Chapter 5

Listeria monocytogenes: Potent Clinical Hazard

Prasann Kumar and Shweta Pathak

Additional information is available at the end of the chapter

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Abstract

Listeria monocytogenes is still the point to be broken by the scientists. In 1967, scientists Gray and Killinger demonstrated, about the presence of *Listeria monocytogenes* and Listeriosis in humans and cattle. *Listeria monocytogenes* was first described by Murray et al., who named it Bacterium Monocytogenes because of a characteristic monocytosis found in infected laboratory rabbits and guinea pigs. In 1927, it was renamed *Listerella hepatolytica* by Pirie who gave its present name in 1940. The first confirmed isolations of the bacterium from infected individuals, following its initial description, were made in 1929 by Gill from sheep and by Nyfeldt from humans. Since then, sporadic cases of listeriosis, have been reported, often in workers in contact with diseased animals. The invasion of peripheral nerve cells and rapid entry into the brain is postulated as a unique characteristic of its virulence.

Keywords: agriculture, biotic, cattle, disease, ecosystem, listeria

1. Introduction

It was the most prominent food-borne and food-causative agent in South America and in some European territories. *Listeria monocytogene* is a Gram-positive type of the facultative intracellular pathogen, which is capable of surviving in presence or absence of oxygen. It is ubiquitous in nature and grows at a minimum temperature of 0°C (typical refrigeration temperatures, greatly increasing its ability to evade control in human foodstuffs) to 50°C, pH, high concentrations of salt or bile, oxidative stress, carbon starvation, and other adverse conditions. Albeit readymade foods, defilement type of raw food, like vegetables, milk, meat, and seafood, is the most abundant contamination zone for such pathogens, not only are these eventually, readymade foods e paradigms of *L. monocytogenes*, they are also the root of the genesis of life-threatening food-borne disease listeriosis, in humans, including young, old,

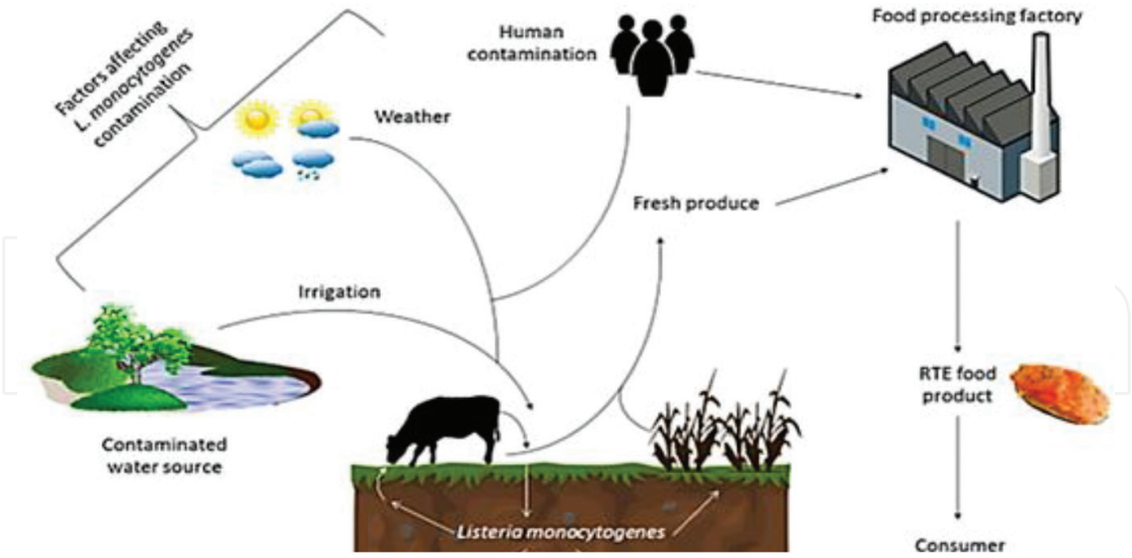

Figure 1. Cross talk of factors responsible for bacteria transmission.

pregnant, and immune-compromised people. Various studies suggested that up to 10% of human gastrointestinal tracts might be colonized by *Listeria monocytogenes*. Approximately 20–30% of the kinds of food-borne listeriosis infections are high risk or may be fatal. It is the highest value observed among all food-borne pathogens overall. The genus *Listeria* comprises nine species: *Listeria monocytogenes*, *Listeria ivanovii*, *Listeria innocua*, *Listeria welshimeri*, *Listeria seeligeri*, *Listeria grayi*, *Listeria marthii* [1], and *Listeria rocourtiae* [2] among which only *L. monocytogenes* is pathogenic to humans and L. ivanovii to animals causing listeriosis (**Figure 1**).

2. Listeriosis

Listeriosis is a disease, irresistibly fundamental spread by the microbes *Listeria monocytogenes*. The sporadic type of listeriosis is found regularly in human beings. The pollute sustenances might be the essential wellspring of tainting. Individuals are inclined to eating defiled, ready-made, or crude sustenances with the microorganisms. It might debilitate with different distinctive locales on a body part, including the cerebrum, spinal rope layers, or the circulation system. Listeriosis is very pervasive, so anybody can be tainted by this sickness, yet the individuals who have debilitated insusceptible framework (for instance, individuals with growth, HIV/Helps, or a transplant), individuals with perpetual liver or kidney ailment, diabetes, or liquor addiction, the neonates, and pregnant ladies are vulnerable to it. In spite of the fact that, dominant part of disease is amicable to who has rose by suppressive Lymphocyte intervened insusceptibility. In any case, the most astounding projection of listerial contamination is generally found in neonates, trailed by people aged 60 years and above (285, 365). In certainty, in a current survey of listeriosis, it was demonstrated that 31 and 22% of the aggregate cases occurred in patients who were aged 60 years and more youthful than 1 month, separately (343). It is evidently get out that of 782 instances of listeriosis in 20 nations 43% were maternal and neonatal diseases, 29% were septicemic contaminations, 24% were focal sensory

system contaminations, and 4% were atypical forms. Sensitivity of focal sensory system with *L. monocytogenes* ordinarily showing of meningitis or encephalitis and for the most part gives beginning side effects, including migraine, retching, fever, and discomfort before the presence of central indications of focal sensory system infection. Although 14 cases have been evaluated, in which *L. monocytogenes* assume a significant part to cause cerebrum abscesses in inclined people, particularly in leukemia patients or in renal transplant beneficiaries (94). Meningitis straightforwardly connected with a high death rate (315) in neonates to more seasoned. Symptoms of listeriosis as indicated by reports, listeriosis can influence different body parts, so the manifestations fluctuate from direct to endless. Manifestations are related to prodromal fever and looseness of the bowels alongside other foodborne germs; however, this sort of listeria contamination is not analyzed frequently. Side effects fluctuate with more disease. Pregnant ladies commonly encounter just fever and other influenza-like indications, for example, exhaustion and muscle pain. However, contaminations amid pregnancy can prompt unsuccessful labor, stillbirth, unexpected labor, or hazardous disease of the infant. But pregnant ladies additionally endure manifestations of cerebral pain, firm neck, disarray, loss of adjustment, and shakings alongside fever and muscle pain [3–7].

3. Pragmatic view: resource, occurrence and effect of factors

Our biosphere is a circular pathway for various paradigms of the food chain in which detritivores have their specific importance. The disease-causing pathogens are also included in this group of classification. Their circulation within the biosphere is a major health issue. An agricultural ecosystem is responsible for the increase in transmission of pathogens to the food chain via production of contaminated raw products. Soil is the edaphic factor, which accounts for circulation of *L. monocytogenes*. An important research performed by Welshimer put forward the first evidence that soil is the primary environment for *L. monocytogenes*, and the occurrence of the bacterium was observed in a third of the 12 sampled farms [8]. This report was further reinforced by a team of headed by a scientist named Weis and Seeliger. They contemplated the existence of *L. monocytogenes* in 746 soil samples collected in Southern Germany in which approximately 160 strains of the pathogen were isolated and account for 21.4% incidents of *L. monocytogenes* [9]. The highest incidence was recorded for uncultivated fields and meadows up to 30.8%, while the occurrence was reported to be quite less in cultivated field [10] (**Figure 2**).

The appropriation of the listeria types of spatial variety in urban region soil was accounted around 30% instead of indigenous habitat in US it was 19% [11]. Globally the identification of *L. monocytogenes* has been reported in the wake of examining at a similar site [9, 11]. Besides, the omnipresence of *L. monocytogenes* saw fundamental factor as indicated by the season and classification of condition. Rate of event was additionally amid the period of summer in common habitats while least during this time in urban situations. A nearby to inquire about revealed after their 3 years of study that in vegetable and product cultivates the commonness has been quite recently hostile, it was most noteworthy in winter season [12]. There have been recordings of *L. monocytogenes* in soil tests gathered from little ruminant and cow ranches [21]. The

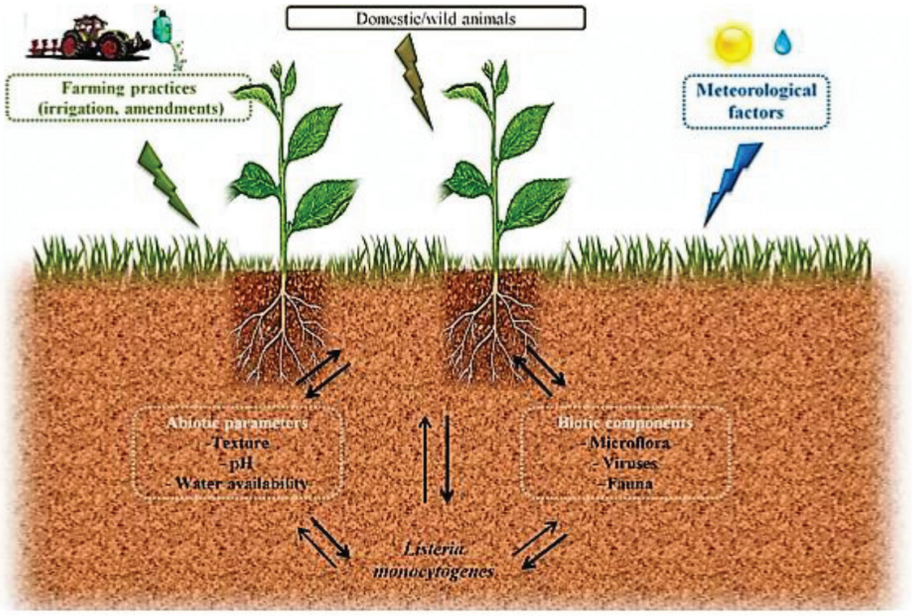

Figure 2. Pragmatic view with special concern to source and occurrence.

recordings show that the number of inhabitants in *L. monocytogenes* in soil is by and large low [13]. This was confirmed in a French across the country review where a PCR examine was performed on a gathering of 1232 soil DNA for the specific identification of *L. monocytogenes* [14]. All examples were underneath the location furthest reaches of 104 g^{-1} of dry soil. Strikingly, a correlation of development construct and sub-atomic location with respect to a subset of 53 crisp soil tests demonstrated that the rate of refined *L. monocytogenes* was 17%, yet just one example showed the discovery of atoms of *L. monocytogenes* and its population was quantified at 2.88104 g^{-1} of dry soil [14]. These overviews obviously exhibit that the dirt is a natural specialty of *L. monocytogenes*, but its population is for the most part low. Worldly and spatial varieties of its event call attention to that ecological factor drive the destiny of *L. monocytogenes* in soil. Soil is a gigantic composite heterogeneous condition made up of natural issue, minerals, frilly plant roots, gases, fluids, and a complex biota, including microorganisms, infections, mesofauna, and macrofauna that together help life. Complex nourishment networks are the characteristic personality of soil that are influenced by subterranean or more ground forms [15]. Because of such properties of soil, it is a significant commonplace errand to disentangle the natural factors that impact the presence of *L. monocytogenes* in soil. For the sake of results from the perception one essential thing turn out that nature of the dirt is a vital factor for event of *L. monocytogenes*. Notwithstanding, in these reports, signs of the dirt attributes are shaggy which is the reason for the difficulty in separating significant data with respect to the connection between soil's qualities and the nearness of *L. monocytogenes*. Examination of listerial population have proven that water is the most fundamental factor for survival of this pathogen [8]. Research to date has revealed that moisture, type of soil, season, the presence of decaying plant material, and possibly the presence of plant root systems, all may influence the growth and survival of *L. monocytogenes* in soil. The soil types examined for their relative ability to support *L. monocytogenes* were distinguished by particle size and organic content. They included a clay

loam soil, a sandy loam soil, and a sandy soil. The fertilizer liquid hog manure, solid chicken manure, and inorganic commercial nitrogen-phosphorus-potassium (NPK) were evaluated for any protective effect on the *L. monocytogenes* population. Glucose and peptone solutions were used as nutrient supplements to reveal if *L. monocytogenes* levels in soil were limited by carbon or nitrogen sources. Finally, high and low initial inoculation levels and the presence of normal and reduced (via autoclaving) levels of initial competition were examined for their effect on the establishment of *L. monocytogenes* population. The ultimate purpose of experiments of this nature was to determine what, if any, environmental conditions or agricultural practices might lead to an increased risk of *L. monocytogenes* contamination of food crops. If certain practices or conditions entail a greatly increased risk of elevating *L. monocytogenes* levels in soils, appropriate measures may be taken to offset the risk of crop contamination. The sort of soil influences population flow. Sandy soil speaks to a domain less positive for *L. monocytogenes* than sandy topsoil and earth soils and reduction in the survival in dirt soil than fruitless garden soil was additionally reported [8]. A disadvantage of these investigations is that just a single soil of each kind was utilized. A factual way to deal with the examination of *L. monocytogenes* survival in soils was performed to dodge this constraint of the distributed information [16]. Information for the survival of *L. monocytogenes* in 100 soil microcosms was dissected in light of a far-reaching and point-by-point portrayal of the dirt samples [16]. These results confirmed the survival rates in these kinds of soil. Survival up to 84 days was seen in 71% of the dirt samples tried, while survival did not surpass 14 days in whatever remained of the dirt microcosms. The long-haul survival could be identified with the dirt surface and particularly earth content. The report by [16] and others prove that the pH of the dirt is a noteworthy driver in the spread of *L. monocytogenes* in soil [9, 16].

4. Farming practices and transfer into the soil

Microflora inside the dirt can exceptionally influence the survival of *L. monocytogenes* (**Figure 1**). Connections between *L. monocytogenes* and diverse sorts of protozoa have already been exhibited [17, 18]. Disinfection of soil can prompt an increase in the development of *L. monocytogenes* proposing that the miniaturized scale verdure of the dirt, for example, bacteriophage or protozoa, affect the steadiness of the bacterium, in spite of the fact that this impact has not yet been completely clarified. Reports likewise confirmed that the smaller-scale biota of the dirt assumes a critical part in survival. In their investigation, they, in part, reconstituted sterile soil with social high-impact segments of the dirt small-scale biota and watched that this prompted an abatement in survival at a later time during the test. This proves the likelihood that this abatement might be because of the rivalry between various small-scale greenery that have supplements inside the dirt. Different components, which may influence the survival of the life form in soil, incorporate compound properties and in addition geological and meteorological impacts. Transient components (water system and precipitation) prompted the pollution of pre-gathered spinach. There was a more noteworthy possibility of confining *L. monocytogenes* in the water system than precipitation, and this possibility was most noteworthy within 24 h of this occurrence. Different investigations have confirmed likewise that the water system is a hazard factor for tainting of pre-harvestable

nourishments. This is regularly because of the tainting of the water source utilized for the water system in the fields. Alongside water system, the utilization of compost as a manure can build disengagement of *L. monocytogenes* from deliver creation destinations [19, 20]. This is not astounding as several animals are known to supply the bacterium [20]. The Edaphic manifestation of *L. monocytogenes* and other sustenance-borne pathogens hail the well-being concerns ranch and brushing it point toward the dirt is the colossal supply of *L. monocytogenes* and it might be a vector of pathogens to developed plants and cultivated creatures. Therefore, cattle and little ruminants are responsible for the spread of *L. monocytogenes* [21]. Diverse support proposes the possibility that cultivating hones have coordinate concern and effect on the dissemination and implantation of *L. monocytogenes*. During the cultivating and harvest season, tainting revolution surpasses the number of inhabitants in *L. monocytogenes*, which are nourished by dairy cattle raising the issue of sepsis in cows which are listeriosis carriers [20]. Using the same natural squanders or composts without sanitation leads to the transmission of *L. monocytogenes* in soil. The disposed sewage sludge has a low measure of *L. monocytogenes* population (1–240 microbes MPN g^{-1} dry issue), yet malicious utilization of such sewage slime as a compost have encouraged its transmission and implantation into the soil [19, 22]. Per hectare, spreading of one to two tons of muck would bring about 106–108 *L. monocytogenes* every year. There are also reports of the presence of *L. monocytogenes* in the defecated samples of homestead creatures [20, 21]. Additionally, investigation confirmed the nearness and the recurrence in 52 ox-like, goat, and sheep cultivates; the recurrence or presence of *L. monocytogenes* changed from 22–33% in cow-like ranches and from 3 to 18% in goat and sheep ranches [21]. Survival recurrence capacity in fecal waste is wholly restricted to half a month, yet every daily contribution to the storerooms of the barnyard could keep up a steady heap of *L. monocytogenes* [23–25]. *L. monocytogenes* could transmit by means of spreading of untreated waste or fecal ashore and that can sully soil and by refined of vegetables or natural products it move into them and they perform like a supply of *L. monocytogenes*. Such unhygienic septic sullied crude nourishment or instant sustenance of things would endanger the well-being of animals. Amid a similar period, an examination detailed that greatest survival period shifted from 4 days to more than 32 days after land application and such survival of this pathogen relies on this sort of waste. The population of the pathogens influenced or declined by confining the use of waste amid cultivating and development beside the seashore [25]. In vitro condition the survival of this pathogen in cow-like fertilizer changed soil fluctuated from 21 to 43 days and relied upon the measurements and on the temperature of brooding [26]. A factual thinks about information give an intriguing perspective that the natural parameters influence the likelihood of the presence of the pathogen, by the assistance of the information of overview it is likewise certain that a solid relationship between climate, soil properties and the likelihood to recognize Listeria sp. in soil. In a current parallel investigation of the event of sustenance-borne pathogens in five food products grown from the ground homesteads, scene and meteorological elements were related to the recurrence of positive examples [12]. Exhaustively, the occurrence of *L. monocytogenes* was distinguished around 15%, while the recurrence in the soil samples was 9%. This result demonstrated that ecological components like temperature, separation from surface water, streets/urban advancement and field/feed grass, in addition to soil-related parameters (accessible water stockpiling, natural soil) were ecological and topographic variables of significance in locating *L. monocytogenes* [12].

Curiously, in this review, the recurrence of identification of *L. monocytogenes* was higher in water tests. The nature of water utilized in the water systems was related to the transmission of pathogens through low-quality water systems [27–29]. Dairy ranches are an example of ecological elements that influence identification of *L. monocytogenes* in watersheds. Wastewater-treated effluents contain *L. monocytogenes* [19, 30–32] with loads fluctuating from 3 to 15 CFU. ml^{-1} [22] to more than 10 3 CFU.ml^{-1}.

5. Biodiversity and prevalence in soil

Biodiversity, short for natural assorted variety, alludes to the majority of the population, species, and groups in a characterized region. As opposed to the more particular term species assorted variety, the term biodiversity was instituted to accentuate the numerous intricate sorts of varieties that exist inside and among creatures at various levels of association. The term biodiversity alludes to the totality of qualities, species, and biological system of the locale. Biodiversity incorporates three progressive levels: hereditary, species, and biological system. Species are unmistakable units of assorted variety each assuming an imperative part in the biological community; it alludes to assortment of species inside a district. The most straightforward measure is more noteworthy the species extravagance more prominent the assorted variety. Biological community incorporates every animal type in addition to all the abiotic factors normal for a district. Biological community decent variety depicts the quantity of specialties, trophic level, and different environmental procedures that support vitality stream, sustenance networks, and the reusing of supplements. Living beings that make up the biotic part of a biological community are generally named autotrophs and heterotrophs, in view of how they get their nourishment or natural supplements in order to survive. *L. monocytogenes* are a facultative heterothophs that use wide variety and range of environment and such virtues represent its specificity. Species traditionally have been described and identified on the basis of morphological criteria. The forms and behavior of organisms adapt to some extent to the resource they exploit and habitats they occupy. Although the classification and identification of bacterial species is not a very easy task as a soil microflora, the term ecotype describes a genetically different population within a species which is adapted to specific environmental conditions. The different ecotypes of a microorganism species may differ in their edaphic, biotic, or microclimatic requirements. It aims at systematic synthesizing of ecology and evolution of microorganisms [33, 34]. Ecotypes are defined as "the smallest groups that (i) show a history of coexistence as separate, ecologically distinctlineages, as inferred from community ecology and (ii) show a prognosis for future coexistence, as inferred from the ecological distinctness of the groups in nature [33]." The phylogenetic structure of *L. monocytogenes* is mind-boggling. Disconnects are gathered in four heredities and major clonal edifices are perceived [35]. These major clonal buildings are dispersed overall [36]. Curiously, there is confirmation that the appropriation of clones and serotypes vary among clinical, sustenance, and natural detaches [36–38]. However, a constraint of these examinations is that the accumulation of separates that were broken down do not completely illustrate the mind-boggling biology of individuals from the species *L. monocytogenes*. Ribotyping of ranch-creature samples of *L. monocytogenes* identified a few subtypes [21, 39]. Confirmation likewise indicated higher

identification of specific subtypes in specific test destinations. These outcomes confirm the presence of ecotypes. Notwithstanding, others write about the across-the-board dispersion of PFGE composes paying little heed to their origin [40]. As proposed by Cohan, [33] defining such ecotypes will require a reasonable exhibition that the nature of disengages of the different grouping bunches is really particular.

6. Food processing environments

L. monocytogenes has the dynamic capacity to make due in invert state of the earth, crude nourishment or instant sustenance stuffs are stores of this pathogen and the likelihood of its event is exceptionally sufficiently solid to develop and make due finished a drawn out stretch of time yet how pathogen survive and what is the unmistakable pathway is as yet the striking inquiry. The wonder of constancy is very appropriate for such pathogens, and it is characterized as a specific subtype re-secluded from a similar situation over a broadened time frame. Be that as it may, *L. monocytogenes* have diverse strains and all have their own particular constancy yet, the perserverance of which strain is happening or more grounded in various natural living space is hard to discover why not process condition or others as well. Level headed discussion and difference, dependably the root to opportunity to find out about this pathogenic properties that whether a hereditary variety relate with presence or whether *L. monocytogenes* can colonize under particular great specialties inside a handling domain to stay continuing on. Bit of the work called attention to practically identical reports of research that made the observation that phenotypic attributes with various strains could bolster the steadiness contrasted with non-relentless strains. Consequently, to classify the non-persistent strain alongside persistent [41–43] strain is extremely commonplace as an outcome of the sporadic type of event of tenacious strain [44]. But hereditary level of concentrate more sight to discover to comprehend the physiology of diligence that could be caused by the rehashed utilization of the associated strain in sustenance-generation businesses or offices. By this method, tainted workforce, gear, or item could fill in as a vector after the rehashed presentation of a similar strain from some septic repository outside the plant [45–50]. Another examination points toward the strains separated and recognized from the outside condition inside fish slaughterhouses [46]. Different investigations have demonstrated that specialists in tainting work inside an office or with various bits of hardware may likewise be considered wellsprings of pollution [47, 49, 51] consisting of *L. monocytogenes* including locker rooms, foyers, and toilets in offices, proposing the likelihood that workforce inside the processing plant create pollution. Another report from an article proposed that the water that was used to cool the fish alongside the measuring table acted as a wellspring of defilement in enterprises [49]. It is as yet the purpose of difference in worry of the contamination, whether occasional variety has a contributing part in the detachment of *L. monocytogenes* from nourishment preparing environments [50]. Numerous examinations demonstrate no connection between regular variety and the occurrence of *L. monocytogenes* [52–54]. *L. monocytogenes* can be characterized in terms of stress tolerance. The expression "worry" in this setting is planned to mean any natural irritation that reduces the development rate (a mellow pressure) or contrarily impacts cell survival (a more serious

pressure). The foundation of *L. monocytogenes* in turn around condition is the allow that makes it fit to get by finished a drawn out stretch of time in soil situations, water, mammalian and avian defecation, and in sustenance and nourishment-handling situations. It is progressively transmitted from nourishment or water assets to gastrointestinal tract of insusceptible people or creatures. With the nature of stress resilience systems, *L. monocytogenes* can hold on and act in acidic condition. It additionally reacts in conditions where there is water pressure in addition to conditions such as dry weather, low temperatures, and bile. Such a system where the pressure is getting away is controlled by a translation factor known as sigma B which is encoded by a general pressure reaction quality that connects with RNA polymerase movement which acquaint it with SigB promoter site that prompts the interpretation of sigma B protein articulation for enhancement from push [55–57]. Presently Broad Pressure Reaction (GSR) by and large very much characterized as a pressure ameliorative hereditarily for push proactive capacity.

7. Stresses encountered in food

Listeria monocytogenes can grow at temperatures as low as −0.4°C [58]. At refrigerated temperatures, they can double their number by 50 h or more [59]. When *L. monocytogenes* were treated with very-low or cold temperatures, its cell wall became more rigid, this reduced further enzymatic reaction and transportation within the cell wall [60]. It is also reported that the bacterial cell wall, due to its hardness and rigidity, the genes could express up to the mark that help to mitigate from stress conditions. Such alteration in expression of gene can involve in cell membrane function, lipid, carbohydrate, and amino acid synthesis, ribosomal structure, and biogenesis and motility [61, 62]. *L. monocytogenes* play a pivotal role in the escape from cold stress by the accumulation of low molecular weight solutes such as glycine betaine, and carnitine. Such types of biochemical solutes always present in abundance in raw or readymade food stuff which help in the survival of this pathogen at refrigerated temperature [63, 64]. The generation time of *L. monocytogenes* reduces as temperature increases by more than 20 h at 4°C in the presence of a medium of compatible solutes [59]. A new report reveals the idea of solutes that were responsible for cold stress that The BetL glycine, betaine transporter, does not seem to be involved in cryotolerance [65]. The researchers found out that exceeded expression of two genes like Gbu and OpuC were responsible for cold stress mitigation but not BetL. During that period of time, it was also observed that as the temperature increased to 8°C, the quantities of metabolite solutes like glycine, betaine, and carnitine were detected within *L. monocytogenes* as compared to 37°C [61, 66]. An account of studies examined the activity of σB with respect to cold stress escape, but the data show conflicting results. A group of researchers [61] demonstrated that some cold-induced genes were under σB control (opuCA). They manifested that these genes could be activated in σB independent manner at 4°C indicating that cold shock may be partially under σB control. They also noticed that a mutant-lacking sigB did not have reduced growth at 4°C in comparison to the wild type [61]. A new observation was made that σB gene does not participate in survival at low temperatures [67]. *L. monocytogenes* also confront the acidic environment of stomach or within the gut of the host when it comes with contaminated food

sources. After entry of *L. monocytogenes* into the host through the ingestion of contaminated food, it encounters acidic conditions, first, within the stomach, and it also encounters the phagosomes after intracellular uptake. The bacterium possesses a variety of different mechanisms including the adaptive acid tolerance response (ATR), the glutamate decarboxylase (GAD) system and the arginine deaminase (ADI) system to help it overcome these acidic environments [68–70].

8. Concluding remarks

Despite the ubiquitous nature of *L. monocytogenes* in food, water, agricultural land, and cattle farms, it has harmful disadvantages. It is the cause of listeriosis in weak immune-responding person along with high risk of public health hazard. A lot of experiments and results have greatly improved the understanding of its ecology, genetics, mechanism, and physiology. By means of whole-genome sequencing method now, *L. monocytogenes* can be rapidly identified in the sources of contamination. It can greatly reduce the effort and help food producers in knowing the presence or absence of contamination in food. There is as yet noteworthy slack in our analysis and information in the worries of the exact systems that *L. monocytogenes* utilizations to detect its condition and how it couples its pressure reaction to its pathogenicity, yet the diligent work and observable research action in these fields prone to be addressed the different inquiry that still unrevealed sooner rather than later.

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Author details

Prasann Kumar[1]* and Shweta Pathak[2]

*Address all correspondence to: prasann.21784@lpu.co.in

1 Department of Agronomy, School of Agriculture, Lovely Professional University, Jalandhar, Punjab, India

2 School of Biochemistry, Davi Ahilya University, Indore, India

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