Automatic Milking Systems (AMS) and their influence on the fat content of milk

H. Grimm

Universität Hohenheim, Inst. of Agricultural Engineering, Garbenstr. 9; D-70599 Stuttgart, Germany
E-mail: grimm@uni-hohenheim.de

Abstract

The influence of irregular milking intervals (MI) on the fat content of milk was investigated on two farms with 85 cows, each milked with one automatic milking system (Lely). In addition to the influence of the „actual" MI, the influence of the MI „before" was also analysed. The difference in milk secretion rates between short (<6h) and long (>12h) actual MI was about 12% and as expected. The fat content of the milk was significantly influenced by both the actual MI and the MI before. Long MI before raised the fat content (<6h → >12h / 3.94% → 4.70%) almost as high as long actual MI lowered it (<6h → >12h / 4.80% → 3.77%). The conclusion is that fat from long MI (with high fat percentage in the residual milk) is transferred into the following shorter MI.

Key words: *Milk, secretion, interval, fat, irregular milking interval*

Introduction

It is well known that milk fat is not evenly distributed in milk during milking with highest values towards the end of the milking process. Experiments with regular milking intervals (MI) show that the percentage of fat in different milk fractions is not constant, but after long MI will be lower in foremilk and higher in strippings or residual milk, compared to shorter MI (Grimm, 1984). More confusing results can be seen in milking with irregular MI: milk after long MI will have lower fat content than milk from the corresponding (shorter) MI (Nuber, 1989). This will also occur with automatic milking and thus will confuse calculations of breeding data. So the aim of the present study is to elaborate possible reasons for these findings.

Material and methods

Two farms with automatic milking systems (LELY) were evaluated; farm I with 58 cows (Deutsche Schwarzbunte, 29.8 kg/day) and farm II with 36 cows (Fleckvieh, 19.8 kg/day). Milk samples were collected over a period of 72 hours on each farm and all samples were analysed separately. Additional data was extracted from information during milking: time of milking, duration of milking, milk yield. Not only were the time and length of the actual MI recorded, but also time and length

of the preceding MI. Here MI „actual“ is the MI from the last milking until the actual milking – where the milk samples were taken – and MI „before“ is the MI before MI actual. For the present evaluation, only data from cows with at least one MI <<9h and one >>12h was used, and if the relation of the calculated milk secretion rates (actual : before) was > 2:3 and < 3:2. In this way, data from incomplete milkings were excluded. The MI were divided in four steps (≤ 6; >6-9; >9-12; >12 [h]). Although data from 94 cows and over 1000 milkings were recorded, only 450 complete data sets from 85 cows could be used. This was due to the necessity of including complete data from two consecutive milkings: both MI actual and MI before. The results were calculated with SPSS (Version 11.5 for Windows). The influence of MI actual and that of MI before (Least Squares Analysis) was calculated according to the following model:

$$y_{ijkl} = cow_i + MI\ actual_j + MI\ before_k + (MI\ actual*MI\ before)_{jk} + 0_{ijkl}$$

were

y_{ijkl}	= trait value
cow_i	= random effect of cow (i = 1…85)
MI'actual´$_j$	= fix effect of the actual interval (j=1…4)
MI'before´$_k$	= fix effect of the interval before (k=1…4)
(MI'actual´*MI'before´)$_{jk}$	= interaction MI actual*MI before
0_{ijkl}	= error of estimate

Results and discussion

Figures 1a – c show the relations between consecutive milkings for the recorded traits. Relations between secretion rates and between protein contents are very close, whereas those for fat are almost undetectable.

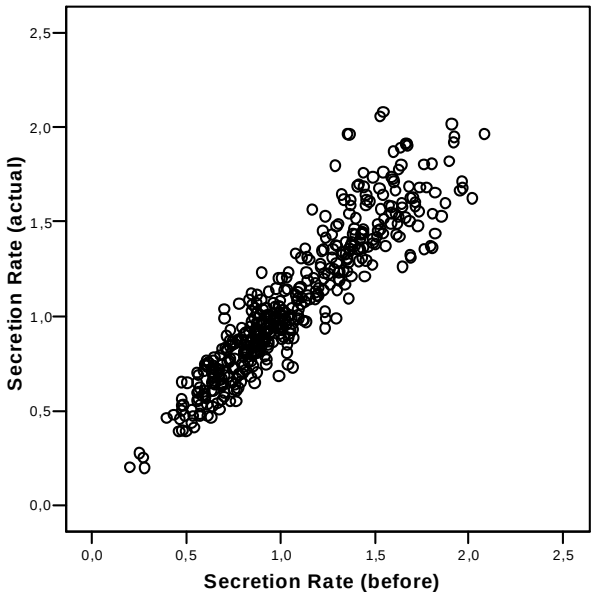

Figure 1a. Actual secretion rates [kg/h] in relation to secretion rates before.

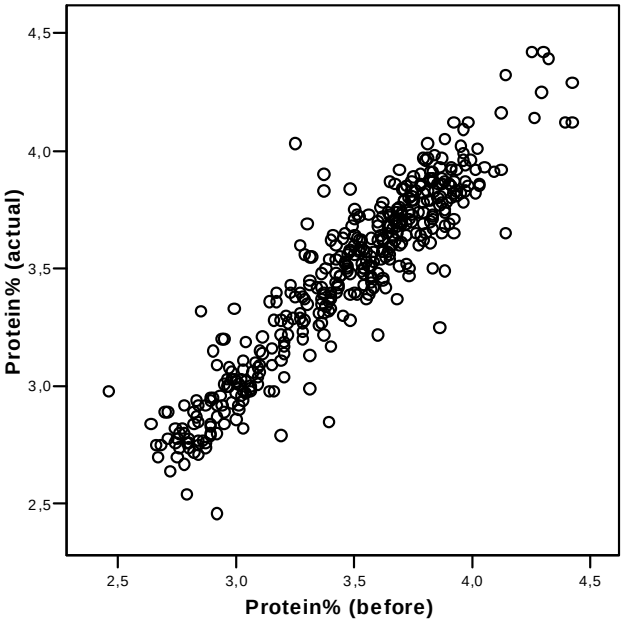

Figure 1b. Actual protein content in relation to protein content before.

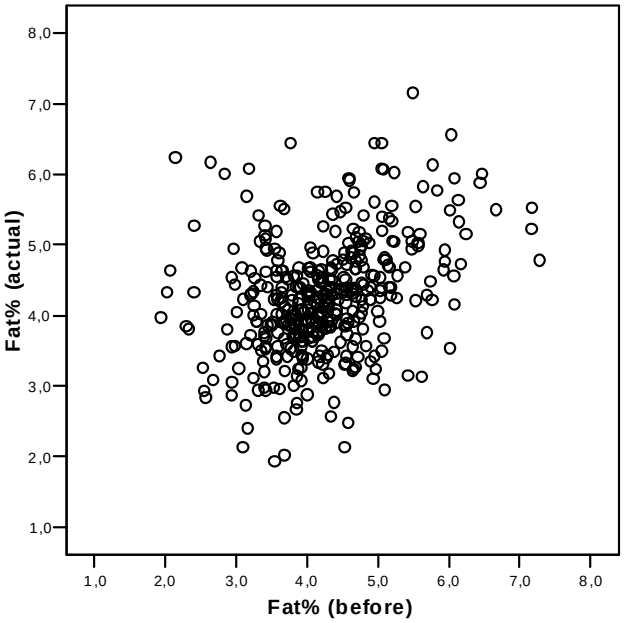

Figure 1c. Actual fat content in relation to fat content before.

The results for protein content ($r^2 = 0.86$) and secretion rate ($r^2 = 0.58$) are as expected. It is astonishing, however, to see almost no correlation between the fat content of milk from two consecutive milkings ($r^2 = 0.1$). These differences can be explained by the results of the least squares analysis according to the statistical model mentioned above: the closest relation between values of two consecutive milkings is found with a parameter that is entirely uninfluenced by milking interval (protein

content), followed by parameters that are (physiologically) influenced by the length of the actual milking interval only (secretion rate, milk yield [$r^2 = 0.22$ – graph not shown]) and almost no relation can be found when the parameter is influenced by both intervals - actual milking and milking before (Table 1).

The lower secretion rate after milking intervals longer than 12 h, compared to short milking intervals of less than 6 h, is as expected (~12%). The fat content of the milk, however, is influenced by both the actual milking interval and the milking interval before. The higher fat content after short actual milking intervals is as expected. The influence of short milking intervals before the actual milking interval is quite the opposite – they will lower the fat content of the milk.

The results from Grimm (1984) may help to explain these findings. He found that the fat content of the milk from a complete milking is neither influenced by the length of the milking interval (6 or 12h) nor by a diurnal rhythm. There are big differences, however, within the milkings: the fat content of the milk after long milking intervals is lower at the beginning of the milking and higher towards the end of the milking (strippings, residual milk) compared with short milking intervals. This means that no differences in fat secretion can be found with regard to any diurnal rhythm, but there are big differences in the stratification of milk fat in the udder. As a consequence, differences in the fat content of the milk – when milking with uneven intervals during day and night, respectively – are not due to different secretion rates of fat. It seems reasonable that in „evening milk" more fat can be found from the residual milk from the morning (longer interval at night and consequently higher fat content of this residual milk) and *vice versa*.

Table 1. Estimated least squares means for actual milking interval (MI actual) and milking interval before (MI before).

Milking Interval	Milk Yield [kg]	Secretion Rate [kg/h]	Protein [%]	Fat [%]
MI actual	***	***	-	***
1 (< 6h)	5.19	1.12	3.43	4.80
2 (6 – 9h)	7.71	1.03	3.45	4.54
3 (9 – 12h)	10.44	1.00	3.47	4.14
4 (> 12h)	12.59	0.97	3.44	3.77
MI before	-	-	-	***
1 (< 6h)	9.06	1.03	3.44	3.94
2 (6 – 9h)	9.14	1.06	3.43	4.17
3 (9 – 12h)	8.77	1.02	3.45	4.43
4 (> 12h)	8.96	1.00	3.48	4.70

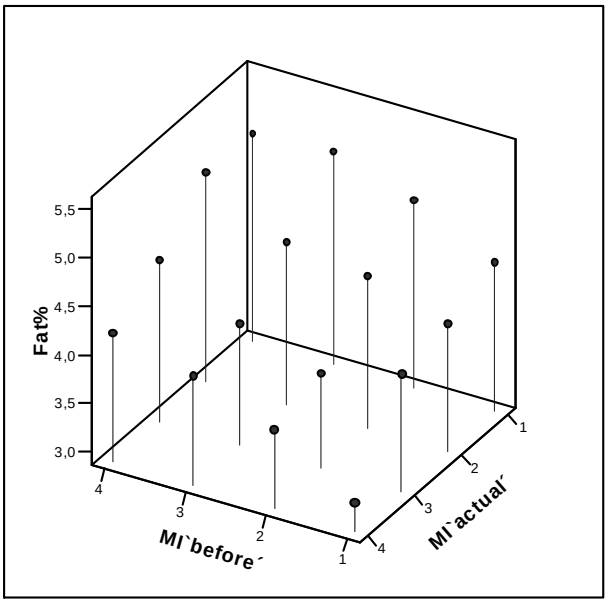

Figure 2. Fat content per cell of (MI actual x MI before)

Conclusions

Earlier results (Ludri, 1984; Nuber, 1989) showed lower fat contents of the milk after longer milking intervals – when the corresponding milking interval was shorter. In those studies the effect of the actual milking interval was investigated, but not that of the milking interval preceding the current milking interval. The present observations, however, show increasing fat contents with longer MI before.

Results

- No difference in fat content during even milking intervals
- Higher fat content in strippings and residual milk after long milking intervals
- Higher fat content after short milking intervals and lower fat content after long milking intervals – when consecutive milking intervals are uneven lead to the following interpretation:

Long milking intervals increase the fat content in the residual milk and cause transfer of milk fat to a following, under practical milking conditions shorter, milking interval – resulting in higher fat contents of milk after these short intervals.

References

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