THE EFFECT OF MILKING PRACTICES UPON THE DETERIORATION OF MILKING MACHINE INFLATIONS

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This research was designed to study the effects of milking practices upon the deterioration of natural rubber liners. Winter rations appear to produce a more severe rate of blistering than either summer pasture or ration.

Cleaning seemed to have little effect upon rate of blistering. Storage in 10% lye solutions increased the time to blister. Pure fatty acids were shown to produce blistering. Udder ointments and mostitis treatments used in this study had no appreciable effects on blistering of rubber.

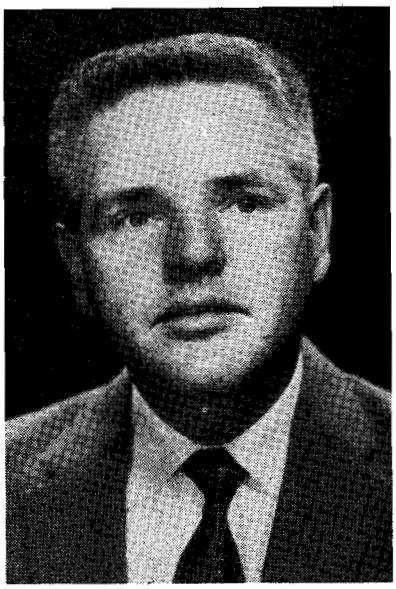
The rather rapid blistering or roughening of the inner surface of natural rubber liners for milking machines, in some field locations, is a problem of long standing. Up to the present time no adequate findings are available to explain the deterioration. It is well-known however that natural rubber (Hevea) is easily attacked by oils and certain other reagents.

English workers have investigated this problem in considerable detail *(1, 2, 5, 6, 7)*. They have concluded that the fatty secretions from the skin and hair of the cow are very important in the deterioration of rubber. Claydon *(3, 4)* has investigated the relation of bacterial contamination in rubber liners with microscopically inconspicious deterioration. The results of a comparison of natural rubber and neoprene inflations has been reported by White and Folds *(9)*.

To minimize the effects of deterioration of liners, general purpose (GRS* Neoprene) and special purpose (Hycar, Perbunan) synthetic rubbers have been used rather extensively in recent years. These synthetics provide a product which has a lower rate of blistering; however, these products lack, in many instances, some of the properties of natural rubber (resilience, hand, etc.) which makes it the preference of some dairymen for milking machine usage.

It has been noted from field observations and in this study that the blistering of the inner surface of the teat cup liner is principally confined to the area where the teat impinges on the inner surface of the rubber liner (see Figure 1). The remainder of the liner is usually free of any noticeable defects. The degree of blistering or roughening depends upon the number of cows milked and other factors.

*GRS — The Government Reserve Board identification for Buna S types of general purpose synthetic rubber.



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In this investigation the following factors were studied with respect to the effects of each on the blistering and/or roughening of milking inflations; *(a)* effect of secretions from the teat and/or udder, *(b)* effect of udder salves and oil base antibiotics for mastitis treatment, *(c)* effect of poor cleaning methods, *(d)* effects related to the breeds of cows, *(e)* effects due to the type of ration, *(f)* effects which might be related to season of the year, and *(g)* effects of milk or milk fat absorption.

METHODS

Inflations made of a blend of natural rubber (Hevea) and general purpose (GRS) were used for this study. The two rubbers were in the ratio of 70 percent Hevea (natural rubber) to 30 percent GRS (General purpose synthetic). These inflations were made from a single controlled batch of rubber at the Gates Rubber Company factory in Denver, Colorado. The production of the actual inflations was care-

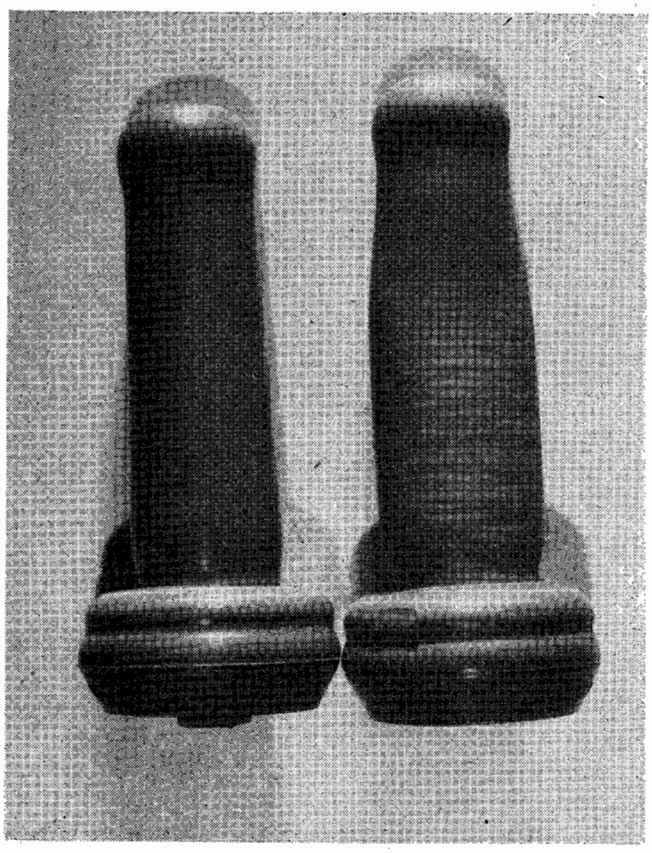

FIGURE 1. An unused natural rubber milking machine liner (left) and a similar liner showing the typical severe blistering after several weeks of heavy usage.

fully supervised through all phases of manufacture to insure a uniform product.

The Colorado State University milking herd of about 80 cows was used in this study which covered a period of one year. This herd consisted of Holstein, Guernsey, Jersey and Brown Swiss breeds. All cows were milked with a bucket type milker using the inflations previously described which were the L-22 type with a cushion top. The cows were tied in stanchions while being milked and were fed during the winter the usual ration which consisted of good quality hay, corn and alfalfa silage. In the summer (four months) the cows had access to pasture grass or green chopped alfalfa. A grain ration of 12% protein was fed at the rate of about one pound of grain to each five pounds of milk.

At the start of each experimental phase new inflations were installed and the time required to observe visible roughness was noted. At that time a new set of inflations was installed and later removed when visible roughness was again noted. This procedure was repeated during the course of the experiment. Milking machine heads were equipped with counters for those trials where the number of milkings involved was important.

An artificial milking set-up was designed consisting of a set of liners containing a sponge in each liner with the top end plugged. The liners were attached to a vacuum line at a vacuum level and pulsation rate to conform to conditions existing at the barn. The entire set-up simulated as nearly as possible actual milking conditions.

RESULTS

Secretions from the teat and/or udder

In an attempt to eliminate or minimize the effect of any oily secretion from the teat and/or udder, the teats and lower udder of three Holsteins were thoroughly washed with acetone just prior to milking. Eleven days or 66 milkings were required to produce any noticeable or significant blistering. It should be noted, however, that these liners were performing six milkings per day.

Acetone extractions of used liners which had blistered and/or roughened were made in an attempt to separate a fraction which would rapidly blister rubber when applied to the inner surface of a new inflation. Since sufficient material was not extracted from liners, it was decided to use special absorbent liners. These special liners consisted of a pure gum rubber compound and were highly absorbent. They were used for about one week and then extracted with acetone. The acetone extract was separated into saponifiable and non-saponifiable fractions.

In a further attempt to prepare a concentrate of the extracted material, the acetone was boiled off and the residue taken up in sodium hydroxide. This resulted in two seperate layers. From this material three fractions were prepared: *(a)* the top layer, *(b)*, the bottom layer, and *(c)* a mixture of the two layers. These were applied to new inflations. The material dried rapidly, but in the treatment where the two layers were combined, some eruptions occured while none were found with the material from separate layers. The bottom layer, or more insoluble layer, was assumed to be the non-saponifiable fraction. The significance of the results obtained are not clear.

It is significant that the residue from the extraction of the used liners was found to give a positive test for cholesterol. Cholesterol is present in butterfat in appreciable quantities and is also believed to be a constituent of glandular secretions. For these reasons tests were carried out with cholesterol. The cholesterol was soluble only in ether. It was noted that ether treatment alone produced a swelling of about two times the normal size of the rubber in 18 hours. When the rubber was allowed to dry and the ether had evaporated, the cholesterol came to the surface of

the rubber. When it was scraped from the surface, it was replaced by more cholesterol from the rubber. Swelling but not blistering resulted from this treatment.

In another trial, sections were cut from new liners and placed in melted, unsalted butter at room temperature. After six hours of exposure, the rubber had swollen and blistered.

Udder Salves and Antibiotics Treatments

Several udder ointments used for chapped teats were applied to cows of the University herd. These ointments did not cause liners to blister faster than those used on untreated cows.

One machine was equipped with new liners and was used exclusively in milking cows which had been treated for mastitis with antibiotic preparation. The rubber on this machine did not blister any more rapidly than those used on the regular herd.

Cleaning methods

It was felt that perhaps improper cleaning was a contributing factor to the deterioration of the rubber. The cleaning method in regular use consisted of a thorough rinse in tepid water immediately after milking. The liners were removed from the shells and brushed clean daily with a good washing powder. Once a week the inflations were boiled for twenty minutes in a 10% lye solution. This was done in a special piece of commercial stainless steel equipment. The liners were stored dry and sanitized immediately before use. To study poor cleaning methods, one set of liners were not cleaned until four hours after milking and compared with liners which were cleaned immediately after milking. The two treatments did not cause any appreciable difference in speed of blistering. At the same time one set of liners was cleaned and stored all day in a cold 10% lye solution. This treatment delayed the appearance of blistering by 7 to 10 days over the usual treatment.

Water and the cleaning solutions as used in the dairy were applied to the sponges of the artificial milking set up. These materials produced no blistering.

Breeds of Cows

In this trial a separate machine was used to milk seven cows of each of the Jersey, Guernsey, and Holstein breeds. The liners used to milk the Jersey cows blistered much more rapidly than those used for the other two breeds. Those liners used on the Holstein cows blistered somewhat more rapidly than those on the Guernsey cows.

Type of Ration

Throughout the winter and spring months, at about two-week intervals, new inflations were put on all of the machines and observations were made on the length of time required for blistering to develop. From December 1 until the time that the cows went on pasture, the length of time required was consistently 3 to 5 days. On May 29th the college herd was divided into three groups: one group was turned on pasture, one group was fed green chopped alfalfa and the other group was fed alfalfa silage. Beginning at this time and continuing until late fall, a period of 10 to 14 days was required for blistering compared to 3 to 5 days when the cows were on winter feed. The pasture, green chopped alfalfa and silage feeding was ended on September 24th. On the following day all machines were equipped with new liners and 10 days were required to produce noticeable blistering. This procedure was repeated several times and about a month later the liners were again blistering in 3 to 5 days During this time the cows were receiving a ration consisting primarily of corn silage and hay.

In July individual milking machines were set up to milk two different groups of cows; one group was on pasture and the other group was on alfalfa silage feed. The liners used for the cows on the silage feed blistered in four days while those liners used for the cows on pasture required ten days to reach the same degree of blistering.

Seasonal Effects

Seasonal effects, of course, are associated with ration effects since the only changes in the rate of blistering occurred immediately after the cows were changed to summer feed. On the other hand, where pasture and green feeding were stopped a thirty-day period elapsed before the rate of blistering returned to the winter level. Other than the effects noted at the times of the change to summer feed, there were no appreciable differences observed in the rate of blistering throughout the year.

Milk and Milk Fatty Acids

A marked difference in blistering rate was found between summer and winter seasons, presumably due to effect of ration; the blistering rate being greater in winter than in summer. It is also well-known that the fatty acid composition of butterfat varies from summer to winter *(10)*. For these reasons a study of the individual component fatty acids was made. These studies were made with the artificial milking set-up and the results are included in Table 1.

The data in Table 1 indicate that the fatty acids of intermediate chain length produce the most rapid blistering. When the acids were diluted with milk, blistering was more rapid than with water. The

TABLE 1 — THE TIME REQUIRED FOR BLISTERING OF INFLATIONS TO BECOME EVIDENT IN THE PRESENCE OF FATTY ACIDS WHEN TESTED IN THE ARTIFICIAL MILKING SETUP

Acid	Dilution in carrier	Extent of blistering
Stearic Acid	1 to 10 in acetone	Slight in 20 hours
Palmitic	1 to 10 in acetone	None in 12 hours
Linoleic	1 to 1 in water	Swelling in 2 hours
Lauric	1 to 1 in water	Swelling and some blistering in 2 hours
Capric	1 to 10 in acetone	Severe in 2 hours
Caproic	1 to 10 in acetone	None in 2 hours
Capyryllic	None	Severe in 2 hours
Butyric	None	Slight in 12 hours
Raw Milk	None	None in 3 hours
Raw Cream	None	Slight in 3 hours
Linoleic	1 to 5 in milk	Typical blisters in 3 hours
Lauric	1 to 5 in milk	Slight in 2 hours
Capric	1 to 5 in milk	Very slight in 2 hours
Capryllic	1 to 10 in milk	Severe in 2 hours
Butyric	1 to 10 in milk	Slight in 3 hours

blistering developed was identical with that which developed under barn conditions except when linoleic acid was used, in which case atypical blistering developed. The blistering was also confined to the area of impingement between the sponge and the inner surface of the liner.

It might be pointed out for the sake of comparison that three hours operation of the artificial milking set-up was equivalent to about one day's use of a milking unit under the conditions in the University herd. Twelve hours of operation would be equivalent to four days of use under herd conditions and twenty hours of operation equals six to seven days of operation under herd conditions. This may be compared with the results reported of three to five days under winter conditions and ten to fourteen days under summer conditions for the development of blistering when used in the usual herd milking operations. However it should be noted that the operation of the artificial milking set-up was continuous which, of course, is not the case under herd conditions. It was found that as the interval between the use of the machines increased, the time to develop blistering was increased. This fact, of course, reduces the value of making comparisons between herd conditions and the artificial milking set-up.

DISCUSSION

Either the type of ration fed or the season of the year appeared to have a marked effect upon the rate of blistering. One year's trial would seem to indicate that the type of ration was more important than the season. When one considers the marked increase in time required for blistering which was associated with the change from winter to summer feeding and the fact that the fatty acids of intermediate chain length were the most effective in producing blisters, one might hypothesize that the summer feeding regime would cause less of these fatty acids to be present in summer milk. There is some support for this reasoning. Reichert-Meissl numbers of butterfat were found to be somewhat lower in the summer months although differences were rather small *(10)*. We were unable to find any information on the fatty acid composition of milk produced under conditions of heavy silage feeding. It is apparent from Table 1 that several of the free fatty acids were much more effective in blistering rubber than was milk or butterfat. Perhaps some free fatty acids are formed in the act of milking and adhere to the milker rubber, however, the damage noted under barn conditions could be explained on the basis of milk alone without the necessity of postulating the presence of free fatty acids.

The authors realize that an explanation for rubber deterioration based upon the action of fatty acids of intermediate chain length is based on meager evidence, however the data obtained provide some indication that the presence of such acids might be a factor in promoting blistering.

The observations made on the effect of the type of ration upon the deterioration of inflations warrants further investigation, particularly studies on the effect of dry-lot feeding of a winter type ration as compared to pasture or green chopped feed.

The ointments or mastitis treatments used in this study had no appreciable effect upon the rate of blistering of milking machine inflations. Likewise, the efficiency of cleaning did not appear to influence the rate of blistering. Soaking in 10% lye solution between milkings, however, did materially reduce the speed of blistering. The value of lye solutions in the extraction of fat from milker liners has been shown by Jensen *(8)*.

In this study, cows of the Jersey breed produced much more rapid blistering of the inflations than the Holstein or Guernsey breeds with the Holsteins producing slightly more rapid blistering than the Guernseys.

CONCLUSIONS

Winter rations appeared to produce a more severe rate of blistering than either summer pasture or ration.

Different rates of blistering appeared to be associated with different breeds of cows.

Cleaning appeared to have little effect upon the rate of blistering. Storage in 10% lye solutions increased the time required to blister. Pure fatty acids were shown to produce blistering.

Udder ointments and mastitis treatments used in this study had no appreciable effects on blistering of rubber.

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