

One Industry Perspective on Research Needs for *Salmonella enteritidis*

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Before I comment on what I believe are important research priorities related to *Salmonella enteritidis* (SE) in eggs, I want to put a little "history" on the table that may help us appreciate where we were, what has been accomplished and where we need to go.

The attitude of the egg industry has undergone a series of adjustments since the SE problem first came to light in 1987.

At first, there was total disbelief. The deposition of SE in eggs produced by normal-appearing hens was counter to all we knew about the association of egg consumption with Salmonellosis in humans. The Salmonellae had not been significantly related to the eating of eggs or egg-containing dishes since the implementation of the Egg Products Act in 1971 which prohibited the sale of dirty or cracked eggs and mandated the pasteurization of liquid eggs.

It was logical then that the first SE research efforts were to determine if hens colonized with SE could lay eggs internally contaminated with SE. If so, when would they be laid relative to hen inoculation? How many bacteria would be in a contaminated egg? What percentage of eggs would be contaminated, where would the bacteria be located, would they replicate in the presence of naturally occurring bacterial inhibitors? How would replication be influenced by storage temperature? Were all SE the same in their ability to result in egg contamination? Was there a difference among the phage types or within phage types? Could we predict the behavior of a SE isolate in a flock, especially as it related to egg contamination? Could the presence of circulating antibodies be used to identify infected flocks? What about the presence of yolk antibodies? Will oil emulsion vaccines provide an acceptable level of protection especially related to egg contamination? What effects would the stress of molting have on the problem?

There were many unanswered questions and it was an exciting time. It is not often that researchers have such an open playing field of problems to work on, uncluttered by the fumbles and dogma left by earlier workers. Unfortunately, neither was there much in the way of research findings on which to build this new effort.

There were significant research successes and there were failures. There was a lot of communication and shared good will as researchers tried to get ahead of a problem that seemed to get bigger and bigger with each passing week. We had informal and very candid meetings of involved individuals at the SEPRL in Athens and in Pennsylvania at the New Bolton Center.

A unique aspect of the problem was that as a research effort was being organized and implemented, a human illness traceback program with diversion of eggs to pasteurization was in process. There was also a prevention/control effort in the Pennsylvania egg industry with USDA/APHIS leadership. The pressure for answers from the researcher's efforts was intense and continuous. The challenge was always to not let the regulatory efforts get ahead of the science needed to support it. The Pennsylvania Pilot Project yielded important information on

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the association of high rodent populations with infected flocks and on the cleaning and disinfection of contaminated houses. Their drag swab sampling of layer houses was the foundation of determining the SE status of flocks and is still relied upon for that purpose.

Many of the questions mentioned above have been answered, albeit some only partially. We have made progress, but there are many questions remaining. I am going to present some, in no special priority order, that I hope will help us achieve a further understanding of SE in layers which will one day lead to ending the association of egg consumption and SE illnesses.

While there can be some progress made in the laboratory, most of these questions will best be answered in field flocks. Flocks that have been found to be SE-positive and their eggs diverted to pasteurization could be used for some of this work with no public health risks and without any increased potential liability. Such an approach will require convincing industry of the need for and potential benefits of the research effort. Here is the list that is obviously not all-inclusive, but done with an attempt to emphasize the problem-solving side of the research issue:

1. What effect does induced molting have on the incidence of SE in flocks including the rate and duration of SE deposition in eggs?
2. What is the effectiveness of both live ST and killed SE oil emulsion vaccines on the susceptibility of flocks including the rate and duration of SE deposition in eggs?
3. Do all SE isolates behave alike? Are there methods to distinguish "hot" isolates from others, identifying SE flocks that should have their eggs diverted and others not?
4. What is the storage temperature influence on the number of SE bacterial cells over time in naturally contaminated eggs?
5. Can there be less labor intensive and more rapid methods to determine the SE status of large numbers of eggs?
6. What are the dynamics of SE infections in layer houses? How is it spread through the house and how rapidly? How readily does it move from house to house in a complex? How does the environmental sampling result relate to the actual extent of infected hens and the rate of contaminated eggs? Is there a temporal relationship of egg contamination to first evidence of infection?
7. Develop innovative intervention strategies that will solve this problem short of forcing egg operations out of business. Special emphasis should be directed toward these larger in-line operations with multiple houses of different ages connected to a processing facility by a common head house. These facilities do not lend themselves to effective cleaning and disinfection and there is very close proximity among the houses with shared workers.

8. All "egg-related" SE illnesses may not be due to internally contaminated eggs from infected flocks. There should be a survey of restaurant and institutional mice to determine if they could be a source of food preparation SE contamination and resulting illnesses. Since the success of the anticipated new SE regulation is going to be based on the number of human illnesses, this could be a very important survey for the objective assessment of the effectiveness of that regulation which will be primarily targeting the egg industry.

The SE in eggs experience that some of us have observed from its beginning has resulted in many frustrations and inequities for the industry. First, as a source of frustration, the regulatory program was implemented before we had the necessary science to support it. The industry was looked at as if they had somehow done something terrible that had to be corrected and no one was capable of telling them where they even got SE, how they could keep from getting SE in the future and how they could assuredly get rid of it and still stay in business. There were many more questions than answers. That relationship between questions and answers has improved, but not by much. That has led to much frustration. The government is turning up the regulatory heat, but can't provide the needed answers on how to avoid or correct the problem.

The inequity comes from a traceback-based diversion program. When eggs are SE positive and not abused in preparation, there is usually no illness and therefore no traceback. When groups of eggs containing some SE-positive eggs are abused and not cooked properly, there can be illnesses and resulting tracebacks with severe economic penalty. Such a system has led to obvious inequities, the extent of which is related to the pasteurization capability or geographic location of the affected company.

We haven't been able to tell an egg complex owner where his SE came from, how to prevent it or even how to transition to negative status without going out of business. We are just demanding that he "fix the problem" as if he were General Motors or Boeing. We owe these people good scientific data that they can use and it needs to be presented in an understandable form.

I always try to put myself in the shoes of the impacted producer. How can I get rid of SE? How can I be certain I don't get it again? Hopefully, everyone that is involved in the SE issue, from the researcher at the bench to the Washington regulator, has been on an in-line egg farm with ten 100,000 layer houses, each of a different age connected by a head house to a processing facility. You cannot see such an operation without being overwhelmed with the obvious difficulty or cycling the facility from SE-positive to SE-negative status while staying in business and not losing it all.

All SE researchers and others of us involved should put ourselves in the shoes of egg producers in the morning as we plan our day. The next day we should think of the aged grandparent or small child that acquires SE from contaminated eggs with very serious consequences. If we did that, we would all work harder, more creatively and, hopefully, with a more beneficial outcome to all; including those we serve.

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