

# Parasites associated with pork and pork products

H.R. Gamble

United States Department of Agriculture, Agricultural Research Service, Parasite Biology and Epidemiology Laboratory, Building 1040, BARC-East, Beltsville, Maryland 20705, United States of America

## Summary

Three parasites pose a public health risk from the ingestion of raw or undercooked pork, namely: *Trichinella spiralis*, *Taenia solium* and *Toxoplasma gondii*. Inspection procedures, when practised according to prescribed methods, are effective in eliminating the majority of risks from *T. spiralis* and *T. solium*. No suitable methods for the post-slaughter detection of *T. gondii* are available. All three parasites are inactivated by various methods of cooking, freezing and curing; some information is also available on inactivation by irradiation. Good production practices, including a high level of sanitation, rodent and cat control on farms, can prevent opportunities for exposure of pigs to these parasites. Alternatively, meat inspection, proper commercial processing and adherence to guidelines for in-home preparation of meat are effective methods for reduction of risks for human exposure.

## Keywords

Cooking – Curing – Freezing – Meat inspection – Public health – *Taenia solium* – *Toxoplasma gondii* – *Trichinella spiralis* – Zoonotic parasites.

## Introduction

There are three important parasites found in pigs which pose a risk to humans who ingest raw or undercooked pork products. These parasites are *Trichinella spiralis*, a nematode or roundworm, *Taenia solium*, a tapeworm, and *Toxoplasma gondii*, a protozoan or single-celled organism. All three parasites have a world-wide distribution.

## *Trichinella spiralis*

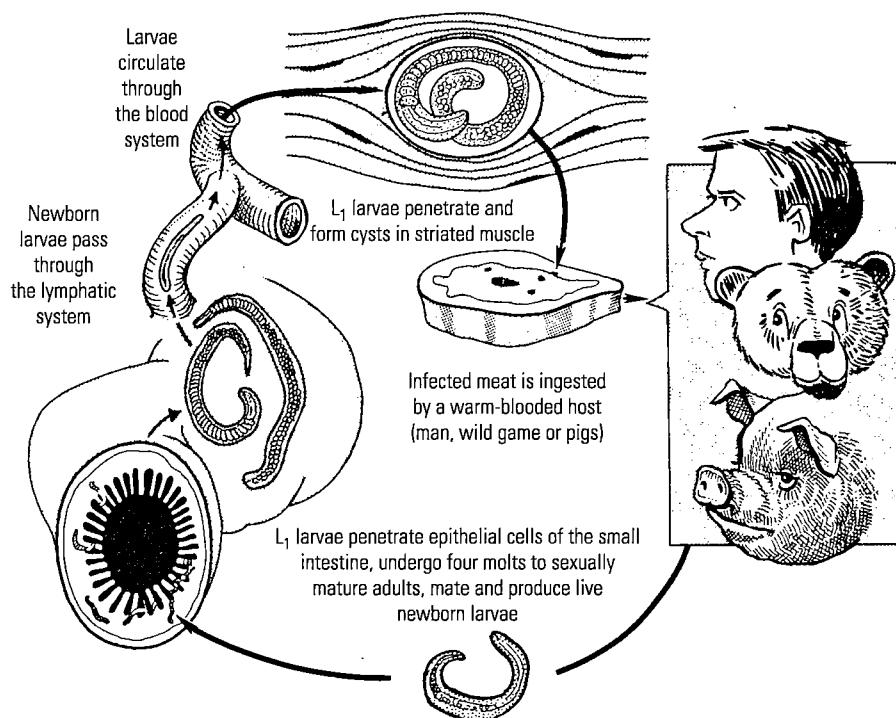
The nematode *T. spiralis* has a long-standing association with pork products. The understanding which many people have about the need to cook pork thoroughly is based on the risk of becoming infected with this parasite. Details of the life-cycle of the parasite are presented in Figure 1.

## Epidemiology

*Trichinella* spp. are found in virtually all warm-blooded carnivores. In addition to the species found in the domestic pig (*Trichinella spiralis* or T-1), several other species (*T. nativa* or T-2, *T. britovi* or T-3 and *T. pseudospiralis* or T-4) and types (T-5, T-6, T-7, T-8) are found in wildlife (38). The importance of wildlife species is related to the ability of the nematode to be introduced into, and infect, domestic swine.

Several studies have shown variable infectivity for pigs for the more common wildlife species/types of *Trichinella*, including T-3, T-5, T-6 and T-7. The Arctic type, *T. nativa* or T-2, is essentially non-infective for the domestic pig.

Transmission of trichinellosis in the sylvatic cycle relies on predation and carrion feeding. Prevalence rates among carnivores are generally thought to increase along the food chain. However, prevalence rates among wildlife have been reported only sporadically. Prevalence in swine varies from country to country and regionally within countries (21). The lowest prevalence rates in domestic swine are found in countries where meat inspection programmes have been in place for many years (including countries of the European Union [EU], notably Denmark and the Netherlands); these countries have reported freedom from trichinellosis in domestic swine. In countries of Eastern Europe, higher prevalence rates have been reported and are supported by significant numbers of cases of human trichinellosis. In the United States of America (USA), the prevalence in pigs was determined to be 0.12% in 1970, but has probably declined substantially since then (53). Sporadic information is available on the prevalence of trichinellosis in pigs in South America, Africa and Asia. Human infections resulting from the ingestion of pork vary from zero in some of the northern and western European countries to hundreds or thousands annually in eastern European and Asian countries (4). The



**Fig. 1**  
**Life-cycle and transmission patterns of *Trichinella spiralis***  
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current rates of human infection in the USA are about 25 cases each year (1991-1996), with only a portion of these infections attributable to pigs (5).

Exposure of domestic swine to *Trichinella* spp. is limited to a few possibilities including feeding of animal waste products contaminated with parasites, exposure to rodents or other wildlife infected with trichinae, or cannibalism within an infected herd. The use of good production and management practices for swine husbandry will preclude most risks for exposure to trichinae in the environment.

## Control

Prevention of human exposure to infected pork products is accomplished in a variety of ways. In many countries, inspection programmes are implemented at slaughter for the detection of trichinellosis in pigs. Inspection methods include direct and indirect serological tests. Where fresh pork is not tested, alternative methods are used to prevent exposure of humans to potentially contaminated products. These include processing methods such as cooking, freezing and curing, along with recommendations to the consumer concerning requirements for thorough cooking. Use of these processes will render pork free from infective *T. spiralis* larvae.

## Slaughter inspection

Many countries have approved methods for post-mortem inspection of pork for trichinae. Since trichinae cysts within

the tissue cannot be seen by macroscopic examination, one of several possible laboratory tests must be performed.

The oldest method, and one still frequently used, is the compression method. Small pieces of pork collected from the pillars (crus muscle) of the diaphragm, or alternative sites, are compressed between two thick glass slides (a compressorium) and examined microscopically. A minimum of one gram should be examined. In practice, the compression method, using the trichinoscope, has an approximate sensitivity of > 5 larvae per gram of tissue (2).

An improvement for direct testing of pork for trichinae is provided by the digestion methods. Samples of tissue collected from sites of parasite predilection are subjected to digestion in acidified pepsin. Larvae, freed from their muscle cell capsules, are recovered by a series of sedimentation steps, then visualised and enumerated under a microscope.

Requirements for performing the digestion test are found in the Directives of the European Economic Community (EEC) (17, 18), in the United States Department of Agriculture (USDA) Code of Federal Regulations (47), in the Office International des Epizooties (OIE) *Manual of Standards* (22) and various other publications.

Post-slaughter samples are taken from the pillars (crus muscle) of the diaphragm or alternative sites including the

tongue, neck, intercostals or psoas. In pigs, the diaphragm and tongue accumulate considerably higher numbers of larvae in comparison to other tissues (19). Sample sizes may be one gram (as required by the EU), five grams (as specified in the USA) or larger to increase sensitivity. Sensitivity of the method using a one gram sample is approximately three larvae per gram (LPG) of tissue (21), while sensitivity using a five gram sample is one LPG or less.

In interpreting the results of direct methods for the detection of trichinae in pork, the following should be considered. Using the most common methods of inspection testing, the sensitivity of the compression method is approximately 5 LPG, while the sensitivity of the digestion method is approximately 3 LPG. These levels of detection are considered effective for identifying swine which pose a significant public health risk (it is generally considered that infections > 1 LPG are a public health risk).

Epidemiological studies have shown that the majority of infections in domestic pigs are well below these levels of detection (< 1 LPG). The disparity between reported clinical cases of human trichinellosis and true prevalence in the human population based on post-mortem surveys suggests that there are large numbers of humans with subclinical or undiagnosed infections (35). It is highly likely that low level pig infections, not detected even when inspection programmes are in place, are responsible for many of these human infections.

An alternative method of testing pigs for trichinellosis is the detection of antibodies to the parasites in serum samples. The enzyme-linked immunosorbent assay (ELISA) test has been used extensively for testing in both pre- and post-slaughter applications (20). Based on the use of an excretory-secretory antigen collected from short-term *in vitro* cultivation of *T. spiralis*, the ELISA has proved to be highly sensitive and specific; no known cross-reactions occur using this test. Since the ELISA is not in widespread use for the detection of trichinellosis in swine at slaughter, the reader is referred to the OIE Manual (22) for specific methodologies involving this test. The use of ELISA for monitoring trichinae-free production practices is discussed below in the section entitled 'Prevention'.

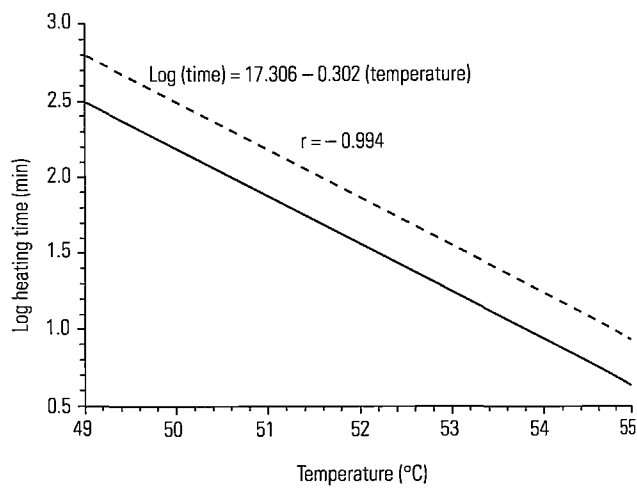
Processing

Specific parameters exist for the inactivation of trichinae in pork products and these may be seen in depth elsewhere (47). The following discussion is intended to provide a general overview of processing requirements.

Cooking

Commercial preparation of pork products by cooking requires that meat be cooked to internal temperatures which have been shown to inactivate trichinae (Fig. 2). Using these and other data, *T. spiralis* has been shown to be killed in 47 min at 52°C, in 6 min at 55°C and in less than a minute at

60°C (27). These times and temperatures apply only when the product reaches and maintains temperatures evenly distributed throughout the meat. Alternative methods of heating, particularly the use of microwaves, have been shown to give different results: parasites were not completely inactivated when the product was heated to reach a prescribed end-point temperature (26). The USDA Code of Federal Regulations for processed pork products reflects these data (26, 27), requiring pork to be cooked for 2 h at 52.2°C, for 15 min at 55.6°C, and for 1 min at 60°C.



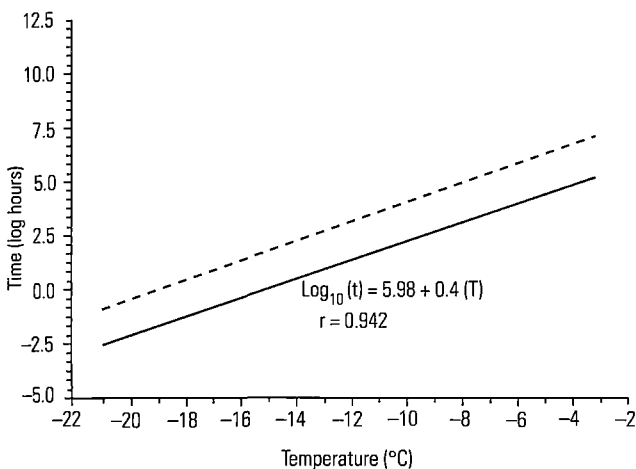
**Fig. 2**  
**Linear regression (solid line) and the 99% upper confidence limits (dashed line) of the cooking time required at each temperature for the inactivation of *Trichinella spiralis* larvae**  
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The USDA recommends that consumers of fresh pork cook the product to an internal temperature of 77°C. Although considerably higher than temperatures at which trichinae are killed (60°C), this temperature allows for different methods of cooking which do not always result in even distribution of temperature throughout the meat.

No information is available on possible differential susceptibility of the different species types of *Trichinella* to heating.

Freezing

Thermal death curves have also been generated for the effect of cold temperatures on the viability of *T. spiralis* in pork (28). Based on the data, the predicted times required to kill trichinae were 8 min at -20°C, 64 min at -15°C, and 4 days at -10°C (Fig. 3). Trichinae were killed instantaneously at -23.3°C. The USDA Code of Federal Regulations requires that pork intended for use in processed products be frozen at -17.8°C for 106 h, at -20.6°C for 82 h, at -23.3°C for 63 h, at -26.1°C for 48 h, at -28.9°C for 35 h, at -31.7°C for 22 h, at -34.5°C for 8 h or at -37.2°C for 0.5 h (47). These extended times take into account the amount of time required for temperature to equalise within the meat along with a



**Fig. 3**  
**Linear regression (solid line), actual data points and the 99% upper confidence limits (dashed line) of the freezing time (log<sub>10</sub>) required at each temperature (–22°C to –2°C) for the inactivation of *Trichinella spiralis* larvae**  
In the regression equation, t = required inactivation time and T = temperature in degrees Celsius  
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margin of safety. It should be noted that other species and types of *Trichinella* are not susceptible to freezing in the same manner as *T. spiralis*. Both *T. nativa* (T-2) and T-6 can survive normal freezing temperatures and remain infective. Several outbreaks of human trichinellosis resulting from freeze-resistant types have been reported (16, 33).

Curing

The multitude of processes used to prepare cured pork products (sausages, hams, pork shoulder and other ready-to-eat products) complicates discussion of standard requirements for inactivation of trichinae. In the curing process, the product is coated or injected with a salt mixture and allowed to equalise at refrigerated temperatures. The product is then dried or smoked and dried at various temperature/time combinations which have been shown to inactivate trichinae (30, 31). Unfortunately, no single or even combination of parameters achieved by curing has been shown to correlate definitively with trichinae inactivation. All cured products should conform in process to one of many published regulations, such as that of the USDA Code of Federal Regulations (47). Products not produced in accordance with approved regulations should be subjected to testing by the manufacturer prior to sale to the consumer.

Irradiation

Treatment of fresh pork with 30 kilorad of cesium-137 renders trichinae completely non-infective (3).

Prevention

The most logical place to control trichinae is to ensure that infection is prevented at the farm level. Prevention of infection requires implementation of good farming practices which

prohibit feeding of animal products which have not been subjected to proper cooking and ensure that good security systems are used to prevent exposure to rodents or other potentially infected mammals. Production practices which are free from or have minimal risk of exposure to trichinae should be monitored periodically (by serology or sampling of slaughtered animals) to verify the absence of infection.

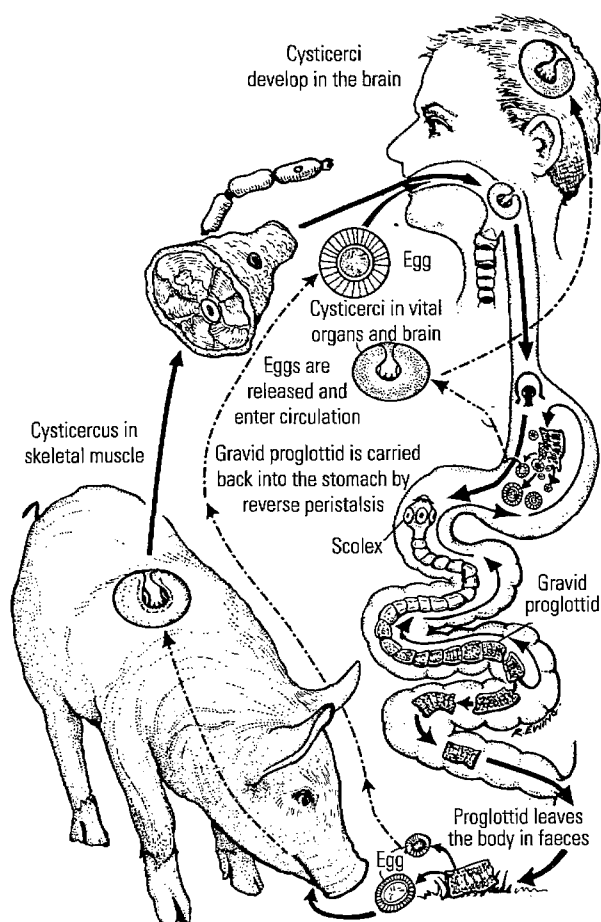
Taenia solium (cysticercosis)

*Taenia solium* infection in pigs and *T. saginata* infection in cattle pose a risk to man of taeniasis, an intestinal tapeworm infection. This disease results from ingestion of intermediate larval stages (cysticerci) found in muscle tissue of pigs and cattle. Adult tapeworms in the intestine can be treated and are seldom life-threatening. Human cysticercosis is caused by accidental ingestion of *T. solium* eggs, from infected persons or in contaminated water or soil, and the subsequent development of cysticerci in the muscle and other tissues. Cysticerci in the brain can induce seizures and related symptoms as a result of mechanical damage to tissues caused by cysticerci, inflammatory reactions to the infection and secondary effects such as fibrosis (37). Reduction in the risk of human cysticercosis is directly related to the reduction in infection of humans with the adult tapeworm acquired from ingestion of infected pork. Details of the life-cycle of *T. solium* are given in Figure 4.

Epidemiology

Areas in which *T. solium* tapeworm infection and cysticercosis in humans are endemic include Central and South America, Eastern Europe, Central and Southern Africa, India and South-East Asia (39). The cycle of infection is perpetuated by sanitary conditions which allow pigs to be exposed to human waste, along with inadequate methods for preparing and cooking pork. Migration of infected tapeworm carriers has resulted in the spread of human neural cysticercosis into areas where the disease is not considered endemic in the swine population (e.g., cases dispersed throughout the USA).

Prevalence rates in pigs have been determined to be 1.1%-2.6% in Central and South America (23, 37, 43, 44) and as high as 24.6% in parts of Africa (34). Infection rates vary regionally with a range of pig infections from 0.005% to 10% in Mexico (42). Under-reporting of swine cysticercosis probably results from the fact that a high percentage of pigs, particularly those prone to exposure to *Taenia*, are not slaughtered through official channels. The distribution of human cysticercosis mirrors infection rates found in swine; for example, 0.5%-2.4% of patients tested serologically gave positive results in studies conducted in Africa (37). A high rate of infection in the USA (> 100 cases a year) has been reported recently, as a result of the immigration of infected individuals from endemic areas (40). Detection of human cysticercosis has been improved greatly by the use of modern technology,



**Fig. 4**  
**Life-cycle and transmission patterns of *Taenia solium***  
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including computer-assisted tomography and magnetic resonance imaging; use of these methods accounts, in part, for the increase in numbers of human cases diagnosed in recent years.

## Control

### Slaughter testing

Most countries require some form of inspection of swine carcasses at slaughter for the presence of cysticerci. If cysticerci are found, carcasses may be condemned or are passed for cooking. Methods of inspection vary from visual to invasive and are dependent, in part, on the relative prevalence of the parasite. Some authors suggest that, unlike beef cysticercosis, there are few light infections with *T. solium* (25), so visual inspection of the tongue (a predilection site) and other exposed and cut surfaces is sufficient. Other authors believe that most infections are missed by traditional detection methods (42, 49). In one direct comparison, 75% of carcasses which gave positive results by extensive necropsy were also detected by visual examination and palpation of the tongue (23). In some countries, an incision in the region of the triceps muscle is also performed as part of the inspection for cysticerci. Observations suggesting the presence of cysticerci

should be confirmed by additional cuts of the carcass to verify the presence and extent of infection.

## Processing

Relatively little information is available on the inactivation of *T. solium* cysticerci in pork, but some data on the effects of cooking and freezing on *T. saginata* may be relevant.

## Cooking

Heating to a temperature of 56°C will inactivate cysticerci in beef (1, 25). This temperature is considerably lower than that required for processing or home cooking to protect against trichinae. Thus processing by heating should render meat safe from infection with *T. solium* cysticerci.

## Freezing

Time and temperature combinations which kill cysticerci in beef include -5°C for 15 days, -10°C for 9 days and -15°C for 6 days (24). Shorter freezing times have been demonstrated to be effective for *T. solium* cysticerci held at -15°C for 75 min or -18°C for 30 min (41). Many countries require that carcasses found to contain cysticerci be frozen at -10°C for 14 days to kill cysts.

## Curing

No conclusive information is available on curing methods which inactivate cysticerci of *T. solium*.

## Irradiation

Treatment of *T. solium* cysticerci with doses of 20-60 kilorad did not prevent evagination or partial development of tapeworms (48). Tapeworms appear to be much less sensitive to ionising radiation than *Trichinella* or *Toxoplasma*. Therefore this is not a viable alternative for control of cysticercosis in pork.

## Prevention

Prevention of infection in swine is strictly a sanitation issue. The only mechanism whereby pigs can become infected is through the introduction of eggs passed by humans carrying the adult tapeworm. Direct introduction of human faeces into pig breeding areas or the introduction of contaminated water or soil are the most common sources for pigs to become infected. Control of infection in pigs in endemic areas should be approached in two ways. Firstly, a programme for the elimination of tapeworm carriers should be employed to reduce the risks of environmental contamination. Secondly, pig-rearing facilities should be located and constructed so as to minimise incidental contamination; workers should be instructed in proper sanitation with respect to pig facilities. In developed countries, modern pig facilities pose little risk of exposure to infection with *T. solium* cysticerci.

# *Toxoplasma gondii*

The protozoan parasite *Toxoplasma gondii* has been associated with cats as the main source of infection to humans for many years. Recent evidence suggests that a high prevalence rate in pigs infers that raw or undercooked meat is a significant source of infection. In many countries, the human population is infected at a rate of 40% or more. *Toxoplasma* poses a significant public health risk to pregnant women (being a cause of birth defects in congenitally infected fetuses) and to immunodepressed or immunocompromised individuals, both resulting from acute or chronic/latent infections. The life-cycle and transmission patterns of *T. gondii* are given in Figure 5. Sporulation in the environment takes at least 24 hours, depending on temperature, and is necessary for oocysts to become infective for the next host (Fig. 5). Transplacental transmission is an important mode of infection in humans, pigs, sheep and goats.

## Epidemiology

Human infection with *T. gondii* is relatively high compared to most other diseases. Serological surveys, summarised by Dubey and Beattie (10) report rates of up to 100% of the population infected in many countries where testing had been conducted. In the USA, surveys suggest that approximately 30% of the general population is infected or has been exposed to infection (8), while prevalence in a younger population

(military recruits) declined from 14.9% in 1962 to 9.9% in 1989 (46); prevalence rates in France are reported to range from 42%-84% of the population (10). Using the tools currently available, the source of infection for humans cannot be determined between exposure to oocysts in the environment or ingestion of contaminated and undercooked meat. However, the assumption that infection in food animals does play a significant role in the transmission of toxoplasmosis to humans is reasonable.

Most species of livestock, including sheep, goats and pigs, are infected with *T. gondii*. Prevalence rates vary in pigs as in humans (6), but generally exceed 10%-20% in most countries. Infection rates are higher in breeding populations than in market pigs, reflecting that time of exposure is a factor in acquiring toxoplasmosis. In the USA, the level of toxoplasmosis was estimated at 23.9% of pigs in 1983-1984 with higher rates in breeders (42%) than in market pigs (23%) (7, 12). When pigs from these areas were tested in 1992, the rate was reduced to 20.8% of breeders and 3.1% of finisher pigs (50). These results suggest that the incidence of toxoplasmosis is declining in confinement reared pigs due to a reduction in risk factors.

Transmission of toxoplasmosis to pigs on the farm occurs by various means. Risk factors for infection by exposure to tissue cysts are virtually identical to risk factors for exposure to

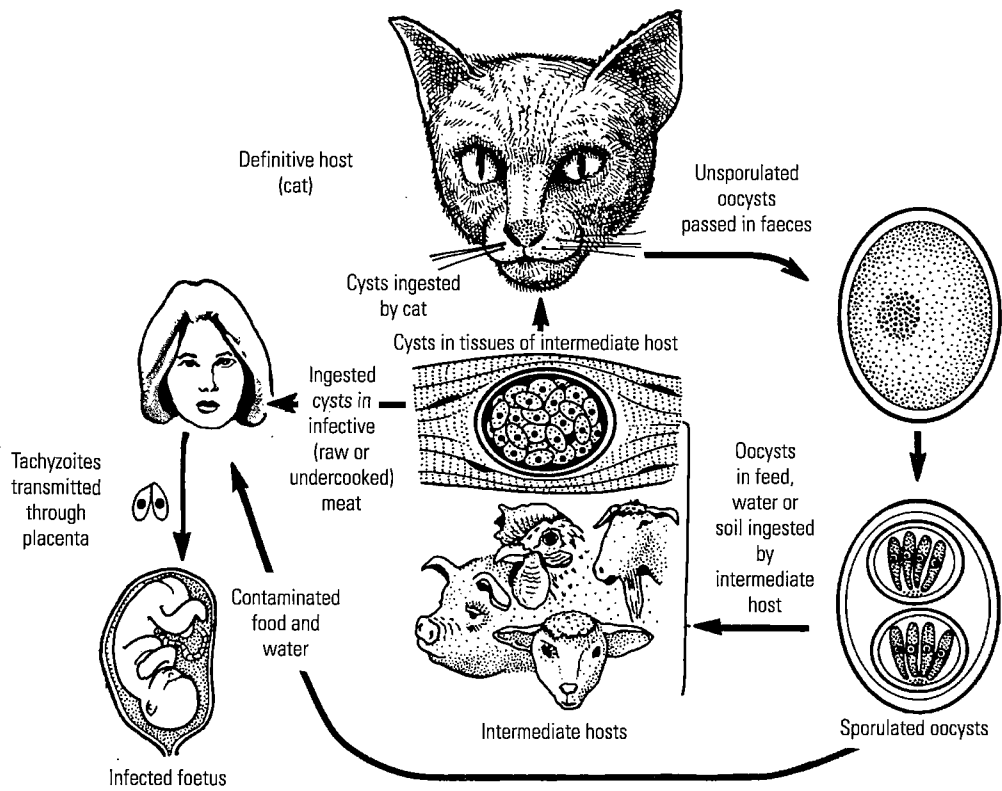


Fig. 5  
Life-cycle and transmission patterns of *Toxoplasma gondii*  
Reprinted with permission of J.P. Dubey (8)

trichinae. These include exposure to live or dead rodents and other wildlife (45), as well as deliberate or inadvertent feeding of raw or undercooked meat scraps containing infective stages. Unlike trichinae, toxoplasmosis can also be acquired from the environmentally resistant oocyst stage, which is shed by cats. Oocysts can be found virtually anywhere, including in pig feed (14) and pig barns where cats are resident.

## Control

### Slaughter testing

There are no programmes for the pre-harvest inspection of pigs for toxoplasmosis. The presence of tissue cysts cannot be detected by visual means since the cysts are microscopic. Methods for testing pigs include serology and bioassay; however, neither of these methods is currently used for inspection purposes. Serological assays include various forms of agglutination tests and ELISA. The most sensitive and specific test method has been shown to be the modified agglutination test using preserved whole tachyzoites (14). However, this test is not suitable for use in the slaughterhouse or for field use by veterinary personnel. The availability of an ELISA with the same levels of sensitivity and specificity would allow wider use of toxoplasmosis testing. The most definitive method for the detection of *T. gondii* infection is bioassay, in which portions of tissue are inoculated into mice or cats. This procedure requires several weeks to determine the presence of parasites and thus is not suitable for testing slaughtered animals.

### Processing

As no regulations require that pork be inspected for toxoplasmosis, no further processing is required to inactivate the parasite. However, methods already used for the processing of pork to destroy trichinae may be effective for the inactivation of *T. gondii* as well. The following discussion summarises findings relative to inactivation of *Toxoplasma* by processing methods.

### Cooking

Data show that *T. gondii* is killed in 336 s at 49°C, in 44 s at 55°C, and in 6 s at 61°C (11) (Fig. 6). These times and temperatures apply only when the product reaches and maintains temperatures which are distributed evenly throughout the meat. The temperatures reported to be necessary to eliminate *T. gondii* are lower than those required for *T. spiralis*. Thus methods prescribed for the destruction of trichinae are effective for the destruction of *Toxoplasma* as well. The use of microwaves is not effective in killing *Toxoplasma*, probably as a result of uneven heating, as described for trichinae (32).

### Freezing

Thermal death curves have also been generated for the effect of cold temperatures on the viability of *T. gondii* in pork (29). Tissue cysts remained viable at temperatures slightly below freezing (11.2 days at -6.7°C and 22.4 days at -3.9°C and -1.0°C), but parasites were inactivated virtually

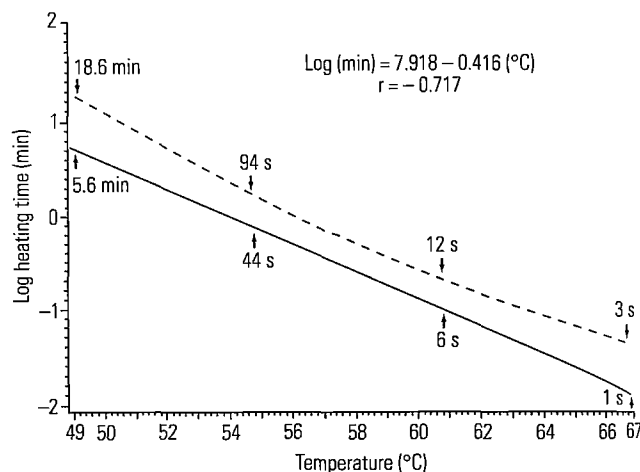


Fig. 6

Linear regression (solid line) and the 99% upper confidence limits (dashed line) of the cooking time required at each temperature for the inactivation of *Toxoplasma gondii*

Three and a half minutes representing the come-up and come-down times must be added to the times obtained from the equation on the curves  
Reprinted with permission of J.P. Dubey *et al.* (11)

instantaneously at temperatures of -9.4°C and lower (Fig. 7). Based on this data, the predicted times required to kill *Toxoplasma* are not as long as those required to kill trichinae and thus, processing times prescribed to kill trichinae in pork will also be effective for *Toxoplasma*. There is no evidence that strains of *Toxoplasma* differ in regard to susceptibility to freezing.

### Curing

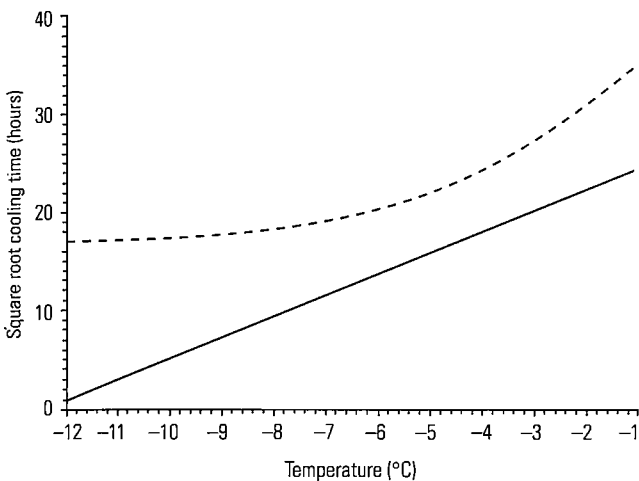
Insufficient studies have been conducted to state the effectiveness of curing methods for the destruction of *T. gondii* in pork and pork products.

### Irradiation

Treatment of *T. gondii* tissue cysts with 40-50 kilorad of cesium-137 has been shown to render the cysts non-infective (9, 13). These results suggest that *Toxoplasma* is somewhat less radio-sensitive than *Trichinella*. Other workers (52) have conducted studies which suggest that some isolates of *Toxoplasma* require even higher levels of radiation (60-70 kilorad) to ensure inactivation.

### Prevention

Prevention of infection in swine is linked to good production practices on the farm. If such practices are used, pigs can be raised free from toxoplasmosis. This is accomplished by adopting the practices for controlling exposure to trichinae, together with additional efforts to eliminate the exposure of pigs to the oocysts produced by cats. The contribution of cats to the spread of toxoplasmosis in pigs cannot be over-emphasised. In studies of prevalence of exposure to *T. gondii* in farm cats, seropositive rates were found to range from 41.9%-70.7% (15, 44). Although cats only shed oocysts for one week, 1.8% of cats tested in one study were found to be



**Fig. 7**  
The least squares linear regression of freezing times and temperatures for the inactivation of *Toxoplasma gondii* (solid line) expressed by the equation: square root of time (h) = 26.72 + 16 (°C), with  $r = 0.77$  and the 99% upper confidence interval for individual values (dashed line)  
Reprinted with permission of A.W. Kotula *et al.* (29)

shedding oocysts actively (15). Of greater importance is the finding of viable oocysts in soil and feed samples from these farms. Risk analysis of management factors associated with positive serological test results in pigs showed correlation of infection with the presence of infected juvenile cats (sources of oocysts) and with the presence of *T. gondii*-infected house mice (51). Thus, a high level of biosecurity and good production practices which take into account the possible sources of environmental and feed contamination are necessary to ensure the raising of pigs free from toxoplasmosis.

## Conclusion: sanitary recommendations

### Trichinellosis

- a) Uninspected fresh pork should be considered to pose a public health risk due to trichinellosis. The consumer should cook this product to reach an internal temperature of 77°C or until all red or pink patches have disappeared from the meat.
- b) Pork inspected using a one gram sample size in the pooled sample digestion test can be assumed to be free of trichinae or to harbour worm burdens below three larvae per gram (the test sensitivity).
- c) Pork inspected using a five gram sample size in the pooled sample digestion test can be assumed to be free of trichinae or to harbour worm burdens below one larva per gram (the test sensitivity).

d) Pork processed by methods of cooking, freezing or curing proven to be effective for the inactivation of trichinae can be considered safe for consumption without further preparation.

e) Pork from pigs raised under conditions which are free of risks for the transmission of trichinae and which are monitored using a statistically valid method, or pigs reared in an area, region or country which has been shown to be free of trichinae in domestic pigs in accordance with guidelines set forth in the OIE *International Animal Health Code* (Article 3.5.3.) may be considered safe for consumption with respect to trichinae (36).

### Taeniasis/cysticercosis

a) Uninspected pork products, and especially those from countries in which cysticercosis is endemic, should be cooked thoroughly in accordance with temperatures recommended for the inactivation of trichinae, or, if known to be trichinae free, cooked to a minimum of 60°C (for killing *Toxoplasma*). These temperatures will also kill cysticerci.

b) Fresh pork which has been inspected by visual or invasive inspection methods will have a lower risk of being infected; however, inspection methods are only partially effective in identifying carcasses with cysticerci. Therefore, even inspected carcasses should be prepared properly by the consumer.

c) Processing methods proved effective for killing cysticerci (cooking, freezing and curing) should render meat safe for consumption without further treatment.

### Toxoplasmosis

a) All pork is potentially infected with *T. gondii*. Therefore, fresh pork should be cooked to a temperature which will inactivate the parasite. For countries in which trichinae are endemic or possibly endemic, cooking to 77°C to inactivate trichinae will be sufficient to destroy *Toxoplasma* as well. Alternatively, cooking to > 60°C will kill *T. gondii* almost immediately. Consumers and public health officials should consider variations in cooking and should allow a margin of safety in preparing meat at home.

b) Methods for the commercial cooking and freezing of pork should conform to those times and temperatures which have been shown to effectively kill tissue stages of this parasite. For cured products, methods of processing require further study.

c) There are currently no programmes which ensure that pigs are raised free of infection with *Toxoplasma*. The feasibility of raising toxoplasmosis-free pigs requires further study.

# Parasites associés à la viande de porc et aux produits dérivés

H.R. Gamble

## Résumé

Trois parasites présentent un risque pour la santé publique en cas de consommation de viande de porc crue ou mal cuite : *Trichinella spiralis*, *Taenia solium* et *Toxoplasma gondii*. L'inspection vétérinaire, lorsqu'elle est effectuée conformément aux méthodes prescrites, permet d'éliminer la plupart des risques liés à *T. spiralis* et à *T. solium*. En revanche, il n'existe aucune méthode efficace pour détecter *T. gondii* après l'abattage. Ces trois parasites sont neutralisés par différents procédés de cuisson, réfrigération et salaison ; l'auteur décrit également la méthode d'inactivation par irradiation. Les bonnes pratiques de production, dont une hygiène rigoureuse et la lutte contre les rongeurs et les chats dans les élevages, peuvent également éviter l'exposition des porcins à ces parasites. L'inspection des viandes, des procédures de transformation contrôlées et le respect des principes élémentaires de cuisson et d'hygiène par le consommateur constituent également des méthodes efficaces de réduction des risques pour l'homme.

## Mots-clés

Congélation – Cuisson – Inspection des viandes – Parasites agents de zoonoses – Salaison – Santé publique – *Taenia solium* – *Toxoplasma gondii* – *Trichinella spiralis*.

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# Parásitos asociados a la carne de cerdo y los embutidos

H.R. Gamble

## Resumen

La ingestión de carne de cerdo cruda o insuficientemente cocida conlleva un riesgo de salud pública, ligado a la posible presencia de tres parásitos: *Trichinella spiralis*, *Taenia solium* y *Toxoplasma gondii*. Si se aplican los métodos prescritos, la inspección basta para eliminar la mayoría de riesgos derivados de *T. spiralis* y *T. solium*. No existen, sin embargo, métodos para la detección de *T. gondii* después del sacrificio. Los tres parásitos pueden ser inactivados por diversos métodos de cocción, congelado o curado, y alguna información existe también sobre la inactivación por irradiación. Las buenas prácticas de producción, entre ellas una higiene cuidadosa y el control de la presencia de gatos y roedores en las granjas, reducen las posibilidades de que los cerdos se vean expuestos a dichos parásitos. Entre otros métodos eficaces para aminorar el riesgo de exposición humana, cabe citar la inspección de la carne, el adecuado tratamiento de la misma para su comercialización y el cumplimiento de las recomendaciones para su preparación casera.

## Palabras clave

Cocinado – Congelado – Curado – Inspección de la carne – Parásitos zoonóticos – Salud pública – *Taenia solium* – *Toxoplasma gondii* – *Trichinella spiralis*.

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