagnosed with clinical ketosis based on use of Ketolac strips. Three cows were diagnosed with subclinical ketosis: one primiparous cow on the basal TMR diet, one on the TMR + A + C diet, and one multiparous cow on the TMR + A + C diet.

Conclusions

Top dressing a basal TMR diet containing at least 20% chopped alfalfa hay with long-stem alfalfa hay with or without additional dry-rolled corn during the first 5 days in milk supported lactation, but did not reduce the incidence of metabolic disorders.

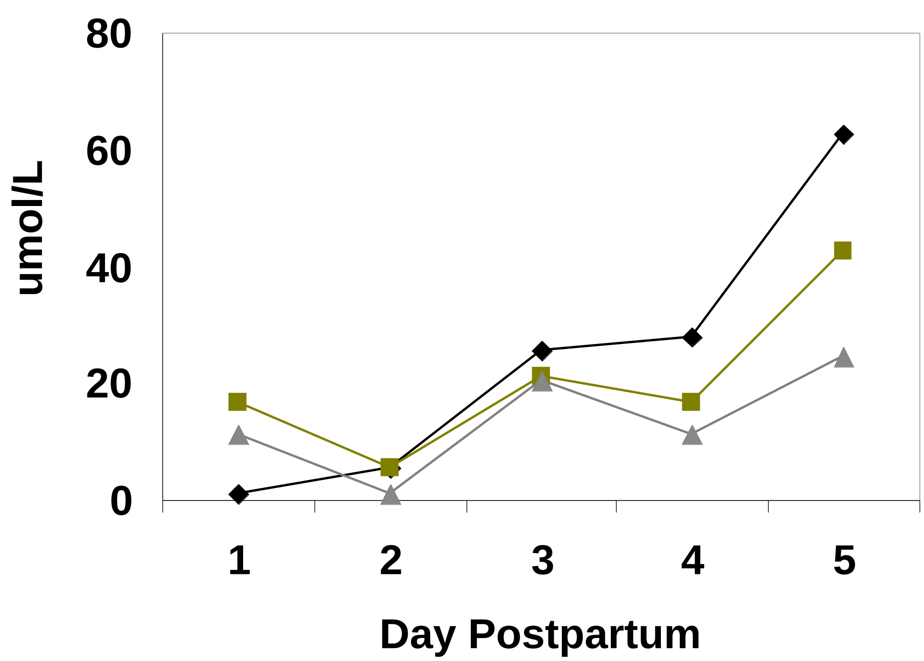

Figure 1. Beta-hydroxybutyric Acid Content in Milk from Primiparous Cows Fed TMR (◆), A (■), or A + C (▲).

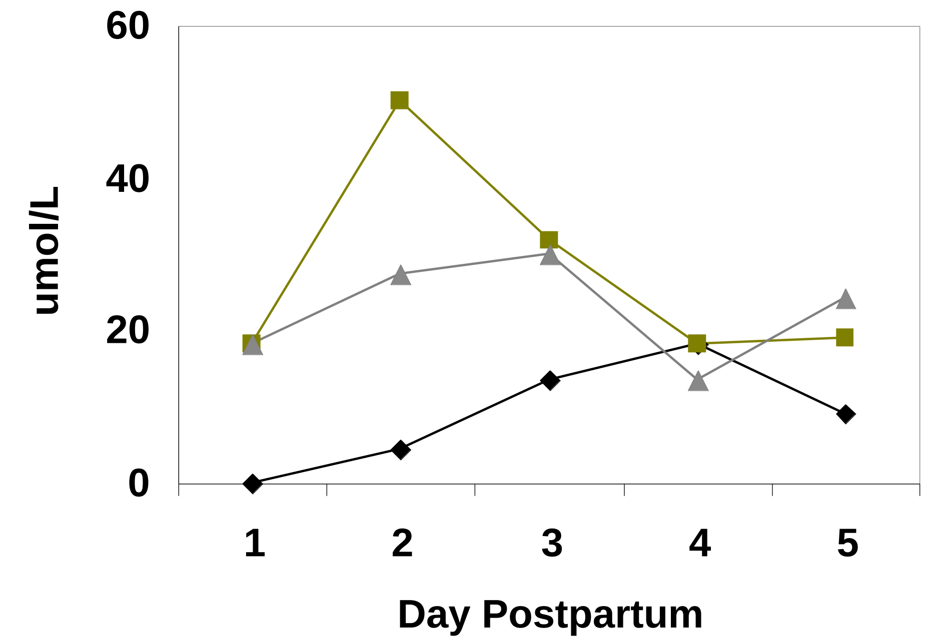

Figure 2. Beta-hydroxybutiric Acid Content in Milk from Multiparous Cows Fed TMR (◆), A (■), or A + C (▲).

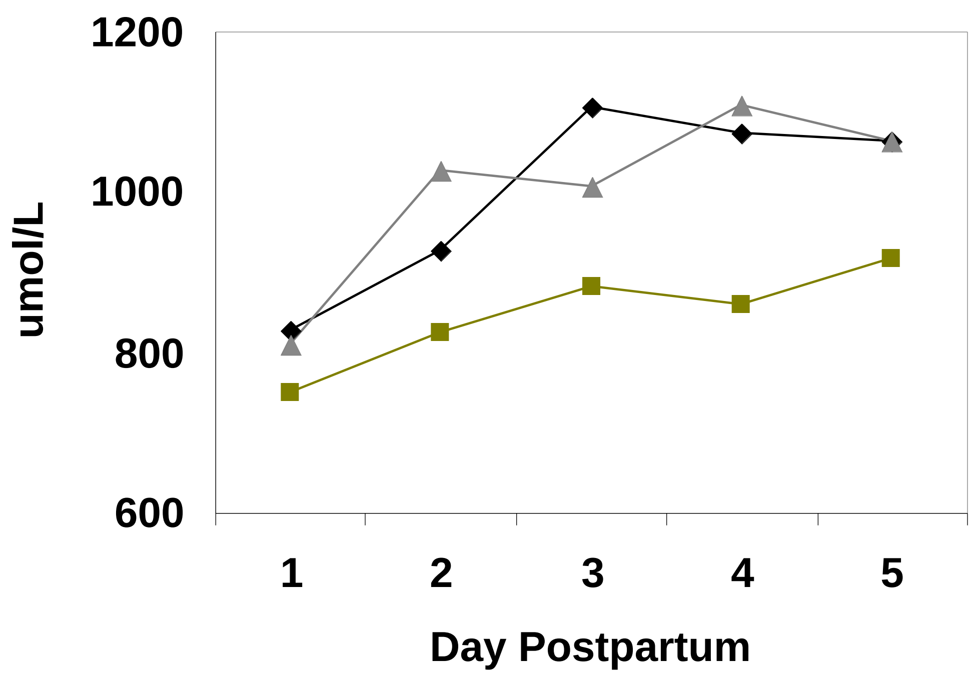

Figure 3. Plasma NEFA Concentration for Primiparous Cows fed TMR (◆), A (■), or A + C (▲).

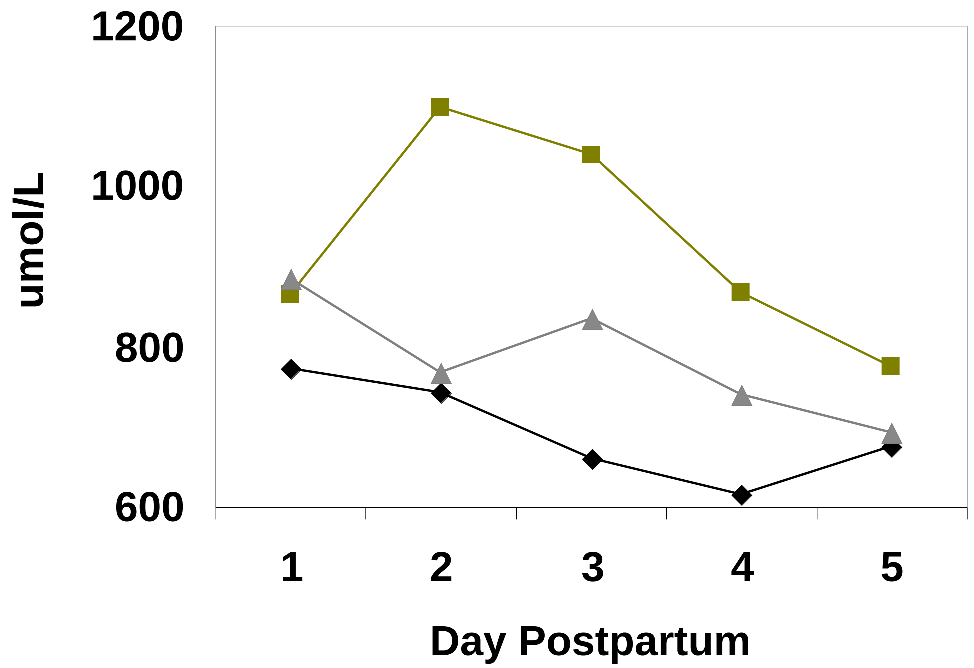

Figure 4. Plasma NEFA Concentration for Multiparous Cows fed TMR (◆), A (■), or A + C (▲).

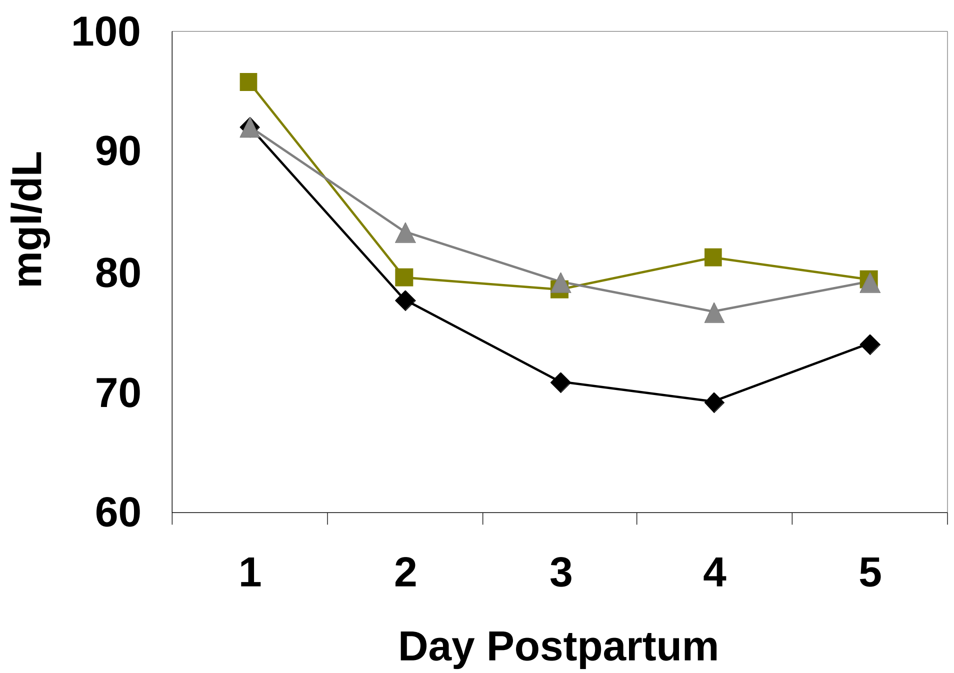

Figure 5. Plasma Glucose Concentration for Primiparous Cows Fed TMR (◆), A (■), or A + C (▲).

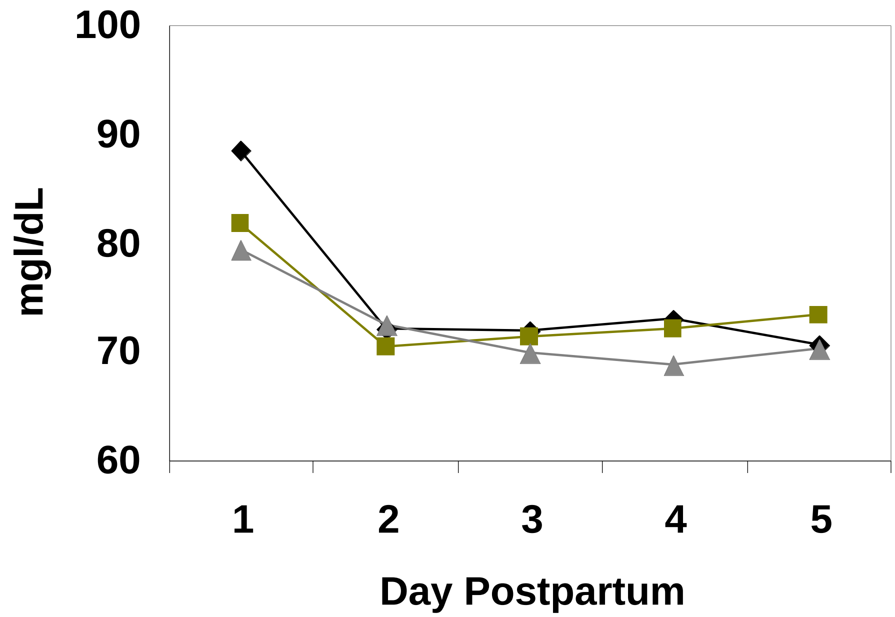

Figure 6. Plasma Glucose Concentration for Multiparous Cows Fed TMR (◆), A (■), or A + C (▲).

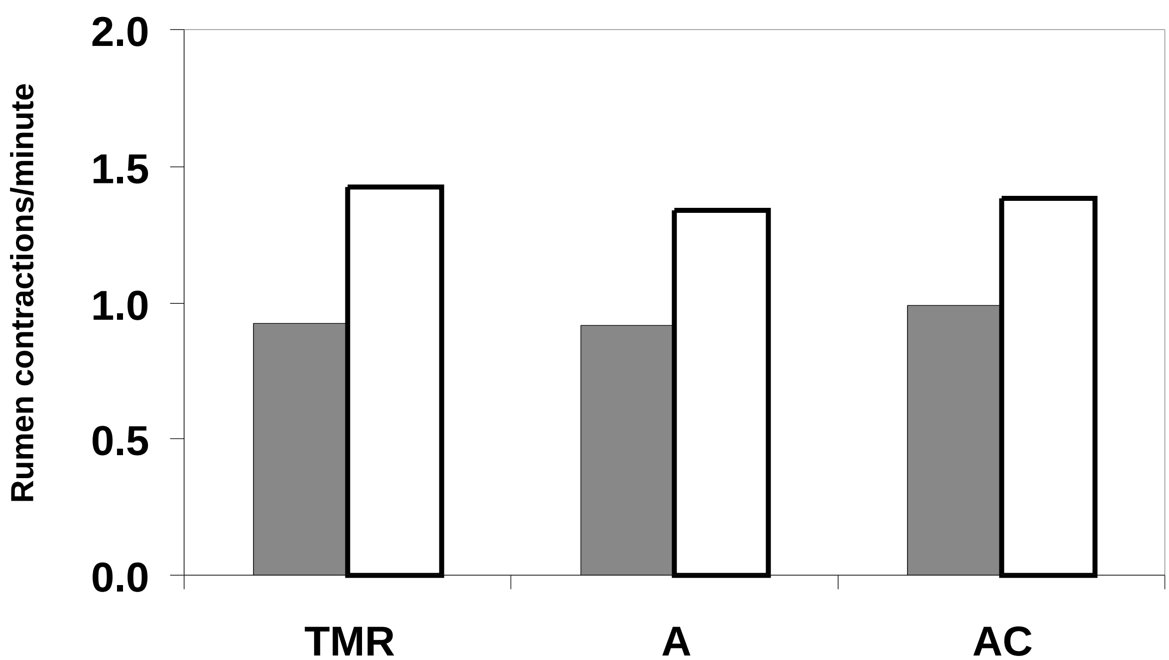

Figure 7. Rumen Contractions for Primiparous (■) and Multiparous (□) cows.

Table 1. Ingredient and Chemical Composition of Experimental Diets

	Diet[1]		
Ingredient	TMR	TMR + A	TMR + A + C
	-----------------% of dry matter	------------------------	
Alfalfa hay	22.0	25.8	24.8
Corn, dry-rolled	27.4	26.1	29.5
Corn silage	10.0	9.5	9.0
Wet corn gluten feed	20.0	19.0	18.1
Whole cottonseed	9.0	8.6	8.1
Soybean meal, expeller	7.1	6.8	6.4
Fishmeal	1.3	1.2	1.2
Molasses	1.2	1.1	1.1
Sodium bicarbonate	0.69	0.65	0.62
Limestone	0.64	0.61	0.58
Trace mineralized salt[2]	0.29	0.28	0.26
Magnesium oxide	0.20	0.19	0.18
Vitamin ADE premix[3]	0.12	0.11	0.11
Zinpro	0.05	0.05	0.05
Sodium selenite premix[4]	0.01	0.01	0.01
Nutrient			
CP, %	20.2	20.3	19.8
NDF, %	29.8	30.2	29.3
ADF, %	17.6	18.3	17.6
NFC, %	41.6	41.0	42.7
NE_L[5], Mcal/kg	1.68	1.68	1.68
Calcium, %	1.0	1.0	0.9
Phosphorus, %	0.5	0.5	0.5

[1]Basal TMR= total mixed ration, TMR + A = TMR + 3 lb of top dressed long-stem alfalfa hay, TMR + A + C = TMR + 3 lb of top dressed long-stem alfalfa hay + 3 lb of top dressed dry-rolled corn.

[2]Composition not less than: 95.5% NaCl, 0.24% Mn, 0.24% Fe, 0.05% Mg, 0.032% Cu, 0.032% Zn, 0.007% I, 0.004% Co.

[3]Formulated to contain 5,733 IU of vitamin A, 2,866 IU of vitamin D, and 17 IU of vitamin E.

[4]Formulated to contain 1,323 mg Se per lb.

[5]National Research Council (2001).

Table 2. Lactation Performance of Cows During the First 30 Days in Milk

	Primiparous			Multiparous			
Item	TMR[1]	TMR + A	TMR + AC	TMR	TMR + A	TMR + AC	SEM[1]
No. of cows	9	9	9	10	11	11	
Milk, lbs/day[a]	57.6	60.9	55.0	87.3	91.3	84.5	4.6
ECM[2], lbs/day[a]	67.8	71.1	63.4	93.5	98.6	92.4	5.3
Milk fat, %[a]	4.91	4.74	4.66	3.82	4.16	4.27	0.21
Milk protein, %	3.10	3.26	3.26	3.24	3.22	3.22	0.10
Milk lactose, %[b]	4.72	4.96	4.85	4.70	4.91	4.72	0.08
Milk SNF, %	8.73	9.17	9.03	8.89	9.03	8.84	0.17
Milk fat, lb/day[a]	2.8	2.8	2.5	3.4	3.7	3.5	0.2
Milk protein, lb/day[a]	1.8	2.0	1.8	2.9	2.9	2.7	0.2
Milk lactose, lb/day[a]	2.7	3.0	2.7	4.1	4.5	4.0	0.2
SCC[3], × 1000	79	93	208	212	125	196	71
Milk urea N, mg/dl[a]	13.4	12.9	12.7	14.8	15.4	14.5	0.77
No. of cows	9	9	9	11	11	11	
Initial BW, lb[a]	1344	1338	1338	1597	1588	1584	26.2
BW change, lb	-169	-101	-119	-191	-103	-112	13.0
Initial BCS[a]	3.33	3.30	3.30	2.82	2.64	2.73	0.12
BCS change	-0.82	-0.33	-0.64	-0.50	-0.30	-0.37	0.15

[1]Basal TMR = total mixed ration, TMR + A = TMR + 3 lb of top dressed alfalfa hay; and TMR + A + C = TMR + 3 lb of top dressed alfalfa hay + 3 of top dressed dry-rolled corn.

[2]Energy corrected milk.

[3]Somatic cell count.

[a]Effect of parity ($P<0.05$).

[b]Effect of treatment ($P<0.05$): TMR + A >TMR + AC and basal TMR: TMR + AC = TMR.

Table 3. Incidence of Health Disorders for Cows During the First 30 Days in Milk

	Primiparous			Multiparous		
Item	TMR[1]	A	AC	TMR	A	AC
No. of cows	9	9	9	10	11	11
Displaced abomasum	2	1	1	0	2	1
Day of incidence	19,30	10	11	-	9,10	16
Clinical ketosis[2]	0	0	0	0	0	0
Subclinical ketosis[3]	1	0	1	0	0	1
Retained placenta	0	0	0	0	1	0
Metritis	2	0	0	0	0	0

[1]Basal TMR = total mixed ration; TMR + A = TMR + 3 lb of top dressed alfalfa hay; and TMR + A + C = TMR + 3 lb of top dressed alfalfa hay + 3 lb of top dressed dry-rolled corn.

[2]Clinical ketosis: Concentrations of beta-dydroxy butyric acid (BHBA) >1000 µmol/L in milk.

[3]Subclinical ketosis: BHBA > 200 µmol/L in milk.

INCREASING MILKING FREQUENCY IN FRESH COWS: MILK CHARACTERISTICS AND REPRODUCTIVE PERFORMANCE

J.S. Stevenson and J.E. Shirley

Summary

Increased milking frequency during partial or whole lactations increases milk yields, but generally reduces percentages of milk fat and protein. Because of greater milk volume, total fat and protein are not reduced. Combining bovine somatotropin (bST) with increased milking frequency is additive. In other words, milk increases in response to both factors. In some studies, increased milking frequency during early lactation improves udder health, as evidenced by reduced somatic cell scores. Reproductive efficiency generally declines when examined on whole herd basis. When examined in single herds with or without bST, pregnancy rates may not be reduced because of increased milking frequency, and in some cases may be improved.

(Key Words: Milking Frequency, Milk Yields, Reproductive Performance)

Introduction

In the dairy industry today, many factors determine profitability. High fixed costs associated with new, fast, and efficient rapid-exit parlor designs must be justified by maximal milk output. Increased use of these parlors by increasing milking frequency to three and four times daily, and adoption of recombinant-DNA technology in the form of bovine somatotropin (bST) for increased milk yields, have partly justified high fixed costs associated with limited daily parlor use. Greater interest in improving mammary health (reducing somatic cell counts, etc.) and greater production of fresh cows milked at more frequent intervals during early lactation has initiated research in this area.

Whole Lactation Studies

Studies of increased milking frequency during entire lactations have demonstrated that increasing milking frequency from once to multiple times daily increased milk yield from 80% (once daily) to about 120% with multiple daily milkings. Increased milking frequency from twice to thrice daily in one study of more than 10,400 herds per year during 1998 to 2000 resulted in a 15 to 16% increase in milk yields or 13 to 14% increase in energy-corrected milk (ECM) yields. Lower ECM yields occurred because higher milk yields generally reduced percentage yields of fat and protein. Only 7% of herds studied were milked thrice daily in the northern and southern United States.

Herds milked thrice daily had more days open, greater numbers of AI services per conception, longer actual calving intervals, and more cows entering and leaving the herd than herds milked twice daily. These measures of reproductive efficiency often are associated with prolonged days to first ovulation and estrus in individual cows. In contrast, somatic cell scores were reduced, with fewer cows per herd with scores in the high range (7 to 9), and more in the low range (0 to 3) after thrice daily milking.

The effects of combining bST and increased milking frequency are additive. Increasing milking frequency from twice to thrice daily increased fat-corrected milk (FCM) yield by 3.5% in both first (9.0 lb/day) and multiple (10.4 lb/day) lactation cows. Injection of bST increased FCM by 11 lb in first and 9.5 lb in multiple-lactation cows over 230 days in milk. Increased milking frequency did not prevent increases in body condition as lactation progressed, but bST prevented these increases.

Part Lactation Studies

Studies of increased milking frequency or combinations of suckling and milking during various parts of the entire lactation revealed interesting results. Cows that were machine-milked in the morning and suckled by calves in the evening during the first 8 weeks of lactation produced 16% more milk (total of milk resulting from suckling and milking) during a 300-day lactation than cows milked twice daily. Suckling apparently increased milk yield by reducing the amount of residual milk in the udder after suckling during the first 4 days after parturition, but not at later periods.

Cows nursing their own calves plus one foster calf each during the first 8 to 9 weeks of lactation produced 18 to 55% more milk than cows with single calves, even after the foster calves were weaned. In a more recent study, cows milked thrice daily plus suckled thrice daily by two calves during the first 6 weeks of lactation produced more milk than cows milked six times daily. Cows milked six times daily during the first 6 weeks of lactation out-produced those milked thrice daily (86.6 vs. 77.8 lb), but yield was similar between 7 and 18 weeks of lactation (93.7 vs. 94.1 lb) when both groups of cows were milked only thrice daily.

Milk fat and protein percentages were slightly reduced during six times daily milking, as shown by whole-lactation studies, but actual yields of fat and protein tended to be greater because of higher total milk volume in cows milked six times daily. However, in another study, only protein percentages were significantly reduced after six vs. three times daily milkings. In that study, conception rates of cows tended to be greater for those milked six times than thrice daily (31.0% vs. 23.3%) after a synchronized insemination between 69 and 76 days in milk.

A recent study at the University of Illinois compared cows that were milked thrice daily to those milked six times daily during the first three weeks of lactation, but thereafter milked only thrice daily. Daily yields of milk increased from 98.5 to 104.5 lb during the first 150 days in milk; peak yields increased from113 to 126 lb; and actual 305-day yields increased from 27,029 to 29,520 lb, whereas SCC declined.

In an experiment conducted at Kansas State University, Holsteins were assigned to be milked four times daily for the first 30 days of lactation and twice daily thereafter, whereas the controls were milked twice daily. Cows were either treated or not treated with estradiol cypionate (ECP) as prophylactic therapy for improved uterine function, and were either treated or not treated with bST starting at 63 days in milk. Mature equivalent 305-day milk yields and components resulting from that study are summarized in Table 1. Ignoring the effects of ECP on milk yields, which were negative, milking four times daily for only the first 30 days in milk improved ECM yields by 2,180 lb compared with twice daily milkings with no bST, and by 771 lb with bST. Injection of bST increased ECM yields by 2,187 lb in twice daily milked cows and 778 lb in four times daily cows, or 2,564 lb overall. Somatic cell scores were not improved or harmed by increased milking frequency during the first 30 days in milk.

Conception rates after a synchronized insemination were not adversely affected by increased milking frequency. On the contrary, four times daily milking in conjunction with previous treatment with ECP produced greater pregnancy rates at first service (Table 1).

Table 1. Mature Equivalent (ME), 305-day Energy-Corrected Milk Yields and First-Service Pregnancy Rates in Lactating Dairy Cows in Response to Milking Frequency (MF), ECP Therapy, and Bovine Somatotropin (bST)[1]

Item	bST	Milked 2x		Milked 4x		bST total
		Oil	ECP	Oil	ECP	
No. of cows	−	15	16	15	17	63
	+	19	20	21	20	80
Energy-corrected milk[2], lb	−	28,493	30,012	30,673	26,868	29,013
	+	30,680	31,473	31,451	32,703	31,577**
No. of cows	−	24	23	26	31	104
	+	9	12	10	5	36
First-service conception rate[3], %	−	37.5	43.5	26.9	51.6	40.4
	+	44.4	50.0	30.0	60.0	44.4

**Different (P<0.01) from no bST.

[1]Cows were milked either 2x vs. 4x daily for the first 30 DIM and then milked 2x thereafter; received 10 mg of ECP in oil vs. oil once between d 2 and 15 postpartum; and were treated with bST or not beginning in the ninth week of lactation.

[2]Interaction (P<0.01) of bST x lactation number (no bST-1st = 30,320 lb; no bST-2nd = 27,703 lb; bST-1st = 31,405 lb; and bST-2nd = 31,747 lb).

[3]Interaction (P=0.05) of milking frequency and ECP (2x-no ECP = 39.4% [n = 33]; 2x-ECP = 45.7% [n = 35]; 4x-no ECP= 27.8% [n = 36]; and 4x-ECP = 52.8% [n = 36]).

VARIATIONS IN THE OVSYNCH PROTOCOL ALTER PREGNANCY RATES IN LACTATING DAIRY COWS

M.A. Portaluppi and J.S. Stevenson

Summary

Initiation of the Ovsynch protocol at random stages of the estrous cycle produces differences in synchronization and pregnancy rates. Use of two injections of $PGF_{2\alpha}$ administered 14 days apart, with the second injection given 12 days before initiating the Ovsynch protocol increased the percentage of cows that start the Ovsynch protocol at a more desirable stage of the estrous cycle (e.g., between days 5 and 13). In this experiment, after applying the Presynch-Ovsynch protocol, timing of the second injection of GnRH and insemination were altered to determine their effect on pregnancy rates. Cows that received the second GnRH injection at the same time as they were inseminated at 72 hours after $PGF_{2\alpha}$ had greater pregnancy rates than cows that received the second GnRH injection at 48 hours after $PGF_{2\alpha}$ and were inseminated 0 or 24 hours later.

(Key Words: Ovsynch, Presynch, Pregnancy Rates)

Introduction

The effective application of an estrus-synchronization or ovulation control program allows one to determine the time of insemination. Recent studies have reported that cows initiating the Ovsynch protocol in the early to midluteal phase (days 5 to 13) of the estrous cycle have greater pregnancy rates than cows in which the protocol was initiated at random stages of the cycle. To target the initiation of the Ovsynch protocol during this favorable stage of the estrous cycle, it is necessary to presynchronize the estrous cycles of cows before the first injection of GnRH of the Ovsynch protocol. Use of two injections of $PGF_{2\alpha}$ 14 days apart constitutes a practical and relatively inexpensive method for presynchronization. Cows receiving the Presynch protocol have greater pregnancy rates than cows treated only with Ovsynch. Furthermore, establishing the optimal and practical time of insemination in which maximal pregnancy rates might be achieved constitutes the reason for recent investigations. Previous studies demonstrated that cows inseminated at different times (from 0 to 24 hours) after the second GnRH had similar pregnancy rates, whereas those inseminated as late as 32 hours after GnRH had reduced pregnancy rates.

The objectives of the present experiment were to determine pregnancy rates after altering times of the second GnRH injection and insemination in the Ovsynch protocol to accommodate once daily lockup of dairy cows.

[1]We thank Duane Meier of Meier Dairy, Palmer, Kan., and Steve Ohlde of Ohlde's Dairy, Linn, Kan., for cooperating in this study.

Procedures

In the current experiment, 715 lactating dairy cows from two dairy herds in northeastern Kansas were studied. Cows were less than 40 days in milk at the start of the Presynch protocol. They were milked three times daily and produced more than 10,000 kg of milk.

All cows received two, 25-mg injections of $PGF_{2\alpha}$ (5 cc of Lutalyse, Pharmacia Animal Health, Kalamazoo, Mich.) 14 days apart, with the second injection given 12 days before initiating the Ovsynch protocol. Cows were blocked by lactation number and randomly assigned to three treatments (A, B, and C) consisting of variations of the Ovsynch protocol. Treatments were initiated every 2 weeks within herd, with each herd breeding cows on alternate weeks. Body condition (scale of 1 to 5; 1 = thin and 5 = fat) was evaluated during the week of insemination.

Figure 1 illustrates the treatment protocol. Cows in treatment A and B received two, 100µg injections of GnRH (2 cc of Fertagyl, Intervet, Millsboro, Del.) 7 days before and 48 hours after a $PGF_{2\alpha}$ injection. Fixed-time inseminations were made at the time of GnRH injection (0 hour; treatment A) or 24 hours later (treatment B). Cows in treatment C received the second GnRH injection at 72 hours after $PGF_{2\alpha}$ and were inseminated at the same time. All cows involved in the experiment were treated and inseminated during the morning hours after milking while they were restrained by feed line head locks. If cows were detected in estrus before their scheduled TAI, they were not inseminated until their scheduled treatment time. Pregnancy was diagnosed weekly by palpation of uterine contents on days 40 or 41 after TAI by the same veterinary practitioner. Results for 666 of 715 cows are reported below. Reasons for the loss of data from 49 cows included death culling for various reasons.

Results and Discussion

Based on previous studies we expected an increase in the proportion of cows that initiated the Ovsynch protocol during the early or midluteal phase because of the Presynch injections of $PGF_{2\alpha}$. The effects of treatment on pregnancy rates are summarized by herd in Table 1. Herds differed ($P<0.01$) in overall pregnancy rates. Across herds, pregnancy rates for cows were greater ($P<0.05$) after treatment C than after treatments A and B. First-lactation cows (n = 265) also had greater ($P<0.05$) pregnancy rates (32 vs. 27%) than older cows (n = 401).

Earlier studies evaluated different times of insemination after estrus. Those studies suggested that inseminating cows at 0, 8, 16, or 24 hours after the second GnRH injection produced greater pregnancy rates than inseminating at 32 hours after GnRH. In the previous scenario, all cows were given GnRH 48 hours after $PGF_{2\alpha}$.

In our study, inseminating at 0 and 24 hours after GnRH, when GnRH was administered at 48 hours after $PGF_{2\alpha}$ produced lower pregnancy rates than inseminating and injecting GnRH at 72 hours after $PGF_{2\alpha}$. Treatment C is a novel treatment not heretofore tested. Further, treatment C allows time and labor savings because cows are inseminated and injected on the same day, and all treatments and inseminations can occur at the same time of the day as all previous injections (all AM or all PM).

Pregnancy rates using treatment C would likely improve if cows expressing estrus before their scheduled TAI on Thursday mornings were inseminated based on detected estrus and the remaining cows were inseminated on Thursday morning and given GnRH. This procedure would serve as a clean-up insemination for cows not detected in estrus and inseminated.

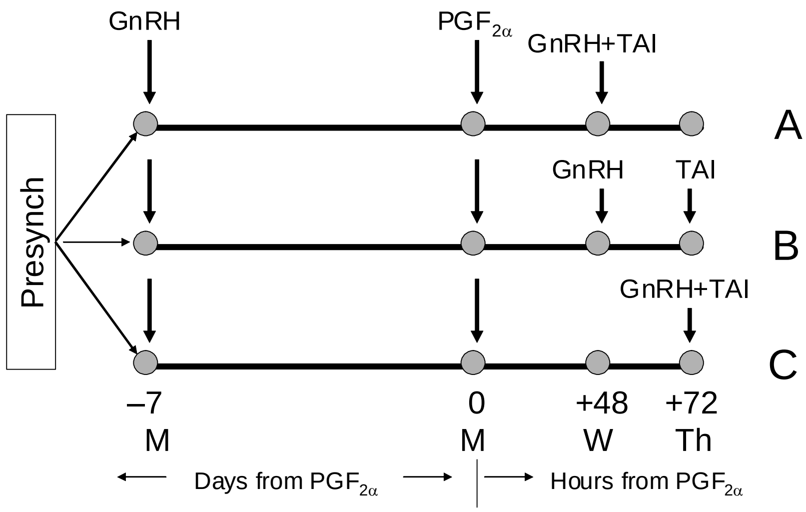

Figure 1. Treatment Protocol for Experiment. All cows received two injections of $PGF_{2\alpha}$ 14 days apart (Presynch), with the second injection given 12 days before initiating the Ovsynch protocol.

Table 1. Pregnancy Rates at 40-41 Days after First Insemination

	Treatment			
Herd	A	B	C	Total
1	16 (80)	19 (78)	24 (76)	20 (234)
2	27 (141)	34 (147)	41 (144)	34* (432)
Total	23 (221)	29 (225)	35** (220)	29 (666)

*Different (P<0.01) from herd 1.
**Different (P<0.05) from treatments A and B.

INDEX OF KEY WORDS

Indexer's note: Numbers indicate the first pages of each article that uses the listed key word.

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BIOLOGICAL VARIABILITY AND CHANCES OF ERROR

Variability among individual animals in an experiment leads to problems in interpreting the results. Although the cattle on treatment X may have produced more milk than those on treatment Y, variability within treatments may indicate that the differences in production between X and Y were not the result of the treatment alone. Statistical analysis allows us to calculate the probability that such differences are from treatment rather than from chance.

In some of the articles herein, you will see the notation "P<.05". That means the probability of the differences resulting from chance is less than 5%. If two averages are said to be "significantly different," the probability is less than 5% that the difference is from chance, or the probability exceeds 95% that the difference resulted from the treatment applied.

Some papers report correlations or measures of the relationship between traits. The relationship may be positive (both traits tend to get larger or smaller together) or negative (as one trait gets larger, the other gets smaller). A perfect correlation is one (+1 or -1). If there is no relationship, the correlation is zero.

In other papers, you may see an average given as 2.5 ± 0.1. The 2.5 figure is the average; 0.1 is the "standard error." The standard error is calculated to be 68% certain that the real average (with unlimited number of animals) would fall within one standard error from the average, in this case between 2.4 and 2.6.

Using many animals per treatment, replicating treatments several times, and using uniform animals increases the probability of finding real differences when they exist. Statistical analysis allows more valid interpretation of the results, regardless of the number of animals. In all the research reported herein, statistical analyses are included to increase the confidence you can place in the results.

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