EAAP 2004

55th Annual Meeting
of the European Association for Animal Production
Bled, Slovenia, September 5th – 9th, 2004

EFFECT OF FEEDING MILKED SHEEP WITH RAPESEED ON THE YIELD AND QUALITY OF MILK AND CURD CHEESE

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Composition and quality of animal food is determined by the overall production cycle, namely the conditions in which the initial raw material is obtained and the processing that leads to the final food product. In this context, the composition, quality and initial parameters of animal raw material will largely determine the composition and quality of the end product. This attitude is particularly important now that efforts are being made to shape the functional (health-promoting) properties of food (Zduńczyk, 2000), namely to obtain food products containing components which have a desired effect on selected physiological parameters in the human body, thus maintaining optimum health and reducing the risk of disease.

In the case of animal-origin products, the high content and undesirable composition of fats raise the greatest objections. Studies on the possibility and scope of nutritionally modifying the composition of fatty acids in fats of animals (ruminants) indicate that it is relatively easy to obtain the intended goal. In dairy cows, administration of feeds rich in polyunsaturated fatty acids (vegetable oils, oilseeds) or protected fat leads to the desired increase in the proportion of polyunsaturated fatty acids at the cost of saturated acids in milk fat (Mansbridge and Blake, 1997). Supplementation of cows with vegetable oils and oilseeds was also shown to increase the CLA content of milk fat (Stanton et al., 1997; Kelly et al., 1998).

Unlike cattle, there are few studies exploring the modification of the composition and health quality of sheep milk and sheep milk products. Polish and foreign experiments (Banskaliewa et al., 2000; Bellof et al., 1997; Bodkowski, 1998; Borowiec et al., 1999; Kaczor et al., 1999; Mir et al., 2000), including our own studies (Borys B. and Borys A., 2001; Borys and Mroczkowski, 2002) indicate that favourable results can be obtained by using oilseeds, including double-low

rapeseed.

This encouraged us to undertake studies on the possibility and scope of influencing with simple nutritional methods the health quality of sheep milk and the bundz-type rennet curd cheese. In more detail, the objective of the study was to determine the possibility of modifying selected parameters of milk health quality and the cheese made thereof by supplementing the diets of milked ewes with full-fat double-low rapeseed containing oil rich in unsaturated fatty acids.

Material and Methods

The experiment was carried out from May to August 2000 with 49 Friesian × Polish Merino F_1 ewes divided into two groups and fed for 102 days. The effects of feeding whole double-low rapeseed to nursing and milked ewes on composition and quality of milk and the curd cheese made from it were investigated.

The experiment lasted from 4 weeks after lambing to 20 weeks of lactation. During this period, ewes were fed with winter and summer feeds, the composition and nutritive value of which is given in Table 1. The difference between the groups (C – control and R – rapeseed) involved the use in group R of whole double-low rapeseed at 150 g per ewe per day. The rations, formulated to traditional sheep feeding standards (Osikowski et al., 1998), had a similar nutritive value expressed in MJ of net energy and crude protein content, adjusted to the predicted, average level of milk production.

Feeds in group R had an almost twice higher content of fat (5.36 vs. 2.89% in group C on average) and differed in the fatty acid profile (Table 1). Fat in the diets of group R contained much less saturated acids and more unsaturated acids (UFA:SFA ratio 81.8% higher than in group C), and of the unsaturated acids, the contained much more monounsaturated and less polyunsaturated acids; PUFA:MUFA lower by an average of 55.4% in group R.

During the experiment, feed offered and consumed was recorded daily. At the start and at the end of the experiment, observations were made on the body weight and body condition status of ewes (Drożdż, 1983). Daily level of milk production was determined from three test milkings at 7-8, 11-12 and 15-16 weeks of lactation.

Bulk milk from ewes in groups C and R was processed twice into the bundz-type rennet curd cheese (from all ewes from one morning and evening milking), once using milk obtained during winter feeding (with silage supplement), the other time under summer feeding with forages. Milk was processed following the procedures used at a farm processing facility of the National Research Institute of Animal Production Experimental Station in Kołuda Wielka.

Observations of cheese mass yield and sensory evaluation of cheese by a panel (external appearance, internal characteristics, aroma and flavour) were made on a 5-point scale according to the methods used at the Institute's Experimental Station in Kołuda Wielka (Osikowski et al., 1995).

Table 1. Feeding of experimental ewes

	Units	I period [winter]		II period [summer]	
		C	R	C	R
Diet composition:					
Maize silage	kg	2,50	1,00		
Silage: sugar beet tops + wet pulp	kg	2,50	4,00		
Lucerne forage	kg			5,50	5,50
Lucerne hay	kg	1,05	1,06		
Grass hay	kg			0,60	0,60
Crushed barley	kg	0,05	0,34	0,20	0,20
Crushed wheat	kg	0,40	0,10	0,50	0,25
Rape extracted meal	kg	0,22	0,16		
Rapeseed „00"	kg		0,15		0,15
Mineral mixture MM	kg	0,015	0,015	0,015	0,015
Feeding value of diet:					
- NE	MJ	13,6	13,7	12,9	12,8
- crude protein	g	364	364	354	356
- dry matter	g	2390	2365	2305	2226
Fat content	%	2,74	5,23	3,05	5,50
Fatty acid profile of diet fat:					
SFA	%	21,6	13,4	19,8	12,1
UFA	%	76,4	86,2	78,6	87,4
UFA:SFA		3,54	6,43	3,97	7,22
MUFA	%	31,9	53,9	31,7	51,9
PUFA	%	44,5	32,3	46,9	35,5
PUFA:MUFA		1,39	0,60	1,48	0,68

Basic chemical composition of bulk milk was analysed at the Regional Dairy Cooperative laboratory in Inowrocław using Milko Scan, and cheese at the Experimental Station Kołuda Wielka laboratory using conventional methods (protein content by Kjeldahl, fat content by Soxhlet, dry matter by drying at 105°C).

Fatty acid profile and the content of conjugated linoleic acid c9, t11 (CLA) were determined following the procedures given by Kramer et al. (1997) as modified by the Meat and Fat Research Institute in Warsaw (Borys et al., 1999). Fats were extracted from the feeds and milk according to standard procedures for individual products. Fatty acid profile was determined by gas chromatography; Hewlett Packard model 6890 with a flame-ionization detector, using

column Rtx – 2330: 105 m × 0.25 mm × 20 μm. Cholesterol content was determined with gas chromatography - Hewlett Packard model 5890 sII with a flame ionization detector, column HP-1: 25 m × 0.20 mm × 0.11 μm.

Results and Discussion

During the experiment, body weight and body condition of ewes deteriorated in group C and improved in group R (Table 2). A favourable but statistically non-significant effect of using rapeseed on the milk production level was also found (on average 7.7% higher in group R than in C). These results indicate a generally more beneficial effect of giving full-fat double-low rapeseed to lactating ewes on their physiological state and productivity.

Table 2. Body weight, condition status and milk yield of ewes

Trait	Statistic parameter	Group	
		C	R
Number of ewes	n	25	24
Body mass change in experiment period; kg	$\bar{x}$	-1,2	+1,8
	v%	848,7	178,7
Evaluation of body condition status [1-5 pkt.]:			
- start of experiment	$\bar{x}$	2,08	1,83
- end of experiment	$\bar{x}$	1,92	2,17
Daily milk production; g	$\bar{x}$	663	714
	v%	41,0	39,8

The experimental processing of bulk milk into curd cheese did not show any effect of feeding rapeseed on cheese mass yield and organoleptic evaluation of cheese (Table 3). In both groups of ewes, these parameters were at a satisfactory level, close to the average values obtained by Pakulski and Dulewicz (2000) for Friesian crossbreds at an on-farm sheep milk processing facility in a lowland region.

In terms of the basic chemical composition, clearer differences were only seen in the content of fat and cholesterol. Both in bulk milk and cheese, these components were higher in products from ewes in group R. In absolute values, they were higher than in the control group C: in milk by 10.3 and 23.4%, in cheese by 15.1 and 14.9% respectively. Similar findings were obtained in the studies performed with milk and cheese of cows (Reklewski et al in., 2002) and in few studies and reports dealing with sheep milk and cheese (Borys et al., 2002; Kinal et al., 2003; Patkowska-Sokoła and Bodkowski, 2003).

Table 3. Composition and processing results of bulk milk and composition and quality of curd cheese [average for two experimental processing]

Specification	Measure unit	Group	
		C	R
Content in 100 g of milk:			
- protein	g	5,95	5,71
- fat	g	5,91	6,52
- lactose	g	4,41	4,25
- dry matter	g	17,15	17,39
- cholesterol	mg	17,5	21,6
Cheese mass yield	%	22,91	22,86
Content in 100 g of cheese:			
- protein	g	13,52	14,77
- fat	g	14,25	16,40
- dry matter	g	42,47	40,18
- cholesterol	mg	57,0	65,5
Cheese organoleptic evaluation [1-5 pnt]			
External features: - form	pnt	4,90	4,95
- skin	pnt	4,95	4,85
Internal features: - eyes	pnt	4,65	4,80
- consistency	pnt	4,90	4,50
- colour	pnt	5,00	4,80
Flavour	pnt	4,65	4,65
Taste	pnt	4,95	4,95

The use of double-low rapeseed in the diets clearly modified the composition of fatty acids in milk and in the cheese made from it. The differences in fatty acid profile of milk and cheese fat from ewes of groups C and R were similar in nature (Tables 4 and 5).

Milk and cheese fat from ewes fed with rapeseed were characterized by a lower percentage of saturated fatty acids (SFA) except the stearic acid C18:0, which in absolute terms was 80% higher in group R than in group C. Overall, however, fats of both products from R ewes contained 11% less SFA than those from C ones. In the case of unsaturated acids, rapeseed feeding led to a clear increase in the proportion of monounsaturated fatty acids (MUFA, by 33.7% on average), with only a minimal increase in the proportion of PUFA (by 2.9%). The greatest absolute increase was noted for oleic acid C18:1 (by 139%), which was due to the fact that this is the dominant fatty acid in rapeseed oil. A significant and favourable, from the viewpoint of health quality of both products, was the increase in group R of the linoleic acid (very clear, by 139% on average) and linolenic acid (by 14%). Overall, fats of R milk and

cheese contained much more unsaturated acids (by 29%) and had a more favourable UFA:SFA ratio (44% higher), but a less favourable PUFA:MUFA ratio (30% lower).

The use of rapeseed also resulted in a beneficial modification of the other health quality parameters of fatty acid profile of sheep milk and the cheese made thereof:

- a marked improvement in the proportion of hypocholesterolemic (DFA) to hypercholesterolemic acids (OFA); a 67% increase in the DFA:OFA ratio accompanied by an increased proportion of DFA by 67% and a drop of OFA by 17%,

- a certain increase in the proportion of PUFA Ω3 (by 3.3% in milk and by 5.8% in cheese) and a beneficial narrowing of the PUFA Ω6:Ω3 ratio (by 3.0 and 5.8%, respectively).

- a clear increase in the CLA content of fats of the two products (by 22% on average) and an even clearer increase (thanks to higher fat content) of this health-promoting component in milk and cheese of group C (by 34.1% in milk and by 41.8% in cheese).

The observed changes in the fatty acid profile of milk and cheese fats as a result of feeding sheep with rapeseed correspond with the changes reported elsewhere when different forms of the same oilseeds were used (Borowiec et al., 1999; Patkowska-Sokoła and Bodkowski, 2003). The introduction of rapeseed alone proved less favourable than the use in the other studies of ours (Borys et al., 2002) of a combination of rapeseed and linseed, which resulted in an additional clear increase in the content of PUFA and no increase in the concentration of cholesterol in milk and cheese.

Conclusions

1. The use in the feeding of lactating sheep of full-fat double-low rapeseed at 150 g per animal per day had a beneficial effect on body weight and condition status of sheep, on increased milk yield and concentration of fat in milk and the curd cheese made from it.

2. No effect of feeding ewes with rapeseed diets on processing yield of milk into cheese and on sensory evaluation of the bundz-type rennet curd cheese was found.

3. Feeding rapeseed modified similarly and beneficially the fatty acid profile of milk and cheese, mainly by increasing the proportion of MUFA and the related parameters (UFA:SFA, DFA:OFA and PUFA Ω6:Ω3), with a beneficial increase in the content of CLA and an unfavourable increase in cholesterol.

4. Overall, the present study confirmed the efficiency of feeding full-fat double-low rapeseed to lactating sheep in beneficially modifying the health quality of milk and the cheese made from it.

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Table 4. Content of fatty acid in bulk milk and curd cheese (n = 4)*

Fatty acid →	C4:0	C6:0	C8:0	C10:0	C12:0	C14:0	C15:0	C16:0	C16:1	C17:3	C18:0	C18:1	C18:2	C18:3
Milk; %														
Group: C	2,03	1,95	2,08	7,80	5,38	13,18	2,20	30,25	2,20	1,15	4,80	18,94	1,05	0,95
R	1,68	1,53	1,68	5,95	4,23	11,18	1,90	24,83	1,70	1,03	8,63	27,60	2,48	1,05
Cheese; %														
Group: C	2,08	2,00	2,08	7,90	5,40	13,33	2,13	30,65	2,15	1,15	4,53	18,19	1,05	0,90
R	1,93	1,78	1,80	6,28	4,33	11,18	1,85	25,05	1,70	1,08	8,28	26,30	2,53	1,05

* average for two experimental processing of bulk milk

Table 5. Content and proportions of fatty acid functional group in bulk milk and curd cheese (n = 4)*

	SFA	UFA	UFA :SFA	MUFA	PUFA	PUFA :MUFA	DFA	OFA	DFA :OFA	PUFA Ω3	PUFA Ω6:Ω3	CLA	
												% FAP	mg/100 g
Milk; %													
Group: C	71,20	27,17	0,382	22,82	4,36	0,191	31,97	66,40	0,481	1,50	1,778	0,74	41,6
R	63,17	34,99	0,554	30,52	4,47	0,146	43,61	54,55	0,799	1,55	1,724	0,90	55,8
Cheese; %													
Group: C	71,48	26,51	0,371	22,06	4,46	0,202	31,03	66,95	0,463	1,45	1,866	0,73	99,5
R	63,88	34,13	0,534	29,52	4,61	0,156	43,40	55,60	0,781	1,55	1,757	0,90	141,1

* average for two experimental processing of bulk milk