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Health Risk Derived From Foods, About *Listeria monocytogenes*

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ABSTRACT

Food-borne diseases are considered vitally important for the public health services due to their incidence, severity and both economic and social aftermath. Among those diseases it's located the listeriosis, which presents a low morbidity and fatal consequences, being consider as one of the highest inside this group of conditions derived from the consumption of poisoned foods contaminated by the bacteria L. monocytogenes, consider as an universal distribution bacteria, tolerant to different physical and chemical conditions for its growth, such as refrigeration, as a typical food-conservation procedure. The current document shows a general scene of the food transmission diseases, in this case, the listeriosis, and its causal agent, Listeria monocytogenes, which has been consider, in the last years, as an emergent food disease in the health matter due to its severe aftermath, especially in demographic groups like the immunosuppressed, children, elderly people and pregnant women; coupled with the problem of a prevalence and a food strains' isolation that show the phenomena of resistance to multiple antimicrobials, some of them used as a first and a second option in the medical treatments against the disease. Likewise, it will show the different actions in control, search and the isolation of the pathogen in foods matters taken in different countries around the world, including México.

Key words: *Listeria, foods, pathogen, health public, listeriosis, safety food.*

INTRODUCTION

Foods and the health risks

Every human being has the right to a healthy and nutritious feeding; therefore, the foods' generation for human consumption must carry the implicit concept of safety, which is defined as the certainty of having no health problems when a product is consumed. Safety is being considered, from several years ago, vitally important for the final consumer and the food industry[5].

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During the food production and their different food chain phases, going from source materials –agricultural and fishing-, production process, transportation, storage to the consumption, are susceptible to a contamination risk, generating foodborne diseases, which are consider as one of the most frequent sanitary issues and one with a greater impact in the public health department around the world[3,5,14,25]. It is generating an estimate annual global of 600 millions of people being ill due to the contaminated food consumption and a fatality rate of 420,000 people[45]. These diseases are the main cause of illness and death in countries with a low development rate and are also related to a meaningful socioeconomic burden. Meanwhile, in developed countries, the aforementioned diseases are causing low productivity rates and high costs related to health services, implementation and monitoring of food products' policies[3,29]. Have been identified around 250 producing agents foodborne diseases, such as bacteria, viruses, funguses, parasites, prions, chemical substances and metals, generally reaching humans through water and contaminated foods[3,29,45]. Different factors have led to an increasing incidence of such diseases, like the social dietary changes, packaged foods consumption, out-of-home food, fast food stands, just to name a few[29].

Some examples of bacterial pathogens causing foodborne diseases are *Salmonella spp.*, *Shigella spp.*, *Campylobacter spp.*, *Vibrio cholerae*, *Bacillus cereus*, *Clostridium botulinum*, *Clostridium perfringens*, *Escherichia coli* O157 and *Listeria monocytogenes*[4,8]. The food-borne pathogens can lead a consumer to have serious conditions such as diarrheas or wasting infections[45], having food-borne illnesses an approximate rate of 70% in the Latin America region for acute diarrheal disease, according to data of the World Health Organization[45]. According to data from the SIRVETA –Regional Information System for the Watch of Food-Borne Diseases, for its acronym in Spanish- in the last 9 years, there have been reported 6332 foodborne diseases outbreak from 22 countries of the region; 6% in the Andean region, 63% in the Caribbean region, 4% in the Central American region, 10% in the North American region and 17% in the South American region[8]. Meanwhile, in Mexico in the 2008, the IMSS (Mexican Security Social Institute, by its acronym in Spanish) reported a care of 2,000,188 medical consultations due to gastrointestinal diseases, having the states of Chihuahua, Coahuila, Jalisco, Michoacán, Guerrero and Oaxaca as the ones with the biggest attendance[15].

The current document shows a general scene of the food transmission diseases, in this case, the listeriosis, and its causal agent, *Listeria monocytogenes*, which has been consider, in the last years, as an emergent food disease in the health matter due to its severe aftermath, especially in demographic groups like the immunosuppressed, children, elderly people and pregnant women; coupled with the problem of a prevalence and a food strains' isolation that show the phenomena of resistance to multiple antimicrobials, some of them used as a first and a second option in the medical treatments against the disease. Likewise, it will show the different actions in control, search and the isolation of the pathogen in foods matters taken in different countries around the world, including México.

Listeria spp.

The *Listeria* genre is a group of bacteria which present different distinctive features, such as being in form of bacilli, gram-positives, cryophilic and no spores-producers, positive catalase, negative oxidase, 0.4 & 1.5 μm facultative anaerobes, no capsule, immobile at temperatures in the range of 10 and 25°C, carbohydrates fermentation with acid production and no gas production and hydrolyze the esculin[10,18,36,37,40]. They are microorganisms with a wide distribution and are localizable in a natural stare in various sources such as the ground, water, foods and as diners in the animals' digestive system. The *Listeria* genre is consisting of 8 species: *Listeria monocytogenes*, *Listeria innocua*, *Listeria ivanovii*, *Listeria welshimeri*, *Listeria seeligeri*, *Listeria marthii*, *Listeria rocourtiae*

and *Listeria grayi*), being the *Monocytogenes* species consider as an emergent zoonotic pathogen of great importance to the human being with opportunistic features, causing the severe listerosis disease provoked by the ingestion of contaminated foods, which generally has fatal consequences approximately from 20% to 30%, and up to 70% in vulnerable groups[1,10,37,40,42]. Some species may be identified through a series of biochemical tests, as the ones showed in the table 1.

Table 1. Biochemical tests for the detection of species of the *Listeria spp.*[16,28]

Species	Sugars and/or derivatives metabolism			β-hemolysis	CAMP test or hemolysis *S. aureus* increase	CAMP test or hemolysis *R. equi* increase
	Xylose	Rhamnose	Mannitol			
L. monocytogenes	-	+	-	+	+	-
L. ivanovii	+	-	-	+	-	+
L. innocua	-	v	-	-	-	-
L. welshimeri	+	v	-	-	-	-
L. seeligeri	+	-	-	(+)	(+)	-
L. grayi subsp. grayi	-	-	+	-	-	-
L. grayi subs. murrayi	-	v	+	-	-	-

(+) = Weak reaction V= Variable reaction + = > 90% of positive reaction - = no reaction

Listeria monocytogenes

L. monocytogenes, based on the differences of its somatic (O) and flagellar (H) antigens, has been distinguished in some serotypes such as 1/2a, 1/2b, 1/2c, 3a, 3b, 3c, 4a, 4b, 4ab, 4c, 4d, 4e y 7, in which all of them present a pathogen nature[10,20,40], being the 1/2a, 1/2b and 4b serotypes the most commonly isolated in more than 90% of the cases of human and animal Listeriosis around the world, and 1/2a, 1/2b, 1/2c serotypes have been frequently located in foods[20,40,42]. It is a universal distribution microorganism, relatively resistant and with the ability of living at different temperatures either in refrigeration or in extreme heat/desert condition, it tolerates a pH from 3, 6 to 9, 6 and salt concentrations greater than 20%. Such features allow it to grow in the ground, vegetables, water sources, residual water, animals' intestinal tract and foods, of course. In this last form, the microorganism is capable of colonizing inert surfaces forming biofilms, including those that are in direct contact with the food and their process, establishing so a contamination source[1,10,18,41].

The serotyping is particularly consider vitally important since the gathered information will be used in epidemiological studies, in the detection and prevention of epidemical outbreaks, such that there can be a control in the contaminations during the food-chain stages, likewise the use of molecular methods like the *Random Amplification of Polymorphic DNA* (RAPD), the *Ribotyping*, the *Pulsed Field Gel Electrophoresis* (PFGE) and the DNA sequencing has permitted a better characterization of the *L. monocytogenes*, allowing to differentiate serotypes and subtypes[20,23]. The pathogen shows an unique circular genome which has been sequenced in such fashion that the *L. monocytogenes* EGD strain (1/2a serotype) presents, in its genetic material, an amount of 2,944,528 pairs of bases (pb) with 2.853 open-reading frames and a 39% content of guanine-cytosine (G+C) making it, along with other

species like the *Listeria innocua*, one with a high grade of homology in the RNAr 165 sequence, and also revealing that the aforementioned show a phylogenetic relation with other bacteria such as the *B. subtillis*[18,42].

This microorganism, due to its intracellular, facultative parasite kind, is consider a proper model for the study of the bacterial molecular mechanisms of intracellular pathogenesis, showing different stages during its infection process in human beings and animals, all of this by means of diverse factors of virulence of a protean nature (internalins, autolysins, fibronectin, hemolysin, listeriolysin, phospholipases, lecithinases, fibronectin & proteases) in which genes get organized inside of genetic units known as "islands of pathogenicity" acquired through a horizontal transference mechanism of genetic information, sometimes as a component of a movable genetic element; these virulence factors are related to the intracellular cycle of life, which stages are as follows: the entry of the bacteria inside the guest, adhesion, invasion, phagocytosis lead by the pathogen itself, phagocytic vacuole's rupture, movement in the cytoplasm and the spreading to adjacent cells[18,20,42].

The *listeriosis* is an opportunist infection that any person can obtain. Its causal agent is the *L. monocytogenes* and its transmission may be in different fashions (fecal-oral, animal-human and mother-fetus), being the contaminated food consumption the main source of outbreak, in a 99% of the cases, due to its capability of enduring in very severe environmental conditions, including refrigeration. Most of the foods consumed, related to *listeriosis*, are beef, fish, raw vegetables and no-pasteurized dairy products, cheeses, sausages, pates, ice-creams, industrially produces foods, refrigerated products and foods that doesn't require neither cooking nor heating[2,41]. So, the *listeriosis* is considered among the diseases with serious consequences for the health, in general, and also one of the highest diseases inside the group of food-borne infections[20]. There are different vulnerable groups or in risk of getting infected, and those are: newborns, pregnant women, elderly people and immunocompromised persons[10,12,20,23,40]. In adults, excluding pregnant women, the listeriosis is generally related to: neoplasias (leukemia, lymphoma or sarcoma) and antineoplastic chemotherapy, immunosuppressive therapy (organ transplants or corticosteroids), chronic hepatic disease, endocarditis, kidney disease, diabetes, HIV infections and lupus[42].

The necessary infective dose to produce listeriosis in the human being is around 100 to 10^6 cells, which will be in direct correlation with the capacity of the host's immune system, strain's virulence, the size of the inoculum and the subjacent immune system of the host[1]. *Listeria* infection has two clinic forms: A. Gastrointestinal *Listeria* non-invasive and B. Invasive *Listeria*[41]. *L. monocytogenes* is the responsible of *listeriosis* outbreaks in humans and massive infections in mammals and birds. In humans, the invasive form attacks mainly the nervous system with fatal consequences or neurological repercussions; on the other hand, in pregnant women, it can provoke abortions or infect the baby during delivery; the non-invasive form, however, results in a self-limiting gastrointestinal syndrome[23,40].

Brief look of listeriosis food around the world

L. monocytogenes is considered as a very significant sanitary and public health problem. In the food industry, its incidence and control becomes hard to do, giving the contamination a chance to come into scene in any stage of the production chain, and turning the foods into transmitting vehicles of diseases such as listeriosis, being a notable consequence of its wide distribution in the nature, its tolerance to extreme conditions (refrigeration), and its adherence capacity to surfaces in direct contact with foods, creating bio-films, giving it shelter against different physical and chemical agents[20,24]. It is considered that the strategies to reduce the incidence of the *L. monocytogenes*

in foods, just like the listeriosis cases, will be influenced by the sanitary and hygienic practices during the production and foods processing, paying special attention since the moment they are in the farm, processing plants and, even, the environment. The aforementioned involves the development e installing of control and prevention systems, like the HACCP, microbiological analysis methodologies for its detection, whether in the foods industry or health institutions, food safety education for the customers, teaching them that every product should be either cooked or heated before consumption, including those "ready-to-serve" products. Even, at a biotechnological level, it has been appealed the use of bio-preservation in foods like meat products, with the usage of crop-starters (lactic acid bacteria) which could reduce the bacterial charge of the *L. monocytogenes*.

Listeriosis is considered an infectious disease in humans, mainly a food-borne disease provoked by species of the *Listeria spp.*, genre, which can be found around the world, being *L. ivanovii* and *L. monocytogenes* the ones with a major importance in pathology and human and animal health[2]. This disease, considered a worldwide health threat for the globe's population, causes and estimate of 1,600 cases a year, resulting in 260 casualties, only in the USA[11], having identified the serotypes 4b, 1b and 1a of the *Listeria monocytogenes* as the main causal agents of the majority of Listerias in the USA[38]. For the European Union, however, is not a minor matter; in 2009, the number of reported listeriosis cases was from 1645, showing an increment of the 19.1% with respect to 2008[19]. Also, in other parts of the world, there have been a series of reports mentioning an incidence of foodborne diseases outbreaks provoked by Listeria; such information can be confirmed in the study performed by Alerte *et al*[3]., in 2012 where it mentions that 10.14% of the 2434 foodborne diseases outbreaks reports involved 12,196 people in the Metropolitan Area in Chile, in the period from January 2005 to July 2010, being the etiological implicated agents *Listeria, Giardia, Anisakis* and *Triquinosis*.

In the United States, listeriosis is a vigilance disease that requires a "mandatory report"[22], meanwhile, in Mexico, it is not consider a "mandatory report" disease, and however, from 1960 to 2011, it has been reported 60 cases, being the 4b serotype the responsible for 13 of them. The outbreaks' research and the sporadic listeriosis cases have allowed the researchers to know that the food's contamination in the production industry is a significant factor in the impact of the disease. Like in the past decades, it is noticeable a bigger awareness and a bigger worry about the food safety, and also, a bigger relation between the actions' control and the prevention of the *Listeria monocytogenes* in the foods production, with a decrease in the risk of contamination and, therefore, *Listeriosis*' cases[37]. Several countries around the world have established a series of rules or guidelines to specific products to regulate the vigilance and the control around them, in a fashion that the food safety will be assured for the products at hand of the population. Besides considering the survival features of this microorganism in different environmental conditions and its wide natural habitat in the many types of foods, either of animal origin or vegetable origin, raw or cooked, some countries, like the USA, display a zero tolerance to the *Listeria monocytogenes* in the "ready-to-serve" foods[13]. In Europe, {the Commission of the European Communities, through its regulation (CE) No. 2073/2005 of the Commission on the November 15th, 2005, and modified by the regulation (CE) No. 1441/2007 of the Commission on the December 5th, 2007}[33], relative to the applicable criteria for microorganisms in the food products, establish that, in the matter of "ready-to-serve" products designated to infants, and "ready-to-serve" products

designated to specific medical uses, *Listeria* must be absent in every 25g and this must be applicable during the commercialization and the product's useful life. In South America, in countries like Chile, the sanitary regulation for foods DTO No. 977/96 (D.OF. 13.05.97)[35] from June 2010, establish the microbiologic criteria for Listeria in the "ready-to-serve" cataloged foods designated to infants less than 12 months old presenting a zero tolerance in every 25g of the foods. Meanwhile, in Mexico, the official Mexican regulation[27], referred to products that can be *Listeriosis*' vehicles like milk, formula milk, combined milk products and dairy products, states that the *Listeria monocytogenes* must be absent in 25g or mL of the foods. For the food products, such as fresh fish, refrigerated and processed products, the official Mexican regulation[26], in its sanitary specifications mention that the *Listeria monocytogenes* must be absent in 25g of the products. Like the aforementioned regulation[28] is referred to the microbiologic test methods, the determination of indicatory microorganisms and pathogens, establishing the methodology for both the isolation and identification of the causal agent of the listeriosis in foods.

Microbiological analysis of the foods

In the specialized literature there have been reported different microbiological methods about the isolation and detection of the *Listeria monocytogenes* in foods; some are used in sundry countries around the world and whose share some similarities as for stages, conditions and cropping manners as selective agents and enrichment procedures to reduce the number of polluting agents and allow the proliferation of the target pathogen. Among the established methods, just to name a few, is the proposed by Hitchins *et al*[16]., in the Bacteriological Analytic Manual (BAM) of the FDA in the USA, which implicates the qualitative and quantitative determination that include different stages during the analysis, such as the strain's preparation, the enrichment procedures (Buffered Listeria Enrichment Broth with pyruvate acriflavin, cycloheximide and sodium nalidixic acid), the isolation in selective crop methods (Agar Oxford, PALCAM, modified Agar Oxford, Lithium Chloride-Phenylethanol-Moxalactam Medium and chromogenic agars), the identification by means of biochemical properties (Catalase, fermentation of xylose and rhamnose, mobility, gram staining, hemolysis, CAMP test, etc.) as well as the serotyping, genetic analysis and enumeration via the most probable number or via the direct counting in the plaque. Besides, the author mentions different quick alternative screening methods based on immunoenzymatic rehearsals. Other lab methods involved in the detection of the food pathogen, it would be the method reported by the United States Department of Agriculture, Food Safety and Inspection Service, Office of Public Health Science at the Laboratory Guidebook -MLG 8.09- entitled: Isolation and Identification of *Listeria monocytogenes* from Red Meat, Poultry and Egg Products, and Environmental samples[44], also the method of the regulation[17] for microbiology in the foods and animal foods consisting on the detection and re-counting of the *L. monocytogenes*, the method reported by the Public Health of England[31] the Standard Method FNES22, and the official Mexican regulation[28] from 2014, which has a concordance with the international normativity[17] in its first edition.

In the figure 1 it is shown a flow chart for the isolation and detection of the *Listeria monocytogenes* in foods, which is taken from the current Mexican regulation[28] for the detection of the pathogen in foods. This normative shown with some analogies with the international normativity[17], the method reported by the Public Health of England 2014 (Standard Method FNES22)[31] and in the analysis reported by Hitchins *et al*[16]., as are some culture media and biochemical identification.

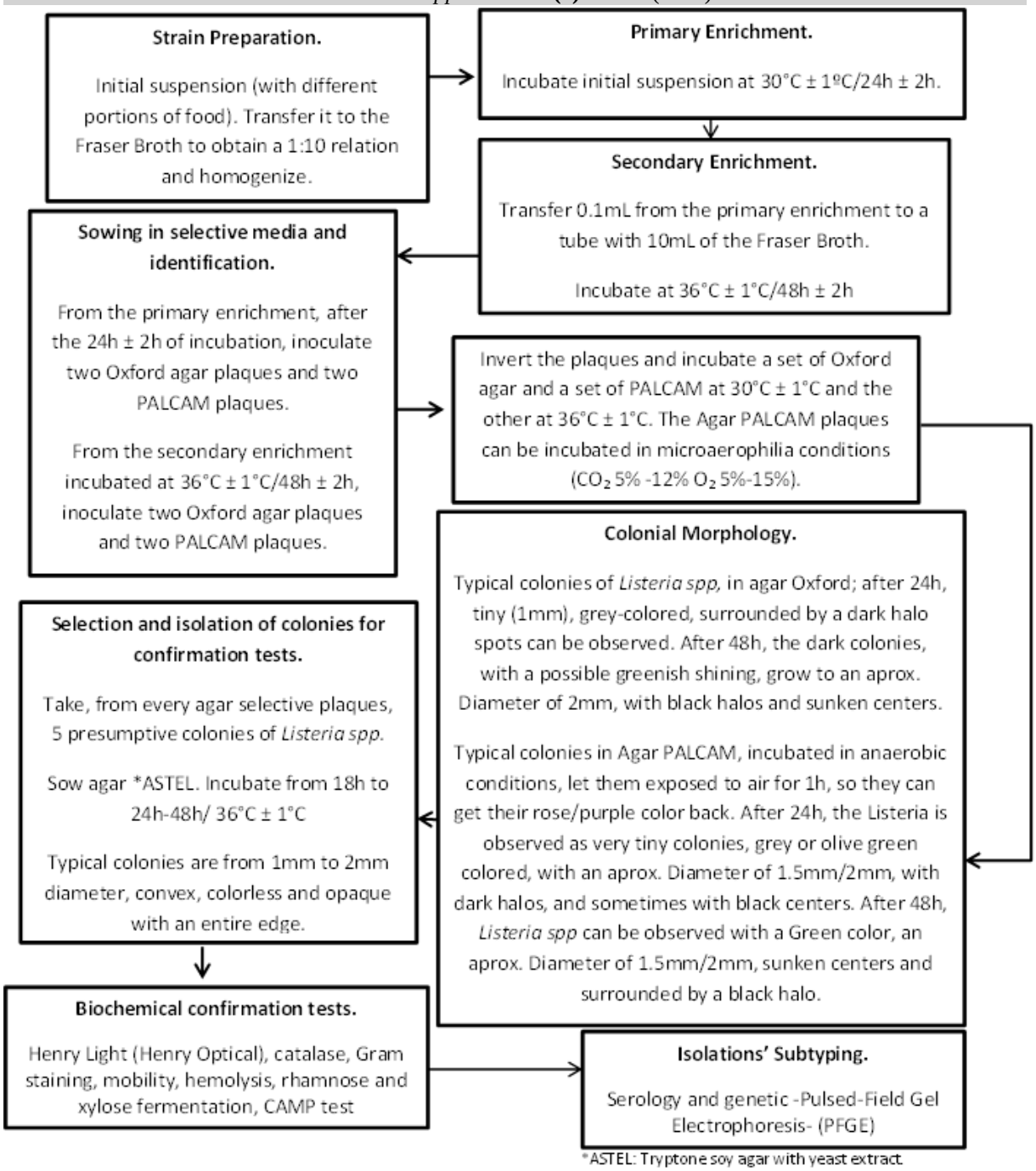

Fig. 1: Flow chart for the isolation and detection of the *Listeria monocytogenes* in foods

Added to this, studies of *Listeria spp.*, strains can be complemented, and more specifically *Listeria monocytogenes* isolated in foods or clinical cases, and for those matters there are methods that allow to dispose of information at different levels of typing, genetic and ecology, all of those with the target of having more specialized studies, and so is the case of the epidemiological analysis that includes the classic serotyping and the molecular serotyping, Pulsed-Field Gel Electrophoresis (PFGE), Random Amplification of Polymorphic DNA (RAPD), Multilocus Sequence Typing (MLST) and Multiple-Locus Variable-number tandem repeat Analysis (MLVA), being the PFGE the tool with the highest levels of discrimination that permits the detection and control of the listeriosis outbreaks in humans, associated to the consumption of foods, even though when they extend in time or space, and so the possible origin of the infection can be tracked[43].

Search for the *Listeria monocytogenes* in foods

The causal agent of the listeriosis can reach the food from any point in the process chain, for which, several researches has been made around the world to detect this pathogen in different foods, going from raw materials to the manipulators. Muñoz *et al*[25]., in 2013, reported that the prevalence of *L. monocytogenes* in Colombia was found in manipulators of establishments of food production in the branches of dairy products and meat products in 10 cities of Colombia (Antioquia, Atlántico, Boyacá, Caquetá, Córdoba, Cundinamarca, Meta, Nariño, Santander and Valle del Cauca), gathering a total of 1,322 samples, from which the 10.4% tested positive for *L. Monocytogenes*; in every city the pathogen was detected in the manipulators, being the Nariño city the one with the highest rate of positive tests (31.2%). The conclusion is that those results are a useful tool for the epidemical characterization of the pathogen, and reinforce the public health vigilance against the food-borne diseases, and also help for the addressing to strategies to reduce the foods' contamination, making special emphasis in the manipulators as a risk factor and the knowledge of the safety food factors and their importance.

Kramarenko *et al*[19]., conducted, in the country of Estonia, a study for the detection of the *Listeria monocytogenes* in different foods from 2008-2010, and it showed that, from 21,574 samples obtained, 554 of them (2.6%) tested positive for the listeriosis causal agent, being the most contaminated: raw meat and derivate products (18.7%), raw mixed salads (18.5%) and 'raw' milk (18.1%), all of them compared to raw fish products (8.8%) indicating that, among the "ready-to-serve" products, the cold smoked fish were the most contaminated with *L. monocytogenes* (32.9%). Finally, the author indicates that the majority of isolations of the pathogen strain belongs to the 1/2a serotype (73.6%), followed by the 1/2b (7.4%), 1/2c (7.4%), 4b (7.7%) and 4d (3.5%).

Meanwhile, Rubio *et al*[39]., conducted a study to determinate the presence of various food pathogens, one of them, the *Listeria monocytogenes* in both Mexican and imported meat marketed in 3 important cities in Mexico: Monterrey (Nuevo Leon state), Villahermosa (Tabasco state) and Ciudad de Mexico (Distrito Federal state) which represent the main economic regions in the country; the results showed an average occurrence total of *L. monocytogenes* of 27.78% in 90 collected samples; in the city of Monterrey, per example, none of the samples (30) tested positive in the imported meat, however, the national meat tested positive in a 26.7% (8). In Mexico City, from 40 taken samples, the imported meat tested positive in 17.5% (7) and the national meat tested positive in 10% (4), and finally in Tabasco, the imported meat tested positive in 5.0% (1) and the national meat tested positive in 25% (5), concluding that it exists the necessity of implementing some mandatory preventive programs as standard procedures for sanitation and operation and Hazard Analysis and Critical Control Points (HACCP) as a requirement in the agriculture department and food safety since in countries like the USA has given excellent results for the decreasing of the pollution by pathogens in the beef.

Rosas-Barbosa *et al*[37]., conducted a study to determine the presence of *Listeria* in 4 craft-made cheese-shops (A, B, C, D) coming from the state of Jalisco, those are the producers of the following cheese types: Adobera, Fresco, Panela and Requeson, obtaining 392 samples that included: raw milk, rennet, curd, cheeses, equipment, surfaces, floor, brooms and brushes used for the cleaning during a period from February 1999 to October 2000. The results indicated that the *Listeria* was found, per cheese-shop, as follows: A: 55%, B: 33%, C: 26 and D: 7%. Surfaces, floors and cleaning equipment were the ones with the highest amount of positive results. The isolated species were: *L. monocytogenes, L. innocua, L. welshimeri y L. ivanovii*. About the cheese samples, the study showed that 18% of the 59 samples coming

from the A and C cheese-shops tested positive for *Listeria Monocytogenes*, and in the A store were found the serovars 1/2a, 1/2b, motionless 1/2 and 4d. The researchers concluded that the food producers mean a source of infection for *listeriosis* for the consumers, they also state the pollution in the crafting process is a dynamic procedure where the contamination and elimination procedures are a consequence of an interaction among some factors, such as the environment, pathogen strains features, adequate facilities for food processing, practices of facilities' cleansing (floors, equipment and surfaces) and personal hygiene actions.

Sensibility to the antimicrobials

The phenomenon of resistance presented by the microorganisms to the antimicrobials is considered a very serious problem in the public health topic, next to the one already existing, due to the danger and severity in the foodborne diseases. The resistant microbial strains appeared by the very first time inside various hospitals where such strains were used regularly and, according to epidemiological studios, Latin America has a very high incidence of nosocomial outbreaks produced by bacteria that show a high resistance to many antibiotics. The aforementioned phenomenon is due to the indiscriminate use of such compounds in a variety of activities, like medicine for treatment of human diseases, agriculture, animal breeding and aquaculture for food production, among others; as well as the lack of educational measures in the using and handling of the meds in a fashion the resistance phenomenon has spread and it is present in both developed and sub-developed countries[9,40].

Some mechanisms have been established whereby the transference can occur, or the dissemination of resistant genes to the antimicrobials between microorganisms, like: 1. Translocation, 2. Horizontal or vertical transmission by conjugation, transformation or transduction (Transposons), 3. The spreading of resistant microorganisms through different flows between animals and environment, 4. Dissemination, from the animals to humans by direct contact and foods, 5. Dissemination around the world by commercialization of animals and contaminated products and 6. Through the antimicrobial resistance transmission in the health institutions[7,40].

Once the microorganisms obtain the capacity of resistance to the action of antibiotics, they express it in different ways, such as: the permeability's membrane modification, the compound's ejection by pumping mechanisms, the antimicrobial inactivation by modification or degradation, the enzymatic inhibition, the modification of a target or the disturbance in the composition and the content of the bacterial wall[32,34].

In the case of the *Listeria spp.*, resistance to the antibiotics, it has been reported that such phenomenon is due to some mechanisms involving 3 mobile genetic elements: auto-transferable plasmids, movable plasmids and conjugation transposons (Tn*916* and Tn*1545*), and also it has been described two specific expulsion bombs of a proteinaceous nature (MdrL and Lde), codified in the genes *mdrL* and *Ide*, which are involved in the removal of toxic substances for the *L. monocytogenes*[21].

In recent years, there have been reports stating that this microorganism shows an "in vitro" sensitivity to a wide spectrum of antibiotics (penicillin, ampicillin, gentamicin, erythromycin, tetracycline, cotrimoxazol, rifampicin and vancomycin), meanwhile, it has been reported that all of the *Listeria monocytogenes* are resistant to fosfomycin, pipemidic acid, aztreonam, and dalfopristin / quinupristin and, in some isolations, it has been shown resistances generally codified through chromosomes, plasmids and transposons transferred horizontally or vertically to third-generation cephalosporins, macrolides and tetracyclines[40,42]. The studies in this field continue and the number has increased, due to a worry in the spreading of this phenomenon and more frequently in strains coming from foods, as in the last years, researchers have reported a phenomenon of resistance in *Listeria monocytogenes* strains isolated and coming from dairy products to

ampicillins, chloramphenicol, clindamycin, erythromycin, gentamicin, oxacillin, penicillin, tetracycline, trimethoprim / sulfamethoxazole, and vancomycin, on the other hand, in meat products, isolated strains showed resistance to cephalothin, doxycycline, chloramphenicol, gentamycin, nalidixic acid, trimethoprim / sulfamethoxazole, ampicillin and erythromycin[21]. The ampicillin and gentamicin are the first election antibiotics, and trimethoprim / sulfamethoxazole are the second choice in the listeriosis treatment in humans[30,36]. Finally, the codifying genes for the antibiotic resistances are known as tetracyclines (*tetA, tetL, tetM, tetS*) and erythromycins (*ermC*) in the *Listeria monocytogenes*[21].

The human listeriosis transmitted through foods is consider a very relevant topic due to its severe aftermath in the public health; meanwhile, the antimicrobial resistance of the *Listeria spp.,* is consider as emergent due to its worldwide isolation in humans' strains, foods production chains, or environment resistant to antibiotics; all of that is focused on food matters and it has given place to deliberations by severe authors, who conclude that the technologies employed in the processing and conservation processes routinely in the food industry, such as refrigeration, dehydration, freezing, thawing, salt treatments, acid pH, exposition to disinfectants and other antimicrobial substances, affect in the physiological state and the virulence of this pathogen, selecting bacterial subpopulations resistant to the stress, and with a major virulence that relate to a greater incidence of food outbreaks[2,21,40].

In some of the conducted studies about the antibiotic resistance showed by some bacteria of the *Listeria* genre, more specifically that one of Balsalobre and Hernandez[6], displayed the sensitivity of the *Listeria monocytogenes* to 17 different antibiotic in 30 isolations, as from fresh meat and derivate products (fresh sausages, Spanish sausage, burger meat, meatballs, cooked ham), reporting, exclusively, the resistance to the tetracycline (30µg) and, even though the resistance profile is low, distribution can have significant geographic differences depending on some habits in the use of the antibiotics. And also, the author emphasizes that *Listeria* is capable of gaining resistances from other bacterial genres that may be not so related (*Enterococcus spp. and Streptococcus spp.*), carrying a bigger problem: the possible future treatment of diseases caused by such pathogens and the number of resistances they can obtain in the way.

Pesavento *et al*[30]., conducted a study where it was reported the isolation and sensitivity to the antibiotics by the *Listeria spp.* in raw foods (cow, chicken and pig meat) and retail commercial foods (fresh cheese, salads, ham, salmon and sandwiches); from a total of 1268 samples, 148 tested positive for *Listeria* spp., 40 samples were identified as *L. monocytogenes*, and from those, the 37.5% showed resistance to an antibiotic, and the 27.5% showed resistance to 3 or more antibiotics and only the 10% were susceptible to the used antibiotics, the 20% showed a resistance to the ampicillin, meanwhile, 22.5%, 7.5% and 27.5% a methicillin, gentamicin and clindamycin, respectively. The study concluded that the resistance phenomenon has been increasing during the last couple of years, besides that it is very important to identify the foods which can represent a serious risk for the health.

CONCLUSIONS

The food safety is a central point in the whole foods production chain, because nourishment, besides supplying every necessary nutrient for the everyday activities, it must guarantee no health damages once it is consumed. The *Listeria monocytogenes* is an emergent, opportunist pathogen of great relevance in the health area and the foods area due to its severe, vicious aftermaths in humans, wide distribution, tolerance to conservation conditions and transmission through foods. Due to the aforementioned, both vigilance and control of the *Listeria monocytogenes* has been so relevant around the world, either for government entities or for the food industry;

however, in recent years, it has gained a bigger emphasis because of the health problematic raised around the antimicrobial resistance. Since it has been gaining strength, multiple actions must be taken by all the instances: government institutions, social sectors, pharmaceutical industry and the food industry are led to exert an awareness in the use of antimicrobial in medical treatments and its use in another activities, such as: cattle raising, agriculture and aquaculture, to try to control and reduce the incidence of resistant microorganisms, including *Listeria*, that can make room to food-borne diseases which resistant, causal agents generate even bigger aftermaths in the matters of health, economy and society.

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