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THE IMPACT OF THE USE OF CANDIED LINGONBERRIES ON THE PHYSICAL-CHEMICAL, MICROBIOLOGICAL CHARACTERISTICS AND ANTIOXIDANT PROPERTIES OF CHEESE CREAM

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Abstract

Cheese creamis a category of dairy product highly appreciated by people of all ages, due both to its sensory characteristics and very pleasant texture, as well as its nutritional properties.Also, the lingonberries, both fresh and candied are considered very valuable because of their antioxidant and nutritional properties. The aim of this studyis to assess the impact of addition of candied lingonberries, in different proportions (10%, 15%, 20%, 25%),on the physical-chemical, microbiological characteristics and antioxidant properties of cheese cream. The experimental results of this research showed a decrease in themoister content and titratable acidity of the cream cheeseswith increasing of the proportion of fruit addeddue to the replacement of fresh cream cheese with candied fruit, whose acidity is lower. Further the total soluble solids content of the samples increased with the amount of added fruit. The total antioxidant activity and total polyphenol content of the cheese cream have been significantly improvedby using the candied lingonberries in the cheese cream formula.In the same time, was found that the microbial load of cheese creams with candied lingonberries decreased with increasing the amount of fruit added.Thus, the addition of candied lingonberries in the cream cheese formula resulted in a change of all the analyzed parameters and could be recommended as natural antioxidants in this type of dairy product.

Key words*: cheese cream, candied lingonberries, total antioxidant activity, total polyphenol content.*

INTRODUCTION

Dairy products represent on average 25-30% of a person's daily food intake (Richmond, 2007). Both milk and dairy products obtained in production units which are in accordance with food safety regulations,represent foods rich in nutrients such as: oleic acid, conjugated linoleic acid, omega-3 fatty acids, vitamins, micro and macro elements and not least in antioxidants (Savu et al., 2002, Mitrea et al., 2003; Saxelin et al., 2003; Petcu, 2006; Oprea et al., 2019). Antioxidants are a class of chemicals considered responsible for neutralizing and eliminating free radicals produced in the human body (Yazdanparast and Ardestani, 2007). Consumer preference for packaged food containing natural antioxidants has grown significantly globally (Vișoescu et al, 2015). For this, obtaining food products with the addition of natural antioxidants has become an important concern of researchers and manufacturers in the field (Santillo, 2009; Predescu et al., 2016). Antioxidant properties of milk and dairy products is attributed to their content in cysteine, vitamins A, E, carotenoids, catalase and glutathione peroxidase, superoxide dismutase, enzyme systems and equol, which it is a polyphenolic metabolite of daidzein (Usta and Yilmaz-Ersan, 2013; Mustonen et al., 2009). There are several researches which present the use of fruits in dairy products in order to improve their nutritional value and antioxidant capacity. It was demonstrated that the use of wine grape pomace it is useful to enhance the antioxidant properties of yogurt and ice cream (Tseng and Zhao, 2013; Hwang, 2009). In another study, the use of grape pomace powder in fortifying semi-hard cheese was reported (Marchiani et al., 2015). In view of the above, we have proposed in this study to use candied lingonberries as a potential source of improving the nutritional properties of cream cheese. This is a soft cheese, characterized by a slightly acidic tasting and diacetyl flavour. It is processed by the coagulation of milk mixed with cream and acidified by the addition of starter cultures. Lingonberries (*Vaccinumvitis-idaea*) are one of the most valuable fruits, distinguished by their pleasant sensory properties, antibacterial and antifungal properties, but also by the remarkable content in bioactive compounds such as folate, potassium and soluble fiber. The antioxidant properties of lingonberries are attributed their content in phenolic compounds, vitamin C (Samad et al., 2014; Paredes-López et al., 2010; Vyas et al, 2013). In some studies conducted before, it was reported that 28 phenolic compounds were identified, among which anthocyanidins, catechins together with their glycosides, flavonols, and different caffeoyl and ferulic acid conjugates, respectively (Ek et al., 2006; Hajazimi et al., 2016; Tian et al., 2017; Antolak et al., 2017). Along with polyphenols, the *Vaccinumvitis-idaea*fruits also contain antioxidant compounds such as organic acids and vitamins (A, B1, B2, B3 and C) (Dróżdż et al., 2018).The aim of the present research was to evaluate the impact of candied lingonberries on physical-chemical, microbiological and antioxidant properties of cream cheese.The moisture content, titratable acidity,total phenolic compounds, total antioxidant activity and microbiological properties werecarried out for each cream cheese with candied lingonberries sample.

MATERIALS AND METHODS

The cheese cream was prepared using the classical method described in introduction. Then the cream cheese was divided into fiveequal portions, in four of them wereadded candied lingonberries (purchased from a local supermarket) in following proportion: 10% (CCrL10), 15% (CCrL15), 20% (CCrL20), 25%(CCrL25). After preparationall cheese cream samples, were packed in closed glass containers and kept in the refrigerator,at 2^0Cuntil the experimental analyzes were performed.All samples were analyzedin terms of physical-chemical characteristics, microbiological properties, -total polyphenols content and total antioxidant activity. All determined parameters of the cream cheese with lingonberries were analyzed by comparison with those of simple cheese cream (CCr) and candied lingonberries (CL)used as a control.

Moisture fraction was performed by drying in the oven using the reference method for the determination of the total solids content of cheese and processed cheese ISO 5534|IDF 4:2004. Determination of cheese samples titratable acidity (expressed in °Thorner) was conducted according whit SR ISO 6092:2008. Titratable acidity (% malic acid) of lingonberries was performed according with AOAC Official Method 942.15. Total soluble solids content (°Brix) were measured with an ABBE refractometer (ORT 1RS, KERN & SOHN GmbH, Germany) - in an aqueous extract(1:1, m/V) - (ISO 2173: 2003).Bacteriological analysis - was performed according to national standards ISO 4831-92/2006 - for coliform bacteria, SR ISO 7251-96/2005, for *E. coli*, SR EN ISO 6579-2003, *Salmonella*, SR EN ISO 6888-2002, for *Staphylococcus aureus* and SR ISO 7954-2001, for yeasts and molds (thermoscientific.com/microbiology, 2013).The evaluation of total polyphenolic content was performed by Folin-Ciocalten method (Folin and Ciocâlteu, 1927; Singleton et al., 1999). The method is based on the reducing properties of polyphenols compared to hexavalent molybdenum in polyphosphomolybdate contained in Folin-Ciocâlteu reagent. Two g of cheese cream were mixed with 20 mL of 70% methanol solution. After two hours,0.5mL from each prepared solution was mixed with 2.5mL of Folin-Ciocâlteu reagent diluted 1:10 and 2 mL of a 7.5% sodium carbonate solution.The mixtures were incubated atdark at room temperature for 30 minutes and then the absorbance of the reaction mixture was read at

750nmwavelengths using a UV–VIS spectrophotometer (SPECORD 205, Analytic Jena). The concentration in polyphenols wasexpressed as mg gallic acid equivalents per 100 g of cheese cream sample (mg GAE/100 g sample). In order to evaluate the total antioxidant capacity of the samples, the CUPRAC method was used (Özyürek et al. 2011). The method is based on reduction of the copper-neocuproine complex in the presence of ammonium acetate with the formation of the copper-neocuproine complex [Cu(Nc)2]+, which is a yellow compound, with a maximum absorption at 450 nm wavelengths. As reference substance was used TROLOX (6-hydroxy-2,5,7,8-tetramethylchromate-2-carboxylic acid). To perform the analysis mix 1mL of copper solution with 1mL of alcoholic ligand solution, 1mL of acetate buffer and 1.1mL of sample and shake well. After 30 minutes at rest in the dark, the absorbance of the blank at 450nm is determined. The molar absorbance coefficient for TROLOX in the CUPRAC method is Ɛ = 1.67 x104 L x mol-1x cm^{-1}. The results can be expressed in mmol Trolox / 100 g sample. All the results are presented as mean of four determinations ± standard deviation (OriginPro 8.5).

RESULTS AND DISCUSSIONS

The physical-chemical characteristics as moisture content (Moisture), titratable acidity (TA) and total soluble solids content (TSS) of samples experimentally analyzed are presented in Table 1.

Table 1 Physical-chemical characteristics of samples determined experimentally

Sample	Moisture[%]	TA	TSS[Brix]
CCr	60,81±0.174	169±0.256[°T]	3±0.348
CL	8,62±0.151	1,5±0.238[%]	60±0.389
CCrL10	54,30±0.161	158±0.238[°T]	6,4±0.419
CCrL15	51,14±0.132	146±0.238[°T]	8,6±0.411
CCrL20	47,66±0.143	131±0.238[°T]	11±0.259
CCrL25	44,84±0.133	121±0.226[°T]	12,8±0.419

The moisture content of cheese cream with lingonberries was in the range of 54,30% (CCrL10) and 44,84% (CCrL25) and decreased with increasing concentration of added fruit as a result of the replacement of cheese cream with candied lingonberries. The highest moisture was registered in case of simple cheese cream (CCr) and the smallest level in candied lingonberries (CL). Taking into account the mentioned results, it can be stated that the addition of candied fruits in cream cheese can be considered responsible for the lower water content of samples with fruits.

As expected, the *titratable acidity of the cream cheeses with candied fruits*was lower than of simple cheese cream and is due to the candied lingonberries from their composition. The candied lingonberries used in cream cheese formula are obtained by osmotic dehydration of fresh fruit in a concentrated sugar solution. During the osmosis process some of the fresh fruit acidsare removed together with water causing a decrease in the acidity of the candied fruits (Chavan, 2012). The highest titratable acidity of the cheese samples with fruits was determined for CCr10 (158^0T) and the lowest value for CCrL25 (121^0T).The experimental results obtained in the case of humidity and titratable acidity for all the analyzed samples are in accordance with those reported in the literature (Perveenet al., 2011; Phadungath C., 2005) and regulated in the national and international standards regarding cream cheese.

Contrariwise the presence of candied fruits in the composition of cheese creams led to an increased–of total soluble solidscontent of the samples directly proportional to the amount of candied lingonberries added from 6.4 Brix in CCrL 10 sample to 12.8 Brix in CCrL 25 sample.The increase of the sugar content in the cheese cream with candied fruits, it can be considered that also benefited from an improvement of their sensory properties.

Bacteriological analysis of cheese cream with candied lingonberries

The values determined experimentally for each of the isolated germs are presented in Table 2.

Table 2 Microbiological load of the analyzed product

Germs	CCr	CL	CCr L10	CCr L15	CCr L20	CCr L25
Coliforms/g	89	0	83	79	72	67
E. coli/g	10	0	8	7	5	3
Salmonella/g	0	0	0	0	0	0
S. aureus/ g	9	0	7	6	6	4
Yeasts and molds/g	81	21	79	75	71	64

The number of coliform bacteria determined experimentally was below the maximum limit imposed by the legislation, for all samples analyzed. The same observation was made for *Escherichia coli*. As expected, the absence of these microorganisms in candied lingonberries led to the reduction of coliforms number in the cream cheese samples in which they were used. This decrease was more advanced as the amount of CCr substituted with CL was higher and varied in the range (7-25%), the lowest value being registered in CCrL25. *Salmonella* was absent in 25 grams of product in all samples analyzed.

The experimentally determined values for the number of positive coagulase staphylococci indicate a compliance with the maximum limit allowed by law for this parameter in the case of all samples of cream cheese and their absence in the candied fruit. Similar to the other microbiological parameters analyzed, the increase in the proportion of fruit added to the composition of the cream cheese had the effect of decreasing the number of staphylococci in these samples. In terms of yeasts and molds number, the obtained results revealsa similarity to those obtained in case of other microorganisms analyzed. Simple cheese cream registered the highest fungal load, and candied lingonberries the lowest load. The decrease in the number of yeasts and molds in the cheese cream with candied lingonberriescould be attributed tothe increase in the percentage of added fruit.This can be explained by the replacement of cream cheese with candied fruit whose load in yeasts and molds is lower than that determined in fresh cream cheese.

Total antioxidant capacity and total polyphenol content

Nowadays there are not many studies regarding the antioxidant capacity of cheeses but in the last period has registered an increase in interest of researchers and producers in this field(Revilla et al., 2016). It was demonstrated that total antioxidant capacity is significantly influenced by the technological process by which the cheese is made(Lucas et al., 2006b). Alsoit is mainly attributed to the fat-soluble vitamins of cheese (Lucas et al., 2006b, 2008b)

Total antioxidant capacity and the total polyphenol content of the samples of cream cheese and candied lingonberries are presented in Table 3.

Table 3. Total antioxidant capacity and the total polyphenol content of the samples

Sample	Total antioxidant capacity (mM TE/g)	Total polyphenol content(mg GAE/g)
CCr	4,399±0.033	n.d.
CL	11,933±0.045	254,704±0.012
CCrL10	4,906±0.033	92,382±0.041
CCrL15	5,749±0.055	116,703±0.112
CCrL20	6,056±0.140	143,232 ±0.032
CCrL25	7,635±0.051	178,411 ±0.037

n.d.- undetectable

Total antioxidant capacity

The experimental values obtained in the case of candied lingonberries were similar with those reported in literature (Dróżdż et al., 2018) and significantly higher than those determined in the case of than all other samples, due to the much higher content in other bioactive compounds with antioxidant activity. The lowest antioxidant activity was determined in the case of CCr (4,399 mM TE/g) and is correlated with literature data (Revilla et al., 2016). The highest antioxidant capacity was registered for CL (11,933mM TE/g) and was 63% higher than that of CCr. Also, the values obtained for antioxidant activity of lingonberries are in accordance with those obtained by other researchers (Dróżdż et al., 2018). As expected this led to increase of this parameter incream cheeses with candied lingonberries up to 27% in the case of CCrL25, Increasing the antioxidant capacity of cheese creams with added fruit was on average 17%.

Total polyphenol content

Cheeses are poor in phenolic compounds and have a low antioxidant activity (Han et al., 2011b). This is due to the fact that the interaction of phenolic compounds and proteins is often influenced by the pH, molar ratio, and molecular properties of the polyphenols (Gad and El-Salam, 2010).

The polyphenol content of the samples determined experimental, reveals that the highest values was obtained in case of candied lingonberries (11,933 mg GAE/g) in according with those from literature (Ozola and Kampuse, 2018)and registered a dynamic similar to those recorded for antioxidant activity. The results obtained for the cream cheese samples were on average 2 times lower than that of the candied lingonberries. The highest content in polyphenols of cheese cream with candied fruits was determined in CCrL25 (178,411mg GAE/g). It must to be noted that in the case of CCr the polyphenol content was not detected. The addition of candied fruit to the cheese-making recipe resulted in significant changes in total polyphenols of these samples. The increase rate of this parameter was on average 18% and can be attributed to the increase of the amount of CL added.

CONCLUSIONS

Results obtained in the present research reveal that the addition of the candied lingonberries to cheese creamincreases significantly the antioxidant properties and total polyphenol content of this. The moisture content, titratable acidity and total soluble solids content are affected by the addition of candied lingonberries in cheese cream formula. The microbiological load of samples was within the limits of the legislation in force. Overall results suggested that the use of candied lingonberries in cream cheese formula can be an effective option for improving the antioxidants properties and to enhance the bioactive compounds of dairy products.

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