CODEX ALIMENTARIUS COMMISSION

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Viale delle Terme di Caracalla, 00153 Rome, Italy - Tel: (+39) 06 57051 - E-mail: codex@fao.org - www.codexalimentarius.org

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JOINT FAO/WHO FOOD STANDARDS PROGRAMME
CODEX COMMITTEE ON FOOD HYGIENE

VIRTUAL
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PROPOSED DRAFT GUIDELINES FOR THE SAFE USE AND RE-USE OF WATER IN FOOD PRODUCTION

(Prepared by the Electronic Working Group chaired by Honduras and co-chaired by Chile, Denmark, European Union and India)

Codex members and Observers wishing to submit comments at Step 3 on this draft should do so as instructed in CL 2021/64/OCS-FH available on the Codex webpage/Circular Letters 2021: http://www.fao.org/fao-who-codexalimentarius/circular-letters/en/

INTRODUCTION

1. At the 51th Session of the Codex Committee on Food Hygiene (CCFH51) in November 2019, Honduras, Chile, Denmark, India and the European Union introduced a discussion paper and project document on Guidelines for the safe use and reuse of water in food production. CCFH51 agreed to take on this new work[1], and to structure the document to include overarching guidance followed by commodity-specific guidance. CCFH51 agreed that the guidelines should be developed using a step-wise approach, with the annexes on fresh produce and fishery products being priority.

2. CCFH51 also agreed to establish an electronic working group (EWG), chaired by Honduras, and co-chaired by Chile, Denmark, India and the European Union, and working in English. The co-Chairs provided proposed terminology/definitions for the commodities that are within the scope of the guideline, stressing that further scientific advice from JEMRA was needed to progress development of the guideline (and itsannexes).

3. The new work was approved by CAC43[2].

PARTICIPATION AND METHODOLOGY

4. The JEMRA report (Safety and Quality of Water Used in Food Production and Processing) published in 2019 has been a fundamental part of the development of these guidelines. During CCFH51, JEMRA was requested to provide scientific advice on sector-specific applications and case studies for determining appropriate and fit-for-purpose microbiological criteria for water sourcing, use and reuse in (1) fresh produce, (2) fish and fishery products (e.g. crustaceans, molluscs and cephalopods) from primary production to retail, and (3) the dairy sector from milk harvest to manufacturing, which will be used as a reference document to continue developing the fishery products annex and initiate the dairy annex.

5. An invitation was sent to all Codex Members and Observers to participate in the EWG. Participants from 34 Codex Members and 9 Observers were registered. The list of participants is attached as Appendix II. The EWG work was conducted online using the Codex Forum.

6. The General section and the two annexes (i.e. Fresh Produce and Fishery Products) went through two rounds of comments by EWG members and revisions were made by the co-Chairs. Revised drafts of the General Section, Fresh Produce Annex, and Fishery Products Annex, were posted on the Forum in May 2020 for EWG input. The second round of consultation was carried out on a revised version and published on the forum in May 2021.

7. For the first round, comments on the General Section were received from 14 Members and 3 Observers; comments on the Fresh Produce Annex were received from 15 Members and 1 Observer; comments on the Fishery Products Annex were received from 11 members. For the second round, comments on the General Section were received from 8 Members and 3 Observers; comments on the Fresh Produce Annex were received from 8 Members; and comments on the Fishery Products Annex were received from 8 Members.

[1] REP20/FH, para 116 and Appendix V.
[2] REP20/CAC, para. 77 and Appendix V

8. The co-Chairs asked for input from the EWG on a number of issues in the documents circulated, including definitions, the retention of certain text, organization of the information, whether the annexes should all follow the same format and examples and/or case studies for determining appropriate and fit-for-purpose microbiological criteria. Comments from the EWG members were used to revise the General Section, the Fresh Produce Annex, and the Fishery Products Annex.

SUMMARY OF DISCUSSION

9. The EWG agreed with the structure and the sections addressed throughout the document. Nevertheless, one of the most debated issues in the general section of the document was to determine whether the correct term to use throughout the document is "drinking water" or "potable water". The co-Chairs considered that it was more appropriate to adopt the term "potable water", since it is widely used in other Codex texts and the JEMRA report. The members are being asked to agree to consider using the term potable water in the document.

10. Also, for the General Section, members of the EWG were invited to determine which definitions were most appropriate for the document, giving them as options for definitions obtained from the JEMRA report,[3] EU 2017/C 163/01[4] and Codex documents and if they agreed with the proposed structure for the document. There was no major dispute among the selection of definitions and most of them agreed that the document had the appropriate structure.

11. Members of the EWG were invited to express their views on whether examples for determining appropriate and fit-for-purpose microbiological criteria should be considered as a way to address Fresh Produce Annex. By way of example, one from the EU 2017/C 163/1 was proposed for consideration and additional examples and/or case studies were invited from EWG members. Despite this request, no examples and/or case studies for determining appropriate and fit-for-purpose microbiological criteria were provided. Some Members indicated that examples and decision trees to determine if water is fit for purpose should be validated by JEMRA. In addition, it was discussed whether the document should include or make reference to the *Code of Hygienic Practice for Fresh Fruits and Vegetables* (CXC 53-2003), and whether the parts on the use of water in CXC 53-2003 should be included in the annex and removed from CXC 53-2003. Apart from this general issue, a number of suggestions were made in these parts extracted from CXC 53-2003, which were addressed by the co-Chairs.

12. EWG members noted that additional definitions could be added in the Fishery Products annex (or a reference to them), especially those addressed in the *Code of Practice for Fish and Fishery Products* (CXC 52-2003). In the same way, the EWG expressed that the definitions in this annex should be more aligned with Codex documents or JEMRA reports, especially the definition of fishery products. Moreover, members expressed that it is not necessary to include an example of *Salmonella spp* in the decision tree (DT) as it is considered that the example of *Vibrio parahaemolyticus* would be sufficient, but water temperature should be considered in the DT since it is an important factor for microorganism growth.

13. Based on the comments received, the co-Chairs have revised the General section and the annexes, which are attached in Appendix I.

CONCLUSIONS

14. The EWG completed the tasks assigned by the CCFH51 and drafted a guideline for the safe use and re-use of water in food production composed of a General Section, Fresh Produce annex and Fishery Products annex.

15. The dairy sector annex will be developed once the JEMRA report on Water use and re-use in the dairy sector becomes available.

RECOMMENDATIONS

16. CCFH is invited to consider:

i. The proposed draft Guidelines as presented in Appendix I: The General Section and the annexes on Fresh Produce and Fishery Sector; and

ii. specifically providing inputs as follows:

a) Whether the term "potable water" rather than "drinking water" should be used throughout the document.

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[3] JEMRA report 2019 (Safety and Quality of Water Used in Food Production and Processing) – Microbiological Risk Assessment Series 33, http://www.fao.org/3/ca6062en/CA6062EN.pdf

[4] EU 2017/C 163/01, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:C:2017:163:FULL&from=EN

b) As regards the Fresh Produce annex:

- To determine whether to keep in paragraphs 5 to 36 adapted to the scope of this guidelines, or to replace by a cross-reference to CXC 53-2003.
- To evaluate the remaining examples and determine if the tools (DT) are appropriate for the development of the document.
- To indicate if it is considered appropriate to ask FAO/WHO if validation of the examples can be considered, as well as more concrete recommendations on thresholds and sampling frequencies.

c) As regards the Fishery Products annex:

- To choose the most appropriate definitions for fishery products, harvesting and fit for purpose water, from the proposed definitions in section 4.
- To consider if the information provided in the annex so far is enough or to hold the document until the JEMRA expert report meeting on water use and reuse for fish and fishery products becomes available to include further information.

APPENDIX I

Proposed Draft Guidelines for the Safe Use and Reuse of Water in Food Production (for comments at Step 3 through CL 2021/64/OCS-FH)

INTRODUCTION

1. Water is an important input in food, through all stages of the food chain from primary production to consumption as it is used as: an ingredient, in direct and indirect contact (e.g. washing, cooling the product or cleaning of surfaces in contact) with food and for hygiene sanitation in food businesses as well as for irrigation in agriculture, and food processing. The important role of water in food production has led to the need to ensure its quality since it can be a vehicle for the transmission of many diseases or contamination.
2. Water is a dwindling resource worldwide and not all food producers and processors have access to safe water sources; while for others, safe water access and waste discharge come at increasing financial and environmental costs. Consequently, it is highly desirable to minimize water use, reduce its waste, and reuse water as much as possible. For this reason, water in food production should be managed in a way that the safety of food is ensured, while simultaneously avoiding unnecessary consumption, and waste and their associated costs.
3. Although availability and quality of water are different in each country, region, context, setting and food establishment, in all cases it should be fit for use for each specific purpose.
4. Water used for food production is a critical key food safety element, since water quality can be affected by the presence of biological and chemical hazards. This applies to water used as an ingredient, in direct or indirect contact with food, and for sanitary operation and is significant throughout the food chain. To address these hazards, the water of the highest quality (i.e. potable water) is traditionally recommended to meet challenges related to variation in water sourcing, water treatment and extent of control performed by local authorities and variations in education level in food businesses. However, the introduction of risk-based approaches in food production and processing has provided the means to address many of these challenges, according to the principle of using the right water quality for the intended purpose/need.
5. Though the safest option in food production may be the use of potable-water; it is, however, often not a sustainable, viable, practical solution and other types of water may be suitable for certain purposes, provided that they do not compromise the safety of the final product for the consumer.
6. Substandard water quality may have serious effects on food processing facilities, hygiene practices and public health. The consequences of using water with inadequate quality (i.e. Water that is not fit for purpose) will depend on the purpose of the use and further processing or handling of potentially contaminated materials. Occasional variations in water quality can be unacceptable for some uses in the food industry and may have consequences with significant economic impacts in food production due to e.g. the withdrawal of the product from the market, or health impacts on the consumer
7. The diverse uses of water in food production and processing result in different water quality requirements. Therefore, the requirements for water quality used along the food chain should be considered in context, taking into account the purpose of the water use, the potential hazards associated with the water use and whether there is any subsequent measure to decrease the potential for contamination further along the food chain. Thus, the quality parameters are not the same for potable water, fish farms, food processing, etc. A risk-based approach to water sourcing, treatment, handling and use will identify the hazards associated with the water and its use and determine treatments the water needs to undergo to meet the quality parameters specific to each intended use.
8. Deciding whether water is fit for purpose should be based on an assessment of risk that considers the source water, including potential hazards linked to this water source, treatment options and their efficacy, application of multiple barrier processes and the end use of the food product (e.g. whether the food is eaten raw).
9. These guidelines respond to the need for a Codex document outlining a risk-based approach to safe sourcing, use and reuse of water fit for purpose, rather than focusing on the use of potable water or water of other specified quality types (e.g. clean water). Using the risk-based approach outlined here will allow for a specific assessment of the fitness of the water for the intended purpose.
10. Associated annexes provide product specific guidelines for the safe microbiological quality sourcing of, use and reuse of water in both direct and indirect contact throughout the food chain. The annexes also provide examples such as Decision tree tools (DTT) to determinate water fit for purpose.

OBJECTIVES

11. The Guidelines for the Safe Use and Reuse of Water in Food Production aim to:

- Provide information to governments and food business operators (FBOs) on the appropriate safe use and reuse of water according to its intended purpose;
- Provide guidance for FBOs on the application of a risk-based approach to safe water sourcing and its use and reuse that is fit for the purpose;
- Develop practical guidance and tools (e.g. Decision Tree Tools) to help FBOs evaluate risks and potential interventions as part of their food safety management programmes; and
- Develop practical guidance to establish appropriate risk-based microbiological criteria for water sourcing use and reuse.

PURPOSE AND SCOPE

12. The purpose and scope of this document are to provide guidance for determining appropriate and fit-for-purpose microbiological criteria for pathogens (bacteria, viruses, parasites), guidance for safe water sourcing, guidance for use and reuse of water for across the food chain (primary production and processing) of relevant commodities. These guidelines will not consider drinking water or domestic use of water.

USE

13. The document is intended for use by FBOs (including primary producers, packing houses, manufacturers/processors, food service operators, retailers and traders) and competent authorities, as appropriate. This document provides a risk-based framework of general principles for making decisions on criteria for fit for purpose water to be used in producing safe and suitable food for consumption by outlining necessary hygiene and food safety controls to be implemented in production (including primary production), processing, manufacturing, preparation, packaging, storage, distribution, retail, food service operation and transport of food, and where appropriate, specific food safety control measures at certain steps throughout the food chain.
14. These Guidelines are complementary to and should be used in conjunction with the *General Principles of Food Hygiene* (CXC 1-1969), the *Code of Hygienic Practice for Fresh Fruits and Vegetables* (CXC 53-2003), the *Code of Practice for Fish and Fishery Products* (CXC 52-2003), the *Code of Hygienic Practice for Milk and Milk Products* (CXC 57-2004), *Principles and Guidelines for The Conduct of Microbiological Risk Management (MRM)* (CXG 63-2007) and *Principles and Guidelines for The Conduct of Microbiological Risk Assessment* (CXG 30-1999).

GENERAL PRINCIPLES

i. Water used at any stage of food production should not compromise the safety of finished foods for consumers.

ii. Water, as well as ice and steam made from water, should be fit for its intended purpose based on a risk-based approach to ensure the safety of finished foods for consumers.

iii. Only water complying with the standards of potable water (such as those established by competent authorities having jurisdiction or the WHO Guidelines for drinking Water Quality) should be used as an ingredient in food.

iv. Re-use of water should not introduce hazards in foods that cannot be managed by the implemented food hygiene system.

v. Water should be obtained from appropriate sources and be of a quality that enables treatment, when necessary, by the means available to the food business, to render the water fit for its intended purpose

vi. Water re-use systems should be subjected to on-going, risk-based monitoring of adequate parameters and verification by testing. The frequency of monitoring and verification are dictated by such factors as the source of the water or its prior condition, the efficacy of any treatments, and the intended reuse of the water.

vii. Treatment or reconditioning of water intended for reuse should be based on knowledge of the types of contaminants the water may have acquired from its previous use, and any physicochemical parameters consequential to the treatment or reconditioning (e.g. particulates or organic material in the water), as well as the intended reuse of the water.

DEFINITIONS

For the purposes of this document, the following definitions apply:

Water fit for purpose: water which is determined through an assessment of risk to be safe when used as intended

Clean Water: water which does not compromise the safety of the food in the context of its use (*Code of Hygienic Practice for Fresh Fruits and Vegetables* (CXC 53-2003))

Fresh produce: Any fresh fruit, nuts and vegetables that are likely to be sold to consumers in an unprocessed (i.e. raw) form and are generally considered as perishable regardless of it being intact or cut from root/stem at harvest.

Potable water: Freshwater fit for human consumption. Standards of potability should not be lower than those contained in the latest edition of the International Standards for Drinking-water issued by the World Health Organization (*Code of Hygienic Practice for Fresh Fruits and Vegetables* (CXC 53-2003))

Reuse water: Water that has been recovered from a processing step within the food operation, including from the food components and/or water that, after reconditioning treatment(s) as necessary, is intended to be (re-)used in the same, prior or subsequent food processing operation. (JEMRA Review 2018)

Reclaimed water: Water that was originally a constituent of a food material, which has been removed from the food material by a process step and is intended to be subsequently reused in a food processing operation. (JEMRA Review 2018)

Recycled water: Water, other than first use or reclaimed water, that has been obtained from a food manufacturing operation and has been reconditioned when necessary such that it may be reused in a subsequent food manufacturing operation (Proposed Guidelines for the Hygienic Reuse of Water (Including Reclaimed Water) in Food Manufacturing Plants CX/FH 99/13).

Risk assessment: A systematic examination to identify hazards and risk and determine appropriate ways to eliminate the hazard or control the risk when the hazard cannot be eliminated (risk control).

Reconditioning: The treatment of water intended for reuse by means designed to reduce or eliminate microbiological, chemical, and physical contaminants, according to its intended use (Proposed Guidelines for the Hygienic Reuse of Water (Including Reclaimed Water) in Food Manufacturing Plants CX/FH 99/13)

SECTION 1: RISK ASSESSMENT AND MONITORING

15. Risk assessment (RA) and monitoring are overarching approaches that apply to all sectors and at multiple steps in the food chain to determine fit-for-purpose water sourcing, use and reuse.
16. RAs can be used to set target objectives for water sources and treatments for achieving public health outcomes, water quality values, targets, performance, and treatment process efficacies; Monitoring is used to generate data for the development of a risk profile or to inform RA.
17. Furthermore, monitoring can be used to inform risk management by identifying safety issues that need to be addressed in a hygiene programme or a food safety management system (FSMS) to ensure the quality of water and therefore, the safety of foods.
18. In the context of safe water sourcing, use and reuse, RAs can include the following approaches:
    - Descriptive assessment (least comprehensive) - e.g. sanitary inspection, used in evaluating and managing risks from irrigation water and rapid assessment of water quality;
    - Semi-quantitative RAs – e.g. risk matrices using categories of risks from high to low that include consideration of sanitary conditions and frequencies of failure or performance. These are normally used for planning, prioritization of water sources and rapid assessment of water quality;
    - Quantitative Microbial Risk Assessment (QMRA) – most comprehensive – e.g. guiding potable water reuse, wastewater use in agriculture, water supply systems.

SECTION 2: FOOD SAFETY MANAGEMENT PROGRAMMES

19. Although the safest option in food production might be the use of potable water quality; this is often not a feasible, practical or responsible solution and other types of water could be fit for some purposes provided that they do not compromise the safety of the final product for the consumer. However, in all situations, water sourcing, use and reuse guidance should be part of an FBO´s prerequisite hygiene and HACCP programmes.
20. Approaches to food safety management have been adapted to water safety highlighting the strong existing synergies between the two areas. Both water safety and food safety management should be risk – and evidence-based, with reduction measures implemented within the framework of an overall water safety

programme or a structured food safety management system (FSMS) and with verification and monitoring to ensure the plans/systems are operating as expected.

21. Risk-based water safety management is a tool for control, monitoring and verification and therefore requires complete knowledge of the system, the diversity and magnitude of the hazards that may exist, and the capacity of existing processes and infrastructure to address and control risks.

22. Risk-based water management plans should, in addition to addressing safe water sourcing, use or reuse also consider many factors when developing and implementing the planation. Additional factors to be considered could include occupational safety for workers, need for special expertise, investments, cost-benefit analyses and management of consumer perceptions.

23. Water safety risk management requires an identification of potential hazards (microbiological, chemical, physical agents with the capacity to cause damage to water safety) and their sources. Once potential hazards and their sources have been identified, the risk associated with each hazard or hazardous event should be compared so that priorities for risk management can be established and documented. A semi-quantitative matrix might be useful to identify hazards and prioritize control measures for risk management purposes.

SECTION 3: DECISION SUPPORT SYSTEMS

24. Decision support systems (DDS) tools, such as decision trees (DTs) or matrices, are considered to be useful risk management tools to assist stakeholders in making decisions on the water's fitness for purpose and the required quality (potable water or other suitable quality) for use or reuse at a given step in the supply chain.

25. Importantly, such DSS tools should be based on an assessment of final health risks of the food at consumption and address the context for water use at a particular step and location.

26. There is a significant amount of diversity in food production, resulting in multiple different types of risks and risk management steps necessary to ensure the fitness for purpose of water in food production. Examples include: the food types involved; the food-water interactions; the specific water-borne food safety hazards; and their likelihood and magnitude of transmission to the consumer when present in different foods.

27. In the annexes, risk-based DTs with direction to further guidance are provided. The implementation of these DTs requires evaluation and refinement in specific case studies before their acceptance.

Annex I Fresh Produce

INTRODUCTION

1. Water can be a source of contamination of all biological pathogens associated with the consumption of fresh produce. These pathogens include bacteria such as, but are not limited to *Salmonella* spp., *Shigella* spp, *Campylobacter* spp., *Listeria monocytogenes* and pathogenic strains of *Escherichia coli* spp., but also viruses such as hepatitis A and norovirus, and parasites such as *Cyclospora* spp., *Giardia* spp.and *Cryptosporidium* spp.

2. Water is used at all steps in the production chain of fresh produce, from irrigation and other pre-harvest practices, such as fertilization and pesticide application, and post-harvest practices, such as rinsing and cooling, until final washing steps by the consumers. Control measures to prevent water from becoming a source of biological contamination of the fresh produce, should be considered at all stages, and an overall management strategy should be developed, taking into account risk factors and control measures applicable at each step.

PURPOSE AND SCOPE

3. The purpose and scope of this annex are to elaborate guidelines for the safe biological quality sourcing, use and reuse of water in direct and indirect contact with fresh produce (for primary production and processing) by applying the principle of 'fit for purpose' using a risk-based approach. The annex recommends Good Hygiene Practices, risk-based, sector-specific potential intervention strategies, and provides examples and/or practical case studies for determining appropriate fit-for-purpose biological criteria (i.e. criteria for bacteria, viruses, parasites), as well as examples of the decision support system (DSS) tools such as Decision Trees (DT) to determine the water quality needed for the specific intended purpose in fresh produce.

USE

4. This Annex is complementary to and should be used in conjunction with the *General Principles of Food Hygiene* (CXC 1-1969), the *Code of Hygienic Practice for Fresh Fruits and Vegetables* (CXC 53-2003), *Principles and Guidelines for the Conduct of Microbiological Risk Management (MRM)* (CXG 63-2007) and *Principles and Guidelines for the Conduct of Microbiological Risk Assessment* (CXG 30-1999).

DEFINITIONS

See general part.

PRE-HARVEST USE OF WATER

5. An adequate supply of water of a suitable quality (fit for purposes) should be available for use in the various operations in the primary production of fresh fruits and vegetables. The source of the water used for primary production and processing as well as the method of delivery and application can affect the risk of contamination of fresh fruits and vegetables.

6. Water has several uses in primary production, e.g. irrigation, application of pesticides and fertilizer, protection against frost/freezing and prevention of sunscald. The quality of water used in primary production may vary. Several parameters may influence the risk of biological contamination of fresh fruit and vegetables via water: the source of water, the type of irrigation (e.g. drip, furrow, sprinkler/overhead) influencing whether the water has direct contact with the edible portion of the fresh fruit or vegetable, the timing of irrigation in relation to harvesting and exposure of plants to sunlight that can reduce contamination that occurs from water (e.g. microbial die-off). Water used for primary production, including for frost protection and protection against sunscald, which has contact with the edible portion of fresh fruits and vegetables, should not compromise their safety.

Water Sources

7. Growers should identify the sources of water used on the farm (e.g. municipality, groundwater including well water, open canal, reservoir, river, lake, farm pond, reused irrigation water, roof water, reclaimed wastewater or discharge water from aquaculture). Apart from municipality (potable) water, examples of water sources that present the lowest risk of contamination (provided these sources, and storage and distribution facilities are properly constructed, maintained, monitored and capped, as appropriate) are:

   - Water in deep wells or boreholes;
   - Water in shallow wells, provided they are not influenced by surface waters; and
   - Rainwater.

8. A number of preventative measures can be implemented to protect a water source if determined to be vulnerable:
    - If using more than one water source, ensure all sources are clearly identified to prevent inappropriate use, e.g. provide separate systems for waste water, potable water supplies etc.
    - Ensure water sources are protected (as much as possible) from contamination by animals, e.g. fencing or netting.
    - If storing manure, slurry, composts and other soil amendments, ensure there are no leaks or spillage and they are positioned downhill from the water source, i.e. at least ten meters away, to minimize contamination.
    - If collecting rainwater, ensure the catchments and gutters of the harvesting system are regularly cleaned and maintained.
    - Ensure that all water storage tanks are covered, i.e. protected, to prevent contamination.
    - If using a private well, ensure it is located away from contamination sources, and constructed appropriately to prevent contamination, e.g. sealed on top.
    - Regularly check irrigation (e.g., weekly), for damage or leaks and flush lines to remove accumulated organic debris/biofilms. If there has been a period of wet weather, it is recommended to flush the system prior to use.
9. Water sources that pose a higher risk of contamination may need treatment, for example:
    - Reclaimed or wastewater: before using reclaimed or wastewater for crop irrigation, a risk analysis by an expert should be carried out to assess the relative risk and determine the suitability of the water source. Reclaimed or wastewater subjected to different levels of treatment should comply with the WHO "*Guidelines for safe use of wastewater, excreta and grey water in agricultural and aquaculture, Volume 2, Wastewater use in agriculture*" , specific to the irrigation of fruits and vegetables marketed to consumers as fresh, fresh-cut, pre-cut or ready-to-eat.
    - Surface water (e.g. rivers, lakes, canals, lagoons, ponds, reservoirs): when contaminated, options such as chemical treatment, sand filtration, or storage in catchments or reservoirs to achieve partial biological treatment should be considered. The efficacy of these treatments should be evaluated and monitored.

Testing of water

10. Growers should assess the biological quality of water, as prescribed by the relevant authority, and its suitability for the intended use, and identify corrective actions to prevent or minimize contamination (e.g. from livestock, wildlife, sewage treatment, human habitation, manure and composting operations, agricultural chemicals, or intermittent or temporary environmental contamination, such as heavy rain or flooding).
11. Where necessary, growers should use the water which is tested for biological contaminants, according to the risk associated with the production. The frequency of testing will depend on the water source (i.e. lower for adequately maintained deep wells, higher for surface waters), the risks of environmental contamination, including intermittent or temporary contamination (e.g. heavy rain, flooding), and factors such as the implementation of a new water treatment process by growers.
12. If water testing is limited to non-pathogenic indicators, frequent water tests may be useful to establish the baseline water quality so that subsequent changes in the levels of contamination can be identified. The high testing frequency may be considered until consecutive results are within the acceptable range.
13. Growers should reassess the potential for biological contamination and the need for additional testing if events, environmental conditions (e.g. temperature fluctuations due to change in season, heavy rainfall (mm)) or other conditions indicate that water quality may have changed.
14. When testing, growers may consult, if necessary, the competent authority or experts, or refer to local regulations, in order to determine and document the following:
    - Which tests need to be conducted (e.g. for which pathogens and/or sanitary indicators);
    - Which parameters should be recorded (e.g. temperature of water sample, water source location, and/or weather description);
    - How often tests should be conducted;

- How test results should be analyzed and interpreted over time, for example, to calculate the rolling geometric mean, and
- How test results will be used to define corrective actions.

15. If the water source is found to have unacceptable levels of indicator organisms or is contaminated with water-borne pathogens, corrective actions should be taken to ensure that the water is suitable for its intended use. Possible corrective actions to prevent or minimize contamination of water for primary production may include
    - the installation of fencing to prevent large animal contact;
    - improvement of good agricultural practices to prevent contamination from animal waste, fertilizer and pesticide runoff;
    - the proper maintenance of wells;
    - water filtering;
    - chemical water treatment;
    - the prevention of the stirring of the sediment when drawing water;
    - the construction of settling or holding ponds or water treatment facilities;
    - changing the irrigation systems to avoid direct contact of the water with the edible portion of the crop;
    - maximizing the interval between application of irrigation water and crop harvest as time-to-harvest intervals will impact the die-off rate of microorganisms and it is affected by different weather conditions, produce types, and type of bacteria.
16. The effectiveness of corrective actions should be verified by regular testing. Where possible, growers should have a contingency plan in place that identifies an alternative source of water.

Water for irrigation (including greenhouses) and harvesting

17. The irrigation system or application method affects the risk of contamination. The timing, the quality of water used, and whether the water has direct contact with the edible portion of the plant should all be considered when selecting the irrigation system or application method to use. Overhead irrigation presents the highest risk of contamination because it wets the edible portion of the crop. The duration of wetting can be several hours, and the physical force of water-droplet impact and the splashing of the soil to the edible part of the product may drive contamination into protected sites on the leaf/produce. Subsurface or drip irrigation that results in no wetting of the plant is the irrigation method with the least risk of contamination, although localized problems may still arise, e.g. when using drip-irrigation, care should be taken to avoid creating pools of water on the soil surface or in furrows that may come into contact with the edible portion of the crop.
18. Water for irrigation should be of suitable quality for its intended use. Special attention should be given to water quality in the following situations:
    - Irrigation by water-delivery techniques that expose the edible portion of fresh fruits and vegetables directly to water (e.g. sprayers), especially close to harvest time;
    - Irrigation of fruits and vegetables that have physical characteristics such as leaves and rough surfaces that can trap water; and
    - Irrigation of fruits and vegetables that will receive little or no post-harvest wash treatments prior to packing, such as field-packed produce.
19. A number of good agriculture practices for irrigation might be considered:
    - Establish no-harvest zones if the irrigation source water is known or likely to contain human pathogens and where failure at connections results in overspray of plants or localized flooding;
    - Record the crop, date and time of irrigation, water source and any pesticides used.
    - Maintain and protect the source of the water used/stored and verify its quality.
    - Where possible, avoid the use of high-risk water sources such as poorly stored rainwater, untreated wastewaters and surface waters from rivers, lakes and ponds.

- Growers should focus on the adoption of GAP to minimize and control the risk of contaminated water and not use testing as the sole method of controlling waterborne hazards.
- The type of crop, i.e. ready-to-eat or requires cooking, timing, irrigation system, soil type and whether the irrigation water has direct contact with the edible portion of the plant should be considered by growers. If contaminated water is in contact with the edible portion of plants, the risk of contamination increases, especially if close to harvesting.
- Overhead irrigation presents the highest risk of contamination because it directly wets the edible portion of plants and its use should be avoided where possible. However, low volume sprays, drip, furrow or underground irrigation are all options that can be adopted to limit contamination.
- Water spraying, i.e. misting, immediately prior to harvest presents an increased microbiological risk. If the soil is heavy and non-free draining, contaminated water can accumulate on the soil surface, increasing the risk of crop contamination. It is recommended that water spraying immediately prior to harvest is avoided as it presents an increased microbiological risk.
- Minimize soil splashing from irrigation by choosing a system that delivers small water droplets. For low growing crops it may not be possible to minimize water contact in this way. It should also be noted that if the soil has been contaminated by irrigation water, soil splash can transfer contamination to crops. The risk of contamination increases if large irrigation droplets are used or heavy rain occurs. It is recommended that growers try to minimize soil splashing from irrigation by choosing a system that delivers small water droplets.

20. Those responsible for the water-distribution system should regularly carry out an evaluation to determine if a contamination source exists and can be eliminated. Water testing records should be maintained.

Water for fertilizers, pest control and other agricultural chemicals

21. Water used for the application of water-soluble fertilizers, pesticides and agricultural chemicals that come in direct contact with products should be of the same quality as water used for direct contact irrigation and should not contain biological contaminants at levels that may adversely affect the safety of fresh fruits and vegetables, especially if they are applied directly on edible portions of the fresh fruits and vegetables close to harvest. Human pathogens can survive and grow in many agrichemicals, including pesticides.

Hydroponic water

22. Biological risks of water used in growing fruits and vegetables hydroponically may differ from the biological risks of water used to irrigate fruits and vegetables in soil because the nutrient solution used may enhance the survival or growth of pathogens. It is especially critical in hydroponic operations to maintain the water quality to reduce the risk of contamination and survival of pathogens.
23. The following should be taken into consideration:
    - Water used in hydroponic culture should be changed frequently or, if recycled, treated to minimize biological contamination;
    - Water-delivery systems should be maintained and cleaned, as appropriate, to prevent biological contamination of water; and
    - In the case of a combination of aquaculture and hydroponics (i.e. aquaponics), effluent from fish tanks should be treated to minimize biological contamination.

Water for other agricultural uses

24. Clean water should be used for other agricultural purposes, such as dust abatement and the maintenance of roads, yards and parking lots, in areas where fresh fruits and vegetables are grown. This includes water used to minimize dust on dirt roads within or near primary production sites. This provision may not be necessary when water used for this purpose cannot reach the fruits and vegetables (e.g. in the cases of tall fruit trees, live tree fences or indoor cultivation).

Water for indoor storage and distribution facilities

25. Where appropriate, an adequate supply of clean water with appropriate facilities for its storage and distribution should be available in indoor primary production facilities. Non-potable water should have a separate storage and distribution system.
26. Non-potable water systems should be identified and should not connect with or allow reflux into potable water systems:

- Avoid contaminating water supplies by exposure to agricultural inputs used for growing fresh produce such as fertilisers and pesticides;
- Clean and disinfect water storage facilities on a regular basis; and
- Control the quality of the water supply.

POST-HARVEST USE OF WATER

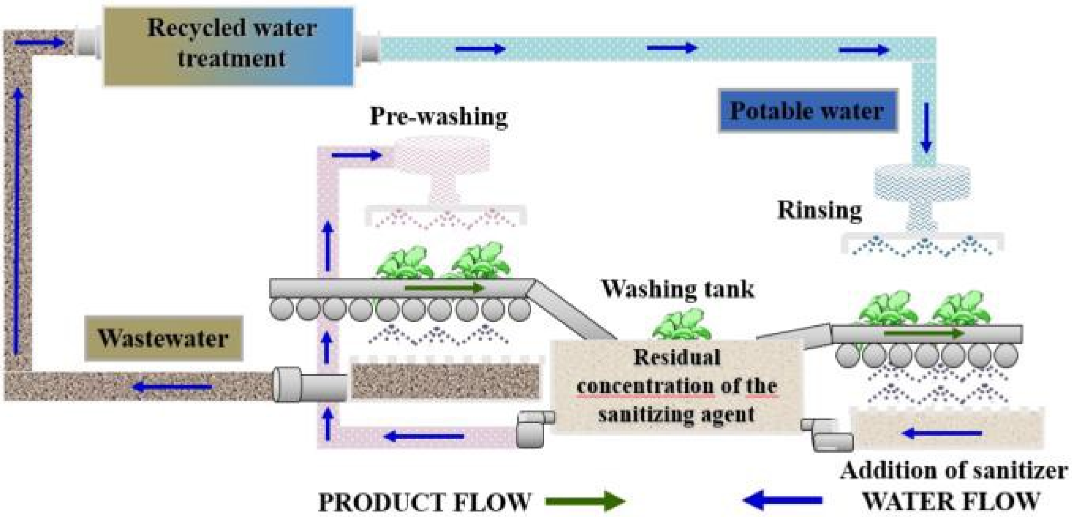
General

27. Water use during postharvest practices includes any water that contacts fresh produce after harvest including water used for rinsing, washing, cooling, waxing, icing, or fluming. The microbiological quality of postharvest water is critical because microbial die-off is minimal.
28. Water-quality management varies throughout the operations. Packers should follow GHPs to prevent or minimize the potential for the introduction or spread of pathogens in processing water. The quality of water used should depend on the stage of the operation: for example, clean water could be used for initial washing stages, whereas water used for final rinses should be of potable quality.
29. Clean, or preferably potable, water should be used when water is applied under pressure or vacuum during washing, as these processes may damage the structure of and force pathogens into plant cells.
30. It is recommended that the quality of the water used in packing establishments be controlled, monitored and recorded by testing for indicator organisms and/or food-borne pathogens.
31. If water is used in prewashing and washing tanks, additional controls (e.g. changing water whenever necessary and controlling product throughput capacity) should be adopted.
32. Post-harvest operations/systems that use water should be designed in such a manner as to minimize places where the product may lodge or dirt build up.
33. The use of biocides should comply with the requirements established by the competent authority. Biocides should never replace GHPs but be used in addition to GHPs and where necessary to minimize post- harvest cross contamination with their levels monitored, controlled and recorded to ensure the maintenance of effective concentrations. The application of biocides should be followed by rinsing as necessary to ensure that chemical residues do not exceed levels established by the competent authority.
34. Where appropriate, characteristics of post-harvest water that may impact the efficacy of the biocidal treatments (e.g. the pH, turbidity and water hardness) should be controlled, monitored and recorded.
35. Ice that may come in contact with fresh produce should be made from potable water and produced, handled, transported, and stored in such a manner as to protect it from contamination.
36. Immersion of warm, whole or fresh-cut produce in cool water may induce water into the internal parts of the fresh produce and some fresh produce with high water contents, e.g. apples, celery, and tomatoes, are more susceptible to internalization through openings in the peel such as stem-end vascular tissue, stomata or puncture wounds; if the temperature of the wash water is less than the temperature of the produce, the temperature differential can force water into the produce contaminating it on the inside; it is recommended that in these cases, the temperature of the initial wash water is 10°C higher than the fresh produce, if possible;

Reuse of water

37. In the fresh produce industry, water re-use is also possible. Figure 1 shows how water from the rinsing step can be used for the washing tank and how the water in the washing tank can be used as a pre- washing step.

Figure 1. Illustration of a potential option for water re-use in the fresh produce industry.



38. The water use in the final rinsing step should be potable water. After rinsing, this water, should be treated with a water sanitizing agent to have a residual concentration of the disinfectant able to minimize cross-contamination in the washing tank. By doing that, the water in the washing tank will have an “antimicrobial” activity to inactivate any potential pathogens that might be present in the washing tank coming from the produce.

39. The water from the washing tank can be also used as a pre-washing step. The pre-washing step should remove most of the organic matter that comes with the produce. Reducing the soil and the dust that comes from the field in the pre-washing step will reduce the amount of organic matter and microorganisms introduced into the washing tank, increase the microbial quality of the water in the tank, and help maintain a residual concentration of sanitizers that are inactivated by organic matter.

40. The final rinsing step should also minimize the residues of the sanitizers in the fresh produce coming from the washing tank.

41. In order to have a more sustainable industry, which avoids the use of excessive amounts of water, the wastewater generated by the industry can be re-cycled using reclamation treatments similar to those that are implemented in wastewater treatment plants to have water of a quality similar to that of potable water. This is illustrated in Figure 1.

42. Recycled water should be treated and maintained in conditions that do not constitute a risk to the safety of fresh fruits and vegetables. The treatment process should be effectively monitored, controlled and recorded. For example, a treatment process that includes primary screening, secondary filtration and a biocidal treatment could be used to maintain the suitability of recycled water.

43. Recycled water may be used with no further treatment, provided its use does not constitute a risk to the safety of fresh fruits and vegetables (e.g. use of water recovered from the final rinsing for the washing step).

44. If treating water for use in washing and rinsing, it is recommended to see professional advice from experts on the safe (re-)use of water in fresh produce before purchasing, installing and using any water treatment system, e.g. water chlorination system.]

Documentation

45. Documented procedures should be developed for the washing and rinsing of fresh produce, including:

- on the use of vigorous washing to increase the chances of removing contamination if the fresh produce is not subject to bruising;
- on the frequency of water replenishment for washing and rinsing considered suitable to minimise risks of fresh produce contamination;
- on the monitoring of the water temperature during washing and rinsing;
- where possible, on the use of a de-watering step to remove excess water as dry produce is less likely to become re-contaminated; in such case, water should be removed gently to prevent damage to produce.

46. Develop documented procedures for cleaning and sanitizing of equipment used in washing and rinsing of fresh produce which includes:

- all washing and rinsing equipment should be hygienically designed to help ensure adequate cleaning and sanitizing;
- all equipment should be cleaned after use. Mud, soil and fresh produce debris should be removed from equipment, then it should be washed with a detergent and rinsed before a final wash with a chemical disinfectant and, where necessary, a thorough rinse with potable water;
- ancillary equipment such as knives, blades, and boots and protective clothing should be cleaned and disinfected at the end of each day.

RISK ASSESSMENT TO DETERLMINE FIT FOR PURPOSE

47. The development of a risk-based strategy for water sourcing, use and reuse should be based on the risk assessment that should take into account:

- Identification of water-related biological hazards and source of those hazards, relevant for the area of production.
- Sources of water available
- Uses of water considered such as irrigation, washing (fresh produce, containers and surfaces), storage on ice, etc.
- Type of irrigation, in particular if the water is in direct contact with the produce.
- Type of crop (e.g. leafy greens versus fruit trees)
- Physiological characteristics of the fresh product (such as the peel and whether the produce would be subject to infiltration)
- Water treatment and water disinfection techniques available
- Consumers' habits such as eating raw, cooking, fermenting, etc.

48. If the fresh produce is normally consumed raw, the source of water should be identified and the related risk should be assessed in view of determining the level of control measures:

- Potentially high or unknown risk if for example untreated wastewater, surface water or shallow ground water;
- Potentially medium risk if for example collected rain water;
- Potentially low risk if treated (waste) water, potable water or deep groundwater.

49. The matrix in Table 1 can be used to further differentiate the level of risk posed by the use or re-use of various water sources during pre-harvest stages of fresh produce and their intended use.

Table 1

Intended use of fresh produce	Contact with edible portion	Water source				
		Wastewater (re-used water) untreated	Surface and groundwater of unknown quality	Groundwater collected from protected wells	Collected rainwater	Potable water, deep groundwater or other water, including treated waste water, that complies with the biological criteria applicable to potable water.
Ready-to-eat	Contact	High risk	High risk	Medium risk	Medium risk	Low risk
	No contact	High risk	High risk	Low risk	Low risk	Low risk
Cooked or processed by consumer or a food business operator	Contact	Low risk	Low risk	Low risk	Low risk	Low risk
	No contact	Low risk	Low risk	Low risk	Low risk	Low risk

RISK MITIGATION/RISK MANAGEMENT STRATEGIES

Indicator organism for monitoring hazards in water used in fresh produce production

(These recommendations are based on the conclusions of the Draft JEMRA Report on the Safety and Quality of Water Used with Fresh Fruits and Vegetables)

50. Indicator organisms should be used as indicators of faecal contamination rather than presence or concentration level of any specific pathogen. The major indicator organisms are *E. coli* and enterococci.

51. Such faecal indicators can be used as process indicators or to validate the efficacy of water treatments if they respond to treatment processes in a similar manner to pathogens of concern.

52. It should be taken into account that, in general, faecal indicators reasonably predict the probable presence of faecal pathogens in water, but they cannot precisely predict the concentrations present, with the possible exception of heavily polluted waters. The correlation becomes erratic and biologically improbable as dilution occurs.

53. Bacteriophages are better indicators of enteric viruses than faecal indicators, although coliphages cannot be absolutely relied upon as indicators for enteric viruses. A combination of two or more bacteriophages can be considered. Bacteriophages can be used as good process indicators to determine the efficacy of water treatments against enteric viruses.

54. Protozoa and helminths cysts / eggs are more resistant than bacteria and viruses and there is no suitable indicator of their presence/ absence in irrigation water. Specific tests should be performed if the presence of these parasites is suspected.

Examples and/or practical case studies for determining appropriate and fit-for-purpose microbiological criteria (bacteria, viruses, parasites)

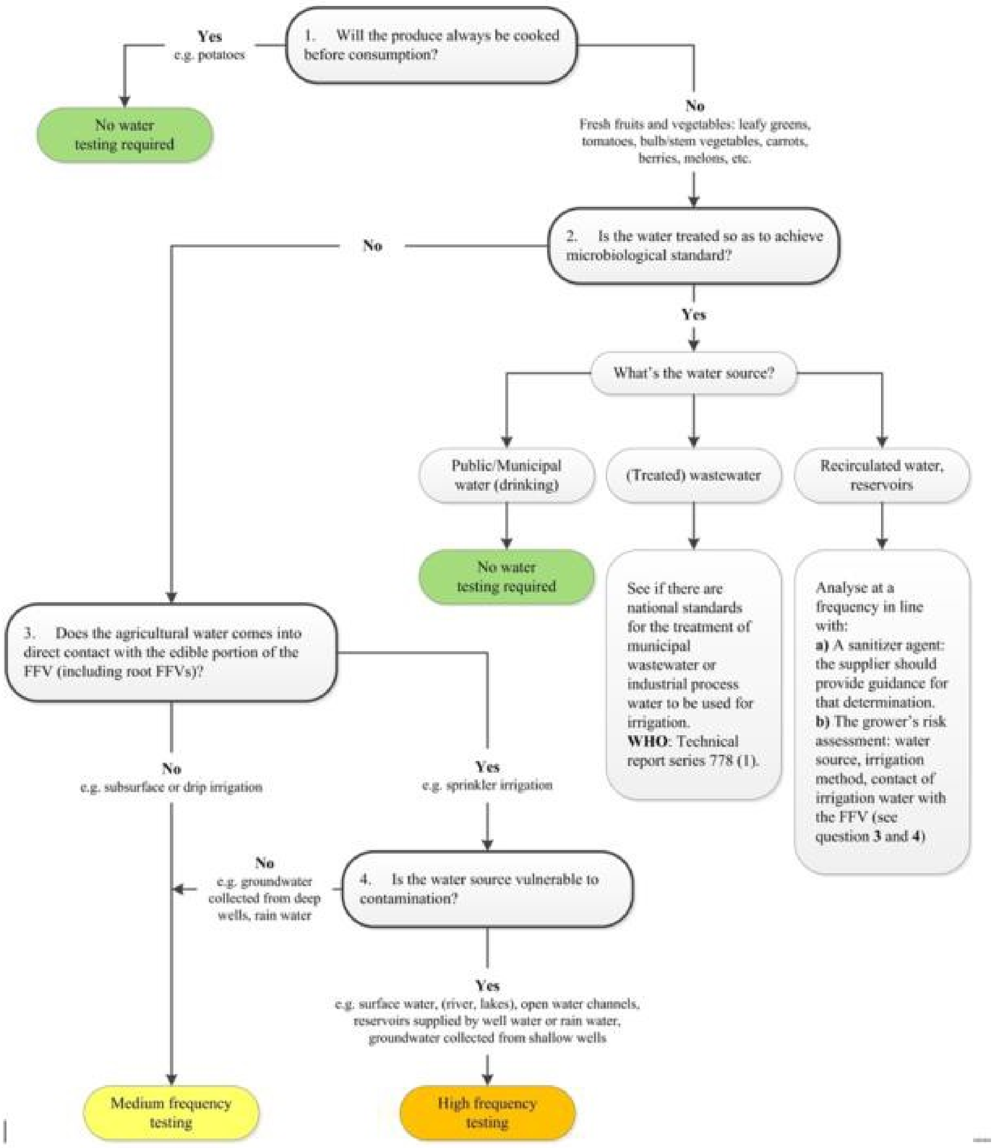
55. To decide on the frequency of sampling and applied microbiological criterion a risk assessment table (see example in the annex) can be used, considering the source and the intended use of agricultural water (e.g. irrigation system, fresh fruits and vegetable (FFV) characteristics, intended use of FFV), defining the suitability for agricultural purposes, the recommended microbiological threshold values and the frequency of monitoring.

56. Such risk assessment can contain the following steps:

- Identify the activities at the farm in which water is applied
- Identify the sources of water available for the farm

- Evaluate the use of water in relation to the potential contamination to edible parts of the fresh produce
- Check the quality of the water before its use (before the start of the growth season)
- Monitor the quality of water regularly during the growing period.

57. An alternative approach may be to use a "decision tree" such as the example below.



Examples of decision support systems tools such as decision trees

<u>Pre-harvest</u>

58. Based on Table 1 of the 2019 FAO/WHO meeting report on Safety and Quality of Water Used in Food Production and Processing, a decision support system is developed, using scores to assess the risk or the effectiveness of control measures related to the risk derived from the use of water. It should be acknowledging that no decision tool fits in all situations. It therefore should be rather considered as an approach to evaluate a situation instead of as a tool fixed for all purposes.

59. Scores related to:

- Irrigation systems/ direct or indirect contact with fresh produce/
  - No direct or indirect contact between irrigation water and produce: 3
  - Drip irrigation: 3
  - Furrow irrigation: 1

    - Overhead irrigation: 0
- Application of Good Agriculture practices
    - YES: 1
    - NO: 0
- Microbial testing of the water:
    - *E.coli* <1 CFU/100 ml: 5
    - < 10 CFU/100 ml: 4
    - < 100 CFU/100 ml: 3
    - < 1000 CFU/100 ml: 2
    - < 10000 CFU/100 ml: 1
    - > 10000 CFU/100 ml, not tested or no stable quality ensured: 0
- Application of mitigation options on water before irrigation:
    - On-farm water treatment ponds with 18+ hrs sedimentation period; water fetching without disturbing pond sediment: 1
    - Filtering water before irrigation: 1
    - None: 0
- Application of one or more of the following mitigation options
    - Irrigation cessation (3 days): 2
    - Washing with running potable water: 1
    - Washing with running potable water + added sanitizer: 2
    - Peeling: 2
    - None: 0

<u>Use of these scores in a decision tool</u>

60. The sum of scores should be made to evaluate if sufficient guarantees can be provided to ensure the safe use of water. If the score is to low, the above scores can be used to select additional mitigation options or have an indication to which extent the microbiological quality of the water should be improved.

- A score of less than 6: control of biological hazards from the use of water not acceptable
- Score of 6: acceptable approach
- Score of 7: good approach
- Score of 8 or more: excellent approach

[Illustrations/examples by using this approach:

- Irrigation water not in contact with fresh produce (3) + *E.coli* < 1000 CFU (2), no other treatment => total of 5: use other source, ensure GAP or add mitigation option(s)
- Irrigation water not in contact with the fresh produce (3) + GAP applied (1) + no water monitoring but filtering before irrigation (1) and irrigation cessation (2) => total of 7: good
- Irrigation water in contact with the fresh produce (0), + E.coli < 100 CFU (3) + irrigation cessation (2) + washing with potable water and sanitizer (2) => total of 7: good.
- Irrigation water in contact with the fresh produce (0), no water monitoring but filtering before irrigation (1) and irrigation cessation (2) + washing with potable water and sanitizer (2) + peeling (1) => total of 6: acceptable
- Irrigation water in contact with the fresh produce (0) + GAP applied (1) + *E.coli* <1 CFU/100 ml: (5)=> total of 6: acceptable

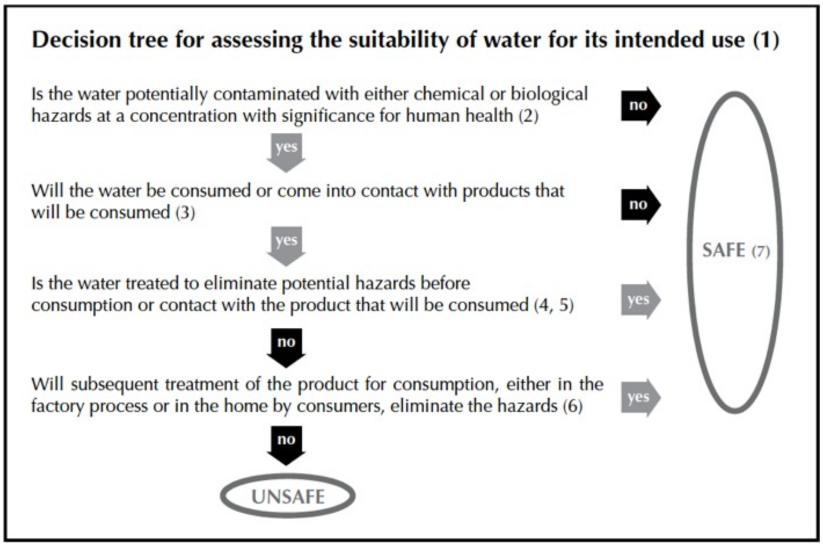
- Irrigation water in contact with the fresh produce (0) + GAP applied (1) + *E.coli* <100 CFU/100 ml: (3) + washing with running potable water and added sanitizer (2) + peeling (2) => total of 8: excellent.]

Post-harvest

61. The examples below are for illustration, voluntarily and may have to be adapted to national or local situations.

Example 1: International Life Sciences Institute (*ILSI), 2008 (* https://ilsi.eu/publication/considering-water-quality-for-use-in-the-food-industry/*):*

62. The ILSI report on water quality for use in the food industry proposes a decision tree for the food industry answering the questions sequentially to classify the water and provide guidance on whether the water is suitable for the intended use. Below is simplified presentation.



63. Before using the decision tree (1) consideration should be given to:
    - the purpose for the use of water;
    - who or what will be exposed to it;
    - contact or not with the product, if so, at which stage, as water, ice or steam?
64. At the first question/step (2) guidelines and applicable regulations should be consulted.
65. At the second question/step (3), the source of water and potential hazards must be considered:
    - water treated or not
    - effective disinfection
    - use of recycled water
66. At the third question/step (4,5), the following should be considered:
    - Existence of steps in the process that will act as mitigation steps to potential hazards;
    - Existence of a wash stage in potable water;
    - Existence of subsequent processing steps, e.g. peeling, that will act as a barrier to transmission of the hazard to the final product;
    - Likelihood of exposure to the consumer.
67. At the fourth question/step (6), consideration should be given if additional mitigation measures can be introduced.
68. When the use of water is considered safe (7), steps for monitoring that the barriers and mitigation measures in place are operating properly, and for verification that the product is safe, should be determined.

Example 2 *Commodity Specific Food Safety Guidelines for the Production and harvest of Lettuce and Leafy Greens, 2020 of the California Leafy Green Products Handler Marketing Agreement (LGMA) program (https://lgma.ca.gov/) Figure 6*

69. In this example, it is recommended to use municipal water, well water with potable water quality or reverse osmosis for any direct contact with edible portions of harvested crops, hand washing or use in food-contact surfaces, meeting microbiological standards set for potable water and/or containing an approved disinfectant at sufficient concentration to prevent cross-contamination.

70. Acceptable criteria are:

- Negative or below the detection limit/100 ml generic *E.coli*, or
- ≥1ppm free chlorine (pH 5.5-7.5), or
- sufficient disinfectant/physical treatment to prevent cross-contamination or other approved treatment for human pathogen reduction in water.

71. In case positive for generic *E. coli*, it is recommended not to use the water and to introduce corrective actions to bring water back to compliance with the acceptance criteria. Retesting and verification of the water quality should be performed as sampling and testing for *Salmonella* and *E.coli* O157:H7.

72. As regards routine sampling frequency, one sample per water source should be collected and tested prior to use if >60 days since the last test of the water source. Additional samples should be collected no less than 18 hours apart and at least monthly during the use of the water. Approved sampling and testing methods should be used.

Example 3 *Commission notice on guidance document on addressing microbiological risks in fresh fruits and vegetables at primary production through good hygiene (Official Journal of the EU, C 163, 23.5.2017, p. 1) Annex II*

73. This example contains conditions for post-harvest use of water, other than potable water.

A general example to decide on the frequency of sampling and applied microbiological criterion, based on the intended use and the source of the water.

The Table provides an idea on the appropriateness of sources to be used for different types of fresh produce and on the sampling frequency to be considered.

If the test result of the water source is unfavorable or identifies a potential problem, the grower should take some corrective actions to reduce the risk to the consumer and after that, another water test should be carried out, to verify the effectiveness of the actions taken.

Intended use of the water	**Source of water**						**Suggested criteria for Indicator of fecal contamination: *E. coli***
	Untreated surface water[5]/ open water channels	Untreated ground water collected from wells[3]	Untreated Rain water	Treated [6] sewage/ surface/ waste water/ water reuse	Disinfected water [7]	Municipal water	
PRE-HARVEST and HARVEST							
Irrigation of fresh produce likely to be eaten <u>uncooked</u> (i.e. ready-to-eat fresh produce) (irrigation water <u>comes into direct contact with the edible portion</u> of the fresh produce) Dilution or application of pesticide, fertiliser or agrochemicals and cleaning equipment for ready-to-eat fresh produce and direct contact.	**Don't use**	**Don't use**	**Medium sampling and testing frequency**	**Low sampling and testing frequency**	**Low sampling and testing frequency**	**No need for testing**	100 CFU/100ml
Irrigation of fresh produce likely to be eaten <u>uncooked</u> (i.e. ready-to-eat FFV) (irrigation water <u>does not come</u> into direct contact with the edible portion of the fresh produce) Dilution or application of pesticide, fertiliser or agrochemicals and cleaning equipment for ready-to-eat fresh produce and no direct contact	**Don't use**	**Don't use**	**Medium sampling and testing frequency**	**Low sampling and testing frequency**	**Low sampling and testing frequency**	**No need for testing**	1,000 CFU/100ml[8]
Irrigation of fresh produce likely to be eaten <u>cooked</u> (irrigation water <u>comes into direct contact with the edible portion</u> of the fresh produce). Dilution or application of pesticide, fertiliser or agrochemicals and cleaning equipment used in this fresh produce direct contact).	**Medium sampling and testing frequency**	**Medium sampling and testing frequency**	**Low sampling and testing frequency**	**Low sampling and testing frequency**	**Low sampling and testing frequency**	**No need for testing**	1,000 CFU/100ml
Irrigation of fresh produce likely to be eaten <u>cooked</u> (irrigation water does <u>not come into direct contact with the edible portion</u> of the fresh produce). Dilution or application of pesticide, fertiliser or agrochemicals and cleaning equipment used in this fresh produce (no direct contact)	**Low sampling and testing frequency**	**Low sampling and testing frequency**	**No need for testing except to test the treatment/disi**	**No need for testing except to test the treat**	**No need for testing except to test the treatment/disi**	**No need for testing**	10,000 CFU/100ml

[5] Surface water and ground water from wells (e.g. boreholes) might be of good microbiological quality and meet the 100 CFU/100 ml thresholds without treatment. If this is repeatedly demonstrated by analysis, the recommendations in the Table might be revised.
[6] For the purpose of this matrix, treated sewage water means wastewater that has been treated so that its quality is fit for the intended use and complies with the standards established by the national legislation of the MS or, in the absence of such national legislation, with WHO guidelines on the safe use of wastewater and excreta in agriculture.
[7]Disinfection treatment should be well controlled and monitored.

			nfection	ment/ disinfection	nfection		
POST-HARVEST							
Post-harvest cooling and post-harvest transport for non-ready-to-eat fresh produce. Cleaning equipment and surfaces where the products are handled. Water used for first washing of products in case of ready-to-eat products.	**Don't use**	**Don't use**	**Medium sampling and testing frequency**	**Low sampling and testing frequency**	**Low sampling and testing frequency**	**No need for testing**	100 CFU/100ml
Water used for washing of products **likely to be eaten cooked** (potatoes…) – non ready-to-eat fresh produce .	**Medium sampling and testing frequency**	**Medium sampling and testing frequency**	**Low sampling and testing frequency**	**Low sampling and testing frequency**	**Low sampling and testing frequency**	**No need for testing**	1,000 CFU/100ml
ONLY POTABLE WATER							
Final washing and ice/water for cooling applied for ready-to-eat fresh produce	**Don't use**	**Don't use**	**Medium sampling and testing frequency**	**Low sampling and testing frequency**	**Low sampling and testing frequency**	**No need for testing**	Microbiological requirements of potable water

Annex II Fishery Products

INTRODUCTION

1. The fisheries sector plays an important role in the economy of many countries and the water used in aquaculture or for fish processing has a significant impact on product safety.
2. Water has multiple applications in the fisheries sector, and water quality could impact the safety of the final product. This annex addresses the water quality used in aquaculture and fisheries and in fishery products processing from the ponds and/or fishing vessels (including water used for onboard storage, ice, washing, etc.) and throughout processing facilities.

PURPOSE AND SCOPE

3. The purpose and scope of this annex is to elaborate on recommendations for the quality sourcing, use, and reuse of water in direct and indirect contact with fish and fishery products. The scope includes farming or capture of the fish or fishery product as well as subsequent holding and processing activities by applying the ‘fit for purpose’ principle and using a risk-based approach. The annex recommends Good Hygiene Practices, and risk-based sector-specific potential intervention strategies, relevant to water and its use. It also provides examples of the decision support system (DSS) tools such as decision trees (DT) to determine the water quality needed for the specific intended purpose in fish and fishery products.

USE

4. This guideline should be used in conjunction with the following Codex Alimentarius standards:
   - *Code of Practice for Fish and Fishery Products* (CXC 52-2003),
   - *General Principles of Food Hygiene: Good Hygiene Practices (GHPs) and the Hazard Analysis and Critical Control Point (HACCP) System* (CXC 1-1969),
   - P*rinciples and Guidelines for the Conduct of Microbiological Risk Management (MRM)* (CXG 63-2007) and
   - *Principles and Guidelines for the Conduct of Microbiological Risk Assessment* (CXG 30-1999).

DEFINITIONS

5. See the *Code of Practice for Fish and Fishery Products* (CXC 52-2003) for the definitions of fish, live bivalve molluscs, shellfish, aquaculture, extensive farming, intensive farming, fish farming, glazing and growing areas.

Aquaculture pond: An artificial lake (reservoir, pond) intended for fish and fishery products breeding and growing.

Evisceration: The removal of gills, viscera, and other internal organs

Fishery products: Any species of fish, including crustaceans, molluscs, gastropods, or part of them intended for human consumption.

Fishery products bis: any cold-blooded aquatic animal, or any part or product derived therefrom, intended for food for human consumption, and includes any fish, crustacean, molluscs, echinoderm, holothurian, or aquatic reptile;”

Hatchery: A place for artificial breeding, hatching, and rearing through the early life stages of animals, finfish, and shellfish in particular. Hatcheries produce larval and juvenile fish, shellfish, and crustaceans, primarily to support the aquaculture industry where they are transferred to on-growing systems, such as farms, to reach harvest size.

Harvesting: Operations involving taking the fish from the water

Harvesting bis: The capture and landing of the fish from growing areas”

Processing plant: A facility where harvested aquatic animals are processed, graded, and packed for further transportation and consumption.

Fit for purpose water: Water of such quality, that once it has been in direct or indirect contact with the fishery products (during cleaning, storage, transport, processing; cleaning of utensils, facilities, equipment; as well as for its use in the hygiene for the personal in contact with food), it will not confer any hazard to the health of consumers.

or

Fit for purpose water: Water of such quality, that it does not confer any hazard to the health of persons using the water for hygienic purposes or to the consumer of fishery products that have been in direct or indirect contact with the water (e.g., cleaning of the fishery products, transport, cooling, holding/storage, processing, and cleaning of facilities, equipment, and utensils).

or

Fit for Purpose Water: Water whose safety requirements are determined by its use and will not confer any hazard at the point of application.

WATER USED AT FISH FARMS OR IN GROWING AREAS.

6. The use of water at fish farms refers primarily to the water where the fish is raised or cultivated.

WATER USED IN EXTENSIVE SYSTEMS

7. Extensive systems refer to coastal bivalve cultures, coastal fishponds or open sea cages. This water should be, to the extent possible, consistent with Good Aquaculture Practice recommendations such that the cultivated fishery products are safe for human consumption.
8. Fish farms or growing areas should be located where contamination is unlikely and that avoids, to the extent possible, introduction of microbial hazards to the growing water. This should also consider potential dumping of waste from boats and overflow from waste management systems during excessive rain periods.

WATER USED IN LAND-BASED SYSTEMS

9. Fresh water is the main source of water for these systems. Fresh water sources should be regularly monitored for indicator microorganisms (e.g. coliforms) or, where appropriate, microbiological hazards (e.g. *Salmonella* spp., *Vibrio* spp.) that could affect food safety. Wells should be protected from run-off associated with surrounding areas and from pests (e.g rodents) that could contaminate the water.

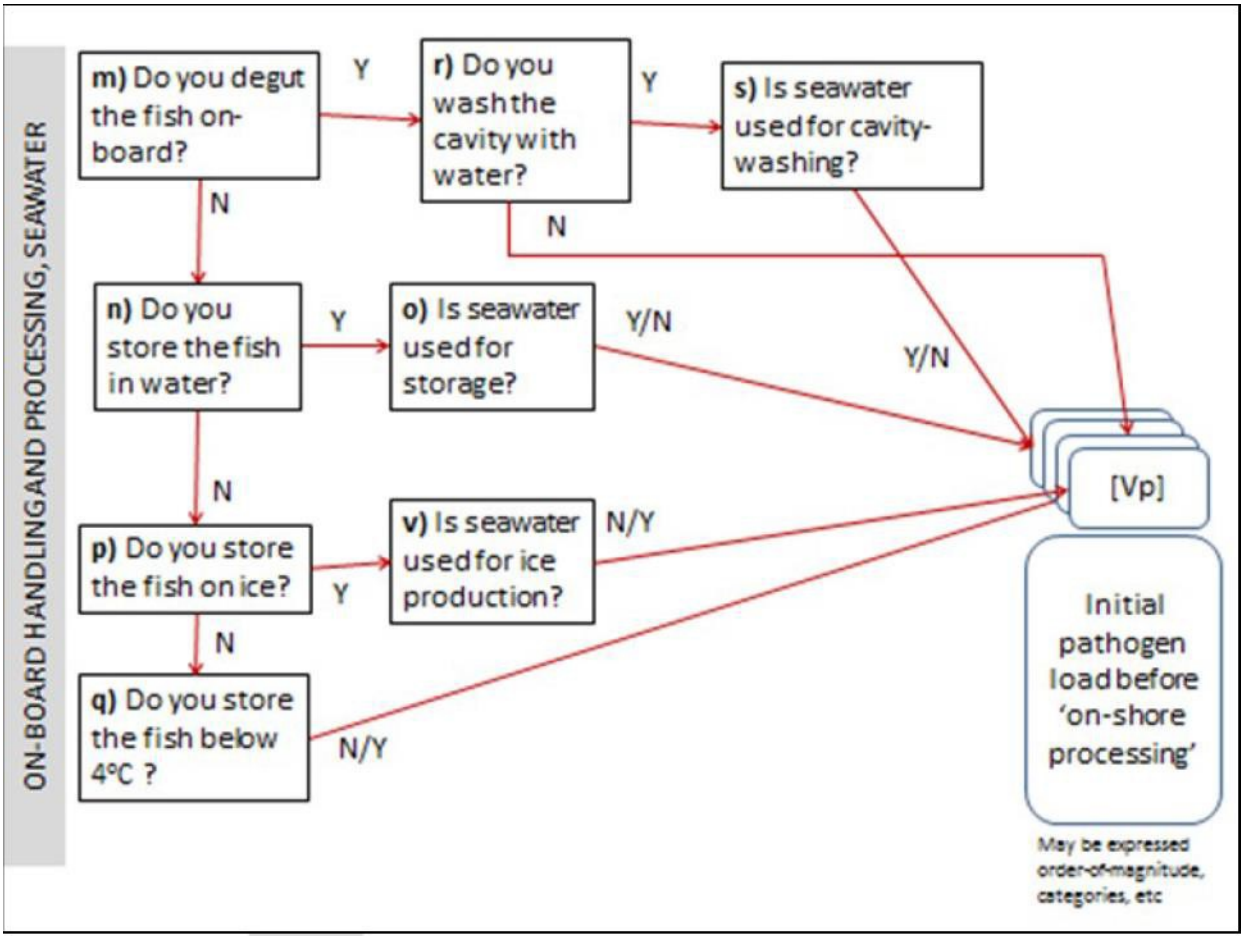
WATER USED AT HARVESTING AND FOR ONBOARD PROCESSING AND PRESERVATION

10. Many different types and sizes of fishing vessels are used throughout the world for harvesting based on the environment and the types of fish and fishery products caught or harvested. Water use in the vessels may vary from onboard preservation purposes to evisceration and further processing of the fishery products. Water quality use for on board processing will depend on the activity.
11. Onboard preservation can be done by chilling or freezing the fishery products. The most common means of chilling is using ice. Other means are chilled water, ice slurries (of both seawater and freshwater), and refrigerated seawater (RSW), including brine freezers. When considering sources of water, including for the manufacture of ice, chilling, or cleaning in onboard fishing vessels, brackish water or seawater will be the natural choice for the water source.
12. Considering whether to use fresh or seawater in land-based operations, the decision will depend on several factors, such as the type of water available, the availability of a regular water supply, the location of the ice plant, etc. It is essential that the water used is free from contaminants that could taint the fish or fishery product so that it becomes unacceptable (FAO, 2003) or pose risks to human health. For example, vessels using RSW should ensure that pumping/ballast water is taken onboard at sea away from engines or areas where waste is eliminated and not in a harbor unless the harbor water can be shown to be clean and sanitary.
13. The following recommendations should be considered:
    - When seawater or chilled seawater is used for on board product preservation, the potential hazards conveyed via the water needs to be considered in the further processing steps.
    - Water use for rinsing the fish cavity after evisceration should be fit for purpose.

EXAMPLES OF DECISION TREE (DT) USE ON HARVESTING AND PROCESSING FISH

14. The following examples were taken from the *Joint FAO/WHO Expert Meeting on the Safety and Quality of Water Used in Food Production and Processing* meeting report (JEMRA, 2018).
15. Before using these examples, you should take into consideration additional water contact events for marine and estuarine fish that may contribute to the pathogen load of the fish before processing. For this Decision Tree only *V. parahaemolyticus* was considered as a fish-borne pathogen.

Decision Tree example of onboard processing and handling of marine/estuarine fish



m) The entry level question is if the fish is gutted on board; whether or not this step has taken place can potentially influence pathogen loads and leads to the following questions:

n) If the fish is not gutted it is often kept (alive) in water in containers.

o) If seawater is used for storage of non-gutted fish, this may lead to different *V. parahaemolyticus* levels compared to other water; the answer to the question of what kind of water is used and its source may lead to an assessment of the expected *V. parahaemolyticus* load.

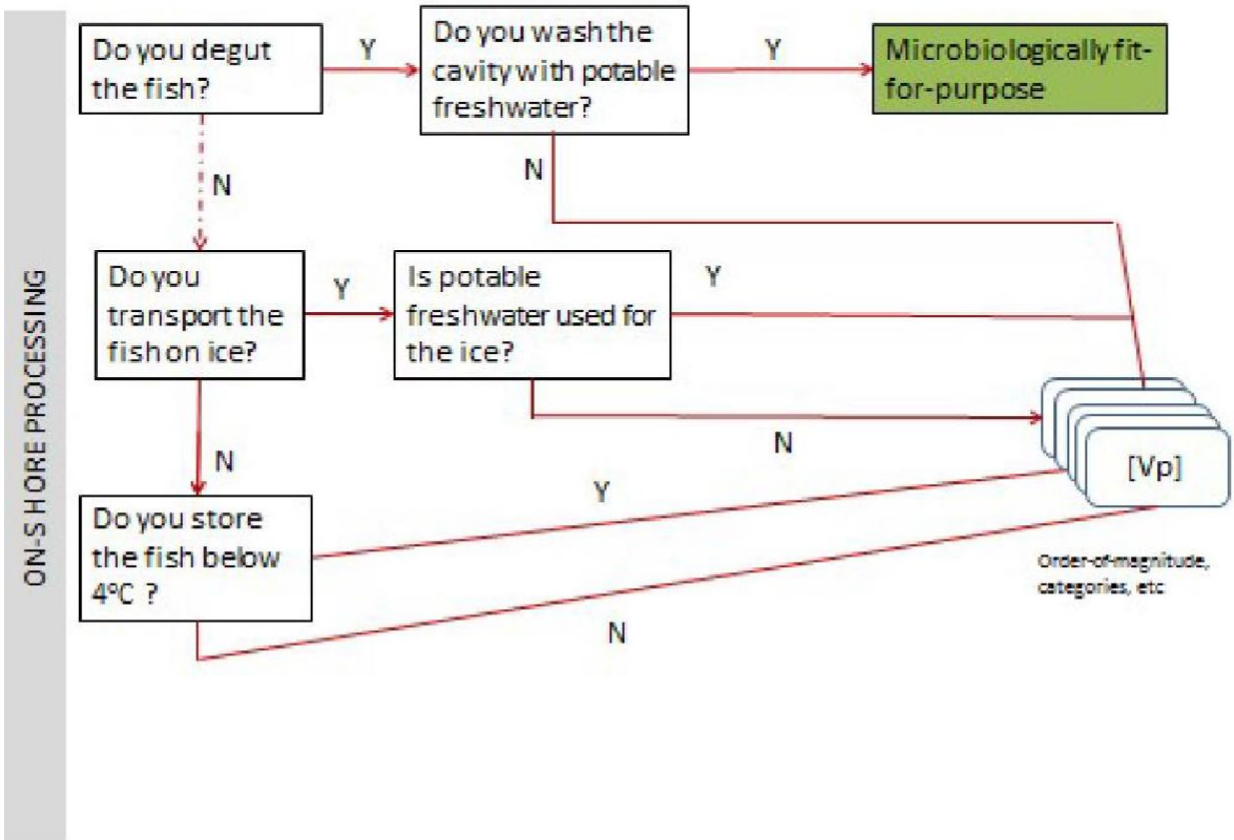
p) If the non-gutted fish is not kept in water, the question is whether it is kept on ice. If this is the case, the next question (v) is whether the ice is made from seawater; again, this may contribute to the expected *V. parahaemolyticus* load and increase risk.

q) If the non-gutted fish is not kept on ice, the questions relate to whether there are other chilled storage methods. The most important control measure with regard to *V. parahaemolyticus* is to keep the fish stored on board at or below 4° C. Again, if this is not the case, then an elevated initial pathogen load is to be expected, depending on storage duration, and possibly contributing to the risk in the onshore processing environment (see Decision Tree example of Onshore processing of marine/estuarine fish).

r) If the answer to the entry level question (m) is yes (Y) and the fish is gutted on board, it may or may not be rinsed. No rinsing may lead to cross-contamination during subsequent handling.

s) If the answer to the question (r) is yes (Y) and if the gutted fish is rinsed with seawater, *V. parahaemolyticus* might be introduced into the cavities. A negative answer also leads to the initial appraisal of the load of *V. parahaemolyticus* before the onshore processing of marine/estuarine fish section of the Onshore processing of marine/estuarine fish DT.

Decision Tree example of onshore processing of marine/estuarine fish



t) The entry level question of the DT is whether the fish will normally be gutted in the processing facility; if the answer is yes (Y), the next question (w) is whether the cavity of the fish is washed with potable freshwater, in which case there would not be a risk of further contamination wit *V. parahaemolyticus* at this point. If the fish cavity is not washed with potable freshwater, depending on what kind of water is used and its source, this may lead to an assessment of the expected *V. parahaemolyticus* load.

u/v), If the answer to the entry level question (t) about whether the fish was gutted is no (N), it is asked in the DT whether the intact fish is transported on ice to the marketplace, restaurant, etc. or kept below 4 °C (question v). This would contribute to any further pathogen die-off, especially if fish would be frozen for 48 hours.

w) Whether or not potable water is used to produce ice may have an additional impact on the pathogenic load of *V. parahaemolyticus* in the fish. Additional washing of the fish with potable water alone, at the household for instance, can mitigate the effect of the initial pathogenic load, but can also spread contamination to other foods.

WATER USES AT PROCESSING IN LAND ESTABLISHMENT

16. Water is used for washing fish, cleaning process areas, cooling and other processing purposes such as brining fish, glazing of frozen fish to maintain quality during frozen storage, etc. The characteristics of the process activity (e.g., direct contact with food) and the intended use of the fishery product should be considered for the quality of water used or reused.

17. For recommendations on type of water uses at processing in land establishment, refer to *Code of Practice for Fish and Fishery Products* (CXC 52-2003).

WATER RE-USE

TREATMENT FOR FIT FOR PURPOSE WATER

18. The comparatively large water usage for fish production may confine possible wastewater recovery to essentially on-site or near-site usage of recovered wastewater. There are several treatment technologies that can recover water of a quality that makes it fit-for-purpose or that can eliminate or inactivate

microorganisms or reduce them to acceptable levels for reuse water, including, but not limited to, heating (e.g., pasteurization or boiling); use of a chemical disinfectant like chlorine, chlorine dioxide, ozone; or physical treatments like UV-light disinfection or membrane filtration. Treatment of water for reuse should, as appropriate, effectively provide a safety and quality level that allows for its use as an ingredient or for a direct or indirect food contact application. These treatment programs should be routinely monitored for efficacy/function and periodically verified with microbiological testing.

APPENDIX II

LIST OF PARTICIPANTS

Chair

Honduras
Mirian Bueno
SENASA
mbueno@senasa.gob.hn

María Eugenia Sevilla
SENASA
msevilla@senasa.gob.hn

Co – Chairs

Chile
Constanza Vergara
Chilean Food Safety and Quality Agency (ACHIPIA)
constanza.vergara@achipia.gob.cl

European Union
Kris De-Smet

Administrator

European Commission

Kris.DE-SMET@ec.europa.eu

India
Sunil Bakshi
Ministry of Health and Family Welfare
sbakshi.fssai@gmail.com

Members and Observers

Argentina
María Esther Carullo
SENASA
mcarullo@senasa.gob.ar

Australia
Angela Davies
Food Standards Australia New Zealand
Angela.Davies@foodstandards.gov.au

Austria
Christina Lippitsch
Ministry of Social Affairs, Health, Care, Consumer
bettina.brandtner@bmlfuw.gv.at

Belgium
Katrien De Pauw
Federal Public Service Health, Food Chain
Safety and Environment
Katrien.depauw@health.fgov.be

Brazil
Ligia Lindner Schreiner
Brazilian Health Regulatory Agency
Ligia.Schreiner@anvisa.gov.br

Carolina Araújo Vieira
Brazilian Health Regulatory Agency
Carolina.Vieira@anvisa.gov.br

Canada
Cathy Breau
Bureau of Microbial Hazards, Food Directorate Health Canada
Cathy.breau@canada.ca

CGF
Marie Claude Quentin
Sanjay.gummalla@affi.com

Colombia
Blanca Cristina Olarte
Ministerio de Salud y Proteccion Social
bolarte@minsalud.gov.co

Costa Rica
Amanda Lasso Cruz
Secretaría Codex Costa Rica
alasso@meic.go.cr

Ecuador
Tatiana Gallegos
Ministerio de Salud Publica
codexalimentarius@normalizacion.gob.ec

Egypt
Zienab Mosad AbdelRazik
Egyptian Organization for Standardization and Qual
Egy.CodexPoint@gmail.com

El Salvador
Claudia Patricia Guzman
OSARTEC
rmartinez@osartec.gob.sv

FAO JEMRA
Kang Zhou
kang.zhou@fao.org

France
Matthieu Mourer
Ministry of Agriculture
sgae-codex-fr@sgae.gouv.fr

Guatemala
Ursula Quintana
CACIF
guatemalacodex@gmail.com

ICMSF
Dr. Leon Gorris
leongorris@gmail.com

IFT
Rosetta Newsome
rlnewsome@ift.org

International Council of Beverages Associations
Simone SooHoo
www.icba-net.org

International Dairy Federation
Aurélie Dubois-Lozier
adubois@fil-idf.org

International Fruit & Vegetable Juie Association
John Collins
john@ifu-fruitjuice.com

ICGMA
Nancy Wilkins
nwilkins@gmaonline.org

India
Codex-India
Food Safety Standards and Authority of India
codex-india@nic.in

Iran
Samaneh Eghtedari
ISIRI
seghtedaryn@gmail.com

Ireland
Wayne Anderson
Food Safety Authority
wanderson@fsai.ie

Japon
Kojima Mina
Ministry of Health, Labour and Welfare
codexj@mhlw.go.jp

Malaysia
Sakhiah Bt Md Yusof
Ministry of Health
sakhiah@moh.gov.my

Mexico
Tania Daniela Fosado
Secretaria de Economia
codexmex@economia.gob.mx

Morrocco
Oleya EL HARIRI
l'Office National de Sécurité Sanitaire des Produits Alimentaires (ONSSA)
oleyafleur@yahoo.fr

Nicaragua
Miriam Canda
Ministerio de Fomentos, Industria y Comercio
codex@mific.gob.ni

Norway
Norwegian Food Safety Authority
codex@mattilsynet.no

OIRSA
Raul Peralta
rperalta@oirsa.org

Perú
Juan Carlos Huiza Trujillo
DIGESA Ministry of Health
codex@minsa.gob.pe

Maria Eugenia Nieva Muzurrieta
DIGESA Ministry of Health
mnieva@minsa.gob.pe

Poland
Magdalena Kowalska
Agricultural and Food Quality Inspection
kodeks@ijhars.gov.pl

Korea
Eun Song Cho
Ministry of Agriculture Food and Rural Affairs (MAFRA)
echo27@korea.kr

Sung-youn Kim
National Agricultural Quality management Service
youn5326@korea.kr

Saudi Arabia
Ali Fahad
Saudi Food and Drug Authority
Codex.cp@sfda.gov.sa

Spain
Lorena Solar de Frutos
AESAN
cioa@msssi.es

Switzerland
Mark Stauber
Federal Food Safety and Veterinary
Office FSVO
Mark.Stauber@blv.admin.ch

Thailand
Virachenee Lohachoompol
codex@acfs.go.th

Uganda
Arthur Mukanga
Uganda National Bureau of Standards
arthur.mukanga@unbs.go.ug

Tabula Arthur
Uganda National Bureau of Standards
info@unbs.go.ug

United Kingdom
Ian Woods
Food Standards Agency
ian.woods@food.gov.uk

United States of America
Jenny Scott, US FDA
Jenny.Scott@fda.hhs.gov

Clark Beaudry, FDA
uscodex@usda.gov

Uruguay
Rossana Bruzzone
codex@latu.org.uy