

A Critical Review on *Listeria monocytogenes*

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ABSTRACT

Listeria monocytogenes is an omnipresent gram +ve, rod shaped, facultative, and motile bacteria. It is an opportunistic intracellular pathogenic microorganism that has become crucial reason for human food borne infections worldwide. It causes Listeriosis, the disease that can be serious and fatal to human and animals. Listeria outbreaks are often linked to dairy products, raw vegetables, raw meat and smoked fish, raw milk. The most effected country by Listeriosis is United States. CDC estimated that 1600 people get Listeriosis annually and regarding 260 die. It additionally contributes to negative economic impact because of the value of surveillance, investigation, treatment and prevention of sickness. The analysis of food products for presence of pathogenic microorganisms is one among the fundamental steps to regulate safety of food. This article intends to review the status of its introduction, characteristics, outbreaks, symptoms, prevention and treatment, more importantly to controlling the Listeriosis and its safety measures.

Keywords: *Listeria monocytogenes*, Listeriosis, Food borne pathogens, Contamination

INTRODUCTION

Food borne health problem is outlined by the World Health Organization as “diseases, generally occurs by either infectious or hepatotoxic in nature, caused by the agents that enter the body through the activity of food WHO 2015 [1]. Causes of food borne health problem include bacteria, parasites, viruses, toxins, metals, and prions [2]. *Listeria monocytogenes* remains massive reason for food borne unhealthiness. The outbreak of Listeriosis is very low as compared to other food borne illness in present scenario. The occurrence of Listeriosis disease higher in inclined population, together with pregnant women, newborn babies, adults aged sixty five and weakened immune system [3]. Food borne Listeriosis is severe and serious food born outbreak. It is caused by the bacterium *Listeria monocytogenes*. It’s comparatively rare illness with 0.1 to 10 cases per 1 million people annually looking on the regions and countries of the world. And also Listeriosis cases are very low and high rate of death associated with this infection. It’s typically transmitted once food is harvested, prepared, processed, packed, transported or keep in environments contaminated with *Listeria monocytogenes*. Worldwide, there are a unit better known 31 global hazards caused along with 600 million food borne sickness and 420,000 deaths in 2010 [1]. The European Food Safety Authority [EFSA] and also the European Centers for Disease prevention and control[ECDC] concern with 14 leading food borne pathogens EFSA and ECDC, 2017 [4], whereas the CDC [Center for disease control] takes into consideration fifteen food related pathogens in USA. Although true bacteria was recognized at intervals the first decade as an infectious agent for mammalians [5]. Human Listeriosis outbreaks in North America involving, it’s contaminated with dairy products and resulting mortality rate is up to 33 % [6,7]. Milk is one in every of the nutrient medium for many micro-organism moreover as pathogens. Though several milk processing industries employs pasteurization for milk, bacterium might survive. Also, post pasteurization contamination might occur as a result of improper sanitary condition of milk process plants. Several outbreaks are reported from milk

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borne micro-organism like *Listeria monocytogenes*, *E. coli* O157:H7, *Salmonella spp*, *Campylobacter jejuni* etc [8]. Many pathogenic bacteria from pasteurized milk like *Listeria monocytogenes*, *Tuberculosis spp*, *Campylobacter spp*. [6] were to blame for outbreaks and deaths in many countries. One to five percent of the raw milk and its products involved in the food borne outbreaks reported from the seven European countries with *salmonella spp*. Responsible for 29 outbreaks, *Escherichia coli* for 11 outbreaks and *Staphylococcus aureus* for 10 outbreaks associated with milk excluding *L. monocytogenes* [8-9]. After major eruption in 1981 [10] from coleslaw (a regional salad dish in US), many researchers explored different kinds of food products and isolated *Listeria* from milk and milk products [11], meat and meat products [12], seafood [13] and raw vegetables [14]. *Listeria monocytogenes* is that the most vital organism caused human health outbreaks by poultry, fish, crustacean etc [15]. Human outbreaks could be a food borne illness and it's been calculated that 99% of human Listeriosis outbreaks area unit caused by consumptions of contaminated food. Though Listeriosis isn't common in humans, it's a clinically important illness owing to its high mortality and severity [15].

Listeria has been referred to as an "emerging food borne pathogen" as a result of solely; it will be transmitted through contaminated food. It is an omnipresent micro-organism. It causes serious infectious Listeriosis disease outbreaks, it may be a vital public health problem [15]. Listeriosis is typically diagnosed once a bacterial culture grows *Listeria monocytogenes* from a body tissue or fluids, such as blood, spinal fluid or the placenta. Effective antimicrobial treatment of *Listeria* is difficult because of the intracellular nature of the pathogenic bacteria. Wide ranges of antibiotics have demonstrated *in vivo* activity against the organism [16]. For Listeriosis disease different types of antibiotics used for controlling the pathogen. Some of the drugs extensively used for the Listeriosis disease, such as penicillin, ampicillin and amoxicillin [16]. These drugs bind with high affinity to PBP3, and thus significantly suppress the activity of pathogenic *Listeria monocytogenes* organism. The penicillin is active against *Listeria* than the acyl ureidopenicillin such as the ticarcillin [17]. Penicillin has shown the equal efficacy both in *In vitro* and *In vivo* studies. And amoxicillin has shown a slight activity in *In vitro* studies [18]. Many alternative antibiotics combination used for the tested against *Listeria*. When erythromycin was combined with penicillin, or gentamicin in *In vitro* testing and all combinations were antagonistic in nature [19]. Mix of amoxicillin with rifampin has also been antagonistic in *In vitro* examination for treatment [20]. In this article explained the brief introduction and overall view of the *Listeria monocytogenes*.

Listeria monocytogenes

Characteristics

Listeria is a ubiquitous, gram positive, facultative intracellular pathogenic micro-organism able to survive, replicate in somatic cells and non somatic cells. This bacteria used for the study of intracellular life and a strong tool to check the basic cellular biology methodology. It's one in the entire foremost well studied infective agent. It's a motile, gram positive, mesophilic and psychotropic, rod shaped, facultative organism. It's have peritrichous flagella and tumbling motility once viewed with light microscopy. It's actively motile in nature and forms flagella at room temperature at 20-25 °C. Organism at 37 °C doesn't form flagella [21]. The *Listeria* looks like in short chains like "V" forms. This bacterium is motile in nature due to peritrichous flagella, which can be lost because the micro-organism enters into human body. Movement remains attainable as a result of the micro-organism polymerize simple protein into long actin tails that propel the microorganism through living substance [22]. *Listeria* bacteria short rods measuring about 0.4µm by 0.5-2.0µm with rounded ends [23] that are ubiquitous in nature.

History

Listeria monocytogenes could be a late comer to sphere of medicine. The organism was at first represented as an explanation for epizootics in veldt rodents from South Africa by Pirie [24]. In 1891 eubacteria might be recognized in tissue samples from German patients. In Sweden 1911, it was isolated from the liver of rabbits [25]. *Listeria*, caused in rabbits and guinea pigs in 1924, were small rods they named it's as *Bacillus monocytogenes*. The *monocytogenes* was supported the pronounced infectious disease proof in infected rabbits. In 1927 organism was later described as *Listerella hepatolytica* because of the liver marks in infected animals and in the honor of Lister [26]. Later in 1940, the name was modified to *Listeria monocytogenes* [25].

Taxonomy

Taxonomic classification

| | | |
|---------|---|-----------------------------|
| Kingdom | - | Bacteria |
| Phylum | - | Firmicutes |
| Class | - | Bacilli |
| Order | - | Bacillales |
| Family | - | Listeriaceae |
| Genus | - | <i>Listeria</i> |
| Species | - | <i>L.monocytogenes</i> [27] |

Listeria monocytogenes is that the foremost vital species of the genera. Members of the eubacterium genera belongs to the Formicutes division, area unit presently classified into 17 species: *L. monocytogenes*, *Listeriaseeligeri*, *Listeria ivanovii*, *Listeria welshimeri*, *Listeria marthii*, *Listeria innocua*, *Listeria grayi*, *Listeria fleischmannii*, *Listeria floridensis*, *Listeria aquatica*, *Listeria newyorkensis*, *Listeria cornellensis*, *Listeria rocourtiae*, *Listeria weihenstephanensis*, *Listeria grandensis*, *Listeria riparia*, and *Listeria booriae*. Solely of those two species, *L. monocytogenes* and *L. ivanovii*, are considered to be a pathogenic microorganism [28].

Growth conditions for *Listeria monocytogenes*

Listeria spp are omnipresent, environmental micro-organism unremarkably found in water, soil, plants, and foods. One in all the significant characteristic of *L. monocytogenes* grows under variable temperature [1-45 °C], growth temperature between 30 to 37 °C. It killed at 60 °C, high temperature. It resists comparatively at extreme growth conditions, it's from pH 4.5 to 9, salt tolerance 10 % NaCl, and optimal growth occurs at neutral pH (Table 1).

Serological association of *Listeria monocytogenes*

A *Listeria monocytogenes* strain is differentiated supported on serology analysis. Thirteen serotypes are recognized in *L. monocytogenes*, which include ½ a, ½ b, ½ c, 3a, 3b, 3c, 4a, 4ab, 4b, 4c, 4d, 4c and 7. Strains of eubacteria species area unit divided into two serotypes are somatic [O] and heat labile flagellar [H] antigens [30].

Biochemical characterization of *Listeria monocytogenes*

Listeria species showed characteristic tumbling motility. Eubacterium is positive tests for Catalase test, methyl red and Vogesproskauer test and negative test for Oxidase, Indole, Urease and H₂S

production. Eubacterium all species hydrolyzes esculin however don't scale back nitrate with the exception of *L. murrayi* that will reduce to nitrate [31].

Table 1: Growth parameters for *Listeria monocytogenes* [29]

| Growth parameters | Minimum | Optimum | Maximum |
|-------------------|---------|---------|-------------|
| Temperature [°C] | -1.5 | 30-37 | 37 |
| pH | 4.0 | 6.0-8.0 | 9.6 |
| Water activity | 0.90 | 0.97 | - |
| Salt [%] | - | 10% | 25 % at 4°C |

Listeriosis

Listeriosis is caused by the bacterium *Listeria monocytogenes*, which was at the start recognized as a food borne infectious agent at intervals the early 1980s [32]. Since its discovery, it's been known as a reason behind food borne outbreaks. In contrast to most alternative food borne pathogens, *L. monocytogenes* will grow in food with low wetness content and high salt tolerance. Significantly, *L. monocytogenes* grows well at refrigeration temperatures. This ability to persist and multiply within the food atmosphere makes *L. monocytogenes* particularly difficult to control [33]. *Listeria monocytogenes*, an aerobic, gram positive, coccobacillus, has emerged at intervals the last twenty years from relative microorganism obscurity to become a vital food borne infective agent of humans. Infectious disease is that the leading reason for reported micro-organism food borne disease related deaths annually within the US. There are an estimated 1,600 cases of infectious disease within the US annually, with a mortality rate of approximately 20%. Less than 1% of recorded food borne outbreaks in the United States was connected to supply throughout the 1970s, but from 1990 to 2005, fruit and vegetable products were responsible for a calculable 13% of food borne outbreaks [34]. In recent survey June 9, 2020 Food and drug administration [FDA] and Center for disease control [CDC], investigated a multistate outbreak of Listeriosis disease it's linked to the enoki mushrooms from Green Co, LTD of the Korea [38].

Outbreaks

Food borne diseases defined as consumption of contaminated food with bacteria, viruses, parasites, and toxins. According to the WHO [2007-2015] guidelines, food borne diseases account for one-third of deaths among children aged under, and annually 420,000 people die because of food borne diseases. There are various agents like bacteria, viruses, and parasites causing food borne diseases, among which, the bacterial agents are more prevalent. Listeria is a causative agent that accounts for serious diseases in humans and animals through the consumption of milk and other dairy products as well as meat, poultry, and ready to-eat products [35]. The occurrence of Listeria is rare and the annual report of illness with Listeria has been decreased from 7.7 cases per one million to 3.1 cases during the period 1990 to 2003 in the USA. Moreover, in Europe, the incidence of infection has declined from 4.5 cases per million to 3.4 cases between 1999 and 2003. Annually, 1600 cases of Listeria infection are reported from the USA. In European countries, overall 1760 cases of listeriosis were reported in human in 2013 by the European Food Safety Authority [EFSA]. On average, 99.1% of the cases needed hospitalization [Control and Prevention, 2011]. Currently; most of the outbreaks are contributed via the consumption of dairy products, while the number of outbreaks due to consumption of ready to eat foods has been decreased. Consumption of fruits, vegetables, and ice

cream are associated with low to moderate numbers of *Listeria* outbreaks. Recent evidence declared that most of *Listeria* outbreaks were linked with contamination of crustaceans, shellfish, mollusks, meat and meat products, cheese, vegetable, and juice in EU regions (Table 2). The highest percentage of contamination in Chinese food industries were *L. monocytogenes* according to a two-year survey conducted, with about 20% contamination [35].

Table 2: Reports on detection of *Listeria monocytogenes* in foods

| Year | Food | Reference |
|------|---|-----------|
| 2000 | Raw milk | 36 |
| 2000 | Raw meat | 36 |
| 2011 | Cantaloupes | 37 |
| 2012 | Ricotta salata cheese | 37 |
| 2013 | Cheese | 37 |
| 2014 | Cheese, bean sprouts , dairy products, prepackaged caramel apples | 37 |
| 2015 | Soft cheeses, Ice- cream | 37 |
| 2016 | Frozen vegetables, raw milk, packaged salads | 37 |
| 2017 | Vulto creamery soft raw milk cheese | 37 |
| 2018 | Pork products , Deli Ham | 37 |
| 2019 | Hard- boiled Eggs and Deli-sliced Meats and cheeses | 37 |
| 2020 | Enoki mushrooms | 37 |

Symptoms

Listeriosis symptoms vary from person to person. Depending on the severity of the unhealthiness, symptoms could last from days to many weeks. Mild symptoms could embody a fever, muscle aches, nausea, vomiting and diarrhea. If the additional severe variety of infectious disease develops, symptoms could embody headache, stiff neck, confusion, loss of balance and elderly, and therefore the immune compromised infectious disease may result in death. People infected with Listeriosis may start to see symptoms in a few hours or as long as two to three days after consumption contaminated food. Additional severe varieties of Listeriosis might take from 3 days to 3 months [38]. Symptoms in people with invasive Listeriosis caused the additional effects on the pregnant women. Infections throughout maternity will cause miscarriage, still birth, and premature delivery or life threatening infection of the newborn [37].

People at risk

CDC estimated that Listeriosis is that the 3rd leading reason behind death from food borne disease, within the United States. The 1600 people get affected from eubacterium annually and 260 die.

The most effected people are

1. Pregnant women
2. Newborn babies
3. Adults aged sixty five
4. Weakened immune system

Pregnant women's are 24 times more likely infected from Listeriosis compared to other general population [38]. It directly effects on the newborn babies. If newborn babies infected with this disease may develop serious health issues.

Diagnosis

Listeriosis is sometimes diagnosed once a bacterial culture grows *Listeria* from a body tissue or fluid like blood, spinal fluid or the placenta [37]. The blood test is often the most effective way to determine *Listeria* infection whether the people infected or not. In some cases samples of urine or spinal fluid will be tested as well.

Treatment of Listeriosis

Effective antimicrobial treatment of *Listeria* is difficult because of the intracellular nature of the organism. Though a large vary of antibiotics have incontestable *in vitro* activity against *L. monocytogenes*, several area unit solely biological process intracellular. Additionally *In vitro* activity would possibly or won't be directly correlates with *in vivo* effectiveness. Vancomycin has had variable activity against eubacteria strains. It's disinfectant at intervals six hours; but, its use is proscribed in cases of infectious disease because of its inability to cross the blood-brain barrier. Vancomycin should be used intraventricularly to possess a bearing against *Listeria meningitis*. GNP-LLO₉₁₋₉₉ and GNP - GAPDH₁₋₂₂ nanovaccines developed with Advax adjuvant defend against Listeriosis when applied during pregnancy. Nanovaccines square measure effective measures for gestation vaccination as they space able to cross the placental barrier and diminish infectious disease morbidities [39]. It has been effective against *Listeria endocarditis* once combined with gentamicin. Cephalosporins are inactive against *L. monocytogenes* and don't have any role at intervals the treatment of infectious disease. *In vitro* studies with the fluoroquinolones recommend for (i.e., sparfloxacin, moxifloxacin, gatifloxacin) treatment of Listeriosis disease [40].

Prevention

Listeria monocytogenes in food are killed by cooking at high temperature and pasteurization.

Some of the important key points to controlling food borne disease are as follows

1. Maintain hygiene
2. Separate raw and cooked
3. Cook meat samples at high temperature
4. Store food at suitable optimum temperatures

High risk peoples should follow

- Intense dairy farm products manufactured from raw milk, able to eat meat products, sea foods.
- Should apprehend the life period and storage temperature whereas exploitation of the products.

It is one amongst the vital aspects should apprehend the duration, storage optimum temperature written on labels on foods products. To make sure that bacterium potentially present in ready to eat foods does not multiply in high numbers. Boil at high temperature before consumption to killing the pathogenic micro-organism [37,38].

Food Safety

Food is crucial to life; thus food safety could also be a basic thing. Billions of individuals within the globe are in danger of unsafe food. Many millions become infected wherever as 1000 die once a year as a result of they consume unsafe food. Therefore, food safety saves the lives and also enhances the individual and population health and economic growth. Food safety issues are closely associated with changes within the society, economy, and life vogue and intake habits. With globalization of jobs, career, and trade opportunities, there's raised travel and immigration by people. The inflated globalization of food provides chain combined with knowledgeable consumers has crystal rectifier to the demand for a secure food provide [41]. Within the 21st century, food issues of safety haven't waned. Native outbreaks will turn out to be international emergencies because of the speed and vary of product distribution. Serious food borne illness outbreaks have occurred on each continent. In China alone, the 2008 contamination of infant formula with cyanuramide affected 300,000 infants and young children, 51,900 were hospitalized and six of whom died. Additionally to urinary organ damages, complications like neoplasm genesis or growth retardation in the future have been raised [42]. Unsafe food poses global health problems. The New born babies, the older people and the weakened immunity peoples are particularly vulnerable. If food provides are unsecured, population shifts to less healthy diets. And consume additional "unsafe foods" in throughout that chemical, microbiological and alternative hazards causes health risks that successively prices higher attention expenditure and drains national wealth [43].

CONCLUSION

Listeria is one of the important foods borne infectious agents with important public health and economic impact. An improvement within the quality of life as results of healthful conditions and helped to stop Listeriosis disease. The food safety is a central point in the whole foods production chain. The world population has exaggerated dramatically and to deal with the demand for food it has been necessary to extend food production in giant scale intensive kind with correct handling, and to regulate the microorganism. Listeriosis continues to be a serious Public health problem worldwide. Among the food borne disease, the least noticeable disease is Listeriosis. It is considered as most dreadful disease with high fatality rate. It additionally contributes to negative economic impacts because of the value of surveillance, investigation, treatment and interference of sickness. The pathogen *Listeria monocytogenes* can survive at extreme environments and presents high risk to human health. The most important means of controlling human infection, Lies in the simple hygienic measure condition, it's aimed at preventing the multiplication of the *Listeria monocytogenes* in the different types of food samples. *Listeria monocytogenes* is well studied bacterial pathogens, in the past twenty years. The bacteria accustomed to study host infectious agent interactions and microorganism adaption to organism host thus it's used as a model organism for further research studies.

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