Survey of Market Swine to Determine Prevalence of Toxoplasma Antibodies in Meat Juice Samples from Selected Abattoirs

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Abstract

Toxoplasmosis is a zoonotic disease caused by a protozoan parasite infection in mammals and birds. Exposure to contaminated cat feces in feed or the environment may spread T. gondii to pigs and to other mammals. Direct exposure to humans from cat feces also occurs. Significant human health risks including congenital birth defects or fetal death, encephalitis or pneumonic forms are attributed to human Toxoplasma infections. A total of 138,682 samples were collected and 74,500 were selected from market swine at 12 cooperating abattoirs. Average seroprevalence was 0.80% for all samples tested. This project demonstrated a low prevalence for Toxoplasma antibodies generally, and significantly different sub-populations based on annual production estimates. Additionally it demonstrated tools for surveillance and monitoring of large populations at the abattoir level rather than requiring point of first sale or down-the-road sampling of these populations to generate a prevalence estimate similar to other on-farm surveys.

Introduction

Toxoplasmosis is caused by a protozoan parasitic infection in mammals and birds. Cat consumption of infected animals (rodents, birds) is the main infectious route for this definitive host, and infected cats may be prolific shedders of the oocysts for variable times after initial infection. Exposure to contaminated cat feces in feed or the environment will spread T. gondii to pigs and other mammals. Direct exposure to humans from cat feces also occurs. The ability to differentiate direct human exposure from indirect food contamination has not been perfected, therefore attributable risks for these exposure routes has not been developed. In swine production, biosecurity with elimination of cats, wildlife and bird-proofing in swine facilities, care to avoid tracking contaminated soils or feces into facilities, control of cannibalism, bans on feeding uncooked garbage or wildlife, and rodent control are proven methods to reduce the prevalence of seropositive swine populations. Current evidence from the National Animal Health Monitoring System (NAHMS) places the seroprevalence in USA market swine at 0.9% in 2000 and 2.6% in 2006.1

Toxoplasma gondii infection of pork is a potential source for Toxoplasmosis in humans. Mead et al. estimated that Salmonella, Listeria, and Toxoplasma infections were cumulatively responsible for 1500 of 1800 total attributable deaths annually in the USA.2 They also attributed 5,000 hospital discharges annually to Toxoplasma. The 1994 NHANES public health survey estimated that 40% of adults over 60 years were Toxoplasma spp. seropositive. Females of reproductive age that are not serologically positive and immunosuppressed populations are more risk-prone populations. Guerina et al. (1994) estimated 1 congenital case of Toxoplasma/10,000 births. 3 Mead et al. estimated that 4,000 HIV/AIDS infected individuals developed Toxoplasma encephalitis annually.2 For these reasons a better understanding of the prevalence and distribution of Toxoplasma in USA swine would be helpful in the development of an effective surveillance and in-field control program for on-farm production strategies. The purpose of this project was to estimate the prevalence of meat-juice-based antibodies to Toxoplasma gondii in swine originating from a range of production systems marketed at 12 high-volume market swine abattoirs representing approximately 65% of national daily USA harvest capacity.
Materials and methods

Toxoplasma antibodies were analyzed by estimated system annual production, harvest plant, and time of submission from November 2007 to March 2008 as a cohort concurrent to PRV surveillance. Twelve cooperating abattoirs supplied facilities and producer information for sampled lots. Five diaphragm pieces weighing ~75-100 gms. each were collected per lot as a convenience sample at the abattoir and identified to plant lot number. Lots to be tested were selected at the laboratory daily based upon a pre-set anticipated annual production algorithm. Large suppliers were limited to 1 or 2 lots daily to reduce their over-representation in the data set. Smaller producers (< 10,000 annual production) were sampled in every lot presented at the processing laboratory. A total of 138,682 samples were collected and 74,500 were selected using this formula. Production systems were divided by annual production estimates into the following groupings: 1-1000 head; 1001-2000; 2001-4000; 4001-9999; 10,000 – >1,500,000; and 10,000 – >1,500,000 top 30 producers. These groups contained similar numbers of producers up to the 4001-9999 grouping then reduced rapidly, but total sample numbers per grouping increased.

Meat-juice samples were tested according to manufacturer’s instructions (ELISA OD ≥ 0.2 positive at a 1:10 dilution) by a commercial enzyme-linked immunosorbent assay (ELISA) (SafePath Laboratories, St, Paul, Minn. 55108, USA). Sensitivity of method was 100% (95% CL = 82.4 - 100%); specificity was 100% (95% CL = 93-100) when compared with a “gold standard” bioassay using naïve cats. Each initial seropositive sample was retested using the same procedures to increase the possibility that only “true” positive samples were identified. Double positive samples were reported as “positive” and assessed accordingly.

Results

During the sampling period a total of 74,451 meat juice results were reported. Average seroprevalence was 0.80% for all samples tested double positive. Plant prevalences ranged from 0.15 – 1.34% for individual samples (Table 1), and from 0.65 – 4.68% for lots. The monthly prevalence values ranged from 0.56 – 1.26% with February as the highest month (Table 2). The prevalence range for the group sizes was 0.43 – 2.44% in descending groups respectively.

Table 1: Prevalence of Antibodies at Abattoirs

![Graph showing prevalence of antibodies at abattoirs]

Table 2: Monthly Prevalence Reported

<table>
<thead>
<tr>
<th>Month</th>
<th>Prevalence</th>
</tr>
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<tbody>
<tr>
<td>Jan</td>
<td>0.50%</td>
</tr>
<tr>
<td>Feb</td>
<td>0.80%</td>
</tr>
<tr>
<td>Mar</td>
<td>1.25%</td>
</tr>
<tr>
<td>Apr</td>
<td>2.00%</td>
</tr>
</tbody>
</table>

A total of 2,538 producers were surveyed with 309 producers registering a > 1 positive sample for the study period. Seventy-nine presented >2 in that period with a range of 2-12 positive samples. For 2-6 positive samples/producer the incidence was 43, 14, 14, 5, and 2 respectively. No positive groups were enumerated from 7-11 positive samples/producer, and only 1 producer was identified with 12 positive samples. These samples were generally distributed across the time period, rather than occurring in single lots per producer. Annual production impacted the prevalence. The smaller three categories were significantly higher than the larger three categories (Table 3). The 1001-2000 and 2001-4000 groupings for annual production were intermediate to the smallest and the three larger production groups, but trended toward the larger grouping prevalence values.
Table 3: Prevalence of Antibodies by Production Size

Production System Size

a=P<0.05, b=P<0.05
Discussion

This survey presents a picture of the Toxoplasma prevalence in USA market swine by four distinct measures – by plant, by time, by producer, and by producer annual production categories. The sample population represents approximately 65% of the daily USA harvest capacity. Therefore it can be anticipated that a national survey of all market swine would generate similar distributions.

A clear pattern demonstrated that in the smaller annual production systems a higher sample and lot prevalence occurred. Based on current understandings of on-farm risk factors these results are not unanticipated. The smaller producers are more likely to have non-confinement or open fronted buildings as a part of their production systems, or have farm cats or wildlife in or around these facilities. Larger production systems are more likely to be closed and a higher level of biosecurity would be expected.

Differences occurred between plants based on supply chains that they harvested. The single plant (#14), which harvests only contract and confined swine, had the lowest prevalence. Intermediate are three plants (#8, 69 and 88) which are known in the industry to harvest predominately from larger independent and contract producers. The eight (8) plants with the more diverse procurement populations demonstrated significantly higher lot and individual sample prevalences. It is unclear from the data why February demonstrated a higher prevalence than the other months of the study. All of the plants were sampled at approximately the same rates in each month except March when the number of samples approached the total to be collected. Additional work should be commissioned to determine whether this temporal observation is epidemiologically significant or a chance occurrence.

This large sample set allows multiple lots from a given producer to be sampled over time. Problematic are the large number producers with single positive samples (230/2538 = 9.1%). This occurred in spite of the double positive strategy for each sample set. The remaining 79 with > 1 positive samples should be evaluated further to determine Toxoplasma on-farm status. Because of the potential for limited individual exposure, such a verification strategy is needed, unlike in experiences with a highly infectious virus (PRV). Based upon that experience, a singleton positive sample, where the producer did not have recurring positives in subsequent lots, lead to an understanding that the singleton reaction was most probably caused by issues with the test vehicle. Further experiences with this ELISA or others, coupled with on-farm evaluations to determine status should be attempted to refine interpretation standards. Experiences gained from this exercise may enable additional interpretation strategies to be brought forward and confirmed.

Conclusions

This project demonstrated the feasibility for a market-based survey to identify epidemiologically important production practices across a wide spectrum of production sizes and systems. It demonstrated tools for surveillance and monitoring of large populations at the plant level rather than requiring point of first sale or down-the-road sampling of these populations. Abattoirs, irrespective of size, can be used in these efforts to sample a range of sub-populations within the commercial compartment of the USA swine industry. It also demonstrated a low prevalence for Toxoplasma antibodies generally, and significantly different sub-populations based on annual production estimates.

References

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