SALMONELLA AS A FOODBORNE PATHOGEN

Introduction

In 1885, the veterinary scientist, Daniel E. Salmon, discovered the first strain of Salmonella. Since then, Salmonella has been isolated from the intestinal tract of almost any vertebrate where researchers have cared to look, including pigs and humans.

Of the more than 2,400 species of Salmonella, all seem capable of causing disease in humans. Some strains (host-adapted) are especially adapted to a single host, such as S. typhi in humans, S. choleraesuis in pigs, and S. pullorum in poultry. S. typhimurium and S. dublin are two of the well-known strains that are non-host-adapted. The severity of the disease after infection depends on the strain, the infectious dose, and the state of health of the individual infected. Children are the most likely to get salmonellosis. Young children, the elderly, and the immunocompromised are the most likely to be severely infected.

S. typhimurium and S. enteritidis are the most common causes of food poisoning in the United States, and every year, approximately 40,000 cases of salmonellosis are reported. Because many milder cases are not diagnosed or reported, the actual number of infections may be 20 or more times greater. Salmonellosis is more common in the summer than winter. In the United States, approximately 1,000 persons die each year with acute salmonellosis.

The most common cause of the illness is eating improperly prepared or stored foods. When food is improperly handled, the Salmonella bacteria are able to proliferate and produce toxins that cause the illness. Anything contaminated with these bacteria that is not heated to destroy the toxins before being eaten may cause illness. After ingestion, symptoms begin within 1 to 3 days and may include abdominal pains, diarrhea, fever, and sometimes vomiting. The illness usually lasts 4 to 7 days, and most persons recover without treatment. However, in some persons, the diarrhea may be so severe that the patient needs to be hospitalized. In these patients, the Salmonella infection may spread from the intestines to the blood stream and then to other body sites. At this point, it can cause death unless the person is treated promptly with antibiotics.

In recent years, concerns have been raised because particular strains of the bacteria have become resistant to traditional antibiotics in both animals and humans.

Sources

Animals are an important source of salmonellae for foodborne human disease. The U.S. Food Safety and Inspection Service (FSIS) reported in 1986 that 72 percent of rendered feeds fed to animals tested positive for the bacteria. Various studies have indicated that salmonellae can be present in from 0 to 48 percent of pork carcasses.

Responsibility

The recent trend in efforts to assure food safety worldwide, but especially in the United States, has been toward an inspection and surveillance system based on risk analysis rather than use of the traditional organoleptic approach to meat inspection. Packing plants are now expected to develop and implement plans that will minimize the risk of contamination. Such plans should logically include preharvest control, but this has not been legislated, partly because we have such a poor understanding of what measures we could reliably and economically implement at the farm level. Underlying that lack of implementation is our poor understanding of the epidemiology of Salmonella at the farm level. As a consequence, the meat industry and consumers shoulder most of the burden of helping to ensure a safe product.

Plant hygiene and employee training are important safety components for the meat industry. Consumers themselves should:

- Wash their hands before preparing foods and eating, after using the bathroom or changing diapers, and after handling pets.
- Refrigerate foods soon after purchase.
- Check expiration dates and dispose of any outdated food.
- Clean all food preparation areas with a diluted solution of bleach and water, then rinse before and after food preparation.
Pork as a hazard

Pork is a major carrier of foodborne salmonellosis throughout the world. A recent study of pork in retail stores found 9.6 percent of samples were contaminated (Duffy, et al., 2000). However, in the United States, more cases of salmonellosis are linked to beef than pork, probably because the fear of Trichinella in pork encourages people to cook the pork more thoroughly. In Denmark in 1993, pork was the critical source of foodborne salmonellosis when meat contaminated with S. infantis resulted in an outbreak of 20 cases per 100,000 inhabitants (Wegener and Baggesen, 1996).

Although slaughter equipment is often the immediate source of contamination, the initial source is the carrier pig. Transmission is thought to occur by pig-to-pig contact or from exposure to a contaminated environment (Berends, et al., 1996). Handling and transport of pigs before slaughter also has long been recognized as increasing the prevalence of Salmonella spp. (Newell and Williams, 1971).

On-farm factors

Generally, pathogens are introduced onto farms with replacement pigs, and Salmonella is probably no exception. In fact, three-site-production, which is commonly practiced in the United States to decrease the impact of swine pathogens, is suspected of increasing the prevalence of Salmonella in the system (Davies, et al., 1997). This situation may be associated with the demonstrated increase in prevalence of Salmonella in pigs after they are transported to slaughter and held in lairage (Williams and Newell, 1971). However, the Dutch have concluded, after much research, that on-farm contamination cycles are so important that the significance of other factors is difficult to assess (Berends et al., 1996). In addition, they concluded that replacement breeding stock is not a significant source. Certainly, even after depopulation and rigorous cleaning and disinfection of facilities in North Carolina, we were still able to culture Salmonella from drag swabs. Pig feed is a well-documented source of Salmonella; however, its role in the total process is questionable. Salmonella spp. isolated from on-farm feed are seldom the same as those isolated from pigs or from human foodborne cases.

What can a farmer do?

Pen hygiene

In any discussion of on-farm Salmonella control, one is sure to encounter those promoting the benefits of pen hygiene. In fact, Berends et al. (1996) state that pen hygiene is the most important factor in Salmonella control. In contrast, an investigation in North Carolina found that fecal shedding was not linked to a subjective measure of “pen hygiene” (Funk, et al., 1999).

Feeding practices

The Danes (Wegener and Baggesen, 1996) have found that liquid feeding and having farmers mix their own rations offer good protection against Salmonella, and the Dutch (Berends, et al., 1996) have reported that feeding whey is protective. The effect of the latter may be attributable to the low pH of whey. If that is the case, adding organic acids to the feed or water may be a solution. The opportunity for feeding cultures to promote “competitive exclusion or the Nurmi effect” still exists, and recent results have been promising (Anderson, et al., 1999).

Vaccination

Although there is a history of successful vaccination with host-specific serotypes (e.g., typhoid vaccines for S. typhi, as are commonly prescribed for travelers to endemic areas), there has been little or no success in developing a vaccine for non-host-specific serotypes such as S. typhimurium or S. dublin. Also, despite much effort, the poultry industry has not been successful in developing a vaccine for S. enteritidis.

Enterisol SC-54, a vaccine produced in the United States by Boehringer Ingelheim Vetmedica, Inc., is recommended for use in healthy, susceptible swine that are one day old or older as an aid in the prevention of salmonellosis in swine caused by S. choleraesuis var. kuzuendorf. The avirulent live-culture vaccine may be administered intranasally or via drinking water. The company contends that reducing the prevalence of salmonellosis eliminates stress that can slow animal growth and that this result is worth up to $13.28 per head. In field trials, Enterisol SC-54-vaccinated pigs, compared to non-vaccinated pigs, had a significantly lower prevalence of Salmonella detected by culture of ileocecal lymph nodes collected at slaughter.

Although S. choleraesuis can be a severe pathogen for pigs, it is only rarely associated with disease in humans. However, when it is, the disease is usually serious.

Summary

Foodborne salmonellosis is a serious problem and one that must be addressed by our industry. Unfortunately, we have much to learn about how we can implement preharvest control. Until that time, farmers should strive to improve pen hygiene, implement an aggressive rodent control program, and endorse postharvest irradiation of pork. While irradiation should not be adopted as a substitute for poor preharvest control, it is the best technique available at the moment for reducing the contamination of pork and subsequently the incidence of salmonellosis in consumers-our ultimate customers.

References


-Morgan Morrow

**PORCINE REPRODUCTIVE AND RESPIRATORY SYNDROME (PRRS) FACTS**

**Infection**

The Porcine Reproductive and Respiratory Syndrome (PRRS) virus is highly infectious. Ten or fewer particles can establish an infection when pigs are exposed by the intranasal route. Other routes (oral, vaginal, or eye) require higher doses, usually of the order of 103 to 105 particles. Breeding females can be infected by both undiluted and extended semen.

**Shedding**

After being infected, pigs shed the virus for extended periods in saliva (42 days), semen (43-92 days), and mammary secretions. The results on fecal shedding are mixed: Some researchers have reported finding no infectious virus in feces up to 42 days post-infection. By contrast, others have reported extensive fecal shedding of the virus over 35 days, while others have found only intermittent shedding. Regardless of the origin, infected pigs shed the virus in copious amounts and quickly contaminate their surroundings.

**Virus survival**

If conditions are right (about 4°C, pH 7.5), the virus can survive from days to weeks. However, it is very susceptible to adverse conditions, especially drying, and will die within hours as conditions change from optimum. On the usual pig-associated fomites (plastic, steel, wood, straw, clothing, slurry, etc.) at normal environmental temperatures (25°-27°C), the PRRS virus will survive less than a day. But it can survive in water for up to 11 days. Thus, normal clean-up procedures with disinfection and drying ensure the non-survival of the virus.

**Carriers**

A marked characteristic of infection with PRRS virus is that some pigs may harbor the virus for at least 157 days and possibly longer. However, it is difficult for other pigs to become infected unless they are in very close contact with the infected pig; that is, the disease is not highly contagious.

**Hosts**

Mallard ducks are susceptible to the PRRS virus and can excrete it in their feces for up to 39 days after infection. In addition, they can also spread it among themselves and are capable of infecting pigs. Although mallards may not be significant vectors in the field, this evidence does indicate that birds can carry the virus and infect pigs. But again, the significance of these factors in field outbreaks is still unknown.

Rodents are not susceptible to or carriers of PRRS virus.

<table>
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<tr>
<th>CALENDAR OF EVENTS</th>
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<tbody>
<tr>
<td><strong>January</strong></td>
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<tr>
<td>27-31 American Society of Animal Science, Southern Section</td>
</tr>
<tr>
<td>Fort Worth, Texas</td>
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<tr>
<td><strong>February</strong></td>
</tr>
<tr>
<td>1 34th Virginia Pork Industry Conference</td>
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<tr>
<td>Wakefield, Va.</td>
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<tr>
<td>13 Edenton Regional Pork Conference</td>
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<tr>
<td>Edenton, N.C.</td>
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<tr>
<td>Contact Diana Rashash 910-455-5873</td>
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<tr>
<td>24-27 American Association of Swine Practitioners</td>
</tr>
<tr>
<td>Nashville, Tenn.</td>
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**ON-FARM PERFORMANCE TESTING:** The following breeders with validated herds have tested animals in the past 30 days.

<table>
<thead>
<tr>
<th>Breeder</th>
<th>Address</th>
<th>Breed</th>
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<tbody>
<tr>
<td>Bob Ivey*</td>
<td>314 N.C. 111 S, Goldsboro 27530</td>
<td>L,D,H,Y,CW,X</td>
</tr>
<tr>
<td>Wesley Looper*</td>
<td>4695 Petra Mill Road, Granite Falls 28630</td>
<td>Y,L,H,D,X</td>
</tr>
<tr>
<td>Thad Sharp, Jr., &amp; Sons</td>
<td>5171 NC 581 Hwy., Sims 27880</td>
<td>Y,D,X</td>
</tr>
<tr>
<td>Tommy Spruill</td>
<td>Rt. 1, Box 149, Columbia 27925</td>
<td>L,X</td>
</tr>
<tr>
<td>Swan Acre Farm</td>
<td>1060 Main Street, Swan Quarter 27885</td>
<td>X</td>
</tr>
<tr>
<td>Thomas Farms</td>
<td>8251 Oxford Road, Timberlake 27583</td>
<td>X</td>
</tr>
<tr>
<td>UCPRS</td>
<td>Rt. 2, Box 400, Rocky Mount 27801</td>
<td>X</td>
</tr>
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*Realtime Ultrasound*  

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Frank Hollowell, David Lee