

PORK SAFETY

Title: Determination of seroprevalence to *Toxoplasma gondii* in the U.S. National swine herd -
NPB # 15-170

Investigator: Dolores Hill

Institution: USDA, ARS, NEA, APDL

Date Submitted: 8/2/2018

Scientific Abstract:

The objective of the study was to complete a national serological survey in market weight slaughter pigs and sows to determine the seroprevalence of *Toxoplasma gondii* and *T. spiralis* in these two populations comprising the national swine herd. We have established seroprevalence of these pathogens as measured in a statistically valid animal level sampling at slaughter in the 50 largest (by volume) plants for market hogs and in the 7 largest sow-only plants in the U.S.

ELISA results indicated antibody to *T. gondii* was present in 2.3% of 40,164 sera (924 positive sera) from market weight hogs, and in 4.1% of 13,000 sera (533 positive sera) from sows. Sows were almost twice as likely to have antibody to *T. gondii* as market weight hogs. ELISA OD values in *Toxoplasma* positive samples from market weight hogs were above 0.8 OD units in 35% of positive samples, and 397 lots identified with one or more positive samples, resulting in a lot prevalence of 16.7%, and a median within lot prevalence of 11.4%. ELISA OD values in *Toxoplasma* positive samples from sows were above 0.8 OD units in 23% of positive samples, and 202 of 650 lots identified with one or more positive samples, resulting in a lot prevalence of 31% and a median within lot prevalence of 19.2%, significantly higher than that seen in the median within lot prevalence (11.4%) for market weight hogs ($p < 0.05$).

These research results were submitted in fulfillment of checkoff-funded research projects. This report is published directly as submitted by the project's principal investigator. This report has not been peer-reviewed.

For more information contact:

National Pork Board • PO Box 9114 • Des Moines, IA 50306 USA • 800-456-7675 • Fax: 515-223-2646 • pork.org

No *Trichinella* positive samples were detected in any of the 53,164 samples tested, demonstrating the success of biosecurity measures that have been implemented by industry to eliminate this parasite from the U.S. swine herd.

Introduction: An overview of the researchable question and its importance to producers.

Perhaps the most widespread protozoan parasite affecting humans, *Toxoplasma gondii* infects virtually all warm-blooded animals, including humans, livestock, birds, and marine mammals (Dubey and Beattie, 1988; Hill et al., 2005). Infection in humans occurs worldwide; however, prevalence varies widely from place to place. Toxoplasmosis is considered one of the Neglected Parasitic Infections, a group of five parasitic diseases that have been targeted by CDC for public health action. In the U.S., the rate of infection with *T. gondii* in humans appears to be declining, though the CDC estimates 1.1 million new infections occur each year. In the most recent serological survey (National Health and Nutrition Examination Survey, 2009-2010; Jones et al., 2014) involving over 7,000 people, 13.2% were positive for *T. gondii* antibodies, indicating infection with the parasite. Prevalence was 6.7% in persons 12-49 years of age and 9.1% in women of child-bearing age. In most adults, infection rarely results in clinical disease; however, there have been reports of focal ocular toxoplasmosis in otherwise healthy adults (Aramini et al., 1998, 1999; Jones et al., 2006; Phan et al., 2008; Wallace and Stanford, 2008). Congenital infection occurs when a woman becomes infected during pregnancy and transmits the parasite to the fetus. Congenital infections acquired during the first trimester are more severe than those acquired later in pregnancy (Desmonts and Couvreur, 1974; Remington et al., 2005). Serious disease can also result in immunosuppressed individuals, such as those given large doses of immunosuppressive agents in preparation for organ transplants or those with acquired immunodeficiency syndrome.

Humans also become infected by ingesting food or water contaminated with sporulated oocysts from infected cat feces, or through ingestion of tissue cysts in undercooked or uncooked meat (Dubey and Beattie, 1988; Cook et al., 2000; Lopez et al., 2000; Tenter et al., 2000; Jones et al., 2009). Food

animals, including pigs, become infected by the same routes, resulting in meat products containing tissue cysts, which can then infect consumers (Smith, 1993; Dubey et al., 1995a, 2005). Some estimates suggest that ingestion of undercooked or improperly cured meats is responsible for approximately one-half of all human infections (Mead et al., 1999). The risk of exposure to *T. gondii* in meats can be determined from prevalence surveys in food animals. In the U.S., various surveys for *T. gondii* infection have been performed in pigs. These have ranged from national surveys, including testing sera collected in the APHIS National Animal Health Monitoring Surveys (NAHMS), to regional or convenience surveys. In a national survey funded by the USDA, Food Safety and Inspection Service in 1983 and 1984 (Dubey et al., 1991), 23% of market hogs and 42% of sows tested positive. Other sow-only surveys have reported infection rates of 22.2% (Dubey et al., 1995b), 36% (Assadi-Rad et al., 1995), 20.8% (Weigel et al., 1995), and 20% (Patton et al., 1996). More recent testing has focused on market hogs only. Testing of the NAHMS sera for the past four cycles has resulted in prevalence rates of 3.2% (NAHMS 1995, Patton et al., 1998), 0.9% (NAHMS 2000, Patton et al., 2002), 2.6% (NAHMS 2006, Hill et al., 2010), and 3.7% (NAHMS 2012, Hill, unpublished).

Toxoplasma prevalence is linked closely with the type of pork production system. Pigs raised in outdoor systems, such as “organic” production have very high rates of infection (Dubey et al., 2012). For example, a survey of 85 farms in the Northeastern U.S., where pigs were largely raised outdoors, found a prevalence rate of 47.5% (Gamble et al., 1999). On farms where very poor management was practiced, even higher rates were identified - 87.2% - in a 2002 survey in Massachusetts (Dubey et al., 2002) and 68.7% in a 2006 survey in Maryland (Dubey et al., 2008). Alternatively, pigs raised in confinement systems have low rates of infection. A survey of 58 production sites in northwestern Iowa, southwestern Minnesota, southeastern South Dakota, and northeastern Nebraska, in which 8434 pigs were tested, showed an overall prevalence of 0.14%, and the within-herd prevalence for infected herds was 1.2% (Gamble et al., unpublished). Of particular note, 52 of 58 production sites had no positive pigs and on 5 of 6 production sites, infection was eliminated by following some

specific bio-security practices, demonstrating that raising pigs free from *T. gondii* infection is an achievable goal.

Toxoplasma ranks second, after *Salmonella*, in annual human disease burden caused by foodborne pathogens, and *T. gondii* in pork ranks second in commodity associated risks for pathogens (Batz et al., 2012). *Toxoplasma* infection results in 750 deaths each year, making it the second most common cause of death related to food-borne diseases (Scallan et al., 2011). There are no tests currently available to detect *T. gondii* infection in food animals at slaughter. Therefore, consumers must follow recommended cooking methods to assure safety of meat relative to *T. gondii* just as would be the case for other potential pathogens. While there are no regulations that currently address *T. gondii* as a food safety issue, both FSIS and the European Food Safety Authority have studied this issue, and the Codex Alimentarius and the World Animal Health Organization (OIE) are considering including *T. gondii* in their respective codes.

For decades, pork has been implicated as the major vehicle for transmission of both *T. gondii* to humans in the U.S. Yet, no data currently exists documenting *T. gondii* transmission to humans via pork in the U.S. Industry changes in swine management have resulted in negligible levels of this zoonoses in conventionally raised swine. A recently developed serological assay which can identify oocyst-transmitted *T. gondii* infection in humans has demonstrated that pork, and meat in general, is a minor contributor to *T. gondii* transmission in humans. Development of current *T. gondii* prevalence data in market pigs will provide the industry with information documenting the low risk to humans of acquiring this parasite from U.S. pork and will support future claims of negligible risk for use in the export market. The data will inform policy makers on the effectiveness of industry-led animal management changes in biosecurity that have resulted in reduction of risk to domestic swine of infection with this parasite, and consequently reduction of risk to human health. This study provides data that clearly demonstrates the nationwide seroprevalence of *T. gondii* in market pigs and sows in

the U.S. These data will facilitate recognition by consumers and regulators of the impact on public health of industry-driven changes in swine production which have led to the low risk of exposure to this parasite posed by consumption of pork raised under modern management conditions.

Although prevalence of *T. spiralis* in pigs raised in confinement is extremely low in the U.S., extraordinary procedures are required to market U.S. pork domestically and to international trading partners due to the perceived risk from *T. spiralis*. Domestically, pork supplies have never been subject to *T. spiralis* testing. However, pork products which are uncooked, considered ready to eat, and have not been otherwise tested or treated are subjected to mandatory processes that are known to inactivate *T. spiralis*.

Currently, individual carcass testing for *T. spiralis* is required for shipping to European, Russian, and Asian markets. This testing is labor intensive and costly; more than 50 million pigs have been tested in this mandatory program since 1994, and no positive pigs have been detected. Recent changes in the Codex requirements for assuring freedom from *T. spiralis* in pork have provided alternatives to individual carcass testing based on the establishment of negligible risk compartments. The use of a negligible risk metric for *T. spiralis* infection in pigs was first established by a group of EU subject matter experts (Alban et al., 2011), and is currently used by the European Union in *T. spiralis* control legislation. The Codex standard states that one option for documenting “negligible” risk to consumers should be based on demonstrating, by surveillance testing, a *T. spiralis* prevalence of less than one infection per one million pigs with at least a 95% level of confidence. Modern pork production systems in the U.S. reduce consumer risk for exposure to *T. spiralis* from commercial production to negligible levels, and it is imperative for international competitiveness of the U.S. pork industry to establish a compliant surveillance program to meet Codex standards, increasing marketability of U.S. pork to international trading partners.