EFFECT OF TEAT CUP LINER DIAMETER AND MOUTHPIECE ON THE MILKING RATE, MACHINE STRIPPING, AND MASTITIS OF DAIRY COWS 1

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SUMMARY
Milking machines equipped with teat cup liners having bore diameters of 7/8, 1 1/16, and 1 1/4 in. and two types of mouthpieces were used to milk dairy cows. Each type of liner was used for 28-day periods. There were no significant differences in milking rate due to bore diameter. The type of mouthpiece did not affect the rate of milk flow nor the machine stripping time. More difficulty was encountered in keeping the narrow bore liners and solid mouthpiece liners attached to the cows' teats.

The bore diameter and type of mouthpiece did not influence the degree of udder irritation or new mastitis infection rate of cows milked with the various types of liners. Under the conditions of this experiment, the narrow-bore molded liner had no advantage for milking cows over the medium- or wide-bore molded liners.

Considerable attention has recently been given to narrow-bore liners. This has been directed primarily to the stretch or extruded type of liner. This liner, however, presents two major problems: (1) difficult to assemble, and (2) difficult to keep clean to meet state and city health requirements.

In a comparison of molded and extruded liners, Dodd et al. (3) found a higher incidence of mastitis in quarters milked with the molded liners; however, the new infection rate was similar for both groups. In another experiment by the same authors (7), a slightly higher incidence of infected quarters and clinical mastitis occurred in quarters milked with the extruded liners in comparison to the molded liners. Murphy (5, 6) also compared the incidence of mastitis in cows milked with molded and two-piece stretched (extruded) liners. In the first trial (5), no difference in the mastitogenic effect of the two liners was noted; however, two infected animals responded more favorably to the stretched liner. In the second experiment (6), the molded liner exhibited a mastitogenic effect in two of five infected quarters. Wilson (10) found that the number of cows badly infected with mastitis was greatly decreased when the liners were changed from a slack, wide-bore inflation to a narrow-bore stretched liner. In a previous report from this laboratory (9), no difference was found in the CMT ratings, Whiteside tests, or leucocyte counts of quarters milked with two types of molded liners.

Dodd (1) states that teat cup liners vary in their milking efficiency. This is particularly true in their ability to remove the last 20% of the available milk. Dodd (2) found that increasing the tension of the walls of the extruded teat cup liner resulted in an increase in the maximum milking rate of the cows.

The object of the experiment was to determine the effect of the teat cup diameter and mouthpiece on the milking rate, machine stripping, and incidence of mastitis in dairy cows.

EXPERIMENTAL PROCEDURE
The liners used in the experiment were shown in Figure 1. The liners were approximately the same except for the diameter of the bore and type of mouthpiece. All liners were straight-sided with wall thickness of 7/32 in. The liners were made of an oil-resistant synthetic blend of rubber by the Crown Dairy Supply Company, Waukesha, Wisconsin. Liners A and B had small take-up rings to maintain the tension on the liner wall. The tension of the other liners was held by the tapered milk
tubes. The internal diameters of the milk tubes of Liners A and B were 7/8 in., whereas those of the rest were 11/32 in. The internal diameters of the liners were as follows: A and B—7/8 in.; C and D—1 1/32 in.; and E and F—1 1/4 in. All of the liners were made to fit the Surge teat cup shell. Liners A, C, and E do not have the extra lip in the mouthpiece found in the Cushion Liners B, D, and F. Liners A and B are called narrow-bore liners in this study; however, liners with smaller diameters are available commercially.

The teat cup liners and shells were attached to a DeLaval claw with an air inlet. This was attached to a Perfection milking machine pail with a variable speed pulsator. The vacuum was supplied by a small vacuum pump mounted on a cart. Fifteen inches of vacuum were used to operate the unit and the pulsators were set at 60 pulsations per minute. The milking measurements and the mastitis data were obtained as outlined previously (9). Milking measurements were obtained on the morning milking of Days 1, 4, 7, 10, 14, 17, 21, 24, and 28 of each experimental period. Fore-milk samples for Whiteside tests, cultures, and leucocyte counts were obtained from each quarter at the evening milking every other day. At the same time, the milk was examined by the California Mastitis Test and on the black plate strip pan.

Eighteen cows were used in the experiment. They were selected on preliminary mastitis survey data, the stage of lactation, and the milk yield per milking. The morning milk yields of the cows ranged between 23 and 44 lb of milk. The cows were divided into six groups of approximately equal production levels. Each group was milked with a different liner for the first experimental period. The experimental period was 28 days in length. After the end of the first period, the liners were switched, using a 6 x 6 Latin-square design with six treatments (liners), six groups, and six periods. The experiment was terminated after the fourth period, because the production level of some of the cows dropped to a low level.

RESULTS AND DISCUSSION

The means of the milking rate observations are given in Table 1. Analyses of variance of these observations showed that the variation due to the nine sampling days on each cow during the 28-day period was not significant; thus, the average value of the nine observations was calculated and it was used for the analyses of variance shown in Table 2. The means in Table 1 are the average values for the 12 cows milked with each experimental liner. From the data in Tables 1 and 2, it will be noted that neither the stripping time nor the total milking time was significantly affected by the diameter of liner or the type of mouthpiece. From Table 2, it will also be noted that the maximum rate
The length and diameter of the teats were then measured. The tip of the teat and the diameter was measured from the base of the udder to the tip of the teat. The average length and diameter of the teats were then correlated with the milking rates, stripping times, and the number of times the units fell off.

The maximum milking rate was averaged for each cow over periods and treatments. The correlation between maximum rate of flow and the length of the teats was -0.37. This was not statistically significant (P > 0.05), due to the small number of degrees of freedom (17); however, it is in agreement with the negative correlation between these two measurements found by Johansson and Malven (4). To determine whether this correlation might be confounded by a stage of lactation effect, the data on stages of lactation and the length of the cow's teats were examined. It was found that the cows with long and short teats were randomly distributed according to the days of lactation.

Considerable difficulty was encountered in keeping the teat cup cluster on the cows with certain types of liners. The units were recorded as having fallen off when the milker had to catch the cluster to prevent it from falling off. The wide-bore liners presented little difficulty, whereas the narrow-bore liners with both types of mouthpieces fell off quite regularly. This is shown in Table 1, and the analysis of variance is shown in Table 2. A significant difference (P < 0.01) occurred between the narrow- and medium-bore liners and also between the medium- and wide-bore liners (P < 0.05). Not all cows presented difficulty in keeping the teat cup assembly attached to the teats. Simple correlations between test length and diameter and the number of times the units fell off with Liners A, B, and C were calculated. These correlations were all small and not significant. This indicates that the difficulty in keeping these liners on the teat was not related to the diameter or length of the teat.

The milking machine can be involved in mastitis in two ways. First it can carry the mastitis organisms from an infected cow to a clean cow. Secondly, it may cause injury to the teats. If the injury is severe enough, it may set up an inflammation and this is then considered mastitis by broad definition. More often, the injury or irritation to the teats may lower the resistance of the gland to the organisms already present in the udder which, in turn, can produce clinical mastitis.

The transfer of the organisms from an infected to a clean cow is primarily dependent upon the sanitation in the milking routine and the condition of the liner. The number of new infections in this experiment is given in Table 3. No significant differences (P > 0.05) occurred between any two treatment means.

The irritation or injury caused by the milking machine should result in a rapid increase in the leucocyte count of the milk. This rapid increase is a possible method of detection.
The first three lines of Table 3. Analyses of increase should show up in a short period of time, especially within a 28-day period. This increase should show up in a short period of time, especially within a 28-day period. Thus, the measure­ment of the leucocyte count of the milk should be long enough for the machine to produce It was found that there were no significant in­creases in the leucocyte count, CMT rating, or Whiteside test during the 28-day periods.

It may be based on the observation by Ratnasabapathy (8), who found a marked increase in the leucocyte count and CMT rating of milk in 4-6 hr after the intraductal injection of 25-100 ml saline. Even though a 28-day period may not be long enough for the machine to produce clinical mastitis, it should be long enough to show the increase in leucocyte count due to udder irritation or injury. Thus, the measurement of the leucocyte count of the milk should indicate whether the milking machine is involved in mastitis.

The figures in Table 3 are taken from the 14 observations made on each cow during the 28-day period. These were then combined for the four periods to obtain the averages shown in the first three lines of Table 3. Analyses of variance were carried out on the observations. It was found that there were no significant increases in the leucocyte count, CMT rating, or Whiteside test during the 28-day periods.

From Table 3 it will be noted that the leucocyte counts were about the same and no significant differences (P > 0.05) occurred between any two treatment means. An arbitrary count of six million leucocytes per cubic centimeter of milk was the highest value used in the analysis for each quarter. The highest recorded value was 30 million leucocytes per cubic centimeter of milk. If such a high value is used per quarter, one value can greatly increase the average value per treatment and not give a true indication of the treatment effect.

Under the conditions of this experiment, it would appear that the narrow-bore molded liner does not have any beneficial effect on rate of milking or reducing udder irritation in comparison to the medium- or wide-bore liners. In fact, the narrow-bore liner was much more difficult to keep on the cows than the wide-bore liner. The type of mouthpiece of the liner also had no effect on the rate of milking, machine stripping time, or incidence of udder irritation; however, much more difficulty was encountered in keeping the solid top liners, especially with the medium-bore liner, on the cows. Most of the previous work on the narrow-bore liner has been done on the extruded liner. It may be that it is more beneficial in increasing milking rate and reducing udder irritation; however, the evidence is far from conclusive.

**REFERENCES**


(3) Dodd, F. H., Olives, J., and Neave, F. K. The Effect of Design of Teat-Cup Liners

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<th>TABLE 3</th>
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<td>Effect of teat cup diameter and mouthpiece on udder irritation and mastitis*</td>
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<td>Liners</td>
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<td>Avg leucocyte count per quarter (mil)</td>
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<td>CMT rating per quarter</td>
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<td>Whiteside rating per quarter</td>
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<td>Highest leucocyte count of non-infected quarter (mil)</td>
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<td>No. quarters showing new infections*</td>
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* None of the differences between any two means are statistically significant (P > 0.05).

b Maximum of six million leucocytes counted for each quarter.

c Reactions rated as 0, trace, 1, 2, 3, and 4 and coded as 0, 1, 2, 3, 4, 5. The coded values are included in the table.

d Quarters showing new infections of Streptococcus nonaglaetiae; Staphylococcus aureus; coliform or paracoli organisms during the experimental period.


