

DOI: 10.5281/zenodo.3464222

CZU 637.352:579.67



ANTIMICROBIAL PROPERTIES OF BERRY POWDERS IN CREAM CHEESE

Rodica Sturza¹, ORCID ID: 0000-0002-2412-5874Elisaveta Sandulachi^{1*}, ORCID ID: 0000-0003-3017-9008Daniela Cojocari^{1,2}, ORCID ID: 0000-0003-0445-2883Greta Balan², ORCID ID: 0000-0003-3704-3584Liliana Popescu¹, ORCID ID: 0000-0003-3381-7511Aliona Ghendov-Moșanu¹, ORCID ID: 0000-0001-5214-3562¹Technical University of Moldova, 168, Stefan cel Mare Bd., Chisinau, Republic of Moldova²State University of Medicine and Pharmacy "Nicolae Testemitanu, 165,
Stefan cel Mare Bd., Chisinau, Republic of Moldova*Corresponding author: Elisaveta Sandulachi: elisaveta.sandulachi@tpa.utm.md

Received: July, 02, 2019

Accepted: September, 15, 2019

Abstract. This study aims to evaluate the efficiency in reducing pathogens using berry powders in a cream cheese recipe, as compared to the traditional method of manufacturing. This article presents a review of the microbiological hazards of dairy products and a case study of antimicrobial properties of berry powders on pathogenic microorganisms that can accidentally colonize cream cheese. The most relevant results in the reduction of pathogenic microorganisms were obtained in cream cheese samples with the addition of rosehip and aronia powders on *Salmonella Abony* ATCC 6017; hawthorn powder on *Staphylococcus aureus* ATCC 25923. All berry powder additions had major effects on *Escherichia coli* ATCC 25922. Research has shown that powders of berries can be used for the manufacture of dairy products with natural ingredients more resistant to accidental contamination and safe for consumption.

Keywords: *reducing pathogens, thermostation period, log CFU, growth of microorganisms.*

Introduction

Due to their unique composition and properties milk and other dairy products are excellent growth media for many spoilage and pathogenic microorganisms [1, 2].

Salmonella continues to be a major concern for the dairy industry because these bacteria have caused recent outbreaks of illness and have been isolated from various dairy products in the market place. *Salmonella* bacteria are generally not heat resistant and normally grow at 35 to 37 °C, but they can grow at much lower temperatures, provided that the incubation time is suitably extended. To minimize problems, foods should be kept at 2 to 5 °C or below at all times [3]. Lately several salmonellosis cases have been recorded due to consumption of raw milk (both regular and organic). It goes to prove that more of the animal origin strains have been gaining entrance and surviving in the raw milk. The

December 2016 recall of nonfat dry milk had a huge resonance regarding dairy contamination [4].

The questions to be asked are: does *Salmonella* gain entrance into raw milk from cows, and does pasteurization kill the bacteria? *Salmonella* does gain entrance into raw milk from cows, and in the majority of cases pasteurization is adequate to kill it. If some strains of *Salmonella* survive high heat treatments, how can we eliminate this problem in dairy products [4]?

Microbiological risks in foods such as milk and dairy products are addressed in several studies. Most research includes the influence of heat treatment or salt in monitoring this risk [5]. The objective proposed in State project 18.51.07.01A / PS was to investigate other methods of reducing and controlling microbiological risk in food. Previous studies [6, 7] have shown that berry powder has an inhibitory effect on pathogenic microorganisms (*S. aureus*, *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella pneumonia*, *B. mesentericus*), including meat products [8].

The purpose of this study was to evaluate the effect of adding berry powders to the cream cheese recipe on pathogenic microorganisms that may accidentally infect the finished product.

Materials and methods

In the pilot laboratory of the Food Technology Department, Technical University of Moldova, cream cheese samples were prepared using various berry powders grown in the Republic of Moldova. In this study the following samples with berry powder additions were investigated microbiologically:

- ✓ Cream cheese - sample control – (S1);
- ✓ Cream cheese with 2% rose-hip powder – (S3);
- ✓ Cream cheese with 2% sea buckthorn powder – (S6);
- ✓ Cream cheese with 2% aronia powder – (S9);
- ✓ Cream cheese with 2% hawthorn powder – (S12).

Microbiological tests were carried out in the laboratory of the Microbiology and Immunology Department, “Nicolae Testemitanu” State University of Medicine and Pharmacy. For the contamination of the experimental samples of cream cheese the microbial strains (*Staphylococcus aureus* ATCC 25923, *Salmonella Abony* ATCC 6017, *Escherichia coli* ATCC 25922) were procured from the National Public Health Agency. Inoculation of microorganisms in cream cheese samples, thermostatization and monitoring of microbial growth was performed according to the following bibliographic sources [8-10].

Results and discussions

The predominant human bacterial pathogens that can potentially be transferred to milk include mainly *Listeria monocytogenes*, *Salmonella spp.*, *Staphylococcus aureus* and *Escherichia coli*. Raw milk provides a potential growth medium for the development of these bacteria [11]. Although pasteurization destroys potential pathogenic microorganisms, post pasteurization processing can lead to the recontamination of dairy products. For hygienic reasons, most cheeses are produced from pasteurized milk; however, with a production of 700,000 tons per year, raw milk cheeses represent a significant proportion of ripened cheeses produced in Europe, particularly in Italy, France and Switzerland. Many artisan cheese makers, customers and researchers claim the benefits/advantages of raw milk cheeses, so it is important to know the consequences and possible implications of

pasteurization on the ripening process, and ultimately on the sensory characteristics of cheese [12, 13].

Efficient pasteurization of milk eliminates the risk of pathogenic organisms, but does not destroy organisms that grow slowly or produce spores. While pasteurization destroys many microorganisms in milk, improper handling after pasteurization can recontaminate it [14, 15]. Both raw and pasteurized milk can be contaminated during bottling, shipment and storage. Pasteurization only destroys the pathogens in milk at the time of processing; if unsanitary conditions allow pathogens to re-enter the milk later, it will be contaminated again [16].

Heat is lethal to microorganisms, but each species has its own particular heat tolerance. During a thermal destruction process, such as pasteurization, the rate of destruction is logarithmic, as is their rate of growth. Thus bacteria subjected to heat are killed at a rate that is proportional to the number of organisms present. The process is dependent both on the temperature of exposure and the time required at this temperature to accomplish the desired rate of destruction. Thermal calculations thus involve the necessity to know the concentration of microorganisms to be destroyed, the acceptable concentration of microorganisms that can remain after (e.g. spoilage organisms, but not pathogens), the thermal resistance of the target microorganisms (the most heat tolerant ones), and the temperature-time relationship required to destroy the target organisms [17].

Table 1 and Figures 1 and 2 include the obtained results in the evaluation of the influence of the berry powders (rose-hip, sea buckthorn, aronia and hawthorn) on *Salmonella Abony* ATCC 6017.

Table 1

Reducing the growth rate of pathogenic microorganisms in cream cheese samples with the berry powders additions.

Sample coding	Estimated values	Incubation duration, h		
		0	24	48
<i>Salmonella Abony</i> ATCC 6017				
S1	CFU/1g product	$1.4 \cdot 10^4$	$7.12 \cdot 10^8$	$1.4 \cdot 10^8$
	log CFU	4.146	8.85	8.15
S3	CFU/1g product	$1.4 \cdot 10^4$	$1.1 \cdot 10^7$	0
	log CFU	4.146	7.041	$-\infty$
S6	CFU/1g product	$1.4 \cdot 10^4$	$4.2 \cdot 10^7$	$5 \cdot 10^6$
	log CFU	4.146	7.62	6.70
S9	CFU/1g product	$1.4 \cdot 10^4$	0	0
	log CFU	4.146	$-\infty$	$-\infty$
S12	CFU/1g product	$1.4 \cdot 10^4$	$6.6 \cdot 10^7$	10^7
	log CFU	4.146	7.82	7
<i>Staphylococcus aureus</i> ATCC 25923				
S1	CFU/1g product	$1.4 \cdot 10^4$	$1.25 \cdot 10^8$	$3.2 \cdot 10^7$
	log CFU	4.146	8.097	7.50
S3	CFU/1g product	$1.4 \cdot 10^4$	$3.8 \cdot 10^7$	$1 \cdot 10^6$
	log CFU	4.146	7.58	6

				Continuation Table 1
S6	CFU/1g product	1.4*10 ⁴	4,0*10 ⁷	2.8*10 ⁷
	log CFU	4.146	7.6	7.45
S9	CFU/1g product	1.4*10 ⁴	7.1*10 ⁷	5.1*10 ⁷
	log CFU	4.146	7.85	7.71
S12	CFU/1g product	1.4*10 ⁴	2.8*10 ⁷	0
	log CFU	4.146	7.45	-∞
<i>Escherichia coli</i> ATCC 25922				
S1	CFU/1g product	1.4*10 ⁴	1.9*10 ⁷	8*10 ⁶
	log CFU	4.146	7.28	6.90
S3	CFU/1g product	1.4*10 ⁴	1.2*10 ⁷	0
	log CFU	4.146	7.08	-∞
S6	CFU/1g product	1.4*10 ⁴	0	0
	log CFU	4.146	-∞	-∞
S9	CFU/1g product	1.4*10 ⁴	2*10 ⁶	0
	log CFU	4.146	6.30	-∞
S12	CFU/1g product	1.4*10 ⁴	6*10 ⁶	0
	log CFU	4.146	6.78	-∞

According to European legislation, raw milk must be processed within a maximum limit of 48 hours, to reduce the development of pathogens [18]. In raw-milk cheese production, checking the acidity (pH and titratable acidity) of the milk and the curd along the production chain can help minimize risk. If acidity develops rapidly (in the first 6, 8 or 12 hours since the start of processing), it means that a good part of the microorganisms dangerous to health and product quality have been limited [19].

Salmonella has long been recognized as an important human health problem of economic significance in animal and humans. A total of 108,614 confirmed cases of salmonellosis were reported in the European Union in 2009, although cases attributed to *S. enteritidis* have decreased during the last years [20]. However, *Salmonella* infections have not declined over the past 15 years in USA [21]. Dairy products along with meat and eggs are the most common causes of food-borne infection by *Salmonella*. Salmonellosis from contaminated milk and dairy products has been associated with inadequate pasteurization and post-process contamination. Most cheeses, including raw or pasteurized milk cheeses, properly manufactured and aged, appear to pose no significant health risk of *Salmonella* infection [22].

There is extensive literature describing strains of lactic acid bacteria (LAB) from traditional dairy products able to inhibit the most important cheese pathogens (*L. monocytogenes*, *S. aureus*, *Klebsiella pneumoniae*, *Salmonella typhimurium*, *Bacillus subtilis*, and *Pseudomonas aeruginosa*) in media laboratory [19, 23]. Single strains of *L. garvieae* and *Lactococcus lactis* inhibited *S. aureus* early in a cheese matrix [24, 25].

Bertrand et al. [26] investigated the effect of raw milk cheese consumption on the enteric microbiota. The study by Fstanz [27] and Podolak et al. [14] is also of interest.

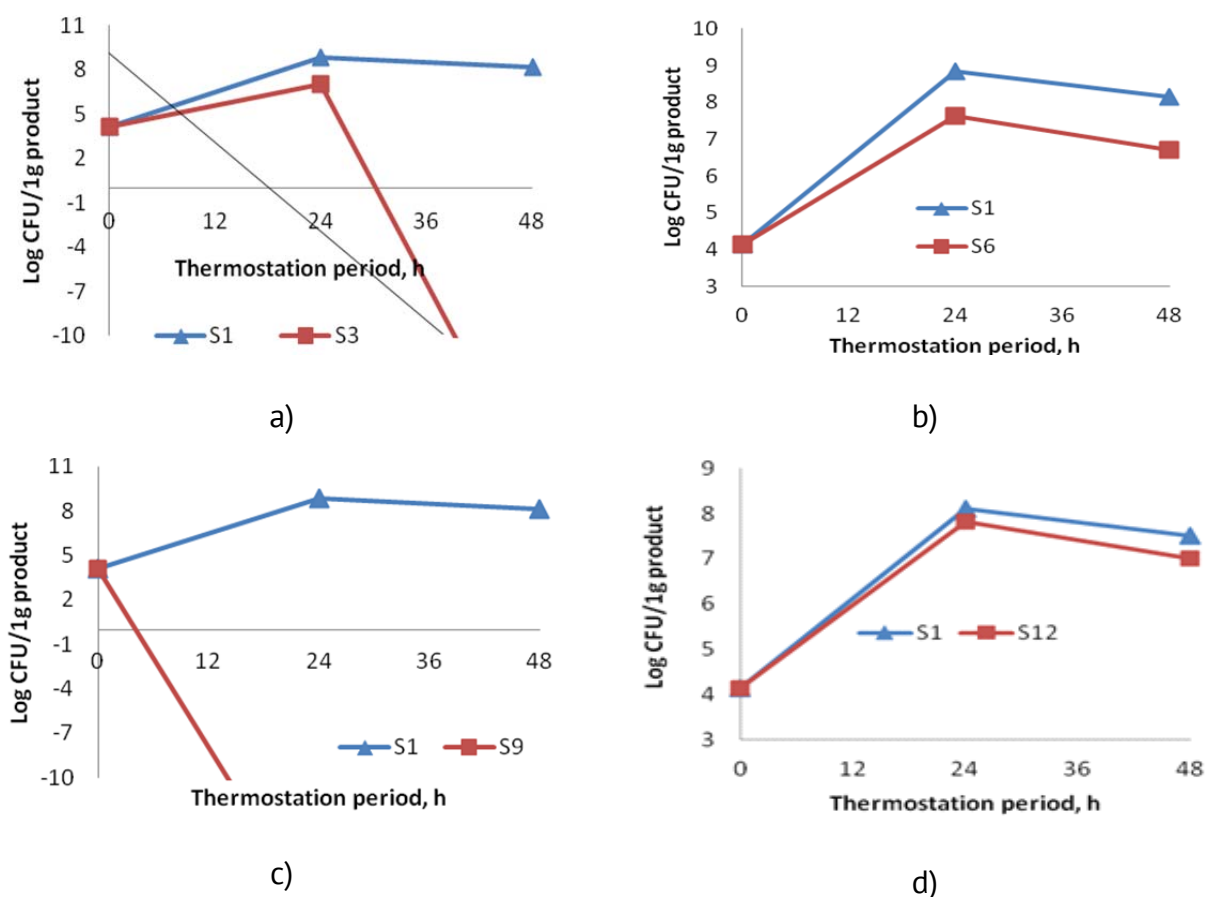


Figure 1. Comparison of the growth rate reduction of *Salmonella Abony* ATCC 6017 in the control sample and the samples with berry powders additions during 48 hours:
a) Cream cheese: sample control – (S1) and with rose-hip powder – (S3);
b) Cream cheese: sample control – (S1) and with sea buckthorn powder – (S6);
c) Cream cheese: sample control – (S1) and with aronia powder – (S9);
d) Cream cheese: sample control – (S1) and with hawthorn powder – (S12).

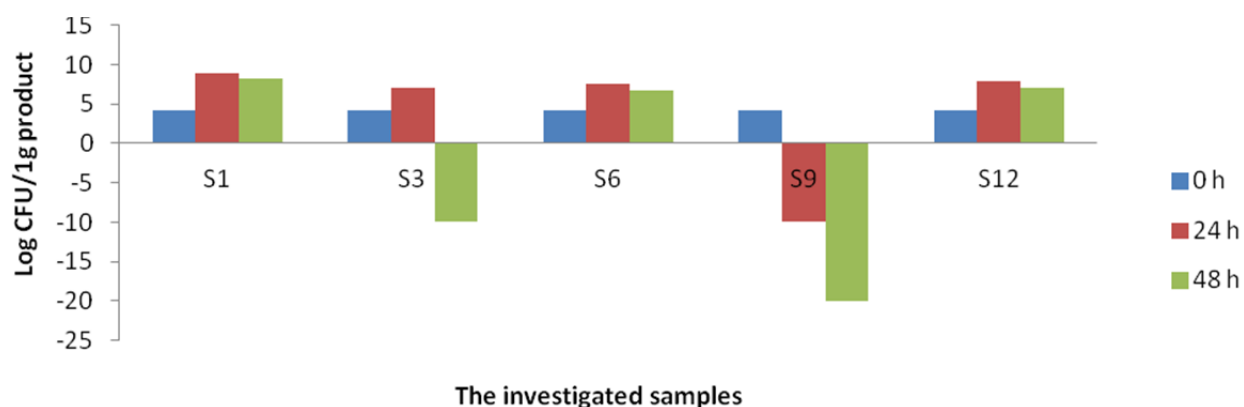


Figure 2. Modification of the content of *Salmonella Abony* ATCC 6017 inoculated in cream cheese samples at thermostat for 48 hours and temperature 37 °C.

The factors that determine the growth of *Salmonella spp.* are included in Table 2 [14, 28]. It is known that groups of grown microorganisms in food have the optimum, minimum and maximum pH. Table 2 lists the approximate pH ranges for growth in laboratory media

for selected organisms relevant to food. Generally, pH interacts with other parameters in food to inhibit growth. The pH can interact with factors such as a_w , salt, temperature, redox potential and preservatives to inhibit growth of pathogens and other organisms. The pH of food significantly impacts the lethality of heat treatment of the food. Less heat is needed to inactivate microbes as the pH is reduced [29, 30].

Table 2

Limits for growth of pathogenic microorganisms when other condition are near optimum*

Indicators	Minimum	Optimum	Maximum
<i>Salmonella ssp.</i>			
Temperature, °C (F)	5 (41)	35 - 37 (95 - 99)	45 - 47 (113 - 117)
pH	3.8	7-7.5	9.5
Water activity	0.93	0.99	>0.99
<i>Staphylococcus aureus growth</i>			
Temperature, °C (F)	7 (45)	35 - 40 (95 - 104)	48 (118)
pH	4.0	6.0-7.0	10.0
Water activity	0.83	0.98	0.99
<i>Staphylococcus aureus toxin</i>			
Temperature, °C (F)	10 (50)	40 - 45 (104 - 113)	46 (115)
pH	4.5	7.0- 8.0	9.6
Water activity	0.88	0.98	0.99
<i>Enteromorarrhagic E. coli</i>			
Temperature, °C (F)	10 (50)	40 - 45 (104 - 113)	46 (115)
pH	4.4	6.9-7.0	9.0
Water activity	0.95	0.99	

*Sources: ICMSF 1980, p 101. [<https://www.canr.msu.edu/uploads/234>]

A literature review showed that pathogenic microbes may be present in raw milk and in various types of dairy products, and these pathogenic microbes may also be present in the finished product, as they can enter industrial products during processing, packaging, distribution and storage [31, 32]. Some individuals are chronic carriers of *Salmonella* and if such an individual comes in contact with the anticaking agents (at the time of their manufacturing), especially dry blended products, the *Salmonella* can gain entrance into the anticaking agents and thus into the finished cheese. It is recommended to use low pH, high-heat spray dried anticaking agents, which are handled by workers to eliminate subdued pathogens [4]. The key factors to reduce the risk of *S. typhimurium* contamination are the implementation of appropriate hygiene measures to minimize the contamination of raw milk and proper storage of cheeses (e.g. water buffalo mozzarella cheese) at refrigeration temperature [33]. There are also alternative methods of controlling the microbiological risk in dairy products [34, 35].

Table 1 and Figures 3 and 4 include the results in evaluating the influence of berry powders (rose-hip, sea buckthorn, aronia and hawthorn) on *Staphylococcus aureus* ATCC 25923.

Staphylococcus aureus is a ubiquitous pathogen, thus, the sources of this bacteria for dairy products contamination are diverse [36]. This bacterium is commonly found in a wide

variety of mammals and birds and can be transferred to food mainly by dairy animals that have mastitis and by human carriers during food processing [37].

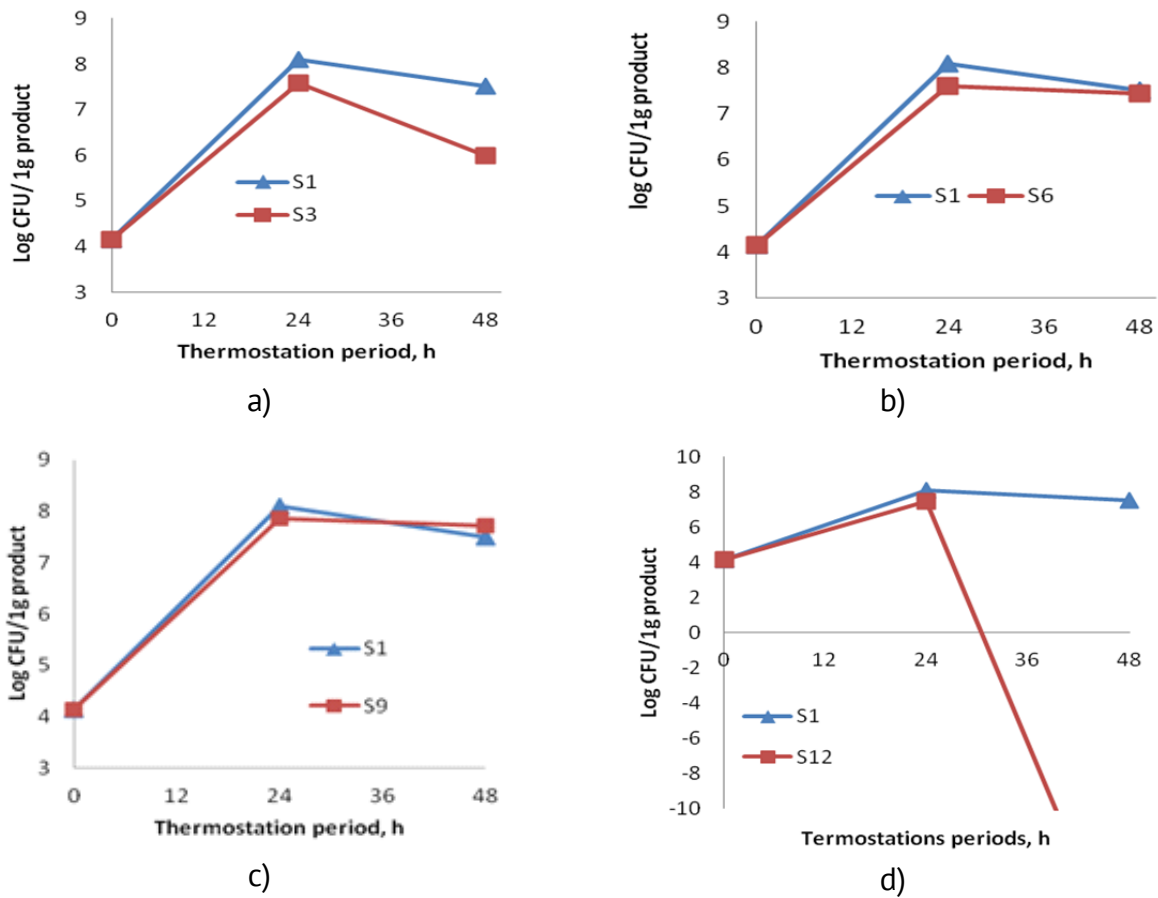


Figure 3. Comparison of the growth rate reduction of *Staphylococcus aureus* ATCC 25923 in the control sample and the samples with berry powders additions during 48 hours:
 a) Cream cheese: sample control – (S1) and with rose-hip powder – (S3);
 b) Cream cheese: sample control – (S1) and with sea buckthorn powder – (S6);
 c) Cream cheese: sample control – (S1) and with aronia powder – (S9);
 d) Cream cheese: sample control – (S1) and with hawthorn powder – (S12).

Contamination of *Staphylococcus aureus* can have a broad occurrence in raw dairy products, with frequencies between 5 and 100% in cheeses [38].

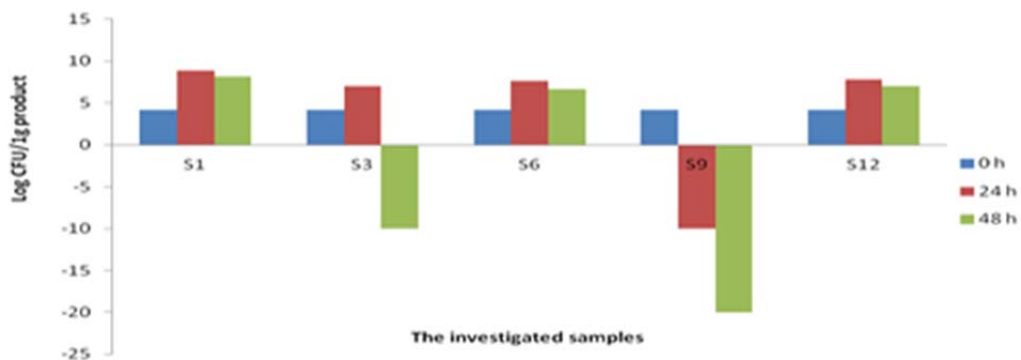


Figure 4. Modification of the content of *Staphylococcus aureus* ATCC 25923 inoculated in cream cheese samples at thermostat for 48 hours and temperature 37 °C.

The number of *Staphylococcus aureus* in raw milk or other dairy products needs to be less than 10^4 CFU g^{-1} , according to the United States Food and Drug Administration regulations [39]. Investigations indicated that *Escherichia coli* O157:H7 is an emerging cause of food borne illness and that young dairy cattle are a reservoir for it. A particularly dangerous type is referred to as enterohemorrhagic *E. coli* (EHEC).

Infection with EHEC strains is often associated with food borne outbreaks traced from milk, dairy products and other foods leading to hemorrhagic colitis (bloody diarrhea) and hemolytic uremic syndrome in humans [40]. Table 1 and Figures 5 and 6 include the results after evaluating the influence of berry powders (rose-hip, sea buckthorn, aronia and hawthorn) on *Escherichia coli* ATCC 25922.

On the other hand, the outbreaks of *Listeria monocytogenes* and *Staphylococcus aureus* (*S. aureus*) are enterotoxin producers. *Salmonella spp.* and *Escherichia coli* O157:H7 result from direct or indirect contamination of cheese. *S. aureus*, one of the pathogenic microorganisms that can be found in cheese, is a significant part of the poisonings from cheese [41].

The growth of *E. coli* can occur at temperatures between 7 – 46 °C, pH of 4.4 – 10.0 and a minimum water activity of 0.95 when other conditions are near optimum.

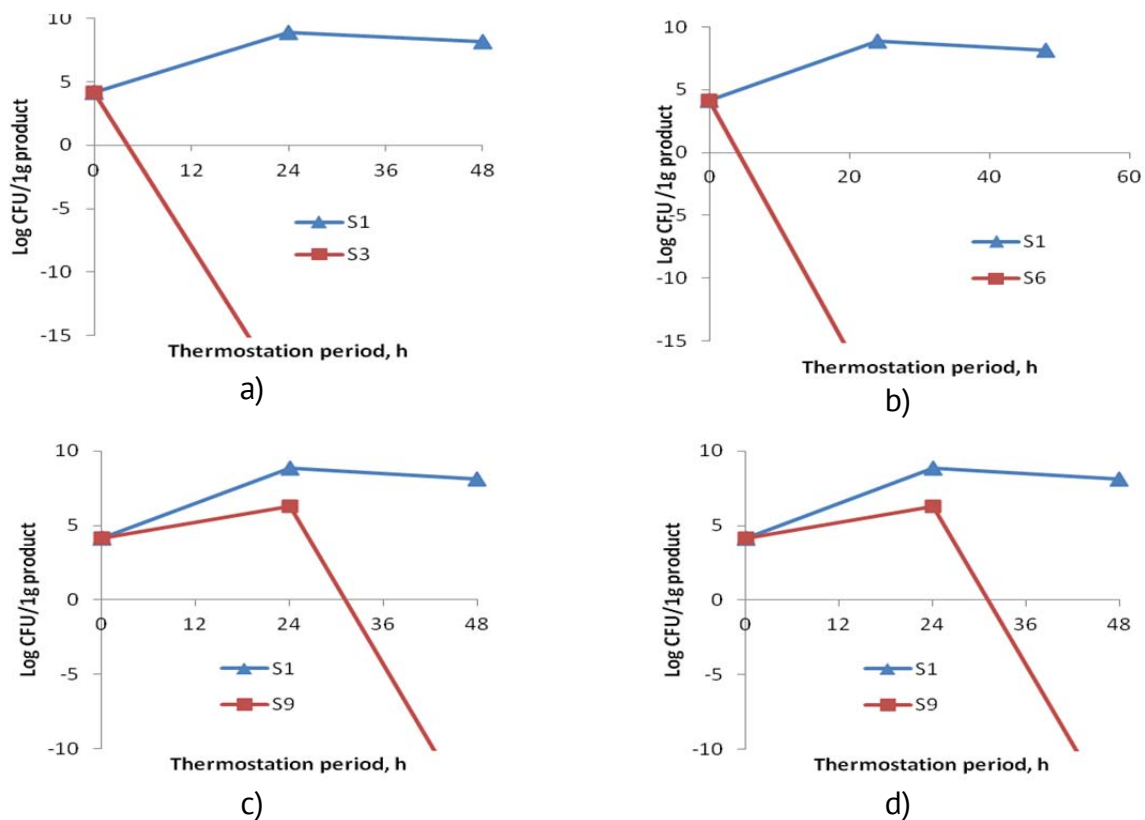


Figure 5. Comparison of the growth rate reduction of *Escherichia coli* ATCC 25922 in the control sample and the samples with berry powders additions during 48 hours:
a) Cream cheese: sample control – (S1) and with rose-hip powder – (S3);
b) Cream cheese: sample control – (S1) and with sea buckthorn powder – (S6);
c) Cream cheese: sample control – (S1) and with aronia powder – (S9);
d) Cream cheese: sample control – (S1) and with hawthorn powder – (S12).

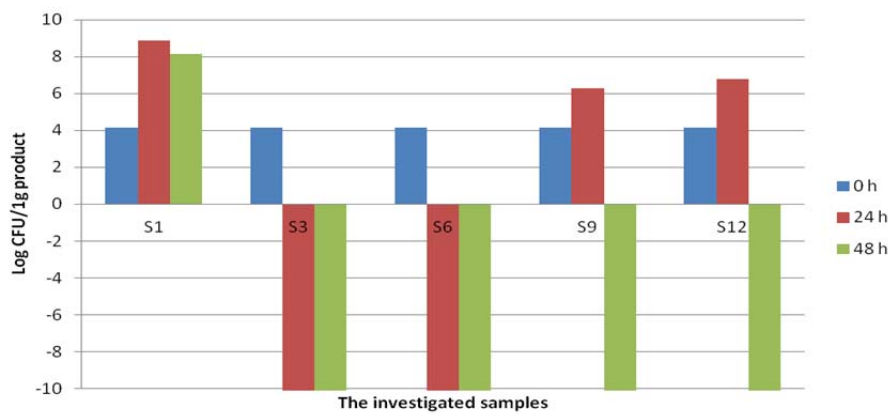


Figure 6. Modification of the content of *Escherichia coli* ATCC 25922 inoculated in cream cheese samples at thermostat for 48 hours and temperature 37 °C.

Some Shiga toxin-producing *Escherichia coli* (STEC) strains can survive at pH 2.5 – 3.0 for over 4 hours. STEC is capable to survive frozen storage at -20°C, however, it is readily inactivated by cooking [42, 43].

STEC can be a contaminant of milk sourced from infected herds. As raw milk cheese production does not include a process that reliably inactivates pathogens, the microbiological quality of raw milk is critical. Other risk factors include temperature control of the raw milk, acidification process, curd cooking, maturation/ripening, salt concentration, water activity, pH and nitrate [44, 45]. *Staphylococcus aureus*, *Salmonella spp.*, *Listeria monocytogenes* and *Escherichia coli* O157:H7 are the most frequent potential pathogens associated with milk or dairy products in industrialized countries [46-48].

The food industry is looking for alternatives to satisfy consumer demand for safe foods with a long shelf-life capable of maintaining the nutritional and organoleptic quality. The application of antimicrobial compounds-producing protective cultures may provide an additional parameter of processing in order to improve the safety and ensure food quality, keeping or enhancing its sensorial characteristics. In addition, strong evidence suggests that certain probiotic strains can confer resistance against infection with enteric pathogens [49]. Thus, it is proposed to use berry powders to control the microbiological risk that can occur in cream cheese at an unconditional deviation.

Conclusions

Various published studies have shown that several food borne pathogens are present in raw milk of different dairy species, and these pathogenic microbes can also be present in manufactured products, because they can enter the manufactured products opportunistically during processing, packaging, distribution and storage processes. The factors that determine the growth of pathogenic microorganisms in dairy products are: temperature, pH, water activity and presence of antimicrobial substances. The efficiency of a certain antimicrobial solution will also depend on the type, genus, species, and strain of the target microorganism. Likewise, it will also depend on environmental factors such as pH, water activity, temperature, atmosphere composition, initial microbial load, and acidity of the food substrate. The test results evaluated the antimicrobial effect of berry powders on pathogenic microorganisms (*Salmonella Abony* ATCC 6017; *Staphylococcus aureus* ATCC 25923 and *Escherichia coli* ATCC 25922). It was determined that the addition of berry

powders (rose-hip, aronia, sea buckthorn and hawthorn) can keep the growth rate of the microorganisms, including the pathogens, under control. Most microorganisms inoculated in tested cream cheese samples with the addition of berry powders were destroyed after 48 hours of thermostation at 37 °C. The calculated CFU log was minus infinity. The most relevant antimicrobial effect was seen for berry powders on *E. coli* strains inoculated in tested cream cheese samples. The additions of rose-hip and aronia powders manifested major antimicrobial effect on *Salmonella* strains. The addition of hawthorn powder manifested major antimicrobial effect on *Staphylococcus aureus*. Therefore, the use of added berry powders in the recipe for the production of dairy products can have two meanings: improving the nutritional value of the food and increasing the product shelf-life by keeping the microbiological risk under control. The results of this study highlighted the need to improve and implement hygienic practices. Moreover, further research is needed to fully study the antimicrobial properties of berry powders in dairy production.

Acknowledgments

This work was benefited from support through the 18.51.07.01A/PS State project "Decreasing contamination of raw materials and food product with pathogenic microorganism", funded by the Government of the Republic of Moldova.

References

1. Smigic, N., Djekic, I., Tomasevic, I., Miocinovic, J., Gvozdenovic, R. 2012. Implication of food safety measures on microbiological quality of raw and pasteurized milk. In: *Food Control*, 2012, 25, pp. 728-731.
2. Claeys, W.L., Cardoen, S., Daube, G., De Block, J., Dewettinck, K., Dierick, K. et al. Raw or heated cow milk consumption: Review of risks and benefits. In: *Food Control*, 2013, 31, 251e262.
3. Gazzar, F.E., Marth, E.H. Salmonellae, salmonellosis, and dairy foods: a review. In: *Journal Dairy Science*.1992, 75(9), pp. 2327-2343. Available at: <https://www.sciencedirect.com/science/article/pii/S0022030292779934>
4. Reddy, M. Prevention of Salmonella in Cheese and Other Dairy Products. In: *Market News*, 2017 <https://hartdesign.com/industry-news/prevention-salmonella-cheese-dairy-products/>
5. Alvarez-Ordóñez, A., Broussolle, V., Colin, P., Nguyen-The, C., PRIETO, M. The adaptive response of bacterial food-borne pathogens in the environment, host and food. Implication for food safety. In: *Journal Food Microbiology*, 2015, 213, pp. 99-109
6. Ghendov-Moșanu, A., Cojocari, D., Balan, G., Sturza, R. Antimicrobial activity of rose hip and hawthorn powders on pathogenic bacteria. In: *Journal of Engineering Science*, 2018, 25 (4), pp. 100-107
7. Ghendov-Moșanu, A., Sturza, R., Sandulachi, E., Patraș, A. Diminution de la contamination des produits de panification en bactéries sporulées *Bacillus subtilis*, *Bacillus mesentericus*. In: *Actes du deuxième Colloque Franco-Roumain de Chimie Appliquée COFrRoCA*, 2018, p. 97.
8. Cojocari, D., Sturza, R., Sandulachi, E., Macari A., Balan, G., Ghendov- Mosanu, A. Inhibiting of accidental pathogenic microbiota in meat products with berry powders. In: *Journal of Engineering Science*, 2019, 26 (1), pp.114-122.
9. *Preparation of McFarland Turbidity Standards, Medical microbiology guide*, <https://microbeonline.com/preparation-mcfarland-turbidity-standards/>
10. Sandulachi, L., Rubțov, S., Popescu L. Controlul microbiologic al produselor alimentare [Microbiological control of food products]. Ed. *UTM, Tehnica*, 2017, 128p. ISBN 978-9975-45-472-8.
11. Farrokh, C., Jordan, K., Auvray, F. et al. Review of Shiga-toxin-producing *Escherichia coli* (STEC) and their significance in dairy production. In: *International Journal of Food Microbiology*, 2013, 162 (2), pp. 190–212.
12. <http://orgprints.org/29120/1/29120.pdf>
13. Newman, K.L. Leon, J.S., Rebolledo, P.A., Scallan, E. The impact of socioeconomic status on foodborne illness in high-income countries. A systematic review. In: *Epidemiology and Infection*, 2015, 143, pp. 2473-2485.

14. Podolak, R., Enache, E., Stone, W., Black, D.G., Elliott, P.H. Sources and risk factors for contamination, survival, persistence, and heat resistance of *Salmonella* in low-moisture foods. In: *Journal of Food Protection*, 2010, 73 (10), pp. 1919–1936
15. Paulin, S., Horn, B., Hudson, J.A. Factors influencing staphylococcal enterotoxin production in dairy products. In: *Ministry for primary industries*, 2012.
16. Marler, B. Comparing the food safety record of pasteurized and raw milk products – Part 3, 2009, pp. 1–33. Available at: <http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Comparing+the+Food+Safety+Record+of+Pasteurized+and+Raw+Milk+Products#0>
17. Thermal Destruction of Microorganisms. Available at: <https://www.uoguelph.ca/foodscience/book-page/thermal-destruction-microorganisms>
18. Council directive 92/46/EEC of 16 June 1992 laying down the health rules for the production and placing on the market of raw milk, heat-treated milk and milk-based products.
19. Diop, M.B., Dibois-Dauphin, R., Tine, E., Jacqueline, A.N., Thonart, P. Bacteriocin producers from traditional food products. In: *Biotechnology, Agronomy, Society and Environment*, 2007 11, pp. 275–281.
20. The European Union summary report on trends and sources of zoonoses, zoonotic agents and food-borne outbreaks in 2010. In: *The EFSA Journal*, 2012, 10, p. 2597.
21. Gilliss, D., Cronquist, A., Cartter, M. et al. Vital signs: incidence and trends of infection with pathogens transmitted commonly through food—food borne diseases active surveillance network, 10 U.S. sites, 1996–2010. In: *Morbidity and Mortality Weekly Report*, 2011, 60 (22), pp. 749–755.
22. Argues, J.L., Rodríguez, E., Langa, S., Landete, J.M., Medina, M. Antimicrobial Activity of Lactic Acid Bacteria in Dairy Products and Gut: Effect on Pathogens. In: *BioMed Research International*, 2015. <http://dx.doi.org/10.1155/2015/584183>
23. Ortolani, M.B.T., Moraes, P.M., Perin, L.M., Vicoso, G.N., Carvalho, K.G., Silva JR., A., Nero, L.A. Molecular identification of naturally occurring bacteriocinogenic and bacteriocinogenic-like lactic acid bacteria in raw milk and soft cheese. In: *Journal. Dairy Science*, 2010, 93, pp. 2880–2886
24. Alomar, J., Loubiere, P., Delbes, C., Nouaille, S., Montel, M.C. Effect of *Lactococcus garvieae*, *Lactococcus lactis* and *Enterococcus faecalis* on the behaviour of *Staphylococcus aureus* in microfiltered milk. In: *Food Microbiology*, 2008, 25, pp. 502–508.
25. Cretenet, M., Nouaille, S., Thouin, J., Rault, L., Stenz, L., Francois, P., Hennekinne, J.-A. et al. *Staphylococcus aureus* virulence and metabolism are dramatically affected by *Lactococcus lactis* in cheese matrix. In: *Environmental Microbiology Reports*, 2011, 3, 340–351.
26. Bertrand, X., Dufour, V., Millon, L., Beuvier, E., Gbaguidi-Haore, H., Piarroux, R., Vuitton, D.A., Talon, D. 2007. Effect of cheese consumption on emergence of antimicrobial resistance in the intestinal microflora induced by a short course of amoxicillin– clavulanic acid. in: *Journal of Applied Microbiology*, 2007, 102, pp. 1052–1059.
27. Food Standards Australia New Zealand. *Microbiological risk assessment of raw cow milk*. Canberra, 2009. Available at: <http://www.foodstandards.gov.au/code/proposals/documents/P1007%20PPPS%20for%20raw%20milk%201AR%20SD1%20Cow%20milk%20Risk%20Assessment.pdf>.
28. International Commission on Microbiological Specification for Foods. *Microorganisms in foods*. Roberts T.A., Baird-Parker A.C., Tompkin R.B., editors. Volume 5, Characteristics of microbial pathogens. London: Blackie Academic & Professional, 1996, p 513.
29. Mossel, D.A.A., Corry, J.E.L., Struijk, C.B., Baird, R.M. *Essentials of the microbiology of foods: a textbook for advanced studies*. In: Chichester (England): John Wiley and Sons, 1995, 699 p.
30. https://www.canr.msu.edu/uploads/234/48511/Safe_Practices_fo
31. Park, Y.W. *Goat milk—chemistry and nutrition*. In: Park YW, Haenlein GFW (ed.), *Handbook of Milk of Non-bovine Mammals*. Blackwell Publishing Professional, Oxford, UK/Ames, Iowa, 2006, pp: 34–58.
32. Idf Recommendations for Hygienic Manufacture of Spray Dried Milk Powders. In : *IDF Bulletin*, 1996, 267. Int Dairy Fed Brussels, Belgium.
33. Serraino, A., Giacomo, G.F et al. Behaviour of *Salmonella Typhimurium* during production and storage of artisan water buffalo *Mozzarella* cheese. In: *Italian Journal of Animal Science*, 2012, 11 (3). <https://doi.org/10.4081/ijas.2012.e53>
34. Loss, C.R., Hotchkiss, J.H. *Inhibition of microbial growth by low-pressure and ambient pressure gasses*. In: Juneja VK, Sofos JN, editors. *Control of foodborne microorganisms*. New York: Marcel Dekker, 2002, pp. 245–79.

35. Morris, J.G. *The effect of redox potential*. In: Lund BL, Baird-Parker TC, Gould GW, editors. *The microbiological safety and quality of food*. Volume 1. Gaithersburg (MD): Aspen, 2000, pp. 235-50.
36. Rosengren, Å. et al. Occurrence of food borne pathogens and characterization of *Staphylococcus aureus* in cheese produced on farm-dairies. *Int. Journal Food Microbiology*, 2010, 144, pp. 263-269.
37. Hennekinne, J., De Buyser M., Dragacci S. *Staphylococcus aureus* and its food poisoning toxins: characterization and outbreak investigation. In: *FEMS Microbiology Reviews*, 2012, 36, pp. 815–836.
38. Verraes, C., Vlaemyck, G., Van Weyenberg, S., De Zutter, L. et al. A review of the microbiological hazards of dairy products made from raw milk. In: *International Dairy Journal* 2015, 50, pp. 32–44.
39. Yu, J., Zhang, Y., Zhang, Y., Li, H., Yang, H., Wei, H. Sensitive and rapid detection of *staphylococcus aureus* in milk via cell binding domain of lysine. In: *Biosensors and Bioelectronics*, 2016, 77, pp. 366–371
40. Nguyen, Y, Sperandio, V. Enterohemorrhagic *E. coli* (EHEC) pathogenesis. In: *Frontiers in Cellular and Infection Microbiology*, 2012, 2, p. 90.
41. Baran, A., Erdoğan, A., Turgut, T., Adigüzel, M. C. A review on the presence of *Staphylococcus aureus* in cheese. In: *Journal of Turkish Nature and Science*, 2017, 6 (2).
42. Food Standards Australia New Zealand. Agents of food borne illness, Canberra, 2013, 2nd ed, http://www.foodstandards.gov.au/publications/Documents/FSANZ_Foodbornellness_2013_WEB.pdf.
43. Meng J., Le Jeune J.T., Zhao T., Doyle M.P. *Enterohemorrhagic Escherichia coli*. Ch 12 In: Doyle MP, Beuchat LR (eds) *Food microbiology: Fundamentals and frontiers*. 4th ed, ASM Press, Washington D.C., 2013, p. 287–309
44. Food Standards Australia New Zealand. Microbiological risk assessment of raw milk cheese, Canberra, 2009. Available at: <http://www.foodstandards.gov.au/code/proposals/documents>
45. <http://www.foodstandards.gov.au/consumer/importedfoods/Documents/Raw%20milk%20cheese%20and%20STEC.pdf>
46. Ostin, A., de Buyser, M. L., Guillier, F. et al. First evidence of a food poisoning outbreak due to staphylococcal enterotoxin type E, France, 2009. In: *Eurosurveillance*, 2010, 15(13), pp.10–13.
47. CDC (Centers for Disease Control and Prevention) Multistate Outbreak of *E. coli* O157:H7 Infections Associated with Cheese, 2010, Available at: <https://www.cdc.gov/ecoli/2010/bravo-farms-cheese-11-24-10.html>
48. Jakobsen, R.A., Heggebø, R., Sunde, E.B., Skjervheim, M. *Staphylococcus aureus* and *Listeria monocytogenes* in Norwegian raw milk cheese production. In: *Food Microbiology*, 2011, 28, pp. 492-496.
49. Arqués, J.L., Rodríguez, E., Langa, S., Landete, J.M., Medina, M. Antimicrobial activity of lactic acid bacteria in dairy products and gut: effect on pathogens. In: *BioMed Research International*, 2015, 1-9. <http://dx.doi.org/10.1155/2015/584183>