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GUIDELINES ON THE APPLICATION OF GENERAL PRINCIPLES OF FOOD HYGIENE TO THE CONTROL OF FOODBORNE PARASITES

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INTRODUCTION

Foodborne parasites are a major public health burden worldwide¹, particularly in areas with poor sanitary facilities and in populations that traditionally consume raw and undercooked food dishes. Infections may have prolonged, severe, and sometimes fatal outcomes, and result in considerable hardship in terms of food safety, security, quality of life, and negative impacts on livelihood.

The joint Food and Agriculture Organization of the United Nations (FAO)/ World Health Organization (WHO) report on Multicriteria-Based Ranking for Risk Management of Foodborne Parasites² lists 24 parasite species, genera or families that ranked highest in global public health concern. The top 8 highly ranked parasites are *Taenia solium*, *Echinococcus granulosus*, *Echinococcus multilocularis*, *Toxoplasma gondii*, *Cryptosporidium* spp., *Entamoeba histolytica*, *Trichinella* spp, and Opisthorchiidae. The ranking was based on 7 criteria of which 5 were public health related. The ranking was based on worldwide impacts and regionally other foodborne parasites may be more important. The ranking indicates that the foodborne parasites of greatest concern from a global public health perspective are not limited to a single parasite group or a food vehicle, but span a number of different parasites groups, and food vehicles.

Knowledge of parasite life cycles, transmission routes and environmental requirements is needed to understand which control measures may be effective. Foodborne parasites are transmitted to humans by ingestion of fresh or processed foods that are contaminated as a consequence of the parasite's life cycle (e.g. meat that contains *Trichinella* larvae or *Toxoplasma* tissue cysts) or that are contaminated with soil or water carrying infective stages of parasites (e.g. cysts, oocysts, eggs). In the first case, human infection can occur through the consumption of an infective stage in raw, undercooked or poorly processed meat and offal from domesticated animals, game, fish, crustaceans, cephalopods and molluscan shellfish. In the second case, human infection can occur from ingestion of infective stages in water and on foods such as fresh fruit and vegetables resulting from animal or human faecal contamination (e.g. oocysts of *Cryptosporidium* spp. in fresh vegetables).

Control of foodborne parasites can be achieved through the prevention of infection of farmed food animals (e.g. livestock, poultry, fish) with infective stages, the prevention of contamination of fresh and processed foods with infective stages, and/or the inactivation of parasites in or on foods during processing. Control during primary production is important for many parasite/food combinations, while control measures during post-harvest are necessary for other parasite/food combinations. During a parasite hazard analysis, producers should consider how the product will be further processed, prepared and consumed in order to determine appropriate parasite control measures. Education and awareness-raising are important components of consumer protection from foodborne parasitic diseases and, in many cases, may be the only feasible option available.

The first step of foodborne parasite risk management should be identifying any potential parasite hazard(s) applicable to the food being produced³. The details of the epidemiology (both human and animal disease) and the life cycle of each parasite are essential in the identification, prevention and control of the risks associated with that parasite. Epidemiological data collection in food and environmental parasite surveys can be effective in identifying hazards and collecting information to be used for risk management strategy decisions. Surveillance for parasitic diseases in humans is complicated by the often prolonged incubation periods, sub-clinical nature, unrecognized chronic sequelae and lack of easily available diagnostic procedures.

The occurrence and distribution of parasitic species in the raw commodities used for food can be affected by climate changes, land use, and other environmental factors. The spread of foodborne parasitic diseases is also affected by human behaviour (for instance, environmental contamination by human faeces due to the lack of latrines and human-to-human contact that spread parasite eggs and cysts), demographics, and global trade. For example, globalization of food trade offers new opportunities for parasite dissemination into new areas.

SECTION 1 - OBJECTIVES

The primary purpose of these guidelines is to provide guidance on preventing, reducing, inactivating, or otherwise controlling foodborne parasite hazards that present a public health risk. The guidelines provide science-based advice to governments and the food industry with the aim of protecting the health of consumers against foodborne parasites and ensuring fair practices in food trade. The guidelines also provide information that will be of value to consumers and other interested parties.

¹ WHO FERG report (2015)

² FAO/WHO. 2014. Multicriteria-based ranking for risk management of food-borne parasites. Microbiological Risk Assessment Series No. 23. Available at <http://www.fao.org/3/a-i3649e.pdf> and http://www.who.int/foodsafety/publications/mra_23/en/

³ [Principles and Guidelines for the conduct of Microbiological Risk Management \(MRM\) \(CAC/GL 63-2007\)](#).

SECTION 2 - SCOPE, USE AND DEFINITION

2.1 Scope

These guidelines for the control of foodborne parasites are applicable to all foods especially those foods identified in the FAO/WHO report, from primary production through consumption. They should complement guidelines in place for any other pathogens (e.g. bacteria and viruses).

Control measures should be applied to parasite hazards in proportion to the public health risk. Countries in which specific parasites are endemic should take special measures to reduce the identified risk.

Section 3 is subdivided into four food categories: i) Meat and meat products, ii) Milk and milk products, iii) Fish and fishery products, iv) Fresh fruits and vegetables. The Scope of these categories is the same as provided in the following codes:

- Meat and Meat products: [Code of Hygienic Practice for Meat \(CAC/RCP 58-2005\)](#), especially raw or undercooked meat.
- Milk and Milk products: [Code of Hygienic Practice for Milk and Milk Products \(CAC/RCP 57-2004\)](#), especially, unpasteurized milk and milk products.
- Fish and Fishery products: [Code of Practice for Fish and Fishery Products \(CAC/RCP 52-2003\)](#), especially, raw or undercooked fish and fishery products.
- Fresh Fruits and Vegetables: [Code of Hygienic Practice for Fresh Fruits and Vegetables \(CAC/RCP 53-2003\)](#), especially fruits and vegetables consumed raw or undercooked.

The remaining sections contain guidelines applicable to the food chain after primary production (i.e. processing, food service, home preparation, and consumption), but are not subdivided into food categories.

2.2 Use

These guidelines follow the format of the [General Principles of Food Hygiene \(CAC/RCP 1-1969\)](#) and should be used in conjunction with it and other relevant codes of practice such as:

- [Code of Hygienic Practice for Meat \(CAC/RCP 58-2005\)](#),
- [Code of Hygienic Practice for Milk and Milk Products \(CAC/RCP 57-2004\)](#),
- [Code of Practice for Fish and Fishery Products \(CAC/RCP 52-2003\)](#),
- [Code of Hygienic Practice for Fresh Fruits and Vegetables \(CAC/RCP 53-2003\)](#).

The World Organization for Animal Health (OIE) develops standards for the prevention, detection and control of some foodborne parasites at the primary production stage. Therefore, these guidelines should also be used in conjunction with relevant Articles of the OIE Codes and Manuals and the OIE/FAO guide to Good Farming Practices for Animal Production Food Safety.

Flexibility in application of the Guidelines is important. They are primarily intended for use by government risk managers and industry in the design and implementation of food control systems.

2.3 Definitions

Definitions relevant to these guidelines include:

Fish⁴

Aquaculture⁴

Feed⁵

Fish farm⁴

Cyst – A transmission stage of a parasite that can cause infection when consumed. Environmental cysts are resistant to outside conditions and can be transferred with soil, dust, and water to food. Tissue cysts are located within animal tissues.

⁴ [Code of Practice for Fish and Fishery Products \(CAC/RCP 52-2003\)](#)

⁵ [Code of Practice on Good Animal Feeding \(CAC/RCP 54-2004\)](#)

Foodborne Parasite – Any parasite that can be transmitted to humans by ingesting food.

Host – An organism which harbours the parasite.

Larvae – Immature form of helminths, before the development of the mature stage. Larvae can be infective or not.

Oocyst – The environmental, developmental stage of coccidian parasites, produced through sexual reproduction in the definitive host. Oocysts can be infective or not when produced or shed.

SECTION 3 - PRIMARY PRODUCTION

It is necessary to conduct a hazard analysis to identify the foodborne parasite hazards that could be present in the feed and food production environment and that may contaminate foods during primary production. Control of parasites during primary production is particularly important when subsequent control steps during processing may not be adequate to eliminate the hazard or reduce it to an acceptable level.

Sources of parasitic contamination of food and food producing animals at the primary production site include feed, water, soil, workers, untreated manure, sludge or fertilizers contaminated by faeces of human and/or domestic and wild animals, or proximity to other activities which could result in run-off or flooding with contaminated water. Therefore, attention to water quality throughout the food-chain, from primary production through processing to consumption is very important. In addition to the above, food-producing animals feeding on other live and dead animals (e.g. mammals, fish, birds, invertebrates), are important sources of parasitic infections.

Farm workers in endemic areas may be infected with parasites without feeling ill or showing any symptoms. In order to minimize the probability for contamination of the production environment with parasitic stages from human faeces, on-farm sanitary facilities should be installed and used, e.g. functional latrines in the field that do not leak contaminants into the primary production area, and an adequate means of hygienically washing (e.g. scrubbing under running water) and drying hands. Waste from sanitary facilities should be hygienically disposed of in such a way as to eliminate contact of potentially infectious faeces with animals or pasture land.

A. Meat and Meat Products

Important meat-transmitted foodborne parasites include, but are not limited to, *Taenia solium* (pigs), *Toxoplasma gondii* (pigs, cattle, chickens, sheep, goats, horses, game), *Trichinella spiralis* (pigs, horses, game) and other *Trichinella* spp. (pigs, horses and game), *Taenia saginata* (cattle), *Sarcocystis* spp. (pigs, cattle) and *Spirometra* spp. (fish, reptiles, and amphibians). Certain foodborne parasites present in domestic animals may be transmitted to food of plant origin via faecal contamination (e.g. *Echinococcus* spp., *Cryptosporidium* spp., *Fasciola* spp. and *Giardia duodenalis*.) These parasites are not associated with human illness from consumption of meat, however they should be controlled in animal production in order to interrupt their life cycle. For information on specific food vehicles for these parasites, see Table 2 in FAO/WHO report on *Multicriteria-Based Ranking for Risk Management of Food-Borne Parasites*².

3.1 Environmental hygiene

Refer to Section 3.1 of the [General Principles of Food Hygiene \(CAC/RCP 1-1969\)](#), and Section 5.5 of the [Code of Hygienic Practice for Meat \(CAC/RCP 58-2005\)](#) and the relevant Chapters of the OIE Terrestrial Animal Health Code⁶.

Faeces of domestic and wild animals (e.g. *Toxoplasma* oocysts in felids), as well as human faeces (e.g. *Taenia* eggs), may contain parasites that are infective to domestic food-producing animals. Some parasites may also be transmitted to domestic animals or other animal hosts when these animals eat infected tissues from other animals. Where parasites will not be controlled at a later processing stage, the feasibility of controlling environmental introduction of foodborne parasites during primary production with available methods should be determined before primary production begins. The risk associated with the introduction of organic material (e.g. faecal and other material that may contain oocysts or eggs) from non-food-producing animals into the production environment should also be assessed.

Game meat may contain parasites that infect humans directly or via the infection of livestock. The environment of wild animals and open range domesticated animals cannot be controlled, therefore, mitigation measures should be in place to minimize the risk at a later stage in the food chain.

⁶ Refer to the OIE website: <http://www.oie.int/en/international-standard-setting/terrestrial-code/access-online/>

3.2 Hygienic production of food sources

For information related to the control of parasites related to animal feed, refer to the [Code of Practice on Good Animal Feeding \(CAC/RCP 54-2004\)](#), Sections 4, 5 and 6.5 of the [Code of Hygienic Practice for Meat \(CAC/RCP 58-2005\)](#), and the relevant Chapters of the *OIE Terrestrial Animal Health Code*, and the WHO/FAO/OIE Guidelines for the surveillance, prevention and control of taeniosis/cysticercosis⁷, and FAO/WHO/OIE Guidelines for the surveillance, management, prevention and control of trichinellosis⁸.

Where indicated by a hazard analysis, control measures and/or hygienic practices should be implemented that prevent foodborne parasites from contaminating foods or infecting food animals during primary production, or that reduce contamination to an acceptable level.

Fully enclosed animal housing systems, or other systems that prevent intrusions of potentially contaminated small animals or unauthorized people, combined with other good production practices, can be effective in controlling foodborne parasite hazards in meat, since such systems have been demonstrated to be effective for a number of parasites (e.g. *Trichinella* spp., *Toxoplasma*).

Feed should be effectively protected against rodents (e.g. *Trichinella* spp. control), cats (e.g. *Toxoplasma gondii* control) and other animals. All dead animals should be immediately removed from feed storage and food-producing animal production areas and disposed of in a safe manner.

Primary producers should supply water that is not a significant source of transmission of foodborne parasites to food-producing animals and to the extent possible block access of food producing animals to surface water and untreated water collection systems to minimize the potential for infection with parasites.

In order to assess whether foodborne parasite controls at primary production are properly implemented and effective, control measures should be documented and verified. Animal surveillance may be a useful tool for assessing control measure needs/shortcomings; however, because of the practical limitations of sampling and testing methodology, testing cannot assure the absence of a parasite hazard.

3.3 Cleaning, maintenance and personnel hygiene at primary production

Refer to the relevant Chapters of the *OIE Terrestrial Animal Health Code* for recommendations on cleaning, disinfection and personal hygiene.

3.5 Monitoring and surveillance at primary production

Refer to the relevant Chapters of the *OIE Terrestrial Animal Health Code*. Surveillance and monitoring of foodborne parasites in food animals and in species that are potential sources of parasites could be effective in developing risk management strategies. Monitoring and surveillance can be useful as tools to verify the effectiveness of parasite controls, and should begin at primary production.

Assurance that a parasite hazard is adequately controlled can be attained through demonstration of properly implemented controls and hygienic practices, which may be supported by a series of negative test results over a sufficient time period through a risk-based surveillance programme.

It is important to exchange information between the owner of the herds and the slaughterhouse or processing plant e.g.:

- When the status of the herd in relation to parasite infection (e.g. history of parasitic infection) is known, it should be communicated to the slaughterhouse in order to facilitate a more targeted monitoring of parasites in the slaughterhouse.
- The status of the meat, following a post-mortem inspection in the slaughterhouse, should be provided to the owner of herds, to facilitate a more targeted control at primary production.

B. Milk and milk products

Consumption of unpasteurized milk has been associated with outbreaks of cryptosporidiosis and toxoplasmosis. Contamination of unpasteurized milk with *Cryptosporidium* spp. may result from unsanitary milking conditions, such as when the udders are not properly cleaned. Outbreaks of toxoplasmosis have been associated with the consumption of unpasteurized goat and camel milk. Infective stages of *Toxoplasma* in recently infected animals may be excreted in the milk and might result in milk-borne infection. For information on specific food vehicles for these parasites, see Table 2 in FAO/WHO report on *Multicriteria-Based Ranking for Risk Management of Food-Borne Parasites*².

⁷ <http://www.oie.int/doc/ged/d11245.pdf>

⁸ http://www.trichinellosis.org/uploads/FAO-WHO-OIE_Guidelines.pdf

3.1 Environmental hygiene

Refer to Section 3.1 of the *Code of Hygienic Practice for Milk and Milk Products* (CAC/RCP 57-2004).

Cats should be excluded, to the extent possible, from barns and food production, handling and storage areas used for dairy herds (e.g. cows, goats, sheep and camels).

3.2 Hygienic production of food sources

Refer to the [Code of Practice on Good Animal Feeding \(CAC/RCP 54-2004\)](#) and Section 3.2 of the [Code of Hygienic Practice for Milk and Milk Products \(CAC/RCP 57-2004\)](#).

3.3 Handling, storage and transport

Refer to Section 3.3 of the [Code of Hygienic Practice for Milk and Milk Products \(CAC/RCP 57-2004\)](#).

3.4 Cleaning, maintenance and personnel hygiene at primary production

Refer to Section 6 of the [Code of Hygienic Practice for Milk and Milk Products \(CAC/RCP 57-2004\)](#).

C. Fish and fishery products

Important fish-transmitted foodborne parasites include Opisthorchiidae in freshwater fish, *Paragonimus* spp. in freshwater crustaceans, Anisakidae in marine fish, crustaceans and cephalopods, Heterophyidae in freshwater/brackish water fish, and Diphyllbothriidae in freshwater and marine fish. For information on specific food vehicles for these parasites, see Table 2 in *Multicriteria-Based Ranking for Risk Management of Food-Borne Parasites*, Report of a Joint FAO/WHO Expert Meeting, 2012.

3.1 Environmental hygiene

Refer to Sections 6.1.1 and 6.1.2 of the [Code of Practice for Fish and Fishery Products \(CAC/RCP 52-2003\)](#).

Wild fish, and aquacultured fish without controlled rearing conditions, may contain parasites that infect people. The environment of wild fish cannot be controlled, requiring measures to be taken at a later stage of the food chain, e.g. processing, for fish that will be consumed raw or undercooked.

The source of water used for aquaculture fish farming can be a risk factor for parasitic infections. The larval stages of certain trematodes, which may be present in fish farm water, can penetrate fish skin and infect fish tissues. Aquaculture primary producers should use clean water and seek appropriate guidance on water quality, and should prevent influx of contaminated water (including waste water). The hygienic suitability of the water, under both normal and rain-storm conditions, should be assessed.

Where feasible, material derived from on-board evisceration of fish showing signs of infection by parasites communicable to humans should not be disposed of at sea unless it has undergone a treatment that kills the parasites, in order not to maintain the parasite life cycle.

Some aquaculture methods may reduce a parasite hazard to an acceptable level, for example, ocean pen-reared salmon that are raised on commercial pelleted feed have not been observed to contain any anisakid worms compared to wild salmon. Closed systems with controlled feed and environment conditions can effectively eliminate parasites that normally occur in wild fish.

3.2 Hygienic production of food sources

Refer to Section 3 and Section 6 of the [Code of Practice for Fish and Fishery Products \(CAC/RCP 52-2003\)](#), and the [Code of Practice on Good Animal Feeding \(CAC/RCP 54-2004\)](#) and the relevant Chapters of the *OIE Aquatic Animal Health Code*⁹ the *FAO Technical Paper on Assessment and Management of Fish Safety and Quality-Current Practices and Emerging Issues*¹⁰.

To prevent potential transmissions of parasites, fingerlings should only be purchased from producers who implement reliable source management systems and Good Aquaculture Practice (GAqP). Fingerlings collected from the wild may contain foodborne parasites that remain a hazard in adult fish.

Animals and people infected with foodborne parasites may excrete parasite eggs that enter water and develop into larval stages that subsequently infect farmed fish. In order to minimize the opportunity for contamination of the production environment with parasitic stages from human faeces, on-farm sanitary facilities should be installed, e.g. functional latrines, and an adequate means of hygienically washing and drying hands.

⁹ <http://www.oie.int/international-standard-setting/aquatic-code/access-online/>

¹⁰ <http://www.fao.org/3/a-i3215e.pdf>

Animals, including dogs and cats, are hosts for freshwater trematode fishborne parasites and should be excluded from land-based fish ponds to the extent possible. Good practices include not feeding raw meat/offal of fish to dogs and cats, preventing fish-eating mammals from accessing fish ponds and controlling the population of semi-domesticated or stray/feral dogs and cats in close vicinity of fish farms. Workers infected with or being treated for fish-borne trematodes (liver and intestinal flukes) should be excluded from the farm environment during treatment.

Attention should also be given to animals that serve as intermediate hosts¹¹ in the life cycle of fishborne parasites. For example, in the case of aquaculture, the exclusion of snails, as intermediate hosts for fishborne trematodes, from fish farm areas, may help interrupt trematode life cycles in fish ponds. For wild fish, intermediate hosts cannot be controlled, and fish migrate from different areas with varying risks for exposure to parasites.

Using raw fish as feed for aquaculture is likely to introduce a risk of parasitic infection, therefore it should be avoided as much as possible. Raw fish used for feed may be previously frozen in order to inactivate parasites. It is particularly important to inactivate parasites in feed where the fish will not be subsequently frozen, and may be consumed raw or undercooked.

Toilets should not directly empty into land-based fish ponds. Fishponds should be protected from contamination from human and animal faeces, pollution with sewage and other wastes. Untreated human and animal excreta should not be used as fertilizer or as fish food.

Where needed, control measures at primary production should be assessed in order to determine if they are properly implemented and effective. Fish surveillance may be a useful tool for assessing control measure needs/shortcomings; however, because of the practical limitations of sampling and testing methodology, testing cannot assure the absence of a parasite hazard.

3.3 Handling, storage and transport

Eviscerating fish without any undue delay during harvest is helpful to prevent migration of Anisakidae larvae from the viscera into the flesh after harvest.

Refer to Sections 6.3.5 and 6.3.6 of the [Code of Practice for Fish and Fishery Products \(CAC/RCP 52-2003\)](#), and the relevant Chapters of the *OIE Aquatic Animal Health Code* for considerations for transport.

3.4 Cleaning, maintenance and personnel hygiene at primary production

Refer to Sections 3.4 and 3.5 of the [Code of Practice for Fish and Fishery Products \(CAC/RCP 52-2003\)](#) and the relevant Chapters of the *OIE Aquatic Animal Health Code*.

3.5 Monitoring and surveillance at primary production

Examining fish for live fishborne parasites may be a useful tool to assess the effectiveness of fishborne parasite preventive control measures. Data from monitoring and surveillance can be useful to develop and review risk management strategies.

Assurance that a parasite hazard is adequately controlled may be attained through demonstration of properly implemented controls and hygienic practices, which may be supported by a series of negative test results over a sufficient time period through a risk-based surveillance programme.

D. Fresh fruits and vegetables

Important fruit- and vegetable-transmitted foodborne parasites include, but are not limited to, *Taenia solium*, *Echinococcus granulosus*, *Echinococcus multilocularis*, *Toxoplasma gondii*, *Entamoeba histolytica*, *Cryptosporidium* spp., *Ascaris* spp., *Giardia duodenalis*, *Fasciola* spp., *Cyclospora cayetanensis*, *Trichuris trichiura*, *Balantidium coli*, and *Toxocara* spp. For information on specific food vehicles for these parasites see Table 2 in FAO/WHO report on *Multicriteria-Based Ranking for Risk Management of Food-Borne Parasites*².

Certain fruits and vegetables are consumed raw without a cooking or freezing step or disinfection to kill parasites. In this case, controls that reduce the parasite hazard to an acceptable level during primary production are especially important.

3.1 Environmental hygiene

Refer to Section 3.1 of the [Code of Hygienic Practice for Fresh Fruits and Vegetables \(CAC/RCP 53-2003\)](#).

Areas for cultivation of fresh fruits and vegetables need to be assessed in terms of their susceptibility to direct or indirect faecal contamination from wild animals, domestic animals and/or humans, whether from run-off, flooding, irrigation water, or natural fertilizers. Prior to selecting the site for cultivation it should be determined if adequate control measures can be implemented to manage any identified risks.

¹¹ A host which harbours the larval developmental stages of the parasite prior to maturity

3.2 Hygienic production of food sources

Refer to the [Code of Hygienic Practice for Fresh Fruits and Vegetables \(CAC/RCP 53-2003\)](#) and the *WHO/OIE Manual on Echinococcus in Human and Animals*¹².

The use of biological soil amendments of animal origin, particularly on fresh produce, should be managed to minimize the potential for contamination with parasites (e.g. adequately treating manure). Parasite eggs and oocysts can survive for years in the environment, and can be highly resistant to environmental changes; for example *Ascaris* eggs can remain viable in anaerobically digested sewage sludge.

In case the presence of infected snail intermediate host (Lymnaeidae) is identified, aquatic plants, such as watercress, grown in the area should not be harvested for raw consumption in order to prevent infection with *Fasciola hepatica* and *F. gigantica*.

Flooding may cause contamination of crops with water containing the parasite eggs, cysts and oocysts from animal or human faeces. After such events, produce should be evaluated for risk of contamination and where there is a risk, proper disposal of the affected produce is needed.

3.4 Cleaning, maintenance and personnel hygiene at primary production

Refer to Sections 3.2.3 and 3.4 of the [Code of Hygienic Practice for Fresh Fruits and Vegetables \(CAC/RCP 53-2003\)](#).

SECTION 4 - ESTABLISHMENT: DESIGN AND FACILITIES

4.2 Premises and rooms

4.2.1 Design and layout

The post-harvest processing establishment should be designed to exclude animals that may excrete faeces that contain parasite stages. The layout should minimize the introduction of soil that may contain faeces from animals and parasite stages from the outside environment (e.g. changing boots/clothes at the entrance of the establishment).

SECTION 5 - CONTROL OF OPERATION

5.1 Control of food hazards

Control measures are used to address specific foodborne parasite hazards, e.g. as part of a Hazard Analysis and Critical Control Point (HACCP)-based system. Contamination of foods during processing with parasites transmitted by the faecal-oral route is typically controlled by a stringent application of hygiene control systems, which could be referred to as, e.g. Good Hygienic Practices (GHPs) and sanitation standard operation procedures (SSOPs). These prerequisite programs, together with validated interventions for specific parasites provide a framework for the control of foodborne parasites.

During the parasite hazard analysis, food business operators should consider how the product will be further processed, prepared and consumed in order to determine appropriate parasite controls. Where the hazard analysis indicates the presence of a significant foodborne parasite hazard, slaughter and post-harvest processing operations should have control measures in place that prevent or eliminate the hazard or reduce it to an acceptable level.

The hazard analysis may determine that a foodborne parasite hazard is adequately controlled at primary production, or by the previous processor. In this case, methods may be used to verify that previous control measures are adequate, such as inspecting the implementation of control measures at the primary producer or previous processor, and for some products, testing incoming product for the presence of parasites.

Various processes have been shown to control parasites in selected food items, but the conditions needed to inactivate parasites are subject to substantial variability depending on the parasites, the food matrix and the location of parasites in the food matrix. Specific processing steps and processing combinations should be subject to rigorous validation to ensure consumer protection. For additional information on validation, refer to the [Guidelines for the Validation of Food Safety Control Measures \(CAC/GL 69-2008\)](#). Control measures may include: freezing, heat treatment, salting, drying, high pressure processing, filtration, sedimentation, UV light, ozone and irradiation. Specific processing steps and processing combinations (hurdle concept) to control parasites should be used in accordance with guidance from competent authorities, where available.

¹² <http://whqlibdoc.who.int/publications/2001/929044522X.pdf>

5.2 Key aspects of hygiene control systems

5.2.1 Time and temperature control

Time and temperature control treatments (freezing and heating) that will result in the reduction/elimination of viable parasites are the most commonly used preventative control measures. Such treatments should be done in accordance with validated parameters, as described in relevant and reliable guidelines and other scientific literature.

5.2.2 Specific process steps

5.2.2.1 Freezing

Many parasites in food are susceptible to freezing. However, specific time/temperature combinations are required to inactivate parasites by freezing, and these are also dependent on the food type and portion size. Some parasites (e.g. *Trichinella nativa* and *T. britovi* larvae or eggs of *Echinococcus multilocularis*) are resistant to freezing.

For control of parasites in fish and fishery products intended for raw consumption by freezing, refer to Annex 1 of the *Code of Practice for Fish and Fishery Products* (CAC/RCP 52-2003). For control of parasites in cold smoked fish, smoke-flavoured fish, and smoke-dried fish refer to Annex 1 of the *Standard for Smoked Fish, Smoke-flavoured Fish and Smoke-dried Fish* (CODEX STAN 311-2013).

5.2.2.2 Heat treatment

Parasites can be inactivated by adequate heat treatment of foods and water. Other validated treatments may be used.

5.2.2.3 Salting, curing, marinating, pickling, smoking

Processing methods such as salting, curing, marinating, pickling, smoking, and addition of food additives that may be effective for the control of certain other foodborne pathogens are generally not sufficient for the control of foodborne parasites. Combinations of several treatments (hurdle concept) can be effective to control parasites. When a combination of treatments is used, it should be subject to rigorous validation to ensure consumer protection.

5.2.2.4 Irradiation

Irradiation is a possible measure for parasite control. Refer to the [General Standard for Irradiated Foods \(CODEX STAN 106-1983\)](#).

5.2.2.5 Washing

Fruits and vegetables should be washed with water in accordance with the Section 5.2.2.1 of the [Code of Hygienic Practice for Fresh Fruits and Vegetables \(CAC/RCP 53-2003\)](#) to reduce parasites. However, it should be noted that most parasite eggs or oocysts are sticky and difficult to remove from fruits and vegetables, particularly those with crevices or folds on the surface.

5.4 Packaging

It should be noted that vacuum packaging does not alter the infectivity of parasites in food.

5.7 Documentation and records

Documentation related to validation, monitoring and verification activities regarding the control measures used for parasites should be kept.

Monitoring and review of foodborne parasite safety control systems is an essential component of application of a risk management framework (RMF). It contributes to verification of process control and demonstrating progress towards achievement of public health goals.

Information on the level of control of parasites at appropriate points in the food chain can be used for several purposes e.g. to validate and/or verify outcomes of food control measures, to monitor compliance with public health goals, and to help prioritise regulatory efforts to reduce foodborne parasite illnesses.

SECTION 6 – ESTABLISHMENT: MAINTENANCE AND SANITATION

6.3 Pest control systems

Insects, such as flies and cockroaches, and animals such as rodents and birds can transport parasite stages from faeces to food and should be controlled.

SECTION 7 – ESTABLISHMENT: PERSONAL HYGIENE

Proper personal hygiene such as hand-washing practices should be used to prevent faecal-oral transmission of parasites. For example, workers infected with the tapeworm *T. solium* with improper hand-washing practices can spread eggs that result in the severe disease neurocysticercosis.

SECTION 9 – PRODUCT INFORMATION AND CONSUMER AWARENESS

9.2 Product information

Labels may be used to help differentiate between products that are intended for raw consumption and products that are intended to be cooked by the consumer. However, even with the beneficial use of labels instructing consumers to cook the product, a parasite hazard should be reduced to an acceptable level before marketing products that are likely to be consumed raw or undercooked.

9.4 Consumer education

In order to increase consumer awareness of foodborne parasite hazards, education, is an important component of risk management, and in some cases may be the only practical option available. Consumers should recognize the risks associated with consumption of raw, undercooked, and lightly processed (e.g. marinated, smoked) meat and fish, as well as the consumption of certain fruits and vegetables that may not be rendered safe simply by washing alone. Consumer advice should be provided on how to prepare foods (e.g. cooking times and temperatures) and on the importance of good hygiene (e.g. hand-washing) in order to avoid infection with foodborne parasites. Consumers should always make sure to separate raw foods from cooked food, and ready to eat fruit and vegetables to prevent cross-contamination while handling and preparing meals. The WHO *Five Keys to Safer Food* could assist in this process.¹³

Education is particularly important for consumers in endemic areas, and in high risk groups, such as those who are pregnant or immunocompromised (e.g. *Toxoplasma gondii* in pregnant women and immunocompromised groups; *Cryptosporidium* spp. in children, immunocompromised groups and older adults.) For such consumers, advice on the preparation and consumption of high-risk foods such as fresh produce, adequate cooking of meat and fish prior to consumption and the importance of hygiene, e.g. hand-washing, is critical. When people are diagnosed with an *Anisakis* spp. nematodes allergy, they should be advised to avoid eating marine fish.

SECTION 10 – TRAINING

Workers engaged in primary production, processing, preparation, retail or food service should be trained and/or instructed in the control of foodborne parasites (e.g. from good animal husbandry practices to hygiene and sanitation measures) to a level appropriate to the operations they are to perform. Particular attention should be paid to abattoir workers who may be performing post-mortem inspection procedures and food handlers of ready-to-eat foods.

10.2 Training programmes

Training programmes should contain information on the following, as appropriate to those being trained:

- The potential for food to be a vehicle of transmission of foodborne parasites if contaminated.
- The potential sources and routes of transmission of foodborne parasites.
- The potential for persistence of parasites in/on contaminated foods and food production settings.
- The need to comply with good animal husbandry practices and the importance of compliance with such practices, including:
 - the role of domestic and wild animals in the transmission of certain parasites;
 - the importance of on-farm sanitation and hygiene in interrupting the life cycle of parasites and minimizing the opportunity for faecal-oral transmission; and
 - the importance of animal feed management to avoid domestic and wild life parasite contamination.

¹³ WHO. 2006. Five Keys to Safer Food Manual. Available at: <http://www.who.int/foodsafety/publications/5keysmanual/en/>

- Proper hand washing practices and the importance of strict compliance with hand washing instructions at all times, particularly after being in contact with faecal matter. It is advisable to educate each new employee in the proper practices that are to be followed for hand-washing.
- The importance of adequate food processing and preparation to eliminate potential parasite risks.
- Task-specific practices to reduce or eliminate the risks of parasites in foods.

10.3 Instruction and supervision

Training and instructions should be given to all new personnel on the transmission and management of foodborne parasites.

Inspectors or other relevant authorities, who inspect fields, post-harvest processing plants, and food service facilities, should also be trained.

Periodic retraining of existing personnel should be given as refresher and to maintain competence level of all personnel.