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Effect of Breed and Feeding Season on the Nutritive Quality of Goat's Milk

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Two-year-old Polish White Improved (30) and Polish Fawn Improved goats (25) were investigated. The animals were kept indoors throughout the year and fed *ad libitum*. Lactation in goats was 8 months long, from March to October. To determine the effects of breed and feeding season on the nutritive quality of milk, milk was collected once a month and analysed using the A_4 method for the basic chemical composition, cholesterol level and the composition and profile of fatty acids. Average daily yield of milk was 2.20 kg in White Improved and 2.40 kg in Fawn Improved goats, with fat content of 3.28% and 3.52%, respectively. The milk of goats receiving winter feeds was characterized by a slightly higher concentration of cholesterol (9.60 and 11.20 mg/100 ml). Regardless of the breed, milk from the winter period had a significantly lower proportion of saturated acids (64.12% in White Improved, 73.62% in Fawn Improved) and a higher proportion of saturated acids (74.62% and 78.36%, respectively).

Key words: Goats, milk, cholesterol, fatty acids.

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Milk and milk products are an important group of food products as they contain many different nutrients that are essential for normal growth and functioning of the body. Thanks to its nutritive, taste and dietetic values, goat's milk is recommended to children (above 8 months of age), allergy sufferers, elderly people and convalescents. Goat's milk is therefore considered the 21st century food, i.e. health-promoting or functional food.

The nutritive value of milk depends on many factors including breed, nutrition and, more specifically, the type of feeds. Polish and foreign literature contains studies on the improvement of milk composition through genetic and nutritional manipulation. The studies of SZCZUREK and PISULEWSKI (1995) dealt mainly with the decrease of fat and the increase of protein content by using an appropriate ratio of concentrates to bulky feeds in the ration. Other studies concerned the increased proportion of unsaturated fatty acids in goat's milk fat by using plant or animal fats (BRZÓSKA *et al.* 1999; JONES *et al.* 2000). Less attention has been given to the nutritive value of the milk of traditionally fed goats (SZYMANOWSKA *et al.* 2002).

The aim of the present study was to determine the basic chemical composition, the cholesterol level and the fatty acid composition and profile of the milk of White Improved and Fawn Improved goats depending on the feeding season.

Material and Methods

Thirty White Improved and 25 Fawn Improved goats in their second lactation were studied. Goats originated from herds in the Kujawsko-Pomorskie province that were milk recorded by the Regional Sheep and Goat Breeders Association in Bydgoszcz.

Animals were kept indoors and fed *ad libitum*. The basic feeds were maize silage and sugar beet pulp in the winter period (October-April) and pasture forage in the summer (May-August). Throughout the year, goats received hay, straw, ground cereals and Polfamix. Daily milk yield, chemical composition and cholesterol content of milk were determined from milk samples taken once a month from control morning and evening milkings. The milk was collected from both teats in keeping with the A_4 method applied at the District Animal Testing Stations, during the entire lactation from March to October. The fat and protein contents were determined using Milko Scan 133B and 5200 devices. Cholesterol concentration in

Table 1

Influence of goat breed and feeding season on chemical composition of milk

Traits	Feeding season / Breed							
	winter				summer			
	white improved		coloured improved		white improved		coloured improved	
	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
1. Daily milk yield (kg)	2.30	0.68	2.20	0.57	2.50	0.85	2.40	0.63
2. Fat %	3.52[a]	0.65	3.76[b]	0.60	3.15[a]	0.59	3.28[b]	0.53
3. Protein (%)	2.85	0.28	2.74	0.28	2.65	0.24	2.60	0.24
4. Lactose (%)	4.42	0.22	4.62	0.20	4.33	0.25	4.56	0.22
5. Dry matter (%)	11.39	0.91	11.82	0.83	10.63	0.72	11.10	0.76
6. Cholesterol (mg/100 ml)	9.60	2.14	11.20	1.82	8.50	1.92	9.52	1.89

Means with the factors marked with the same letter are significantly different ($P \leq 0.05$)

Table 2

Fatty acid composition and profile in goat's milk (%)

Fatty acids (%)	Feed / Breed								Significance of differences $P \leq 0.05$	
	winter				summer					
	white improved WI		coloured improved CI		white improved WI		coloured improved CI		Feeding season	
	mean	SD	mean	SD	mean	SD	mean	SD	WI	CI
C8 : 0	3.07	0.35	1.96	0.56	2.05	0.94	1.99	0.29		
C10 : 0	10.70[a]	2.85	7.68[a]	2.12	8.53[b]	1.24	5.90[b]	1.14		
C12 : 0	6.53	1.47	6.66	1.90	3.54	0.96	4.61	0.81	x	x
C14 : 0	12.01	2.99	10.94	3.33	14.84	3.15	14.24	1.17	x	x
C16 : 0	22.20[a]	4.89	19.74[a]	4.75	29.46	4.78	29.90	2.79	xx	xx
C18 : 0	9.62	3.28	9.80	3.22	18.82[b]	4.08	15.91[b]	1.91	xx	xx
C16 : 1	1.38	0.52	1.86	0.72	1.18	0.32	0.94	0.25		
C18 : 1	32.96[a]	6.50	28.24[a]	4.51	22.96[b]	4.16	19.29[b]	1.46	xx	xx
C18 : 2	1.53	0.41	1.43	0.41	1.24	0.28	1.39	0.28		
SFA	64.12		73.62		74.62		78.36		xx	xx
UFA	35.88		26.72		25.38		21.64		xx	xx
UFA/SFA	0.56		0.36		0.34		0.28			

Means with the factors marked with the same letter are significantly different ($P \leq 0.05$)

milk was determined using the Röse-Gottlieb method. The composition of fatty acids was determined twice during the summer and winter feeding. The separation and quantitation of fatty acids were performed using a Hewlett-Packard gas chromatograph.

Statistical analysis of the results, which considered the effects of breed, lactation period and feeding season on the milk yield, nutrient content, cholesterol concentration and the composition and profile of fatty acids were determined by two-way variance analysis using Statistica v. 5.5 software.

Results and Discussion

In both White Improved and Fawn Improved goats, lactation in the analysed herds lasted for 8 months, from March to October. Depending on the month of lactation, average milk yield per goat ranged from 1.60 kg to 2.80 kg in White Improved goats and from 2.00 kg to 2.60 kg in Fawn Improved goats. The highest yield was observed at 2 months of lactation and the lowest towards the end of lactation (Fig. 1). These differences were confirmed statistically.

Figure 2 shows the fat and cholesterol content of the milk of analysed goats by month of lactation. Average fat content was 3.28% (White Improved) and 3.52% (Fawn Improved). Milk from the first two months (March, April) and the milk of White Improved goats from the last month (October) was richer in fat than the milk from the other months of lactation (significant differences).

Cholesterol plays an important role in the body and is essential for the formation of hormones, bile acids, vitamin D3 and other compounds. Excess cholesterol in humans may lead to atherosclerosis. As reported by REKLEWSKI (2000), goat's milk contains less cholesterol than cow's milk and for

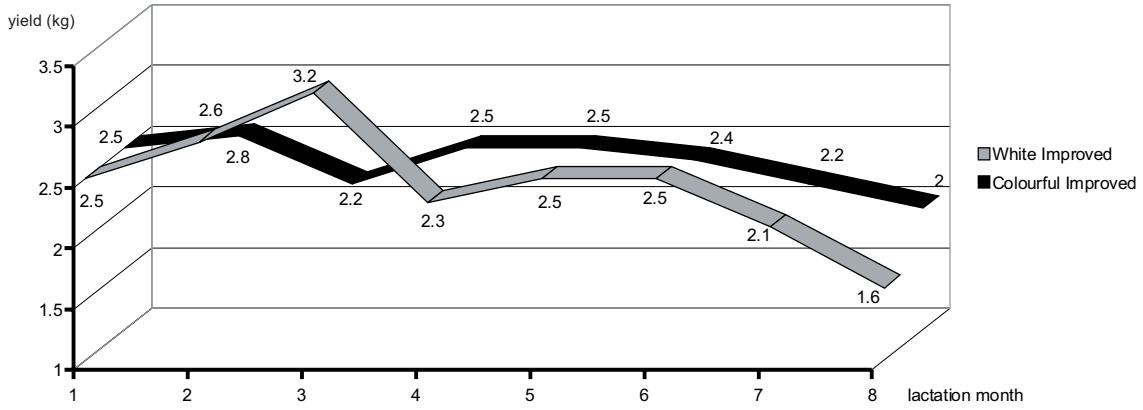

Fig. 1. Goat's milk yeld of White and Colourful Improved breed in the subsequent lactation months.

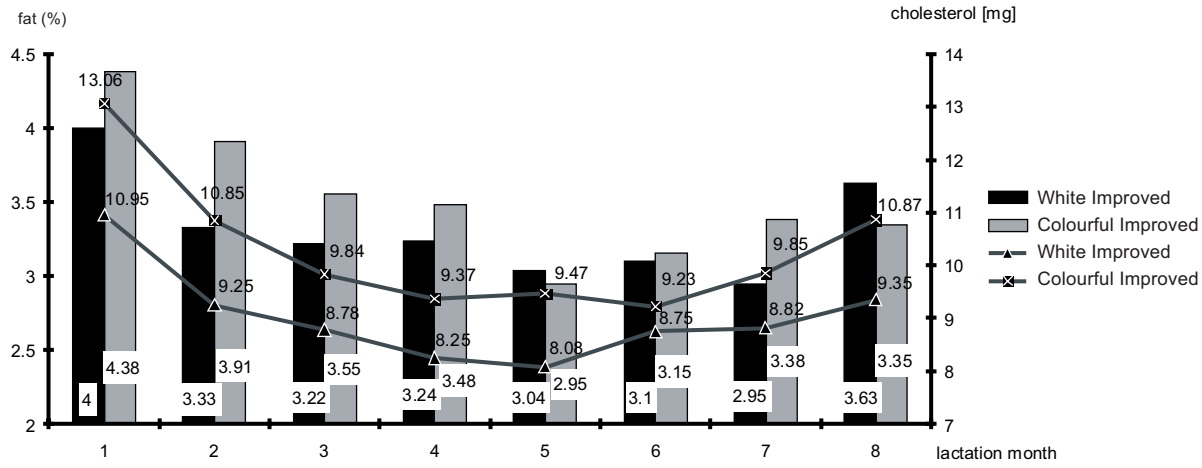

Fig. 2. Fat and cholesterol content in goat's milk of White and Colourful Improved breed in the subsequent lactation months (Bar – graph refers to fat content and linear graph to cholesterol in goat's milk).

this reason it should be included in our daily diets. Average content of cholesterol in the milk of goats studied was 9.23 mg/100 ml in White Improved goats and 10.90 mg/100 ml in Fawn Improved goats. This is lower than the values given by other authors (DANKÓW *et al.* 2000; REKLEWSKI 2000; WÓJTOWSKI *et al.* 2001). REKLEWSKI (2000), who studied the effect of goat feeding on cholesterol content of milk, showed that it ranged from 15 to 16 mg/100 cm^3. Similar results were obtained by DaNKÓW *et al.* (2000) and WÓJTOWSKI *et al.* (2001).

As shown in Figure 2, the cholesterol level in the milk of the analysed goats showed variation throughout lactation. It was the highest, regardless of the breed, in the first two months (9.25 to 13.06 mg/100 ml) and in the final month of lactation (9.35 to 10.87 mg/100 ml). These differences were statistically significant. It is therefore thought that both the fat and cholesterol content of goat's milk is related to the month of lactation and, more specifically, to the type of feeding, because in the winter season (1, 2 and 8 months of lactation – March, April and October) the level of these components was higher, and in the summer season when foraging formed the basis of the diet, the level of these components was lower, as confirmed by the data in Table 1. Milk obtained from goat's during the winter feeding period was characterized by a higher fat content by 0.37 (White Improved) and 0.48 percentage units (Fawn Improved). Different results were obtained by SZYMANOWSKA *et al.* (2002), who showed that milk in the summer feeding period was characterized by a marginally higher proportion of fat and protein and a significantly lower content of lactose. In this study, no statistically significant differences were found between the feeding seasons for the content of protein, lactose, solids and cholesterol, or for the milk yield (Table 1).

Milk fat is among the most complex natural fats in terms of the composition of fatty acids. Fatty acids are a source of energy and their consumption should match the body's needs, because in excess they can have negative effects. BANASZKIEWICZ (2001) reports that lauric, myristic and palmitic ac-

ids tend to elevate serum levels of cholesterol and LDL lipoproteins. In general, saturated acids increase the tendency of platelets towards aggregation, increasing the risk of blood clots. Unsaturated fatty acids, mainly oleic acid, show hypolipidemic properties, i.e. decrease the total levels of cholesterol and LDL cholesterol. Oleic acid is regarded as a factor preventing coronary thrombosis. This is why great weight is attached to the presence of unsaturated fatty acids in the human diet. According to nutritionists, 1/3 of the energy from fat should be provided by saturated fatty acids, over 1/3 by monounsaturated fatty acids, and less than 1/3 by polyunsaturated fatty acids (PIENIAK-LENDZION 2002).

In this study, a comparison of the content of particular saturated and unsaturated fatty acids in milk fat of both breeds reveals that the milk fat of White Improved goats was richer in capric ($C_{10:0}$), palmitic ($C_{16:0}$) and oleic acids ($C_{18:1}$) regardless of the feeding season, and additionally in stearic acid in the summer period ($C_{18:0}$). These differences were confirmed statistically (Table 2).

The studies of SZYMANOWSKA *et al.* (2002) have shown that goat breed (White Improved and Saanen) did not influence the amount of particular fatty acids of the milk lipid fraction except for myristoleic acid ($C_{14:1}$), the content of which was significantly higher in the milk of White Improved goats. The authors concluded that the content of fatty acids was affected by the season of goat feeding. Milk from the summer season contained more myristic ($C_{14:0}$) and palmitic acids ($C_{16:0}$), and less $C_{14:1}$, $C_{16:1}$, $C_{18:0}$, $C_{18:1}$, $C_{18:2}$ and $C_{18:3}$ acids.

In terms of the content of particular fatty acids, goat's milk is a fully valuable food product which shows some variation under the influence of traditional feeds.

The studies of BRZÓSKA *et al.* (1999) and CALDERON *et al.* (1984) concerning the effects of diet on the content and composition of goat's milk fat indicate that rations with a high proportion of concentrates and a low proportion of bulky feeds cause a decrease in milk yield and fat content, an increase in the proportion of unsaturated fatty acids and a decrease in the proportion of saturated acids.

As shown in Table 2, during the period of winter feeding compared to summer feeding, the milk of both White Improved and Fawn Improved goats was characterized by a significantly lower proportion of saturated fatty acids and a higher proportion of unsaturated fatty acids. Saturated acids accounted for 64.12% (White Improved) and 73.62% (Fawn Improved) in the winter, and for 74.62% and 78.36%, respectively, in the summer. Unsaturated acids accounted for 35.88 and 26.72% in the winter season and for 25.38 and 21.64% of total acids determined in the summer season (Table 2). In addition, milk from the winter feeding period was characterized by a more favourable ratio of unsaturated to saturated fatty acids, which was 0.56 for White Improved goats and 0.36 for Fawn goats.

It is therefore thought that feeding season, or more specifically, the type of feed, affects the composition and profile of fatty acids. Similar results were obtained by SZYMANOWSKA *et al.* (2002).

In summing up the present study, it is necessary to stress that goat's milk obtained in the summer and winter feeding conditions did not show clear differences in terms of the basic chemical composition. In trying to determine factors behind the variation in the cholesterol level of the milk of the lactating goat, it should be pointed out that it was mainly related to the type of feeding (higher in winter, lower in summer). Breed and the type of feeds had a significant effect on the fatty acid profile. The milk fat of White Improved goats was richer in some fatty acids. Regardless of the breed, the milk from goats receiving winter feeds was characterized by a significantly lower proportion of saturated acids and a higher proportion of unsaturated acids.

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