

From the Medical Department I, Royal Veterinary College, Stockholm, Sweden.

COMPONENT ACIDS OF MARE'S MILK FAT*)

By

Eero Tanhuanpää and Odd Knudsen

In the course of an investigation on the fatty acid composition of sow's milk comparisons with other domestic species were made. An unusually high content of linolenic acid in mare's milk as compared with milk from sows was then observed. We found one early publication dealing with mare's milk, namely by *Hilditch & Jasperson* (1944). The present paper describes the composition of milk fat in mares, which were either stable-fed or on pasture.

MATERIAL AND METHODS

Experimental animals. Twenty-nine mares of the American trotter race, 9 stable-fed and 20 on pasture, were used. Milk was collected when they were nursing their foals.

The food in the stable consisted of hay, which was given *ad lib.*, and of grain mixture. The latter was mainly composed of oats, and to a lesser part of barley and wheat bran. The grain mixture was given at the amount of 1—5 kg per day and horse.

Chemical procedure. The milk was extracted with ether-ethanol (1:3 v/v), and total lipids were determined by weighing. Methylating was done with 0.5 N Na-methylate (*Luddy et al.* 1960). The methyl esters were extracted with n-pentane, and the solvent was evaporated in vacuum at 20°C. The methyl esters were then analysed by gas-liquid chromatography, using a Perkin-Elmer fractometer 116 E and a 2 m diethylene glycol succinate column (15 % in 80—120 mesh Gas-chrom P) at 206°C. For identification purposes a 50 m 0.5 mm ID BDS (butanediol succinate) capillary column, and a 2 m BDS standard column were also used. Polyunsaturated fatty acids were determined

*) Supported by grants from Jordbrukets Forskningsråd.

Table 1. The error of analysis as calculated from double determinations of 8 milk samples. Fatty acids are given as relative %, total lipids and polyunsaturated fatty acids (PUFA) as % of dry substance.

	Mean	Error of analysis
C6:0	0.17	± 0.09
C8:0	2.11	± 0.22
C10:0	5.38	± 0.26
C10:1	0.78	± 0.11
C12:0	5.29	± 0.18
C14:0	5.47	± 0.16
C14:1	0.29	± 0.07
C16:0	19.88	± 0.21
C16:1	4.62	± 0.21
C18:0	1.28	± 0.15
C18:1	24.39	± 0.40
C18:2	20.59	± 0.43
C18:3	7.68	± 0.21
Total lipids	1.63	± 0.06
PUFA	0.460	± 0.007

according to *MacGee* (1959). The error of determination of relative percentages of fatty acids, total lipids and polyunsaturated fatty acids was calculated (Table 1).

Samples of red clover and timothy were examined. Fatty acid composition, total fatty acids, and polyunsaturated fatty acids were determined as described previously (*Lindberg et al.* 1964).

RESULTS AND DISCUSSION

The results of milk analyses are presented in Table 2. A characteristic feature of mare's milk seems to be the high content of C18:3, and of fatty acids with less than 14 carbon atoms in the chain. In stable-fed mares the C18:3 amounts to about 7 relative %, and in mares on pasture to about 22 %. The corresponding figure is 1 % or less in sow's milk (*Lindberg & Tollerz* 1964), 0.7—2 % in cow's milk (*Mattsson* 1949), and 0.5 % in man (*Hilditch* 1956). *Hilditch & Jaspersen* (1944) examined the milk from a Shire mare. They found 16.1 % of C18:3 but not even traces of this acid in milk from goat and ewe.

It is possible that this relatively large quantity of C18:3 in mare's milk represents a higher need for this acid in foals than in piglets and calves. The biopotency of C18:3 has been demon-

Table 2. Milk fat in mares (mean \pm error of mean). Sow milk fat (mean of 8 determinations) is shown for comparison.

	Mare's milk		Sow's milk
	On pasture N= 20	Stable fed N= 9	
C6:0	0.20 \pm 0.01	0.21 \pm 0.02	
C8:0	2.12 \pm 0.16	2.24 \pm 0.49	
C10:0	6.25 \pm 0.41	8.01 \pm 1.66	0.28
C10:1	1.16 \pm 0.18**)	0.66 \pm 0.04	
C12:0	7.29 \pm 0.47	7.04 \pm 1.04	0.28
C14:0	6.80 \pm 0.31	6.22 \pm 0.57	4.21
C14:1	0.44 \pm 0.03**)	0.30 \pm 0.02	0.26
C16:0	19.72 \pm 0.43	22.43 \pm 0.54***)	29.36
C16:1	5.53 \pm 0.33	6.62 \pm 0.44	11.94
C18:0	0.86 \pm 0.01	1.05 \pm 0.15	3.21
C18:1	18.51 \pm 0.72	23.81 \pm 1.33**)	37.90
C18:2	9.39 \pm 0.57	13.27 \pm 0.92**)	11.71
C18:3	21.78 \pm 0.93***)	7.49 \pm 0.78	0.41
Total lipids	2.19 \pm 0.22	2.30 \pm 0.16	5.40
PUFA	0.803 \pm 0.072	0.556 \pm 0.048	0.83

) Greater than corresponding value of the other column P < 0.05

**) " " " " " " " " " " P < 0.01

***) " " " " " " " " " " P < 0.001

strated by several authors (cf. *Deuel* 1957) although there seems to be different views concerning its effect when compared with C18:2.

Mare's milk is poor in total fatty acids. The value found here, slightly more than 2 %, is only half of that of cow's milk and $\frac{1}{3}$ — $\frac{1}{4}$ of the total fatty acids in sow's milk.

A more detailed comparison between mare's and sow's milk can be made from Table 2. The sow's milk fat is represented by the mean values of 8 determinations of sow no. 5 in the report by *Lindberg & Tollerz* (1964). This sow was given a food consisting of barley 44 %, oats 28 %, wheat bran 5 %, oil-seed meal, fish and meat meal 20 %, and alfalfa leaf meal 3 %. In stable-fed mares 17 % of the fat is composed of acids with 12 or less carbon atoms. In the sow's milk there are only traces of these acids. There are significantly less C16:0 and C18:1 in the mare's milk, whereas C18:2 is approximately on the same level as in sow's milk. As mentioned above C18:3 is abundant in mare's milk, but occurs only as traces in the milk of sows.

Table 3. Fatty acid composition of red clover and timothy.

	Red clover		Timothy	
	hay	young, growing	hay	young, growing
C12:0	0.2	0.4	0.3	0.2
C14:0	0.6	0.2	1.5	0.6
C16:0	24.7	14.2	28.8	15.4
C16:1	1.6	1.9	1.3	1.9
C18:0	3.0	2.0	2.9	1.5
C18:1	2.4	1.6	4.4	2.3
C18:2	20.4	17.4	18.3	20.1
C18:3	44.5	62.3	39.8	58.0
PUFA	0.78	0.91	0.65	0.83
TFA*)	1.70	1.13	1.13	1.07

*) total fatty acids as % of dry substance.

There is an obvious difference in C18:3 content in milk from stable-fed mares and mares on pasture. This is essentially due to the fact that young, growing grass is richer in C18:3 than hay (Table 3). The stable-feeding also included grain, which consequently reduced the amount of hay. Oat contains 5—7 % of total fatty acids, but only 1.5—2 relative % of C18:3 (*Lindberg et al.* 1964).

Table 3 shows the fatty acid composition in clover and timothy. The content of total fatty acids, is relatively low but the relative content of C18:3 amounts to about 40 % in hay and 60 % in the young, growing plants. These figures are in agreement with those found for grasses by other authors (*Smith & Chibnall* 1932). Thus the consumption of 1 kg (dry substance) of oat means the intake of about 1 g C18:3, whereas 1 kg of growing grass corresponds to about 7 g. The body fats of the horse are also comparatively rich in C18:3 (*Hilditch* 1956). In ruminants polyethenoid C18 acids occur in very small quantities, whilst stearic acid is present in large amounts.

REFERENCES

- Deuel, Jr. H. J.*: The lipids. Interscience Publishers, Inc., New York 1957.
- Hilditch, T. P.*: The chemical constitution of natural fats. Chapman & Hall Ltd., London 1956.
- Hilditch, T. P. & H. Jasperson*: The component acids of milk fats of the goat, ewe and mare. *Biochem. J.* 1944, 38, 443—447.

- Lindberg, P., S. Bingefors, N. Lannek & E. Tanhuanpää*: The fatty acid composition of Swedish varieties of wheat, barley, oats and rye. *Acta agric. scand.* 1964, 14, 3—11.
- Lindberg, P. & G. Tollerz*: An investigation on sow-milk fat with special reference to the fatty-acid composition. *Acta vet. scand.* 1964, 5, 311—330.
- Luddy, F. E., R. A. Barford & R. W. Riemenschneider*: Direct conversion of lipid components to their fatty acid methyl esters. *J. Amer. Oil Chemists' Soc.* 1960, 37, 447—451.
- MacGee, J.*: Enzymatic determination of polyunsaturated fatty acids. *Analyt. Chem.* 1959, 31, 298—302.
- Mattsson, S.*: Polyunsaturated fatty acids in butter and their influence on the oxidation of butter. XIIth. Int. Dairy Congr., Stockholm 1949, 2, Sect. 11, 308—324.
- Smith, J. A. B. & A. C. Chibnall*: Phosphatides of forage grasses. I. Cocksfoot. *Biochem. J.* 1932, 26, 1345—1357.

SUMMARY

The milk fat from 20 mares on pasture and 9 stable-fed mares was analysed. It is richer in C18:3 than the milk of other domestic species. This was especially marked when the mares were on pasture and were not given any grain. Further, mare's milk fat is rich in fatty acids containing less than 14 carbon atoms in their chains.

ZUSAMMENFASSUNG

Zusammensetzung der Fettsäuren im Milchfett von Stuten.

Das Milchfett von 20 Stuten auf der Weide und von 9 stallgefütterten Stuten wurde analysiert. Es enthält mehr C18:3 als das Milchfett anderer Haustiere. Dieses war speziell ausgeprägt für Stuten die auf der Weide gingen und kein Getreide bekamen. Das Milchfett der Stute enthält weiter viel von Fettsäuren mit weniger als 14 Kohlatomen in ihren Ketten.

SAMMANFATTNING

Fettsyrekompositionen i mjölkfett från ston.

Mjölkfettet analyserades hos 20 ston på bete och 9 ston under stallutfodring. Stomjölksfettet innehåller mer C18:3 än vad man finner hos andra husdjur. Detta var särskilt påtagligt hos de ston som gick på bete och inte erhöll någon spannmål. Stomjölksfettet är vidare rikt på fettsyror med mindre än 14 kolatomer i sina kedjor.

(Received June 10, 1965).