Info shared by Pitbull SA.

Manjaro APBT kennel.

South Africa.

My Website www.pitbullsa.co.za

My E mail "manjaro@pitbullsa.co.za"

My Facebook "Gawie Manjaro"

My Facebook page "Manjaro Kennel"

My mobile +27827838280.

Zello.com "VoIP" – ask for info.

Trichinae "roundworm" parasite in meat.

Introduction.

"Trichinella spiralis" is a parasitic nematode (roundworm) which is found in many warm-blooded carnivores and omnivores, including pigs.

Trichinella has a direct life cycle, which means it completes all stages of development in one host.

Transmission from one host to another host *can only occur by ingestion of muscle tissue which is infected with the encysted larval stage of the parasite.*

When ingested, muscle larvae excyst and enter tissues of the small intestine, where they undergo development to the adult stage.

Male and female adult parasites mate and produce new-born larvae which leave the intestine and migrate, through the circulatory system, to striated muscle tissue.

There, they penetrate a muscle cell, modify it to become a unique cyst, and mature to become infective for another host.
The total time required for this development is from 17 to 21 days.
Adult worms continue to produce larvae in pigs for several weeks before they are expelled.
Once adult worms are expelled and larvae reach and encyst in musculature, no further contamination can occur.
An animal that is infected with Trichinella is at least partially resistant to a subsequent infection due to a strong and persistent immunity.

Trichinella and pork.
Trichinella spiralis has a long standing association with pork products around the world.
The concept which many people have about the need to cook pork thoroughly is based on the risk of becoming infected with this parasite.

This concern is well founded in history.
At the beginning of the 20th century conservative estimates showed a 2.5% infection rate in U.S. pigs.
Even more alarming were postmortem surveys, conducted in the 1930's.
A National Institute of Health report published in 1943 found 16.2% of the U.S. population to be infected (1 out of every 6 people).
This type of information led to considerable publicity on the dangers of eating pork.
The historical problem of trichinae infection in pigs is responsible for strict federal control of methods used to prepare ready-to-eat pork products in the U.S., and expensive carcass inspection requirements in Europe.
These regulations are still in effect in the Code of Federal Regulations, for processed products, and in the Directives of the **European Union.**
Despite the historical problems of trichinae and its association with the pork industry, major changes have occurred in the last 50 years.

Human cases of trichinellosis reported to the Centers for Disease Control declined from about 500/year in the 1940's to fewer than 50/year over the last decade. Further, many of these cases *result from non-pork sources such as bear and other game meats.*

A major decline has also occurred in the prevalence of this parasite in pigs (see Table 1).
While prevalence has declined considerably in U.S. pigs, the lowest prevalence rates in domestic pigs are found in countries where meat inspection programs have been in place for many years (including countries of the European Union, notably Denmark and the Netherlands); these countries consider themselves essentially free of trichinae.
The dramatic declines in trichinae in pigs reflect changes in the industry.
Historically, trichinae infection in pigs was associated with feeding of raw garbage.
Major inroads were made into trichinae infection with the advent of garbage cooking laws passed for vesicular exanthema (1953-1954) and the hog cholera eradication program (1962).
Of equal importance has been the movement to high levels of biosecurity and hygiene under which most pigs are now raised.
Still, opportunities for exposure of pigs exist and some precautions should be implemented (see below).
Despite the fact that trichinae is rare in today's industry, pork **still** suffers from its legacy.

Today, the trichinae issue is a question of perception versus reality.
Dramatic declines in prevalence in pigs and the extremely low numbers of cases in humans are largely unrecognized by domestic consumers who still raise questions about "worms in pork" and religious dogma.
Further, lack of a trichinae control program creates problems for fresh pork in international markets despite the extremely low prevalence (essentially zero in intensive management systems).

Epidemiology.

Several species of Trichinella are found in warm-blooded carnivores, omnivores and raptorial birds.

In North America, there are five known species or types of Trichinella.

These include Trichinella spiralis, T. nativa, T. pseudospiralis, Trichinella T-5, and Trichinella T-6. Trichinella spiralis is most commonly associated with domestic pigs.

The other species and types mentioned have low relative infectivity for pigs and are primarily of importance because they occur in game animals (T-5 in bears and other wildlife in the eastern U.S., T-6 in bears and other wildlife in the Northwestern U.S., and T. nativa in Alaska). Both T. nativa and Trichinella T-6 are resistant to freezing.

Trichinella pseudospiralis has been reported infrequently from birds, but can infect pigs also.

Exposure of domestic pigs to Trichinella is limited to just a few risk factors which include:

Feeding of animal waste products contaminated with parasites; exposure to living or dead rodents or other wildlife infected with trichinae;

Cannibalism among pigs within an infected herd.

Other means of transmission such as tail biting or coprophagy are not important.

Generally, the way in which pigs become infected can be determined by a simple evaluation of farm management practices.

Since it is illegal to feed raw garbage, this source of infection should never be an issue.

However, feeding of any raw or undercooked meat scraps, including table waste could pose a risk.

Of much greater significance is exposure of pigs to rodents and wildlife.

Rodents, and rats in particular, serve as both a reservoir host and as a bystander host for trichinae infection.

Rodents can pick up infection from landfills, carrion or even dead pigs.

When rat populations are in close contact with pigs, it is possible that either live or dead rats will be caught and eaten.
If the rat happens to be infected, then trichinae infection will occur.
The same type of risk holds true for other small mammals.
Pigs which have free range to browse outdoors occasionally encounter carcasses which they might chew on.

By taking the following steps, risk of exposure of pigs to trichinae will be greatly reduced.
* Don't feed uncooked waste products, table scraps or animal carcasses to pigs. This is particularly important in the case of carcasses from hunted or trapped wildlife.
* Eliminate or minimize exposure of pigs to live wildlife.
Create barriers which are effective in separating pigs from small mammals.
* Implement and maintain an effective rodent control program.
Biosecurity, maintaining perimeters, baiting and trapping are all part of rodent control.
* Maintain good hygiene. Remove dead pigs as soon as they are found.
Keep barns free from clutter and feed stored securely.
The use of good production/management practices for swine husbandry will preclude most risks for exposure to trichinae in the environment.

Control.

There are a variety of ways in which trichinae control is approached.
Many countries require slaughter testing of each carcass.
The traditional approach for trichinae control is strict control of processed products to inactivate trichinae and warnings to consumers of the need to cook fresh pork.
This approach no longer seems appropriate since trichinae is almost non-existent in U.S. pork.
However, to overcome the stigma of trichinae, some organized approach to demonstrating product safety will be needed.

The following summarizes the current methods used for trichinae control and a proposal for herd certification which could have a major positive impact on the image of U.S. pork.

Slaughter testing.

Despite the relatively low prevalence of trichinae in pigs in many developed countries, considerable energy goes into preventing human exposure.

These efforts are largely a continuation of measures implemented when trichinae was a serious problem.

In many countries, slaughter inspection programs are required, and these requirements are often imposed as trade barriers to countries which do not inspect for trichinae.

As an example of the cost of this testing, the European Union spent $572 million in 1997 for trichinae inspection.

Approved inspection methods.

For trichinae in pigs include direct methods for visualization of parasites.

Since it is not possible to see trichinae cysts within meat tissue by macroscopic examination, it is necessary to perform one of several laboratory tests.

The oldest method, and one still frequently used, is called the compression method.

Small pieces of pork collected from the pillars (crus muscle or hanging tenderloin) of the diaphragm are compressed between two thick glass slides (a compressorium) and examined microscopically for the presence of worms.

A minimum of 1 gram is tested and the sensitivity of this test is approximately 3 larvae per gram of tissue.

An improvement for over the compression method, and a method which is now widely used in Europe, is the pooled sample digestion method.

Samples of tissue collected from sites where parasites concentrate, such as the diaphragm, masseters or tongue, are subjected to digestion in acidified pepsin.
Larvae, which are freed from their muscle cell capsules by this process, are recovered by a series of settling steps, then visualized and counted under a microscope.
Requirements for performing the digestion test are found in the Directives of the European Economic Community, in the U.S. Code of Federal Regulations, and various other publications.

ELISA test as alternative testing.
An alternative method of testing pigs for trichinae infection is an indirect method which looks for antibodies to the parasites in pig blood.
This test called the ELISA has been used extensively for testing in both pre- and post-slaughter applications and is an extremely useful tool for determining or monitoring infection in herds.

Eliminate trichinae by heat (by cooking) - freezing – maturing raw pork.
Where fresh pork is not tested for trichinae, as is the case in the U.S., alternative methods are used to prevent exposure of humans to potentially contaminated product.
These include processing methods such as cooking, freezing and curing along with recommendations to the consumer concerning requirements for thorough cooking.
Cooking - Commercial preparation of pork products by cooking requires that meat be heated to internal temperatures which have been shown to inactivate trichinae.

For example, Trichinella spiralis is killed in 47 minutes at 52□ C (125.6□ F), in 6 minutes at 55□ C (131□ F), and in < 1 minute at 60□ C (140□ F).

It should be noted that 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, with parasites not completely inactivated when product was heated to reach a prescribed end-point temperature.
The U.S. Code of Federal Regulations for processed pork products reflects experimental data, and requires pork to be cooked for 2 hours at 52.2□ C (126□ F), for 15 minutes at 55.6□ C (132□ F), and for 1 minute at 60□ C (140□ F).
The U.S. Department of Agriculture recommends that consumers of fresh pork cook the product to an internal temperature of 71□ C or 160□ F.
Although this is considerably higher than temperatures at which trichinae are killed (about 55□ C or 131□ F), it allows for different methods of cooking which do not always result in even distribution of temperature throughout the meat.
It should be noted that heating to 77□ C (171□ F) or 82□ C (180□ F) was not completely effective when cooking was performed using microwaves.
Freezing - Experiments have been performed to determine the effect of cold temperatures on the survival of *T. spiralis* in pork.
Predicted times required to kill trichinae were 8 minutes at -20□ C (-4□ F), 64 minutes at -15□ C (5□ F), and 4 days at -10□ C (14□ F).
Trichinae were killed instantaneously at -23.3□ C (-10□ F).
The U.S. Department of Agriculture's Code of Federal Regulations, requires that pork intended for use in processed products be frozen at -17.8□ C (0□ F) for 106 hours, at -20.6□ C (-5□ F) for 82 hours, at -23.3□ C (-10□ F) for 63 hours, at -26.1□ C(-15□ F) for 48 hours, at -28.9□ C (-20□ F) for 35 hours, at -31.7□ C (-25□ F) for 22 hours, at-34.5□ C (-30□ F) for 8 hours, and at -37.2□ C (-35□ F) for 0.5 hours.

These extended times take into account the amount of time required for temperature to equalize within the meat along with a margin of safety.

Curing - There are a great variety of processes used to prepare cured pork products (sausages, hams, pork shoulder, and other ready-to-eat products).

Most processes currently used have been tested to determine their efficiency in killing trichinae.

In the curing process, product is coated or injected with a salt mixture and allowed to equalize at refrigerated temperatures. Following equalization, product is dried or smoked and dried at various temperature/time combinations which have been shown to inactivate trichinae.

The curing process involves the interaction of salt, temperature and drying times to reach a desired water activity, percent moisture, or brine concentration.

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 the U.S. Department of Agriculture's Code of Federal Regulations Title 9, Chapter III, §318.10.

Irradiation - Treatment of fresh pork with 30 krad (0.3kGy) of cesium-137 has been proven to render trichinae completely non-infective. Irradiation with cobalt-60 or high energy x-rays at this same level should also be effective for inactivating trichinae.

Alternative methods for control.

In lieu of carcass testing or treatment to show that pigs are not infected, there are alternative methods to assure the safety of product.

These include herd testing to prove that trichinae infection is not present or raising pigs under conditions which prevent exposure.

In the former case, considerable testing on a regular basis is required to document absence of infection.
In the latter case, documentation of good management practices is required to show that pigs have not had an opportunity to become infected.
An example of the use of regular herd testing used to show how this information has been used to declare an area "free" from trichinae infection.
Then, an example of how a herd certification system for the U.S. pork industry might be used will be discussed.
Certification by region - Canada has adopted the approach of regional freedom from trichinae in domestic pigs based on a history of testing and finding animals to be negative.
This means that most of Canada is considered a "trichinae-free" zone; in one small focus of infection which is not included in the trichinae-free zone, pigs are tracked and tested regularly.
The basis for this regional approach is found in the OIE Code of Animal Health.
OIE is an international organization devoted to animal and veterinary public health.
The OIE Code states the following:
A country, or part of the territory of a country may be considered free from trichinae in domestic swine when:
1) trichinellosis humans and animals is compulsorily notifiable in the country;
2) there is in force an effective disease reporting system shown to be capable of capturing the occurrence of cases; and
3) it has been found that trichinae infection does not exist in the domestic swine population as determined by regular testing of a statistically significant sample of the population; or
4) trichinellosis has not been reported in five years and a surveillance program shows that the disease is absent from wild animal populations.

In Canada, no cases of human trichinellosis caused by pork have been reported since 1980 and extensive surveillance has been in place since 1966.
From 1980 through 1995, over 550,000 pigs were tested.
This surveillance demonstrated that, except for one infected zone in the Province of Nova Scotia, Canada is free from trichinae in domestic pigs.
Within the infected zone, movement of pigs is restricted.
All pigs from the infected zone are tested at slaughter and depopulation of infected herds is required.
According to Canadian animal health personnel, maintaining freedom from trichinae infection throughout most of the country has been instrumental in the $1 billion annual export market ($410 million in fresh cuts) and the 28 kg per capita annual consumption of pork.
Farm certification as a method of trichinae control - Like Canada and many other developed countries, the U.S. has an extremely low incidence of trichinae infection in pigs.
Although human trichinellosis is a reportable disease, the U.S. has no history of regular testing to determine trichinae infection in pigs, nor do most states require reporting of trichinae infection in pigs if found.
Considering the existing public perception of trichinae as a problem coupled with the reality of a very low level of occurrence, the U.S. pork industry would likely benefit substantially from a program which assured the absence of trichinae from pigs.
One way to accomplish this goal in a reasonable time frame is to certify herds free from trichinae based on the use of good production practices (GPPs). In this case, GPPs are defined as those production practices which reduce or prevent exposure of pigs to risks for trichinae infection.
Recent research efforts and pilot studies involving the National Pork Producers Council, the USDA's Animal and Plant Health Inspection Service, the Food Safety and Inspection Service, the Agricultural

Research Service and private industry and packer groups have resulted in development of a model for herd certification.
This model includes certification of production practices which eliminate or minimize risk factors for transmission of trichinae to pigs along with systematic monitoring of the product (trichinae-free pigs).
The model for a trichinae-free certification program incorporates many of the principles of HACCP.
The hazard, of course, is the exposure of pigs to the parasite, Trichinella spiralis.
Critical control points (CCPs) have been elucidated from a number of studies on the epidemiology of trichinellosis and its transmission to the domestic pig.
These CCPs are limited to management practices which would allow pigs to ingest contaminated feed (uncooked waste products containing trichinae), rodents or animal carcasses, including other pigs that contain infective parasite stages.
In the certification model, documentation of GPPs for risk-reduced production practices is accomplished by completing a farm audit, administered by trained veterinarians.
This audit, which would be conducted on a regular basis, takes into account all production practices which impact the trichinae status of market animals.
Audits consider adherence to:
1) feed integrity, source and storage;
2) building construction and condition as it pertains to biosecurity;
3) integrity of rodent control programs; and
4) general management and hygiene issues as they pertain to rodent control, cannibalism and other issues. In addition, the producer assumes responsibility for maintaining the integrity of good production practices between trichinae-CCP audits.
The process of raising pigs under GPPs to prevent trichinae infection requires both documentation (in the form of an audit as discussed above) and verification.

Herds which meet GPPs, and thus receive certification, would still need to be monitored periodically (by testing pigs at slaughter) to verify the absence of infection.
This monitoring could take of form of spot testing at the packer and testing would be based on a statistical sample of the "national certified herd".
To summarize, the overall certification process includes the following elements:
 Accredited veterinary practitioners are trained in good production practices relative to trichinae.
They work with producers to assure that risks are minimized in production systems.
The farm audit is used on a regular basis to document absence of risk.

 Periodically, some pigs are tested to verify the absence of infection.
Since the system is based on a pre-harvest HACCP approach, only a sample of production needs to be tested.
Efforts to certify pork free from trichinae should have an immediate impact on international markets by producing a product which is competitive with countries which currently inspect for trichinae.
The U.S. pork industry can't catch up with the rest of the world on trichinae by starting now to test pigs at slaughter.
We can however, initiate a better approach to food safety by implementing a system at the farm which is superior to individual animal testing.
In addition, implementation of a trichinae certification system will provide an infrastructure for tackling more complex issues in on-farm certification.
In the domestic market, the issue of trichinae is primarily perception, since the infection is so rare in today's product.
However, changing public perception requires education with respect to safety and educational efforts need to be supported by a process which validates the absence of the parasite from the pork supply.

Trichinae has long been a stigma to the pork industry. Today, with a small effort on the part of producers, packers and government, it may be possible to put this issue to rest.

Selected References and Additional Reading

Brake R.J., Murrell K.D., Ray E.E., Thomas J.D., Muggenburg B.A. & Sivinski J.S. 1985. Destruction of *Trichinella spiralis* by low-dose irradiation of infected pork. Journal of Food Safety, 7: 127-143.

Code of Federal Regulations. 1990. - *Animals and Animal Products*, Office of the Federal Register, Government Printing Office, Washington, D.C. 9: 212-220.

European Economic Community 1984. Commission Directive 84.319/EEC. Journal of the European Communities, 167: 34-43.

Gamble H.R. 1996. Detection of trichinellosis in pigs by artificial digestion and enzyme immunoassay. Journal of Food Protection, 59: 295-298.

Gamble H. R. & Murrell K.D. 1988. Trichinellosis. *In*, Laboratory Diagnosis of Infectious Disease: Principles and Practice (W. Balows, ed). Springer-Verlag, New York, 1018-1024.

Gamble H.R. and Murrell K.D. 1998. Trichinellosis. *In*, OIE Manual of Standards for Diagnostic Tests and Vaccines. Chapter 3.5.3.

Kotula A.W., Murrell K.D., Acosta-Stein L., Lamb L. & Douglass L. 1983. Destruction of *Trichinella spiralis* during cooking. Journal of Food Science, 48: 765-768.

Kotula A.W., Murrell K.D., Acosta-Stein L., Lamb L. & Douglass L. 1983. *Trichinella spiralis*: Effect of high temperature on infectivity in pork. Experimental Parasitology, 56: 15-19.

Kotula A.W., Sharar A., Paroczay E., Gamble H.R., Murrell K.D. & Douglass L. 1990. Infectivity of *Trichinella* from frozen pork. Journal of Food Protection, 53: 571-573.

Lin K.W., Keeton J.T., Craig T.M., Huey R.H., Longnecker M.T., Gamble H.R., Custer C.S. & Cross H.R. 1990. Dry-cured ham processes which affect *Trichinella spiralis*: Bioassay analysis. Journal of Food Science, 55: 289-298.

Lin K.W., Keeton J.T., Craig T.M., Gates C.E., Gamble, H.R., Custer C.S. & Cross H.R. 1990. Dry-cured ham processes which affect *Trichinella spiralis*: Chemical composition. Journal of Food Science, 55: 283-289.
Morse J.W., Ridenour R. & Unterseher P. 1994. Trichinosis: Infrequent diagnosis or frequent misdiagnosis? Annals of Emergency Medicine, 24(5): 969-971.
Schad GA, et. al., 1985. Swine trichinosis in New England slaughterhouses. American Journal of Veterinary Research, 46: 2008-2010.
Schad GA, et. al., 1985. Swine trichinosis in mid-Atlantic slaughterhouses: possible relationship to hog marketing systems. Preventative Veterinary Medicine, 3: 391-399.
Zimmermann WJ, et. al., 1973. Trichiniasis in the U.S. population, 1966-1970. Health Service Report, 88: 606-623.
Zimmermann WJ, et. al., 1971.
The prevalence of trichinosis in swine in the United States Health Service Report, 86: 937-945.

Table 1. Prevalence of *Trichinella spiralis* infection in pigs in the United States.

Year	**Percent Positive**	**Number Tested**	**Comments**
1898-1906	1.41	8 million	slaughter testing
1933-1937	0.95	13,000	grain / forage fed
	0.55	1,987	fed cooked garbage
	5.7	10,500	fed uncooked garbage
1948-1952	0.63	3,031	grain fed
	11.21	1,328	garbage fed
1961-1965	0.12	9,495	grain fed market hogs

	0.22	6,881	grain fed breeders
	2.6	5,041	fed cooked garbage
1966-1970	0.125	22,451	all hogs / national survey
	0.51	590	garbage fed hogs
1983-1984	0.73	5,315	New England slaughter samples
	0.58	33,482	mid-Atlantic slaughter samples
1990	0.16	3,048	APHIS National Swine survey
1994-1995	0.47	2,132	New England farm samples
	0.26	1,946	mid-Atlantic farm samples
1995	0.013	7,987	APHIS National Swine survey
1996	0	221,123	mid-Western market hogs