codex alimentarius commission

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

WORLD HEALTH ORGANIZATION

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Agenda Item 12 **CX/FAC 05/37/16**
November 2004

JOINT FAO/WHO FOOD STANDARDS PROGRAMME

CODEX COMMITTEE ON FOOD ADDITIVES AND CONTAMINANTS

Thirty-seventh Session

The Hague, the Netherlands, 25 – 29 April 2005

DISCUSSION PAPER ON THE TERMS OF REFERENCE FOR THE FAO/WHO JOINT EXPERT CONSULTATION TO CONDUCT A COMPREHENSIVE ASSESSMENT OF USE OF ACTIVE CHLORINE (ASPECTS RELEVANT TO CCFAC)

Governments and international organizations in Observer status with the Codex Alimentarius Commission wishing to submit comments on the following subject matter are invited to do so **no later than 31 January 2005** 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 - ***preferably***), 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 - ***preferably***).

INTRODUCTION

1. The 35th Session of the Codex Committee on Food Additives and Contaminants (CCFAC) recognized the use of active chlorine compounds for controlling microbiological contamination during the processing of various food products, and the inclusion of provisions for the use of active chlorine in texts developed by certain Codex Committees.[1] CCFAC, therefore, agreed to begin work on the development of a Code of Practice for the Safe Use of Active Chlorine. The 26th Session of the Codex Alimentarius Commission approved the elaboration of the Code of Practice as new work for the Committee with the understanding that recommendations on the safe use of active chlorine would require close collaboration with other Codex Committees, such as the Codex Committee on Food Hygiene.

2. In presenting a Proposed Draft Code of Practice[2] to the 36th Session of the CCFAC, the Delegation of Denmark noted that an evaluation of the technological effects and efficacy, and a risk assessment for residues and reaction products of the active chlorine compounds were necessary in order to assess whether the benefits of reducing the microbiological contamination outweigh the possible risks of consumer exposure to active chlorine compounds and their reaction products. In this regard, the Committee noted that a Joint FAO/WHO Expert Consultation would be a more appropriate forum to carry out this evaluation and assessment, as it could bring together all necessary expertise.[3]

3. The 36th CCFAC agreed to advance its work on the use of active chlorine in or on food in the following manner:

a. to request FAO and WHO to convene a joint expert consultation to conduct a comprehensive assessment of the use of active chlorine, taking into account both its benefits and risks,

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1 ALINORM 03/12A, paras. 62-63
2 CX/FAC 04/36/11
3 ALINORM 04/27/12, paras. 90-92

b. on the need to first define the scope of an expert consultation, in recognition of the multiple aspects of the use of active chlorine on food,

c. that a working group led by Denmark with the assistance of Australia, Canada, EC, Ireland, Korea, Philippines, United States, and ICGMA would prepare terms of reference for the expert consultation for the aspects relevant to the CCFAC for discussion at its next Session,

d. to request relevant committees, including the Codex Committee on Food Hygiene, to: (1) consider safety/benefit issues relevant to uses of active chlorine within their respective purviews, (2) elaborate terms of reference for the expert consultation within their mandates, and, (3) pose questions so that the expert consultation can be comprehensive.

4. The 36th CCFAC decided to discontinue work on the code of practice with the understanding that the Committee would consider resuming this work in light of any recommendations emanating from the proposed FAO/WHO consultation.[4]

5. The Codex Committee on Food Hygiene (CCFH) has agreed[5] that a drafting group lead by Canada with assistance of Austria, Denmark, EC, France, Ireland, Japan, Republic of Korea, the Netherlands, the United States of America, and IDF would prepare draft terms of reference for the FAO/WHO Expert Consultation on the uses of active chlorine, which would include safety/benefit issues within their purview, and prepare questions within its terms of reference for the consultation.

6. At the request of Denmark, the United States prepared the first draft of this discussion paper, and circulated it for comment within the working group.

Purpose

7. The purpose of this discussion paper is to develop draft terms of reference, that are within the purview of the CCFAC, for a Joint FAO/WHO Expert Consultation on the risks and benefits associated with the treatment of food with active chlorine. CCFAC terms of reference include the potential toxicological risks associated with possible residues of active chlorine compounds and their reaction by-products that are relevant to the uses of active chlorine in or on food.[6] In particular, this paper focuses on identifying specific active chlorine treatments and their conditions of use, as well as the commodities to which they are applied, in order to limit the scope of the risk assessment to residues resulting from known uses of active chlorine and to focus the questions to be presented to the expert consultation.

8. This paper also requests information from Codex member countries relating to uses of active chlorine interventions in or on food of which the drafting group may not be aware, and therefore, are not included in the appendices of this paper. Annex I to this paper provides a form that may be completed and submitted as a comment, should Codex members wish to include additional commodities or conditions of use to these terms of reference.

9. The benefits of active chlorine use, however, through control of detrimental microorganisms associated with food are not addressed herein. Rather, the scope of the microbiological aspects of the proposed expert consultation will be defined in collaboration with the Codex Committee on Food Hygiene (CCFH). It is expected that the CCFH, in its draft terms of reference for this consultation, will identify foods or food products and the conditions under which active chlorine is used to control specific pathogens or spoilage organisms, and the reasons for a particular chlorine intervention (e.g., food borne illness, economic impacts of spoilage, etc). Questions related to germicidal efficacy on food commodities should be raised by CCFH.

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4 ALINORM 04/27/12, para.93

5 ALINORM 04/27/13, para. 158

6 The scope of both this discussion paper and eventually the risk assessment is limited to the use of active chlorine to control microorganisms in or on the food itself or to control the microbial load of the process water. The scope does not include the use of active chlorine for cleaning the surfaces of food processing equipment or food handling utensils, nor the use of chlorine compounds for the direct processing of food as in, e.g., modified food starch.

BACKGROUND

Active chlorine and drinking water

10. WHO has established maximum guideline levels for the chlorinated organic reaction by-products of hypochlorite solutions used to treat drinking water.[7] Although not the subject of this discussion paper, the establishment of these drinking-water guideline levels for chlorinated by-products from hypochlorite use raises the question of the potential formation of chlorinated by-products on food as a result of the treatment of food with water containing oxychloro chemicals. It is worth noting that other active chlorine compounds may be used in drinking water as a replacement for chlorine/hypochlorite to minimize chlorinated by-product formation. Nonetheless, the potential for chlorination, as opposed to oxidation, is an issue that should be considered during the risk assessment of active chlorine species. The conditions under which any active chlorine treatment is used may affect the likelihood of chlorination side reactions as well as the germicidal efficacy of the treatment.

The Chemistry of Active Chlorine Compounds used in Food

11. Active chlorine compounds currently used to treat food include hypochlorous acid and its conjugate base, hypochlorite ion, chlorous acid and its conjugate base chlorite ion, and chlorine dioxide. While other active chlorine chemistries such as sodium dichloroisocyanurate and chloramines exist, the drafting group is unaware that these other chemistries are used in or on food or in food processing water.

12. Hypochlorous Acid/Sodium or Calcium Hypochlorite (HOCl/NaOCl or $Ca(OCl)_2$) Elemental chlorine (a gas under ambient conditions), used in many of the larger facilities that process raw agricultural commodities, is first dissolved in water before it is applied directly to food. Upon dissolution, it rapidly reacts to form hypochlorous acid and hypochlorite ion. The rate of reaction is so rapid that at 0^o, only a few seconds are required to reach the equilibrium concentrations of the three species. The relative equilibrium concentrations are dependent on temperature, pH, and total chlorine concentration. Above a pH of 3, little elemental chlorine is present in solutions of less than 1000 mg/kg total chlorine. The principal chlorine-containing species under these conditions is hypochlorous acid. The equilibrium concentration of hypochlorite ion is several orders of magnitude lower than that of hypochlorous acid.

13. Hypochlorous acid is one of the most effective of all the oxychloro compounds in terms of germicidal properties.[8] The mechanism of its germicidal activity is thought to be due to its reaction with enzymes within the cell walls of microorganisms. Hypochlorous acid is similar in size and structure to water and, unlike the hypochlorite anion, possesses no charge, making it much easier for the acid to penetrate cell walls; therefore, it is a more effective than hypochlorite ion. Additionally, as the pH of a hypochlorous acid solution increases, the residual chlorine decreases, as does the germicidal efficacy. Nonetheless, between pH 3 and 7.5, dilute solutions contain very little dissolved chlorine gas. The fraction of hypochlorous acid, however, remains significant and, therefore, the solutions are effective antimicrobials through this broad pH range. The chlorine atom in hypochlorous acid can also readily undergo substitution reactions with organic compounds forming chlorinated organic compounds.

14. Chlorous Acid/Sodium Chlorite ($HClO_2/NaClO_2$) Sodium chlorite is manufactured by introducing chlorine dioxide gas into a basic aqueous solution containing a reducing agent, usually hydrogen peroxide. (Generally, hydrogen peroxide is recognized and used for its oxidizing properties. However, because chlorine dioxide is a stronger oxidizing agent than hydrogen peroxide, the latter acts as a reducing agent with respect to the former.) The hydrogen peroxide helps prevent disproportionation (decomposition) of chlorine dioxide which would yield chlorate. The final sodium chlorite product may be shipped dry, or as a solution.

15. When sodium chlorite is used, it is diluted in an aqueous acidic solution (e.g., dilute hydrochloric acid). Sodium chlorite is the conjugate base of the weak acid chlorous acid with which it is in equilibrium in solution. The concentration of each species present in an aqueous solution is determined by the pH of the solution. In low pH solutions, chlorous acid decomposes into chlorine dioxide and chlorate ion. In the presence of chloride ion (i.e., if the acid is hydrochloric acid) the rate of decomposition increases, but the chlorate ion is not formed. The chlorine atom in chlorous acid is less likely to form carbon- and nitrogen-chlorination by-products than is the chlorine atom of hypochlorous acid.

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[7] WHO, 1996, Guidelines for Drinking-Water Quality, - 2. ed. Mastercom/Wiener Verlag, Austria.

[8] Geo. Clifford White, *Handbook of Chlorination for Potable Water, Wastewater, Coolong Water, Industrial Processes, and Swimming Pools,* Van Nostrand Reinhold Company, New York (1972) p. 216.

16. Chlorine Dioxide. Chlorine dioxide (a gas) is produced at the site of use by treating an aqueous solution of sodium chlorite with either elemental chlorine, or a mixture of sodium hypochlorite and hydrochloric acid. Chlorine dioxide may also be generated by treating an aqueous solution of sodium chlorate with hydrogen peroxide in the presence of concentrated sulfuric acid.

17. Chlorine dioxide partitions between water and the gaseous state such that it is 23 times more concentrated in the aqueous phase when at equilibrium at 25°. The disproportionation of chlorine dioxide to chlorate and chlorite in aqueous solution is very slow. Thermal decomposition of chlorine dioxide to chlorate can be accelerated by lowering the pH, or by adding chloride ions. However, even then the thermal decomposition is appreciable only at high levels of acidity and temperatures. The chlorine atom in chlorine dioxide is also less likely to form carbon- and nitrogen-chlorination by-products than is the chlorine atom of hypochlorous acid.

Need for a Risk Assessment of Active Chlorine in Contact with Food

18. Active chlorine compounds, generally oxychloro species, enjoy varied uses in food processing in some Codex member countries. These compounds derive their germicidal activity from their ability to penetrate cell membranes, and oxidize enzymes that are essential to the life of microorganisms. In addition to oxidation reactions, oxychloro compounds may also undergo other reactions with organic compounds including carbon- and nitrogen-chlorination, addition reactions, and ester formation. The active chlorine compounds that are used in food processing also may undergo auto-decomposition (disproportionation).

19. The likelihood that chlorination rather than oxidation by-products will be formed as a result of the use of specific active chlorine interventions in or on food depends on the chemistry of the intervention, the commodity upon which it is applied, and the time/temperature and concentration conditions of use employed in the intervention. These conditions also affect the germicidal efficacy of such treatments.

20. Both an assessment of the risks associated with the residues and reaction products of active chlorine compounds in food and an assessment of the benefits relating to the reduction or elimination of microbiological contamination (both pathogenic and spoilage organisms) are necessary to determine whether the benefits of active chlorine treatments outweigh the risks, and to determine the conditions under which treatment is most beneficial.

21. Importantly, the development of useful risk management options depends on understanding the effects of various food processing parameters on the potential risks and benefits of such uses. By understanding these relationships, processors can design active chlorine interventions that maximize the benefits while minimizing the possible risks.

GENERAL PRINCIPLES AND RATIONAL FOR RISK ASSESSMENT

22. In defining the scope and questions for a risk assessment, it is essential to first define the active chlorine treatments to be assessed. In identifying such treatments, it is reasonable to segregate them by the chemistry of the chlorine species and the type of commodity (meat, fish, fruits and vegetables, etc.) to which it is applied.

23. The chemistries of the various oxychloro compounds used for microbiological interventions differ significantly. Consequently, their microbiological performance and potential for chlorination (versus oxidation) can also differ significantly. It is therefore reasonable to further sub-categorize these treatments by specific chemistry within each commodity. JECFA has done this in a toxicological monograph on the use of chlorine dioxide as a flour treatment agent[9] which was categorized as a “Chlorine IV” compound (The Roman numerals refer to the oxidation state of the chlorine in a given chemical species). National regulations in the United States have also established separate food additive regulations for chlorine dioxide (IV), and acidified sodium chlorite (III) solutions. Also, in 2003, the Scientific Committee on Veterinary Measures Relating to Public Health of the European Commission’s Health and Consumer Protection Directorate-General issued a draft opinion on the Evaluation of Antimicrobial Treatments for Poultry Carcasses that provided criteria for assessing antimicrobial agents, and considered specifically chlorine dioxide (IV) and acidified chlorite (III) solutions.

[9] NMRS 35/TRS 281-JECFA 7/159

24. The conditions of use of active chlorine treatments and the level and type of organic load encountered will likely differ for different commodity types. Further, the public health and/or economic benefits accrued by reducing microbial load as a result of active chlorine interventions are expected to be as different for each commodity type, as the microbiological flora common to each.

25. The scope of an expert consultation on the use of active chlorine in food that is within the mandate of the CCFAC should be limited to the potential toxicological safety hazards that may result from such use. Therefore, once the conditions of use on each commodity type are defined in some detail, the CCFAC may wish to ask the expert consultation to evaluate the following information:

a. estimates of consumer exposure to the specific chlorine species,

b. identification of chlorine reaction by-products resulting from such use,

c. estimates of consumer exposure to identified and persistent chlorine reaction by-products,

d. toxicological risk to the consumer resulting from exposure to each active chlorine species or its reaction by-products,

e. organoleptic effects, and effects, if any, on the nutrient content of the treated food, including differences in these effects between commodities, as well as between poultry and beef carcasses and their respective parts.

26. Questions relating to the changes in the composition of the microflora of the commodity, germicidal efficacy against various organisms, and public health consequences resulting from the specific active chlorine treatments are appropriately raised by the CCFH.

REQUEST FOR COMMENT AND INFORMATION

27. In some countries, active chlorine interventions are applied to meat, poultry, and seafood and to raw agricultural commodities, and shell eggs. Certain of these interventions are intended to control microorganisms in or on the food itself, while others are intended to control only the microbial load of the process water that contacts the food. The active chlorine treatments of food and process water that are known to the drafting group were organized into these commodity categories and have been placed into appendices 1 through 5 attached to this paper. The active chlorine treatments are further categorized by their oxidation number within each commodity category. Codex member countries are encouraged to provide any available information on active chlorine treatments of food that has not already been explicitly listed in the appendices of this paper. In particular, comments and specific information are requested relating to three aspects of active chlorine use in or on food:

a. other commodities or commodity categories that are known to be treated with active chlorine interventions, including interventions for pathogenic, as well as spoilage, organisms,

b. other active chlorine chemistries that are used as microbiological interventions in or on food or in process water that contacts food; and,

c. the conditions of time, temperature, use level, pH, etc, under which such interventions are applied.

28. In providing this information, it is important to specify whether the organisms that are being targeted by the interventions are in or on the food itself, or whether the intervention is intended to control the microbial load of water that is used to process the food.

29. Active chlorine interventions for food processing water can be classified under each commodity type that the water is used to process, or in a separate category specifically for process water. Such classification can be better determined once all such conditions of use are identified.

Member states are invited to fill in information in Annex 1, see some examples in Appendices 1-5.

Annex 1

Additional Active Chlorine Interventions

The following blank tables may be used to provide additional information on active chlorine interventions on food, and the details of their conditions of use. As an example, the use of calcium hypochlorite on sweet potatoes is illustrated under Use 1 of the hypochlorite table.

Hypochlorite / Hypochlorous Acid (I)

Conditions	**Use 1**	**Use 2**	**Use 3**	**Use 4**
Method of Application	Spray or dip			
Food/Food Type Restrictions	Sweet potatoes			
Stage of Processing				
Use Level (mg/kg)	150-500 mg/kg			
Exposure Time	2-5 minutes			
Temperature				
pH				
Additional Requirements	Monitor chlorine concentration			

Chlorite / Chlorous Acid (III)

Conditions	**Use 1**	**Use 2**	**Use 3**	**Use 4**
Method of Application				
Food/Food Type Restrictions				
Stage of Processing				
Use Level (mg/kg)				
Exposure Time				
Temperature				
pH				
Additional Requirements				

Chlorine Dioxide (IV)

Conditions	Use 1	Use 2	Use 3	Use 4
Method of Application				
Food/Food Type Restrictions				
Stage of Processing				
Use Level (mg/kg)				
Exposure Time				
Temperature				
pH				
Additional Requirements				

Appendix 1

Active chlorine interventions on **Red Meat and Red Meat Products**

The interventions are separated by type of chlorine chemistry and described by the conditions under which they are used. Please use the form provided in Appendix 6 to list known chlorine interventions and conditions of use that supplement those listed here.

Hypochlorite / Hypochlorous Acid (I)

Conditions	Use 1	Use 2	Use 3	Use 4
Method of Application	Injection by hypochlorinator on intake side of water pump			
Food/Food Type Restrictions	Potable process water used in meat plants			
Stage of Processing	Introduction to plant			
Use Level (mg/kg)	0.1-0.6 mg/kg			
Exposure Time				
Temperature				
pH				
Additional Requirements	Regular testing to assure proper chlorine residuals			

Chlorite / Chlorous Acid (III)

Conditions	Use 1	Use 2	Use 3	Use 4
Method of Application	spray	spray or dip	spray or dip	
Food/Food Type Restrictions	red meat	red meat parts, organ meat	processed, comminuted or formed meat products	
Stage of Processing			prior to packaging	
Use Level (mg/kg)	500-1200	500-1200	500-1200	
Exposure Time				
Temperature				
pH	2.5-2.9	2.5-2.9	2.5-2.9	
Additional Requirements				

Chlorine Dioxide (IV)

Conditions	Use 1	Use 2	Use 3	Use 4
Method of Application				
Food/Food Type Restrictions				
Stage of Processing				
Use Level (mg/kg)				
Exposure Time				
Temperature				
pH				
Additional Requirements				

Appendix 2

Active chlorine interventions on **Poultry and Poultry Parts**

The interventions are separated by type of chlorine chemistry and described by the conditions under which they are used. Please use the form provided in Appendix 6 to list known chlorine interventions and conditions of use that supplement those listed here.

Hypochlorite / Hypochlorous Acid (I)

Conditions	Use 1	Use 2	Use 3	Use 4
Method of Application	Injection by hypochlorinator on intake side of water pump			
Food/Food Type Restrictions	Potable process water used in poultry plants			
Stage of Processing	Introduction to plant			
Use Level (mg/kg)	0.1-0.6 mg/kg			
Exposure Time				
Temperature				
pH				
Additional Requirements	Regular testing to assure proper chlorine residuals			

Chlorite / Chlorous Acid (III)

Conditions	Use 1	Use 2	Use 3	Use 4
Method of Application	Spray or dip	As a pre-chiller or chiller solution	Spray or dip	Spray or dip
Food/Food Type Restrictions	Intact carcass	Intact carcass	Poultry carcass parts	Poultry meat, organs, or related parts or trim
Stage of Processing	Prior to immersion in a pre-chiller or chiller tank	Pre-chiller or chiller tank		Post-chill spray or dip
Use Level (mg/kg)	500-1200	50-150	500-1200	500-1200
Exposure Time				
Temperature				
pH	2.3-2.9	2.8-3.2	2.3-2.9	2.3-2.9
Additional Requirements				

Chlorine Dioxide (IV)

Conditions	Use 1	Use 2	Use 3	Use 4
Method of Application	Process water treatment			
Food/Food Type Restrictions	Process water used in poultry plants			
Stage of Processing				
Use Level (mg/kg)	3			
Exposure Time				
Temperature				
pH				
Additional Requirements				

Appendix 3

Active chlorine interventions on **Seafood**

The interventions are separated by type of chlorine chemistry and described by the conditions under which they are used. Please use the form provided in Appendix 6 to list known chlorine interventions and conditions of use that supplement those listed here.

Hypochlorite / Hypochlorous Acid (I)

Conditions	Use 1	Use 2	Use 3	Use 4
Method of Application	dip			
Food/Food Type Restrictions	Eviscerated and degilled fish intended for filleting			
Stage of Processing	Prior to filleting			
Use Level (mg/kg)	25 mg/kg			
Exposure Time				
Temperature				
pH				
Additional Requirements	Remove fish from treated water 24-48 hours before filleting			

Chlorite / Chlorous Acid (III)

Conditions	Use 1	Use 2	Use 3	Use 4
Method of Application	Dip, Spray, ice	Spray or Dip		
Food/Food Type Restrictions	In water or ice used to rinse, wash, thaw, transport or store Seafood	Seafood		
Stage of Processing		single-use application during harvesting, handling, heading, evisceration, butchering, storing, holding, packing or packaging of finfish and crustaceans; or following the filleting of finfish		
Use Level (mg/kg)	40-50	1200		
Exposure Time				
Temperature				

Conditions	Use 1	Use 2	Use 3	Use 4
pH	2.5-2.9	2.3-2.9		
Additional Requirements	seafood intended to be eaten raw, shall be rinsed with potable water prior to consumption	Only in processing facilities. Treated seafood shall be cooked prior to consumption		

Chlorine Dioxide (IV)

Conditions	Use 1	Use 2	Use 3	Use 4
Method of Application				
Food/Food Type Restrictions				
Stage of Processing				
Use Level (mg/kg)				
Exposure Time				
Temperature				
pH				
Additional Requirements				

Appendix 4

Active chlorine interventions on **Fruits, Vegetables, Legumes and Roots**

The interventions are separated by type of chlorine chemistry and described by the conditions under which they are used. Please use the form provided in Appendix 6 to list known chlorine interventions and conditions of use that supplement those listed here.

Hypochlorite / Hypochlorous Acid (I)

Conditions	**Use 1**	**Use 2**	**Use 3**	**Use 4**
Method of Application		Spray	Spray	Submersion followed by spray
Food/Food Type Restrictions	Fruits and vegetables	Mushrooms	Potatoes	Fruits and vegetables
Stage of Processing	washing, or to assist in the lye pealing		After cleaning, prior to storage	After washing
Use Level (mg/kg)	GMP	100-200 mg/kg	500 mg/kg	25 mg/kg
Exposure Time				2 minutes
Temperature				
pH				
Additional Requirements		Sprayed directly on pins to control small infection foci	Not to exceed 4 liters per 900 kg of potatoes	Rinse fruit only prior to packaging

Hypochlorite / Hypochlorous Acid (III)

Conditions	**Use 1**	**Use 2**	**Use 3**	**Use 4**
Method of Application	Spray or dip			
Food/Food Type Restrictions	Sweet potatoes			
Stage of Processing				
Use Level (mg/kg)	150-500 mg/kg			
Exposure Time	2-5 minutes			
Temperature				
pH				
Additional Requirements	Monitor chlorine concentration			

Chlorite / Chlorous Acid (III)

Conditions	Use 1	Use 2	Use 3	Use 4
Method of Application		Spray or dip	Dip solution	
Food/Food Type Restrictions	raw agricultural commodities	processed fruits and processed roots, tubers, bulbs, legume, fruiting (i.e. eggplant, ground cherry, pepino, pepper, tomatillo, and tomato) and cucurbita vegetables	Processed leafy vegetables (i.e. vegetables other than roots, tubers, bulbs, legume, fruiting and cucurbita vegetables) and vegetables in the Brassica [Cole} family	
Stage of Processing	preparing, packing, or holding food for commercial purposes	preparing, packing, or holding food for commercial purposes	preparing, packing, or holding food for commercial purposes	
Use Level (mg/kg)	500-1200	500-1200	500-1200	
Exposure Time				
Temperature				
pH	2.3-2.9	2.3-2.9	2.3-2.9	
Additional Requirements	Treatment followed by potable water rinse, or by blanching, cooking or canning	Treatment followed by potable water rinse, or by blanching, cooking or canning	Treatment preceded and followed by a potable water rinse, and followed by a 24 hour holding period prior to consumption	

Chlorine Dioxide

Conditions	Use 1	Use 2	Use 3	Use 4
Method of Application	Wash water			
Food/Food Type Restrictions	Fruits and vegetables that are not raw agricultural commodities (i.e. processed or minimally processed vegetables)			
Stage of Processing				
Use Level (mg/kg)	3			
Exposure Time				
Temperature				
pH				
Additional Requirements	Treatment followed by potable water rinse, or by blanching, canning or cooking			

Appendix 5

Active chlorine interventions on **Shell Eggs**

The interventions are separated by type of chlorine chemistry and described by the conditions under which they are used. Please use the form provided in Appendix 6 to list known chlorine interventions and conditions of use that supplement those listed here. .

Hypochlorite / Hypochlorous Acid (I)

Conditions	**Use 1**	**Use 2**	**Use 3**	**Use 4**
Method of Application		spray		
Food/Food Type Restrictions	Shell Eggs	Shell eggs		
Stage of Processing	Cleaning & destaining	Sanitizing after washing		
Use Level (mg/kg)	gmp	200 mg/kg		
Exposure Time				
Temperature	wash solution at least 11^{o}C warmer than the eggs	Not to exceed 57^{o}C		
pH				
Additional Requirements	use is followed by a potable water rinse	Do not rinse, do not reuse		

Chlorite / Chlorous Acid (III)

Conditions	**Use 1**	**Use 2**	**Use 3**	**Use 4**
Method of Application				
Food/Food Type Restrictions	Shell eggs			
Stage of Processing	Cleaning & destaining			
Use Level (mg/kg)	500-1200			
Exposure Time				
Temperature	wash solution at least 11^{o}C warmer than the eggs			
pH	2.3-3.2			
Additional Requirements	use is followed by a potable water rinse			

Chlorine Dioxide (IV)

Conditions	Use 1	Use 2	Use 3	Use 4
Method of Application				
Food/Food Type Restrictions	Shell eggs			
Stage of Processing	Cleaning & destaining			
Use Level (mg/kg)	3			
Exposure Time				
Temperature	wash solution at least 11°C warmer than the eggs			
pH				
Additional Requirements	use is followed by a potable water rinse			