Food and Agriculture Organization of the United Nations

World Health Organization

Joint FAO/WHO Expert Meeting on Microbiological Risk Assessment of *Listeria monocytogenes* in foods. Part 2: Risk Assessment Models
WHO HQ, Geneva, Switzerland: 29 May – 2 June 2023

SUMMARY AND CONCLUSIONS

Issued in July 2023

A Joint FAO/WHO Expert Meeting on Microbiological Risk Assessment of *Listeria monocytogenes* in foods was convened in response to Codex Committee on Food Hygiene's (CCFH) request at its 52nd session[1] to undertake a production-to-consumption risk assessment of *Listeria monocytogenes* in foods, to inform a possible future revision of the *Guidelines on the Application of General Principles of Food Hygiene to the Control of* Listeria monocytogenes *in Foods* (CXG 61- 2007)[2].

This document summarizes the conclusions and recommendations of the microbiological risk assessments of *L. monocytogenes* in specific foods; namely, diced ready-to-eat (RTE) cantaloupe, frozen vegetables and cold-smoked ready-to-eat (RTE) fish, in light of new data and approaches. This document has been prepared to facilitate the deliberations of the upcoming CCFH meeting. A full report of the meeting will be published as part of the Food and Agriculture Organization of the United Nations (FAO) and World Health Organization (WHO) Microbiological Risk Assessment (MRA) Series.

The meeting participants are listed in Annex 1 of this summary report. Dr. Roland Lindqvist served as Chairperson and Dr. Bing Wang as Rapporteur.

[1] **FAO & WHO.** 2022. Codex Alimentarius. Report of the 52nd Session of the Codex Committee on Food Hygiene. http://www.fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%252Fcodex%252FMeetings%252FCX-712-52%252FReport%252FREP22_FHe.pdf

[2] **FAO & WHO.** 2007. Codex Alimentarius. Guidelines on the application of the general principles of food hygiene to the control of *Listeria monocytogenes* in foods (CAC/GL 61 - 2007). https://www.fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%252Fcodex%252FStandards%252FCXG%2B61-2007%252FCXG_061e.pdf

More information on this work is available at:

http://www.fao.org/food-safety/en/

and

https://www.who.int/foodsafety/en/

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Background

FAO and WHO have undertaken risk assessments of *Listeria monocytogenes* in various foods since 1999. This work has provided scientific insights into the risk characterization of *L. monocytogenes* through food consumption, with the consideration of the susceptibility of different populations (MRA4 and MRA5)[3,4]. In 2020, a virtual meeting of the Joint FAO/WHO Expert Meeting on Microbiological Risk Assessment (JEMRA) of *L. monocytogenes* in ready-to-eat (RTE) food: attribution, characterization and monitoring, recommended expanding future risk assessments on *L. monocytogenes* in RTE food to diverse commodity sub-groups, incorporating a production-to-consumption perspective, and reviewing groupings of susceptible populations (MRA38)[5]. Therefore, the 52nd Session of the CCFH requested JEMRA to undertake full production-to-consumption risk assessments of *L. monocytogenes* in foods to inform a possible revision of the *Guidelines on the Application of General Principles of Food Hygiene to the Control of* Listeria monocytogenes *in Foods* (CXG 61- 2007)[6]. In response to this request, JEMRA convened two meetings, one each in 2022 and 2023, for the preparation and development of risk assessments of *L. monocytogenes* in various foods. In the first meeting (hereafter Part 1 expert meeting), the expert group elaborated formal models for the risk assessment of *L. monocytogenes* for lettuce, cantaloupe, frozen vegetables and RTE fish and it was concluded that these models should be programmed, tested and reviewed[7]. During this second meeting (Part 2 expert meeting), several risk assessment models were developed and evaluated to characterize the risk of listeriosis due to the consumption of diced RTE cantaloupe, frozen vegetables, and cold-smoked RTE fish. However, the model for RTE lettuce was not ready for the experts to evaluate.

Scope and objectives

The FAO/WHO Joint Expert Meeting on Microbiological Risk Assessment (JEMRA) convened a meeting in Geneva, Switzerland, from 29 May to 2 June 2023, with the scope of performing risk assessments of *L. monocytogenes* in selected foods using models developed since the Part 1 expert meeting. The objectives were: i) to test and evaluate the full production-to-consumption models for the selected commodities, ii) to use the models with different scenarios to provide examples and recommendations to risk managers to control *L. monocytogenes*, and iii) based on the findings, to inform possible updates of the *Guidelines*

[3] MRA4: https://www.fao.org/documents/card/en/c/dfba1baa-f028-50f9-96d1-09f6137f6f7c/ or https://www.who.int/publications/i/item/9241562617

[4] MRA5: https://www.fao.org/documents/card/en/c/b99a38f9-8636-5738-b369-38247c284643/ or https://www.who.int/publications/i/item/9241562625

[5] MRA38: https://www.fao.org/documents/card/en/c/cc2400en or https://www.who.int/publications/i/item/9789240034969

[6] **FAO & WHO.** 2007. Codex Alimentarius. Guidelines on the application of the general principles of food hygiene to the control of *Listeria monocytogenes* in foods (CAC/GL 61 - 2007). https://www.fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%252Fcodex%252FStandards%252FCXG%2B61-2007%252FCXG_061e.pdf

[7] Summary and conclusions: https://www.fao.org/3/cc2966en/cc2966en.pdf or https://www.who.int/news-room/events/detail/2022/10/24/default-calendar/joint-fao-who-expert-meeting-on-microbiological-risk-assessment-of-listeria-monocytogenes-in-foods

on the application of general principles of food hygiene to the control of Listeria monocytogenes *in foods* (CAC/GL 61 - 2007) (FAO and WHO, 2007).

The expert group agreed:

- To evaluate the models by comparing the structures suggested from the Part 1 expert meeting with the functions implemented in the new models and testing models' flexibility to change data inputs.
- To evaluate the outputs of models when tested with reference scenarios, by comparing with published results and/or expert experience, and to optimise parameterisation of models if needed.
- That the models used for the scenario evaluation were for the diced RTE cantaloupe, frozen vegetables, and cold-smoked RTE fish.
- To use an updated dose response model.
- That the outputs to evaluate were the average per-serving risk for the susceptible population using the JEMRA dose response model developed in 2004[8] and the average per-serving risk (hereafter referred to as "risk") when integrated over all age and gender groups in the population using the updated dose-response model.
- That for each of these models a reference scenario was run representing a well-managed process, and consequently resulting in a low probability of risk of *L. monocytogenes* in food.
- That alternative scenarios were selected to accomplish the objectives in alignment with the recommendations from the Part 1 expert meeting, spanning different stages from primary production to consumption, and addressing factors such as time-temperature control, cross-contamination, environmental hygiene practices, water management, and climate change.
- That modelling results are subject to assumptions and context, making relative indicators more appropriate.
- That the relative impact of different factors and interventions along the production-to-consumption continuum was estimated by comparing the alternative scenarios to the reference scenario.
- To evaluate/illustrate the impact of virulence and susceptibility on risk with the updated dose-response model distinguishing classes of *L. monocytogenes* strains of different virulence.

[8] MRA5: https://www.fao.org/documents/card/en/c/b99a38f9-8636-5738-b369-38247c284643/ or https://www.who.int/publications/i/item/9241562625

Conclusions

The expert group concluded the following:

Risk assessment models

- The processes and the steps from the Part 1 expert meeting and the structure and functions in the evaluated risk assessment models were consistent.
- The functions and parameters of the models as provided can be modified to evaluate the model performance and evaluate different scenarios.
- The outputs generated by the models were consistent with expert experiences. Based on the evaluation process that could be achieved during the meeting, the risk assessment models were considered useful and fit-for-purpose.
- The dose-response model can be further improved by considering additional factors, such as underlying health conditions of populations at risk.
- There is a need for additional representative data on *L. monocytogenes* in the food chain to better inform *L. monocytogenes* occurrence, virulence, and dose-response, so that a risk assessment for different classes of virulence of *L. monocytogenes* strains can be performed.
- The models should remain available as open-source tools.

Conclusions from elaboration of the risk assessment models

These conclusions are based on the conditions, data and practices simulated and evaluated in the scenarios during the meeting. Further, applicability and implication depend on specific conditions and individual production practices.

Diced RTE cantaloupe

- The model considered a full production-to-consumption chain representing pre-harvest, harvest and storage, cleaning and washing, processing, cold chain storage, and consumer handling practices.
- The use of fit-for-purpose water in primary production was shown to reduce the risk.
- The use of an irrigation system that avoids the contact between water and the edible part of the crop also reduced the risk.
- Poor management of wash water increased the risk. The magnitude of the effect is dependent on the level of contamination in the wash water and amount of water deposited on the product.
- Poor management of environmental hygiene during processing increased the risk.
- Climate change can considerably increase the risk as a result of its impact on different stages of the production-to-consumption chain, as tested in the model by assuming an increase of the prevalence of *L. monocytogenes* in soil, an increase of the quantity of soil transferred to produce (e.g. number of rainy weather days), a decrease of the agricultural water quality and an increase of storage temperature.

Frozen vegetables

- The stages represented in the model considered pre-conditioned vegetables as the raw material and included processing (blanching and packaging), environmental contamination, and consumer handling practices (defrosting and cooking).
- Blanching reduced the risk of *L. monocytogenes*. However, post-blanching contamination and growth of *L. monocytogenes* may occur.
- Poor environmental hygiene management increased the risk.
- If non-RTE frozen vegetables are consumed without adequate cooking, then defrosting practices influence the risk.

Cold smoked RTE fish

- The model considered a full production-to-consumption chain including primary processing, secondary processing, cold-chain, and consumer handling.
- Considering the presence of the naturally occurring lactic acid bacteria (LAB) in the predictive growth model reduced the risk.
- Increased *L. monocytogenes* levels on incoming fish increased the risk.
- Poor environmental hygiene practices at filleting and slicing increased the risk.
- An elevated level of contamination of *L. monocytogenes* in brine solutions increased the risk.
- Addition of lactic acid and diacetate or LAB culture to the product lowered the risk due to the reduced growth of *L. monocytogenes*.
- The potential effect of climate change, evaluated by assuming an increase in the initial levels of *L. monocytogenes* in the raw fish and an increase in the storage temperature during the shelf-life of the product, led to an increase of risk.

Dose-response (DR) model

- An updated DR model was developed to take into account class of strain virulence and age-sex group, as a surrogate for susceptibility, as determined by underlying health conditions.
- The updated model allowed for improved risk estimation for different classes of strain virulence.
- The updated DR model resulted in greater relative risk between the most extreme DR curves, based on age-sex group and class of strain virulence, compared with other age-sex based DR models.
- The updated model still lacks the actual information on susceptibility (as determined by underlying health conditions), and its potential interaction with defined classes of strain virulence. This information would make the DR model more specific and globally relevant.

Testing

- End-product sampling and microbiological testing on its own as a control measure had little effect on reducing the risk, even when applied to every lot produced (e.g., for lot release). However, there is a value in sampling and testing to verify that other control measures are effective, as described in MRA24[9].

Recommendations and considerations for the revision of guidelines related to control of *L. monocytogenes*

- General
  - The ability of a food to support growth of *L. monocytogenes* and the likelihood of its consumption without further processing or treatment depend on consumers' practices which may deviate from the intended use of the food. Hence, caution should be used when classifying foods into distinct categories, e.g. as supportive/non-supportive of the growth of *L. monocytogenes,* or as RTE / non-RTE.
  - The potential effects of climate change, such as increased temperatures and contamination, should be assessed by food business operators (FBO) and effective control measures should be implemented if needed.
- Primary production
  - Control of *L. monocytogenes* at primary production can reduce the risk.
- Processing
  - The impact on the predicted risk of contamination during processing highlights the need for effective management of environmental hygiene practices.
  - An important value of end-product sampling, environmental sampling and microbiological testing is to verify the effectiveness of implemented control measures.
- Product information and consumer awareness
  - The impact of non-intended use of food highlights the need for improved food labelling about intended preparation and use.
  - Consumer education on safe preparation, food storage, and intended use should be enhanced.
  - FBO should provide clear messages to consumers for intended food use (e.g., website and social media).

[9] MRA24: https://www.who.int/publications/i/item/9789241565318

Annex 1: List of participants

EXPERTS

Ana Allende, Centro de Edafología y Biología Aplicada del Segura-Consejo Superior de Investigaciones Científicas, Spain

Li Bai, China National Center for Food Safety Risk Assessment, China

Elena Carrasco Jiménez, University of Cordoba, Spain

Heidy M. W. den Besten, Wageningen University, the Kingdom of the Netherlands

Qingli Dong, University of Shanghai for Science and Technology, China

Aamir Fazil, Public Health Agency of Canada, Canada

Andreas Kiermeier, Statistical Process Improvement Consulting and Training Pty. Ltd., Australia

Jovana Kovacevic, Oregon State University, the United States of America

Roland Lindqvist, Swedish Food Agency, Sweden

Bing Wang, University of Nebraska-Lincoln, the United States of America

RESOURCES PERSONS

Sarah Cahill, Joint FAO/WHO Food Standards Programme, Italy

Vasco Cadavez, Instituto Politécnico de Bragança, Portugal

Ursula A. Gonzales-Barron, Instituto Politécnico de Bragança, Portugal

Laurent Guillier, French Agency for Food, Environmental and Occupational Health & Safety, France

Régis Pouillot, Independent Consultant, Morocco

SECRETARIAT

Juliana De Oliveira Mota, World Health Organization, Switzerland

Akio Hasegawa, World Health Organization, Switzerland

Jeffrey LeJeune, Food and Agriculture Organization of the United Nations, Italy

Moez Sanaa, World Health Organization, Switzerland

Kang Zhou, Food and Agriculture Organization of the United Nations, Italy