Vaccination: a key control strategy for salmonella in poultry meat production

Increasing per capita consumption of poultry meat and eggs combined with the ever increasing publicity of incidences of outbreaks of foodborne illness has placed greater pressure on poultry producers to reduce or eliminate these bacteria that can be transmitted to humans.

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Although, the news sensationalism of these outbreaks is recent, our knowledge of what can be done to reduce salmonella is not. We have been successfully reducing salmonella for over 50 years. However the beginning of HACCP and ISO requirements in our processing plants creates greater pressure to further reduce salmonella.

The poultry industry can accomplish the task of salmonella reduction by accepting one primary concept: salmonella is a management disease.

How, we manage our production system will determine our success in reducing salmonella. There has been a tremendous growth in the number of products and services that can be used to 'eliminate' salmonella. Many can be useful!

Salmonella control

Salmonella control on the farm actually begins in the hatchery for breeders, broilers, or layer pullets. Bailey and Cox have demonstrated repeatedly that the salmonella that infects chicks early in life is most often the same one that will be found later in life. Therefore, those control strategies that can be used to reduce/eliminate salmonella exposure in the breeders, hatchery, or first few days of a chick's life, are the most critical.

Salmonella control is a multi-discipline program requiring involvement of all segments of poultry production. It should also be remembered there is no single magic bullet that will prevent or eliminate salmonella.

The major areas we need to focus our management on are:

- Identify the salmonella.
- Stop the input.
- Vaccination (live/bacterin).
- Intestinal flora replacement (CE).
- Judicious use of an antimicrobial.
- Environmental clean-up or move flock.

Identify the salmonella

As with most health issues, there is more than one method for success and often it takes multiple steps to be successful.

In my experience, the first two steps should be to determine the source of the salmonella to this flock, or to all of your flocks, and then to stop the input.

Many of the intervention steps we use will not be less successful if salmonella continues to challenge the flock(s). Also remember there can be big differences in the difficulty/ease of elimination between the different serotypes of salmonella.

For example, some S. heidelberg isolates can be more difficult to reduce or eliminate than some of the S. enteritidis.

Stop the input

The task of controlling a bacteria that can survive, reproduce or be transmitted by mammals, birds, reptiles, or insects appears overwhelming. However, if broken down into smaller areas of responsibility, it becomes more manageable.

For example, in an integrated broiler company the broiler manager should focus on those management areas on the broiler farm that will reduce salmonella.

The broiler manager then asks his supplier, the hatchery manager, to reduce salmonella.

The hatchery manager concentrates on those management areas in the hatchery that will reduce salmonella in the chicks and asks the breeder manager to supply the hatchery with eggs with reduced salmonella. This system works all the way to the top of the breeding pyramid to the elite or pedigree birds of the primary breeder.

Continuous use of live vaccination in broilers may contribute to sustained reduction in salmonella to the processing plant.

Since each organisation must customise their salmonella control program, the following outline may help highlight some of the key areas:

- **Breeding pyramid**

Begin at the top: If you are a primary breeder, you must eliminate salmonella in the elite breeders. If you are at the commercial bird level, begin to control salmonella from your parent stock.

- **Biosecurity program**

Write and implement a biosecurity program with the help of the production people who will be carrying out the program. A biosecurity program should include managing people and equipment movement, cleaning, disinfecting, pest management (rodent/insect) and designing and building biosecure buildings.

- **Feed**

Feed and feed ingredients are a critical part of the program but in many instances are not the most important. Proper heat and chemical treatment of the feed, control of the dust in the feed mill and insect/rodent control are some critical areas to review.

- **Shavings/litter**

Litter is an input into a poultry house that should not be overlooked. Also, do not overlook the effect of moisture in the litter during a flock's life on the level of salmonella multiplication in the environment. Watering system management is important.

- **Water**

Water is a critical area to understand both as a source of salmonella coming into a house and more importantly as a method of spread within a house (water activity in the litter). Regular chlorination to 3-5ppm can reduce the level of salmonella transmission by as much as 50% in broilers.

- **Education**

Education of staff, contract workers and anyone entering your facilities (farms, hatcheries, feed mills, etc) is one of the most important steps in implementing a successful program to control salmonella. If people know why they are doing their job and how to do so in the proper way, they will do a good job.

Competitive exclusion

Competitive exclusion (CE) cultures or the normal intestinal flora of healthy adult chickens can prevent the colonisation of intestinal pathogens such as salmonella.

Dr Nurmi in 1973 found that CE can make chicks immediately resistant to a challenge of 1000 to 1 mil-

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lion salmonella cells. To date, the exact mechanism of CE has eluded scientists; however, the theories are:

- Production of volatile fatty acids.
- Lower the intestinal pH.
- Physical occupation of intestinal attachment sites.
- Stimulation of intestinal immunity.
- Production of antibacterial compounds.
- Competition for nutrients.

It is important to remember that for CE to be effective, it must colonise the chickens' intestine before the salmonella.

Note: CE treatment will prevent colonisation of the live vaccines so do not give both at the same time.

CE and antibiotic treatment

The combined use of an antibiotic followed by CE administration has been very successful in eliminating or reducing the level of salmonella in flocks of chickens.

Dr E. Goren published on the successful treatment with antibiotic and CE of 32 flocks of broiler breeders and also D. J. Reynolds et al. were successful in treating 13 broiler breeder flocks with both antibiotics followed by CE.

In both papers, the authors were convinced that the normal intestinal flora must be replaced after the antibiotic therapy for the treatment to be successful. An additional step from my own experience would include either moving the flock (if pullets) to a clean house/farm or treating the litter with a disinfectant to reduce the salmonella challenge.

Vaccination in broiler breeders

In many countries there are commercially available inactivated SE vaccines, with some combined with IBV and NCD. These are inactivated whole cell bacterins with an oil emulsion adjuvant. For some countries there may be an option of having an autogenous bacterin made from your isolate.

All of these inactivated vaccines are more successful when given at least two times before the flock comes into lay. Bacterins will result in a good humoral response that gives only partial protection against organ invasion and intestinal colonisation.

One of the major effects of bacterins is the maternal antibody transfer from the hen to reduce the number of chicks picking up salmonella early in life.

A disadvantage for bacterins is limited cross-protection between serotypes of salmonella. Two other things to keep in mind regarding bacterins is the immunity from a bacterin may not last the entire length of lay and also the flock may test plate agglutination positive for S. pullorum. Many countries have live vaccines available that are either attenuated ST or SE.

The major advantage of live vaccines is they afford protection to multiple serotypes i.e. give cross protection.

For example, a group B, S. typhimurium, can give protection against S. enteritidis (SE), a group D.

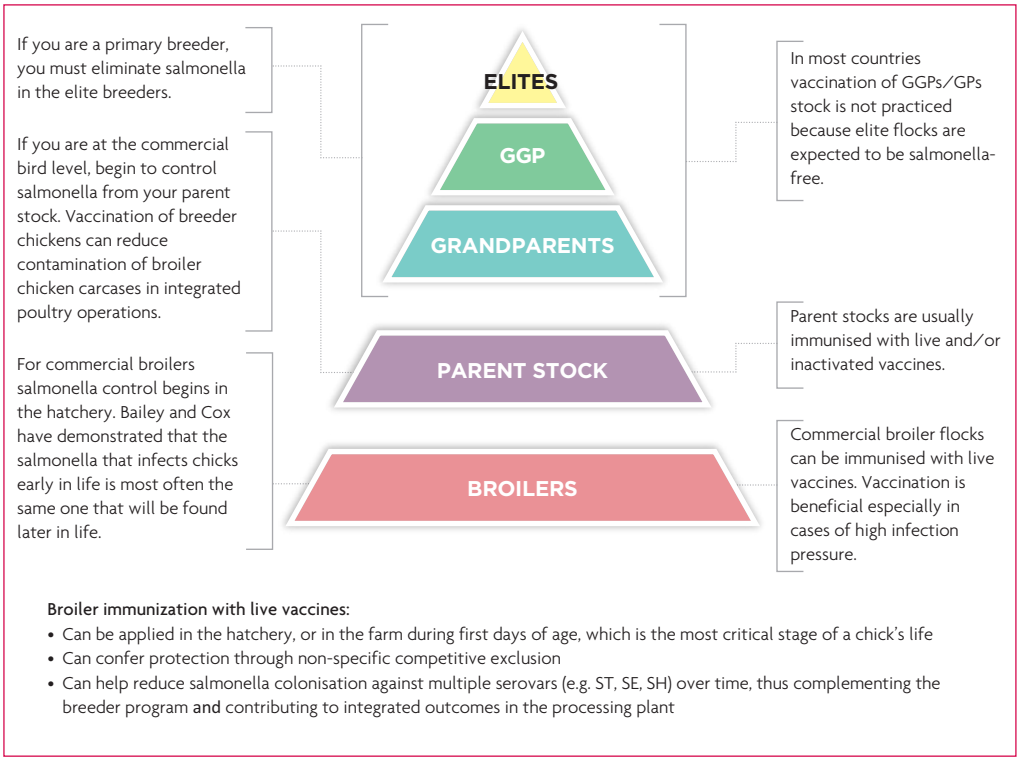

Fig. 1. Salmonella vaccination in poultry meat production (breeding pyramid).

Vaccination in broilers

In broilers we have two goals, first to reduce the overall level of salmonella coming into the processing facility. The second is to minimise or prevent those serotypes that have the greatest potential to cause human illness from entering the processing facility.

Live vaccination of broilers can be a very effective strategy for helping achieve both of these goals.

The live salmonella vaccines have the ability to give cross protective antibodies to many different serotypes effectively reducing the colonisation numbers of nearly all serotypes of human salmonella illness potential.

Therefore, when a processing facility is faced with a high incoming level of a salmonella that is a human health risk, live vaccination of broilers becomes a key control component along with biosecurity, probiotics, organic acids, etc in successful broiler intervention programs.

The science behind the vaccination

- In 2007, Dr Bailey, at the USDA Russell Research, showed that when you give a live salmonella vaccine you get antibodies in the crop and intestine of chicks that gives them protection for approximately 28 days. If you want protection into lay, he found you needed to also give one and better two inactivated or killed vaccines prior to lay.
- In a study at two different broiler companies, Dr John Maurer, and others at The University of Georgia, was able to show that breeder hens given live vaccines as pullets and two killed vaccines had significantly less salmonella in their caeca and ovaries compared to hens from another company that did not vaccinate. Even more important, the broilers from these vaccinated hens had nearly 50% less prevalence of salmonella positive (17%) vs. broilers from non-vaccinated hens (29%).
- In a second study by Drs Berghaus, Maurer and others looking at six flocks vaccinated vs. six flocks non-vaccinated, at the same broiler company, found a similar trend as in the first study, this time 14% positive for vaccinated broilers at the plant vs. 25.5% salmonella positive for the broilers from non-vaccinated hens. What is even more important is the amount of salmonella in the positive broilers from vaccinated hens was 50% lower than broilers from non-vaccinated hens. This means less contamination coming into the processing plant from broilers from vaccinated hens.

Keys to a successful breeder vaccination program

- Live vaccine protects pullets.
- Killed vaccine protects pullets and hens and gives maternal antibodies to broilers.
- A check of the vaccination crew 3-4 weeks after the first inactivated vaccine should show at least 95% serology positive by salmonella ELISA or pullorum plate test.

Conclusion

There is no single remedy, magic or silver bullet for salmonella control or eradication.

One of the most consistently effective tools is vaccination of breeders, conceived as a required and permanent component of any program, along with biosecurity measures.

Live vaccination, because it gives cross protection to different serovars, is a relevant tool to be used in broilers, especially in those instances where we need to have a reduction in that particular broiler flock.

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The most successful programs will be those that utilise as many of the intervention programs as is economically possible. ■

References are available from the author on request