Food and Agriculture Organization of the United Nations

World Health Organization

SUMMARY RISK PROFILES ON *TRICHINELLA* IN MEAT and ON *C. BOVIS* IN MEAT FROM DOMESTIC CATTLE

Acknowledgments

The work on the proposed Draft Guidelines for Control of *Trichinella spiralis* and *Cysticercus bovis* in meat (CX/FH11/43/6) required the preparation of two risk profiles to assist the Committee members. The Codex Committee for Food Hygiene (CCFH), during its 43rd Session, requested that FAO and WHO conduct a peer review of two summary risk profile documents, one for *Trichinella spp*. and a second one for *Cysticercus bovis.* The Committee considered that the information presented in the risk profiles was useful for other stakeholders, and had to be peer reviewed before making the risk profiles available to the public.

The Food and Agriculture Organization of the United Nations and the World Health Organization would like to express their appreciation to all those who contributed to the preparation of these risk profiles through their participation in the initial drafting, peer review process and the provision of their time, expertise, data and other relevant information.

Dr. Steve Hathaway	Co-chair of the CCFH working group on *Trichinella* spp. and *Taenia saginata/Cysticercus bovis* Director, Science and Risk Assessment , Standards, Ministry for Primary Industries - Manatū Ahu Matua, Wellington, New Zealand
Dr. Kris de Smet	Co-chair of the CCFH working group on *Trichinella* spp. and *Taenia saginata/Cysticercus bovis* European Commission, Head of Team Food and Feed Hygiene and Zoonoses Control, Health & Consumers Directorate General, Directorate G - Veterinary and International affairs, DDG2. G4 - Food, alert system and training Office B 232 - 03/010 - 1049 Brussels, Belgium
Dr. Pierre Dorny	Department of Biomedical Sciences, Head of the Veterinary Helminthology Unit, Institute of Tropical Medicine, Antwerp, Belgium
Dr. Alvin Gajadhar	President, International Commission on Trichinellosis (ICT), Research Scientist & Head, Centre for Foodborne & Animal Parasitology, OIE Reference Laboratory (Trichinellosis) & Collaborating Centre (Food-borne Zoonotic Parasites), Canadian Food Inspection Agency, Saskatoon, Saskatchewan S7N 2R3, Canada

Dr. Suleiman Haladu	Epidemiology Division, Department of Veterinary services, Ministry of Agriculture and Natural Resources, Kano State, Nigeria
Dr. Edoardo Pozio	Director, Unit of Gastroenteric and Tissue Parasitic Diseases, Department of Infectious, Parasitic and Immunomediated Diseases, Istituto Superiore di Sanita, Rome, Italy
Dr. Nicolas Praet	Department of Biomedical Sciences, Veterinary Helminthology Unit, Institute of Tropical Medicine, Antwerp, Belgium
Dr. Jaime Romero	Associate Professor, VPH and Veterinary Epidemiology and Economics, Faculty of Agricultural Sciences, Universidad de La Salle, Bogotá, Colombia
Dr. Brad Scandrett	Veterinary Diagnostic Parasitologist, Centre for Foodborne & Animal Parasitology, Canadian Food Inspection Agency (CFIA), Saskatoon, Saskatchewan S7N 2R3, Canada

Special appreciation is extended to Dr. Alvin Gajadhar and Dr. Brad Scandrett for their help on finalizing the summary risk profiles on *Trichinella* spp. and *Taenia saginata/Cysticercus bovis*.

A. SUMMARY RISK PROFILE ON *TRICHINELLA* IN MEAT

1. Hazard-food commodity of concern

Trichinellosis is a parasitic disease of humans caused by eating raw or inadequately treated meat from domestic or game animals infected by *Trichinella spp*. Infective first stage larvae live in muscle cells of a wide range of meat-eating mammals, and some birds and reptiles (OIE, 2012). Human trichinellosis contracted from commercial supplies of meat have been most often linked to infected pigs, wild boar, or horses. Human cases have been also linked to the consumption of infected meat from game animals including bears and walruses. The parasite is a nematode which has an atypical direct life cycle that does not involve stages developing outside of the host. Muscle larvae are released from infected meat in the stomach of suitable host species, develop to adult worms in the intestine, and produce pre-encapsulated larvae which migrate preferentially to certain muscle sites in the host to complete the life cycle within several weeks. Within the muscle cells the larvae of some *Trichinella* species are encapsulated in a thick collagen layer. Within the host muscle larvae remain infective for up to several years. All genotypes of *Trichinella* are pathogenic for humans, but in animals the infection appears clinically unapparent. Some animal species serve as reservoir hosts. Domestic pigs and rats have been reported to harbour *T. spiralis* within the domestic cycle mostly in temperate regions of the world (Dupouy-Camet, 2000). Wild carnivores and other meat-eating species such as wild boar and bears maintain the sylvatic *Trichinella* cycle which involves other species of *Trichinella.* Feeding behaviours such as predation, scavenging and cannibalism facilitate transmission. Encapsulated species of *Trichinella* infect only mammals, and include *T. spiralis* (T1), *T. nativa* (T2), *T. britovi* (T3), *T. murrelli* (T5), *T. nelsoni* (T7), and T6, T8, T9, T12 (OIE, 2012). The non-encapsulated species infect mammals as well as birds (*T. pseudospiralis*) or crocodiles (*T. papuae* and *T. zimbabwensis*). *Trichinella*'s geographical distribution and biological characteristics such as freeze tolerance and reproductive capacity for host species vary according to the species of parasite and host. Species which thrive in pigs and represent a potentially high level of food safety risk for consumers of pork and pork products include *T. spiralis*, *T. britovi*, *T. pseudospiralis*, *T. papuae*, and *T. zimbabwensis*. Historically, most outbreaks of human trichinellosis have been associated with *Trichinella*-infected swine (Murrell and Pozio, 2011, Dupouy-Camet, 2000). Regulations for the inspection and control of *Trichinella* have been applied in many countries for over a century. Consequently, in countries with effective inspection and regulatory systems, human trichinellosis from commercial meat is rare.

2. Description of the public health concern

It is estimated that approximately 11 million people are infected with *Trichinella* worldwide, with significant under-reporting likely in many parts of the world (Dupouy-Camet, 2000). A recent analysis of outbreak data reports 65,818 human cases from 41 countries worldwide from 1986-2009 (Murrell and Pozio, 2011). Even when mandatory testing for *Trichinella* is performed at slaughter, in some countries human outbreaks linked to imported meat or consumption of wild game have been reported. Although *Trichinella* has a global distribution, most species are geographically limited.

Trichinellosis in humans can be a debilitating, occasionally fatal, disease. Food safety experts extrapolate that ingestion of 100 larvae is sufficient to cause clinical disease. In early infection, the adult worms in the intestine can cause a transient gastroenteritis, but the most severe symptoms are associated with the migration and establishment of the larvae in muscle. These include periorbital and facial oedema, myalgia, fever, conjunctivitis, photophobia, and skin rash. Myocarditis, endocarditis, encephalitis and meningitis have been observed in severe cases with poor prognoses. Most symptoms diminish approximately 1-2 months post-infection, but chronic myalgia and fatigue can persist. In addition to supportive therapy, anthelmintics are most effective for treatment of infection involving pre-muscle

stages (Kociecka, 2000). However, most infected patients are not diagnosed until two or more weeks after exposure, when larvae have already become established in the muscles, where drug bioavailability may be limited.

3. Food production, processing, distribution and consumption

Important risk factors for farmed swine and other susceptible livestock include feeding of infected food waste, and exposure to swine carcasses, rats and other wildlife species (OIE, 2012). Mitigation of these risks in free-range pasturing and back-yard rearing practices can be challenging. Education, regulations and compliance to prevent access to infected food waste, carcasses, rats and wild animals and birds can be effective. Standard biosecurity measures implemented in modern swine production facilitate the certification of *Trichinella*–free farms and herds in non-endemic areas (Pyburn et al., 2005). Serological testing of pre-or post-mortem samples for *Trichinella* can be a valuable tool for surveillance programmes and disease outbreak investigations at the herd or population level, but cannot reliably determine individual animal status for food safety purposes , as recommended by the OIE (OIE, 2012).
Artificial digestion incorporating adequate quality assurance is currently the only method recommended for food safety purposes (OIE, 2012). This method is capable of testing up to 100 g of pooled meat samples with a detection sensitivity of ≥ 1 larva per gram (lpg) for individual samples ≥ 3g. An infection intensity of 1 lpg is considered sufficient to cause clinical disease in humans (Gajadhar et al, 2009). Sensitivity of the digestion assay is enhanced when samples from sites of predilection are tested. Although these vary according to host species, tongue and diaphragm are often amongst the preferred sites. Trichinoscopy, another direct method based on the detection of larvae in-situ in grain-size meat samples compressed between 2 glass plates and observed under magnification is less sensitive than digestion, and is not recommended for reliable testing (OIE, 2012).
Three treatment methods have been shown to reliably inactivate *Trichinella* larvae in meat, namely cooking and irradiation, and freezing for some *Trichinella* genotypes.
Heat treatment is a suitable method for killing *T. spiralis* in meat from domestic swine. Different time/temperature/meat thickness combinations can be applied to infected pork to ensure destruction of the parasite. The thermal death point for *T. spiralis* is 54-57 °C. Data related to other host species and *Trichinella* genotypes are not available. However, it is likely that thorough cooking will effectively inactivate all *Trichinella*, and so is currently the most widely recommended method to ensure food safety. No curing or smoking processes are recommended to reliably inactivate *Trichinella* larvae in pork, horse, or game meat (Gamble et al., 2000).
Freezing, at -15°C for no less than 3 weeks for meat up to 15 cm thickness and for no less than 4 weeks for meat up to 50 cm thickness, can kill *T. spiralis* in pig meat. However, other *Trichinella* genotypes, such as *T. nativa, T. murrelli* and *T. britovi* occurring in game, horses, etc. are freeze tolerant (OIE, 2012). It is therefore recommended that meat from game or other potential hosts of these genotypes be thoroughly cooked to mitigate risk of infection for consumers. Irradiation, where permitted, can also be an acceptable method for rendering meat safe for human consumption, since levels of at least 0.3 kGy have been proven to inactivate *Trichinella*.

4. International trade

The movement of domestic pigs and farmed wild boar represents a significant risk for the control of *Trichinella* and trichinellosis in the domestic cycle. Commercial movements of these animals and their meat and meat products have been implicated in the spread of the parasite to farms and countries. The amount of such meat involved in international trade is enormous, where the largest exporters of pig meat are USA, Denmark, Belgium and Germany (FAO, 2013a). Globally, over 5 million tonnes of pork and 140,000 tonnes of horsemeat were exported in 2011 (FAO, 2013b). Guidelines and control recommendations to reduce the risk of *Trichinella* in food animals and their products exist

(FAO/WHO/OIE, 2007). Nonetheless, meat and meat products from susceptible host species such as pigs and horses continue to be a potential source of infection for consumers.

References

Dupouy-Camet J. 2000. Trichinellosis: a worldwide zoonosis. Veterinary Parasitology 93: 191-200.

FAO. 2013a. FAO Statistical Yearbook 2013. World food and agriculture. http://www.fao.org/economic/ess/ess-publications/ess-yearbook/en/

FAO. 2013b. FAOSTAT statistical database. http://faostat.fao.org/

FAO/WHO/OIE. 2007. Guidelines for the surveillance, management, prevention and control of Trichinellosis.

Gajadhar AA, Pozio E, Gamble HR, Nockler K, Maddox-Hyttel C, Forbes LB, Vallee I, Rossi P, Marinculic A, Boireau P. 2009. *Trichinella* diagnostics and control: Mandatory and best practices for ensuring food safety. Veterinary Parasitology 159: 197-205.

Gamble HR, Bessonov AS, Cuperlovic K. Gajadhar AA, van Knapen R, Nockler K, Schenone H, Zhu X. 2000. International Commission on Trichinellosis: Recommendations on methods for the control of Trichinella in domestic and wild animals intended for human consumption. Veterinary Parasitology 93: 393-408.

Kociecka W. 2000.Trichinellosis: human disease, diagnosis and treatment. Veterinary Parasitology 93:365-83.

Murell, KD, Pozio E. 2011. Worldwide occurrence and impact of human Trichinellosis, 1986-2009. Emerging Infectious Diseases 17(12):2194-2202.

OIE. 2012. Terrestrial Manual of Diagnostic Tests and Vaccines. Chapter 2.1.16. Trichinellosis.

Pyburn DG, Gamble HR, Wagstrom EA, Anderson LA, Miller LE. 2005. Trichinae certification in the United States pork industry. Veterinary Parasitology 132:179-83.