The Pharma Innovation Journal 2023; 12(5): 3334-3338

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(5): 3334-3338

www.thepharmajournal.com
Received: 05-02-2023
Accepted: 19-03-2023

B Pavan Kumar Naik
Department of Horticulture, Annamalai University, Chidambaram, Tamil Nadu, India

Tejavath Ram Raju
Assistant Professor, Department of Crop Production, Government Degree College, Osmania University, Ibrahimpatnam, Hyderabad, Telangana, India

J Sam Ruban
Associate Professor, Department of Horticulture, Annamalai University, Chidambaram, Tamil Nadu, India

K Vignesh
Ph.D. Scholar, Department of Plant Pathology, Faculty of Agriculture, Annamalai University, Tamil Nadu, India

K Manikandan
Ph.D. Scholar, Department of Plant Pathology, Faculty of Agriculture, Annamalai University, Tamil Nadu, India

Corresponding Author:
B Pavan Kumar Naik
Department of Horticulture, Annamalai University, Chidambaram, Tamil Nadu, India

A food borne pathogen: *Listeria monocytogenes*

B Pavan Kumar Naik, Tejavath Ram Raju, J Sam Ruban, K Vignesh and K Manikandan

Abstract
Listeria monocytogenes is a gram positive bacteria, approximately 0.4-0.5 µm diameter and 0.5-2 µm length. *Listeria* is a food borne pathogen grows at low temperature of 4 ºC. It affects due to consumption of contaminated food on new-borns, older adults, pregnant women and weaker immune peoples. *Listeria monocytigenes* outbursts the dairy products, refrigerated foods, contaminated fruits and vegetables get listeriosis infection to humans which leads to stress. Outbreaks of *Listeria monocytogenes* on food, incidence and growth in dairy products and various processed vegetable are source of applications to control pathogen. Following the ionizing radiation treatment is dynamic technique to eliminate *Listeria monocytogenes* on vegetables. Water washing is a treatment which reduces the population of microbial levels. To control *Listeria monocytogenes*, can use chemical treatments like potassium lactate or sodium di-acetate.

Keywords: Listeria monocytogenes, pathogens, dairy processing, HACCP systems, cheese

Introduction
The principal health concerns of world is food poisoning, food borne illness and food wastage. They are the main negative effects on national economy and society. World Health Organization reported in December 2015 that, one in every year 10 persons or around 600 million individuals fall ill and virtually 4,20,000 die each year by consuming spoiled contaminated food. Generally, food spoilage denotes to change in color, flavor, texture and nutritional value of food having deleterious health effects on society. Various agents like bacteria, fungi, parasite, viruses, toxins and chemicals are responsible for food contamination and food borne diseases. Among these most of the food borne diseases are caused by bacteria. *Salmonella, Campylobacter, enterohaemorrhagic Escherichia coli, Vibrio cholera* and *Listeria* are some of the most common foodborne pathogens that affect millions of people annually, sometimes with severe and fatal outcome.

Listeria monocytogenes cells are approximately 0.4-0.5 µm diameter and length is 0.5-2 µm, that are capable of growing between pH is 4.2 to 9.5 and at temperature ranging from -0.4-50 ºC with the production of peritrichous flagella resulting in tumbling motility most active between 20 and 25 ºC (Schuchat *et al.*, 1991). *Listeria* is the causative agent of listeriosis, related to animal and human food disease. It is a serious infection caused by the bacteria *Listeria monocytogenes*. *Listeria* generally affects newborns, older adults, pregnant women and weak immune system peoples after eating the contaminated food (Fig. 1). *Listeria* has different species related with food are *L. monocytogenes, L. welshimeri, L. ivanovii, L. seeligeri, L. innocua, L. murrayi, L. denitrification* is excluded from the genus and transferred to a new genus, *Jonesia* as *J. denitrificans.*

Listeria is a gram positive bacteria, non-fastidious, non-sporing, intracellular facultative anaerobic (Farber and Peterkin, 1991). *Listeria* has a capability to grow at low temperatures of 4 ºC, also can grow at freezing temperatures (Ramaswamy *et al.*, 2007) [15]. *Listeria* outbreaks have been associated with refrigerated ready to eat foods with meats, cheese, milk, hot dogs, smoked fish and other dairy products (Jackson *et al.*, 2018) [6]. *Listeria monocytogenes* contamination of vegetables and fruits may pay to the burden of human listeriosis infections, predominantly as *Listeria monocytogenes* is capable to survive and multiply under various stress conditions, comprising those probable encountered in plant surfaces (Garner *et al.*, 2006) [3]. *Listeria monocytogenes* infections were significantly associated with consumption of contaminated vegetables like cabbage, radish, lettuce and celery and derived foods including salad vegetables like alfalfa sprouts, melons humus and mushrooms.

Interaction between plant and *L. monocytogenes*

Most of the plants interact with microorganisms in their close area and can offer habitat for commensal and human pathogens. Certainly, listeriosis outbreaks have been traced back to pre-harvest contamination of fresh produce due to the presence of *L. monocytogenes* in the farm environment. In that sense, pants must be considered as habitats that are potentially colonized by the human pathogen and as possible vectors of the contamination. To colonize plants bacteria must be able to utilizing the available nutrients, to sense the plant and develop a chemotactic response and to outcompete other microorganisms and occupy available micro niches. In addition for successful colonization of the rhizoplane or root tissues, microbes must be able to attach to the surface and enter root tissue while evading immune responses (Truong *et al.*, 2021) [16].

Listeria monocytogenes attachment to and growth on some plants, including spinach and alfalfa sprouts, has been documented (Jablasone *et al.*, 2005) [5]. Nonetheless, studies on *Listeria monocytogenes* and plant interactions using genetically traceable, well-characterized plant species and pathogen strains are needed to further understanding of interactions between foodborne pathogens and plants.

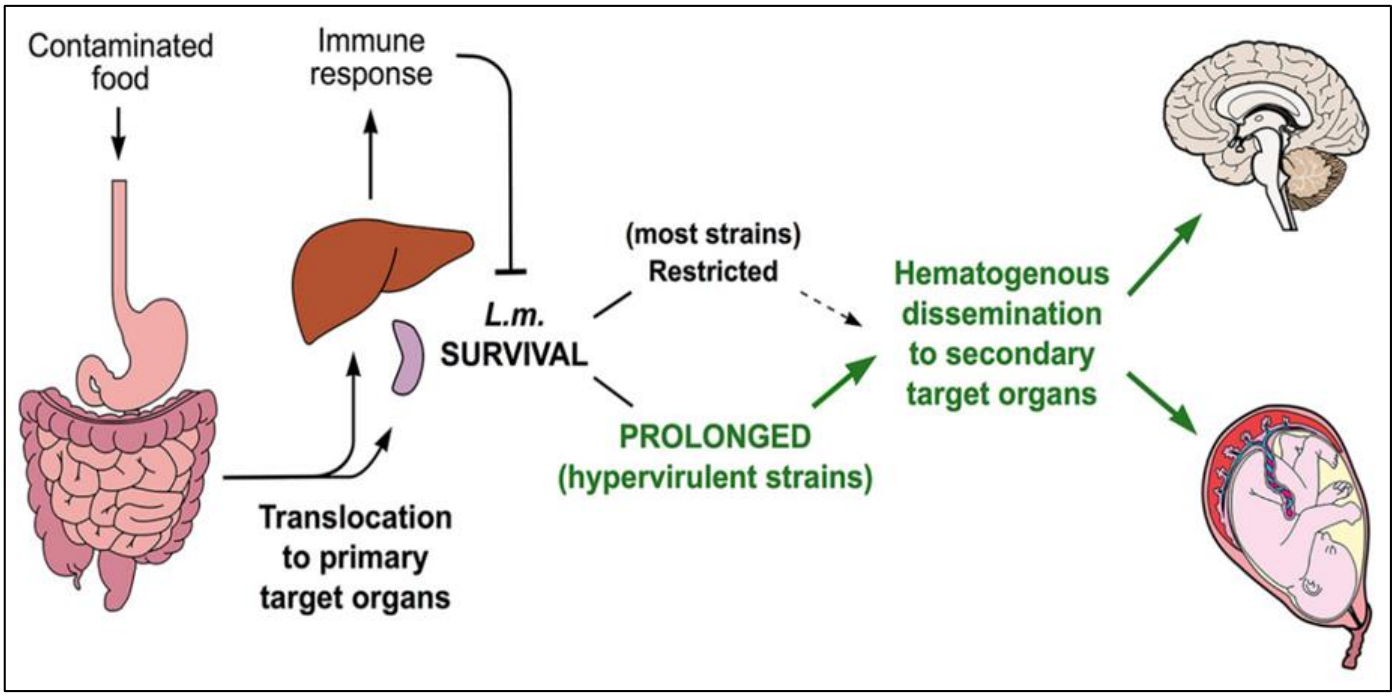

Fig 1: Model illustrating the hypothesis that prolonged survivability in primary infection foci in liver and spleen may explain the increased likelihood of *L. monocytogenes serovar* 4b hyper virulent strains to cause brain and placental infection (Vazquez-Boland *et al.*, 2020).

Pathogenesis of *L. monocytogenes*

Listeria monocytogenes as a facultative intracellular pathogen, it can invade and replicate in epithelial cells and macrophages. In mouse and guinea pig models, in the small lining of the small intestine *Listeria monocytogenes* has been shown to be taken up by enterocytes or M cells near Peyer's patches and it multiplies in underlaying phagocytic cells (McDonald and Carter, 1980) [9]. Through the circulating macrophages cells, bacteria are disseminated from the intestine and reach the targeted organs in liver and spleen, where most of them are killed by resident macrophages (Lepay *et al.*, 1985 and Pron *et al.*, 1998) [8, 13]. If the host T cell-mediated immune response is conceded, in hepatocytes and macrophages the bacteria is multiplied and are carried out in the blood to various organs, particularly the brain and uterus, due to their potential to rupture the blood brain and placental walls.

Application to control *L. monocytogenes*

1. Food borne outbreaks of *Listeria monocytogenes*

Farber and Peterkin (1991) observed a *Listeria monocytogenes* on food. The sources of raw vegetables for the plant identified a farmer who raised cabbage and kept a flock of sheep. The cabbage was grown in fields fertilized by both composted and raw manure from this flock of sheep. Cabbage crop was harvested and stored in large cold storage during October. As *Listeria spp.* are able to grow at low temperature that the organisms either die or enter a stationary phase, the period of cold storage acted essentially as a period of selective enrichment for this species (Fig. 2).

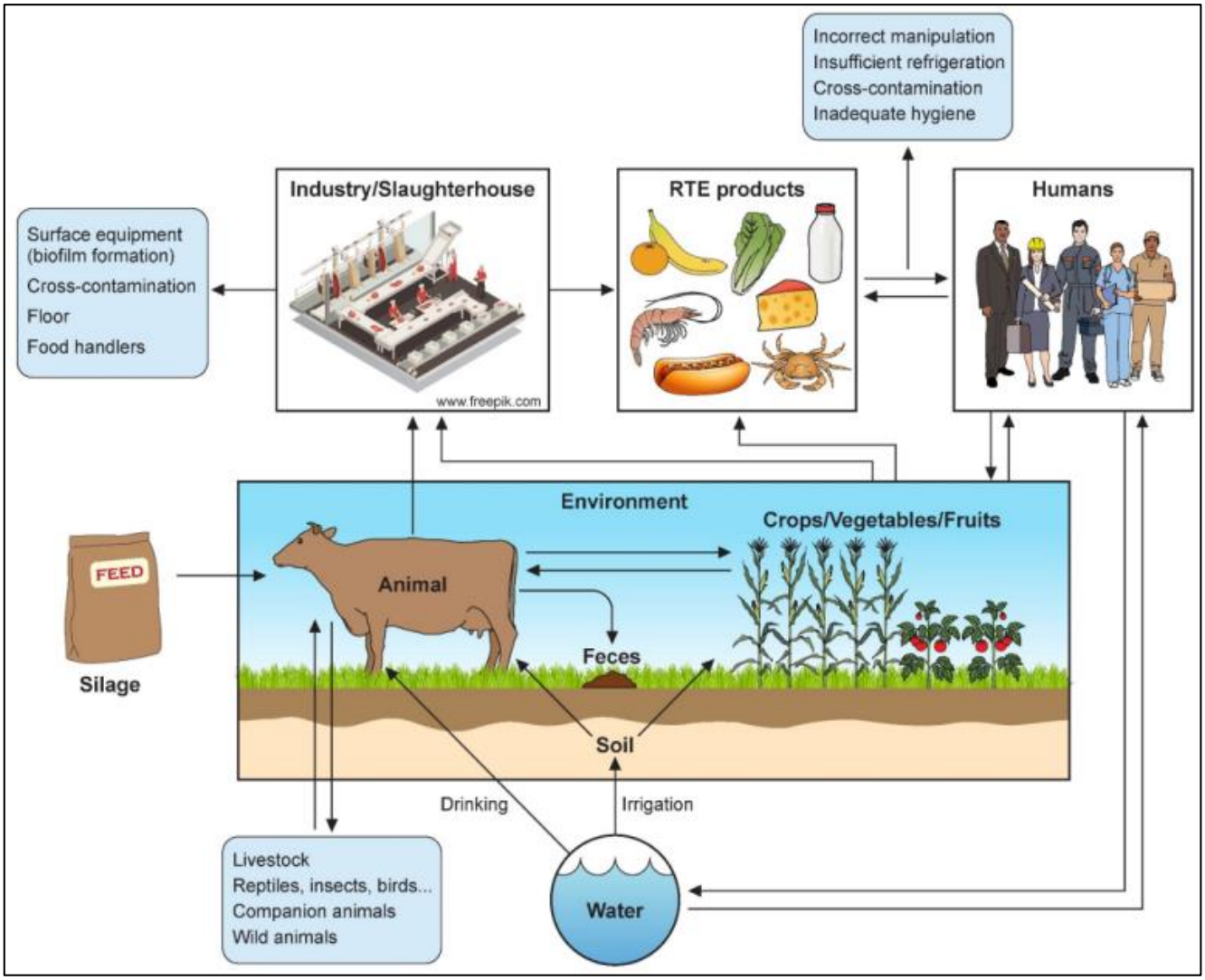

Fig 2: *Listeria monocytogenes* contaminous sources. Transmission scenarios for *L. monocytogenes* between soil, water, animals, crop, vegetables, fruits, industries, food products, humans and environment (Quereda *et al.*, 2021) [14].

2. Incidence and growth in dairy products

Listeria monocytogenes has found in wide range of dairy products. Among these, cheese has been the most intensively examined because of its known association with food borne listeriosis. The level of *Listeria monocytogenes* as high as 10^7 cfu/g (Colony-forming unit per gram) have been found in some naturally contaminated cheeses (Michard and Jardy, 1989 and Renterghem *et al.*, 1990) [11, 17]. *Listeria monocytogenes* appeared in raw milk around 2.2% in World Wide, excluding Spain. Thus, raw milk must be considered by the dairy processor as a source of contamination coming into the plant. The organisms has also been shown to survive in products such as cultured butter milk, butter and yoghurt. Differing results have been obtained on the length of time that *Listeria monocytogenes* can survive in stored yoghurt, mainly owing to differences in the methods of recovering injured organism, in the strains used and in the solids content and pH of the product (Griffith and Deibel, 1990) [4].

3. Incidence of *Listeria sp.* in slightly processed vegetables

Listeria species was isolated in 23 samples out of 52 samples of slightly processed salad products. *Listeria* species was detected in 16 samples of brand A (n=24), 5 samples of brand B (n=10) and 2 samples of brand C (n=18). Among the various species of *Listeria*. The *Listeria monocytogenes* detected 7 samples, where this is prevailed in warm weather samples. At the molecular analysis out of 175 *Listeria* strains, 160 strains isolates were characterized. Among the total 43 different patterns with 15 fragments were observed. The most frequent pattern was pattern 41 and detected in 33 isolated. *Listeria monocytogenes* and *Listeria seeligeri* presented the highest number of patterns in common. 14 patterns was found in more than one species and 7 patterns was detected in one species completely (Verdin *et al.*, 2007) [19].

4. Inactivation of *Listeria monocytogenes* on fresh vegetables by irradiation treatments

To control the growth of spoilage of food and food borne pathogenic bacteria, ionizing radiation can be effective on *Listeria monocytogenes*. (Bari *et al.*, 2005) [1] reported that the inoculated samples was treated with 0.0, 0.2, 0.6, 0.8 and 1.0 kGy radiation doses with maintain by single temperature. The inoculated samples was irradiated at dose rate of 1.4 kGy/h from a cobalt-60 gamma source of 16,841 Ci to eliminate *Listeria monocytogenes* on laboratory inoculated cabbage, broccoli, tomatoes and mung bean sprouts. Irradiation of cabbage and tomato at 1.0 kGy resulted in reductions of approximately 5.25 and 4.14 log cfu/g, respectively of a five strain cocktail of *Listeria monocytogenes*. Reductions of approximately 4.88 and 4.57 log cfu/g were found with

broccoli and mung bean sprouts at a similar dose. The overall acceptability like color, texture, taste and appearance did not undergo significant changes after seven days of post irradiation storage at 4ºC with compare to control. Consequently, low dose ionizing radiation treatment could be an active method for eliminating *Listeria monocytogenes* on fresh vegetables.

Growth of *Listeria monocytogenes* on spinach leaves

Leafy greens like spinach may contaminated with *Listeria monocytogenes* during pre harvest and post harvest handling stages. (Omac *et al.*, 2015) [12] observed that the microorganism like *Listeria monocytogenes*, initial level of population load and washing with water containing 200 mg/L of chlorine was more effective than water washing on fresh baby spinach leaves. The range of initial population is 10^3 to 10^5. The initial population load at 10^3 cfu/mL in chlorine (200 mg/L) were 0.097 ± 0.34 was more effective than water 0.58 ± 0.17 in *Listeria monocytogenes*. This experiment says that the micro organism had different responses to the type of washing treatment, so the microbial population levels reduces due to water washing was significantly different for *Listeria monocytogenes* and with the pathogen.

Control of *Listeria monocytogenes* in food processing environments

In food industry, various control approaches are applied to diverse food processing environments. For example, addition of antimicrobials such as potassium lactate or sodium di-acetate during product manufacturing, thermal treatment of the final product with steam, application of high hydrostatic pressure or irradiation or reduction in the product shelf life would be appropriate control measures for RTE meat products (Mataragas *et al.*, 2010) [10]. Though, alternative strategies would be required for some other foods depending on their physical and chemical properties. Another issue is the use of specific in-house microbiota that are often used to give sensory characteristics such as taste, odour or other organoleptic properties to foods. Thus, it is important that the cleaning and disinfection routines remove only the spoilage or pathogenic bacteria without affecting the beneficial microbes (Lebert *et al.*, 2007) [7].

It is mainly focused in control of *Listeria monocytogenes* in the processing environment. Dealing with a routinely encountered pathogen such as *Listeria* requires a practical approach to achieve the food safety objectives in any production environment. It is important to advise and implement various risk management strategies to reduce the incidence of listeriosis (Walls and Buchanan, 2005) [20]. The numerous control strategies include GMP, sanitation, standard operating procedures, HACCP programs, intensive environmental sampling, time and temperature controls throughout the entire processing and storage period and post packaging treatments to destroy *Listeria monocytogenes* on products.

References

1. Bari ML, Nakauma M, Todoriki S, Juneja VK, Isshiki K, Kawamoto S. Effectiveness of irradiation treatments in inactivating *Listeria monocytogenes* on fresh vegetables at refrigeration temperature. Journal of Food Protection. 2005;68(2):318-323.
2. Farber JM, Peterkin PI. Listeria monocytogenes, a food-borne pathogen, Microbiological reviews. 2005;5:476-511.
3. Garner MR, James KE, Callahan MC, Wiedmann M, Boor KJ. Exposure to salt and organic acids increases the ability of Listeria monocytogenes to invade Caco-2 cells but decreases its ability to survive gastric stress. Appl. Environ. Microbiol. 2006;72:5384–5395.
4. Griffith M, Deibel KE. Survival of Listeria monocytogenes in yogurt with varying levels of fat and solids. J. Food Saf. 1990;10:219-230.
5. Jablasone J, Warriner K, Griffiths M. Interactions of Escherichia coli O157:H7, Salmonella typhimurium and Listeria monocytogenes plants cultivated in a gnotobiotic system. Int. J. Food Microbiol. 2005;99:7–18.
6. Jackson KA, Gould LH, Hunter JC, Kucerova Z, Jackson B. Listeriosis outbreaks associated with soft cheeses, United S tates, 1998-2014. Emerging Infectious Diseases. 2018;24(6):1116–1118.
7. Lebert I, Leroy S, Talon R. Effect of industrial and natural biocides on spoilage, pathogenic and technological strains grown in biofilm. Food Microbiology. 2007;24:281-287.
8. Lepay DA, Steinman RM, Nathan CF, Murray HW, Cohn ZA. Liver macrophages in murine listeriosis. Cell-mediated immunity is correlated with an influx of macrophages capable of generating reactive oxygen intermediates. J Exp Med. 1985;161:1503-12.
9. MacDonald TT, Carter PB. Cell-mediated immunity to intestinal infection. Infect Immun. 1980;28:516-23.
10. Mataragas M, Zwietering MH, Skandamis PN, Drosinos EH. Quantitative microbiological risk assessment as a tool to obtain useful information for risk managers - Specific application to Listeria monocytogenes and ready-to-eat meat products. International Journal of Food Microbiology. 2010;141:S170-S179.
11. Michard J, Jardy N. Denombrement et localisation de Listeria monocytogenes dans des fromages a pfate molle et a croute lavee fabriquds avec du lait cru en provenance d'une entreprise fromagere. Microbiol. Aliments Nutr. 1989;7:131-137.
12. Omac B, Moreira RG, Castillo A, Castell-perez E. Growth of *Listeria monocytogenes* and *Listeria innocua* on fresh baby spinach leaves: Effect of storage temperature and natural microflora. Postharvest Biology and Technology. 2015;100:41-51.
13. Pron B, Boumaila C, Jaubert F, Sarnacki S, Monnet JP, Berche P, *et al*. Comprehensive study of the intestinal stage of listeriosis in a rat ligated ileal loop system. Infect Immun. 1998;66:747-55.
14. Quereda JJ, Moron-Garcia A, Palacios-Gorba C, Dessaux C, Portillo FG, Pucciarelli MG *et al*. Pathogenicity and virulence of *Listeria monocytogenes:* A trip from environmental to medical microbiology. Virulence. 2021;12(1):2509-2545.
15. Ramaswamy V, Cresence VM, Rejitha GS, Lekshmi MU, Dharsana KS, Prassad SP, *et al*. Listeria –Review on epidemiology and pathogenesis, Journal of Microbial Immunological Infection. 2007;40(4-13):2007.
16. Truong HN, Garmyn D, Gal L, Fournier C, Sevellec Y, Jeandroz S, *et al*. Plants as a realized niche for *Listeria monocytogene.* Microbiology Open. 2021;10:e1255. DOI: https://doi.org/10.1002/mbo3.1255.
17. Van Renterghem R, Waes G, de Ridder H. Detection of

Listeria monocytogenes in cheese by DNA colony hybridization. Milchwissenschaft. 1990;45:426-427.
18. Vazquez-boland JA, Wagner M, Scortti M. Why are some *Listeria monocytogenes* genotypes more likely to cause invasive (Brain, Placental) infection? mBio. 2020;11(6):03126-20.
19. Verdin SEF, Silva SRP, Pereira DC, Schatkoski AM, Corcao G. Occurrence and genetic characterization of *Listeria* spp. in minimally processed vegetables commercialized in Porto Alegre, Brazil. Acta Scientiae Veterinariae. 2007;35(2):167-172.
20. Walls I, Buchanan RL. Use of food safety objectives as a tool for reducing foodborne listeriosis. Food Control. 2005;16:795-799.