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DETERMINATION OF FREE FATTY ACID CONTENT OF MACEDONIAN WHITE BRINED CHEESE¹

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ABSTRACT

The main objective of this scientific research was to determine the free fatty acids content of Macedonian white brined cheese. Four variants of white brined cheese were selected and analysed for concentration of free fatty acids. The results of free fatty acids content which were obtained from the analysed cheese samples, define the Macedonian white brined cheese as a typical cheese, in which all free fatty acids were determined, with the exception of the following free fatty acids: valeric acid, caproic acid and α -linoleic acid. The detected free fatty acids in the tested cheese variants were present with different but approximate parameter values. From the detected free fatty acids, the concentration of palmitic acid was highest in all examined cheese samples with values from 34.40 ± 0.2 mg% to 36.10 ± 0.1 mg% and the concentration of butyric acid was at lowest level from 0.01 ± 0.003 mg% to 0.02 ± 0.003 mg%). The concentration of saturated fatty acids in all examined cheese samples was from 69.32 ± 0.42 mg% to 70.76 ± 0.72 mg% and the concentration of non-saturated fatty acids was from 29.24 ± 0.55 mg% to 30.68 ± 0.67 mg%). The concentration of free fatty acids in examined cheese samples was statistically significant at level $p < 0.05$.

KEY WORDS: white-brined cheese, free fatty acids, content.

¹ original scientific paper

INTRODUCTION

White brined cheese belongs to the group of cheeses that ferment in brine solution in anaerobic conditions. This product is characterized with acid-salty flavor, no rind, usually white color, but sometimes with yellowish tint, anaerobic brine fermented in plastic cans and pieces which are usually in form of cubes with dimensions 10x10x10 cm. Lipolytic processes similar to proteolytic processes in white brine cheese, are not significantly expressed. The level of free fatty acids is between 2 and 4 g · kg⁻¹ of cheese, including the acetic acid. In addition to the type of cheese and the degree of maturity, various factors can affect the concentration and composition of free fatty acids. Cheeses made from raw milk (without pasteurization) contain additional free fatty acids because the lipase remains intact or is not fully inactivated. Most starter cultures have poor lipolytic activity, and some increase the concentration of free fatty acids in the final product. Some types of cheese enzymes increase the concentration of free fatty acids, (Moatsou *et al.*, (2004); Kandarakis *et al.*, (2001); Georgala *et al.*, (2005)). During the ripening and storage period the milk fat does not undergo major changes in white brine cheeses (Mihailova *et al.*, 1995), this is because intracellular lipases and esterases from starter cultures have poorly expressed activity (Khalid и Marth, 1990).

The main objective of this scientific research was to determine the free fatty acids content of Macedonian white-brined which is the most used dairy product in our country

MATERIAL AND METHODS

Four white brined cheese variants (WBC1, WBC2, WBC3 and WBC4) were selected for free fatty acid determination. The selected white brined cheese variants were produced in different dairy industries in our country, and these cheese variants are mostly used by the consumers. The cheese samples were taken from the factories where they were produced and then taken to a laboratory due to fatty acid analysis.

There were some differences in the technological process of the production of white brined cheese variants (WBC1, WBC2, WBC3 and WBC4). The variants WBC1, WBC2 and WBC4 were produced from non-standardized milk, the variant WBC3 was produced from

standardized milk (protein 32-35g/kg, milk fat: 37-40 g/kg). The temperature of pasteurization was different for each cheese variant, WBC1:72-74°C/ 15 minutes, WBC2:72-74°C/ 10 minutes, WBC3: pasteurization I:74-77°C/ 60 seconds, pasteurization II:74-77°C/5 minutes and WBC4: 72°C/5 seconds. The added starter cultures were also different. The following starter cultures in WBC1 were added: *Lactococcus lactis ssp. Lactis*, *Str. thermophilus*, *Lact. delbrueckii ssp. bulgaricus*; The following starter cultures were added in WBC2: *Lactobacillus helveticus*, *Str. Thermophilus*, *Lactobacillus. delbrueckii ssp. Bulgaricus*; The following starter cultures were added in WBC3: *Str. thermophilus*, *Lactobacillus bulgaricus*; and the following starter cultures were added in WBC4: *Lactobacillus bulgaricus*, *Str. thermophilus*, *Lactobacillus acidophilus*; The addition of CaCl₂ was also different in production process of the variants. In WBC1 was added 0.035-0.050% of CaCl₂, in WBC2 was added 0.030-0.045% of CaCl₂, in WBC3 was added 0.010-0.020% of CaCl₂ and in WBC4 – 0.010-0.015% of CaCl₂ was added. The coagulation time for each variant was the same (45 minutes to 1 hour). *Brine* may refer to salt *solutions* ranging from about 8% till 12%. The fermentation process lasts 45 days. The method that was used to determine the free fatty acids in white brined cheese samples was according Bligh and Deyer (1959).

RESULTS AND DISCUSSION

As for this research the composition and content of free fatty acids regarding all four varieties of white brined cheese have been determined at the 60th day after the ripening process has been completed. The results obtained from the analysis characterize the white brine cheese as a typical cheese in which all free fatty acids were determined, with the exception of the following fatty acids: α -Linoleic acid, Valeric acid and Capronic acid, which are not detected in any of the examined cheese samples. The significant differences between variants for fatty acids content at level $p < 0.05$ are presented Table No.1. In all examined white brined cheese samples, the following free fatty acids were determined in highest percentage: palmitic acid, oleinic acid, stearic acid and myristic acid. Beside these free fatty acids in smaller percentage, the following free fatty acids were determined in all cheese samples: Caproic acid, Lauric acid and Linoleic acid, and in very low concentrations were determined: Acetic acid, Butyric acid, Caprylic acid, Margaric acid and Behenic acid.

Table No.1: Free fatty acids content of examined cheese variants

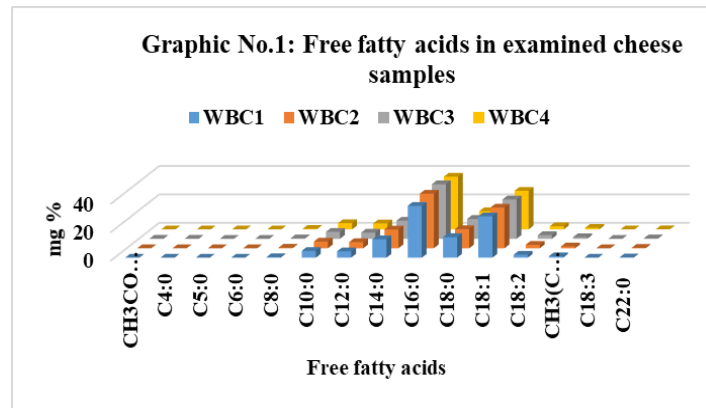
Free fatty acids, mg (%)		White brined cheese variants (day 60)			
		WBC1	WBC2	WBC3	WBC4
CH ₃ COOH	Acetic acid	0.04±0.001 ^a	0.03±0.001 ^a	0.03±0.001 ^a	0.02±0.001 ^a
C4:0	Butyric acid	0.02±0.003 ^a	0.02±0.004 ^a	0.03±0.002 ^a	0.01±0.003 ^a
C5:0	Valeric acid	not detected	not detected	not detected	not detected
C6:0	Caproic acid	not detected	not detected	not detected	not detected
C8:0	Caprylic acid	0.4±0.02 ^a	0.38±0.01 ^a	0.36±0.01 ^a	0.36±0.02 ^a
C10:0	Capric acid	4.8±0.3 ^a	4.7±0.1 ^a	4.9±0.2 ^a	4.4±0.2 ^{a,b}
C12:0	Lauric acid	4.5±0.3 ^a	4.3±0.2 ^a	4.4±0.2 ^a	4.2±0.1 ^a
C14:0	Myristic acid	13.0±0.1 ^a	11.8±0.1 ^b	12.1±0.1 ^c	12.3±0.2 ^{c,d}
C16:0	Palmitic acid	34.5±0.2 ^a	35.2±0.2 ^b	34.4±0.2 ^{a,c}	36.1±0.1 ^d
C18:0	Stearic acid	13.5±0.2 ^a	13.2±0.1 ^b	13.1±0.2 ^{b,c}	12.8±0.2 ^d
C18:1	Oleic acid	26.1±0.1 ^a	26.4±0.1 ^b	26.7±0.2 ^b	26.5±0.5 ^b
C18:2	Linoleic acid	2.0±0.01	2.4±0.03	2.6±0.02	2.2±0.02
CH ₃ (CH ₂) ₁₅ COOH	Margaric acid	1.0±0.03 ^a	1.3±0.05 ^b	1.08±0.03 ^a	1.01±0.01 ^a
C18:3	α-Linoleic acid	not detected	not detected	not detected	not detected
C22:0	Behenic acid	0.14±0.01 ^a	0.27±0.01 ^b	0.3±0.02 ^{b,c}	0.1±0.01 ^{a,d}
Saturated fatty acids		70.76±0.72	69.63±0.42	69.32±0.51	70.19±0.52
Non-saturated fatty acids		29.24±0.55	30.37±0.49	30.68±0.67	29.81±0.84

*Differences of values with different superscripts in the same row are statistically significant at level $p < 0.05$;

The dominant free fatty acid in all four variants was palmitic acid, which was determined in the largest amount in the variant WBC4 - 36.1 ± 0.1 mg%, and the lowest amount in the variant WBC3 - 34.4 ± 0.2 mg% was determined. The highest level of oleic acid in variant WBC3 was determined – 26.7 ± 0.2 mg%, and the lowest amount of this acid - 26.1 ± 0.1 mg% was determined in Variant WBC1. In higher percentage the following free fatty acids were also determined: Stearic acid (Variant WBC1- 13.5 ± 0.2 mg%) and Myristic acid (Variant WBC1- 13.0 ± 0.1 mg%). These free fatty acids were determined in Bulgarian white brined cheese at highest level by Ivanov et al. (2015).

Butyric fatty acid, as a representative of short-chain fatty acids, was determined in all white brined cheese samples, but in very small concentrations ranging from 0.01 mg% to 0.03 mg%. Capric fatty acid was also determined with concentrations from 4.2 ± 0.1 mg% to 4.5 ± 0.3 mg%, and caprylic fatty acid from 0.36 ± 0.02 mg% to 0.4 ± 0.02 mg. According to the presented data in Table No.1 and in Graphic No.1 it can be concluded that the that the presence of free fatty acids in the different

variants is approximate, and no major deviations between the examined cheese samples have been determined. The significant differences between variants for fatty acids content at level $p < 0.05$ are presented Table No.1.



The taste and aroma of white brine cheese depends entirely on the amount of free fatty acids. According to Baltadzieva (1993), minimal changes in the amount of Butyric acid, Caproic acid and Capric acid, have significant impact on the taste and aroma of white brined cheese. Freitas and Malcata (1998) in their research indicate that the change in the amount of fatty acids that have medium and long chain, don't have much effect on the formation of the taste and aromatic profile of ripened white brine cheese, in comparison to fatty acids with short-chain.

According to the results it can be concluded that in all four variants white brine cheese, saturated fatty acids are present with approximately 70%, and unsaturated fatty acids are present with around 30%. Ivanov et al., (2015) determined identical presence of saturated and unsaturated fatty acids in Bulgarian white brined cheese.

Barac *et al.*, (2018), have examined the fatty acid composition of Serbian traditional white brine cheeses from cow's milk (Sjenica, Homolje and Zlatar) and have determined that palmitic, oleinic, stearinic and myristic acids were the most common in the composition of free fatty acids of Serbian white brined cheese, and the ratio of saturated and unsaturated fatty acids was 70%: 30%, which is in accordance with our results.

Kalinova *et al.*, (2017) have examined the fatty acid composition of Bulgarian white brine cheese depending on the season in which it was produced. According to their findings obtained from a total of 625 samples of cheese, palmitic, myristic, oleinic and stearinic acids are

dominant in the composition of the cheese, whether it is produced in winter or summer, and differs only in their percentage representation. The ratio between saturated and unsaturated fatty acids was 70% - 30% and is identical, regardless of the production period. This results are also in accordance with our results. Our findings are also confirmed by Naydenova et al., (2013), which in the Bulgarian white brine cheese have determined the following free fatty acids: myristic, palmitic and oleinic acid.

In Turkish white brined cheese, Kesenkaş and Akbulut (2005) have determined an identical fatty acid composition that is in accordance with our presented results. Dominant free fatty acids in Turkish white brined are: myristic, palmitic, oleinic and stearic acid. The ratio between saturated and unsaturated fatty acids is 66.5% - 33.5%.

CONCLUSION

After the conducted analyses we determined the presence of all of the fatty acids in all cheese variants, except: α -linoleic acid, valerianic acid and capronic acid. In highest percentage the following fatty acids were determined: palmitic acids, oleic acid, stearic acid and myristic acid. Small percentage of the following fatty acids were determined: caprine acid, lauric acid and linoleic acid, and in very low concentrations were determined: acetic acid, butyric acid, caprylic acid, margaric acid and behenic acid acid. The predominant fatty acid in all four variants was palmitic acid, of which the variant WBC3 appeared with the highest percentage. The ratio of saturated and unsaturated fatty acids in all examined variants was approximately 70% to 30%.

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