RAPESEED PRODUCTS AS FEED FOR DAIRY COWS, EFFECT ON MILK QUALITY

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Introduction

There has been a growing interest in the use of fat supplements in concentrate mixtures in ruminant diets. Fat is particularly interesting in relation to high producing dairy cows because of its high energy value and its ability to increase the energy intake in these cows.
Whole rapeseed is a particularly attractive fat source since it can be grown under Swedish conditions. The development of double-low (00) varieties of rapeseed has enhanced the possibilities of using rapeseed in greater quantitites in the feed. It is however necessary to investigate if any unwanted changes in the milk composition will occur as a result of the increased use of rapeseed in the feed. Of special interest is the influence on the fatty acid composition (if the whole seed is used), both in regards to nutritive value and processing properties, and also whether any increase in concentration of breakdown products of glucosinolates in milk will take place. Various breakdown products, for example thiocyanate, may be transferred to the milk (Virtanen et al., 1960; Vilkki et al., 1962).
The concentration of free fatty acids (FFA) in the milk, in particular the short chain fatty acids, are largely responsible for occurrence of rancid flavour in the milk. Differences in the concentration of FFA caused by different feeds, especially different fat sources given to dairy cows, are therefore also a subject of interest (Astrup et al., 1979). It is generally accepted that lipolysis is increased by admixture or air, which disrupts the protecting milk fat globule membrane, or by temperature fluctuations of the milk. For review see Jellema (1975), Deeth & Fitz-Gerald (1975) and Olivecrona (1980). The free fatty acid concentration in milk is, on the other hand, poorly correlated with milk lipase activity (Castberg & Solberg, 1974; Ahrné & Björck, 1985).
A larger long term experiment has been conducted at the Swedish University of Agricultural Sciences (Emanuelson et al., 1987) where effects of feeding high levels of rapeseed products (00-varieties) to dairy cows on performance and health were studied. As a part of this experiment, the effects on the fatty acid composition and spontaneous lipolysis of milk fat by feeding "rapeseed fat" were also investigated. Furthermore, since high levels of rapeseed products were included, the occurrence of thiocyanate in the milk was studied.

Materials and methods

In this paper results from the first lactation of the cows that were introduced in the experiment during the first year will be presented. All cows were of the Swedish Red and White Breed. Cows were randomly allotted into 3 groups and were fed at maximum either 3.0 kg (RR), 1,5 kg (RS) or 0 kg (SS) of rapeseed products of double-low varieties. The whole, crushed rapeseed used in this experiment was heat treated. The

fat supplement in the concentrate mixture for the group RR was almost exclusively of rapeseed origin, while the fat for the two other groups were of mixed origin, mainly tallow. Further details on the feeding experiment concerning the different feeding regimes, registration on animals, analyses of feed and other analyses of milk samples are given in Emanuelson et al. (1987).
Individual milk samples from morning milking were analysed for fatty acid composition, concentrations of FFA and thiocyanate.
The milkfat was extracted by the BDI-method; milk was allowed to stand until a cream layer formed on the surface. 40 ml of the cream was decanted into a 100 ml volumetric flask. A solution of 70 g sodium hexametaphosphate and 30 g of Triton X-100 diluted to 1000 ml was then added into the volumetric flask up to 100 ml. The flask was then allowed to stand in a boiling water-bath until the fat separated.
Methyl-esters of the fatty acids were prepared according to the method described by Smith (1961). The fatty acid composition was analysed on a temperature programmed gas chromatograph (CARLO ERBA HRGC 5300) equipped with split injection and capillary column (Chrompack CP-Sil 88, length 50 m, inner diameter 0,22 mm) and calculated on a Varian 4270 integrator.
Concentration of free fatty acids was determined in duplicate according to the method described by Deeth et al. (1975) within 1 h after sampling and after a storage period of 48 h at 5°C. Milk lipolysis was expressed as the difference in FFA concentration between the initial sample and after 48 h.
The concentration of thiocyanate ions was determined in duplicate by the method described by Sörbo (1953).
For the organoleptic test both morning and evening milk was sampled. Milk from 5 cows per group were mixed in equal amounts and then treated as one sample.

Results and discussion

The fatty acid composition in the milk (Table 1) from group RR differed from the two other groups by having a higher proportion of stearic (18:0) and oleic acid (18:1) and a lower proportion of palmitic acid (16:0). These differences were more pronounced in early lactation, when the cows recieved more fat supplement in the diet (results not shown). Milk from cows in group RS tended to have a higher proportion of oleic acid and a lower proportion of palmitic acid than milk from cows in group SS.
The fatty acid composition of milk fat from ruminants is less affected by the fatty acid compositon of the feed than non-ruminant milk fat because of the hydrogenation of the fatty acids in the rumen. The hydrogenation of the long chain fatty acids would lead to a lower degree of liquid fat in the milk at a given temperature. This change in melting pattern is compensated by a synthesis of short chain fatty acids in the mammary gland in ruminants.
Changes in fatty acid composition, caused by different fatty acids in the feed, are accompanied by altered proportions of solid fat in the milk (Banks et al., 1980). Feeding products rich in C18 acids (e.g. rapeseed) elevates the content of oleic acid in the milk and a lower proportion of the fat becomes solid. Conversely, by using a feed rich in C16 acids (e.g. tallow), the palmitic acid content of the milk fat is increased and a bigger proportion of the fat becomes solid. These changes in the milk fats are reflected in the rheological properties of butters made from the milk fat. Milk from cows in group RR could thus give a more easily spreadable butter compared with milk from group SS.

On the other hand the losses in buttermaking for the latter milk would be affected in a positive way.
The higher proportion of unsaturated fatty acids in milk from group RR involves also a possible risk of development of an oxidative flavour of the milk. This is however not a big risk since the proportion of polyunsaturated fatty acids was not high in group RR. Accordingly the organoleptic tests of milk from the three groups did not show any differences between the groups.

Table 1. The fatty acid compositon in milk from the three feeding groups. Average values (w/w %) and standard error of means (s.e.) of samples taken 30, 60, 90, 150 and 300 days after calving from 14 cows each in group RR and SS and 15 cows in group RS

Feeding	Fatty acid									
group	C4-C8	C10	C12	C14	C16:0	C16:1	C18:0	C18:1	C18:2	C18:3
RR x[1]	5.5	2.9	3.2	11.5	28.3	1.4	15.3	27.0	1.2	1.2
s.e.	0.15	0.06	0.06	0.15	0.24	0.05	0.28	0.26	0.03	0.06
RS x[1]	6.2	2.9	3.2	11.5	31.1	1.3	14.4	25.0	1.2	0.9
s.e.	0.23	0.06	0.06	0.15	0.27	0.03	0.27	0.27	0.02	0.04
SS x[1]	6.0	3.1	3.3	11.8	32.7	1.4	14.3	23.2	1.2	1.0
s.e.	0.23	0.05	0.05	0.14	0.29	0.03	0.26	0.26	0.02	0.04

[1]The percentage does not add to 100 for any group because the percentage of minor fatty acids is not given in the table.

The lipolysis of the milk fat differed between the groups. The most marked difference was the lower concentration of FFA being hydrolysed in group RR (Table 2). The difference in lipolysis in the milk did not lead to any differences in the organoleptic test between the groups.
The results on the lipolysis obtained in this experiment by feeding rapeseed are well in agreement with the results obtained by Astrup et al. (1980). On the other hand Astrup (1983) found no differences in rancid flavour of milk from cows given 20 % rapeseed or 20 % barley in the concentrate.

Table 2. Hydrolysed free fatty acids (mM) during 48 h incubation at 5°C. Average (x) and standard error of means (s.e.) of samples taken 30, 60, 90, 150 and 300 days after calving

Feeding group	$\bar{x}$	s.e.
RR	0.17	0.04
RS	0.32	0.06
SS	0.33	0.06

The concentration of thiocyanate ions was significantly (Student's t-test, $P<0.001$) higher in group RR and RS than in group SS (Table 3). The difference in thiocyanate concentration between the two groups recieving rapeseed was not significant with the exceptions of 30 and 300 days after calving ($P<0.05$).

The thiocyanate concentration was within the range as that found by Laarveld et al. (1981). The reasons for such small differences between the two "rapeseed groups" are not clear. However the thiocyanate ion is related to the same mecanisms for transportation in the blood as iodine. This relationship was confirmed in this study, since the concentration of protein bound iodine in the milk decreased to the same degree in the two groups fed rapeseed (not reported in this paper). This question will be further discussed in a coming paper from this experiment where further data concerning thyroid function will be presented.

Table 3. Mean values ($\bar{x}$) and standard error of means (s.e.) of the concentration of thiocyanate ions (mg/l) in samples taken at 30, 60, 90, 150 and 300 days after calving (n = no. of samples)

Day after calving	Feeding group RR			RS			SS		
	$\bar{x}$	s.e.	n	$\bar{x}$	s.e.	n	$\bar{x}$	s.e.	n
30	4.91	0.2	14	4.29	0.2	15	1.76	0.2	15
60	5.35	0.3	14	4.97	0.2	11	1.62	0.1	14
90	5.15	0.3	14	5.31	0.2	12	1.50	0.1	14
150	6.66	0.4	13	6.28	0.3	10	2.37	0.2	11
300	7.70	0.6	14	9.35	0.7	14	2.36	0.2	8

Feeding double-low varieties of rapeseed affect the composition of the milk. The fat supplement of rapeseed origin gave a milk fat with a higher proportion of stearic and oleic acid, and hence a more unsaturated milk fat compared with fat supplements with a higher proportion of C16 acids. It seems, however, the risk of development of an oxidative flavour of the milk fat is not great. The rapeseed derived fat supplement also decrease lipolysis. The elevated level of thiocyanate concentration found here was also found by Boulangé (1959) and Lawrence (1970)in milk from cows fed only small amounts of rapeseed.

The results in this study concerning milk quality in relation to feeding rapeseed to cows seems to indicate that the milk quality is not significantly affected. Actually, some effects on milk quality by feeding rapeseed products to dairy cows could be considered positive.

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