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Bern, December 21, 2007

To
DeLaval International AB, Tumba Sweden
and
Andrea Papa, Elona Farka, Georgios Papageorgiou, Patra, Greece

Draft Research Report

On the study according to the testing agreement of November, 2, 2007

The study was conducted to test a newly invented milking cluster by Andrea Papa, Elona Farka, Georgios Papageorgiou, Patra, Greece in agreement with the inventors and DeLaval.

MATERIALS AND METHODS

Experimental animals and housing

Ten dairy cows (5 Red Holstein and 5 Holstein) in early- and mid-lactation from the Swiss Federal Research Station in Posieux were used in the experiment.

The mean lactation performance of these cows was 8256kg during the previous lactation (range of 5937 to 10076kg). During the experiment they were in their 2nd to 7th lactation.

Milking and milk flow recording

The cows were milked in a tie stall barn with a bucket milker at a vacuum level of 42 kPa, and milk flow was recorded during milking. Milking started in the morning at 5:30 h (i.e. 13.5 h after previous milking), and in the evening 16:00 h (i.e. 10.5 h after previous milking). For 2 days the animals were milked with a DeLaval milking machine at a pulsation rate of 60 cycles/min and a pulsation ratio of 70/30. From day 3 the cows were milked for 7 days with the new machine to be tested (until day 9). From day 10 to day 19, they went back to conventional milking, but without experimental recordings. On day 20 (i.e. day 11 after changing back to conventional milking) milk flow was again recorded with the use of the conventional DeLaval milking cluster.

During every milking (except from the period between day 10 to day 19) total milk yield, peak flow rate (highest milk flow which is maintained for 22s), time until peak flow rate, main milking time (without stripping), duration of increase (until plateau),

duration of plateau, duration of decline (after plateau) and average flow rate (of main milking) was measured with a mobile milk flow recording system (LactoCorder).

Teat Ultrasound

On all days with milk flow recording, B-mode ultrasonography was once a day used to perform longitudinal cross sections of the teat. Parameters measured, were the teat diameter, the cisternal diameter and the 2 wall thicknesses (average was used for data evaluation) immediately after milking and again at 12 minutes after milking with the teat in a bath of hand-warm water. For ultrasonography a linear scanner at a frequency of 5 MHz was used.

In addition, similar ultrasound cross sections were performed before milking immediately after a 1-min pre-stimulation on days 2, 9 and 20.

Teat Tip Photography

Once a day on all days with milk flow recording, a digital picture of the teat tip was taken to observe potential changes of the teat tip condition.

Mathematical and Statistical Evaluations

All data are presented as arithmetic means and standard error of the means. For statistical evaluation a mixed procedure of SAS was used. The model contained the experimental day (which also characterizes the type of milking cluster used on a particular experimental day) and the individual cow as the repeated subject. Due to different intervals between milkings in the morning and in the evening, morning and evening milkings were evaluated separately.

RESULTS AND DISCUSSION

Milk flow traits

Total milk yield (Figure 1) was lower in the evening than in the morning throughout the experiment as expected due to the different milking intervals. Significant changes of total milk yield with time were not observed.
Peak flow rate (PFR; Figure 2) was similar at morning and evening milkings. PFR decreased ($p<0.05$) from days 3 to 9 (i.e. with the new cluster) and reached again the level of days 1 and 2 on day 20.
Time until peak flow rate (Figure 3) was longer from days 3 to 9 (i.e. with the new cluster) as compared to days 1, 2, and 20. It was observed in most of the milk flow curves that with the new cluster the milk flow did not peak during the early plateau phase and rather increased further.
Main milking time (Figure 4) was numerically, but not significantly longer on days 3 to 9 (i.e. with the new cluster) as compared to days 1, 2, and 20.
Duration of increase (Figure 5) showed some variation but now significant changes between days.
Duration of plateau (Figure 6) was longer at morning than at evening milkings, however did not significantly change between experimental days.

Duration of decline (Figure 7) did not differ between morning and evening milkings and did not significantly change between experimental days.
Average milk flow rate (Figure 8) decreased from days 3 to 9 (i.e. with the new cluster) and increased again on day 20. A decreased average milk flow rate with the new cluster was observed in 8 out of the 10 experimental cows, independently of the stage of lactation.

Ultrasound cross sections

Longitudinal cross sections of one teat were performed immediately and 12 min after the end of milking. No differences between experimental days were observed for cisternal diameter (Figure 9), teat diameter (Figure 10), and teat wall thickness (Figure 11). Thus the new cluster did clearly not have any damaging effects on the teats.

Teat tip photography

No changes of the teat tip were observed throughout the experimental period.

COMMENTS REGARDING SPECIFIC OBSERVATIONS

General comments

After cluster attachment it was sometimes necessary to adjust the cluster, in order to avoid that the teat canal is closed by the liner. This was especially true if the teat orifice was not located in the center of the teat tip.

Air entered into the liner and produced some noise with small and thin teats.

The residual milk seemed to be less with the new cluster then with the conventional one. Only if there were bulges, which lie deeper then the teat base, the residual milk seemed to be like in the conventional system. Within the frame of this study it was not possible to exactly detect the amount of residual milk.

During the removal of the cluster the liners often adhere to the teat.

Throughout the whole experimental period, we got an impression of the cows, while they were milked. We recognized a difference in the animal's behaviour during the overmilking time with the conventional and the new clusters.
With the conventional cluster (as well known) the cows start getting disquietingly during overmilking. With the new cluster they are really calm throughout the whole overmilking period.

Special comments on individual animals

- 1289 total milk yield was decreased from the 4th day in the evening until the 9th day in the evening. She was not eating very well.
- 1400 on the 5th day in the morning this cow was already empty on 3 quarters and gave still 3-4 kg on the last quarter. During this last

period of milking 3 empty teats the cow was totally calm.

- 1416 on the right front quarter the milk started always later to flow, then on the other ones. It started to flow properly, when one or two quarters were already empty.

- 1481 this cow had a clinical mastitis at the end of the experiment. She was kept in the tie stall, she was lying the whole time in her own manure and was really dirty.

- 1509 on the 9th day in the evening the cow was standing on the long milk tube, so the machine fell down.

- 1546 she had always a lot of residual milk left at the end of milking with the new cluster. We think, it is, because she had small and thin teats.

- 1658 the SCC of this cow increased during day 1 to day 9 from 164’000 cells/ml to 1018’000 cells/ml.

Figure 1

total milk yield [kg]

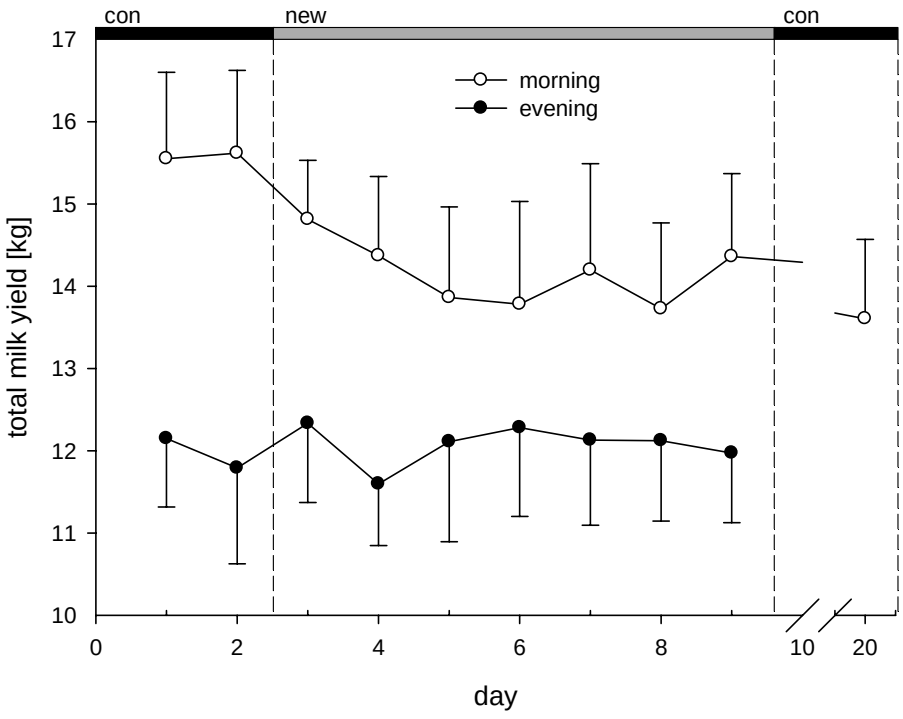
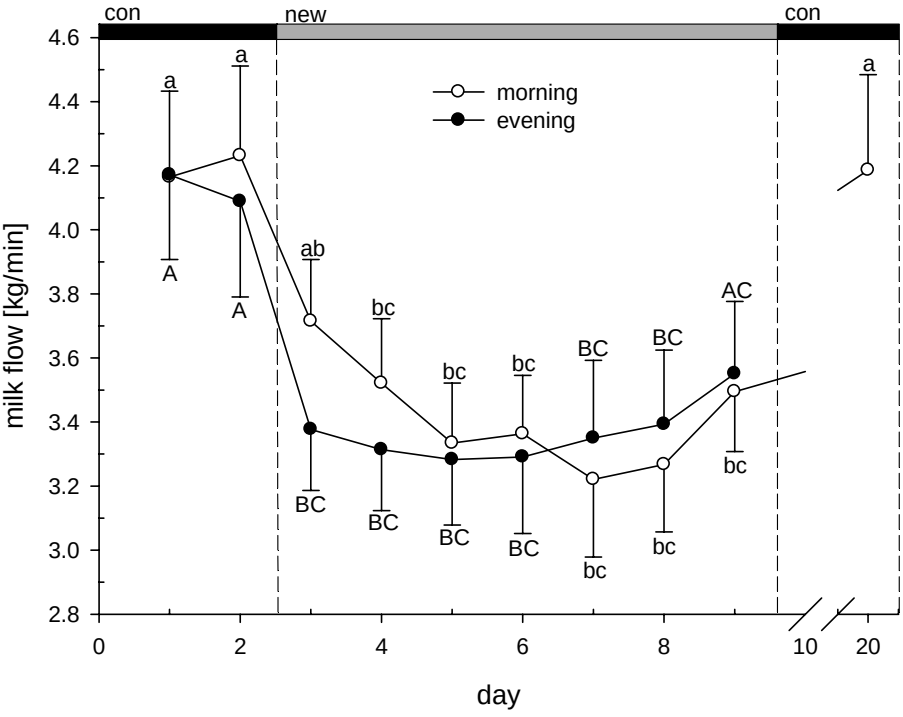


Figure 2

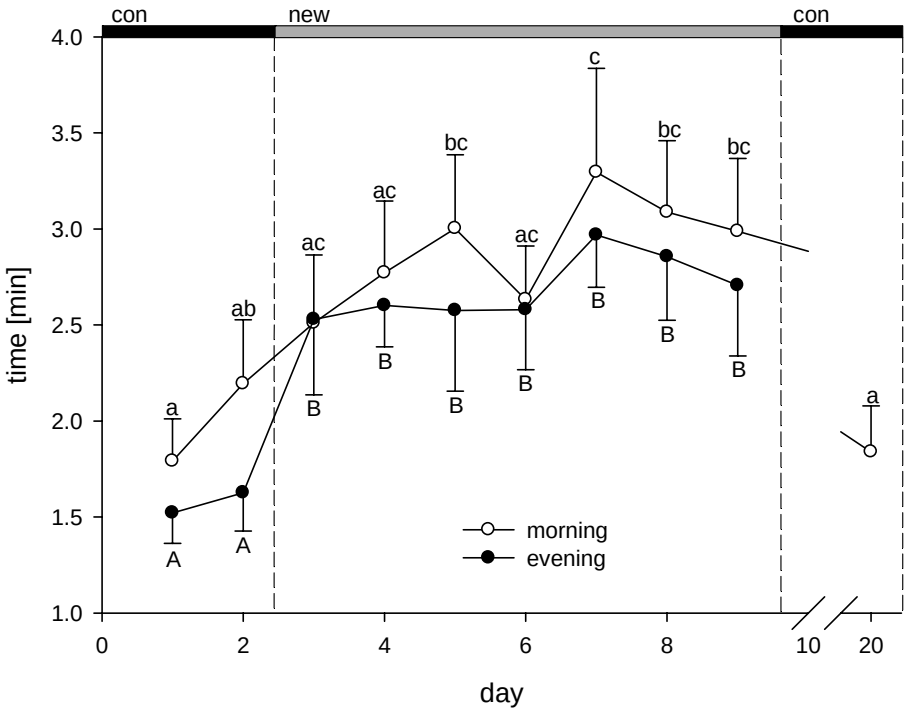
peak flow rate [kg/min]



a,b,c:) morning milking
A,B,C:) evening milking
means without common letter are significantly different ($p<0.05$).

Figure 3

time until peak flow rate [min]



a,b,c:) morning milking
A,B:) evening milking
means without common letter are significantly different ($p<0.05$).

Figure 4

main milking time [min]

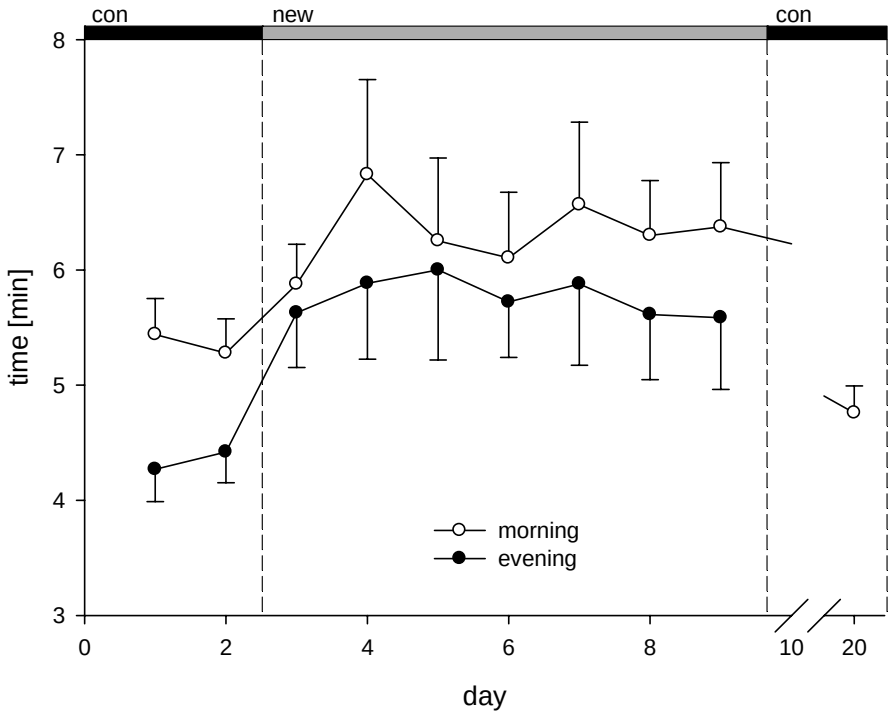


Figure 5

duration of increase [min]

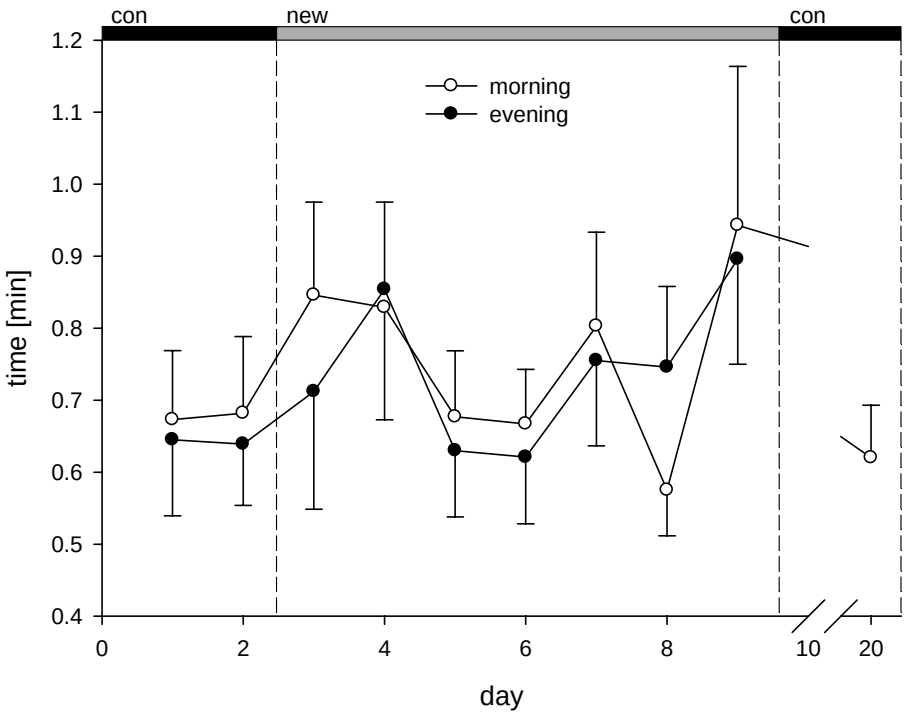


Figure 6

duration of plateau [min]

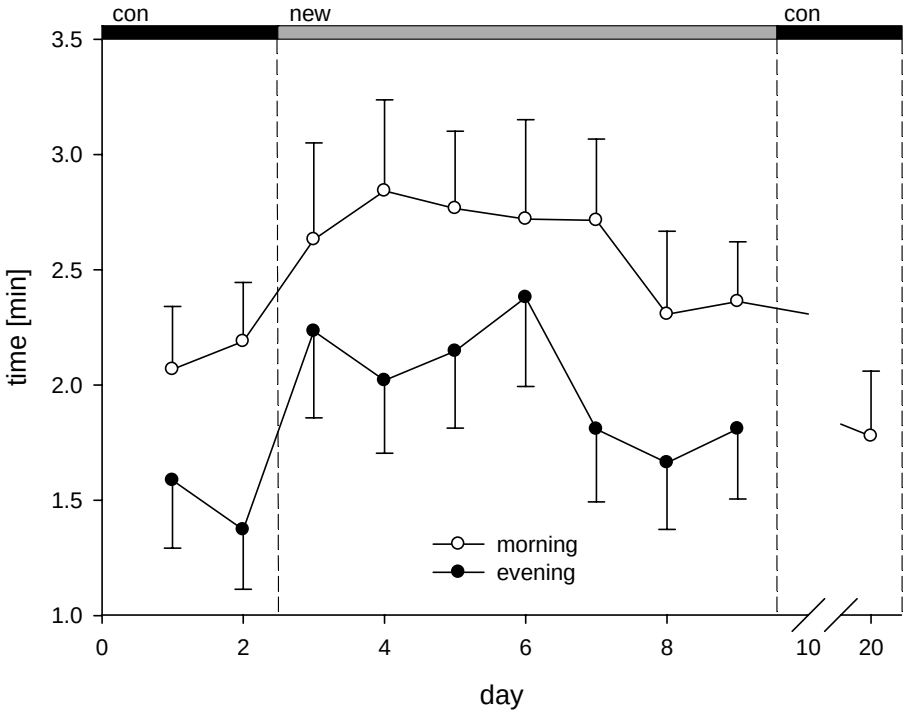


Figure 7

duration of descent [min]

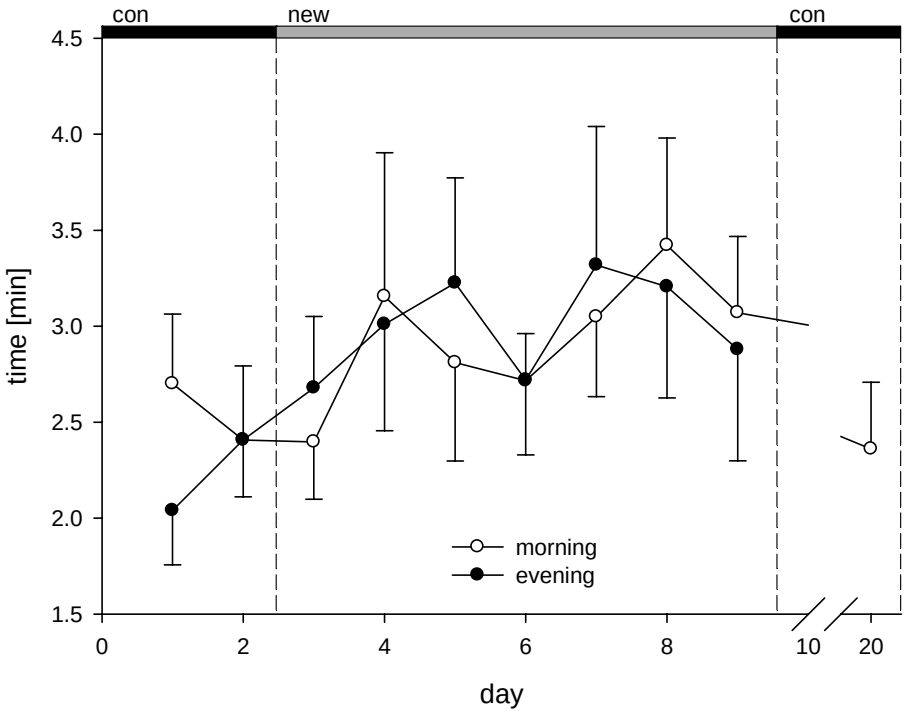
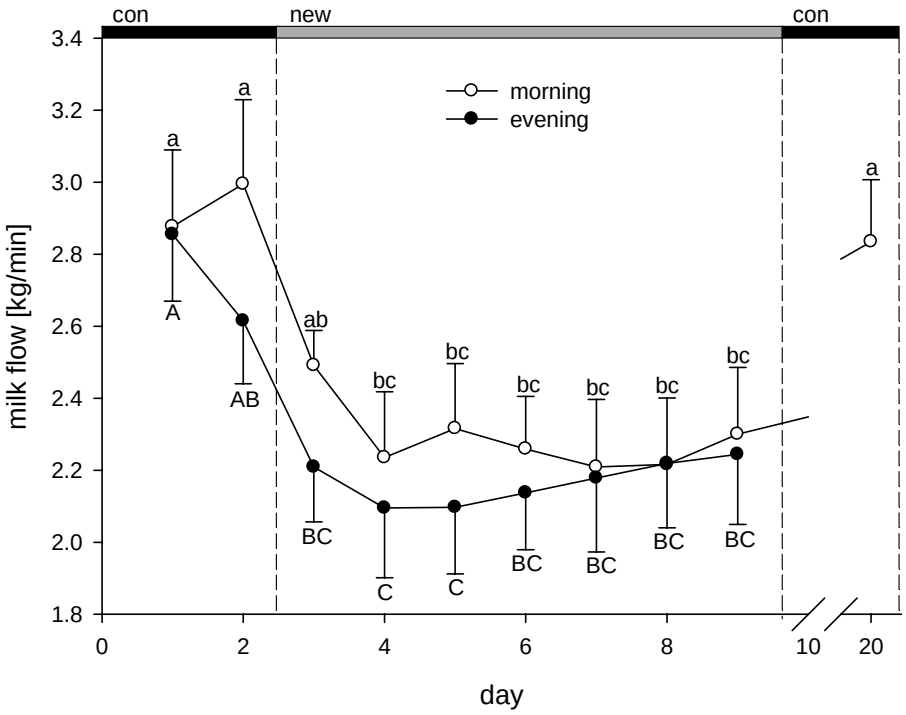


Figure 8

average milk flow rate [kg/min]



a,b,c:) morning milking
A,B,C:) evening milking
means without common letter are significantly different ($p<0.05$).

Figure 9
cisternal diameter

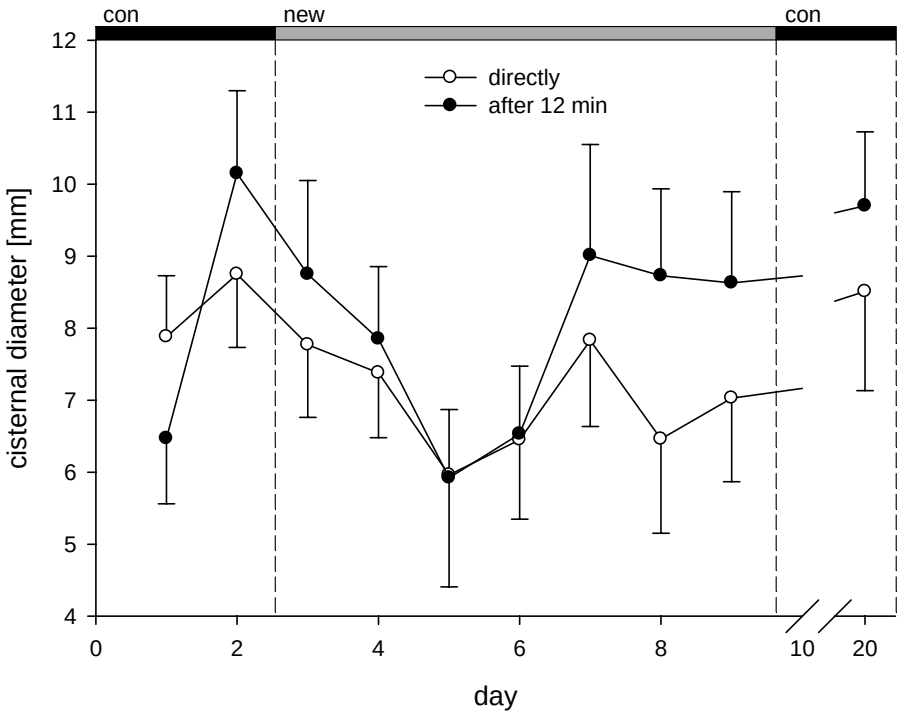


Figure 10
teat diameter

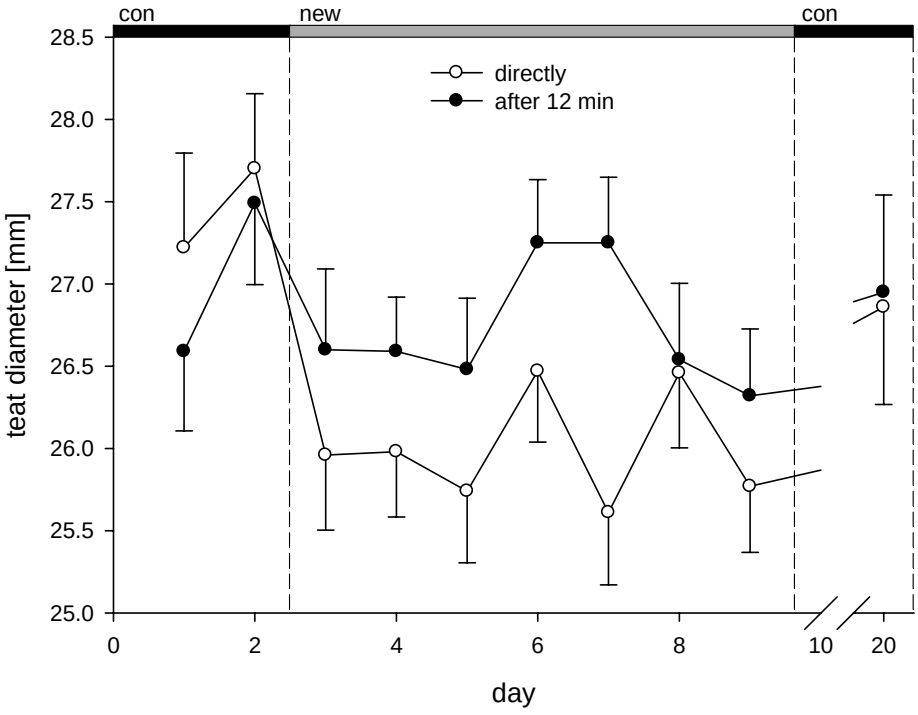
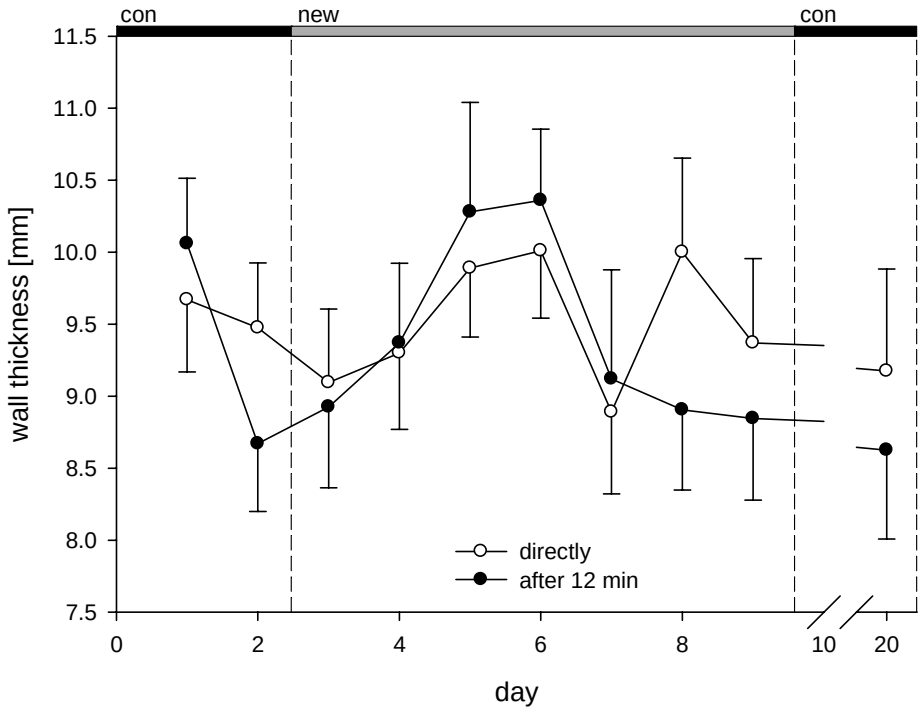


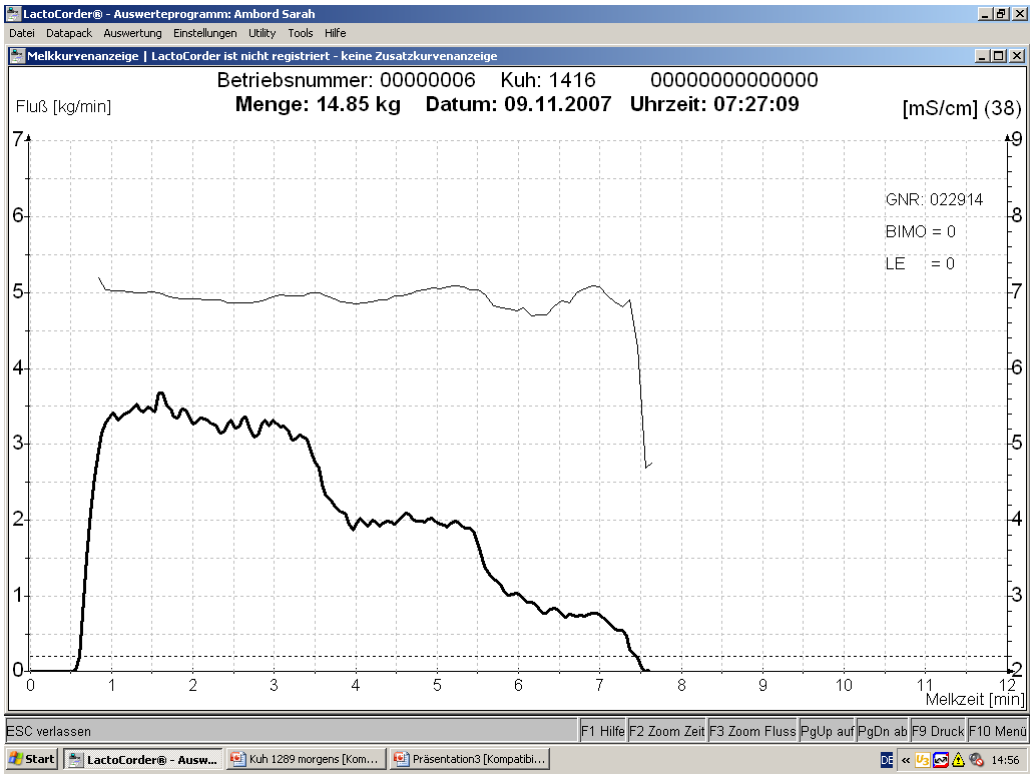
Figure 11

wall tickness [mm]

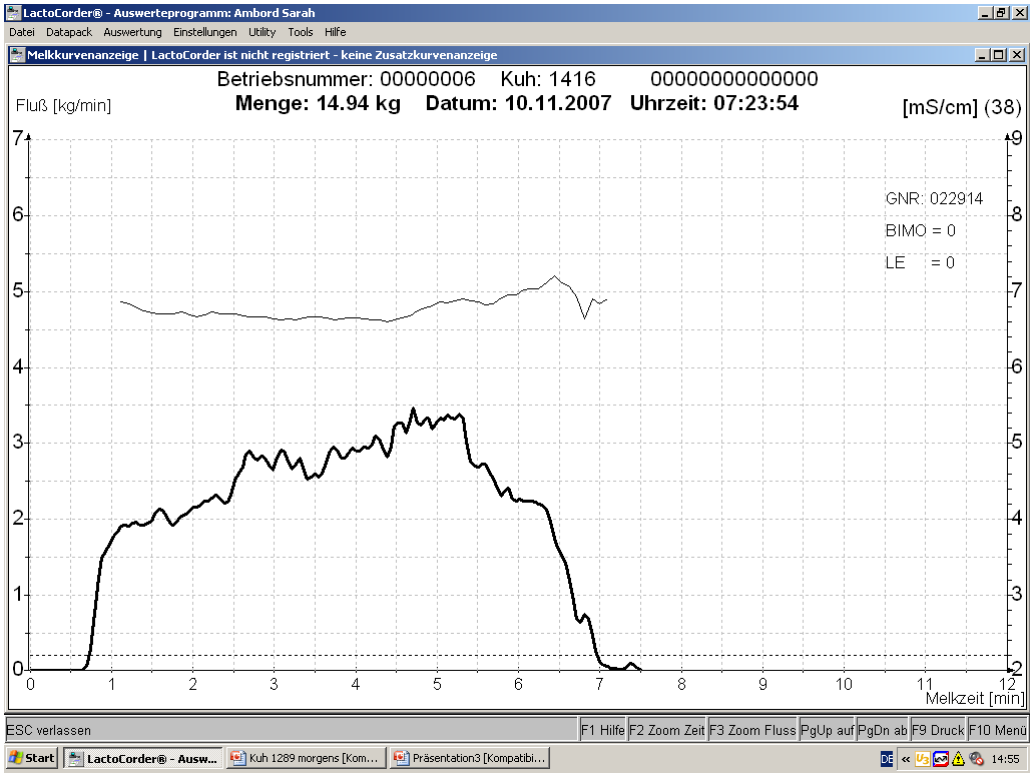


CONVENTIONAL SYSTEM COW 1416

(PRE-EXPERIMENT)



NEW SYSTEM DAY 1 COW 1416



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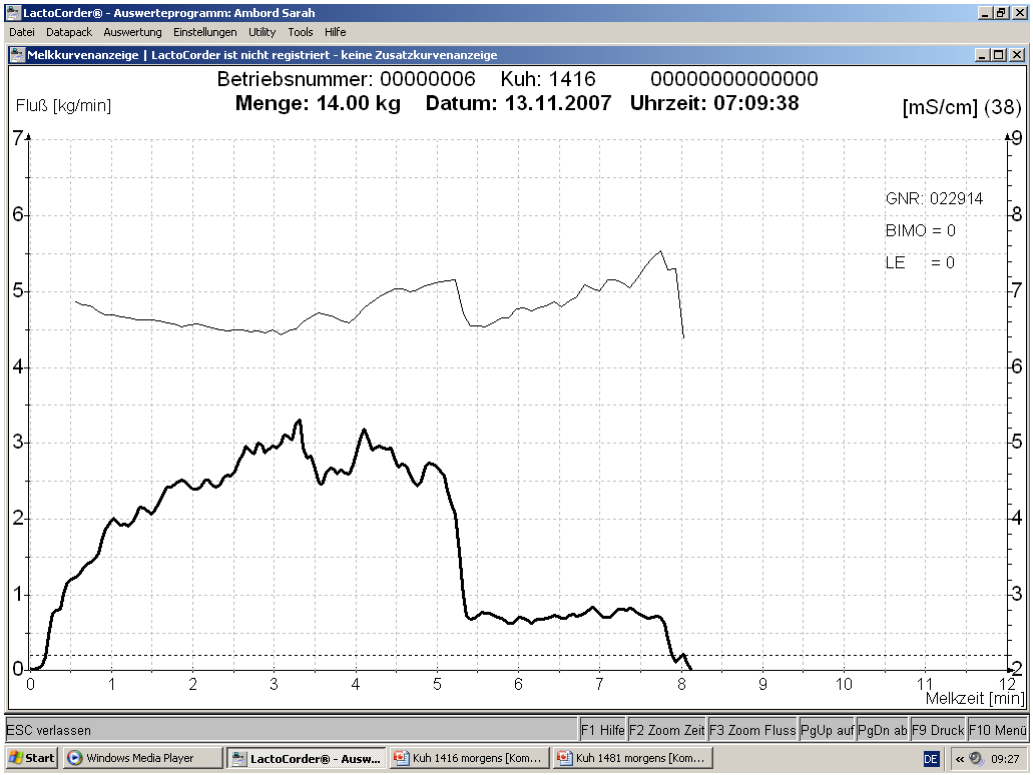

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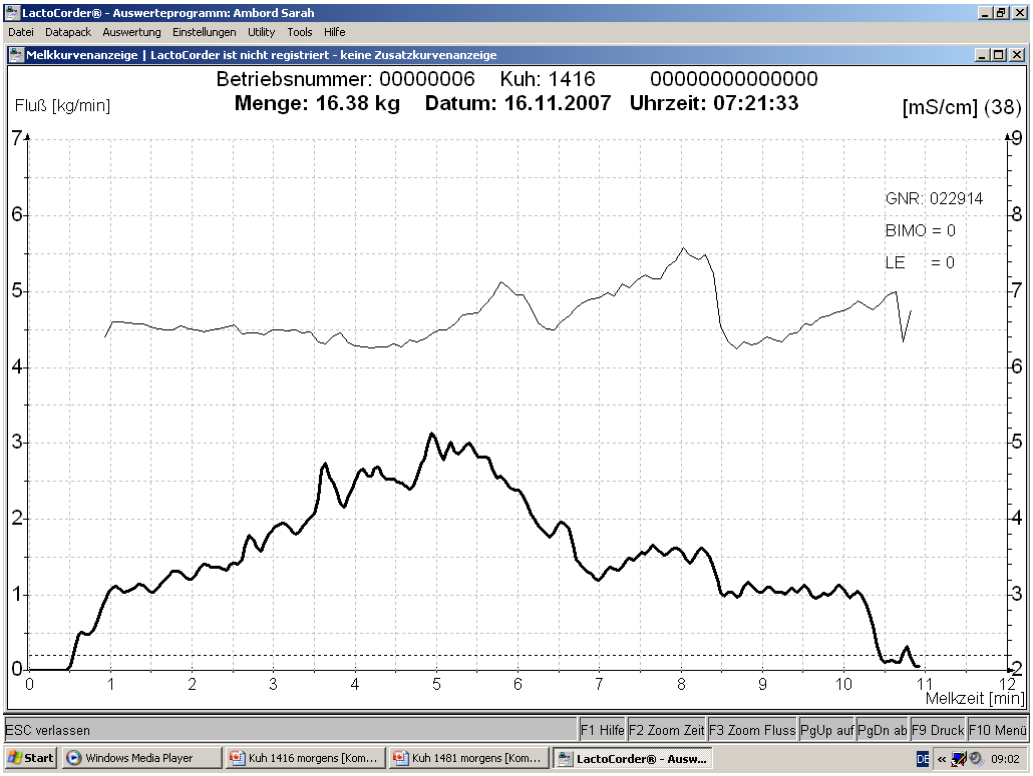
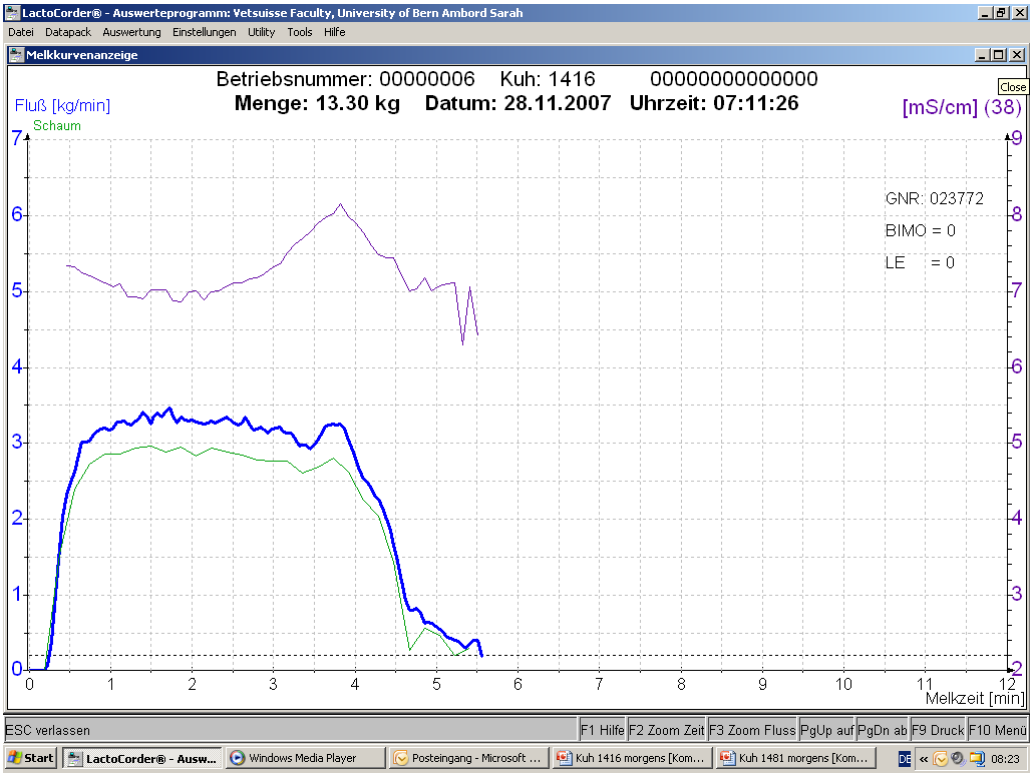


CONVENTIONAL SYSTEM COW 1416

(POST-EXPERIMENT)

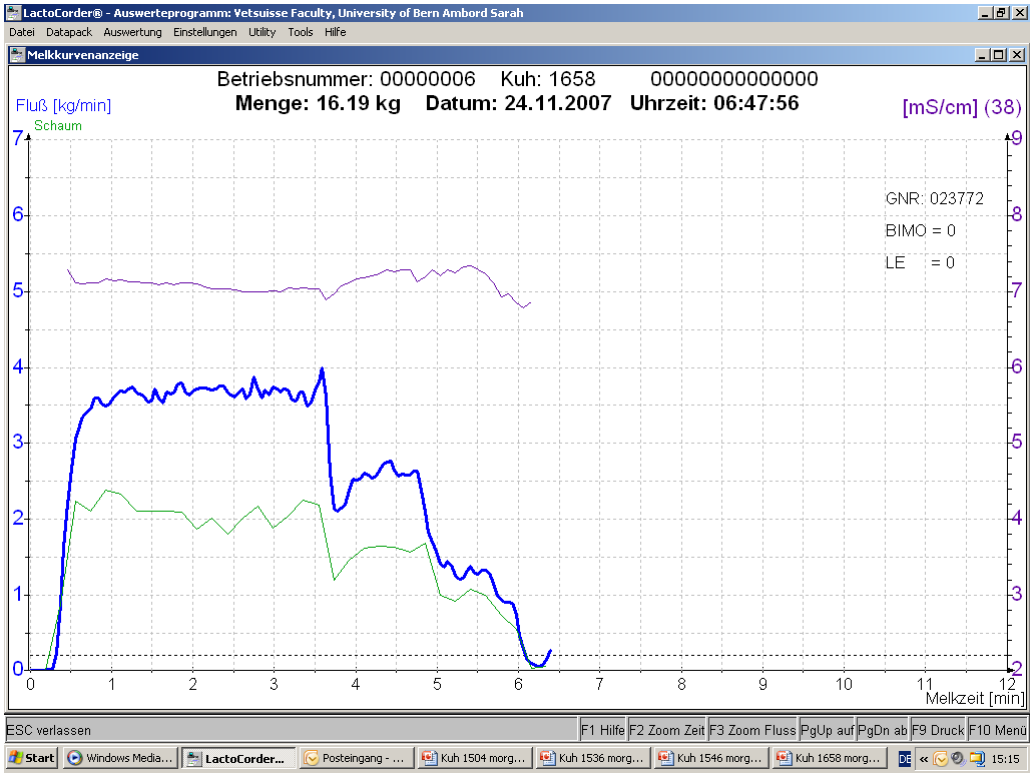


CONVENTIONAL SYSTEM COW 1658

(PRE-EXPERIMENT)

NEW SYSTEM DAY 1 COW 1658

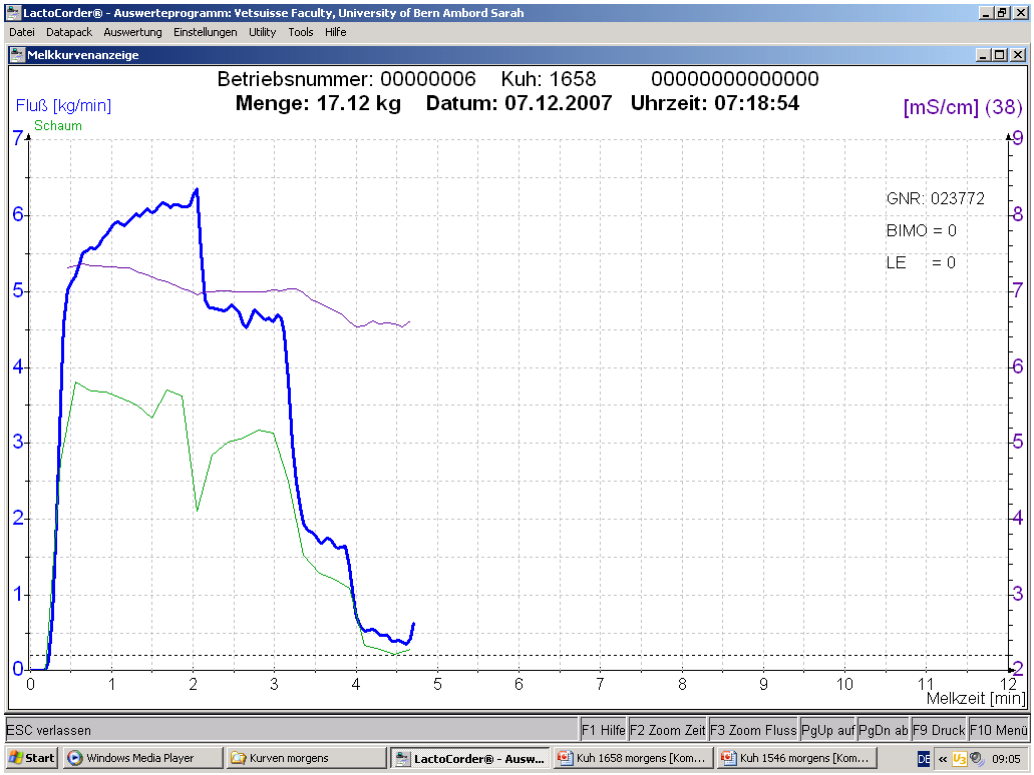
NEW SYSTEM DAY 4 COW 1658



NEW SYSTEM DAY 7 COW 1658

CONVENTIONAL SYSTEM COW 1658

(POST-EXPERIMENT)



CONVENTIONAL SYSTEM COW 1504

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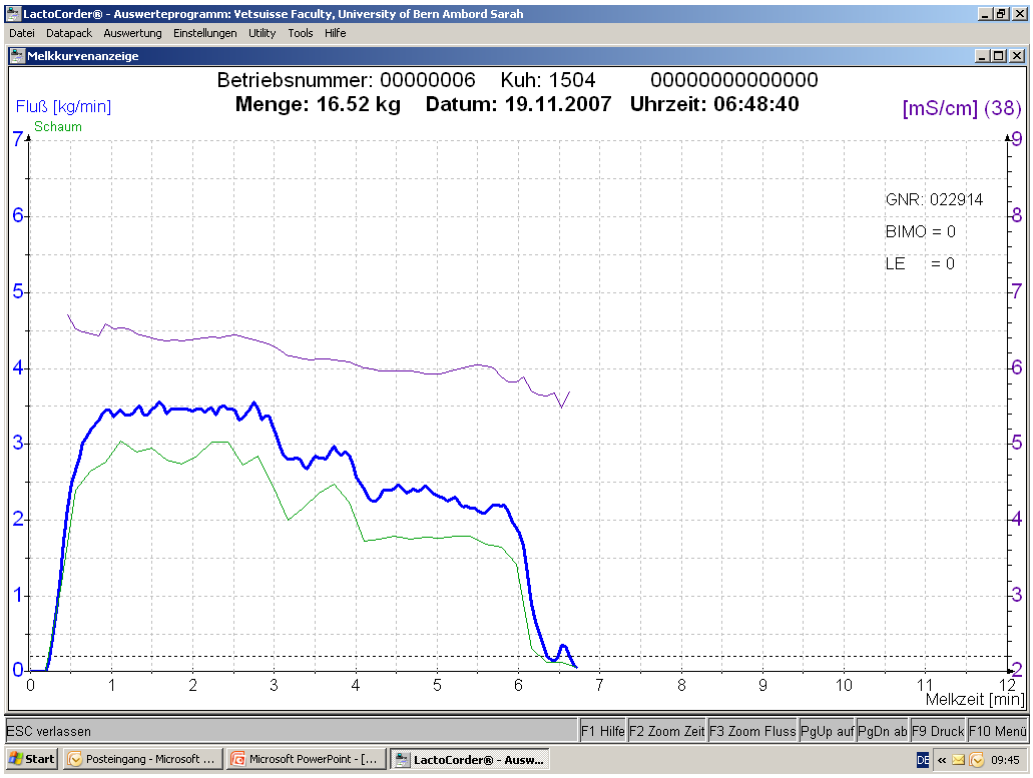

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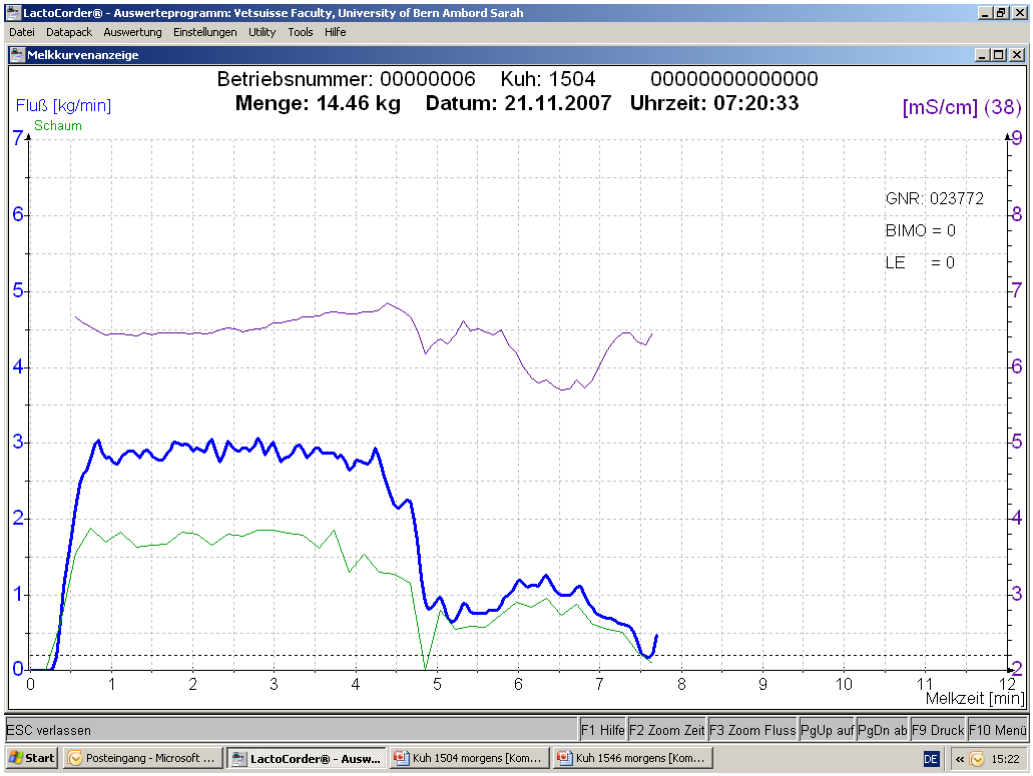

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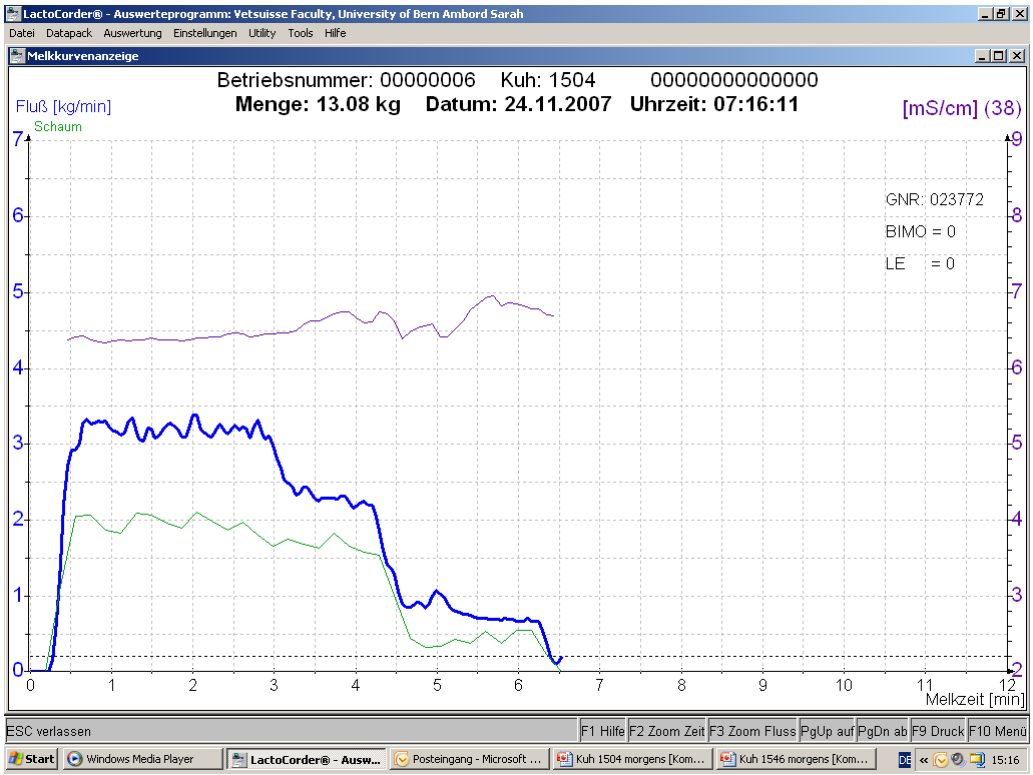

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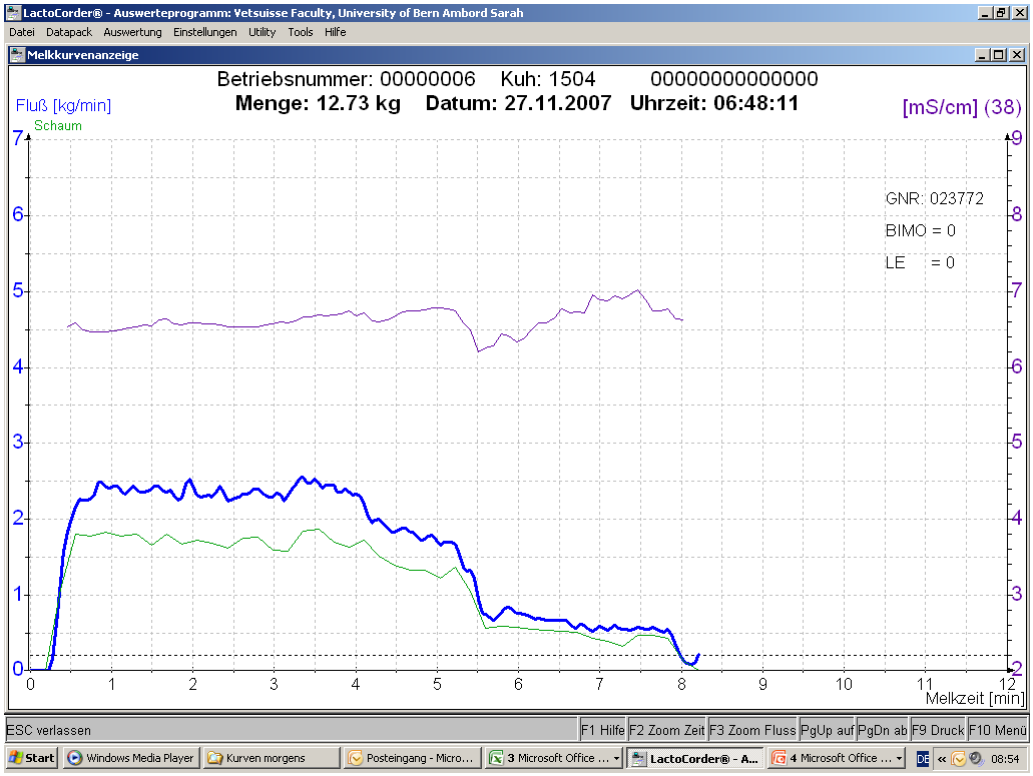
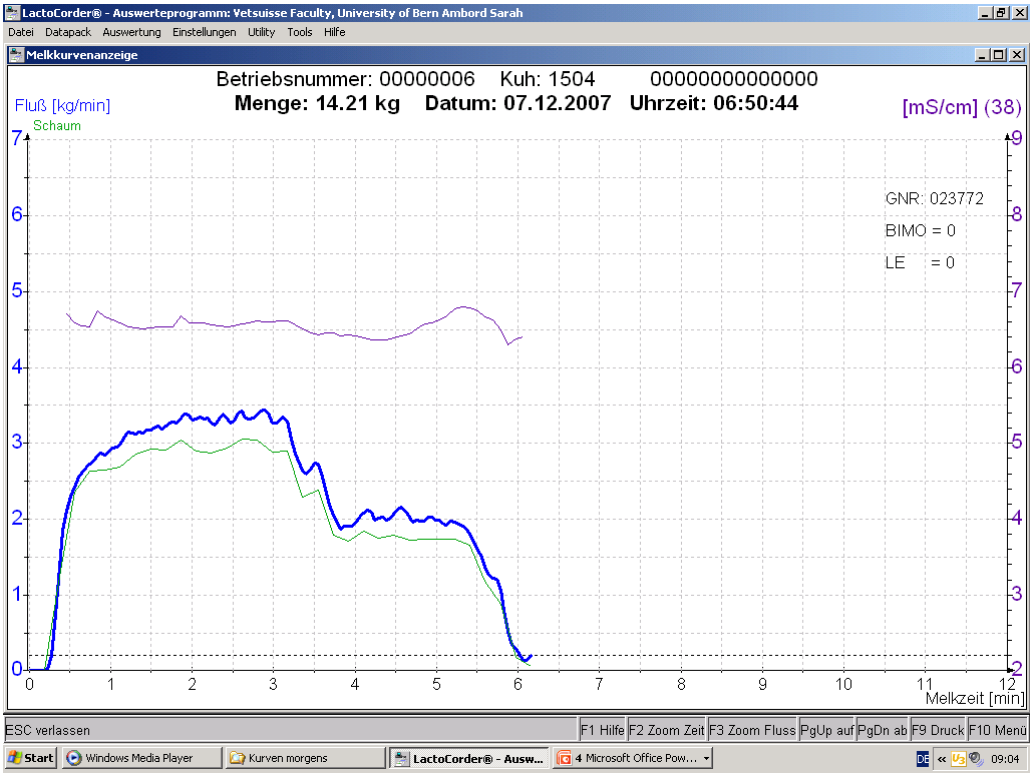


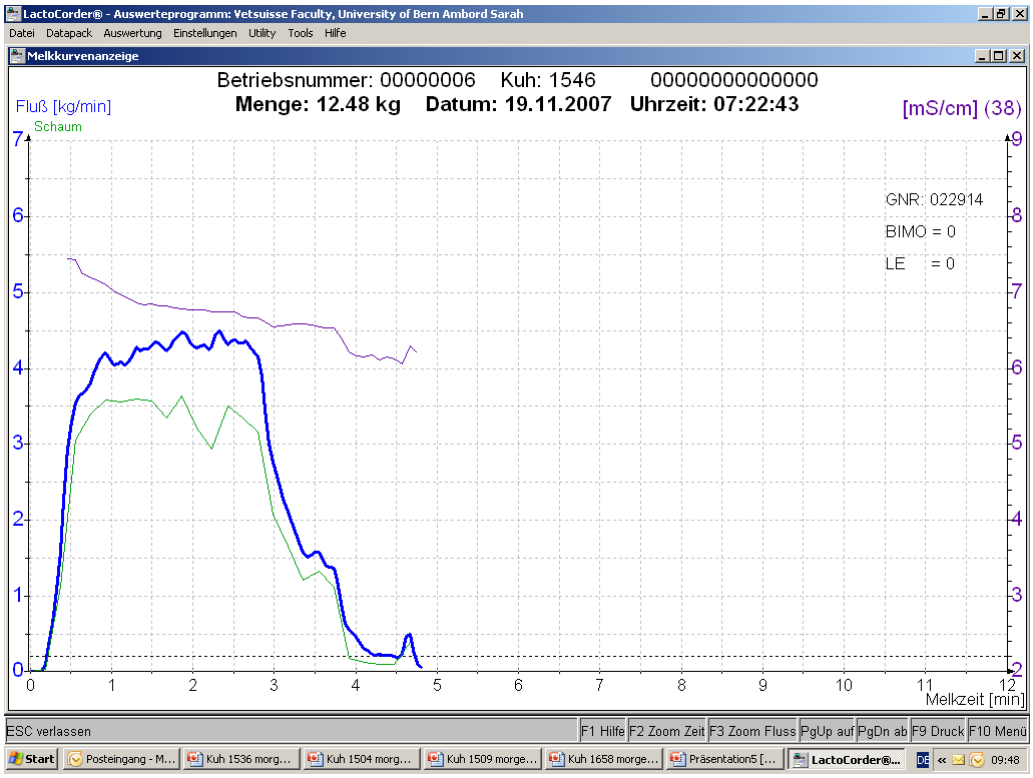
CONVENTIONAL SYSTEM COW 1504

(POST-EXPERIMENT)

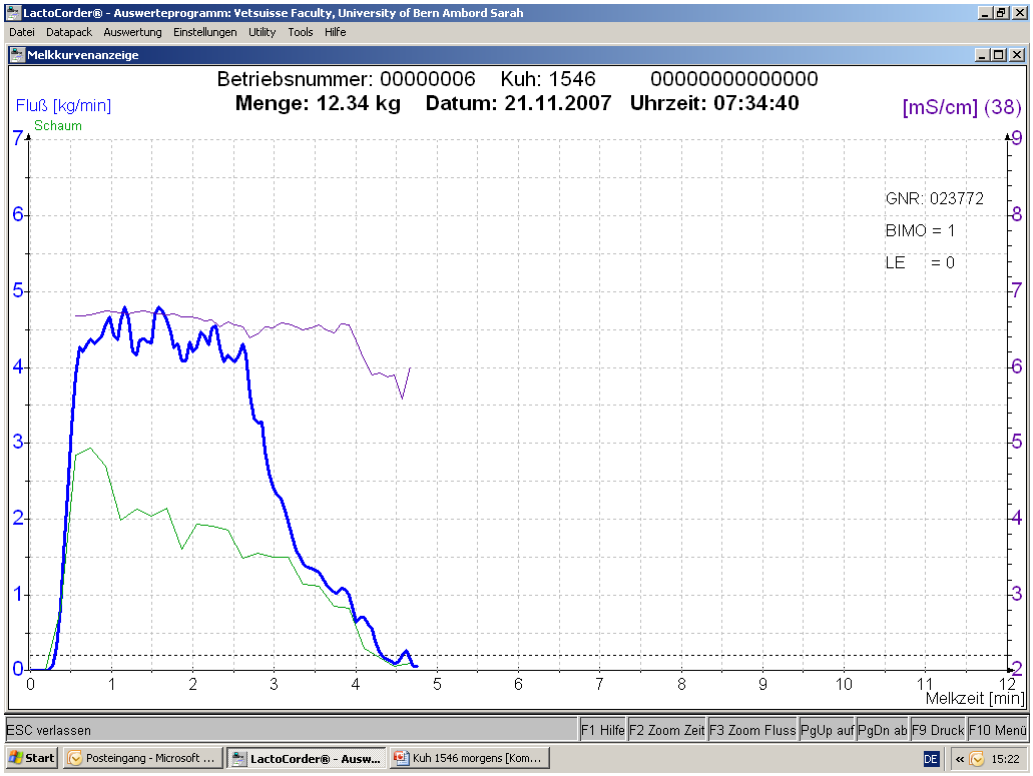


CONVENTIONAL SYSTEM COW 1546

(PRE-EXPERIMENT)

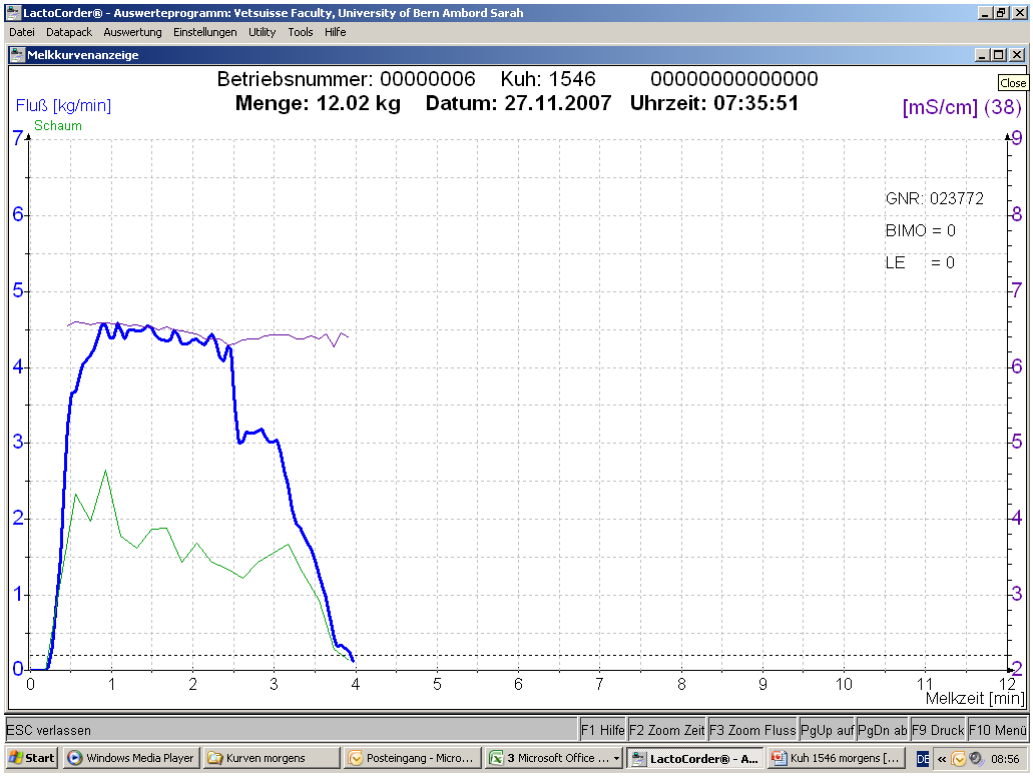


NEW SYSTEM DAY 1 COW 1546



NEW SYSTEM DAY 4 COW 1546

NEW SYSTEM DAY 7 COW 1546



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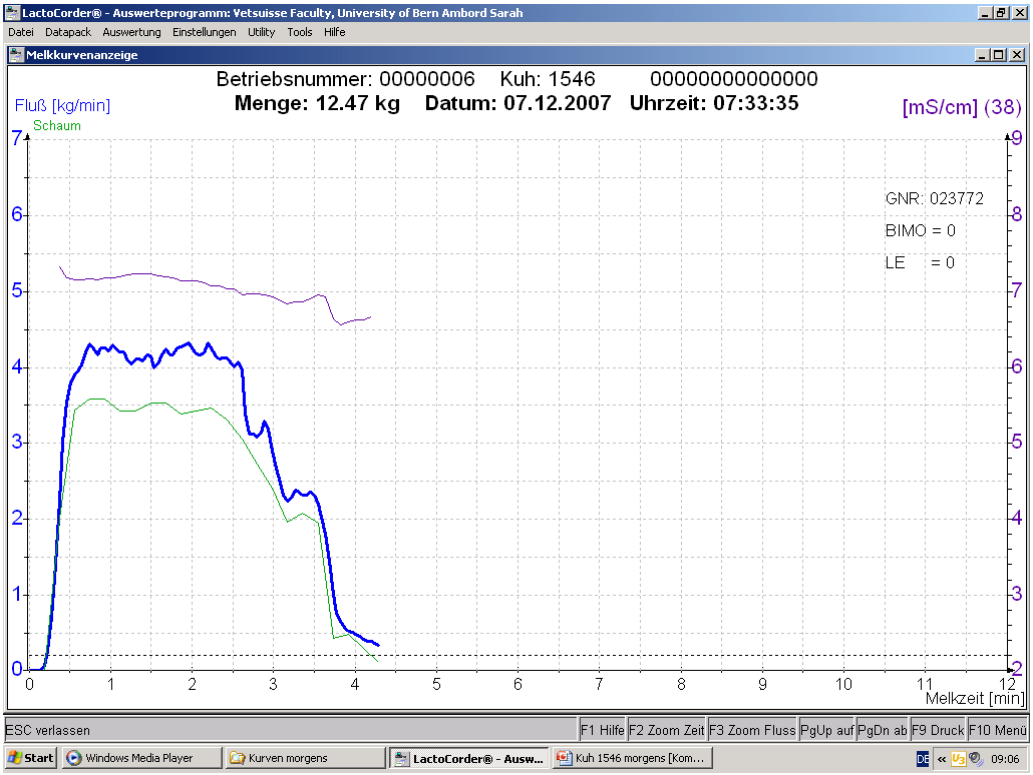
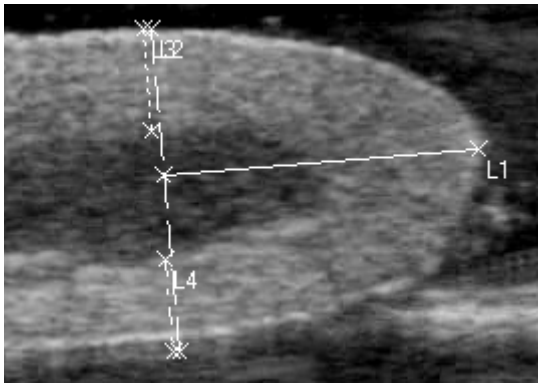


CONVENTIONAL SYSTEM PRE-EXPERIMENT COW 1546
(directly after milking)



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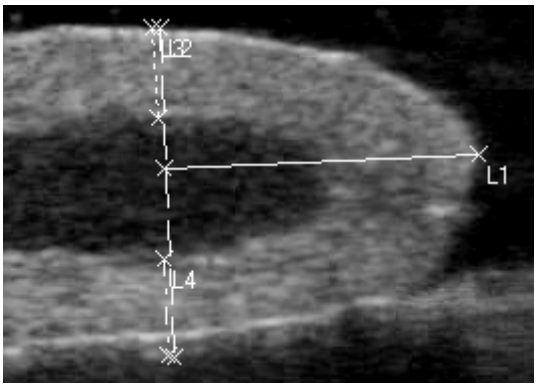

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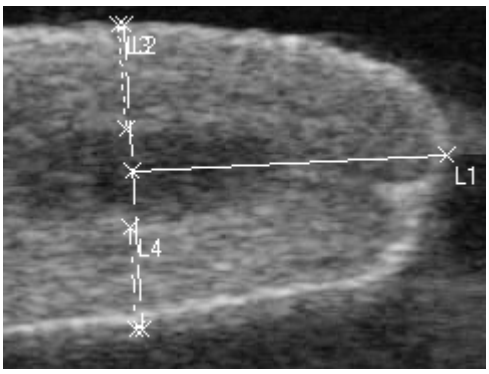

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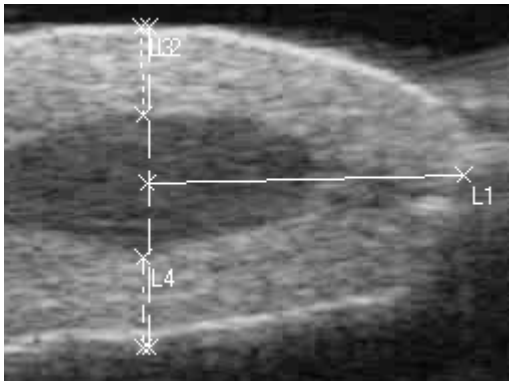
(12 min after milking)



NEW SYSTEM DAY 4 COW 1546
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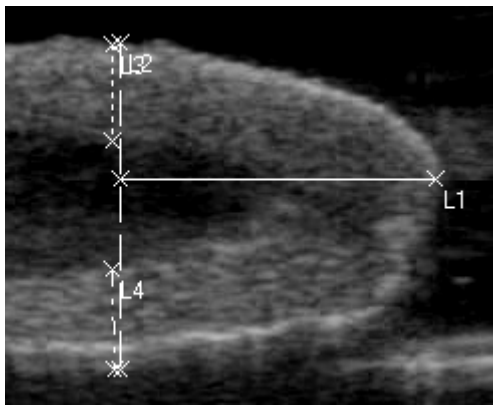
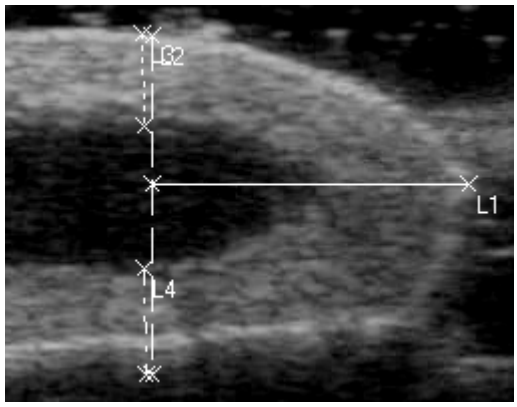


NEW SYSTEM DAY 4 COW 1546
(12 min after milking)



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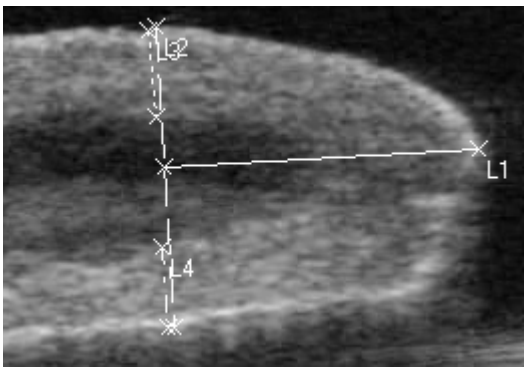
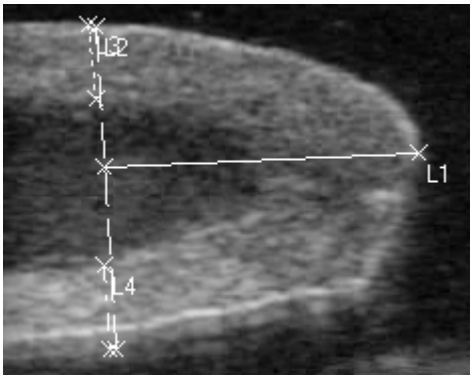
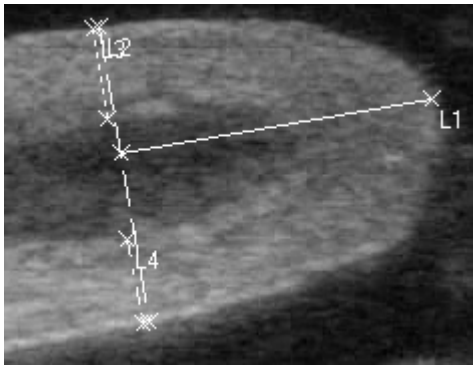
(directly after milking)



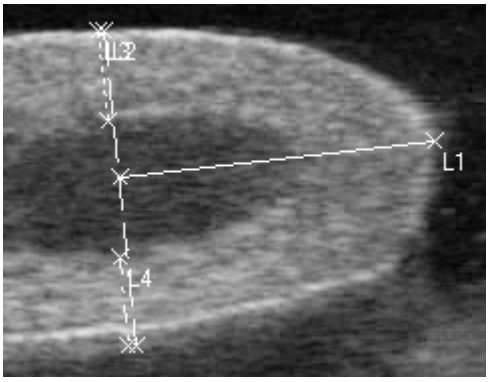
NEW SYSTEM DAY 7 COW 1546
(12 min after milking)



CONVENTIONAL SYSTEM POST-EXPERIMENT COW 1546
(directly after milking)



CONVENTIONAL SYSTEM POST-EXPERIMENT COW 1546
(12 min after milking)



CONVENTIONAL SYSTEM PRE-EXPERIMENT COW 1528
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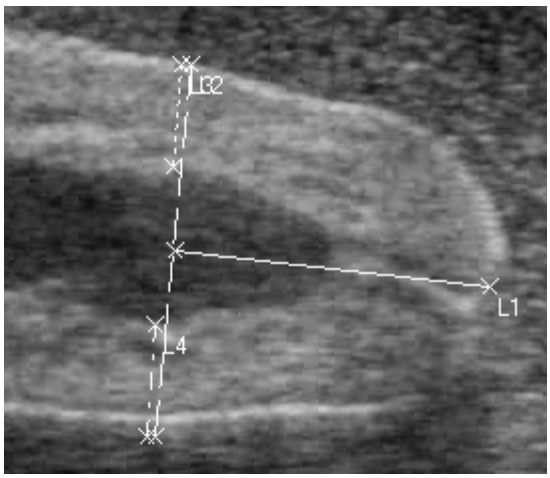
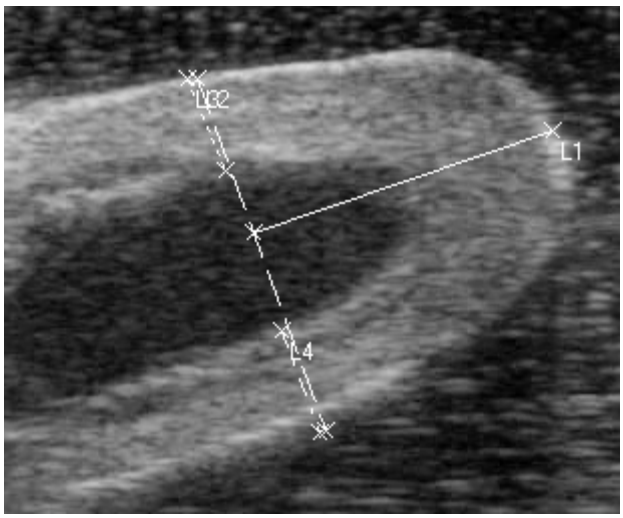


CONVENTIONAL SYSTEM PRE-EXPERIMENT COW 1528
(12 min after milking)



NEW SYSTEM DAY 1 COW 1528
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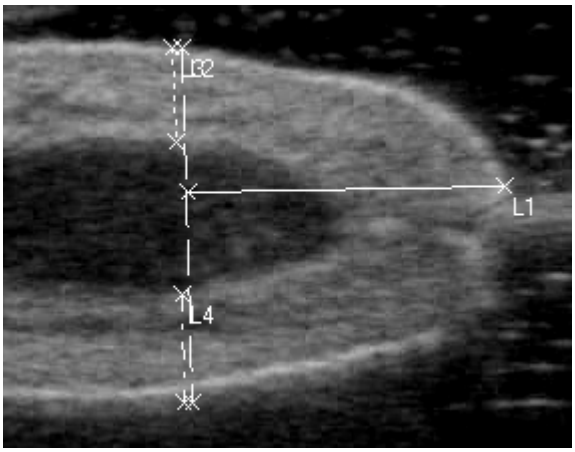
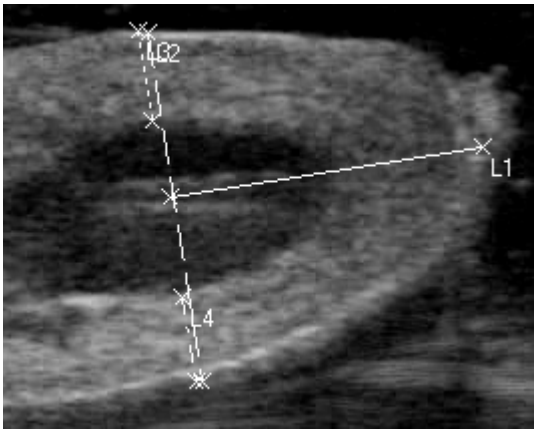


NEW SYSTEM DAY 1 COW 1528
(12 min after milking)



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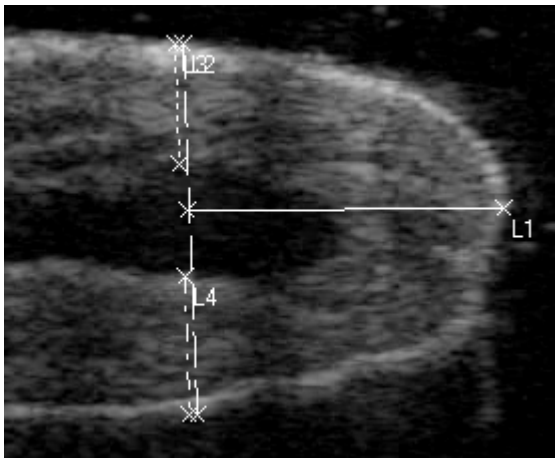
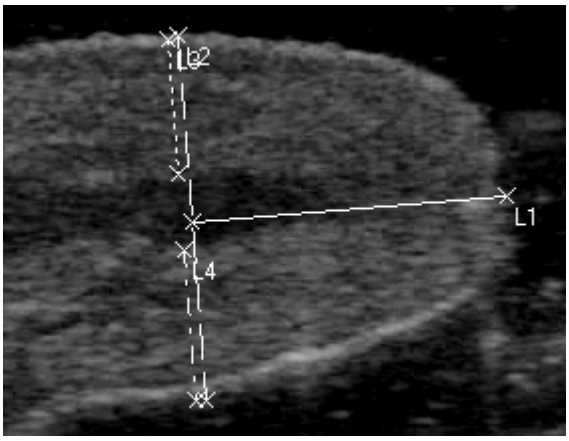
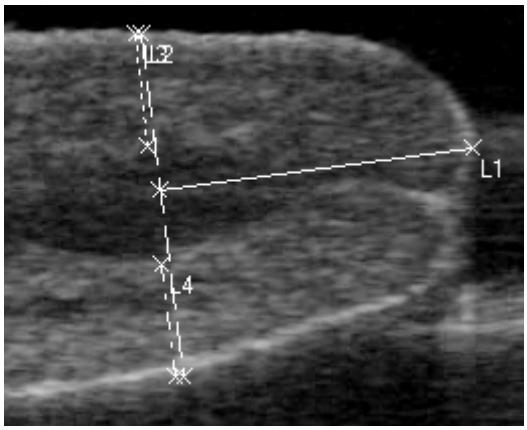


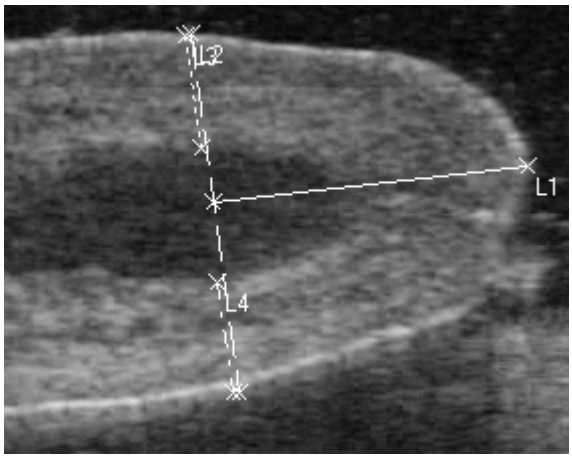
NEW SYSTEM DAY 4 COW 1528
(12 min after milking)



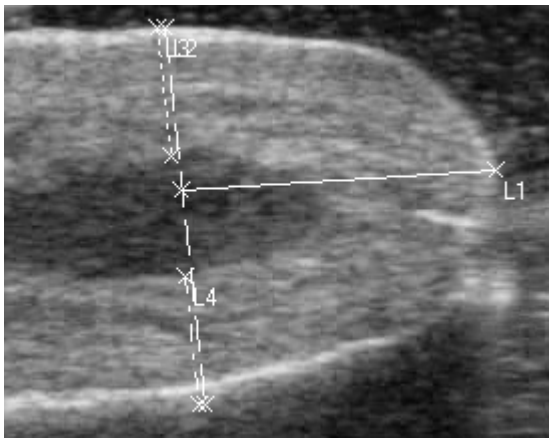
NEW SYSTEM DAY 7 COW 1528
(directly after milking)



NEW SYSTEM DAY 7 COW 1528
(12 min after milking)



CONVENTIONAL SYSTEM POST-EXPERIMENT COW 1528
(directly after milking)



CONVENTIONAL SYSTEM POST-EXPERIMENT COW 1528
(12 min after milking)