codex alimentarius commission

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

WORLD HEALTH ORGANIZATION

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Agenda Item 9

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JOINT FAO/WHO FOOD STANDARDS PROGRAMME

CODEX COMMITTEE ON FOOD ADDITIVES AND CONTAMINANTS

Thirty-sixth Session
Rotterdam, The Netherlands, 22 – 26 March 2004

PROPOSED DRAFT CODE OF PRACTICE ON THE SAFE USE OF ACTIVE CHLORINE

(At Step 3)

Governments and international organizations wishing to submit comments at Step 3 on the following subject matter are invited to do so **no later than 16 February 2004** as follows: Netherlands Codex Contact Point, Ministry of Agriculture, Nature and Food Quality, P.O. Box 20401, 2500 E.K., The Hague, The Netherlands (Telefax: +31.70.378.6141; E-mail: info@codexalimentarius.nl, with a copy to the Secretary, Codex Alimentarius Commission, Joint FAO/WHO Food Standards Programme, FAO, Viale delle Terme di Caracalla, 00100 Rome, Italy (Telefax: +39.06.5705.4593; E-mail: Codex@fao.org).

BACKGROUND

The 35th Session (March 2003) of the Codex Alimentarius Committee on Food Additives and Contaminants agreed that a Code of Practice for the Safe Use of Active Chlorine in food production be developed and that a drafting group under the direction of Denmark, with the assistance of Greece, Ireland, Korea, Morocco, Philippines, Thailand, United States, European Commission, Tanzania and WHO would elaborate a proposed draft Code of Practice for the Safe Use of Active Chlorine for circulation, comment and further discussion in the next Session of the CCFAC.

It was noted that information on the need for the use of active chlorine and the food categories involved should be provided by comments to a circular letter to the report from the 35th Session of the CCFAC. No comments were received on this CL.

SCOPE

The Code of Practice covers the use of active chlorine compounds in direct contact with food.

Drinking water is not covered by the terms of reference of Codex Alimentarius and this Code of Practice does not cover the use of active chlorine in treatment of the drinking water supply system.

CHEMICAL COMPOUNDS - STATUS

The active chorine mentioned in the Code of Practice covers a number of different chemical compounds. The chorine compounds normally covered by the group “active chlorine” are chlorine dioxide, acidified sodium chlorite and sodium hypochlorite; see also the background information in the Appendix to this Code of Practice. If no specific compound is mentioned the term “active chlorine” covers the entire group of chemicals.

The WHO/FAO Joint Expert Committee on Food Additives (JECFA) has not assessed the use of active chorine in direct contact with foodstuffs and possible reaction products in contact with specific commodities. However some of the knowledge and risk assessment concerning active chlorine and the reaction products in foodstuffs from the use of active chlorine will be referenced in this Code of Practice where appropriate.

USE OF ACTIVE CHLORINE IN DIRECT CONTACT WITH FOOD

In general, use of active chlorine in direct food contact may be acceptable when this Code of Practice is followed, including an evaluation of the technological effects and efficacy and risk assessment of the residues of the active chlorine compounds used and the reaction products thereof.

An evaluation of the technological effects and efficacy and risk assessment of the residues and the reaction products of the active chlorine compounds is necessary in order to assess whether the benefits on the microbiological contamination outweigh the possible risks of intake of chlorine and its reaction products

The Code of Practice for the Use of Active Chlorine includes a risk/benefit analysis of individual uses, assessing the effect on the risk of infection due to microbes versus the risk of chemical reaction products in the final food. If the conclusion is that the benefits concerning pathogen reduction treatment in total are 7greater that the risks concerning intake on the chlorine and its reaction products, the use of active chlorine could be justified.

PROPOSAL FOR PROCEDURE IN CODEX COMMODITY COMMITTEES AND IN THE CODEX COMMITTEE ON FOOD HYGIENE.

Codex Commodity Committees and the Codex Committee on Food Hygiene should discuss and identify processes where the use of active chlorine might be justified. The Committee should present the documentation of this need, including documentation on efficacy and on potential residue levels of active chlorine and its reactions products for CCFAC for adoption in accordance with normal procedures in Codex.

RISK ASSESSMENT BY JECFA/JMRA

The general purpose of the Codex Alimentarius is to protect consumers' health while ensuring fair practice in the food trade. Chemical substances used in food or found in the food due to contamination should be subject to a risk assessment before the uses are adopted by the CCFAC. In the specific question of active chlorine, a risk/benefit analysis would be needed, as the background for introducing chlorine in food processing often are to control pathogens in the raw materials etc.

The WHO/FAO Joint Expert Committee of Food Additives has not evaluated the active chlorine compounds when used in process water for direct contact with food. A risk assessment of active chorine and the reactions products would be important prerequisite for the use of the active chlorine components. Either has the WHO/FAO Joint Experts Microbial Risk Assessment, JMRA assessed the use.

CCFAC should consider if this requested treatment is in line with the guidelines on the use of other chemicals in foodstuffs and if so, request a joint risk assessment from JECFA (FAO/WHO Joint Expert Committee on Food Additives) and JMRA (Joint Experts Microbial Risk Assessment).

The proposal of the drafting group is annexed to this document. In view of the short time period between the submission of comments and the 36th Session of the Committee, comments received will be kept in original language.

Governments and interested international organizations are invited to comment **at Step 3** on the attached ***Proposed draft Code of Practice on the Safe Use of Active Chlorine*** as directed above.

PROPOSED DRAFT CODE OF PRACTICE FOR THE USE OF ACTIVE CHLORINE IN FOOD PRODUCTION

1. INTRODUCTION

The general purpose of the Codex Alimentarius is to protect consumers' health while ensuring fair practice in the food trade.

This paper define a Code of Practice for the Use of Active Chlorine in Food Production from the Codex Committee on Food Additives and Contaminants, including a balanced view of the risks and benefits of active chlorine used in direct contact with food during processing or used for reduction or elimination of the microbes in the final foodstuffs. The benefits taken into account in this paper will only include the potential for lowering the risks to human health from microbiological hazards.

2. SCOPE

The subject of this Code of Practice is the addition of chlorine to the drinking water used in direct contact with food during processing. Principal uses of active chlorine are mainly in the pre-market washing and decontamination of fresh produce, in particular fruit and vegetables.

The Code of Practice does not cover the use of active chlorine in relation to:

a. Drinking-water in the drinking water supply system

b. Disinfection and cleaning of food processing equipment

Drinking water as delivered from the drinking water supply system is not part of this Code of Practice. This includes chlorination in the drinking water supply system and the use of chlorinated drinking water supplied and used in food production.[1]

The use of chlorine as a general *disinfectant in the cleaning of food processing equipment* is also not covered in the Code of Practice. It is assumed that flushing with potable/drinking water to remove the residues of disinfectants and cleansing agents always follows cleaning of food contact materials.

3. DEFINITIONS[2]

Treatment with chlorine could be covered by one of the following definitions

a. *Contaminant* is defined as "any substance not intentionally added to food, which is present in such food as a result of the production (including operation carried out in crop husbandry, animal husbandry and veterinary medicine), manufacture, processing, preparation, treatment, packaging, transport or holding of such food or as a result of environmental contamination. The term does not include insect fragments, rodent hair and other extraneous matter.

b. *Food additives* is defined as "any substance not normally consumed as a food by itself and not normally used as a typical ingredient of the food, whether or not it has nutritive value, the intentional addition of which to food for a technological (including organoleptic) purpose in the manufacture, processing, preparation, treatment, packing, transport or holding of such food results, or may be reasonably expected to result, (directly or indirectly) in it or its by-products becoming a component of or otherwise affecting the characteristics of such food. The term does not include "contaminants" or substances added to food for the purpose of maintaining or improving nutritional qualities or maintaining nutritional qualities."

c. *Processing aids* is defined as "any substance or material, not including apparatus or utensils, and not consumed as a food ingredient by itself, intentionally used in the processing of raw materials, foods or its ingredients, to fulfil a certain technological purpose during treatment or processing and which may result in the non-intentional but unavoidable presence of residues or derivates in the final product."

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[1] As knowledge of the potential chlorine compounds, might be of importance for the food producer, the WHO guidelines limits for drinking water are summarised in Annex I.

[2] Codex Procedural Manual, Eleventh Edition, FAO and WHO 2000.

d. *Disinfectants* are *not* defined in Codex. However, in this Code the term disinfection is defined as follows: The destruction of pathogenic and other microorganisms by thermal or chemical means to eliminate a defined scope of microorganisms, but not necessarily all microorganisms. The terms is normally used for the antimicrobial treatment of surfaces of food contact materials, tools etc. The normal requirement would be that after disinfection, the surface etc. is cleaned with potable water, or in some regions, a recommendation of "drainage" only (without rinsing) if concentration of chlorine compounds does not exceed a certain level. This applies also to other disinfectants, at varying concentrations

e. *Drinking water* is water which meets the quality standards of drinking water described in the WHO Guidelines for Drinking Water quality.

4. GENERAL CONDITIONS IN FOOD PROCESSING

4.1 Water used in direct contact with food in food processing and treated with active chlorine in the food plans, should in principle be of drinking-water quality in accordance with the WHO guideline

4.2 A risk analysis should be conducted for individual processes of foodstuffs or groups of foodstuffs before treatment with active chlorine, as described in section 6.

4.3 Decontamination treatment should only be used as an adjunct to good hygienic practices and HACCP principles and not as a substitute for them. The use should always be as an aid to existing hygienic processing and the preventive measures implemented at the production level.

5. EVALUATION OF COMPLIANCE WITH RELEVANT LEGISLATION

5.1 The intended use of chlorine should be specified according to relevant national or international legislation and standards. The intended use of active chlorine could be to obtain different functions, for instance as disinfectants, processing aids, food contaminants or additives.

6. RISK ANALYSIS BEFORE TREATMENT WITH ACTIVE CHLORINE

The food producer should carry out a risk analysis on the intended use of chlorine before treatment is decided as an option (see also Annex II).

The risk analysis should address the following points:

- ⇨ Available drinking water supply
- ⇨ Overall efficacy
- ⇨ Microflora changes and implications, including the reduction of pathogens in the final foodstuff and effect on consumer health
- ⇨ Potential for introducing other food safety hazards like residues of chemicals and reaction products and the effect on consumer health
- ⇨ Feasibility and effectiveness of control under commercial conditions (cost, availability, accupational hazards)
- ⇨ Controllability
- ⇨ Impact on environment

Other legitimate factors should also be considered like

- ⇨ Consumer perception
- ⇨ Effects on sensory properties and quality of the product (the ideal method would have no adverse effects on the appearance, smell, taste or nutritional properties of the food.)

6.1 Addition of chlorine to the drinking water for decontamination of food

6.1.1 If the quality of the available drinking water supply is not in accordance with the WHO guidelines, active chlorine could be used as a water treatment agent by the food producer after a proper risk analysis, including the efficacy of the treatment.

6.1.2 The microbiological quality of the drinking water should be evaluated in relation to its potential to contaminate the processed foodstuffs and the growth conditions for pathogens during processing and in the final food.

6.2 Overall efficacy:

6.2.1 Use of chlorine should be justified by documentation of a need and documentation of a proven effect.

6.2.2 The use of chemicals such as active chlorine compounds should only be initiated after a risk analysis, including the efficacy and controllability of the use and effect on pathogens and the safety concerning residues of the chemical and its reaction products in the final foodstuff. For effect on some pathogens see Annex III and concerning chemical reaction products and residues, see also Annex IV.

6.3 Microbial aspects

6.3.1 The microbiological status of the foodstuff should be assessed as well as the effect of chlorine. The assessment should include monitoring of the microbiological quality of the foodstuff over a period of time corresponding to the duration of treatment in order to make sure that the effect is satisfactory. See Annex III.

6.3.2 The microbiological status of the drinking water should be assessed and the effect of chlorination should be evaluated. The use of active chlorine compounds has various different effects on the micro-flora. The efficiency of chlorine as a disinfecting or decontaminating agent is depending on conditions such as pH and temperature. The specific conditions in processing should be taken into account in the risk/benefit assessment.

6.4 Chemical aspects

6.4.1 The chemical composition of the foodstuff which comes into contact with the chlorine should be described in order to assess possibilities for reaction products.

6.4.2 Considerations should be made as to which “active” chlorine compound should be used. A clear description of each specific "active" chlorine substance and knowledge of their physico-chemical properties is critical to an informed risk assessment. Depending on the oxidative/chlorination propensity of the "active" chlorine compound, it will form different reaction by-products as a result of interaction with commodity protein, carbohydrate, and lipid composition.

6.4.3 The occurrence of residue chlorine should be assessed. Residue levels of active chlorine and its reaction products should be in accordance with the limits set in the WHO guidelines for drinking-water quality (See Annex I).

6.4.4 Any residue levels of chlorine and reaction products thereof should be below those limits listed in annex I. CCFAC should specify maximum levels for individual foodstuffs or groups of foodstuffs following the advice of JECFA (Joint FAO/WHO Expert Committee on Food Additives and Contaminants) and JEMRA (Joint FAO/WHO Expert Meetings on Microbiological Risk Assessment).

6.4.5 The possible reaction products from the use of chlorine should be assessed. Active chlorine can react with organic materials in food or/and water and the risk due to chemical reaction products have to be assessed. Treatment of foods with chlorine dioxide or acidified sodium chlorite results in oxidative reaction by products. In contrast, treatment of foods with chlorine solutions results in chlorination and oxidation by-products. Various halogenated by-products can be formed during chlorine disinfection, whose toxicological effects have been investigated in animal and in vitro studies.

6.4.6 The effects of high doses of these substances range from oxidative toxicity, e.g. chlorite and mutagenicity, e.g. trichloronitromethane to reproductive effects, e.g. chloroacetates, neurotoxicity, e.g. trihalomethanes and carcinogenicity, e.g. trichloroacetaldehyde, dichloroacetate, trihalomethanes. Among the reaction products, most frequently seen are trihalomethanes. However, many other compounds may be found in food as a result of the active chlorine. Some of these by-products may be undefined at present and therefore not detected analytically.

7 RISK MANAGEMENT AND PRACTICAL TREATMENT

7.1.1 Treatments should be carried out in accordance with the manufacture’s instructions for the intended purposes.

7.1.2 Production should be in accordance with good manufacturing practices (GMP's) to prevent or minimise the potential for the introduction or spread of pathogens in processing water and prevent or minimise residues of chlorine and reaction products.

7.1.3 Monitoring systems should be established to monitor

- Microbial status of the water
- Microbial status of the food before and after processing
- pH and temperature during treatment
- Chemical residues of chlorine and reaction products thereof.

7.1.4 The monitoring of chemical residues and the microbiological quality should be registered as part of the in-house-control.

Annex I

WHO drinking-water guideline limits.

The WHO drinking-water guideline has the following levels for chlorine and reaction products from the use of active chlorine:

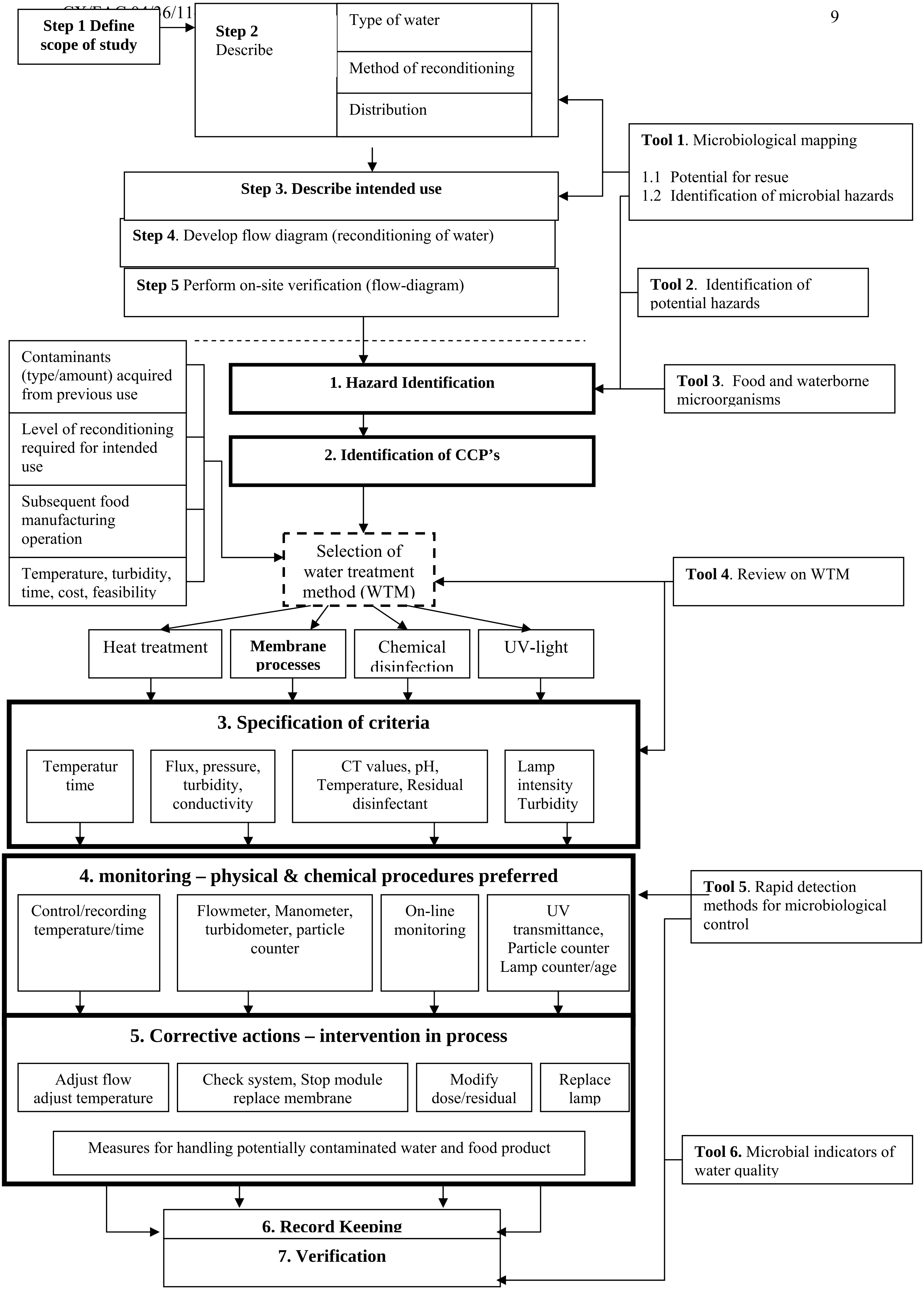
Chemical compound	WHO guideline level	WHO comments
Monochloramine	3 mg/l	-
Di- and trichloramine	-	No adequate data to permit the recommendation of a health-based guideline value
Chlorine	5 mg/l	Concentrations of the substance at or below the health-based guideline value may affect the appearance, taste or odour of the water. For effective disinfection, there should be a residual concentration of free chlorine of ≥0.5 mg/litre after at least 30 minutes contact time at pH < 8.0.
Chlorine dioxide	-	A guideline value has not been established because of the rapid breakdown of chlorine dioxide and because the chlorine guideline value is adequately protective for potential toxicity from chlorine dioxide.

WHO guideline values in drinking water for disinfection by-products are the following (WHO, 1996):

Disinfection by-products	Guideline values (µg/l)
dibromochloromethane	100 µg/l
chloroform	200 µg/l
bromodichloromethane	60 µg/l
bromoform	100 µg/l
dichloroacetate	50 µg/l
trichloroacetate	100 µg/l
trichloroacetaldehyde	10 µg/l
dichloroacetonitrile	90 µg/l
dibromoacetonitrile	100 µg/l
trichloroacetonitrile	1 µg/l
2,4,6-trichlorophenol	200 µg/l
cyanogenchloride	70 µg/l
chlorite	200 µg/l

No guideline values have been established for other by-products of potential concern, such as chloropropanols and chlorinated hydroxyfuranone (MX).

Annex II (see next page)


Step 1 Define scope of study
Step 2 Describe
Type of water
Method of reconditioning
Distribution
Tool 1. Microbiological mapping
1.1 Potential for resue
1.2 Identification of microbial hazards
Step 3. Describe intended use
Step 4. Develop flow diagram (reconditioning of water)
Step 5 Perform on-site verification (flow-diagram)
Tool 2. Identification of potential hazards
Contaminants (type/amount) acquired from previous use
Level of reconditioning required for intended use
Subsequent food manufacturing operation
Temperature, turbidity, time, cost, feasibility
1. Hazard Identification
Tool 3. Food and waterborne microorganisms
2. Identification of CCP's
Selection of water treatment method (WTM)
Tool 4. Review on WTM
Heat treatment
Membrane processes
Chemical disinfection
UV-light
3. Specification of criteria
Temperatur time
Flux, pressure, turbidity, conductivity
CT values, pH, Temperature, Residual disinfectant
Lamp intensity Turbidity
4. monitoring – physical & chemical procedures preferred
Tool 5. Rapid detection methods for microbiological control
Control/recording temperature/time
Flowmeter, Manometer, turbidometer, particle counter
On-line monitoring
UV transmittance, Particle counter Lamp counter/age
5. Corrective actions – intervention in process
Adjust flow adjust temperature
Check system, Stop module replace membrane
Modify dose/residual
Replace lamp
Measures for handling potentially contaminated water and food product
Tool 6. Microbial indicators of water quality
6. Record Keeping
7. Verification

Annex III

Some examples are given on the bactericidal effect of active chlorine on various microorganisms[3].

Organism	**pH**	**Temperature (°C)**	**Exposure time (minutes)**	**Cl_2 Concentration (mg/l)**	**Bactericide effect (% Reduction)**
Bacillus anthracis	7,2	22	120	2,3 – 2,4	100
Escherichia coli	7,0	20-25	1	0,055	100
Listeria monocytogenes	9,5	20	0,5	100	99-100
Staphylococcus aureus	7,2	25	0.5	0,8	100
Endamoeba histolytica cysts	7,0	25	150	0,08-0,12	99-100
Adenovirus	8,8-9,0	25	0,6-0,8	0,2	99,8
Poliovirus	7,0	25-28	2	0,11-0,2	99,9

Please note, that the effect might not be equivalent to effects on real foods, as the effect on microorganisms on food might be different (less bactericidal) by orders of magnitude.

To the Committee: more data, especially on effects on pathogensis needed, e.g. on effect on cholera. USA mentioned in their comments to the 34th CCFAC especially cholera and references to cover this point is needed.

3 Block, 1991

Annex IV

POTENTIAL CHEMICAL REACTION PRODUCTS

The use of active chlorine includes the use of chlorine gas, liquid chlorine, chlorine dioxide, organic forms such as chloramines or derivatives of isocyanuric acid. The most common used chlorine as an antimicrobial is hypochlorous acid. Chlorine dioxide is used in much lower concentrations than hypochlorous acid, as the chemical reactions of chlorine dioxide are different. Chlorine dioxide forms less organic by-products but unfortunately has other disadvantages.

Chlorine Reaction Products and By-Products

Experience with establishing safe conditions of use for chlorine dioxide, acidified sodium chlorite, and sodium hypochlorite as antimicrobial treatments for food is instructive for the risk assessment of "active" chlorine treatment of food. The following are some of the lessons we have learned from our chemical risk assessments of "active" chlorine compounds.

Physico-chemical properties of "active" chlorine substances.

There exist several active chlorine species that are used in food production today. Knowledge of the physico-chemical properties of each "active" chlorine substance is critical to the risk assessment. For example, chlorine dioxide (ClO2) is a gas at room temperature, it is soluble in water and is stable in aqueous solutions over a broad pH range. Redox reactions in water result in the formation of chlorite ions (ClO2-) with a redox potential of +0.95 V. Chlorite ion is also an effective oxidant when reduced to chloride (Cl-) (+0.78 V). Chlorine dioxide is a weaker oxidant than hypochlorous acid (HOCl), which is formed from chlorine in water solution. However, chlorine dioxide has a larger oxidation capacity than hypochlorous acid because it can accept 2.5 times more electrons than HOCl. Thus, a clear description of each specific "active" chlorine substance and knowledge of their physico-chemical properties is critical to an informed risk assessment.

Chemical reactions and food types

Knowledge of the chemical composition of commodities to be treated, such as fruits, vegetables, and seafood is important to any chemical risk assessment.

Studies have shown that depending on the oxidative/chlorination propensity of the "active" chlorine compound, it will form different reaction by products as a result of interaction with commodity protein, carbohydrate, and lipid composition. For example, the primary products of lipid oxidation are hydroperoxides, generally called peroxides. The peroxides may break down to carbonyls, form polymers, or react with vitamins, pigments, etc.

One of the secondary oxidation products is malondialdehyde commonly measured via colour reaction with thiobarbituric acid (TBA). Cooking generally increases the content of malondialdehyde in muscle meat due to additional oxidation of unsaturated fatty acids during cooking as well as decomposition of peroxides formed earlier during storage of raw muscle meat. Subjecting meat and fats to oxidants, such as ozone, chlorine or chlorine dioxide is expected to oxidize unsaturated fatty acids during exposure and, possibly during refrigerated storage and cooking. The latter effect may be due to residual chlorite (a reduction product of chlorine dioxide). Several studies comparing the reaction products of chlorine and chlorine dioxide with amino acids, peptides and proteins have been published. These studies indicate that chlorine reacts with essentially all 21 amino acids and suggest that chlorinated derivatives are formed. However, these chlorinated derivatives are unstable and gradually degrade to carbon dioxide, ammonia, aldehydes, ketones, and other compounds. Chlorine incorporation into proteins has been reported in shrimp, poultry, meat, flour and several isolated proteins.

Studies have also demonstrated that chlorine dioxide reacts only with sulphur or aromatic ring containing amino acids and acts as an oxidizing rather than a chlorinating agent. The formation of chloroderivatives has not been demonstrated in reactions of chlorine dioxide with proteins.

Chlorine dioxide reactions with amino acids have been shown to be pH dependent.

Chlorine dioxide, in contrast to chlorine, does not produce trihalomethanes in reactions with humic acids, nor does chlorine dioxide react with ammonia.

Some chemical reaction products from treatment with chlorine are given in the two tables below[4]

Reaction products	
Trihalomethans	Trichloro-, bromodichloro-, dibromochloro- and tribromomethane
Halogenated alkanes	Chlorinated and bromated ethane, propane and butane
Halogenated alkenes	Chlorated and bromated ethylene, propene and butene
Halogenated acids	Monochloro-, dichloro- and trichloro acetic acid
Halogenated aldehydes	Trichloroethanal, chlorpropanals
Halogenated ketones	Di-, tri- and tetrachlorsubstituted propanone
Halogenerated alcohols	Chloral hydrate
Haloacetonitrils	Trichloroaceto-, dichloroaceto-, dibromoaceto- and bromochloroacetonitrile
Haloamins	Chloramine
Trichlornitromethane	Chlorpicrine
Halogenerede phenols	Mono-, di- and trichlorophenols
Halopropanols	3-chloropropandiol, dichloropropanol
Halohydroxy-furanons	3-chloro-4-(dichlormethyl)-5-hydroxy-2(5H)-furanone

4 Klein, 1990; LeBel et al., 1997; Lykins Jr. et al., 1986; Merlet et al., 1985; Richardson et al., 1996; Ventura et al., 1999 and Zimmerli et al., 1993.

Source	**Compound**	**Concentrations found**
Water for processing[5]	Trichloromethane	4,6 – 57,0 µg/l
	Monobromodichloromethane	2,2 – 14,1 µg/l
	Trichlorethylene	3,0 – 7,8 µg/l
	1,1,1-trichloroethane	2,0 – 4,3 µg/l
	Tetrachloroethylene	1,3 µg/l
Drinking water[6]	Monochloroacetic acid	3,6 – 13,4 µg/l
	Dichloroacetic acid	4,2 – 208 µg/l
	Trichloroacetic acid	0,6 – 115 µg/l
	Chloralhydrate (2,2,2-Trichlor-1,1-ethandiol)	<0,03 – 16,4 µg/l
	Trichloropropanone	<0,5 – 2,4 µg/l
	Trichloronitromethane	< 3 µg/l
Cola type beverages[7]	Trichloromethane	9 – 178 µg/l
	Monobromodichloromethane	1,2 – 3,8 µg/l
Other carbondioxide-containing beverages[8]	Trichloromethane	14,5 – 32 µg/l
	Trichloromethane	2,3 – 15,6 µg/l
	Monobromodichloromethane	1,2 – 2,3 µg/l
Pasteurized milk[9]	Trichloromethane	17 µg/l
	Trichloromethane	0 – 3,1 µg/l
	1,1,1-trichlorethane	0 – 0,03 µg/l
	Tetrabromomethane	0 – 0,02 µg/l
	Monobromodichloromethane	0 – 0,07 µg/l
	Monochlorodibromomethane	0 – 0,3 µg/l
Cheese[6]	Trichloromethane	15 – 17 ng/g
	Trichloromethane	2,4 – 10,9 ng/g
	1,1,1-trichlorethane	1,2 – 6,4 ng/g
Butter[6]	Trichloromethane	56 ng/g
	Monobromodichloromethane	7 ng/g
Ice cream[6]	Trichloromethane	4,6 – 31,2 ng/g
	1,1,1-trichlormethane	2,7 – 37,3 ng/g

5 Uhler and Diachenko, 1987
6 Jolley, 1989
7 Entz, Thomas and Diachenko, 1982, Uhler and Diachenko, 1987
8 Entz, Thomas and Diachenko, 1982, Uhler and Diachenko, 1987
9 Entz, Thomas and Diachenko, 1982; Kroneld and Reunanen, 1990

Appendix[10]

BACKGROUND INFORMATION FOR THE CODE OF PRACTICE

The purpose of this Appendix is to give some of the background knowledge and references of relevance for the Code of Practice. The Appendix should be seen in connection with the Code of Practice, but once the Code is adopted, the Appendix will be deleted. Therefore some of the text could seem to be repetition from the Code, but this is just to make the text more understandable.

National and international legislation or guidelines on the use of Active Chlorine in Food Processing

Active chlorine is mentioned as a disinfectant or decontaminant within the hygiene standards of Codex, although there are a number of possible definitions under which chemicals such as chlorine can be classified in the Codex system as a function of their intended use, namely as disinfectants, processing aids, food contaminants or additives. The use of active chlorine in food processing is included in some Codex Codes of Practice or draft Codes of Practice and it is also included in the WHO Guidelines for Drinking Water Quality.

The use of active chlorine compounds is covered by regulation of guidelines in national legislation and/or international guidelines. There seems to be no consistency in the evaluation on whether chlorine is use as food additive, disinfectant, post harvest treatment or are covered by other definitions.

In this section, it is not the intention to give a complete overview of the legal status in all Codex Member Countries, but to give some examples of national and international standards or legislation.

National legal status in some countries

Denmark

The use of active chlorine compounds for the reduction of the microbial load in food and for prolongation of shelf life of the foodstuffs is regarded as a food additive use covered by the legislation on food additives list. It is possible to apply for approval of the substance, provided that documentation on the safety aspects and the technological need is submitted.

Ireland

The use of active chlorine compounds is accepted as disinfectant under specified conditions in the process water in the production of fresh produce. Commonly used concentrations of free available chlorine are 50 – 100 ppm with a contact time of 1-2 minutes.

Korea

Under the Food Sanitation Act, Article 2(definitions) specifies the term "food additives" and it includes materials which are indirectly shiftable to food by being used for the purpose of disinfection or sterilization of apparatus, containers or packages as well as common direct food additive. However, unlikely with common direct additive, these chemicals have been recognized "list of names only" without specifications. These chemicals/materials have to be followed a special pre- market petition process which is not same as the one with common direct food additives. The petition requires the submission of the test results which confirm the safety and efficacy of the chemicals/ materials. For example, the efficacy result must show 99.999% reduction of E.coli and staphylococcus.

USA

The table below identifies the major uses of active chlorine chemicals that are regulated as food additives in the United States. The list is not exhaustive but contains most of the uses that fall within the Food and Drug Administration’s authority. In addition, the U.S. Environmental Protection Agency regulates certain uses of active chlorine chemicals in the production of food, most notably, as raw agricultural commodity washes.

[10] The Appendix includes background information to the Code of Practice and will not be included in the final Code of Practice.

"Active Chlorine Species"	**Intended Conditions of Food Use**	
Chlorine dioxide	Water used for poultry processing	≤3 ppm Residual chlorine dioxide
Chlorine dioxide	Water used to wash fruits & vegetables that are not raw agricultural commodities, followed by potable water rinse, or blanching, canning or cooking.	≤3 ppm Residual chlorine dioxide
Acidified Sodium Chlorite	Sodium chlorite plus a generally recognized as safe (GRAS) acid 1. In poultry processing as a component of a carcass spray or dip prior to immersion of the carcass in a pre chiller or chiller tank 2. In a pre-chiller or chiller solution for application to carcasses 3. As a spray or dip for application to poultry parts 4. In a pre-chiller or chiller solution for application to poultry carcass parts	when used as a spray or dip: sodium chlorite concentrations between 500 and 1200 ppm with pH of 2.3 - 2.9 when used as a prechiller or chiller solution: sodium chlorite concentrations between 50 - 150 ppm at a pH 2.8 - 3.2
Acidified Sodium Chlorite	Antimicrobial agent in the processing of red meat, red meat parts and organs as a component of a spray or in the processing of red meat parts and organs as a component of a dip	Sodium chlorite concentrations between 500 and 1200 ppm in combination with a GRAS acid to achieve a pH of 2.3 - 2.9.
Acidified Sodium Chlorite	Antimicrobial agent in water and ice used to rinse, wash, thaw, transport or store seafood, any seafood that is intended to be consumed raw shall be subjected to a potable water rinse	Sodium chlorite concentrations between 40 and 50 ppm in combination with a GRAS acid to achieve a pH of 2.5 - 2.9.
Acidified Sodium Chlorite	Antimicrobial agent on raw agricultural commodities applied as a dip or a spray	Sodium chlorite concentrations of 500 - 1200 ppm in combination with a GRAS acid to achieve a pH of 2.3 - 2.9.
Acidified Sodium Chlorite	Antimicrobial agent on processed, comminuted or formed meat food products prior to packaging, applied as a dip or spray	Sodium chlorite concentration of 500-1200 ppm in combination with a GRAS acid to achieve a pH 2.5-2.9
Acidified Sodium Chlorite	Antimicrobial agent in water applied as a spray or dip solution to processed fruits and processed root, tuber, bulb, legume, fruiting (e.g., eggplant, ground cherry, pepper, tomato) and cucurbit vegetables, followed by a potable water rinse and a 24 hour holding period prior to consumption. For processed leafy vegetables and vegetables of the *Brassica* family, application must be by dip treatment only and must be preceded by a potable water rinse and followed by a potable water rinse and a 24 hour holding period prior to consumption.	Sodium chlorite concentration of 500-1200 ppm, in combination with a GRAS acid to achieve a pH of 2.3-2.9

International legislation/standards or assessments.

The Codex Committee on Fish and Fishery Products (CCFFP) addressed the use of chlorinated water in fish and fishery production and had for consideration a document prepared by the WHO in collaboration with FAO, including a survey of current practices in member countries. This paper showed that chlorinated water was widely used to prevent microbial contamination and concluded that additional work in the area was recommended, and current scientific evidence did not warrant the change of the Codex recommended level of 10 mg/l (Code of Practice for Frozen Shrimps and Prawns). The CCFFP concluded that no further action was necessary on this matter.[11]

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[11] Alinorm 01/18, paragraphs 146-149

The Codex Committee on Food Hygiene (CCFH) is currently elaborating a Proposed Draft[12] Code of Practice for the Primary Production and Packing of Fresh Fruit and Vegetables. This Proposed Draft Code of Practice is forwarded to step 8, and includes a proposal for the use of chemicals as a "decontaminants" or "disinfectants" in post-harvest water use.

In the European Union, the Scientific Committee on Veterinary Measures Relating to Public Health addressed the question on benefits and limitation of antimicrobial treatments for poultry carcasses.[13] One of the conclusions is that "Chlorine is rapidly inactivated in contact with carcasses and therefore is not consistently effective as a direct carcasses decontamination."

Furthermore, the CCFH has proposed draft Guidelines for the Hygienic Reuse of Processing Water in Food Plants[14], which also mentions the use of active chlorine.

Microbiological Effects

In most cases, the use of active chlorine would be requested due to microbiological problems occurring in food or water used in food processing. The concentration of active chlorine used would be a balanced compromise between the microbiological benefits against the microbiological hazards and the hazards to humans due to residues of chemicals in the final foodstuffs.

The use of active chlorine compounds has various different effects on the micro-flora. The efficiency of chlorine as a disinfecting or decontaminating agent is depending on conditions such as pH and temperature.

Risk Assessment of Active Chlorine in Food Processing.

Whenever the use of active chlorine in direct contact with foodstuffs is considered, it is essential to consider whether active chlorine indeed has the requested effect or not. Moreover, the decision should be based on relevant data concerning the risk for consumers. The risk assessment of active chlorine has to include:

- Effect and potential reduction on the presence of pathogens and other microbiological organisms in the specific foodstuffs.
- Implications on public health of such microorganisms.
- Assessment of the chlorine residues and reaction products of chlorine.

WHO has assessed free chlorine and has allocated a TDI of 150 microgram per kg body weight, derived from a NOAEL for the absence of toxicity in rodents ingesting 15 mg of chlorine per kg BW per day in drinking water for 2 years and incorporating an uncertainty factor of 100 (for intra- and interspecies variation). With an allocation of 100 % of the TDI to drinking water, the guideline value in the WHO drinking water guideline is set at 5 mg/litre.

Chlorine was evaluated by JECFA as a food additive in 1963. There are allocated international numbers, INS 925 for chlorine and INS 926 for chlorine dioxide, both defined as flour treatment agents.

The use of active chlorine is furthermore included in some of the Codex Code of Practice or draft Code of Practice as well as in the WHO Guidelines for Drinking Water Quality. However, JECFA has not evaluated the active chlorine compounds when used in process water for direct contact with food

The guideline value in the WHO guidelines for drinking water is based on a TDI for free chlorine of 150 microgram/kg body weight, and for monochloramine based on a TDI of 94 microgram/kg of body weight as a guideline value. The WHO maximum guideline value for chlorine residue in drinking water is 5 mg/l (3.2.3). In 1998, the American Environmental Protection Agency established a maximum residual disinfection level (MRDL) of 4 mg/l for chlorine in public water systems.

Results from animal studies with oral administration of chlorine or chlorine-treated food products showed no signs of teratogenicity, reproductive toxicity and carcinogenicity (Vetrano, K.M., 2001). There is conflicting evidence whether the administration of chlorine-bleached flour to rats has acute toxic effects.

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12 Alinorm 01/13A, paragraphs 31-82 and Appendix II.

13 Report of the Scientific Committee on Veterinary Measures Relating to Public Health on Benefits and Limitations of Antimicrobial Treatments for Poultry Carcasses, 30 October 1998.

14 CX/FH 00/8

Various halogenated by-products can be formed during chlorine disinfection, and their toxicological effects have likewise been investigated in animal and in vitro studies. The effects of high doses of these substances range from oxidative toxicity (e.g. chlorite) and mutagenicity (e.g. trichloronitromethane) to reproductive effects (e.g. chloroacetates), neurotoxicity (e.g. trihalomethanes) and carcinogenicity (e.g. trichloroacetaldehyde, dichloroacetate, trihalomethanes).

In 2000, the disinfectants and the disinfectant by-products were evaluated by IPCS (International Programme on Chemical Safety (WHO, 2000) and the main conclusions were:

No by-product studied to date is a potent carcinogen at concentrations normally found in drinking water.

1. Epidemiological studies do not provide convincing evidence that chlorinated water increases the risk for cardiovascular disease, cancers or adverse pregnancy outcomes.

Although the scientific evidence for potentially harmful effects of ingesting chlorine-treated food products is weak, the formation of toxic halogenated by-products is still an uncertain and relevant factor to be investigated and an updated risk assessment from an international expert committee on food and chemicals in food is needed.

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