Study of Salmonella typhimurium infection and vaccination in laying hens

Pardeep Sharma
(B.V.Sc. & A.H., M.V.Sc.)

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THE UNIVERSITY
of ADELAIDE

School of Animal and Veterinary Sciences

The University of Adelaide

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Thesis Abstract

*Salmonella* Typhimurium is responsible for the majority of egg-associated foodborne outbreaks in Australia. It colonises sub clinically in commercial laying hens, and these hens can shed bacteria in the poultry environment resulting in egg contamination; hence, it is of significant public health concern. Therefore, understanding the biology of *S. Typhimurium* shedding, host-pathogen interaction, and its management in laying hens is essential. In our study we conducted a 16-week infection trial, using layer hens reared free from exogenous *Salmonella*. The results highlighted that *S. Typhimurium* continued to persist in the internal organs for 16 weeks post challenge and infection was not eliminated despite measurable antibody response from the asymptomatic *S. Typhimurium* carrier adult birds. The stress of onset of lay led to the recrudescence of *S. Typhimurium*, further leading to its proliferation, intermittent shedding and causing eggshell contamination.

Live attenuated *Salmonella* vaccine is commonly used for the vaccination of chickens to control the contamination of poultry products. *Vaxsafe® ST*; (Strain STM-1, ≥ 10^{7.0} cfu/dose, Bioproperties Pty Ltd) is the only commercially available live attenuated *aroA* deletion mutant *S. enterica* serovar Typhimurium vaccine in Australia and was used in this study. The antibody response to vaccine and efficacy of *Vaxsafe® ST* during pullet rearing and early production were investigated. The pullets vaccinated after intramuscular injection at 12 weeks produced significantly higher antibody response (*p < 0.001*) to *S. Typhimurium* vaccine strain. The vaccine strain STM-1 successfully colonised the chicken gut but did not induce a systemic antibody response until after parenteral administration. The load of STM-1 in litter samples increased gradually and was significantly higher at week 13, highlighting that *Vaxsafe® ST* has a potential as an antigen delivery system.
During laying, Vaxsafe® ST was tested in naturally infected *S*. Typhimurium laying hen flocks. At the onset of lay there was no significant difference in prevalence of *Salmonella* spp. in faeces in vaccinated and unvaccinated groups, although antibody titre was significantly higher in vaccinated than unvaccinated group at all sampling points during this study. The prevalence of wild-type *S*. Typhimurium did not vary significantly in subsequent samplings. *S*. Typhimurium was consistently found in dust and shoe cover samples, throughout the study. Given that *S*. Typhimurium and other serovars can survive/persist in the shed environment (such as in dust), regular cleaning, disinfection and or removal of dust from shed is necessary. *Salmonella* spp. can form biofilms on various surfaces hence cleaning of the shed could be challenging.

Three commercial disinfectants (Product A, B and C: containing a chlorinated compound, quaternary ammonium compounds (QAC), and twin-chain QAC; respectively) tested in this experiment significantly reduced viable biofilm cells; however, none of the product eliminated the biofilm cells. The results of this study showed that biofilm age was associated with the increased resistance to disinfectant treatments. These findings may have future implications for the use of disinfectants such as required concentration and exposure time in the poultry industry to control biofilm.

From this work, it can be concluded that *S*. Typhimurium persists in the internal organs of hens for a prolonged period and these hens act as a latent carrier with a continuous source of egg and environmental contamination. Vaccination of poultry, which would decrease *S*. Typhimurium contamination of flocks, is considered as an effective measure to reduce human cases of salmonellosis. However, use of the Vaxsafe® ST vaccine in laying hens is “not an ultimate intervention” for reduction of *S*. Typhimurium, hence, implementation of more than one or several interventions strategies is essential.
Thesis Declaration

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name, in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name, for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint-award of this degree.

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List of Publications


Manuscripts submitted for Publications


Conference Oral and Poster Presentations


Salmonella Typhimurium shedding and egg contamination in experimentally infected laying hens (Oral). The 43rd Annual General Meeting of the Australian Society for Microbiology, 12-15 July 2015, Canberra, Australia.