

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 walrus. 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 ≥ 3 g. 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

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