

Domestic Meat Handling Practices and Listeriosis Risk Assessment in Delhi: A Brief Survey

Snigdha Homroy¹, Aparna Agarwal^{1*}, Anjana Kumari¹, Abhishek Dutt Tripathi²

¹Lady Irwin College, New Delhi, India

²Department of Dairy Science and Food Technology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi-221005, U.P., India

*Corresponding Author – Dr Aparna Agarwal, aparna.gupta@lic.du.ac.in, +91-99582 11704

Abstract

Listeria monocytogenes are the causative pathogen of listeriosis. The infection is associated with a high mortality rate and is detrimental to pregnant and immune-compromised populations. Numerous researches reported the widespread presence of *listeria* in the Indian environment, indicating a potential outbreak threat. This study surveyed the public to gather information and understand perceptions regarding standard meat handling practices of the Delhi population. Most respondents followed hygienic methods while procuring and processing meat and its products at home.

Further interrogations revealed that a significant portion of the population was largely uninformed of foodborne pathogens, specific traits, and peculiarities. The survey sample seemed oblivious to listeriosis and its hazards. Our findings prove the need to develop food safety education programs in India. The Indian public should be educated regarding the disease preventive measures to establish a clear understanding and rationalize their routine actions.

Keywords: Food-borne, India, *Listeria monocytogenes*, Listeriosis, Public, Survey

Introduction

Listeria monocytogenes is a foodborne bacterium, commonly contaminating raw poultry products, unpasteurized dairy products, seafood products, or Ready-To-Eat (RTE) products. Cross-contamination and ubiquitous presence lead to their isolation from fresh produce, vegetables, and fruits. (Kaptchouang Tchatchouang et al., 2020) It can survive and proliferate in refrigeration temperature ranges and oxygen-poor conditions, unlike other common pathogens. *L. monocytogenes* is an opportunistic pathogen, meaning those with a weak immune system are most likely to suffer from severe infection. Invasive listeriosis, the severe form, is detrimental to high-risk groups, including pregnant, infants, elderly, cancer, AIDS patients, those undergoing organ transplants, and immuno-compromised. (Mook et al., 2011) The infection has the following characteristic symptoms: fever, myalgia, septicemia, and meningitis. Perinatal listeriosis can lead to abortion, stillbirth, or premature delivery. (Hof, 2003) Regardless of its relative rarity, with 0.1 to 10 cases per 1 million people per year, the associated high mortality rate (20%–30%) makes it a significant public health concern. (WHO, 2018) An estimated 23,150 illnesses and 5463 deaths occurred in 2010 due to listeriosis. (de Noordhout et al., 2014) Since the discovery of the organism, the notable outbreaks took place in 1981 (Canada; due to contaminated coleslaw), 1987-1989 (UK; due to pâté), 1992 (France; due to pork tongue) to state a few. (Goulet et al., 2008; McLauchlin et al., 2020; Todd & Notermans, 2011) During the 1980s, USA and Switzerland faced many outbreaks stemming from spoiled cheese. (Swaminathan & Gerner-Smidt, 2007) The infection alone was accountable for approximately 1,600 illnesses and 260 deaths annually in the United States. (CDC, 2021) Numerous research findings in India convey growing incidence and sporadic cases of listeriosis; however, they largely remain publically under-reported. (Tirumalai, 2013) The emergence of antibiotic-resistant *L. monocytogenes* is an additional threat. According to the various analyses and studies conducted in India, milk and derived products, meat products, seafood, and vegetables often get contaminated by *Listeria*. (Barbuddhe et al., 2012) The nation, as a unit, must prioritize the investigations for risk factors and examine outbreaks to locate the sources of contamination as a measure to eliminate possible dissemination using preventive measures. (Barbuddhe et al., 2016; Swaminathan & Gerner-Smidt, 2007)

This study attempted to survey to gather information regarding standard practices and hygiene protocols followed by the general public when buying, storing, and cooking meat and meat products. The survey provides us with greater awareness about the likely risk factors of the infection. It serves as a preliminary listeriosis risk assessment survey for Delhi, India.

Materials and Methods

An online survey was made on the Google forms platform, comprising multiple-choice answer (MCQ) questions. A few questions were adapted from the document '*PR/HACCP RULE EVALUATION REPORT Listeriosis Food Safety Messages and Delivery Mechanisms for Pregnant Women: Final Report.*' (USDA-FSIS, 2001) The questionnaire was sent through WhatsApp, Gmail, and other similar online platforms.

The following formula calculated the initial sample size:

$$\text{Required Sample Size} = \frac{pqz^2}{e^2}$$

Where,

p = Prevalence rate;

$q = 1 - p$ (inverse of the above);

e = accepted margin of error (taken as 5% here);

z = for a confidence of 95%, this value is 1.96; ($t_{0.05} = 1.96$)

60.5% population residing in Delhi follows a non-vegetarian diet. (Government of India, 2014) After substituting the values in the above formula, a requirement of 368 samples was calculated. However, due to time constraints and COVID-19 restrictions, a sample size of 300 respondents was selected for the study.

Result and Discussion

Three hundred respondents residing in Delhi, India, answered the questionnaire. All the respondents were educated and expected to have basic knowledge regarding hygiene and sanitation.

Usually, within a week, 15% of the participants ate meat for 4- 5 days, and 31% ate for 2- 3 days; meanwhile, 12% population ate daily. Studies have noted that solely the frequency of eating meat or other flesh food can not be associated with listeriosis risk. Many other factors play a role in causing the infection, for instance, an underlying gastro-intestinal infection or frequent antacid consumption. (Hitchins, 1996) People are often exposed to *L. monocytogenes*, yet the infection rate is relatively low. (Notermans et al., 1998) Nevertheless, meat ranks as the riskiest product due to the higher level of consumption than most carrier food products. Thereby it becomes crucial to know the public's consumption rate. (Todd & Notermans, 2011) Most people prefer buying their meat products from retail meat shops or the local vendors (figure 1). Food handling has a significant role in the prevention of food poisoning. Hazard analysis critical control point (HACCP) and Good Manufacturing Practices

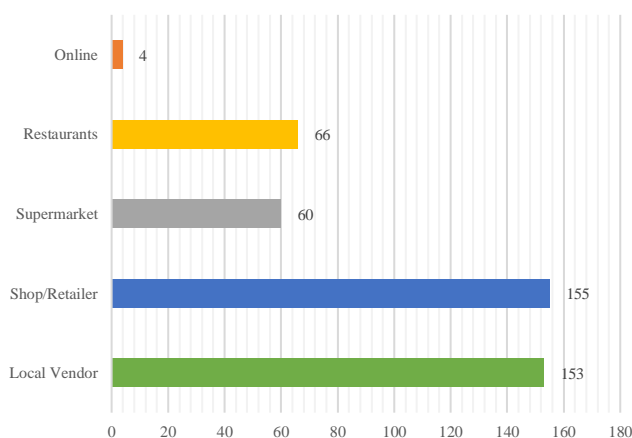


Fig 1 Source of the purchased meat

(GMP) are crucial in food safety and hazard prevention. Cross-contamination during preparation or handling and followed by improper storage encourage pathogens to proliferate. Supermarkets and online stores tend to follow the protocols to gain acceptance of the certifying authorities, although they cannot be depended upon always. Local vendors and retail shops are inadequately monitored and might not follow hygiene practices. It is undeniably better to consume freshly cut meat as there is a lower risk and 70% of respondents did so. *L. monocytogenes* get ample opportunities to multiply when stored at the shop before the sale. (Swaminathan & Gerner-Smidt, 2007) Reduction of the meat storage duration results in

lowering the risk of listeriosis. Storage temperature also influences the threat. The generation time of *L. monocytogenes* hastens when temperatures near the higher range during storage. (Evans & Redmond, 2015) Provided the general facilities seen in Indian retail meat shops, these factors could increase infection risk.

It was inferred from the survey responses that more than three-fourths of the sample population correctly stored the meat products in the freezer compartment (-23 to -18°C). The optimum temperature for the growth of *Listeria* ranges from 35-37°C, having said that certain strains able to grow at 1°C as well. (Junttila et al., 1988) Findings suggest that it is safer to store meat in the freezer compartment of the domestic refrigerators that is within 0 to -18°C temperature. Walker et al. observed a lag time of 1-3 days at 5°C for *L. monocytogenes*, whereas at 0°C incubation it was 3-34 days while the generation time range for 5°C storage was noted to be 13–24 hours and increased to 62–131 hours at 0°C (Walker et al., 1990). Temperature can even influence the expression of virulence genes in *L. monocytogenes*; increased virulence at higher temperatures. (Duodu et al., 2010) One-third of the public believes freezing temperatures kill the microorganisms present in the food. Generally, freezing halts the growth of most microorganisms by minimizing the enzymatic changes and microbial activity. (Frazier & Westhoff, 2014) Loss of viability differs with strain and depends on conditions such as the freezing method employed, the composition of the food, the storage duration and temperature of the freezer, and other factors. (Jay et al., 2005) After purchasing meat or any related products, consumers should freeze unopened packages immediately and discard them within three days of thawing and/or opening. (Simpson Beauchamp et al., 2010) The psychrotrophic nature of *L. monocytogenes* makes controlling the pathogen in products tricky during refrigeration. In a 2010 study observing *L. monocytogenes* growth in RTE ham slices, three days later of storage, the bacterial load reached the limited regulation concentration at 5°C. When extended to five days, the bacterial population was at hazardous values (Garrido et al., 2010). More extended storage promotes bacterial proliferation of *listeria*, as it does for most food-poisoning microorganisms.

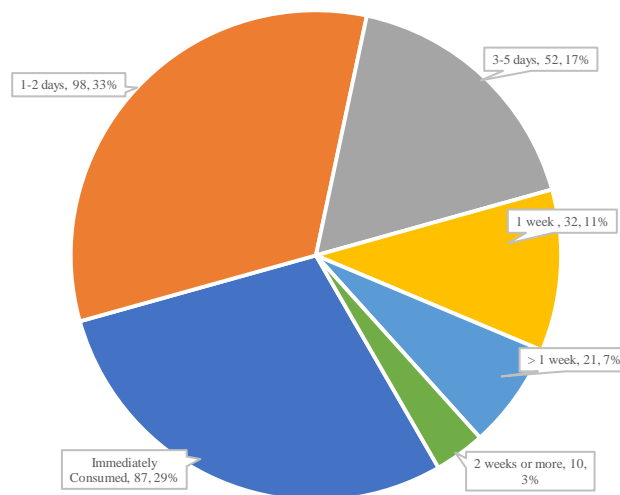


Fig 3 Duration of meat storage at home

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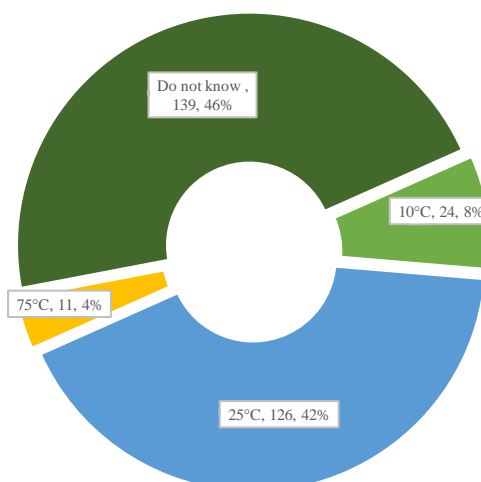


Fig 2 Public opinion on favorable growth temperatures for bacteria

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91% of people chose to wash the raw food before cooking/preparation. Washing meat with water does not significantly decrease the load of microorganisms on meat but does help to an extent. (Jaja et al., 2018) Microbial load reduction depends on the temperature of the water, washing time, disinfectant quality and quantity, water-to-food ratio, the shape of food, and such determinants. (Pirovani et al., 2004) Washing of meat carcass pieces with acetic or lactic acid results in lower microbial concentration on carcasses than those washed with tap water. (Sakhare et al., 1999) Many studies have specified that cross-contamination can happen markedly when contaminated food comes in contact with utensils or other food. The probability of *L. monocytogenes* contamination was higher on comparatively cleaner surfaces because it is not a competitive bacterium. (Schäfer et al., 2017) To prevent listeriosis or merely maintain hygiene, cutting boards and other surfaces and tools must be different when dealing with raw and/or cooked food. (Goh et al., 2014) 84% of respondents claimed they wash their utensils as soon as they are through using them and/or before using them again for another food preparation and cooking. Within homes, contamination occurs when the same unwashed utensils like knives are used for raw/contaminated foods and later for preparing clean food. (Thevenot et al., 2006) Most people reported following sanitary cleansing; 78% washed their utensils with soap and water. A 2015 study observed pathogen dissemination from the contaminated slicers onto the retail delicatessens products, starting chain cross-contamination. (Pouillot et al., 2015) Due to such possible hazards, industries follow the clean in place (CIP) protocol involving washing all equipment with hot water, alkali detergents, acid washing to eliminate biofilm-forming *L. monocytogenes*. (Naik et al., 2017)

25% of the study participants risked the chances of infection by eating raw and semi-cooked meat. In India, numerous experimental analyses testing *Listeria* presence and isolation revealed that milk and its products (particularly unpasteurized), raw meat and meat products, seafood, and vegetables could act as carriers of the microbe. (Barbuddhe et al., 2012) Many studies attest those raw meats are more contaminated with *Listeria* spp. than cooked or packaged meat products. (Gibbons et al., 2006) Many traced outbreaks arose from RTE meat products, often eaten raw or with minimal cooking/preparations such as salamis, sausages, and previously cooked meat products like turkey and rilette. For instance, the two consecutive nationwide outbreaks that struck France within six months were analyzed.

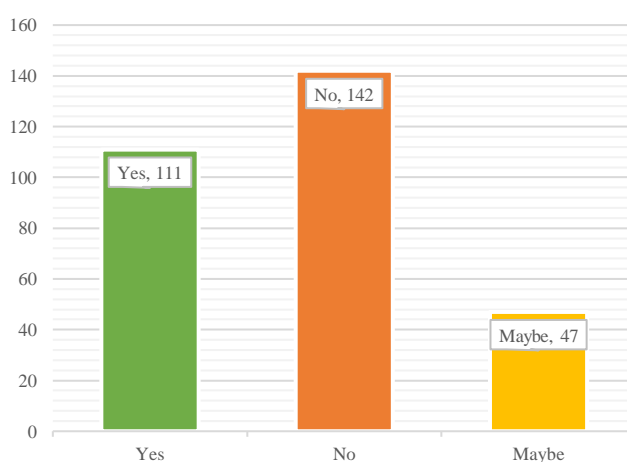


Fig 4 Usage of separate kitchen utensils

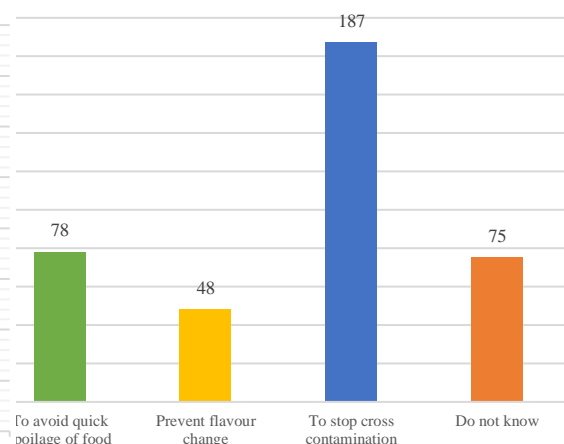


Fig 5 Rationale for storing raw and cooked food separately

Rillettes was identified as the source of infection in the first outbreak and jellied pork tongue for the second. (de Valk, 2001) Backed by research data, the food safety authorities have advised that raw food, especially meats, should be kept separately, away from cooked and ready-to-eat food. If there are contaminants on the uncooked food/meat, the chances of cross-contamination get reduced due to the physical separation. As refrigeration temperatures are suitable for *L. monocytogenes* proliferation, cross-contaminated cooked food would threaten health despite being fully cooked once. (Ishaq et al., 2020)

Infections caused by *Salmonella* spp, *Bacillus cereus*, *Escherichia coli*, *Staphylococcus aureus*, *Clostridium perfringens*, *Campylobacter*, *Listeria monocytogenes*, and *Vibrio parahaemolyticus* constitute more than 90 percent of the foodborne illnesses occurrences. (Bintsis, 2017) The World Health Organization (WHO) estimated that around 600 million people are infected with a foodborne disease yearly. Most people in the sample population are aware of *Salmonella* spp. and *Escherichia coli*, followed by *Staphylococcus aureus* and *Bacillus cereus*. Educating the public about the common pathogens and related preventive measures to minimize infection risk can strengthen public health effectively as foodborne illnesses can be checked with proper hygiene and sanitation. With the advancements in science and technology and the ease of public communication and extension, even the newly identified pathogens can come under control presently. Out of the 300 participants, only 18% knew about listeriosis. *L. monocytogenes* is being studied globally, emphasizing the high mortality rate linked to its infection, reaching up to 20% -30%. (WHO, 2018) Not much evidence can be found from Asian countries that indicate the high prevalence of listeriosis in those regions. India has poor foodborne disease surveillance systems and inadequate reporting on outbreaks; hence very little is known about human listeriosis cases. (Tirumalai, 2013) Studies on the isolation and prevalence of *L. monocytogenes* have discovered that bacteria are widely spread in our surroundings and inside everyday food products like milk and meat. Raw flesh food products like sausages, salamis, raw seafood (salmon, shrimps, mussels), unpasteurized milk products like soft and fresh cheese (Brie, Roquefort, Feta, Ricotta), milk, or even unclean fruits and vegetables can act as *Listeria* carriers. Unhygienically prepared food like sandwiches, deli meat recipes at retail shops, frozen foods, RTE packages can also get contaminated by *Listeria*. The 53 participants rightly identified raw/semi-cooked meat and unpasteurized milk as the source of *Listeria* on their plate, but many missed out on Seafood and Frozen/RTE. Few participants incorrectly marked fats and oils, canned products, and stored cereals and pulses as foods that this pathogen can contaminate.

Listeria monocytogenes is a low-grade pathogen. Most healthy, immune-competent individuals can overcome the infection in a few days, with or without medication. (Hof, 2003) On the other hand, a group within the human population is more susceptible to *listeria* attack, including infants, the elderly, the immune-compromised public (by drugs or due to disease), and pregnant women. (Forsythe & Hayes, 1998) When polled, the respondents recognized nearly all the high-risk sections of the population, although few people included children. Immuno-compromised, elderly, and pregnant gained the most recognition with 35, 33 and 30 scores. The infection may take up severe form and cause, particularly abortion, septicemia or central nervous system infections and meningitis within individuals of the high-risk population. (Forsythe & Hayes, 1998) Pregnant women are at risk of Listeriosis 12 times

more than the average population after consuming contaminated food. The pregnant woman herself would have mild, flu-like symptoms, but the bacteria can go past the placental barrier, cause placentitis, and then infect the developing fetus. It might result in either stillbirth or early-onset listeriosis. (Hof, 2003) A United Kingdom (UK) study found that cancer patients account for more than one-third of listeriosis cases due the low immunity. (Mook et al., 2011)

Conclusion

The survey data revealed the urgent need for an education program or scheme to spread correct knowledge and information about common foodborne illnesses. Considering the research reports on the incidence of *Listeria*, it could be drawn that bacteria has already been widely disseminated around our surroundings and, most notably in our food and raw materials. Listeriosis case counts in India have been rising with increasing accounts of sporadic cases and incidence in clinical samples. Listeriosis is an emerging foodborne disease in India and should be addressed and managed by our country as soon as possible before it causes damage like it did in the west.

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