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Force Measurements in Automatic Milking Systems

For the past few years automatic milking systems (AMS) have increasingly been used. The systems differ mainly in their attachment system and in tube guiding. Determining the differences in the effects of force between the various brands sold was the objective of this investigation. The DLG developed a test rig to measure vertical, side and horizontal forces. Various types of tube guidance are the main factor in horizontal side and tilt forces.

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Keywords

Automatic milking systems, milking technique, force measurements, udder form

It could be expected that with the introducing of automatic milking systems (AMS) a better udder health for dairy cows is possible. Udder diseases are one of the important problems in dairy farms. In comparison to cows, which were milked with conventional milking techniques there was no difference in the mastitis frequency [5]. Milking in AMS increased production, lowered somatic cell count and improved teat condition [8]. The technical construction and the milking equipment may have an influence on udder health and milk quality. One important reason for udder diseases may be the wrong positioning of the milking unit, leading to the teats being pulled by different forces. As a second point a wrong positioning can cause air inlets and vacuum variations.

More frequent milking, however, may also have potentially negative effects. The teat duct is opened more frequently causing a higher risk of invasion of udder pathogens [6]. Regarding these problems various scientists [1, 4 and 9] assert that automatic milking systems are better for the udder health than conventional milking systems. For example they expect a higher average milk yield per cow presumably explained by a higher number of milking operations per day.

Another aspect is the adaptability of the teat cups to different udder forms. To examine this and to investigate the influence of the resulting forces, different AMS were tested. For this reason the German Agricultural Society (DLG) developed a test machine, making it possible to measure four forces acting on the teats.

Test machinery to record forces

The test machine measures the vertical, turn and horizontal forces at the same time. Data is transmitted to a PC and the milking system can be checked immediately for problems and difficulties. The forces are measured with the aid of strip tensometer (strain-gauged strips). The teats are made of silicon (DIN ISO 6690). It is possible to lead through liquid, which is controlled with the aid of flow meters. Further the vacuum can be measured at the teat end (wet-test-method).

Preceding studies have shown that the milk flow has a low influence on the forces [3]. Therefore a milk flow of 5 l/min was used for all experiments. The measuring time is 30 s. The teat cups are attached on with five repetitions per udder form. The resulting data provide the basis for calculating mean values.

The AMS attaches the teat cups on to the test machine udder automatically as in real working practice. In this study the udder forms „normal“ and „stepped“ and the cow position „optimal“ have been investigated. Of each brand a minimum of two AMS have been tested.

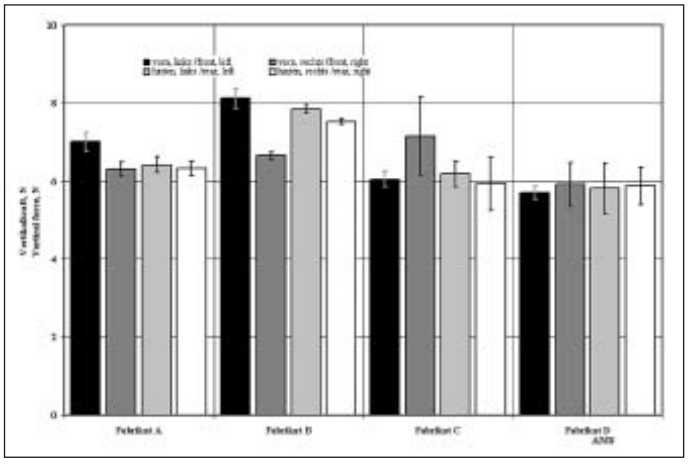

Fig. 1: Average vertical force at the teats in different automatic milking systems (normal udder)

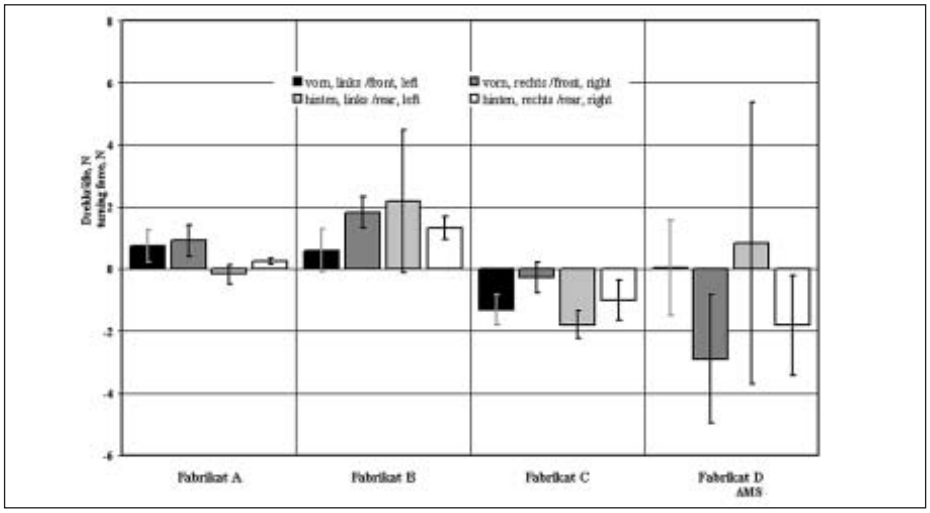

Fig. 2: Average turn force at the teats in different automatic milking systems (normal udder)

- make A: single tube guiding to every teat cup
- make B: robot-arm with single row to teat cup
- make C: mobile milking unit
- make D: single tube guiding to every teat cup

Vertical force

A lot of milking clusters have difficulties with the adaptability of the teat cups especially to stepped udder forms. *Figure 1* describes the average vertical force in the four AMS with normal udder form. The mean vertical force amounts 7.2 N. The vertical forces mainly result from the mass of the milking cluster. Regarding the single makes they nearly show the same results and are subjected to nearly the same force on every teat. In opposite to the conventional milking systems there had been measured values over 10 N between the front and rear teats [7]. The standard deviations are low, this confirms the good adaptability to the teats by every milking. [2] shows the result, that 90 % of all attaching of milking cluster by AMS without external correction have been successful.

The differences between the makes are explained mainly by the different tube guiding systems. Makes A and D show the best results, because they have a real single tube guiding to every teat cup. This could be valuated very positive for the regular forces to the teats as well with stepped udder.

Teat cup attaching influences the torque

Torques are mostly influenced by the milker, because it results when the cluster is attached to the teats. In the following section the turning force is used instead of torque to get a better comparison with the other forces. Regarding the resulting forces in *Figure 2*, they show positive results. The resulting turning forces are between 0 N (0 N = optimal case) and 3 N. The high standard deviations especially for makes B and D are noticeable. In this case there are some difficulties in teat cup attaching. One reason for this could be the problem of the silicon teat. There had been a lot difficulties with the teat finding in comparison with original cow teats. Because of this, it should not overvalued.

Horizontal forces

The resulting horizontal forces have been calculated from the horizontal longitudinal and diagonal forces. Make B had the highest deviations from the data of the measuring teat. That means there are longitudinal forces which pull the teats to the front direction of the cow (head of cow). This is the consequence of the construction of the tube guiding. More aspects and results about the horizontal forces are shown in LANDTECHNIK-NET.com

Conclusions

Generally the adaptability of the milking cluster in AMS can be rated very positive. All teats are subjected with nearly the same vertical force. This could be a reason for better udder health compared to conventional milking systems. Reliable working techniques and the construction of clusters have a major influence on the correct positioning of the cluster in automatic milking systems. In further studies these factors should be analysed exactly to obtain ideas for solving the problems mentioned above.

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