Session 16/8

CHANGES IN INTENSITY OF BIOSYNTHESIS OF MILK FAT FATTY ACIDS DURING LACTATION IN GRAZING DAIRY COWS

***Kirchnerová, K.*[1]*, Foltys, V.*[1] *and Špička, J.*[2]

[1]*Animal production research centre Nitra, Hlohovecká 2, 951 41 Lužianky, Slovak Republic*

[2]*South Bohemian University, Branišovská 31a, 370 05 České Budějovice, Czech Republic;*

kirchnerova@cvzv.sk

Human nutrition value of milk fat

Milk fat is of the negative evaluation

-dominant content of saturated fatty acid (SAFA) with high Atherogenic index (AI).

Intake of milk fat in the diet is important

-monounsaturated FAs, acting favorably against cardiovascular diseases

-essential fatty acids (EFAs), linoleic and alpha linolenic acid and CLA, which is found only in meat and milk of ruminants. These are precursors of biologically active substances - hormones and enzymes

The objective

- **of this work was to study**
- **relations among representation of fatty acids of milk fat**
- **and lactation stage and qualitative and production parameters of milk**
- **in dairy cows held at pasture in mountain dairy farms in Slovakia**

Material and methods

- The milk samples were taken in total from 134 cows at summer pasture period (breed Pinzgau, Holstein, Simental).
- At 6 dairy farms in the mountain area in field below High Tatras in the altitude about 800 m about the sea level.
- The dairy cows were at first lactation on different number of days of lactation evenly distributed in the interval of 10 - 111 days .
- The data on their milk performance were processed on the basis of milk recording.
- The milk was sampled from the whole amount of milked milk at regular milk recording.
- Single milk samples were analyzed for physiological and biochemical parameters and for fatty acids in milk fat using gas chromatography.

Analyses of milk samples

- **Content of fat, protein and lactose was determined by infrared analyser Milkoscan FT 120 (FOSS Electric), with DID detector (diode array = diode field in whole red spectrum) according to ISO 9622: 1999 Whole milk – Determination of milk fat, protein and lactose content – Guidance on the operation of mid-infrared instruments.**
- **Somatic cells count (SCC) was determined in apparatus Somacount 150 (Bentley Instruments), on the principle of through-flow cytometry, according to STN EN ISO 13366-1: 2008.**
- **Temperature of milk freezing (TMF) was determined in thermistor cryoscopic apparatus Cryostar (Funke Gerber), according to the norm ISO 5764: 2002 Milk – Determination of freezing point.**
- **Content of urea was determined photocolorimetrically with Ehrlich's agent at 530 nm wave length.**

Analysis of fatty acids by gas chromatography

Milk fat was isolated from lyophilized milk samples by extraction in petroleum ether according to Röse-Gottlieb, then it was re-esterified by methanol potassium hydroxide solution, and methyl esters of fatty acids were extracted by hexane.

Methyl esters of fatty acids were analysed by gas chromatography (apparatus GC Varian 3800, Techtron, USA), using FID detector in capillary column Omegawax 530; 30m. Irregular temperature gradient from 40 to 240 C, injection and detection at 250 C were used. Nitrogen flow rate was 6 ml.min .

In the chromatography record 54 fatty acids inclusive of particular isomers were identified by standard reference sample of milk fat and analytical standards Supelco, followed by GCMS analysis.

Their representation was expressed relatively in percents (%). Groups of fatty acids and their abbreviation as well as calculated indexes were created according to traditional structural-chemical and nutrition criteria in line with studies cited in References.

Mathematic-statistical evaluation of results

•

• **Results of analyses were processed by variation-statistical methods using the Statgraphics software.**

•Following statistical characteristics were calculated: arithmetical mean (x), minimum and maximum value, standard deviation (sx), variation coefficient (v%).

•The test of two means agreement (t-test - type for uneven variances) was used to determine significance of difference.

•Coefficients of linear correlation (r) were calculated to express relations among the studied parameters, and their statistical significance was tested.

•The results did not show waves or change in course in relation to the number of lactation days, which would indicate dissection of lactation into linear parts. On this basis we studied the relations among the detected parameters by means of linear regression for the studied number of lactation days.

Tab1: Basic parameters of milk production and fatty acids composition.

Comparison		Pasture (n=134)	Whole year feed mix (n=100)
Milk kg/D	**x**	**21,81[b]**	**27,78[a]**
	Sx	6,34	6,27
Fat kg/D	**x**	**0,9**	**1,03**
	Sx	0,33	0,29
Protein kg/D	**x**	**0,71[b]**	**0,85[a]**
	Sx	0,2	0,17
SAFA %	**x**	**70,48**	**71,24**
	Sx	4,04	6,28
BCFA	**x**	**2,02[a]**	**1,75[b]**
	Sx	0,33	0,21
MUFA	**x**	**26,26**	**25,84**
	Sx	3,59	5,82
PUFA	**x**	**3,26[a]**	**2,92[b]**
	Sx	0,69	0,77
EFA	**x**	**2,96**	**2,85**
	Sx	0,61	0,75
CLA	**x**	**0,54[a]**	**0,39[b]**
	Sx	0,23	0,19

[a, b] Statistically significant difference ($P<0,001$)

Tab. 1 Correlation coefficients of milk fat fatty acids content to milk production parameters (Daily milk production 8,5-41,5 kg; 21,8 kg in average)

SAFA short – positive long – negative

Fatty acid sign	content x±Sx (%)	Days of lactation 10– 111	Milk total production (kg) 380-3735	Fat 14-155	Protein 15-109
C4:0 BA	2,43±0,56	0,217	0,231	0,161	0,166
C6:0 VA	2,06±0,51	0,412	0,43	0,347	0,379
C8:0 CA	1,48±0,37	**0,512**	0,468	0,371	0,442
C10:0 CA	**3,50±0,90**	**0,646**	**0,516**	0,398	**0,515**
C11:0	0,09±0,05	0,43	0,433	0,432	**0,513**
C12:0 CA	**4,16±0,94**	**0,713**	0,499	0,367	**0,522**
C13:0	0,19±0,08	**0,518**	0,278	0,251	0,315
C14:0 MA	**12,71±1,55**	**0,592**	0,468	0,317	0,44
C15:0	1,40±0,24	0,223	-0,019	-0,068	0,065
C16:0 PA	**31,53±3,11**	0,264	0,359	0,396	0,397
C17:0	0,73±0,16	**-0,657**	**-0,642**	**-0,556**	**-0,651**
C18:0 SA	**7,98±1,66**	**-0,607**	-0,453	-0,326	**-0,509**
C20:0	0,11±0,03	-0,245	-0,4	-0,361	-0,432
C22:0	0,05±0,02	-0,303	-0,459	-0,382	-0,419
C24:0	0,03±0,02	-0,369	-0,403	-0,282	-0,352

Tab. 1 Correlation coefficients of milk fat fatty acids content to milk production parameters (Daily milk production 8,5-41,5 kg; 21,8 kg in average)

MUFA (short – positive, long – negative)

Fatty acid sign	content x±Sx (%)	Days of lactation 10 – 111	Milk total production (kg) 380-3735	Fat 14-155	Protein 15-109
C10:1	0,38±0,12	**0,745**	**0,617**	0,479	**0,64**
C12:1	0,12±0,05	**0,712**	0,487	0,363	**0,562**
C14:1	1,13±0,27	**0,627**	0,364	0,267	0,441
C15:1	0,02±0,03	0,468	-0,109	-0,072	-0,105
C16:1n7cis POA	**1,49±0,3**	-0,213	-0,162	-0,102	-0,062
C16:1	0,43±0,06	-0,204	-0,355	-0,314	-0,244
C17:1n7cis	0,42±0,10	**-0,682**	**-0,531**	-0,398	**-0,508**
C18:1n9cis OA	**21,08±3,59**	**-0,645**	**-0,531**	-0,428	**-0,528**
C19:1	0,09±0,03	-0,21	-0,184	-0,194	-0,187
C20:1n9cis	0,15±0,06	-0,298	-0,32	-0,209	-0,306

Tab. 1 Correlation coefficients of milk fat fatty acids content to milk production parameters (Daily milk production 8,5-41,5 kg; 21,8 kg in average)

BCFA

Fatty acid sign	content x±Sx (%)	Days of lactation	Milk total production (kg)	Fat	Protein
		10 – 111	380-3735	14-155	15-109
C13:0i	0,16±0,05	**0,69**	0,395	0,291	0,469
C14:0i	0,19±0,05	0,254	-0,079	-0,191	-0,099
C15:0ai	0,61±0,13	0,055	-0,278	-0,357	-0,254
C16:0i	0,36±0,06	0,052	-0,208	-0,25	-0,266
C17:0i	0,41±0,08	-0,568	**-0,575**	**-0,516**	**-0,542**
C17:0ai	0,46±0,08	-0,52	**-0,599**	**-0,54**	**-0,588**

Tab. 1 Correlation coefficients of milk fat fatty acids content to milk production parameters (Daily milk production 8,5-41,5 kg; 21,8 kg in average)

PUFA (predominantly negative – with increase of production decreases the content of PUFA)

Fatty acid sign	content x±Sx (%)	Days of lactation 10– 111	Milk total production (kg) 380-3735	Fat 14-155	Protein 15-109
C18:2n6cis,cis LA	**1,79±0,28**	-0,477	-0,316	-0,277	-0,295
C18:3n3cisALA	0,50±0,19	-0,242	-0,403	-0,469	-0,434
C18:2 9,11 CLA	**0,54±0,23**	-0,224	-0,404	-0,436	-0,403
C20:2n6	0,10±0,05	-0,417	-0,341	-0,286	-0,343
C20:3n6cis	0,04±0,02	-0,282	-0,264	-0,166	-0,185
C20:4n6cis ETA	0,12±0,05	-0,317	-0,234	-0,141	-0,195
C20:4n3cis	0,03±0,02	-0,189	-0,309	-0,252	-0,273
C20:5n3cisEPA	0,05±0,02	**-0,523**	-0,472	-0,377	-0,44
C22:5n3cisDPA	0,08±0,03	-0,254	**-0,512**	-0,498	-0,478

Tab. 1 Correlation coefficients of milk fat fatty acids content to milk production parameters

	Days of lactation	Milk	Fat	Protein
		total production (kg)		
C4:0	0,217	0,231	0,161	0,166
C6:0	0,412	0,43	0,347	0,379
C8:0	**0,512**	0,468	0,371	0,442
C10:0	**0,646**	**0,516**	0,398	**0,515**
C11:0	0,43	0,433	0,432	**0,513**
C12:0	**0,713**	0,499	0,367	**0,522**
C13:0	**0,518**	0,278	0,251	0,315
C14:0	**0,592**	0,468	0,317	0,44
C15:0	0,223	-0,019	-0,068	0,065
C16:0	0,264	0,359	0,396	0,397
C17:0	**-0,657**	**-0,642**	**-0,556**	**-0,651**
C18:0	**-0,607**	-0,453	-0,326	**-0,509**
C20:0	-0,245	-0,4	-0,361	-0,432
C22:0	-0,303	-0,459	-0,382	-0,419
C24:0	-0,369	-0,403	-0,282	-0,352
C13:0i	**0,69**	0,395	0,291	0,469
C14:0i	0,254	-0,079	-0,191	-0,099
C15:0ai	0,055	-0,278	-0,357	-0,254
C16:0i	0,052	-0,208	-0,25	-0,266
C17:0i	-0,568	**-0,575**	**-0,516**	**-0,542**
C17:0ai	-0,52	**-0,599**	**-0,54**	**-0,588**
C10:1	**0,745**	**0,617**	0,479	**0,64**
C12:1	**0,712**	0,487	0,363	**0,562**
C14:1	**0,627**	0,364	0,267	0,441
C15:1	0,468	-0,109	-0,072	-0,105
C16:1n7cis	-0,213	-0,162	-0,102	-0,062
C16:1	-0,204	-0,355	-0,314	-0,244
C17:1n7cis	**-0,682**	**-0,531**	-0,398	**-0,508**
C18:1n9cis	**-0,645**	**-0,531**	-0,428	**-0,528**
C19:1	-0,21	-0,184	-0,194	-0,187
C20:1n9cis	-0,298	-0,32	-0,209	-0,306
C18:2n6cis,cis LA	-0,477	-0,316	-0,277	-0,295
C18:3n3cisALA	-0,242	-0,403	-0,469	-0,434
C18:2 9,11 CLA	-0,224	-0,404	-0,436	-0,403
C20:2n6	-0,417	-0,341	-0,286	-0,343
C20:3n6cis	-0,282	-0,264	-0,166	-0,185
C20:4n6cis ETA	-0,317	-0,234	-0,141	-0,195
C20:4n3cis	-0,189	-0,309	-0,252	-0,273

Outcome

The results show that

- In comparison of milk fat of groups of cows with different treatment is important to to take into account lactation stadium and milk yield of individual cows in these groups
- Cows within one herd show different milk fat FAs composition in dependence on milk yield and count of days after parturition (it may be related with origin and precursors of FAs in biosynthesis in mammary gland)
- Summarization of saturated, mono- and poly- unsaturated FAs without regard to carbon chain longness is not conducive for evaluation of results

Conclusion

Grazing of dairy cows has a better value of the composition of milk fat from a health perspective, but at the account of lower production as seen by correlations at mountain farms with dairy grazing systems.

This article was written during realization of the project „CEGEZ no. 26220120042“, supported by the Operational Programme Research and Development funded from the European Regional Development Fund.

Thank You