CODEX ALIMENTARIUS COMMISSION

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Proposed Draft Guidelines for the Safe Use and Reuse of Water in Food Production and Processing

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

Codex Members and Observers wishing to submit comments on the discussion paper should do so as instructed in CL 2022/48/OCS-FH available on the Codex webpage/Circular Letters 2022: https://www.fao.org/fao-who-codexalimentarius/resources/circular-letters/en/

INTRODUCTION

1. At the 51st 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 and to structure the document to include overarching guidance followed by commodity-specific guidance. CCFH51 further agreed that the guidelines should be developed using a step-wise approach, with fresh produce and fishery products being priorities.

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 were within the scope of the guideline, stressing that further scientific advice from JEMRA was needed to progress the development of the guideline (and its annexes).

3. CCFH52 held in February 2022 did not specifically discuss the proposed draft Guidelines, but rather focused on asking for feedback on the terminology covered by the Guidelines, as well as the request for further scientific advice to JEMRA. CCFH52 agreed to continue the work of the EWG, chaired by Honduras, and co-chaired by Chile and the European Union to continue developing the proposed draft guidelines, and annexes.

4. CCFH52 further agreed to convene a PWG, chaired by Honduras and co-chaired by Chile and the European Union to meet in conjunction with CCFH53 to consider comments received at Step 3 and prepare recommendations for consideration by the plenary.

PARTICIPATION AND METHODOLOGY

5. An invitation was sent to all Codex Members and Observers to participate in the EWG. Participants from 35 Codex Members and 7 Observers were registered as participants of the EWG. The list of participants is attached as Appendix II. The EWG work was conducted using the Codex online platform.

6. The General Section and the two annexes; Fresh Produce and Fishery Sector went through one round of comments by EWG members and revisions by the co-chairs. The revised drafts of the General Section, Fresh Produce Annex, and Fishery Products Annex, were posted on the Forum in June 2022 for EWG input.

7. Comments on the General Section were received from 16 countries and 2 observer organizations; comments on the Fresh Produce Annex were received from 13 countries; and comments on the Fishery Products Annex were received from 11 countries.

8. Comments from the EWG have been addressed by the co-Chairs to the extent possible. Sometimes a compromise has been sought when comments were contradictory. Most comments were mainly editorial with the purpose of improving the draft. Bilateral meetings with JEMRA resulted in a better alignment to understand the JEMRA Reports.

9. The co-Chairs asked for input from the EWG on a number of issues in the documents circulated, including definitions, organization of the information, and additional text. Comments from the EWG members were used to revise the General Section, the Fresh Produce Annex, and the Fishery Sector Annex.

SUMMARY OF DISCUSSION

10. For the General Section, members of the EWG were invited to determine which of the two definition options for water fit for purpose was the most appropriate for the document, if members agreed with the definitions included in the document, its proposed structure, and if the proposed decision tree (DT) was useful or if it should be improved. Most of the members agreed that the document had the appropriate structure, and that the DT was useful. However, no consensus was reached on which definition would be the most appropriate for water fit for purpose. New definitions and text to improve clarity and consistency were also included in the document.

11. For Annex I on Fresh Produce, members of the EWG were invited to express their views on whether the examples (DT and table 1) were appropriate and requested to provide additional text to improve them. The rest of the comments were mainly editorial with the purpose of improving the draft with most of them being incorporated into the document.

12. For Annex II on Fishery Products, members were invited to provide comments to the text with EWG members expressing their positive views on the utility of decision trees and stressing the need to have the JEMRA report published in order to be used in the development of the guidance.

13. The EWG however, was not able to draft Annex III for dairy products considering the small window of time available between CCFH52 and CCFH53.

14. Based on the comments received, the co-Chairs have revised the General section and annexes I for fresh produce and II for fishery products, which are attached in Appendix I.

15. The EWG has included specific questions in the document to be addressed Members in providing comments in response to the Circular Letter and by the Physical Working Group that will be convened at the margins of CCFH53.

CONCLUSIONS

16. The EWG completed most of the tasks assigned by CCFH52; drafted a document composed of a general section, fresh produce annex, and fishery products annex.

17. Annex III for dairy products could be elaborated at a different stage subject to approval from CCFH53 to the establishment of an EWG.

RECOMMENDATIONS

18. CCFH53 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 provide their inputs; and

ii. specifically provide input on the following:

a) Definitions in the General Section:

- Whether there is agreement with the definitions currently included in the document;
- Whether there are any definitions missing and if so to provide proposed text for any missing definitions;
- Whether certain definitions should be retained in the document (e.g., HACCP system, food hygiene system) or rather insertion of a cross-reference to the appropriate Codex documents;

- To indicate a preference for option 1 or 2 for the definition for water fit for purpose;
- To indicate a preference for the term water risk assessment or water risk analysis; and
- To indicate whether a definition is needed for Active management and/or Passive management and if so to provide proposed text for the definition.

b) As regards the fresh produce annex specific input is required in order:

- To agree to the modifications proposed to the definition of fresh produce (see section on Definitions in Annex I) and to decide where to put it (in the general part or in Annex I)
- To determine whether to maintain or eliminate texts referring to chemical hazards or their control, considering that it is out of the scope of the document (e.g. paragraph 34);
- To evaluate the remaining examples and determine if the tools (DT) are appropriate for the development of the document;
- To agree on the additional wording proposed in the second part of paragraph 30 pertinent to the implementation of simple complimentary operational monitoring in small-scale systems; and
- To agree on the changes made to Table 1 to indicate medium risk instead of low risk in case of fresh producer that is cooked or processed by the consumer or the food business operator.

c) As regards the fishery sector annex specific input is required in order:

- To indicate if the scope of the annex is the most appropriate;
- To decide if the annex requires further description of the different types of source water to mirror the guidance provided in annex I; and
- To determine whether the proposed DTs are useful for the proper use of water in the process.

19. Following resolution of the above issues, it is recommended that CCFH consider advancement of the General Part of the Guidelines and Annex I and II in the step process.

20. In addition it is recommended that CCFH53 consider the establishment of an EWG to address the development of the dairy sector annex, for the consideration by CCFH54.

APPENDIX I

GUIDELINES FOR THE SAFE USE AND REUSE OF WATER IN FOOD PRODUCTION AND PROCESSING

PROPOSED STRUCTURE FOR THE DOCUMENT:

INTRODUCTION

1. Water has an important role in all stages of the food chain from initial sourcing, storage, treatment, distribution, use in irrigation of food crops and forage for animals, primary production, and food processing through to consumption of the final food. It is used as an ingredient, in direct and indirect contact (e.g. washing, cooling the product, or cleaning of equipment surfaces in contact) with food, food packaging, and for hygiene sanitation in food processing. The important role of water in food production has led to the need to ensure its safety and quality since it can be a carrier for the transmission of diseases, contamination, or unwanted sensory attributes.
2. Water is a dwindling resource worldwide and not all food producers and processors have access to safe water sources or this access may be limited. Noting that the availability and biological quality of water are different in each country, region, context, setting, and food establishment, water should always be fit for use for each specific purpose, and it should be managed in a way that the safety of food is ensured, while simultaneously avoiding unnecessary consumption, waste, and the environmental impact.
3. Water used along the food production and processing chain can have different biological quality requirements and types of water other than potable water may be suitable for certain purposes, provided that they do not compromise the safety of the final product for the consumer.
4. Requirements for water safety should therefore be considered in context, considering 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 along the food chain.
5. A risk-based approach to water sourcing, treatment, handling, storage, and use can help in identifying the hazards associated with the water and its use and determine treatments, if applicable, that water needs to undergo to meet the safety parameters specific to each intended use. This approach can also provide a means to address many of the water access and safety challenges associated with reuse based on the principle of using the right water safety for the intended purpose/need.
6. Deciding whether water is fit for purpose should be based on a hazard analysis that considers risks associated with the source water, treatment options and their efficacy, application of multiple barrier processes for risk

mitigation, and the end-use of the food product (e.g. whether the food is eaten raw without steps that would mitigate potential hazards introduced by the water source).

7. 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 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.

8. Associated Annexes provide product-specific guidelines for the safe sourcing collection, storage, treatment, handling, distribution, 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 (DTTs) that can help to determine if water is fit for purpose.

OBJECTIVES

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

- Provide guidance for competent authorities and food business operators (FBOs) on the application of a risk-based approach for the use and reuse of water that is fit-for-purpose
- Provide practical guidance and tools (e.g. DTTs) and risk-based microbiological criteria as examples to help FBOs evaluate risks and potential interventions of water as part of their food hygiene system

PURPOSE AND SCOPE

10. These guidelines provide a framework of general principles and examples for making risk-based decisions for fit-for-purpose water to be sourced, used, and reused across the primary production and processing of relevant commodities. These guidelines do not consider chemical hazards, water for direct animal and human consumption, or the use of water in households.

USE

11. The document is intended for use by FBOs (including primary producers, packing houses, manufacturers/processors, food service operators, retailers, and traders) and competent authorities (risk managers and assessors), as appropriate.

12. 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), *Principles and Guidelines for the Establishment and Application of Microbiological Criteria Related to Foods* (CXG 21-1997), and *Principles And Guidelines for the Conduct of Microbiological Risk Assessment* (CXG 30-1999).

GENERAL PRINCIPLES

i. Water, as well as ice and steam made from water, used at any stage of the food chain, should be safe and fit for its intended purpose based on a risk-based approach and should not compromise the safety of finished foods for consumers.

ii. When using water as an ingredient in food, it should meet the standards of potable water (such as those established by competent authorities having jurisdiction or the WHO Guidelines for Drinking Water Quality).

iii. Reuse of water should be encouraged, but it should be treated/reconditioned and validated to reduce or eliminate microbiological hazards to an acceptable level according to its intended use.

iv. In all situations, water sourcing, use, and reuse should be part of an FBO´s food hygiene system or HACCP system.

DEFINITIONS

13. For the purposes of this document the following definitions apply:

Option 1: [Water fit for purpose]: water that is determined to be safe for an intended purpose through an assessment of potential hazards, treatment options and their efficacy, control measures, history of use, and the end use of the food product.]

Option 2: [Water fit for purpose]: water which is determined to be safe for an intended purpose through a water risk assessment.]

Option 1: [**Water risk assessment]: Option 2: [Water risk analysis]:**

A systematic evaluation of the water source can be used to identify potential microbiological hazards, available control measures, and other risk factors (e.g. end use of the food product, history of use, etc.) to establish appropriate risk mitigation practices (e.g. treatment options and their efficacy) to determine if the water can be fit for purpose.

[Active management:]

[Passive management]

Clean Water: water that does not meet the criteria for potable water but does not compromise the safety of the food in the context of its use.

First-use water: Potable water from an external source that can be used in any food processing operation. Examples of this type of water include wastewater, rainwater, surface water, and effluents of sewage treatment plants that are properly reconditioned to be considered potable.

Potable water: Water fit for human consumption.

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. Types of reuse water can include reclaimed water from food, recycled water from food operations, or recirculated water in a closed loop system.

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.

Recycled water: Water, other than first-use or reclaimed water, which has been obtained from a step in the food production or food processing operation to be reused in the same, prior or a subsequent step of the operation, after reconditioning, when necessary.

Recirculated water: Water reused in a closed loop for the same processing operation without replenishment.

Risk assessment: A scientifically based process consisting of the following steps: (i) hazard identification, (ii) hazard characterization, (iii) exposure assessment, and (iv) risk characterization.

Reconditioning: the treatment of water intended for reuse by means designed to eliminate or reduce microbiological contaminants to an acceptable level according to its intended use.

Water sourcing: the act of identifying and obtaining water for food production from a particular water source (e.g. groundwater, surface water, captured water).

Food hygiene system: Prerequisite programmes, supplemented with control measures at CCPs, as appropriate, that when taken as a whole, ensure that food is safe and suitable for its intended use.

HACCP System: The development of a HACCP plan and the implementation of the procedures in accordance with that plan.

SECTION 1: WATER RISK ASSESSMENT AND MONITORING

14. Water Risk Assessment [Analysis] (WRA) 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, collection, storage, treatment, handling, use and reuse.

15. WRAs can be used to set target objectives for water sources and treatments for achieving public health outcomes, water quality values, performance targets (e.g. food safety objectives, performance objectives), acceptable levels of risk, and treatment process efficacies. Monitoring is used to generate data for the development of a risk profile or to inform WRA and can be used to inform risk management by identifying safety issues that need to be addressed in a food hygiene system to ensure the safety of water and, therefore, the safety of foods.

16. Like food safety management, water safety management should be risk- and evidence-based, with reduction measures implemented within the framework of an overall water safety plan or a structured food hygiene

system or HACCP system and with verification and monitoring activities in place to ensure the plans/systems are operating as expected.

17. Water use and reuse systems should be subjected to ongoing, risk-based monitoring of appropriate parameters and verification by testing. The frequency of monitoring and verification can be dictated by different factors such as the source of the water or its prior condition, the efficacy of any treatments, and the intended reuse of the water. In any case, this should be included in an FBO´s food hygiene system, water safety plan, or HACCP system.

18. Monitoring must be able to detect potential deviations and provide information in time for corrective actions to be taken such that unsafe foods are not placed on the market.

19. In the context of safe water sourcing, collection, treatment, handling, use, and reuse, WRAs can include the following approaches:

   - Descriptive assessment (least comprehensive) - a written onsite as well as document-based evaluation from which a written descriptive assessment is generated. Examples include a sanitary inspection, used in evaluating and managing risks from irrigation water and rapid assessment of water safety.
   - Semi-quantitative WRAs – the development and use of risk matrices that establish categories of risks from high to low, including consideration of sanitary conditions and their likelihood and estimated frequencies of unacceptable sanitary conditions. These are normally used for planning, prioritization, and a rapid assessment of the safety and quality of water sources collection, storage, treatment, and handling.
   - Quantitative Microbial Water Risk Assessment (QMWRA) (most comprehensive) – a mathematical modeling approach that can be used for estimating risks related to water use with a health outcome target. QMWRA helps identify how much of an impact a pathogenic microorganism in water will have on the health of the population e.g. guiding potable water reuse, wastewater use in agriculture, and water supply systems.

SECTION 2: FOOD HYGIENE SYSTEMS

20. Water safety plans can be a tool for control, monitoring, and verification of the safe use and reuse of water. They should be risk and evidence-based, with control or mitigation measures implemented within the framework of an overall water safety program or a structured food hygiene or HACCP system with verification and monitoring to ensure that it is operating as expected.

21. The development of such plans requires complete knowledge of the water 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. As part of the food hygiene or HACCP system, all water systems should be mapped in a process flow diagram and evaluated in the hazard analysis. Water systems also require identification of potential hazards (microbiological, physical agents) with the capacity to cause damage to water safety and their sources and should also address safe water sourcing, use or reuse, when developing and implementing the plan. Additional factors to be considered could include water storage/distribution, including hygienic design, and the need for special expertise.

23. Once potential hazards and their sources have been identified, the risks 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.

24. Treatment or reconditioning of water intended for fit-for-purpose reuse should be based on hazard analysis of the sourced water and, where deemed necessary, treatments should ensure that hazards are controlled to an acceptable level.

SECTION 3: DECISION SUPPORT SYSTEMS

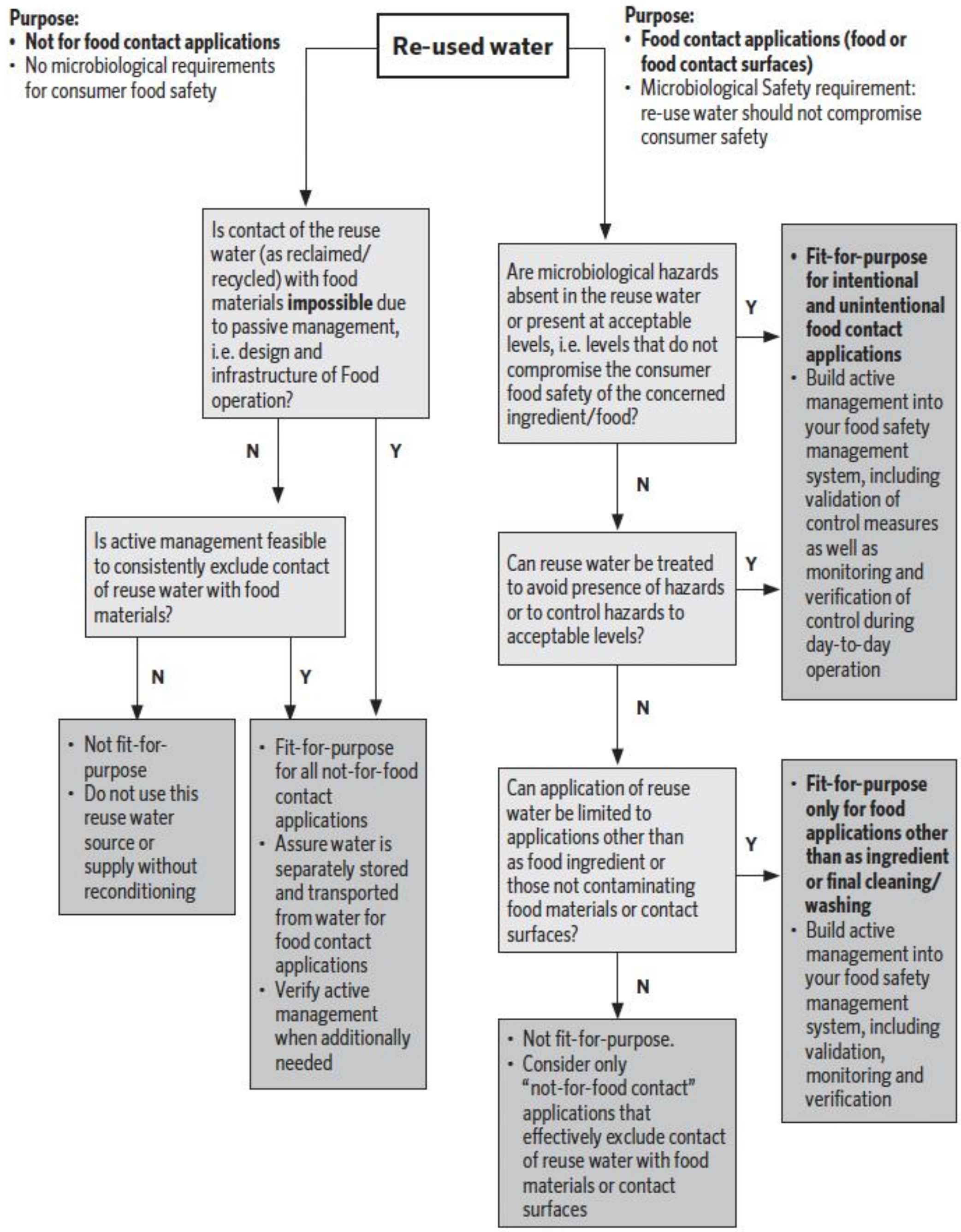
25. Decision support systems (DSS) tools, such as decision trees (DTs) or matrices, are considered to be useful risk management tools to assist stakeholders in making decisions on the water’s fitness for purpose and the required quality for use or reuse at a given step in the supply chain.

26. DSS should allow for the diversity in food production, resulting in different types of risks and risk management steps necessary to ensure the water’s fitness for purpose in food production. Examples include the food types

involved and their intended use; 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. An example of a risk-based DSS tool with further guidance is provided in Figure I.

Figure I. Example of a risk-based DDS framework tool for the purpose of deciding if reused water can be used in either a food contact application or a not-for-food-contact application for microbiological hazards.



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., and 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, during harvesting, such as washing in the field, and post-harvest practices, such as cooling, transporting, washing and rinsing, 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 (GHP), risk-based, sector-specific potential prevention and 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 the fresh produce supply chain

USE

4. This Annex is complementary to and should be used in conjunction with the main document, 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)* (CAC/GL 3-2007) and *Principles and Guidelines for the Conduct of Microbiological Risk Assessment* (CAC/GL 30-1999).

DEFINITIONS

See the general part of these Guidelines for the safe use and reuse of water in food production.

[Fresh produce: Any fresh fruit, nuts, **<u>fungi</u>** and vegetables that are likely to be sold to consumers in a raw form, either unprocessed **<u>or minimally processed (e.g., washed, peeled, cut or otherwise physically altered from its original form but remaining in the fresh state),</u>** and that are generally considered as perishable regardless of it being intact or cut from root/stem at harvest.]

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 produce. The source of the water used for primary production as well as the method of delivery, water storage infrastructure, and application system can affect the risk of contamination of fresh produce.

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 is usually very variable. Several parameters may influence the risk of biological contamination of fresh produce via water: the source of water, water storage and delivery infrastructures, the type of irrigation system (e.g. drip, furrow, sprinkler/overhead) influencing whether the water has direct contact with the edible portion of the fresh produce, 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 produce, should not compromise their safety.

Water Sources

7. Growers should identify the sources of water used during primary production (e.g. municipality, groundwater including well water, surface water (e.g. open canal, reservoir, river, lake, farm pond), reused irrigation water, rainwater, 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
    - Hygienically collected 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 wild and domestic 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, and at least ten meters away, to minimize contamination.
    - Ensure the catchments and gutters of the water harvesting, distribution and delivery system are regularly cleaned and maintained.
    - Ensure that all water storage tanks or water reservoirs 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 systems 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, an expert should be consulted to assess the relative risk and determine the suitability of the water source. Measures to ensure the safe use may include wastewater treatment, application techniques that minimize contamination, die-off periods before harvesting, produce washing, disinfection and cooking.
    - Surface water (e.g. rivers, lakes, canals, lagoons, ponds, reservoirs): when contaminated, options such as application of chemical treatment, sand filtration (combined with other treatment such as such as application of UV-C), microfiltration or storage in catchments or reservoirs to achieve partial biological treatment should be considered. The efficacy of these treatments should be evaluated and monitored.

Assessing and testing of water

10. Growers or associated operators should assess the biological quality of water, as prescribed by the competent authority, and its suitability for the intended use, and identify corrective actions in case of unacceptable results, to prevent or minimize contamination (e.g. from livestock, wildlife, sewage treatment, human habitation, manure and composting operations or intermittent or temporary environmental contamination, such as heavy rain or flooding).

11. When water is tested for biological hazards, the results should be used by growers and associated operators to inform on the use of water 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), observed quality based on preceeding testing, the risks of environmental contamination, including intermittent or temporary contamination, and factors such as the implementation of a new water treatment process by growers.

12. If water testing is limited to indicator organisms, frequent water tests may be useful to establish the baseline water quality so that subsequent changes in the levels of contamination can be identified. Water testing should be more frequent when establishing the baseline, but the frequency can be lowered once there is a better understanding of the patterns (e.g. seasonality) for microorganisms in the water source. Then, if there are results outside of the range, testing frequency can be increased again at that point.

13. Growers and associated operators 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) 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 regulations, in order to determine and document the following:

    - where to sample (e.g. surface of the water or deeper, close to the edge of surface water or farther back from the bank) and how much to sample;
    - Which validated test methods should be conducted (e.g. for which pathogens and/or indicators organisms);
    - 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 contamination of water and fresh produce at 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;
    - the prevention of the stirring of the sediment when drawing water;
    - the proper maintenance of distribution and storage systems
    - changing the water application method 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.

Possible corrective action to reduce contamination at primary production may include:

- water filtering by a system that allows capturing particles on which biological contaminants may be attached;
- chemical water treatment;
- the construction of settling or holding ponds or water treatment facilities;

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)

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 where 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. If overhead irrigation cannot be avoided, the use of low volume sprays can reduce the risk. 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 produce directly to water (e.g. sprayers), especially close to harvest time;
    - Irrigation of fresh produce that have physical characteristics such as leaves and rough surfaces that can trap water; and
    - Irrigation of fresh produce 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 (GAP) 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 or fertilizers applied using water.
    - 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 requiring 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.
    - Water spraying, i.e. misting, immediately prior to harvest presents an increased biological 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 be avoided.
    - 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. The risk of contamination increases if large irrigation droplets are used or heavy rain occurs. It should also be noted that if the soil has been contaminated by irrigation water, soil splash can transfer contamination to crops.
    - Inspection of the complete irrigation system under the farmer's control at the beginning of each growing season and repair the system or apply corrective measures if necessary.
    - Proper storage of organic fertilizers and manure in areas away from water sources, with no possibility of being washed away by runoff.

20. Those responsible for the water-distribution system, where appropriate, 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 other 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 produce, especially if they are applied directly on edible portions of the fresh produce close to harvest. Human pathogens can survive and multiply 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/growth 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 produce is 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 (for example with labels or color codes) and should not connect with or allow reflux into potable water systems. Water for indoor storage and distribution facilities should:

- 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.

HARVEST and POST-HARVEST USE OF WATER

General

27. Water used during harvesting and postharvest practices includes any water that contacts fresh produce during or after harvest including water used for rinsing, washing, transporting or fluming, cooling, waxing or icing. The microbiological quality of postharvest water is critical because microbial die-off of the fresh produce before consumption is minimal, in particular in case of ready-to-eat produce.

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. Since the results of such (verification) testing is not available right away, it is recommended to carry out simple complimentary operational monitoring such as rapid water quality testing by testing of turbidity, chlorine residuals or visual observation. This last one is of particular importance in small-scale systems where the frequency of verification testing is typically low.

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. If large quantities of fresh produce (hundreds of kilograms) are washed in the same volume of water (1000 L), accumulation of microorganisms occurs which favours cross-contamination between different product batches. Maintenance of residual concentration of biocides in the process water, can be used as processing aids to maintain the microbiological quality of process water to avoid accumulation of microorganisms in the water tank and reduce cross-contamination in the washing tank.

33. 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.

34. The use of biocides to maintain the microbiological quality of process water should comply with the requirements established by the competent authority and should be validated for efficacy. Biocides should never replace GHPs but be used in addition to GHPs and where necessary to minimize post-harvest cross contamination with biocide 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 using overhead spray, not by an immersion tank without cross-contamination attention.

35. 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.

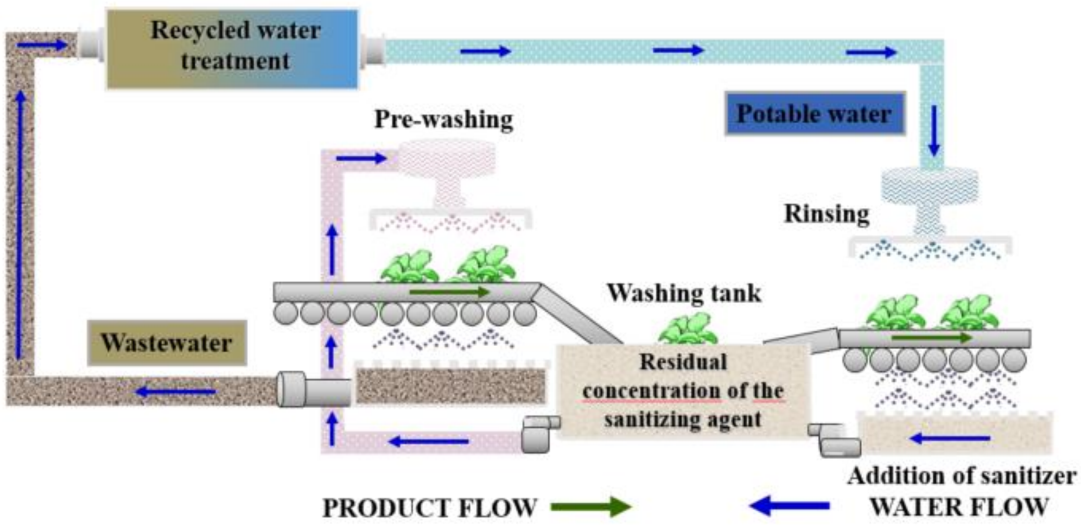
36. Ice that may come in contact with fresh produce should be made from potable water and produced, handled, transported, and stored in such a manner as to protect it from contamination.

37. 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, melons 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

38. Water reuse is also possible in the fresh produce industry. As a principle, water reuse should move backwards through the system from clean to less clean steps in the process. 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. Example of a potential option for water reuse in the fresh produce industry.



39. The water used in the final rinsing step should be potable water. After rinsing, this water should be treated with a biocide to have a residual concentration of the biocide able to minimize cross-contamination in the washing tank. By doing this, 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.

40. 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 and reduce the bacterial load that comes with the produce. This step will help maintain a residual concentration of biocides in the wash water tank, as some biocides are inactivated by organic matter. 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 biocides that are inactivated by organic matter.

41. The final rinsing step should also minimize the residues of the biocides (e.g. disinfection-by-products) in the fresh produce coming from the washing tank.

42. In order to have a more sustainable industry, which avoids the use of excessive amounts of water, the water used 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.

43. Recycled water should be treated and maintained in conditions that do not constitute a risk to the safety of fresh produce. 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.

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

45. If treating water for use in washing and rinsing, it is recommended to seek 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

46. 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;
- on the use of a de-watering step, where possible, to remove excess water from the fresh produce, as dry produce is less likely to become re-contaminated; in such case, water should be removed gently to prevent damage to produce.

47. Develop documented procedures for cleaning and sanitizing of surfaces coming into contact with the fresh produce and 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 and blades, and boots and protective clothing should be cleaned and disinfected at the end of each day;
    - maximum run time, between cleaning and sanitation cycles, should be determined for each process line.

RISK-BASED STRATEGY TO DETERMINE FIT FOR PURPOSE

48. The development of a risk-based strategy for water sourcing, use and reuse should be based on a risk-based strategy 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;
    - the description of the water supply system (e.g. delivery and storage system)
    - 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 such as heating, microfiltration and treatment with chlorine, chlorine dioxide, chloramine, ozone, UV-C;
    - application after use of water (e.g. Irrigation cessation, washing, peeling)
    - consumers' habits such as eating raw, cooking, fermenting, etc.
49. 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.
50. The matrix in Table 1 can be used to simply approach the level of risk posed by the use or reuse of various water sources during pre-harvest stages of fresh produce and their intended use.

Table 1[1]

Intended use of fresh produce	Contact of the water with edible portion?	Water source				
		Reused water untreated	Surface and groundwater of unknown quality	Groundwater collected from protected wells	Hygienically collected rainwater	Potable water, deep groundwater or other water, including treated reused water, that complies with the microbiological criteria applicable to potable water.
Ready-to-eat	YES	High risk	High risk	Medium risk	Medium risk	Low risk
	NO	High risk	High risk	Low risk	Low risk	Low risk
Cooked or processed by consumer or a food business operator	YES	Low risk	Low risk	Low risk	Low risk	Low risk
	NO	Low risk	Low risk	Low risk	Low risk	Low risk

51. When data (e.g. on microbial quality of the water sources, on relevant health data from exposed populations) and resources allow, the conduct of a quantitative risk assessment can be considered. This may allow risk mitigation measures to be more cost-effective and tailored to the specific needs.

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 JEMRA Report on the Safety and Quality of Water Used with Fresh Fruits and Vegetables, MRA 37)

52. 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.

53. 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.

54. 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.

55. Bacteriophages are better bacterial 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.

56. 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.

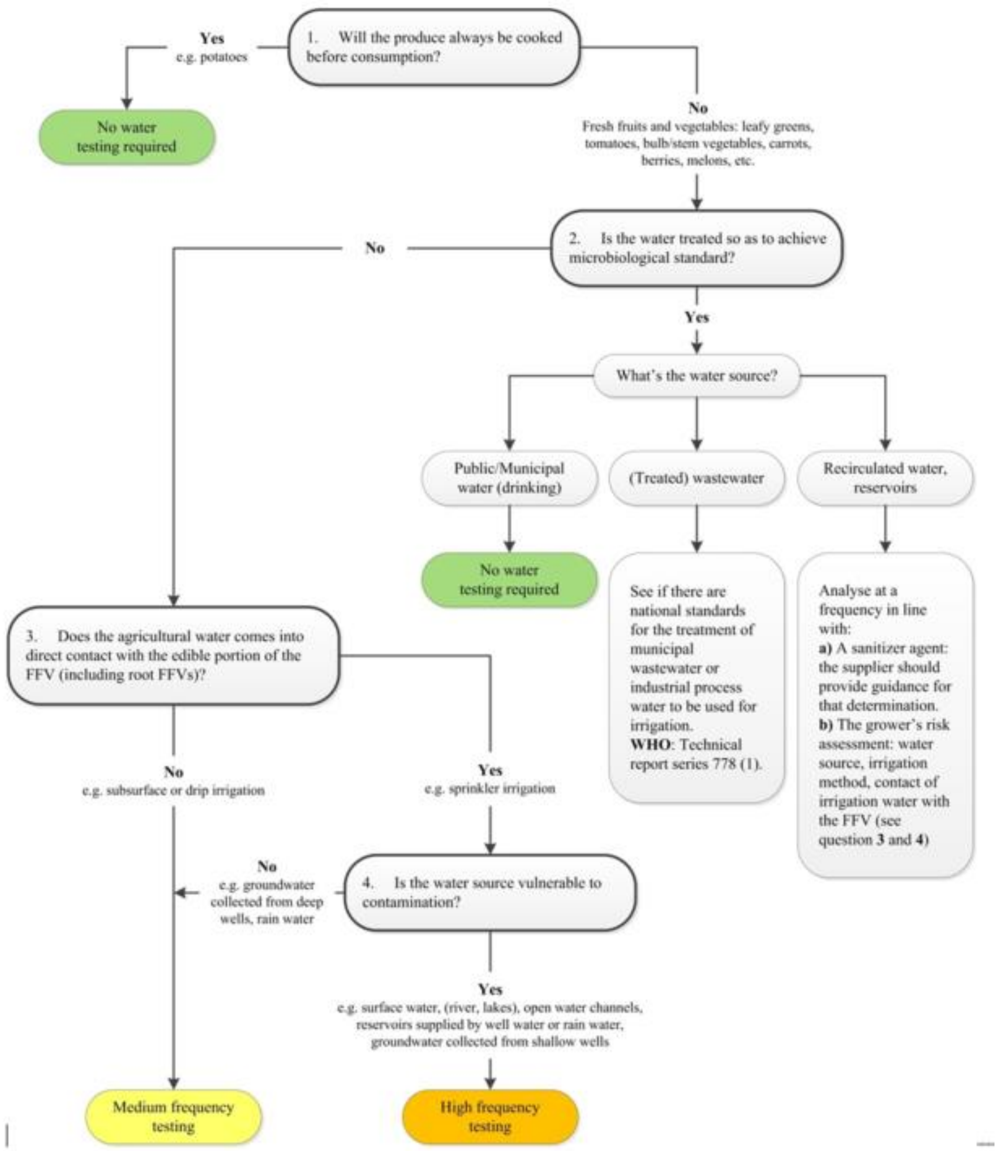
Examples for determining fit-for-purpose sampling frequency and biological criteria

57. The determination of a fit-for-purpose sampling frequency can contain the following steps:

[1] From FAO/WHO MRA 33 Meeting report on Safety and Quality of Water Used in Food Production and Processing.

- 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.

58. For determining the sampling frequency a "decision tree" approach such as the example below can be used.



59. Alternatively to decide on the frequency of sampling and applied biological criteria, a table assessing risk can be used as in the third illustration of Appendix 2, considering the source and the intended use of agricultural water (*e.g.* irrigation system, washing the fresh produce), characteristics of the fresh produce and its intended use, defining the suitability for agricultural purposes, the recommended biological threshold values and the frequency of monitoring.

Examples of decision support system tools

60. There is no single decision support system tool that applies/fits in all situations. The Decision trees and examples below therefore should rather be considered as an approach to evaluate a situation instead of as a tool fixed for all purposes.

61. 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 can be 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 acknowledged that no decision tool fits in all situations. The scores below are examples for illustration only. There can be other considerations that would result in a different score.

62. Scores in the decision tool are:

- Related to the 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
- Related to the 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
- Related to the application of one or more of the following mitigation options at or post-harvesting
    - Irrigation cessation (3 days): 2
    - Washing with running potable water: 1
    - Washing with running potable water + added biocide: 2
    - Peeling: 2
    - None: 0

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

- When low risk water (potable water, deep groundwater, other water showing compliance with biological criteria of potable water) is used and no fresh manure, excreta or sludge as fertilizer, the risk at primary production can be considered as low.
- When medium risk water (e.g. collected rainwater or other water showing low biological contamination e.g. *E. coli* 10 to 100 CFU/100ml) is used and no fresh manure, excreta or sludge as fertilizer, the risk at primary production can be considered as low, if a score of about 4 (3-5) is reached by applying the irrigation system or mitigation options in paragraph 60.
- When high or unknown risk water (wastewater, surface water, shallow ground water, other water showing high biological contamination e.g. E. coli 1000 CFU/100ml or more) and no fresh manure, excreta or sludge as fertilizer, the risk at primary production can be considered as low, if a score of 6 and more is reach by applying the irrigation system or mitigation options in paragraph 60.

- Examples of decision support system tools are provided in the Appendices. Appendix 1 is based on the decision tool in paragraphs 60 to 62. Appendix 2 contains other examples applied in certain parts of the world. The examples below are purely for illustration, can be used voluntarily and may have to be adapted to national or local situations.

Appendix 1: Examples of decisions based on support systems tool described in paragraph 59 to 62:

- Medium risk water, irrigation water not in contact with the edible portion of the fresh produce (3), no other treatment => total of 3: better to use other source or add mitigation option(s)
- Unknown risk water, irrigation water not in contact with the edible portion of the fresh produce (3), filtering before irrigation (1) and irrigation cessation (2) => total of 6: acceptable
- Medium risk water, irrigation water in contact with the edible portion of the fresh produce (0), irrigation cessation (2) + washing with potable water and biocide (2) => total of 4: acceptable.
- Unknown risk water, irrigation water in contact with the edible portion of the fresh produce (0), but filtering before irrigation (1) and irrigation cessation (2) + washing with potable water and biocide (2) + peeling (1) => total of 6: acceptable
- Medium risk water, irrigation water in contact with the edible portion of the fresh produce (0) + washing with running potable water and added biocide (2) + peeling (2) => total of 4: acceptable.

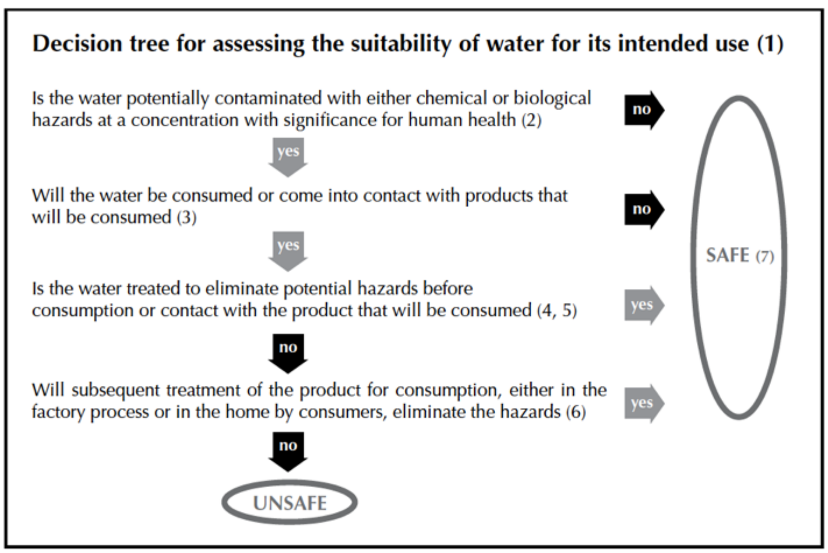
Scoring:

- 1-3 unacceptable (use other source or add mitigation options),
- 4-6 acceptable without further mitigation options.

Appendix 2: Other examples of decision support system tools applied in certain parts of the world.

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

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.



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;
- whether there is contact or not with the product, and, if so, at which stage, as water, ice or steam?

At the first question/step (2) guidelines and applicable regulations should be consulted.

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

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.

At the fourth question/step (6), consideration should be given if additional mitigation measures can be introduced.

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.

B) **Illustration 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*

In this illustration, it is recommended to use municipal (potable) water, well water with potable water quality or reverse osmosis for any water in 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.

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.

C) **Illustration 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*

Intended use of the water	**Source of water**						**Suggested thresholds for Indicator of fecal contamination: *E. coli***
	Untreated surface water[2]/ open water channels	Untreated ground water collected from wells[2]	Untreated Rain water	Treated[3] sewage/ surface/ waste water/ water reuse	Disinfected water [4]	Potable 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 into direct contact</u> with the edible portion of the fresh produce) Dilution or application of pesticide, fertiliser or agrochemicals and cleaning equipment for	**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[5]

[2] 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.

[3] 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 member state or, in the absence of such national legislation, with WHO guidelines on the safe use of wastewater and excreta in agriculture.

[4] Disinfection treatment should be well controlled and monitored.

[5] Since the irrigation water does not come into contact with the edible part of the FFV a value higher than 1 000 CFU/100 ml should be applied for *E.coli*. Irrigation methods such as drip or sub-surface will present a lower risk of contaminating the edible part of a lettuce FFV than overhead irrigation.7) Since the irrigation water does not come into contact with the edible part of the FFV a value higher than 1 000 CFU/100 ml should be applied for *E.coli*. Irrigation methods such as drip or sub-surface will present a lower risk of contaminating the edible part of a lettuce FFV than overhead irrigation.

ready-to-eat fresh produce and no direct contact							
Irrigation of fresh produce likely to be eaten cooked (irrigation water comes into direct contact with the edible portion 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 cooked (irrigation water does not come into direct contact with the edible portion 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/ disinfection**	**No need for testing except to test the treatment/ disinfection**	**No need for testing except to test the treatment/ disinfection**	**No need for testing**	10,000 CFU/100ml
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
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 water is a key element in the production and processing of fishery products.

2. Water is a key element in the production and processing of fishery products. Water can be sourced from the sea or rivers or, in the case of land-based fish farming systems, from springs, wells, rivers, lakes, or other drinking water supply systems.

3. These waters can be subject to many detrimental effects from climate change, pollution associated with population growth and development, and higher demands for food production and other uses (JEMRA 2021).

4. 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 at fishing vessels (including water used for onboard storage, ice, washing, etc.) and throughout processing facilities.

5. There is a need to implement more sustainable practices for the management and efficient use/reuse of water resources in the fish production process. (JEMRA, 2021).

PURPOSE AND SCOPE

6. The purpose and scope of this annex is to provide recommendations for the quality sourcing, use and reuse of water processing of fishery products for human consumption by applying the 'fit for purpose' principle and using a risk-based approach.

USE

7. This Annex is complimentary to and 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*: (CXC 1-1969),
- *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

8. See the general part of these Guidelines for the safe use and reuse of water in food production.

9. 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.

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

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

Processing facilities: A facility where harvested fishery products are processed, graded, and packed for further transportation and consumption.

WATER USED AND REUSED IN PROCESSING AND PRESERVATION

10. Water use and reuse needs to be tailored to the particular conditions of the specific fish production or processing operation it is applied to, considering its potential reusable water sources, the various applications of the reused water, available recovery and treatment technologies.

11. In the fish/shellfish production and processing industry, examples on where water is used are:

- for rearing or harvest,
- as an ingredient,
- to transport/convey products,
- to wash, cool down and cook foods,
- to clean and sanitize facilities, utensils, containers, and equipment,
- to make ice and glazed products

12. The use of water in the processing of fishery products should be subject to a risk-based approach covering the whole water system from the source or catchment area, treatment and storage, distribution and up to the point of use (from "source to tap"). In this context, sanitary surveys/profiling and an HACCP based approach such as water safety plans (WSP) are important to determine if water is fit-for purpose and the likelihood of contamination in the production and processing systems. (JEMRA 2021).

Processing at fishing vessels

13. 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. The quality of the water used for onboard preservation and processing will depend on the activity.

14. 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. To preserve the sanitary quality of fish and fishery products on board vessels and in processing factories, measures are needed to prevent any cross-contamination and temperature abuse. (JEMRA 2021)

15. It is essential that the seawater used is free from contaminants that could pose risks to human health. For example, vessels using RSW should ensure that pumping/ballast water is taken onboard at sea away from areas where waste is eliminated.

16. The following recommendations should be considered:

- When seawater or chilled seawater is used for on board product preservation, the potential hazards (e.g., Faecal pollution or contamination with endogenous marine flora) conveyed via the water needs to be considered in the further processing steps.
- Abstracting seawater with high salinity and free from particulate material will increase seawater quality prior to treatment since endogenous marine flora are associated with temperature and salinity as well as sediments.
- Water use for rinsing the fish cavity after evisceration should be fit for purpose.
- Seawater from offshore sources (geographically away from inland or inland pollution) is generally considered safe. However, depending on the geographical region, proximity to marine dumping[6], industrial or sewage outflow (e.g., wastewater, storm water, sewer overflow), agricultural run-off and temperature, seawater can hold indigenous potentially pathogenic bacteria, such as Vibrio, that may require monitoring and control.

Water uses at processing in land facilities

17. 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.

[6] Deliberate disposal at sea of waters or other materials from vessels, aircraft, platforms, etc.

18. The decision on whether to use fresh or seawater in land-based operations, 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.

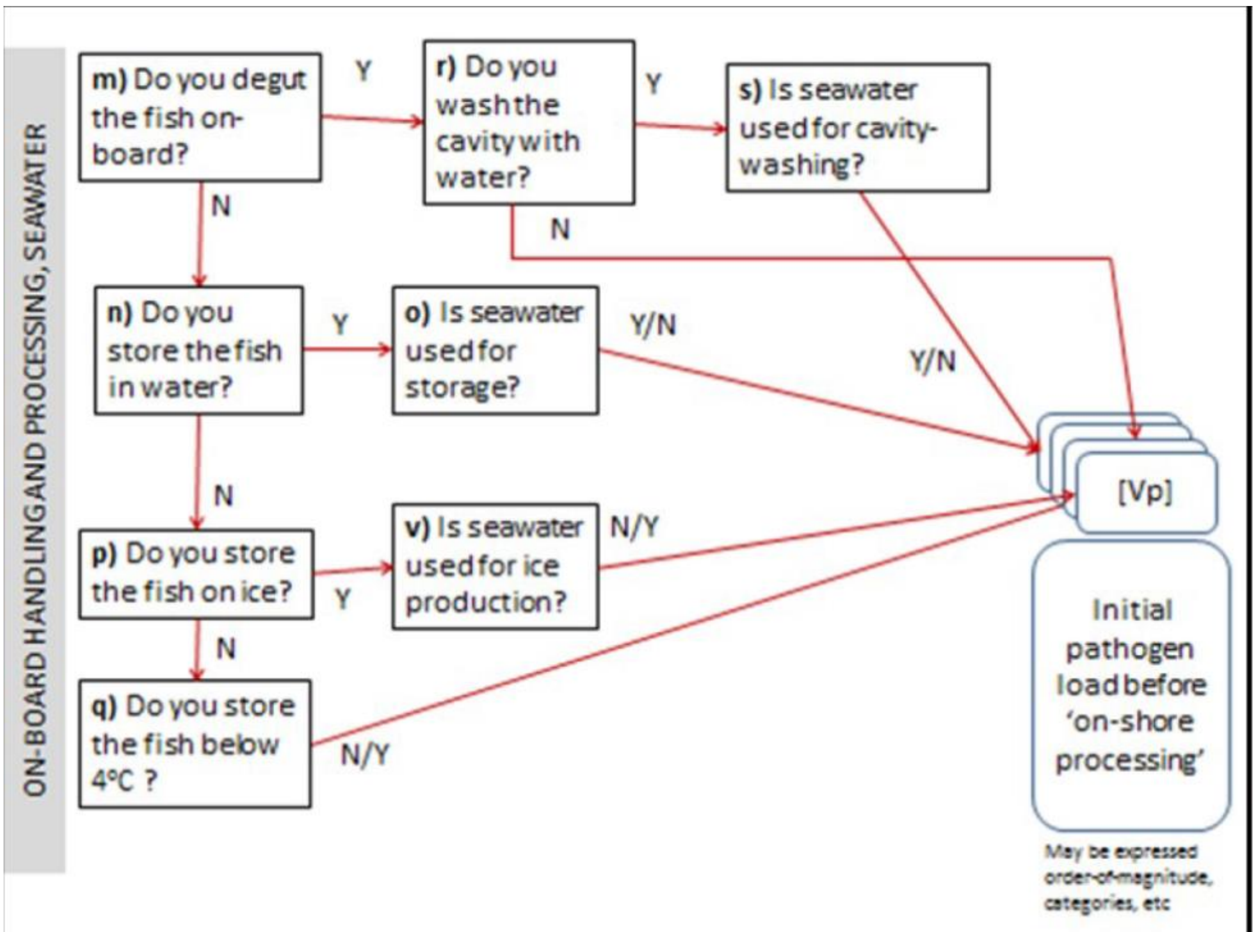
19. When coastal sources, used as the source of seawater abstraction, cannot be guaranteed to be free from pathogens from the marine biota or from faecal contamination, the water cannot be classified as a fit-for-purpose source without the appropriates monitoring and control measures.

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

Examples of Decision Tree (DT) use on processing fish[7].

21. Before using these examples, additional water contact events for marine and estuarine fish and fishery products that may contribute to the pathogen load before processing should be taken into consideration.

Figure 1: Decision Tree example of onboard processing and handling of marine/estuarine fish using *V. parahaemolyticus* (Vp) as an example of a fish borne pathogen.



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 questions related to the following:

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.

[7] Microbiological Risk Assessment Series 33. Safety and Quality of Water Used in Food Production and Processing Meeting Report. https://www.fao.org/publications/card/en/c/CA6062EN/

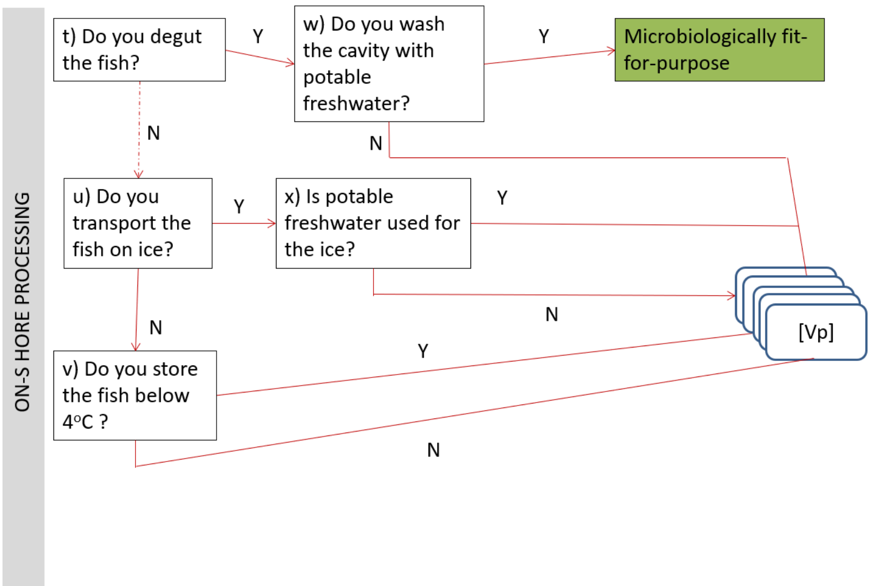
p) If the non-gutted fish is not kept in water, the question is whether it is kept on ice. If this is the case, the next question (v) is whether the ice is made from seawater; again, this may contribute to the expected *V. parahaemolyticus* load and increase risk.

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.

Figure 2: Decision Tree example for onshore processing of marine/estuarine fish using *V. parahaemolyticus* (Vp) as an example of a fish borne pathogen.

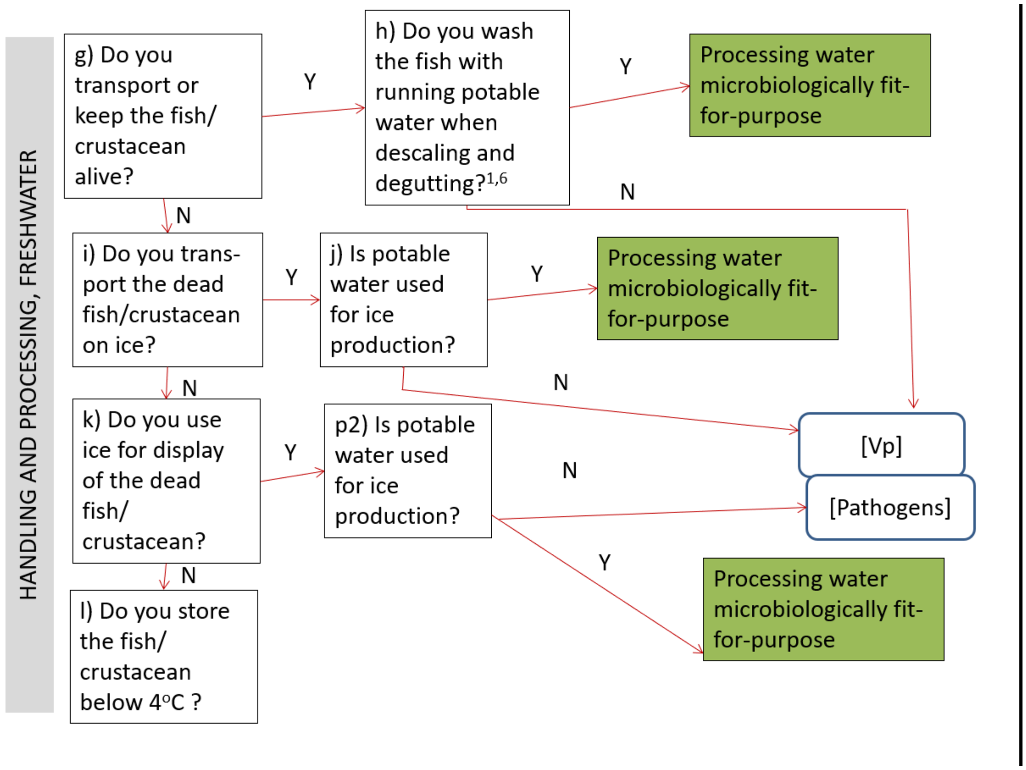


t) The entry level question of the DT is whether the fish will normally be gutted in the processing facility; if the answer is yes (Y), the next question (w) is whether the cavity of the fish is washed with potable freshwater, in which case there would not be a risk of further contamination wit *V. parahaemolyticus* 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.

Figure 3: Decision Tree example for processing and handling of freshwater fish/crustaceans which will potentially be eaten raw.



g/h) The entry level question is whether the fish will be transported alive. If the answer is yes (Y) and the fish is kept alive during transport until processing at the marketplace the next question (h) would be if potable quality water is used when washing fish during descaling and gutting. Water of potable quality is required also for basic hygiene measures where there is contact with fish (e.g. knives, cutting boards). If the answer to this last question (h) is no (N) and the fish is intended to be consumed raw, the final product is likely to contain a load of pathogens. If the answer is yes (Y) the processing water(wash) is considered microbiologically fit for purpose. If the answer to the entry level question (g) is no (N), the fish is not kept alive, the DT leads to question (i).

i/j) The next questions relate to whether the dead fish are transported on ice . If the answer is yes (Y) the DT leads to the next question (j), about whether potable water is used for ice production. If the answer is yes (Y), the water used for ice production is considered fit for purpose; if the answer is no (N), and the fish is intended to be consumed raw, the final product is likely to contain a load of pathogens and the water used for ice production was not fit for purpose. If the answer to the initial question (i) is no (N), and the fish is not kept on ice prior reaching the market, the DT leads to question (k).

k/p2) The next questions relate to on whether the fish are displayed on ice. If the answer is yes (Y), the DT leads to the next question (p2), about whether potable water is used for ice production. If the answer is yes (Y), the water used for ice production is considered fit for purpose; if the answer is no (N), and the fish is intended to be consumed raw, the final product is likely to contain a load of pathogens.

Water reuse

22. Any water reuse scenario considered for implementation, should consider the following in assessing and managing microorganisms in water:

- Ensure the safety of water using a risk-based approach covering the whole water system from the source to the point of use.
- Elaborate and put in place risk assessment and management procedures and implement efficient monitoring plans.
- Risk assessment should consider the specific waterborne hazards (e.g., marine microbial contaminants) that may impact the safety and quality of the fishery product(s).

Treatment for fit for purpose water.

23. Where water treatment is applied, the efficiency should be validated

24. The application for which water is intended to be reused determines whether that water is fit-for-purpose and/or a specific treatment is required before it can be used.

25. Treatment options will have to be designed on a case-by-case basis and consider both the hazards from faecal pollution as well as those from the endogenous marine flora (e.g., pathogenic *Vibrio* spp. and *C. botulinum*).

26. Due to the comparatively large use of water to produce fishery products, wastewater reclamation may be limited to essentially on-site or near-site use of reclaimed wastewater.

27. 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.

28. 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.

Water quality monitoring (JEMRA, 2021)

29. Water monitoring is a core element of food safety management systems and is essential to ensure water quality and safety and to define fit-for-purpose water in the seafood sector.

30. Monitoring practices should be risk-based, covering the whole water system from the source to the point of use, including considering the historical data to determine the frequency of monitoring.

31. Risk assessment should include an operation-specific assessment to determine which indicator(s) (e.g. microbiological parameters) are appropriate to be used. Geographical region and temperature of seawater should be considered as they may impact the level of indigenous, potentially pathogenic bacteria.

32. Indicator microorganisms should be used in assessing the fitness of water for its intended use(s) and in reducing human exposure to microbial hazards. However, consideration should be given that on a sample-by-sample basis, there is rarely a direct correlation between indicator microorganisms such as coliform bacteria and indigenous marine pathogenic bacteria such as *Vibrio*, enteric protozoans or viruses.

33. When monitoring water quality in a harvest region or area, characterization of surface or groundwater quality in abstraction points should be done, upstream extension should also be considered, when possible, to include the whole water catchment area.

APPENDIX II

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