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3. **Chemistry and Microbiology of Food**
4. **Economics and Management in the Food Industry**

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STUDIES ON THE COMPOSITION OF ORGANIC AND CONVENTIONAL MILK PRODUCTS

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Abstract: The changes in the basic physicochemical characteristics and the lipid composition of Bulgarian organic and conventional dairy products (cow's yoghurt and cow's cheese) during the winter and summer period have been investigated. There were no significant changes in the basic physicochemical characteristics for organic and conventional milk products (fat content in dry matter, content of milk protein, dry matter, acidity, salt content) in the studied periods. Organic yoghurt has lower acidity in comparison with conventional yoghurt. Organic cheese is the only one with a degree of maturity (21.7% and 20.5%), corresponding to the regulated value in the Bulgarian state standards for cheese (not less than 14%). The lipids have identical fatty acid composition, dominated by saturated fatty acids (68.7% -74.5%) and that their content is higher in winter. During the summer period quantities of trans fatty acids in mono- ($C_{18:1}$) and polyunsaturated fatty acids ($C_{18:2}$ and $C_{18:3}$) was higher than in winter. The content of tocopherols in the yoghurt fats is minimal, as their values in summer period is higher, such in the various trademarks cheese tocopherols not detected.
Keywords: organic and conventional dairy products, cow's yoghurt, cow's cheese, physicochemical characteristics, fatty acid composition, trans fatty acids

Introduction

Milk and milk products are highly evaluated for their nutrient properties. Certain organic milk products have been produced lately to feature lower contaminants percent. Comparative studies on the differences between the organic and conventional foods are rare to find in the scientific literature while no data on the composition of the organic and conventional type milk products being distributed through the retail trade system in Bulgaria is available at all. The current study aims to track the alterations across the general and lipid compositions of various organic and conventional milk products (yoghurt and cheese) brands during the winter and summer seasons.

Materials and methods

Milk sample collection

Cow's yoghurt – Organic cow's yoghurt "Harmonica" and conventional cow's yoghurt "Elena"; Cow's cheese – Organic cow's cheese "Kostovi - Saedinenie" and conventional white cow's cheese "Kostovi - Saedinenie" and "Elena". Dairy products were examined during winter and summer.

Methods

Fat content. The Gerber method was used to determine the fat content of the milk [8]. The fat content of the cheeses was determined according to a Shmid-Bondzynski-Ratzlaff method [12].

Moisture content and total solid. The determination of moisture was done by oven drying at 100^0C until a constant weight was obtained [1]. The dry matter is calculated by 100 – moisture content.

Titratable acidity. The titratable acidity was determined by titrating of the milk and the solution of cheese with 0.1 M sodium hydroxide solution in presence of phenolphthalein indicator [1].

Protein content. The protein content of the milk was determined by the Kjeldahl method and was calculated from the nitrogen content using factor 6.38 [6]. ***Soluble protein.*** Soluble proteins were extracted with hot water and subjected to digestion, distillation and titration in similar manner to total protein in cheese.

Salt. Salt (sodium chloride) was extracted with hot water, and then titrated with standard solution of 0.1N $AgNO_3$ according to BS 8274:1982 [7].

Analysis of fatty acids. The total fatty acid composition as well as the fatty acid composition of oils was determined by gas chromatography (GC) after transmethylation with 2 N NaOH in absolute CH_3OH at 50^oC [3]. GC was performed on a HP 5890 gas chromatograph equipped with a 30 m x 0.25 mm capillary EC-Wax column and a flame ionization detector [4]. **Total content of Trans isomeric fatty acids** was determinate in the oils by IR- spectrophotometry [2], which takes into account quantitatively the presence of trans double bonds as elaidic acid.

Analysis of tocopherols. Tocopherols were determined directly in the oil by high performance liquid chromatography on a “Merck-Hitachi" instrument equipped with 250 mm x 4 mm Nucleosil Si 50-5 column and fluorescent detector "Merck-Hitachi" F 1000 [5].

Results and discussion

The basic physicochemical characteristics of the yoghurt and Bulgarian white brine cheese brands under study during both seasons are given in a Table 1 below.

The organic and conventional yoghurts under study have failed to comply with certain required Bulgarian standard measures such as fat contents, moisture contents and dry matter respectively. No significant differences in the basic measures during both seasons (summer and winter) have been detected while changes within protein contents and titrable acidity of the yoghurt depending on the season have been recorded only.

The organic cheese has shown higher fat contents (23.4 and 27.7% respectively) during either season compared to the conventional cow cheese (21.5 - 23.4% respectively). Higher fat contents during the summer season has been found with the organic cheese only while both conventional cheeses „Elena” and „Saedinenie” have demonstrated higher fat contents during the winter season. The organic and conventional cheese brands under study have shown greater fat contents (16.0% - 18.4%) than that specified for the milk products (14.0 - 16.0%). The total amount of protein involves the most important cheese production measure - namely the degree of maturity. Based on the degree of maturity (21.7%) and moisture content (54.0%) only the organic cheese meets the Bulgarian state standard requirements in either seasons. The results obtained on the salt contents have shown measures close to the required standard one (3.5±0.5%). All milk products brands under study have shown titratable acidity to comply with the required one.

Table 1 Physicochemical characteristics of studies cow's yoghurt and white cow's cheese

Physicochemical characteristics	Cow's yoghurt				
	Winter time		Summer time		Requirements
	Organic	Elena	Organic	Elena	for Bulgarian cow's yoghurt [9]
Fat content, %	3.4±0.1	3.5±0.1	3.5±0.1	3.2±0.1	not less than 3.6
Moisture content, %	88.7±0.1	87.8±0.1	88.4±0.1	87.7±0.1	no more than 88.2
Dry matter, %	11.3±0.1	12.2±0.1	11.6±0.1	12.3±0.1	not less than 11.8
Protein content, %	3.3±0.01	3.8±0.02	3.2±0.01	3.5±0.01	not less than 3.2
Titratable acidity, ^{0}T	80.0±2.0	102±1.0	89.0±2.0	124.0±1.0	from 90 to 150

Physico-chemical characteris-tics	Cow's cheese						
	Winter time			Summer time			Requirements for cow's cheese [10]
	Organic	Saedinenie	Elena	Organic	Saedinenie	Elena	
Fat in product,%	23.4±0.1	23.4±0.2	21.6±0.4	27.7±0.1	21.5±0.1	21.7±0.2	-
Fat in dry matter, %	50.9±0.1	52.9±0.2	55.4±0.4	51.8±0.1	49.9±0.1	48.1±0.2	not less than 44.0
Moisture content,%	54.0±0.1	55.8±0.4	61.0±0.1	54.3±0.3	54.8±0.2	59.5±0.2	54.0
Dry matter, %	46.0±0.1	44.2±0.4	39.0±0.1	45.7±0.3	45.2±0.2	40.6±0.2	not less than 46.0
Protein content,%	16.5±0.1	17.2±0.1	16.0±0.1	18.4±0.1	16.3±0.1	17.5±0.1	14.0-16.0
Degree of maturity, %	21.7±0.1	13.5±0.1	9.5±0.1	21.7±0.2	11.5±0.1	5.3±0.1	not less than 14.0
Titratable acidity, ^{0}T	240±5.0	243±3.0	210±5.0	293±8.0	253±3.0	213±5.0	200-270
Salt content,%	3.5±0.1	3.5±0.1	5.3±0.2	2.9±0.1	4.1±0.2	3.6±0.1	3.5±0.5

The fatty acid composition of the milk fats from the tested organic and conventional milk product brands during both seasons is given in the Table 2 below.

The caprylic acid quantity varies from 0.4% to 0.7% during the winter only at that while its quantity has been found to be lower that that recorded by other authors [13]. The capric acid varies from 0.7% to 3.7% while its quantity during the winter is found to be 2 to 5 times higher than in the summer. The quantity of the palmitic and oleic acids in lipides being isolated out from organic and conventional milk products brands dominates. The palmitic acid contents within the fat phase ("Saedinenie" cheese in the summer season) varies from 32.9% to 37.3% ("Elena" yoghurt in summer season) while the oleic acid content (organic yoghurt in the winter season) varies from 20.8% to 28.9% (organic yoghurt in the summer season). The linoleic acid quantity varies from 0.7% to 1.5% while in the summer is twice as high compared to that in the winter season and the essential linoleic acid is scarcely present varying from 0.1% to 0.3%.

Table 2 Fatty acid composition of the fat from cow's yoghurt and cow's cheese

Fatty acids %		*Cow's yoghurt*				Published data
		Winter time		Summer time		
		Organic	Elena	Organic	Elena	[13]
$C_{4:0}$	Butanoic	-	-	-	-	3.6
$C_{6:0}$	Caproic	-	-	-	-	2.2
$C_{8:0}$	Caprylic	0.4±0.05	0.7±0.1	-	-	1.2
$C_{10:0}$	Capric	3.6±0.1	3.7±0.3	0.7±0.1	1.8±0.1	2.8
$C_{12:0}$	Lauric	5.7±0.1	5.3±0.1	2.4±0.1	4.4±0.1	2.8
$C_{12:1}$	Lauricoleic	0.2±0.01	0.2±0.01	0.1±0.01	0.1±0.01	-
$C_{14:0}$	Myristic	17.8±0.03	15.2±0.3	12.5±0.3	14.2±0.2	10.1
$C_{14:1}$	Myristoleic	1.3±0.1	1.1±0.1	0.5±0.01	0.9±0.05	-
$C_{15:0}$	Pentadecanoic	1.6±0.1	1.6±0.01	1.5±0.1	1.5±0.1	-
$C_{16:0}$	Palmitic	33.9±1.0	36.2±0.5	33.3±0.5	37.3±0.5	25.0
$C_{16:1}$	Palmitoleic	1.6±0.1	1.7±0.05	1.5±0.1	1.8±0.1	2.6
$C_{17:0}$	Margaric	0.6±0.1	0.7±0.01	0.9±0.1	0.7±0.1	-
$C_{18:0}$	Stearic	10.8±0.5	10.7±0.4	15.9±0.2	11.9±0.2	12.1
$C_{18:1}$	Oleic	20.8±1.0	21.2±0.4	28.9±0.3	23.7±0.4	27.1
$C_{18:2}$	Linoleic	0.7±0.1	0.7±0.01	1.5±0.1	1.5±0.1	2.4
$C_{18:3}$	Linolenic	0.1±0.01	0.1±0.01	0.1±0.01	0.1±0.01	2.1
$C_{20:0}$	Arachidic	0.1±0.1	0.1±0.05	0.2±0.01	0.1±0.01	-
$C_{20:1}$	Gadoleic	0.3±0.05	0.2±0.1	-	-	-
$C_{20:2}$	Eicosadienoic	0.5±0.05	0.6±0.05	-	-	-

Fatty acids %	*Cow's cheese*					
	Winter time			Summer time		
	Organic	Saedinenie	Elena	Organic	Saedinenie	Elena
$C_{8:0}$	0.5±0.05	0.7±0.05	0.5±0.01	-	-	-
$C_{10:0}$	1.4±0.2	3.1±0.1	2.2±0.1	0.7±0.05	1.9±0.1	1.3±0.05
$C_{12:0}$	2.4±0.2	4.1±0.1	3.5±0.1	2.6±0.1	4.3±0.2	3.4±0.1
$C_{12:1}$	0.1±0.01	0.2±0.01	0.2±0.01	0.1±0.01	0.2±0.01	0.2±0.01
$C_{14:0}$	10.6±0.2	14.1±0.3	14.2±0.01	13.0±0.2	14.6±0.2	13.6±0.3
$C_{14:1}$	0.5±0.01	1.0±0.01	0.7±0.01	0.6±0.05	0.8±0.05	0.8±0.1
$C_{15:0}$	1.4±0.01	1.5±0.01	1.9±0.1	1.6±0.1	1.8±0.1	1.8±0.1
$C_{16:0}$	33.6±0.5	36.1±0.5	35.2±0.2	36.5±0.2	32.9±0.4	34.1±0.3
$C_{16:1}$	1.4±0.01	1.5±0.01	1.5±0.01	1.4±0.1	1.6±0.1	1.7±0.2
$C_{17:0}$	0.9±0.1	0.8±0.01	1.0±0.01	0.9±0.1	0.8±0.05	0.9±0.1
$C_{18:0}$	17.4±0.1	12.5±0.1	14.1±0.1	15.6±0.2	14.5±0.1	14.7±0.1
$C_{18:1}$	26.7±0.2	21.7±0.4	21.4±0.2	25.5±0.3	25.0±0.3	25.4±0.2
$C_{18:2}$	0.7±0.1	0.7±0.1	0.9±0.1	1.1±0.1	1.2±0.1	1.4±0.1
$C_{18:3}$	0.3±0.01	0.2±0.01	0.2±0.01	0.1±0.01	0.1±0.01	0.3±0.05
$C_{20:0}$	0.3±0.01	0.2±0.01	0.3±0.01	0.3±0.05	0.3±0.01	0.4±0.05
$C_{20:1}$	0.2±0.1	0.3±0.1	0.2±0.1	-	-	-
$C_{20:2}$	1.4±0.1	1.3±0.1	1.8±0.1	-	-	-
$C_{22:0}$	0.2±0.01	-	0.2±0.01	-	-	-

The ratios between the saturated and unsaturated acids as well as the trans isomeric fatty acids contents are illustrated in the Fig. 1.

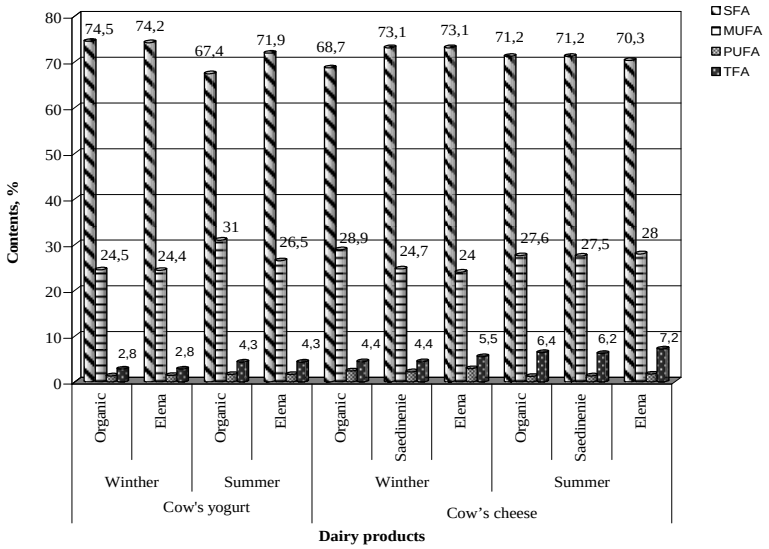

Fig. 1. Content of saturated (SFA) and unsaturated (MUSFA - monounsaturated, PUSFA - polyunsaturated) and trans fatty acids (TFA) in fat from cow's yoghurt and cow's cheese

High content of saturated fatty acids (over 67.4%) has been observed with all lipides being isolated out of the milk products brands under study. During the winter season both organic and "Elena" yoghurts have demonstrated the highest percent of saturated fatty acids (74.5% and 74.2% respectively) while both organic and "Saedinenie" cow's cheese have demonstrated higher content of saturated acids during the summer season (71.2%). The organic yoghurt has demonstrated the lowest percent of saturated fatty acids during the summer season – 67.4% и and the organic and "Elena" cheeses – 68.7% during the winter season respectively while showing higher percent of monounsaturated acids (31.0% and 31.3% respectively). The quantity of the monounsaturated acids with the milk products under study is higher in the summer season which can most probably be accounted for by the grass grazing as the grass contains certain quantity of dien and trien fatty acids.

In the winter season lower percent of trans fatty acids has been found with the organic and conventional milk products (2,8% with the milk and 4.4 - 4.5% with the cheese respectively) in comparison with that in the summer: 4,3% with the yoghurt and 6.2 - 7.2% with the cheese respectively. The milk lipids under study have not demonstrated higher percent of trans isomeric fatty acids in comparison with the cited data (1.0 - 7.0%) [11]. The percent of the trans fatty acids content in yoghurt varies from 0.1% to 0.15% while in cheese its within 1.0 to 1.8%.

The organic and conventional yoghurts are found to contain tocopherols in minimal percent at that (Organic – 14.6 mg/kg winter time and summer time – 23.6mg/kg and for "Elena" 5.9 and 25.5 mg/kg respectively). The α - tocopherol (100%) is the basic representative in the tocopherols list. Cheese is not found to contain tocopherols. Most probably this is due to the low percent of tocopherols in the milk itself and their probable decomposition while the milk is being processed into cheese.

Conclusions

Most of the Bulgarian milk products do not comply with the Bulgarian state standard requirements based on their physicochemical measures. The moisture contents, fat contents, titratable acidity, degree of maturity and salt content are found to deviate from their allowable measures. The organic and conventional milk products have not been found to show differences between their composition as well as between the different milk products under study during both seasons. The lipides being isolated out of the organic and conventional milk products type brands under study are found to show identical fatty acid composition dominated by the saturated fatty acids (67.4 - 74.5%). Mono-, polyunsaturated and tran sisomeric fatty acids are found to show higher percent in the summer season.

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