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PREVALENCE AND PERSISTENCE OF *LISTERIA* SPP. AND *LISTERIA MONOCYTOGENES* IN PROCESSED MILK FROM SMALL RETAILERS IN TIRANA, ALBANIA

Enkeleda Berberi[1*], Ilir Lloha[1], Ildja Rudho[2], Suada Lalaj[1], Ervin Shishmani[1], Anxhela Kiri[2]

[1]Department of Food Science and Biotechnology, Faculty of Biotechnology and Food, Agricultural University of Tirana, Paisi Vodica nn, Kodër-Kamëz, 1025 Tirana, Albania
[2]Laboratory of Food Microbiology/AQSCERT, Jusuf Vrioni nn, 1001 Tirana, Albania

[*]e-mail: eberberi@ubt.edu.al

Abstract

Although milk is a primary source of high-quality protein and accessible nutrients, it also represents the ideal habitat for the growth of a range of pathogenic microorganisms such as *Listeria monocytogenes* that cause listeriosis in human populations. Globally, the demand for dairy products has grown significantly in recent decades and Albania shares the same patterns in terms of consuming milk and dairy products. The increase in production in this sector goes hand in hand with the raising of awareness to ensure the quality and safety of milk to fulfill the demand of local and wider consumers. Based on the aforementioned, the main aim of this study is to evaluate the occurrence and persistence of *Listeria* spp. and *Listeria monocytogenes* in different processed milk samples marketed in small retailers in Tirana city.

A total of 252 milk samples were collected from small retailers in six different areas in Tirana. All the samples are divided into three major categories based on their technological process: Pasteurized Milk (PM) samples (n = 90), Ultra High Temperature (UHT) milk samples (n = 126), and Sterilized Milk (SM) samples (n = 36). Furthermore, all the samples belonged to different dairy companies from Albania, dairy companies from the Western Balkans, and dairy companies from the European Union. Growth, isolation, and confirmation of *Listeria* spp. and *Listeria monocytogenes* were performed following ISO 11290-1:2017 protocol. All the data were analyzed with the statistical program SPSS 29.00.

Our data show that the prevalence and persistence of *L. monocytogenes* and *Listeria* spp. depend on the technological process that the milk samples were subjected to. *Listeria monocytogenes* was detected in 12.2% (n = 11) of the total PM samples analyzed and in 0.79% (n = 1) of the total UHT milk samples analyzed. None of the SM samples resulted positive for the presence of *Listeria monocytogenes*. The paired t-test shows a statistically significant difference in means between the type of processed milk and milk samples that resulted positive for the presence of *Listeria monocytogenes* $t(13) = 4.809$, $p < .001$.

The data presented in this research have underlined gaps that need to be filled regarding pathogen control throughout the whole chain of milk production, and marketing environments up to consumers. Future research should consider the examination of milk processing environments in Albania for better traceability of Listeria monocytogenes in milk.

***Key words**: Listeria monocytogenes, Listeria spp., Processed milk, ISO 11290-1:2017 protocol, SPSS 29.00.*

1. Introduction

Even though milk and dairy products are major sources of high-quality protein and bioavailable nutrients, milk also represents a perfect environment for the growth of a wide variety of spoilage-inducing and pathogenic microorganisms, due to its highly nutritious nature (Owusu-Kwarteng *et al*., [22]). These pathogenic microorganisms can be introduced into the dairy chain during any step, from milking to consumers (Ribeiro *et al*., [24]) which further complicates the process of traceability. As a result, milk

and dairy products usually are associated with cases of foodborne disease, such as listeriosis. Foodborne disease represents a major concern globally (Lee and Yoon [13], Pires *et al*., [23], Savelli *et al*., [26], and Lake *et al*., [10]), and locally (Molla *et al*., [18], Daja *et al*., [3], and WHO [30]). In the European Union, higher fatality rates between 15 - 17.8% have been reported due to *Listeria monocytogenes* (Lee and Yoon [13]). As the cause of listeriosis in humans, *Listeria monocytogenes* is a Gram-positive, intracellular, non-spore-forming, motile, rod-shaped, facultative anaerobic bacteria that can infect susceptible groups like newborns, the elderly, and people with impaired immune systems (Mary and Shrinithivihahshini [17], and Schlech [27]). Although the prevalence of cases reported with listeriosis is low (Lee and Yoon [13]), *Listeria monocytogenes* represent a serious threat to the food industry due to its ability to survive the most common food processing conditions such as extreme pH, high salt concentration, and low water activity (Ribeiro *et al*., [24], Law *et al*., [11], and Leong *et al*., [15]). Furthermore, *Listeria monocytogenes* can survive in refrigeration temperatures because it contains a specific temperature-dependent response (stress response mechanisms) that is important for growth and survival during exposure to stressful outside environments (Chakraborty *et al*., [2]). Another strategy used by *Listeria monocytogenes* to survive adverse conditions is related to the capability of biofilm formation. Therefore, the persistence of *Listeria monocytogenes* in processed food, such as UHT milk or pasteurized milk, mostly is related to its ability to form biofilm (Law *et al*., [11]).

Globally, the demand for milk and dairy products has grown significantly in recent decades, due to the growing world population and because of the increasing demand of consumers for diets rich in protein and nutrients (Grout *et al*., [6], and Salter [25]). Albania shares similar patterns in terms of consuming milk and dairy products, showing significant growth in the last decades (MBZHR [21]). The increase in production in this sector goes hand in hand with the raising of awareness to ensure the quality and safety of milk and milk products. On the other hand, Albania represents a unique country in Europe because the agricultural sector relies on extensive small-scale domestic production (Bombaj *et al*., [1]). According to a recent publication (Bombaj *et al*., [1]), more than 90% (n = 352,315) of the farms in Albania are below 2 hectares and characterized as centered family farming which somehow represents a challenge to trace a product. We strongly believe that a weak traceability system due to the fragmented structure of the milk sector is one of the main factors that the opportunity to export milk and dairy products remains limited now.

According to Albanian Food Law (MBZHR [19]) and the Guideline "On microbiological criteria for food products" of the Ministry of Agriculture and Rural Development of Albania (MBZHR [20]) it was established a regulatory limit of 100 cfu/g for *Listeria monocytogenes* on ready to eat food that can support the growth and absence for the foods intended for infants or foods that should be used in consumers with specific medical condition. Despite a few sporadic scientific publications, reports, and statistics from EFSA in 2019 [5], there is no objective picture of the occurrence and persistence of *Listeria monocytogenes* in either raw milk or processed milk in Albania. Data gaps, as the major hurdle in estimating the foodborne disease burden in Albania, are also underlined in the report from WHO in 2015 ([31]). Therefore, the present study aims to determine the occurrence and the persistence of *Listeria* spp. and *Listeria monocytogenes* in different processed milk samples from small retailers in Tirana city.

2. Materials and Methods

2.1 Sampling procedure

Commercially processed milk was purchased from different small-scale retailers and supermarkets in the city of Tirana as displayed in Figure 1. All samples were collected between January 2023 and May 2023 and belong to different dairy companies categorized into three groups: dairy companies from Albania, dairy companies from the Western Balkans, and dairy companies from the European Union. Six different representative locations in the city of Tirana were selected for the purchase of the processed milk samples as displayed in Figure 1.

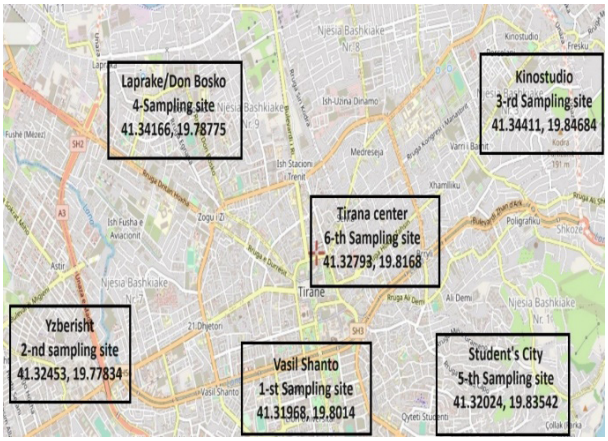

Figure 1. Sampling sites in Tirana from January to May 2023

Based on the technological process that milk has undergone all the samples are divided into three major groups: Pasteurized Milk (PM), Ultra High-Temperature Milk (UHT), and Sterilized Milk (SM). A database for

each sample was created, which contains information about the date of sample collection, site and location, the expiration date of the products, the date of analysis in the laboratory, and others. Furthermore, all the samples were codified. The code used is composed of three parts: type of technological process of milk (expressed in letters e.g., PM, UHT, and SM), dairy company (expressed in capital letters e.g., E, L, M, etc.), and site/location of sampling (express in numbers e.g., 1, 2, 3, 4, 5, and 6). Samples transportation was realized in portable refrigerators on ice and were stored in the laboratory of Food Microbiology /AQSCERT at the appropriate temperature according to the recommendations underlined in the labeling of each milk sample. All samples were analyzed on average 3 days after their collection.

2.2 Growth and isolation *Listeria* spp. and *Listeria monocytogenes*

Growth and isolation of *Listeria spp*. and *Listeria monocytogenes* were based on ISO 11290-1 protocol [7]. Two types of selective enrichment mediums were used. The initial suspension of the samples was carried out in EcoBio® Listeria enrichment half-Fraser broth (25 mL sample in 225 mL primary enrichment medium). After the incubation at 30 ^{0}C for 25 h, 0.1 mL of the culture obtained was transferred to 10 mL of secondary enrichment medium (EcoBio® Listeria enrichment Fraser broth) and incubated at 37 ^{0}C for 24 h. Culture obtained after the incubation from both types of enrichments was used to inoculate two common *Listeria monocytogenes* selective, differential, and chromogenic medium: ChromoBio® Listeria agar according to Ottaviani and Agosti (ALOA agar), and EcoBio® *Listeria* selective Agar Base, Palcam (PALCAL agar). Both selective mediums were incubated for 24 ± 2 hours at 37 ^{0}C. When necessary, serial dilutions were performed using EcoBio® *Listeria* enrichment half-Fraser broth based on ISO 11 290-1:2017 [7] for the enumeration of colonies.

2.3 Confirmation of *Listeria* spp. and *Listeria monocytogenes*

Conventional methods for the identification of *Listeria* spp. and *Listeria monocytogenes* were performed. Bacterial colonies growth in ALOA agar and PALCAM agar after 24 hours of incubation at appropriate temperature were used to inoculate an EcoBio® Tryptone Soya Yeast Extract agar, (TSYEA) a non-selective agar, according to ISO 12290-1:2017 protocol [7]. Confirmation tests include microscopic aspect, catalase reaction, mobility test, and Voges-Proskauer reaction (VP) test for the case of *Listeria* spp. Beta-haemolyses test and carbohydrates utilization test (L-Rhamnose and D-Xylose) were further used for the confirmation of *Listeria monocytogenes*.

2.4 Positive control sample

Listeria monocytogenes isolated from the FAPAS® Proficiency Test in Food Microbiology on January 2023 was used as a positive control sample.

2.5 Data analysis

All the data were analyzed with the statistical program SPSS 29.00. Descriptive statistics were used to summarize the data. Furthermore, Pearson correlation (two-tailed), paired t-test, and relationship map were performed to examine the association between different variables. In the independent variables, we have included the type of technological process that milk has undergone. The dependent variables are the occurrence and persistence of *Listeria* spp. and *Listeria monocytogenes* in milk samples.

3. Results and Discussion

3.1 Demographic characteristics

Processed milk samples from local dairy companies (n = 7), that we have taken under consideration, were categorized as follows: PM samples (n = 5), UHT milk samples (n = 1), and sterilized milk samples (n = 1). Processed milk samples of dairy companies from the European Union countries (n = 5) were categorized as follows: UHT milk samples (n = 4), and sterilized milk samples (n = 1). The third group of processed milk samples belongs to dairy companies from the Western Balkans countries (n = 2). Both samples belong to the category of UHT milk. Each sample, purchased from six different regions in Tirana, was taken in triplicate from small-scale retailers, which resulted in a total of 252 milk samples that were analyzed for the presence of *Listeria* spp. and *Listeria monocytogenes*.

The data displayed in Table 1 shows that out of 252 milk samples, 37.5% (n = 90) belong to the PM samples categories, 50% (n = 126) belong to the UHT milk samples categories, and 14.28% (n = 36) were SM samples. Furthermore, Table 1 displays all the data related to milk samples that resulted positive for the presence of *Listeria* spp. and *Listeria monocytogenes* and milk samples that resulted negative for the presence of both *Listeria* spp. and *Listeria monocytogenes*. The data are expressed in N and frequency (%). Mean and Standard Deviation (SD) were also calculated with the SPSS 29.00 program as displayed in Table 1.

3.2 Confirmation of *Listeria monocytogenes*

Based on ISO 12 290-1:2017 protocol, the beta-haemolyses test as displayed in Figure 2, and the carbohydrates utilization test as displayed in Figure 3 were used as confirmation tests for *Listeria monocytogenes*.

Table 1. The prevalence of *Listeria* spp. and *Listeria monocytogenes* in milk samples was categorized by the type of technological process

Milk samples	*Sample's Code	N; %	Positive samples with *Listeria* spp. (n)	Freq. (%)	Positive samples with *Listeria monocytogenes* (n)	Freq. (%)	Negative samples (n)	Freq. (%)
PM	PM-F (1 - 6)	18	10	11.1	0	0	8	8.9
	PM-E (1 - 6)	18	14	15.6	4	4.4	0	0
	PM-L (1 - 6)	18	11	12.2	3	3.3	4	4.4
	PM-M (1 - 6)	18	12	13.3	2	2.2	4	4.4
	PM-N (1 - 6)	18	9	10	2	2.2	7	7.8
Total		**90 37.5%**	**56**	**62.2**	**11**	**12.2**	**23**	**25.5**
Mean ± SD			**11.20 ± 1.924**		**2.20 ± 1.483**		**4.60 ± 3.130**	
UHT	UHT-S (1 - 6)	18	6	4.8	0	0	12	9.5
	UHT-Z (1 - 6)	18	3	2.4	1	0.79	14	11.1
	UHT-De (1 - 6)	18	6	4.8	0	0	12	9.5
	UHT-Fe (1 - 6)	18	3	2.4	0	0	15	11.9
	UHT-A (1 - 6)	18	2	1.6	0	0	16	12.7
	UHT-La (1 - 6)	18	10	7.9	0	0	8	6.3
	UHT-Am (1 - 6)	18	5	3.9	0	0	13	10.3
Total		**126 50%**	**35**	**27.8**	**1**	**0.79**	**90**	**71.4**
Mean ± SD			**5.00 ± 2.708**		**.14 ± 0.378**		**12.86 ± 2.610**	
SM	SM-Gj (1 - 6)	18	0	0	0	0	18	50.0
	SM-D (1 - 6)	18	1	2.8	0	0	17	47.2
Total		**36 14.3%**	**1**	**2.8**	**0**	**0**	**35**	**97.2**
Mean ± SD			**.50 ± .707**		**0.00 ± 0.00**		**17.50 ± .707**	
Total		**252**	**92**	**36.5**	**12**	**4.8**	**148**	**58.7**

Legend: *The sample's codification procedure is explained in section 2. Materials and Methods.

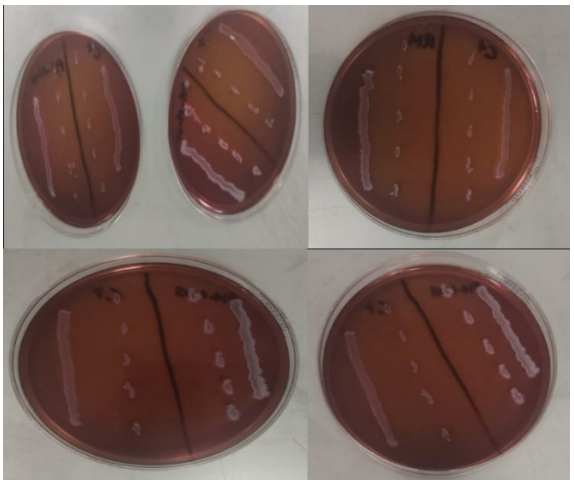

Figure 2. Beta-haemolyses test results

For the beta-hemolysis in blood agar both the control positive (C+ as displayed in Figure 2) and the milk samples (PM-M-5 and PM-L-3) show narrow, clear light zones of hemolysis which is a typical reaction for *Listeria monocytogenes*. Bacterial colonies from PM samples and UHT milk samples confirmed as *Listeria monocytogenes* resulted positive for the utilization of *L-Rhamnose* as displayed in Figure 3 and negative for the utilization of D-Xylose.

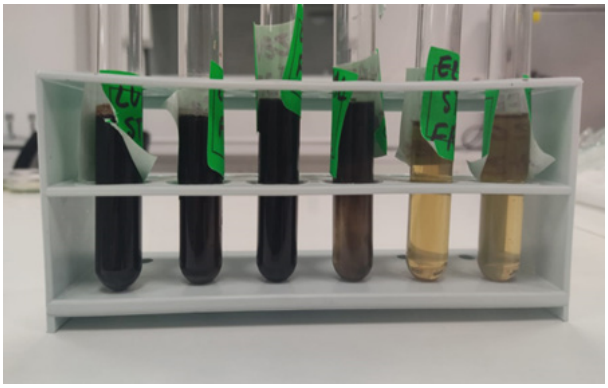

Figure 3. Carbohydrates utilization test, L-Rhamnose

3.3 Prevalence of *Listeria* spp. and *Listeria monocytogenes* in milk samples

The data as displayed in Table 1 show that 62.2% (n = 56) of the total PM samples (n = 90) that we have analyzed resulted positive for the presence of *Listeria* spp. and 12.2% (n = 11) resulted positive for the presence of *Listeria monocytogenes*. The total samples that resulted were negative for both *L. monocytogenes* and *Listeria* spp. for the case of PM is 25.5% (n = 23). It was a challenge for us to compare our data because we encountered a dearth of data and publications regarding the isolation and identification of *L. monocytogenes* in processed milk in Albania. There are some publications in the frame of the microbiological assessment of raw milk and dairy products, however, it is insufficient to estimate the prevalence of *L. monocytogenes* in milk and dairy products in Albania. Quite a recent publication from Leno *et al*., [14], estimated the incidence of *Listeria monocytogenes* in pasteurized milk in two districts of Albania during three years (2006 - 2008). Different results were published by Leno *et al*., [14], where all the PM samples that they analyzed resulted in negative for the presence of *L. monocytogenes*. This discrepancy between our findings and those provided by Leno *et al*., [14], may have been caused by several factors. These factors act before the treatment, during the treatment of the milk (processing factors), and after the treatment which in general is related to the capability of *Listeria monocytogenes* to recover after sublethal inactivation (Lee *et al*., [14]). During sampling, we have observed that PM is packaged in plastic bottles and stored at refrigerator temperature, usually at 4 ^{0}C, in the small retailers. PM samples that we have analyzed were within the expiration date and therefore based on the Guideline on "Microbiological criteria for food products" foods when placed in the market must be declared as free for the precence of *L. monocyogenes*. Anyway, different publications indicate that pasteurization only causes *Listeria monocytogenes* to become dormant and thus the storage of pasteurized milk at refrigerator temperature can be a potential for the growth of *L. monocytogenes* (Syahriana Sabil *et al*., [28]). Meaning, pasteurization as a technological process performed by dairy companies at a temperature that varies from 90 ^{0}C and 95 ^{0}C shows no *L. monocytogenes* after 1 day of storage, but after 1 and 2 weeks of storage there was a suspected level of *L. monocytogenes*. Data presented by Syahriana Sabil *et al*., [28], shows that the longer the milk is stored, the more *Listeria* spp. was found. Furthermore, according to Syahriana Sabil *et al*., [28], milk should be stored in a refrigerator for no more than 7 days due to the nature of *L. monocytogenes* that can grow at low temperatures. Although PM is expected to eliminate pathogenic bacteria without changing the taste and nutritional values (Syahriana Sabil *et al*., [28]), other studies suggest that *L. monocytogenes* contamination can persist even after pasteurization due to inappropriate temperatures or contamination during subsequent production steps (Ribeiro *et al*., [24]). Moreover, there are studies (Takeuchi-Storm *et al*., [29], Di Ciccio *et al*., [4], and Leong *et al*., [15]) that back the data of *Listeria monocytogenes* persistence in the equipment of the production environment due to its ability to biofilm formation and the ability to reproduce at very low storage temperatures, at 4^{o}C, which in any case will raise the probability of milk contamination (Kasalica *et al*., [8]). In our case, it is difficult to determine whether the contamination occurred during or after the production of PM because we have not analyzed samples from facilities and equipment from dairy companies that we took under consideration for our research.

Regarding the other two types of processed milk samples, namely UHT and SM, the data are very encouraging. Out of n = 126 UHT milk samples analyzed only 0.79% (n = 1) resulted positive for the presence of *Listeria monocytogenes* in UHT milk samples. None of the sterilized milk samples (n = 36) resulted positive for the presence of *Listeria monocytogenes*. Furthermore, 27.8% (n = 35) of UHT milk samples resulted positive for the presence of *Listeria* spp. compared to 2.8% (n = 1) of SM samples that resulted positive for *Listeria* spp. Moreover, 71.4% (n = 90) of the total UHT samples and 97.2% (n = 35) of the total PM samples resulted in negative for both *Listeria* spp. and *Listeria monocytogenes*. Our data indicate that the application of high pressure and high temperature involved in the production of UHT milk and SM are more effective in the inactivation of bacterial colonies of *Listeria monocytogenes*. Several studies, where technological approaches for the inactivation of *Listeria monocytogenes* in milk fluid are underlined, emphasize the role of high-pressure processing (HPP) among others in reducing and eliminating these hazards (Lee *et al*., [12], and Liepa *et al*., [16]). Furthermore, a recent publication (Komora *et al*., [9]) suggested similar approaches toward the application of high pressure alone or combined with different technological processes on the inactivation of *L. monocytogenes*.

3.4 Persistence of *Listeria monocytogenes* in processed milk

Our data shows that *Listeria monocytogenes* has mostly persisted in pasteurized milk samples belonging to two local dairy companies codified as PM-E-(1 - 6) and PM-L-(1 - 6) compared to other PM samples, UHT milk samples, and SM samples. From 6 areas in Tirana where processed milk was purchased, *Listeria monocytogenes* was detected in 4 of them, respectively: In PM-E samples *Listeria monocytogenes* was confirmed in PM-E-1 (n = 1), PM-E-2 (n = 2), and PM-E-3 (n = 1), accounting for 4.4%

of cases where *Listeria monocytogenes* was determined as positive for its presence in PM samples. For the case of PM-L *Listeria monocytogenes* was confirmed in 3.3% (n = 3) of cases respectively in PM-L-1, PM-L-2, and PM-L-3 as displayed in Table 1 and Figure 4.

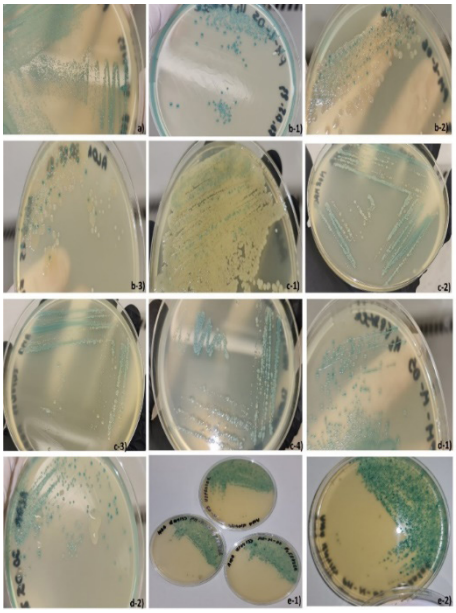

Figure 4. Isolation of *Listeria monocytogenes* in ALOA agar from PM samples.
a) control positive of *L. monocytogenes* from FAPAS® Proficiency Test in Food Microbiology,
b-1) *L. monocytogenes* isolated from milk samples PM-L-2, b-2) *L. monocytogenes* isolated from milk samples PM-L-3, also was confirmed the presence of *Bacillus licheniformis*, b-3) *L. monocytogenes* isolated from milk samples PM-L-01, also was confirmed the presence of *Bacillus licheniformis*,
c-1) *L. monocytogenes* isolated from milk samples PM-E-2, also was confirmed the presence of *Bacillus licheniformis*, c-2) *L. monocytogenes* isolated from milk samples PM-E-5, c-3) *L. monocytogenes* isolated from milk samples PM-E-3, c-4) *L. monocytogenes* isolated from milk samples PM-E-1,
d-1) *L. monocytogenes* isolated from milk samples PM-M-2, d-2) *L. monocytogenes* isolated from milk samples PM-M-5, e-1) *L. monocytogenes* isolated from milk samples PM-N-1, e-2) *L. monocytogenes* isolated from milk samples PM-N-2

Referring to the Guideline "On microbiological criteria for food products" of the Ministry of Agriculture and Rural Development of Albania (MBZHR [20]) we have categorized the results achieved for the persistence of *Listeria monocytogenes* as unsatisfactory and satisfactory as displayed in Figure 5.

We found a statistically significant Pearson (2-tailed) correlation at the 0.01 level (R^2 = 0.869, p < 0.001) between the days that milk is storage in supermarkets and the detection of *Listeria monocytogenes* expressed as log (cfu/mL) as displayed in Figure 6.

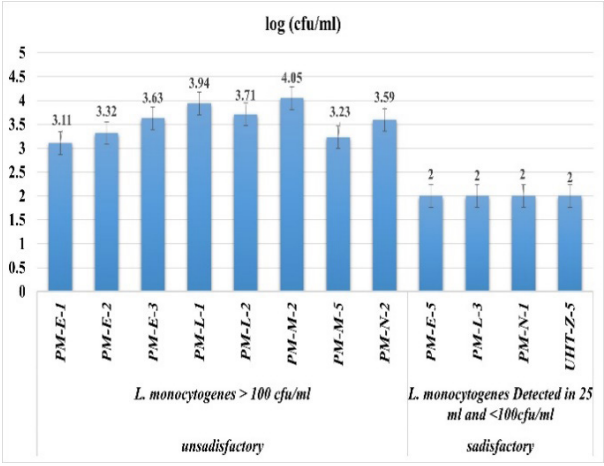

Figure 5. Log (cfu/mL) of *Listeria monocytogenes* in different milk samples

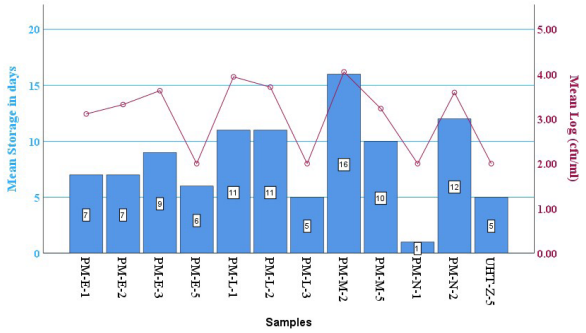

Figure 6. Mean storage in days of milk and the mean of Log (cfu/mL) of *Listeria monocytogenes* in different milk samples

Listeria spp. has mainly persisted in PM samples respectively: In PM-E samples *Listeria* spp. was detected in 77.8% (n = 14) out of a total of 18 samples purchased in 6 areas in Tirana city and PM-M samples were detected in 66.6 % (n = 12) out of a total of 18 samples. Regarding the UHT milk samples *Listeria* spp. has mainly persisted in UHT-La milk samples accounting for 55.6% (n = 10) of the total samples analyzed (n = 18).

3.5 Statistical analyses

To determine whether our results from the microbiological analysis were statistically significant, paired t-test (two-tailed), Pearson correlation (2-tailed), and relationship map were conducted using the statistical program SPSS 29.00.

A paired t-test was conducted to analyze two pairs of variables as displayed in Table 2. Pair 1: Type of processed milk and milk samples that resulted positive for the presence of *Listeria* spp. We found no significant difference in means in the first pair of variables, t(13) = .426, p = 0.677 (two-tailed significance). Based on our microbiological data, *Listeria* spp. was detected

in all types of processed milk with a predominance in PM samples. Pair 2: Type of processed milk and milk samples that resulted positive for the presence of *Listeria monocytogenes*. The difference in means is statistically significant, t(13) = 4.809, p < 0.001 (two-tailed significance). Based on our microbiological data, *Listeria monocytogenes* was detected mainly in PM samples. Pair 3: Type of processed milk and milk samples that resulted negative for the presence of both *Listeria* spp. and *Listeria monocytogenes*. There is a statistically significant difference in means, t(13) = -3.466, p = 0.004 (two-tailed significance). Based on our microbiological data negative samples for both *Listeria* spp. and *Listeria monocytogenes* were mainly determined in UHT milk samples and SM samples compared to PM samples.

A Pearson (2-tailed) correlation was performed between types of processed milk and the dependent variables mentioned above (samples positive for *Listeria* spp., samples positive for *Listeria monocytogenes*, and samples that resulted negative for both *Listeria* spp. and *Listeria monocytogenes*). We found a statistically significant Person (2-tailed) correlation at the 0.01 level and the 0.05 level (α = 0.99 and α = 0.95%) as displayed in Table 3.

Moreover, in the frame of variables analyses a relationship map was performed with SPSS 29.00. We analyzed the relationship between the different types of processed milk and the detection of *L. monocytogenes* in milk samples as displayed in Figure 7. The data show that there is a strong relationship (relationship count equal to 1) between PM samples (PM-L, PM-M, PM-E, and PM-N) and the detection of *L. monocytogenes*, *Listeria* spp., and negative samples. A strong relationship count equal to 2 was underlined between UHT and SM samples and samples that resulted negative for the presence of *Listeria monocytogenes* and negative for both *L. monocytogenis* and *Listeria* spp.

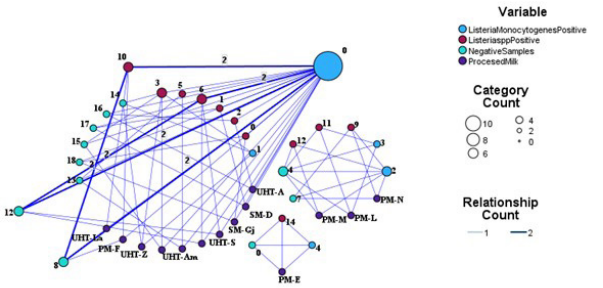

Figure 7. Relationship map between variables performed with SPSS 29.00

4. Conclusions

- The data presented in the manuscript have underlined gaps that need to be filled regarding pathogen control throughout the whole chain of milk production, and marketing environments up to consumers. So, we strongly believe that additional measures are required. The establishment of more rigorous policies for monitoring and controlling *Listeria monocytogenes* in processing environments from responsible bodies is important. Moreover, an increase in the frequency of inspections of dairy products in marketing environments is also crucial.
- It is important to note that there may be limitations in the preliminary data presented in this research. Firstly, we have analyzed only milk samples collected from small-scale retailers in Tirana and we have not analyzed any samples from the facilities and equipment of the diary companies in question for the presence of *Listeria monocytogenes*. Thus, it is difficult to conclude where the weak point was throughout the whole chain of production, transportation, storage, and retail. Secondly, further molecular analyses are necessary for the strain determination of *Listeria monocytogenes* isolated in milk samples.
- Based on the aforementioned, we are confident that these data will contribute to creating a more complete picture regarding the safety and quality of milk products in Albania.

Table 2. Paired t-test performed with the statistical program SPSS 29.00

Parameters		Mean	Std. Dev.	t	df	Two-sided p Sig.
Pair 1	Processed Milk - *Listeria* spp. positive	.929	8.157	.426	13	.677
Pair 2	Processed Milk - *L. monocytogenes* positive	6.643	5.168	4.809	13	**<.001**
Pair 3	Processed milk - Negative samples	-3.071	3.316	-3.466	13	**.004**

Table 3. Pearson correlation (2-tailed) performed with the statistical program SPSS 29.00

Parameters		Processed milk	Positive samples with *Listeria* spp.	Positive samples with *Listeria monocytogenes*	Negative samples
Processed Milk	**Pearson Correlation**	1	-.785**	-.653*	.798**
	Sig. (2-tailed)		<.001	.011	<.001
	N	14	14	14	14

Legend: **Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).

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