

# **SOURCES OF VARIABILITY IN COMPRESSIVE LOAD APPLIED TO BOVINE TEATS**

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## Introduction

Compressive load (CL) is the force applied to the teat by the closed liner during the D phase of the pulsation cycle. The main purpose of this cyclic pressure is to relieve congestion and edema in teat-end tissues, which develops during the open, or B phase, of the pulsation cycle (Mein et al. 1987). However, too much CL contributes to the development of excessive teat-end hyperkeratosis (Mein, et al., 2003). Several methods and devices, developed to measure the CL applied by the liner on the teat, have indicated the magnitude of the effects of vacuum level, liner wall thickness, liner material hardness, and liner tension on CL (Davis et al., 2001; Reinemann, et al., 1994). One such method that is applicable to measurements on live teats is the start of milk flow (SMF) test (Reinemann et al., 1994, Mein et al., 2003). The objective of this study was to identify sources of variability in CL applied to teats as measured using the SMF method. Investigations included cow-specific variables such as teat end shape, teat length, and teat end diameter and equipment-specific variables such as liner type and vacuum level.

## Materials and Methods

The CL applied by three liners (L1, L2 and L3) at one vacuum level and one liner at three different vacuum levels (40, 44, and 48 kPa [11.8, 13, and 14.2 "Hg]) was measured using the SMF method. The length and diameter of the teats were also measured immediately after milk claw detachment. The 'Touch Point' (pressure difference at which the inner barrel walls of a mounted liner just touch) also was measured for each liner at the time of the SMF measurements.

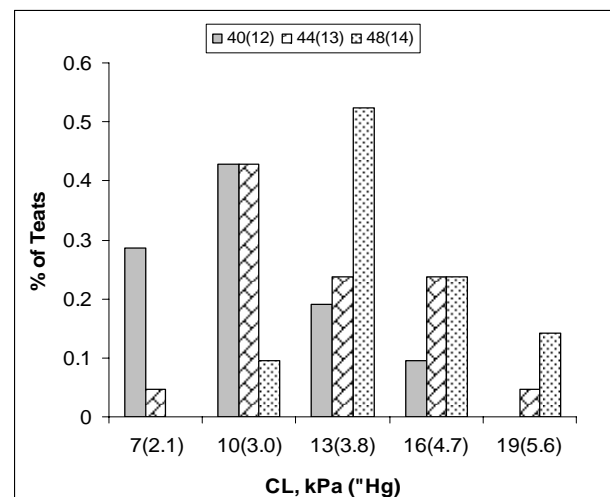
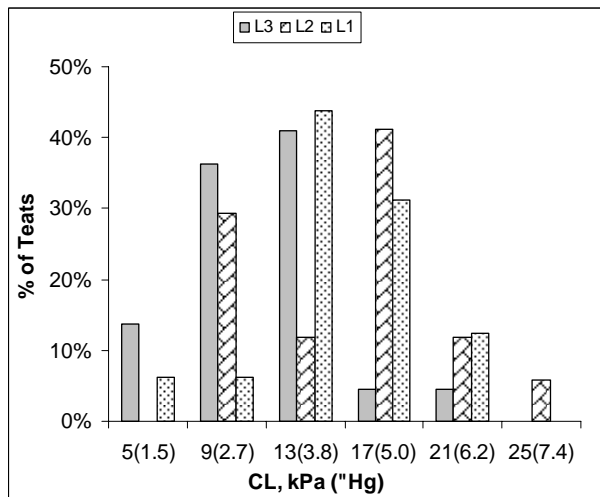
## Results and Discussion

A summary of CL measurements for different liner types and vacuum levels are presented in the following tables. Sample population distributions of CL are presented in the figures. Fifty-five of the fifty-seven teats (one per cow) measured in the first day of test series A were measured again 3 days later with three different liner types. CL was measured on the same group of 21 cows for three different system vacuum levels on three consecutive days in test series B. Mixed model GLM analysis of test series A with cow as a random variable indicated that the mean CL applied by L1 and L2 did not differ from each other, or across test days for L2, but that the mean CL applied by both L1 and L2 differed from that applied by L3. A similar analysis of test series B indicated that the mean CL applied by L2 was significantly different between all of the vacuum levels tested.

Teat length and teat diameter were weakly correlated with CL. While statistically significant, residual vacuum (the difference between TP and system vacuum) explained less than 50% of the

variation in CL. These data can be used to estimate the required sample size to detect differences between the mean CL applied by different liners and at different vacuum levels. Cow-cow variability (partially explained by teat length and diameter) in CL was found to be larger than liner-liner variability for this limited selection of liners. Cow-cow variability may help to explain the variation in hyperkeratosis scores within a dairy herd. Increasing vacuum level increased mean CL considerably and the effect of vacuum level was comparable to the effect of liner type for the liners and vacuum levels tested here.

Test Series	Liner Type	# of teats	Liner Age (40 milkings/day)	Vac. Lev. kPa("Hg)	TP kPa("Hg)	Avg. CL kPa("Hg)	Std. Dev. CL kPa("Hg)
A	L2	57	11 days	44(13)	12.5(3.7)	15.9(4.7) <sup>a</sup>	4.0(1.2)
A	L1	16	2 days	44(13)	12.2(3.6)	16.4(4.9) <sup>a</sup>	4.0(1.2)
A	L2	17	14 days	44(13)	12.3(3.6)	17.2(5.1) <sup>a</sup>	4.5(1.3)
A	L3	22	2 days	44(13)	19.3(5.7)	13.2(3.9) <sup>b</sup>	3.6(1.1)
B	L2	21	14 days	40(11.8)	12.5(3.7)	11.8(3.5) <sup>x</sup>	2.6(.8)
B	L2	21	12 days	44(13)	12.5(3.7)	14.1(4.2) <sup>y</sup>	3.0(.9)
B	L2	21	13 days	48(14.2)	12.5(3.7)	15.3(4.5) <sup>z</sup>	2.3(.7)



## References

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