ANALYSIS OF DAILY MILK PRODUCTIVITY CHANGE IN DAIRY COWS

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Summary. Research on fluctuations in cow milk productivity traits was carried out in July and August of the years 2001 and 2002, within a period of 30 days each year. Latvian Brown milking cows, 74 and 66 respectively, reared by one person, were included in trial group. Coefficients of variation were calculated for each cow for all the studied productivity traits to elicit dynamics of milk productivity traits. Dynamics of cow daily milk productivity was found higher in the year 2002. In both trial years greatest values of coefficients of variation were obtained for somatic cell count, 16.83% and 37.01% on average per group of cows. Lactose content in milk was most stable milk productivity trait. The observed variability was from 1.43% to 3.37%, however this difference was significant. The average variability in milk yield, fat and protein content in milk was 9.77%, 10.94% and 8.76% respectively in 2002.

Physiological factors, such as cow age at lactations and lactation phase might be the factors, which could significantly affect milk productivity dynamics. Feed means used as supplement in cow diet as well as concentrated feed fed significantly affected dynamics of fat, protein and lactose content in milk. In analysis of the dynamics of the milk yield, fat and protein content in milk in different cow lactation phases we found that these traits could significantly change already in the following day of control. In second trial day, cows of the 1st phase lactation showed significant change in average milk yield, fat and protein content in milk by 6%, 10% and 6% respectively compare to the first trial day.

Keywords: dairy cows, milk productivity traits, variation.

MELŽIAMŲ KARVIŲ PAROS PRODUKTYVUMO KAITOS TYRIMAI

Santrauka. Melžiamų karvių produktyvumo savybių tyrimai atlikti 2001–2002 metų liepos–rugpjūčio mėnesiais, trukmė – 30 dienų kasmet. 74 ir 66 Latvijos žalosios melžiamos karvės, auginamos vieno asmens, buvo įtrauktos į dvi bandymo grupes.

Norint išaiškinti pieno produktyvumo savybių dinamiką, buvo atliktas statistinis skaičiavimas.

Didesnė karvių dienos primilžio produktyvumo dinamika nustatyta 2002 metais. Per abu bandymo metus vidutiniškai karvių grupėse somatinių ląstelių skaičius padidėjo 16,83% ir 37,01%.

Laktozės kiekis piene bandymo laikotarpiu buvo nuo 1,43 % iki 3,37 %; skirtumas buvo statistiškai patikimas. Pieno primilžio vidurkis, riebalų ir baltymų kiekis piene 2002 metais buvo 9,77 %, 10,94% ir 8,76 % didesnis.

Fiziologiniai veiksniai, t. y. karvės amžius, laktacijos tarpsnis gali paveikti pieno produktyvumo dinamiką. Šėrimo būdas, taip pat koncentruoti pašarai pastebimai paveikė riebalų, baltymų ir laktozės kiekio dinamiką piene. Tirdami pieno primilžio, riebalų ir proteinų kiekio piene dinamiką skirtingais karvių laktacijos tarpsniais įsitikinome, kad šie rodikliai gali pastebimai pasikeisti jau kitą kontrolės dieną.

Kitą bandymo dieną pirmos laktacijos tarpsnio karvių pienas smarkiai pakito – pieno riebalų ir baltymų palyginti su pirmąja bandymo diena padaugėjo 6%, 10% ir 6%.

Raktažodžiai: melžiamos karvės, pieno produktyvumo savybės, nukrypimas.

Introduction. Animal surveillance is an individual control system for animals, which ensure productivity and product quality data for breeding value determination. So obtaining data more precise is of great significance.

Milk recording in dairy farming in Latvia is organized according the instruction No.2 (1998) of the Ministry of Agriculture "On cow surveillance in Latvia Republic". The instruction has been elaborated in conformity with rules set by the International Council for Animal Regulation (ICAR).

Regulations in Latvia provide for over-surveillance, which is realized by the inspection of the Genetic Improvement of Livestock. All herds under surveillance are subjected to over-surveillance. According the instruction of the Ministry of Agriculture, over-surveillance according to schedule may be realized in three days after recurrent control.

Milk-recording data indicate that milk productivity traits during lactation may be subjected to great fluctuations. Research results obtained in Germany show that milk productivity traits during lactation may significantly vary. These traits are most stable from the 3rd to 28th week of lactation. During this period, the daily milk yield variation is from 7% to 10%. The 28th week onward, with cow pregnancy being in progress milk productivity traits gradually drop (Huth, 1995). Analysis of milk yield and composition fluctuation amplitude in a cow group in the period of 30 days showed that these traits were affected by phase of lactation (Paura et al., 2002). Significant factor was a cow′s age in lactations. Short fluctuations in milk productivity could be caused by different external environmental factors, such as changes in feed ration, shortage of drinking water, high air temperatures, change in milking regime, incomplete milking of cows, animals being in heat, and others (Huth, 1995).

The goal of our research was to clarify daily milk productivity variation in dairy cows and analyse factors, which affect milk productivity traits under milk recording.

Materials and methods. Research was carried out in the herd of Latvian Brown breed cows at the Training and Research Farm "Vecauce" of the Latvia University of Agriculture in the years 2001 and 2002 from mid-July till mid-August, 30 days each year. Milking cows with the average milk yield 16.49±0.080 kg in 2001 and 17.49±0.081 kg in 2002 at research initiation, reared by one person were included in trial. The average age of trial group cows was 2.69 lactations in 2001 and 2.92 lactations in 2002. On the farm, semi-automatic milking equipment and measuring instruments from the company *De Laval* were used in milking cows, milk yield recording and making samples of milk.

Milk was analysed for fat, protein and lactose in milk laboratory of the Kurzeme Artificial Insemination Station using *Milko-Skan 133B* and *Fossomate-90* in somatic cell counting.

In the summer period of 2001, cows were fed with pasture grass, cut green feed of different botanical composition and self-produced concentrated feed. In 2002, feed ration consisted of pasture grass, haylage, and self-produced concentrated feed.

Physiological and environmental factors affecting cow milk productivity were grouped into classes of grades (Table 1). Obtained data statistical processing was done according to SPSS computer program. Coefficients of variation were compared using Z test. Factorial analysis was done using linear model:

Table 1. **Division of milk productivity affecting factors**

Factors studied	Classes of gradation	
	Year 2001	Year 2002
Lactation	1st; 2nd ; 3rd and older lactation cows	
Lactation phase	Till 100 lactation day; 101– 200; from 201 day till the end of lactation	
Air temperature, C^0	Below 20 C^0; 21 C^0-24 C^0; above 24 C^0	
Humidity, %	Below 60%; 61-69%; 70-79%; 80-89%; above 90%.	
Pastures	Utilize: 1st day; 2nd day; 3rd day; 4th day	
Feed supplementation	Green feed cut in late vegetation phase; chopped mix; chopped alfalfa, hay	Haylage, hay
Concentrated feed	Self-produced concentrated feed; Self-produced concentrated feed + oats	Self-produced concentrated feed; Self-produced concentrated feed + rape + field pea

$$y_{ijklmno\ p} = \mu + \alpha_i + AT_j + H_k + L_l + LP_m + G_n + F_o + C_p + e_{ijklmnop}$$

$y_{ijklmno}$ – investigated item; μ - general mean; a_i – cows effect (random); AT_j - air temperature ºC (fixed); H_k - humidity% (fixed); L_l - lactation (fixed); LP_m - lactation phase (fixed); G_n - grassland (fixed); F_0 .fodder (fixed); C_o - concentrate (fixed). $e_{ijklmno}$ - residual.

Results. The obtained mean values of milk productivity traits during the period of 30 days did not show any significant changes in milk yield between days in the years 2001 and 2002, however fluctuations in milk fat and protein content between days were significant in both trial years. Significant fluctuations in lactose content in milk between days were observed only in 2001, but significant changes in somatic cell count were observed in 2002 (Table 2).

Table 2. **Variability of cows milk productivity traits between days during trial**

Traits	Year	
	2001	2002
Milk yield. kg	0.28	0.25
Fat content. %	< 0.01	< 0.01
Protein content. %	< 0.01	< 0.01
Lactose content. %	< 0.01	0.42
SCC_log	0.09	< 0.01

p-value < 0.01factor is significant

SCC_log = log2 (SCC/100 000) + 3 (DA at al. 1992)

The main task of our research was to clarify the level of variation in milk productivity traits for each individual animal. To reach the goal, values of the coefficient of variation were calculated for analyse milk productivity traits for each cow in trial group. Results obtained showed greater variability of milk productivity traits in the summer season 2002 compare to that of 2001. Somatic cell count was the trait being most variable in both trial years, besides the value of coefficient of variation was by 20.18% higher in the summer 2002. There was observed increased variability for fat and protein content in milk by 4.02% and 5.41%, respectively. Milk yield variability between days as well increased by 1.91% in the summer season 2002. The increase of lactose content by 1.96% was significant (Table 3).

Table 3. **Variation coefficients of milk productivity traits in years 2001 and 2002**

Traits	Year						Difference
	2001			2002			
	$\bar{x}$	min	max	$\bar{x}$	min	max	
Milk yield, kg	7.86	1.83	24.26	9.77	3.97	26.75	1.91
Fat content, %	6.92	2.23	13.86	10.94	4.49	48.86	4.02
Protein content , %	6.92	2.23	13.86	8.76	1.99	12.57	5.41
Lactose content, %	1.43	0.40	5.02	3.37	0.91	10.15	1.94*
SCC_log	16.83	4.21	59.02	37.01	8.91	81.20	20.18

* < 0.05 difference is significant

Division of the investigated animals into trial groups according to values of coefficient of variation in studied traits is presented in Figs. 1 and 2.

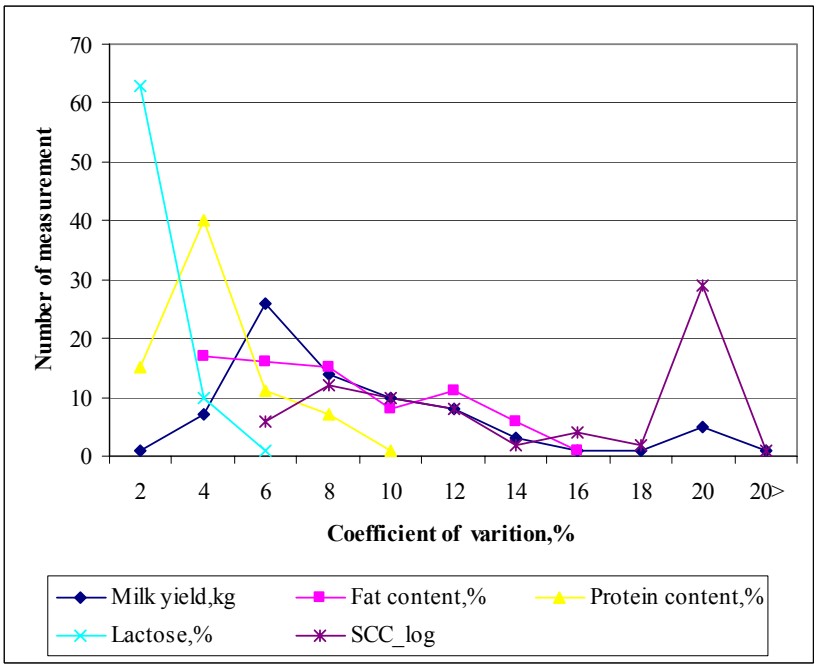

Figure 1. **Distribution of coefficients of variation for milk produktivity traits in year 2001**

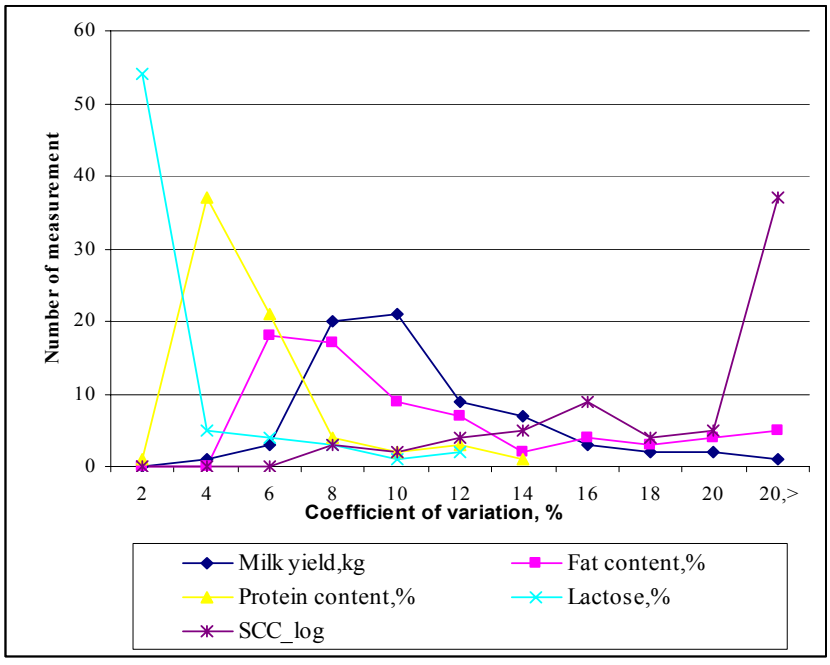

Figure 2. **Distribution of coefficients of variation for milk produktivity traits in year 2002**

In both trial years lactose content in milk is the trait with the least variability. For 85% investigated animals the value of coefficient of variation was below 4%. SCC-log was the most variable trait as the value of coefficient of variation was above 6% and exceeded 18% limit even for 67% animals in 2002. In 2001, the produced milk yield was 3.80 – 27.8 kg per control day for animals in trial group. In 2002, daily produced minimal and maximum milk yields were 4.80 and 31.80 kg respectively. For that reason greater or smaller number of animals occurred in each of coefficient of variation groups. In the summer 2001, the greatest proportion of animals – 69% had milk yield variability from 6% to 10%. In 2002, milk yield variability for the investigated animals was from 8% to 12%. In the summer season 2002, milk fat content variability between days was from 6% to 14% for trial group cows exceeding variability level in 2001. More stable trait was milk protein content, as it was not exceeding 6% limit for more than 80% investigated animals in both trial years.

Analysis of physiological, environmental and feeding factors effect on the traits studied helped us to clarify factors, which significantly affected variability of milk productivity traits in the summer season (Table 4). Cow age in lactations significantly affected all the traits studied except lactose amount in milk. Lactation phase is a factor significantly affecting variability of all studied traits (Huth, 1995, Paura etc. 2002). The air temperature and humidity in 2001 significantly affected lactose amount fluctuations in milk. In 2002, the air temperature had significant effect on variability of fat and protein content in milk as mean air temperatures during trial was by 2.2 °C higher comparing the same period previous year. Humidity in 2002 significantly affected changes of protein content in milk, because in 24 out of 32 trial days, humidity was below 80%. In the summer 2001, humidity was below 80% only in 5 days.

Table 4 Analysis of factor effect on milk productivity traits

Factors	*p-value*									
	Milk yield, kg		Fat content, %		Protein content, %		Lactose content, %		SCC_log	
Yaer	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002
Lactation	< 0.01	< 0.01	<0.01	< 0.01	< 0.01	< 0.01	0.07	0.05	<0.01	<0.01
Lactation phase	< 0.01	<0.01	<0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	<0.01	<0.01
Air temperature °C	0.38	0.25	0.22	< 0.01	0.56	< 0.01	< 0.01	0.02	0.81	0.25
Dampness, %	0.27	0.46	0.78	0.08	0.03	< 0.01	< 0.01	0.43	0.49	0.19
Grassland	0.66	0.10	0.02	0.49	< 0.01	0.29	< 0.01	0.43	0.95	0.45
Fodder	< 0.01	<0.01	0. 06	0.81	<0.01	0.05	< 0.01	0.54	0.83	0.35
Concentrate	0.31	0.26	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.07	0.95	0.34

p–value > 0.01 factor is not significant; *p-value* < 0.01 factor is significant
SCC_log = log2 (SCC/100 000) + 3 (DA at al. 1992)

The length of grassland use in 2001 significantly affected protein and lactose content in milk. Food means used for animal feed supplementation significantly affected milk yield, protein and lactose content in milk. In 2001 chopped 2nd cut alfalfa supplementation resulted in increased value of the studied traits. In both trial years the kind of concentrated feed supplementation significantly affected fat and protein content in milk.

Being aware of lactation phase as a factor, which has significant effect on all milk productivity traits (Paura etc. 2002), all investigated cows were grouped between lactation phases. Milk yield, changes in milk fat and protein content as attributed to the first control day were compared, because over-control can be realized in 3 days after current control (Table 5).

Table 5. **The average milk productivity of cows dependiding on the phase of lactation**

Lactation phase	Year 2001				Year 2002			
	n	Control days			n	Control days		
		1.	2.	3.		1.	2.	3.
Milk yield, kg								
1.	23	18.1±0.85	17.9±0.98	18.8±0.85	27	19.4±0.69	18.3±0.69***	19.3±0.79
2.	26	15.9±0.59	16.4±0.57	15.9±0.60	23	17.3±0.70	17.7±0.69	17.8±0.77
3.	25	14.0±0.44	14.0±0.50	14.1±0.51	16	14.6±0.58	14.8±0.75	15.0±0.50*
Fat content, %								
1.	23	4.23±0.16	4.28±0.11	4.36±0.14*	27	4.08±0.16	3.69±0.13***	4.35±0.33**
2.	26	4.13±0.07	4.27±0.09**	4.19±0.08	23	4.05±0.11	3.66±0.09***	4.00±0.07
3.	25	4.37±0.11	4.40±0.10	4.48±0.10*	16	4.54±0.18	4.07±0.14*	4.44±0.12
Protein content, %								
1.	23	3.06±0.05	3.15±0.05**	3.12±0.05	27	2.92±0.04	3.00±0.04***	3.05±0.05***
2.	26	3.26±0.04	3.29±0.04	3.34±0.03*	23	3.26±0.04	3.27±0.04	3.27±0.04
3.	25	3.51±0.05	3.56±0.04	3.60±0.04*	16	3.27±0.0	3.42±0.05***	3.52±0.05***

* p < 0.05; ** p < 0.01; *** p < 0.001

Fluctuations in average milk yield in the first three trial days in 2001 were not observed for cows of any lactation phase. In 2002, there were observed significant changes in milk yield for cows of the 1st lactation phase already in the second control day, but these changes were significant for the cows of the 2nd and 3rd lactation phases in the third control day. Milk fat content for cows of all lactation phases in the first control day was significantly different from that in the following days. Significant changes in milk protein content were not observed only for cows of the 2nd lactation phase in the first three trial days in 2002, however these changes were significant for the cows of the rest lactation phases. So, when realizing over-control, lactation phase of a cow should be considered as cows of the 1st lactation phase more sharply reacted to the changes in air temperature and humidity, when in the second control day in 2002 the air temperature raised by 3 °C and humidity was only 55%. Other animal feeding and keeping conditions in first trial days were similar. So, when realizing over-control lactation phase of a cow should be considered.

Discussion and conclusions. The goal of our 30-days long research on milking cows in the summer seasons 2001 and 2002 was to clarify daily milk productivity traits variability in cows and analyse which factors affect milk productivity traits under milk recording. Results of the experiment lead to the following conclusions:

1. In the summer season, changes in the average fat and protein content in milk between trial days were significant for the investigated animals in both trial years. Lactose content between days significantly varied in 2001, but somatic cell counts varied in the summer 2002 ($p<0.01$). The average milk yield of trial group did not change significantly between days.
2. Analysis of milk productivity traits variability for individual animals indicate, that mean values of the coefficients of variation for all studied traits were higher (2.37 –37.01%) in 2002 compare to those in 2001 (1.43 – 16.83%), and for lactose content different between years ($p<0.01$).
3. Milk productivity traits (except lactose) under surveillance were significantly affected by a cow′s physiological condition (age in lactations and lactation phase). Air temperature above 25 °C and humidity below 65% during trial significantly affected changes in milk fat, protein and lactose content. Milk yield, protein and lactose content were significantly affected by the kind of supplemented green feed (rape extracted meal and field pea meal).
4. When realizing over-control in milk-recording, it should be considered, that depending on the above mentioned factors, milk yield produced by a cow group, fat content and protein content could significantly change on the average by 6%, 10% and 6%, respectively.

References

1. DA Y., Grossman M., Misztal I. Estimation of genetic parameters for somatic cell score in Holstein. J. Dairy Sci., 1992. Vol. 75. P. 2265-2271
2. Gagini H., Keown J.F., Van Vleck L. D. Genetic parametrs of test day milk. fat and protein yields. Proc. of the 6th World Congress on Genetics Applied to Livestock Production. Armidale. Australia. 1998. Vol. 23. P. 311 – 314
3. Huth F.-W. Die Laktation des Rindes: Analyse. Einfluss. Korrektur. –Stuttgart: Ulmer. 1995. 289 s.
4. Jonkus D., Paura L., Kairiša D. Analysis of the cow milk produktivity dynamics in different lactation phases / Proc. of the 9th Baltic Animal Breeding Conference. Sigulda-2003. P. 46 - 50
5. Paura L., Kairisha D., Jonkus D. Repeatability of milk productivity traits / Veterinarija ir zootechnika. 19 (41) tomas. Kaunas-2002 P. 90 – 93.
6. Paura L., Kairisha D., Jonkus D.Changes of Daily milk content in different lactation phases / Agronomijas vēstis Nr.4.,2002. Jelgava-2002 P 111.- 115.