Effects of vacuum level and teat cup weight on milk removal in an automatic milking system

J. Macuhova & R. M. Bruckmaier

Physiology-Weihenstephan, Weihenstephaner Berg 3,
D-85354 Freising, Germany
E-mail: bruckmaier@wzw.tum.de

Milkability is an important functional trait in dairy cattle with respect to milking performance, udder health and is therefore considered in selecting and breeding of animals. The rate of milk flow is one of the critical parameters causing variation in milking time. Besides anatomical traits of the cow (teat canal length, diameter of the teat canal and the tension of the teat sphincter) and management of the milking routine also physical properties of the milking machine can affect milking performance. The aim of this study was to test the effects of different vacuum levels (44 and 48 kPa) and teat cup weights (standard teat cups (400 g/cup) and heavy teat cups (800 g/cup)) on quarter and udder milking parameters (average milk flow and machine-on time) and the efficiency of udder emptying during milking in an automatic milking system (AMS) (Merlin®, Lemmer-Fullwood, Germany). Therefore, quarter milk flow was recorded during four days by an especially rebuilt set of four Lactocorders® while vacuum level and teat cup weight changed in 2×2 design. To test the efficiency of udder emptying, residual milk was removed after 10 IU of oxytocin injected i.v. at the end of milkings. To exclude possible effects of teat cup reattachment on milking parameters and efficiency of udder emptying, only milkings with attachment of all teat cups at first attempt were evaluated. Altogether quarter milk flow was recorded and residual milk was removed during 83 milkings (20 milkings with low vacuum and standard teat cups, 23 milkings with low vacuum and heavy teat cup, 12 milkings with higher vacuum and standard teat cups and 28 milkings with increased vacuum and heavy teat cups). During automatic milking, intervals between milkings differ individually. Moreover, cows in different parity and lactational stage at different production levels were used for the experiment. Therefore, besides effects of treatments (different vacuum levels and teat cups weights) on quarter and udder milking parameters also the effects of parity, lactational stage, milking interval, quarter (resp. udder) milk yield were tested. Moreover, on a quarter level also effects of quarter position (front right, front left, rear right and rear left) and on an udder level effects of duration of teat cup attachment were tested.

Average quarter milk flow was significantly (P<0.05) affected by treatments, milking interval and quarter milk yield. Higher average quarter milk flow was observed during milkings at a higher vacuum level, but without an effect of teat cup weight. With increasing milking interval average quarter milk flow decreased. In quarters with higher average quarter milk flow was observed. Parity, lactational stage and quarter position did not influence average milk flow. Quarter machine-on time was significantly (P<0.05) influenced by treatments, milking interval, quarter milk yield and quarter position. Shorter quarter machine-on time was observed at higher vacuum level, but without difference in machine-on time between teat cup weights. Quarter machine-on time increased also with increasing milking interval and quarter milk yield. Quarter machine-on time was longer in rear quarters than in front quarters. On an udder level, machine-on time was significantly influenced only by the milk yield and just tended to be influence by treatments (P=0.22) and milking interval (P=0.21). With increasing milk yield and milking interval udder machine-on time was prolonged. Numerically longer udder machine-on time was observed during milking at low vacuum. However, average udder milk flow was not significantly influenced by any of tested parameters. Only a tendencial effect was observed by treatments (P=0.12) and milk yield (P=0.24).

The amount of residual milk was 1.33±0.11 kg (11.5±0.8 %) by applying low vacuum and standard teat cups, 1.53±0.14 kg (11.9±1.2 %) by a low vacuum and heavy teat cups, 1.83±0.25 kg (13.3±1.8 %) by higher vacuum and standard teat cups and 1.88±0.15 kg (13.5±0.9 %) by higher vacuum and heavy teat cups. From tested parameters (treatments, parity, lactational stage, milking interval and total milk yield (milk yield removed during milking in AMS including residual milk)) amount of residual milk was significantly influenced only by total milk yield. The amount of residual milk increased with increasing total milk yield. Lactational stage tended (P=0.16) to have a effect on the amount of residual milk. Percentage of residual milk was affected by none of tested parameters. This was not surprising, because the percentage of residual milk is typical for individual animals. Moreover, the percentage of residual milk did not change in the course of lactation, i.e. it was not depended on actual milk yield or milking interval.

In summary, higher vacuum level increased average quarter milk flow and decreased duration of quarter machine-on time. However, on the udder level no effect of vacuum level on milkability was found. The udder emptying during milking in AMS was in the normal range and was not influenced by vacuum level or teat cup weight. In conclusion, neither vacuum level nor teat cup weight influences amount of residual milk.