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Targeted low cost solutions for control of *Salmonella* in pig production



Key external stakeholders:

Pig sector, Department of Agriculture, Food and the Marine, Food Safety Authority of Ireland

Practical implications for stakeholders:

This project investigated low cost practical solutions to control *Salmonella* in pig production, including the use of feed additives and lairage decontamination strategies. Studies to identify if breeding sows played a role in the perpetuation of *Salmonella* on-farm and whether vertical transmission occurred suggest that *Salmonella* shedding in sows is low and transmission to their progeny appears negligible. The contaminated pen environment appears to be more significant in the spread of the organism indicating that improving management and hygiene practices within farms would be beneficial for the control of *Salmonella* and other infections. Findings from studies investigating the usefulness of organic acid-based feed additives in the control of *Salmonella* in weaned and finisher pigs indicate that, although some of the additives reduced faecal shedding, feed additives are unlikely to be effective as the sole measure in controlling *Salmonella* levels on commercial pig farms with good management including effective biosecurity and control of concurrent disease also essential. Studies conducted in the abattoir showed that drying lairage pens after cleaning and disinfection with a chlorocresol-based disinfectant eliminated *Salmonella*. This is a useful finding for the industry as the role of contamination acquired in lairage in subsequent contamination of carcasses is well established.

Main results:

This project investigated a number of low cost practical solutions to control *Salmonella* carriage and transmission on Irish commercial pig farms

- *Salmonella* shedding by breeding pigs was low in all stages of the production cycle and it appears that sows do not pose a major risk in the maintenance and transmission of *Salmonella* to their progeny but contaminated pen environments are significant in perpetuation of the organism on farm.
- In grower pigs, a significant reduction in *Salmonella* faecal concentration was observed after supplementation with both coated sodium butyrate (Adimix®; $p = 0.001$) or a formic citric acid blend (FormaXOL™; $p < 0.001$). Average daily weight gain (ADWG) of grower pigs was significantly increased in all groups fed the supplemented feed.
- In finisher pigs, feed supplementation with Adimix®; and FormaXOL™ for 28-days prior to slaughter was effective in reducing *Salmonella* shedding and seroprevalence but only in the absence of secondary infections.
- In the abattoir, drying lairage pens after cleaning and disinfection with a chlorocresol-based disinfectant eliminated *Salmonella*. Additionally, misting of pigs with a preoxygen disinfectant was also shown to have a beneficial role in topical treatment of pigs contaminated with *Salmonella*
- *Salmonella* infections decrease productivity in pigs and its control, even when this costs money, can result in a cost-benefit to the farmer. Adding other interventions to the use of organic acids (biosecurity, control of concomitant diseases etc.) increases the control of *Salmonella* with low cost.

Opportunity / Benefit

The cause of *Salmonella* in pig herds is multifactorial and control measures must be part of overall health plan for the individual herd. It could be improved by enhanced biosecurity, better hygiene and management. The project results are readily applicable to farmers, abattoirs and regulatory agencies; and have added novel findings to the field of *Salmonella* control in pigs:

Collaborating Institutions: University College Dublin, Waterford Institute of Technology

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External collaborators: Dr Nola Leonard, University College Dublin
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Dr Gillian Gardiner, Waterford Institute Technology
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1. Project background

Salmonella in pigs is a significant food safety issue in Ireland. Previous research has highlighted that risk factors for *Salmonella* contamination in pork, include high carriage of the pathogen at primary production and cross contamination in the lairage. This project investigated low cost practical solutions to control *Salmonella* carriage and transmission on Irish pig farms. The strategy was the targeted use of selected in-feed organic acids at different stages of pig production, growers and finishers, as well as the use of lairage decontamination strategies.

2. Questions addressed by the project:

- What are the benefits of low cost solutions i.e. acid feed additives and decontamination strategies to control *Salmonella* carriage and transmission in pig production ?
- What are the benefits of low cost solutions such as decontamination strategies and disinfectant misting to control *Salmonella* transmission in the lairage of the slaughterhouse ?
- What is the impact of combined treatments in a production cycle on a model commercial farm ?
- What is the cost benefit of treatments at each of the four stages of the pig chain ?

3. The experimental studies:

- Shedding patterns in breeding pigs were investigated throughout a full production cycle and the risk of transmission of infection from the sow to her offspring. A longitudinal study was conducted on five farrow- finish commercial pig farms, with sampling of faeces and the environment for *Salmonella*
- The effect of 3 organic acid-based products added to the feed of grower pigs on *Salmonella* levels was investigated
- In finishing pigs dietary supplementation with feed additives investigated (1) coated sodium butyrate (Adimix[®]) and (2) an encapsulated blend of formic acid, citric acid, and essential oils (FormaXOL[™]) for their effectiveness to control *Salmonella* shedding and seroprevalence in pigs when fed for ~28 prior to slaughter.
- In the abattoir, two strategies: a) cleaning and disinfection of lairage pens with a quaternary ammonium chloride or chlorocresol-based disinfectant; or (b) misting pigs with a peroxygen disinfectant at 0.5% were evaluated for their ability to eliminate *Salmonella* in the lairage environment and to topically reduce *Salmonella* prior to slaughter, respectively
- A case study investigated the efficacy of three interventions: (1) cleaning and disinfecting finisher pens with an peroxygen agent and a chlorocresol-based disinfectant followed by a drying step, and (2) supplementing finisher feed with sodium butyrate (3 kg/t) for 63 days prior to slaughter, or (3) supplementing finisher feed with sodium butyrate (3 kg/t) for 28 days prior to slaughter on *Salmonella* shedding and seroprevalence on a commercial farm with a history of high *Salmonella* seroprevalence and secondary infections.
- A cost benefit analysis was conducted on the use of *Salmonella*-control strategies in commercial pig operation

Main results:

- *Salmonella* shedding by breeding pigs was low in all stages of the production cycle and it appears that sows do not pose a major risk in the maintenance and transmission of *Salmonella* to their progeny but contaminated pen environments are significant in perpetuation of the organism on farm.
- In grower pigs, a significant reduction in *Salmonella* faecal concentration was observed after supplementation with both sodium butyrate ($p = 0.001$) or a formic citric acid blend ($p < 0.0001$). Average daily weight gain (ADWG) of grower pigs was significantly increased in all groups fed the acid supplemented feed.
- In finisher pigs, feed supplementation with sodium butyrate and the formic citric acid blend for 28-days prior to slaughter was effective in reducing *Salmonella* shedding and seroprevalence but only in the absence of secondary infections. Neither feed additive influenced intestinal carriage, nor did they reduce seroprevalence to below the cut-off used for the high *Salmonella* risk category in Ireland

(50%), In the abattoir, drying lairage pens after cleaning and disinfection with a chlorocresol-based disinfectant eliminated *Salmonella*. Additionally, misting of pigs with a preoxygen disinfectant was also shown to have a beneficial role in topical treatment of pigs contaminated with *Salmonella*. *Salmonella* infections decrease productivity in pigs and its control, even when this costs money, can result in a cost-benefit to the farmer. Adding other interventions to the use of organic acids (biosecurity, control of concomitant diseases etc.) increases the control of *Salmonella* with low cost.

4. Opportunity/Benefit:

The issue of *Salmonella* in pig herds requires multifactorial control and must be part of overall health plan for the individual herd. It could be improved by enhanced biosecurity, better hygiene and management. The project results are readily applicable to farmers, abattoirs and regulatory agencies; and have added novel findings to the field of *Salmonella* control in pigs.

5. Dissemination:

Main publications:

Argüello H, Walia K, Lawlor PG, Duffy G, Gardiner GE, Leonard FC. (2016). Evaluation of an Alternative Experimental Infection Method, which closely mimics the Natural Route of Transmission of Monophasic *Salmonella Typhimurium* in Pigs. *Foodborne Pathog Dis.* 14(1):23-28.

Walia, K. Argüello, H, Lynch, H., Leonard, F.C., Grant, J., Yearsley, D., Kelly, S., Duffy, G., Gardiner, G., Lawlor, P.G. (2016). Effect of feeding sodium butyrate in the late finishing period on *Salmonella* carriage, seroprevalence, and growth of finishing pigs. *Preventive Veterinary Medicine* 1;131:79-86

Lynch, H. Finola C. Leonard, Kavita Walia, Peadar G. Lawlor, Geraldine Duffy, Seamus Fanning, Bryan K. Markey, Colm Brady, Gillian E. Gardiner, Hector Arguello-Rodriguez. (2017). Investigation of in-feed organic acids as a low cost strategy to combat *Salmonella* in grower pigs. *Preventive Veterinary Medicine*, 139 50–57

Walia, K. Argüello, H, Lynch, H., Leonard, F.C., Grant, J., Yearsley, D., Kelly, S., Duffy, G., Gardiner, G., Lawlor, P.G. (2017). Effect of strategic administration of an encapsulated blend of formic acid, citric acid, and essential oils on *Salmonella* carriage, seroprevalence, and growth of finishing pigs. *J Prev. Veterinary medicine* 1;137, 28-35.

Walia, K., Arguello, H., Lynch, H, Grant, J., Leonard, F; Lawlor, P.G. and Gardiner, G and Duffy, G (2017). The efficacy of different cleaning and disinfection procedures to reduce *Salmonella* and *Enterobacteriaceae* in the lairage environment of a pig abattoir. *Int J Food Micro* 4; 246:64-71

Walia, K., Lynch, H, Grant, J., Duffy, G, Leonard, F; Lawlor, P.G. and Gardiner, G (2017). The efficacy of disinfectant misting in the lairage of a pig abattoir to reduce *Salmonella* and *Enterobacteriaceae* on pigs prior to slaughter *Food Control* 75 55- 61.

Lynch, H., Gardiner, G.E., Egan, J., Walia, K., Duffy, G., Lawlor, PG and Leonard, F.C. (2018) *Salmonella* in breeding pigs: shedding pattern and transmission of infection to progeny in Irish commercial farrow-to-finish herds. *Zoonoses and Public Health.*;1–11.

Arguello, H., Manzanilla, E.G., Lynch, H., Walia, K., Leonard, F.C., Egan, J., Duffy, G., Gardiner, G.E., and Lawlor, P.G. (2018). Surveillance data highlights feed form, biosecurity and disease control as significant factors associated with *Salmonella* infection on farrow-to-finish pig farms *Frontiers in Microbiology*

6. Compiled by: Geraldine Duffy and Peadar Lawlor