

Vaccination of Turkey Breeders to Control *Salmonella*

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Salmonella continues to be a top food safety concern for the turkey industry, the USDA, and the consumer. *Salmonella* bacteria are the most frequently reported cause of foodborne illness in the U.S. (USDA, FSIS *Salmonella* and Salmonellosis). USDA’s Economic Research Service estimated the cost of all *Salmonella* (non-typhoid) illnesses in the U.S. in 2013 to be \$3,666,600,031 (USDA ERS. Cost Estimates of Foodborne Illnesses, 2016). CDC reported over 1,000,000 illnesses and 380 deaths were caused by *Salmonella* in the U.S. annually between 2000-2008 (www.cdc.gov/foodborneburden/PDFs/pathogens-complete-list-01-12.pdf). While these numbers take into account all sources of *Salmonella*, four human outbreaks of salmonellosis due to turkey products were documented in 2015, showing the risk of infection due to turkey products remains a concern (CDC Foodborne Outbreak Online Database).

In an effort to reduce the rate of outbreaks in humans, USDA has recently modified the plant testing procedures and *Salmonella* performance standards. The turkey carcass maximum acceptable percent positive is 1.7% and the comminuted turkey maximum percent positive is 13.5% (Table 1) (FSIS Performance Standards Verification Testing, 2016. USDA). In an effort to better assess *Salmonella* levels, the comminuted turkey sample size has increased from 25g to 325g (FSIS Notice 36-36-16: June 1, 2016). In addition, a neutralizer has been added to the buffered peptone water used in turkey carcass sampling to neutralize any products used in the plant which may inhibit *Salmonella* culture (FSIS Notice 41-16: June 8, 2016).

Table 1.
Salmonella/Campylobacter Performance Standards for Poultry

Product	Maximum Acceptable % Positive		Performance Standard	
	<i>Salmonella</i>	<i>Campylobacter</i>	<i>Salmonella</i>	<i>Campylobacter</i>
Broiler Carcasses ^a	7.5	10.4	5 of 51	8 of 51
Turkey Carcasses ^a	1.7	0.79	4 of 56	3 of 56
Comminuted Chicken [*]	25.0	1.9	13 of 52	1 of 52
Comminuted Turkey [*]	13.5	1.9	7 of 52	1 of 52
Chicken Parts [*]	15.4	7.7	8 of 52	4 of 52

^a The maximum percent positive for *Salmonella* and *Campylobacter* under the performance standards for young chicken and turkey carcasses is listed in FSIS Directive 10,250.1
^{*} Developed proposed performance standards published in the FRN Docket No. FSIS-2014-0023

Increasingly strict *Salmonella* standards combined with brand protection concerns, antibiotic free or N.A.E. (no antibiotics ever) production increases, and a reduction in antibiotics used in the hatchery and field place increasing emphasis on an effective *Salmonella* control plan. Controlling *Salmonella* contamination by strictly relying on plant interventions is no longer feasible. Today, a holistic approach is required. A strong *Salmonella* control program will address risks at all stages of live production. Interventions to control *Salmonella* contamination will be in place supported by standard operating procedures and quality assurance to assess intervention effectiveness. A comprehensive *Salmonella* control program must look at all opportunities of *Salmonella* entry into the supply chain, including feed, water, ventilation, litter, rodent and insect control, personnel, transportation, biosecurity, hygiene,

monitoring, and vaccination. Vaccination of poultry is a critical component of a *Salmonella* program, providing the hen with protective immunity to control *Salmonella* infections as well as reducing vertical transmission from the hen to the poult (Hassan & Curtiss, 1994). Both live and inactivated (killed) *Salmonella* vaccines are available for use and each is an important component of a *Salmonella* control program in turkey breeders.

Live Vaccination

Early application of a live *Salmonella* vaccine is important as newly hatched poult have minimal intestinal flora (Fig. 1) therefore, harmful bacteria, including *Salmonella*, have little competition in the intestine and may more readily colonize birds. Live *Salmonella* vaccines are applied in the hatchery or on the farm at day of age via coarse spray. Early application of a live *Salmonella* vaccine allows the vaccine strain to multiply and colonize the intestinal tract (Fig. 2). Colonization of the intestinal tract by the vaccine strain provides a competitive exclusion effect against wild strain *Salmonella* (McReynolds et al, 2007).



Figure 1 – Intestinal lining of newly hatched bird
Photo courtesy of Dr. I. Alvarado

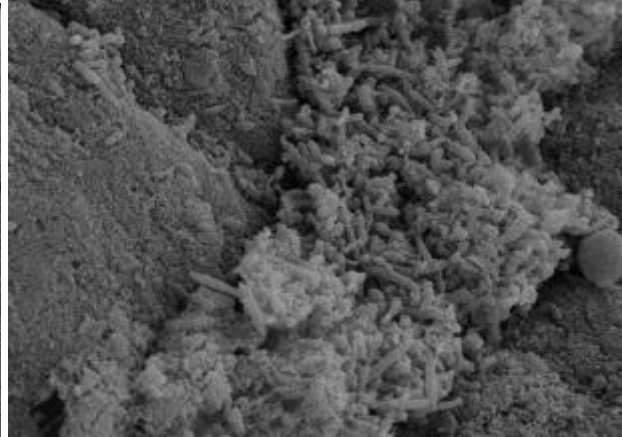


Figure 2 –Intestine colonized with AviPro Megan Vac 1, a live *Salmonella* Typhimurium vaccine.

In addition, live vaccines allow localized immunity in the intestinal tract, primarily IgA, aiding in the ability to respond to a wild strain *Salmonella* insult (Hassan & Curtiss, 1990). Finally, circulating antibody is produced by the humoral immune system which can be measured and monitored through serologic ELISA tests. By stimulating the immune system of the turkey, a "memory" is formed, allowing the bird to more quickly respond to wild-type *Salmonella* challenge. When a live *Salmonella* vaccine is used prior to the administration of killed *Salmonella* vaccine, the live vaccine helps to prime the immune system, allowing a quicker and more robust response to the killed vaccine (Hafez et al, 2001).

Research has shown the precursor to Megan Egg, a live *S. Typhimurium* vaccine licensed for use in turkeys, provides cross protection to other *Salmonella* serovars (Hassan & Curtiss, 1990). The researchers concluded that: protection against challenge with virulent group B *Salmonella* serotypes was excellent with very good protection against challenge with group D or E *Salmonella* serotypes, while protection against challenge with group C *Salmonella* serotypes was marginal but significant (Hassan & Curtiss, 1990).

Inactivated Vaccines

Inactivated vaccines are cultures of organisms that have been killed chemically, by heating or by irradiation. An adjuvant is added to the vaccine to enhance the immune response to the bacterial antigen. Water and oil emulsions are commonly used adjuvants in the preparation of bacterin poultry vaccines. Commercial inactivated vaccines are available for select serovars. Autogenous inactivated vaccines allow the customer to customize a blended vaccine of targeted serovars isolated on the farm.

Inactivated vaccines stimulate long-term circulating antibody and also allow the hen to deposit antibody (IgY) into the egg (Pavic et al, 2010). The deposition of antibody in the egg is referred to as maternal IgY antibody, and helps the poult when challenged with wild-type *Salmonella* early in its life (Hassan & Curtiss, 1996).

Conclusion

Both live and inactivated *Salmonella* vaccines play a critical role in a comprehensive *Salmonella* control program. Live vaccines can provide early protection for breeder poults through competitive exclusion, local immunity of the intestinal tract, and humoral antibody production for extended protection. Inactivated vaccines provide focused serovar-specific protection for breeding stock for an extended period of time. Live and inactivated *Salmonella* vaccines, when used in combination, provide broad protection for breeding stock over the life of the flock. This duration of immunity is evident when offspring benefit from the antibodies passed from the mother hen through the egg. In addition to best management practices, preventive biosecurity and vaccination with live and inactivated *Salmonella* vaccines are key components of a pre-harvest *Salmonella* control program. Since contaminated food, and especially poultry products, are the major source of human *Salmonella* infection, vaccination of turkeys is an important strategy to reduce the levels of *Salmonella* in flocks, which should ultimately lower the risk of *Salmonella* food-borne illness.

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