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LISTERIA MONOCYTOGENES IMPORTANT FOODBORNE PATHOGEN AND CAUSATIVE AGENT FOR LISTERIOSIS IN HUMANS AND ANIMALS

LISTERIA MONOCYTOGENES ZNAČAJAN KONTAMINENT HRANE I UZROČNIK LISTERIOZE KOD LJUDI I ŽIVOTINJA

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Abstract

Listeria monocytogenes, causal agent of listeriosis in human and animals is a facultative intracellular microorganism widespread in a variety of habitats such as soil, water, vegetation, contaminated water, feed and farm. The organism can be found in a wide variety of foods, including meats, poultry, vegetables, dairy products and seafood products. Approximately, 0.2 – 0.8 listeriosis cases occur annualy out of 100,000 people in developed countries. Although it appears that the annual incidence of listeriosis is not high, mortality rate of about 20 % is the most serious public health concern. It most commonly affects older adults, newborns, pregnant women, patients with cancer, diabetes, AIDS, kidney disease and persons who are under glucocorticoid therapy. Although the connection between eating contaminated food and appearance of listeriosis was established in 1980, today there is no doubt that this is the primary mode of transmission of *L. monocytogenes.*

INTRODUCTION

Listeria monocytogenes, opportunistic Gram-positive bacteria is widespread in a variety of habitats such as soil [1], water [2], vegetation [1, 3], feed [4], industrial plants [5] and farms [6, 7]. It can also be readily isolated from humans, domestic animals, raw agricultural and fishery products, food processing environments and home. It is microaerophilic and psychrophilic bacteria. *L. monocytogenes* became one of the biggest problems in the food industry because of its ability to grow at very low temperatures (0°C to 7°C) and to survive long periods of time under adverse environmental conditions, although *Listeria* is a non-spore and non-capsule forming bacteria [2]. *L. monocytogenes* is found worldwide occuring more commonly in temperate climates than tropical or sub-tropical climates [8].

Listeria monocytogenes in food

Understanding the factors that impact positively and negatively on the ability of *L. monocytogenes* to survive and proliferate in food and in the food processing environment is essential to the development and management of effective *L. monocytogenes* control measures. It should be assumed that growth of *L. monocytogenes* in foods is dependent on the intrinsic characteristics of the product (e.g. pH, water activity), the extrinsic characteristics of the product (e.g. storage temperature, relative humidity) and processing techniques (e.g. cooking, non-thermal processing) used in its production. The principal factors that influence the survival and growth of *L. monocytogenes* in food are temperature, pH and water activity (a_w). As with other bacteria, the tolerance of *L. monocytogenes* to particular environmental constraints (processing and/or storage conditions) is greatest when all other

conditions are optimal for growth. However, it has also been demonstrated that previously stressed cells (e.g. exposure to sub-lethal heating before process heating) can be more resistant to additional stresses. Namely, sanitation, using sublethal concentration of sanitisers, can result in the development of a more resistant *L. monocytogenes* population in the processing environment which may then contaminate food [9].

Transmission of this foodborne bacteria was epidemiologically and microbiologically established in 1980 during outbreaks in Nova Scotia, Canada [10]. Since then, epidemiological studies have repeatedly indicated that primary mode of transmission of *L. monocytogenes* to humans is the consumption of contaminated minimally processed food [11-13]. *L. monocytogenes* can be found in many foods. The results in Table 1 shows the prevalence of *L. monocytogenes*, based on specific products in different countries. Epidemiological studies indicate that the prevalence of *L. monocytogenes* in poultry meat is higher than 50% [14, 15] and it is believed that, in households, the high incidence of *L. monocytogenes* in poultry meat is consequences of possible cross-contamination with other foods, as well as the ability of bacteria to survive inadequate heat treatment [16].Also, it is non negligible contamination of beef and pork meat [17-19]. Furthermore, *L. monocytogenes* is present in raw fish and milk, but its prevalence in these foods is significantly lower than in poultry, beef or pork meat [20-23]. Many „*Ready to eat*" (RTE) foods are particularly high risk foods for *Listeria* infection. Within the 20 categories of RTE, which were analyzed in 2001 (The Food and Agriculture Organization of the United Nations and the World Health Organization), consumption of delicatessen (deli) meat products has caused the largest number of listeriosis [24, 25]. Therefore, the foods considered in the risk are RTE foods that are eaten without being cooked or reheated just prior to consumption.

Food processing methods (e. g. slicing) represent a high risk of *L. monocytogenes* contamination [26]. The date indicate that retail sliced deli meats continue to be seven times more likely to habor *Listeria* than packages of deli meats sliced by the manufacture [27].

The prevalence of *L. monocytogenes* in fishery products may be high due to temperatures used in the cold smoking process are not sufficient to destroy this bacteria. In 1998, Keto and Rahkio [28] indicated the high prevalence of *L. monocytogenes* in vaccum packed fish products. Also, several studies have indicated that raw fish can be contaminated by *L. monocytogenes* [29, 30]. Contamination of the skin and abdominal cavity of fish by *L. monocytogenes* can occur due to contamination of the water in which they live [31, 32] or due to improper handling before the fish arrives in industrial plants [33]. In respect of milk products, soft cheese was considered to be highly sensitive foodstuff to the presence of *L. monocytogenes* (bacteria may grow to significant numbers during refrigeration), although it can be found in other types of cheese and milk products, too [34]. In 2000, the Institute of Food Science and Technology in the United Kingdom indicated the potential public health hazards posed by pathogens in cheeses made from unpasteurised milk apply particularly to soft and semi-soft cheeses [35]. While butter is typically made from pasteurised and often salted milk, it has been implicated in outbreaks of listeriosis illness due to cross contamination of finished product with *L. monocytogenes* from the processing environment [36, 37].

Contamination of eggs with *L. monocytogenes* is rare. The presence of the organism in raw, commercially broken egg due to shell contamination from droppings and the processing environment appears inevitable but it has rarely been isolated from raw liquid egg products [38].

As a contaminent, *L. monocytogenes* occurs in many types of plant origin foods, although both domestic and wild animals may represent a significant reservoir of this microorganism. The studies have shown that listeriosis is a major problem in domestic ruminants (cattle, sheep, goats) where feed is considered highest risk factor [39-41].

In addition extensive research has addressed the survival, growth and control of *L. monocytogenes* in food processing environment, in particular in relation to the RTE food sector.

Listeria monocytogenes in food processing plants

Food processing plants are relatively closed environments and many control measures are applied in order to prevent have many controls in place to prevent *L. monocytogenes* from contaminating the plant's environment and RTE products. These may include footbaths, sanitizer misters, clean rooms, protective clothing and rigorous personal hygiene standards. However, retail environments are much more exposed with many people coming and going. These open retail environments may allow for the introduction of *L. monocytogenes* at various points and times of the day, potentially making control of *L. monocytogenes* in the retail environment more difficult [42]. Some specific subtypes of *L. monocytogenes* can persist for extended periods in many different food processing environments [43, 44].

In any case *L. monocytogenes*, like many other bacteria, can grow as planktonic cells or can grow as surface attached communities of cell embedded in an extra cellular polysaccharide matrix known as a biofilm or an invisible slime layer. Biofilm formation is important because in this form the bacteria are more resistant to physical and chemical agents (intended to kill the bacteria) and are able to survive for extended periods with minimal nutrient supply [9].

The bacterium was identified in various plants for food production, including dairies, slaughterhouses and those for the preparation of RTE foods. Mainly, it is most frequently found in moist production environments such as: drains, floors, walls, air vents, grease traps and areas where rodent or insects may enter the establishment [42].

It should be noted that *L. monocytogenes* harborage sites in processing facilities are likely to be similar to those found in retail facilities [42]. Furthermore, this pathogen may also be found on equipment used to transport, store, or prepare food: slicer, wheels of carts that transport foods, refrigerated storage units such as display cases and coolers, cracks in preparation tables, cooling fans in display cases. Also, any food contact surface such as knives, cutting boards, gloves or bamboo mats may be a potential source of *L. monocytogenes*. It is known that some humans carry the *L. monocytogenes* in their gastrointestinal tract. Poor personal hygiene

practices, such as improper handwashing or dirty uniforms, can lead to the contamination of food and equipment with *L. monocytogenes* [42].

Listeriosis

Human listeriosis is a severe foodborne disease caused by *L. monocytogenes*. It is a zoonosis that represents a significant concern for the food industry due to the high mortality rate it causes and the fact that the organism is capable of growing at refrigeration temperatures [45]. In the EU, human listeriosis was the first cause of death due to foodborne illness in 2009 [46]. Unfortunately, the decrease in the incidence of human listeriosis observed in 2007 and 2008 in the EU did not continue in 2009. In that year, the EU reported an increase of 19% in human cases of listeriosis compared to 2008 [46]. The increase primarily reflected a higher rate of listeriosis among elderly people [47]. The main route of transmission of human listeriosis is associated to consumption of contaminated food. Infection can also be transmitted, although very rarely, directly from infected animals to humans as well as between humans. Due to transmission via contaminated food, *L. monocytogenes* is a major cause of massive product recalls worldwide. The foods known to be associated with transmission of listeriosis are mostly RTE foods that support the growth of *L. monocytogenes* [48]. Between 1991-2002, 19 outbreaks of invasive listeriosis infection were reported in nine European countries, with a total of 526 related cases. In 1997, one large outbreak resulting in 1,566 cases of listeria gastroenteritis was reported in Italy and traced to the consumption of contaminated corn salad. A recent nationwide outbreak linked to contaminated packaged meat products occurred in Canada in 2008 resulting in 56 patients, including 20 deaths [49].

Most healthy people infected with listeriosis are asymptomatic or only have a mild febrile illness. Symptomatic infection most commonly occurs in pregnant women, infants, elderly and the immunosuppressed and include septicemia, meningitis (or meningoencephalitis), encephalitis, and intrauterineor cervical infections in pregnant women, which may result in spontaneous abortion or stillbirth. Human infection is usually (> 98%) caused by serovars 1/2a, 1/2b, 1/2c and 4b [50].

CONCLUSION

L. monocytogenes can differ in many aspects from other foodborne pathogens. Due to its wide distribution and considerable resistance to various unfavorable environmental conditions such as low pH and high concentations of NaCl, its microaerophilic and psychrophylic properties, food contamination by this pathogen has become one of the main problems of public health and food industries. Controlling the presence of *L. monocytogenes* in the environment can reduce the risk that product or a product surface will become contaminated. The significance of these areas will vary depending upon the facility, the processes, the temperature and humidity of the room, and the product. The food safety procedures for manufacture products without *Listeria* have not yet been discovered and developed. Therefore, the food industry must rely on strict environmental sanitation program and HACCP principles in order to improve the hygienic condition of food and health care consumers.

Table 1. *Prevalence of L. monocytogenes in beef, pork, chicken, fish and dairy products (Lundén, 2004).*

Products	Country	Prevalence %
Raw meat		
Beef	UK	35
	Mexico	16
	Switzerland	6.3
Pork	UK	28
	Switzerland	4.5
Minced beef and pork	ex Yugoslavia	69
Processed meat		
Sausages	Italy	14
	America	7.5
Hot smoked	ex Yugoslavia	21
Pate	Spain	5.4
Fermented products	America	3.3
Different products	America	3.1
	Spain	9.2
	Finland	2
	France	22
„*Ready to eat*" products	Canada	33
	America	ND
	New Zealand	1.8
Raw meat		
	Finland	27
Chicken (ready for baking)	Finland	62
	Portugal	41
	Northern Ireland	59
Carcasses	Belgium	30
	Spain	32
Processed meat		
Chicken (roast)	New Zealand	13
	Northern Ireland	ND
Chicken and turkey	Belgium	25
Turkey	New Zealand	ND
Sausages	Denmark	8.8
Cooked products	America	2.1
Fresh fish	UK	13
	Finland	ND
Processed fish		
	Switzerland	26
	Iceland	26
	Sweden	21
Marinated	Finland	23
	Finland	33
	Finland	50
	Finland	6
	Switzerland	14
	Sweden	12
	Finland	14
	Finland	15
Cold-smoked	Finland	17
	Spain	22
	Spain	27
	Finland	4
	Finland	13
	Switzerland	9
	Sweden	1.5
Hot-smoked	Finland	ND
	Finland	1
	Finland	2
	Iceland	16
"*Ready to eat*" products	New Zealand	26
	Canada	0.3
	Canada	ND
Milk		
	Hungary	3.8
	UK	3.6
Raw milk	Finland	1.7
	Ireland	4.9
Pasteurized milk	UK	1.1
Dairy products		
	Hungary	ND
	Italy	1.6
Soft cheese	UK	5.9
	Norway	11
	England	0.4
	Australia	3.4
	Finland	ND
	Europe	6.3
Semi-soft cheese	Hungary	ND
	Europe	7.6
Soft and semi-soft cheese	Ireland	ND
	Sweden	6
	Finland	ND
Fresh cheese	Finland	2.5
	Finland	ND
Hard cheese	Hungary	ND
	Europe	4.4
Ice cream	UK	2.0
	Finland	ND
	Finland	0.5

ND = not detected

Sažetak

*Listeria monocytogene*s, prouzrokovač listerioze kod ljudi i životinja je fakultativni intraćelijski mikroorganizam široko rasprostranjen u različitim staništima kao što su zemljište, voda, vegetacija, zagađene vode, stočna hrana i farme. Incidenca listerioze na godišnjem nivou u razvijenim zemljama iznosi od 0.2 do 0.8 ‰. Mada se čini da incidenca listerioze na godišnjem nivou nije visoka, procenat smrtnosti od oko 20 % predstavlja najozbiljniju brigu za javno zdravlje širom sveta. Listerioza se najčešće javlja kod starijih osoba, novorođenčadi, trudnica, osoba obolelih od kancera, dijabetesa, SIDA-e, bubrežnih bolesti i osoba koje su pod glukokortikoidnom terapijom. Iako je veza između konzumiranja zaražene hrane i pojave listerioze utvrđena tek 1980. godine, danas nema sumnje da je to primarni način prenošenja ove bakterije.

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