acid and hydrogen peroxide, inhibiting growth of pathogens, and enhancement of digestion and utilization of nutrients (Lutful Kabir, 2009). However, no differences were found between piglets raised in CE and control units in our study. In addition, no differences in fecal consistency was noticed. In addition, no differences in TD100 were found. A possible explanation for not obtaining the claimed effect of reducing the microbiological infection pressure and improved feed conversion might be the too low administered dose of CE bacteria resulting in the need to revise the product compositions and application protocols. On the other hand, there is also the possibility that CE is not a valuable alternative for classical cleaning and disinfection.

Conclusion

Very few studies about the impact of microbial cleaning and administration during production on the environment in animal houses is available. Our results showed that competitive exclusion by probiotic type bacteria could not meet the claims provided by the manufacturer. Moreover, this study showed that a good cleaning and disinfection protocol during vacancy is still very important for reducing infection pressure in nursery units. However, more research should be carried out for a valuable alternative, because disinfectant resistance might be an upcoming problem.

Acknowledgments

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References

[References are listed in the document, starting with the year of publication and author names.]

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Introduction

Ireland has a high prevalence of Salmonella contamination on pork carcasses (20%) (EFSA, 2008) and this is related to a high level of Salmonella carriage in some pig herds within the country (Burns et al., 2013). This highlighted a need to find measures to control Salmonella shedding in pigs at primary production, especially in finishing pigs, as they are a significant source of Salmonella in the abattoir. Dietary supplementation with organic acids has shown promise in controlling Salmonella in pigs (Friendship et al., 2006). After a critical review of the literature, sodium butyrate was selected for further evaluation. Sodium butyrate acts via down-regulation of the expression of hilA (an invasion gene) in Salmonella, thereby suppressing its ability to invade porcine intestinal epithelial cells, which in-turn decreases faecal shedding of the bacteria in pigs (Boyen et al., 2008). This study investigated the ability of dietary supplementation with sodium butyrate during the last month of growth pre-slaughter to reduce faecal shedding and intestinal carriage of Salmonella in finisher pigs.

Material and Methods

(a) Farms

Farm A had a historically high Salmonella seroprevalence (according to the Irish National Pig Salmonella Control Programme) i.e. > 60%; however, prior to commencement of the trial, the seroprevalence declined to 0%. Thus, artificial contamination of pens using a Salmonella strain recovered from sows on the farm during the same time period was performed in advance of the feeding study. This strain was a monophasic variant of S. Typhimurium (4,5,12:i-), and its antimicrobial resistance pattern was determined to be ASSuT. Farm B, on which pigs had been shown to carry S. Typhimurium, also had a historically high Salmonella seroprevalence (i.e. > 50%).

(b) Animal Housing and Diets

Farm A had 14 pens with a total of 168 pigs (72 males and 96 females, with 12 same gender pigs/pen),
while Farm B had 12 pens with a total of 177 pigs (86 males and 91 females, with 12-17 same gender pigs/pen). Approximately 4-weeks before the target slaughter date, pigs on both farms were randomly assigned to one of two dietary groups: a standard finisher feed with no feed additive (control) or the same finisher feed with 0.3% sodium butyrate (Adimix®, Nutriad, Kasterlee, Belgium; acid). The sodium butyrate additive used was coated to ensure delivery to the lower intestinal tract.

(c) Sample Collection

On both farms, pigs were weighed before diets were administered (day 0) and before pigs were sent to slaughter (day 26 for Farm A and day 24 for Farm B). Feed intake for each pen was recorded on a weekly basis. Faecal samples (25 g) were collected from each pig on days 1, 12 and 24/26; and swabs were taken from the trucks used to transport pigs to the abattoir (before loading) and from two holding pens at the abattoir. On day 28, all 168 pigs from Farm A were sent to slaughter; whereas for Farm B, 88/177 pigs were sent to slaughter on day 26 and the remaining 89 pigs were sent to slaughter on day 32. Following slaughter, caecal digesta (≥ 25 g), and ileocaecal lymph nodes (ILN) together with mesenteric lymph nodes (MLN) (≥ 10 g) were collected from 88 animals (45 control and 43 acid) from each farm for Salmonella detection. The ILN and MLN were pooled prior to analysis. Carcass quality data were also collected from each animal post-slaughter. All samples were collected aseptically and kept cool on ice until analysis (within 24 hours).

(d) Sample Analysis

Salmonella Detection and Serotyping: The presence/absence of Salmonella was determined in all samples using standard enrichment procedures (ISO6579:2007; Amendment 1: Annex D). Serotyping of all presumptive Salmonella isolates was performed using a real-time PCR assay for identification and differentiation of Salmonella enterica serovar Typhimurium and monophasic serovar 4,[5],12:i:- as described by Prendergast et al. (2013). Any isolates not identified as Salmonella Typhimurium or its monophasic variant, were serotyped according to the White-Kauffmann-Le Minor scheme using commercial antisera.

Statistics: All statistical analysis was performed using the Proc Glimmix procedure of SAS (SAS Inc, Cary, N. Carolina).

Results

Compared to the control group, administration of sodium butyrate resulted in a decline in Salmonella shedding as compared to the control group (30% vs. 57% probability of detecting Salmonella in faeces, respectively; p<0.01; Figure 1a). When comparing the effect of treatment between days 12 and 26, supplementation with sodium butyrate was again more effective in reducing Salmonella shedding (66% vs. 63% probability of detecting Salmonella in faeces, respectively p<0.001) than no supplementation (50% vs. 77%, respectively; p=0.08, Figure 1a). No effect of acid treatment on Salmonella shedding was observed for Farm B (Figure 1b). Truck swabs for both farms were Salmonella-negative; while the 2 lairage pens swabbed (for Farm B) were Salmonella-positive.

No significant treatment differences in Salmonella recovery rates were observed in the caeca or ILN/MLN collected at the slaughterhouse for either farm (Figure 1c). The Salmonella serovars recovered from the faecal samples were S. 4,5,12:i:- (Farm A) and S. Typhimurium 1,4,[5],12:i:1,2 (Farm B). The caecal and ILN/MLN isolates were serotyped as S. 4,[5],12:i:- (Farm A and B) and S. Typhimurium 1,4,[5],12:i:1,2 (Farm B) and the lairage isolates as S. 4,[5],12:i:-.

In terms of production parameters, no significant differences were observed in feed intake, weight gain or feed conversion efficiency (FCE) between control and acid-treated groups for both farms. For Farm B, female pigs on the acid treatment had a significantly higher kill-out yield than male pigs on the acid treatment (79.4% vs. 77.1%, respectively; p=0.02). There was also a tendency for females to have a higher kill-out yield than males (79.0% vs. 78.0%; p=0.06). Muscle depth of pigs in the control and acid-treated groups were 51.8 mm and 50.1 mm, respectively (p=0.06).

Discussion

This study evaluated the effectiveness of a commercially available sodium butyrate in reducing Salmonella shedding and intestinal carriage in finisher pigs and also investigated its ability to improve growth performance. Dietary supplementation with sodium butyrate was successful in decreasing Salmonella shedding over a 26-day period on a highly contaminated farm with no secondary infection. This result is in line with previous research that showed reductions in Salmonella shedding in weaner pigs deliberately infected with Salmonella after 12 days of dietary supplementation with sodium butyrate (Boyen et al., 2008). However, this is the first on-farm trial that has used sodium butyrate as a control measure to reduce the shedding of Salmonella in finishing pigs. A co-infection by Lawsonia intracellularis on Farm B may explain the absence of a sodium butyrate effect on that farm. In addition, for Farm B, the caecal and ILN/MLN isolates were identified as both S. Typhimurium and its monophasic variant. The latter serotype was not recovered from the pig faeces at farm level but was recovered from the two lairage pens sampled at the abattoir, prior to loading the pigs. This suggests that the pigs from Farm B may have also acquired a new infection in the lairage.

Despite the absence of statistically significant effects on growth, pigs fed the acid treatment on Farm A showed a 7% increase in growth rate and an 8% improvement in FCE over the 26-day feeding period compared with pigs on the control diet. Similarly, for Farm B, pigs on the acid treatment showed a 2.6% increase in growth rate and a 4% improvement in FCE over the 24-day feeding period compared with those on the control diet.

Conclusion

Overall, dietary supplementation with sodium butyrate for a relatively short period of time (<30 days) prior to slaughter can be considered an effective control measure to reduce faecal shedding of Salmonella in finishing pigs. However, it did not reduce intestinal carriage at slaughter and did not significantly improve growth performance in pigs.

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References


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Table 1. Salmonella prevalence in faeces collected from individual finisher pigs fed either a control diet or a diet supplemented with sodium butyrate during sampling days 0, 12, 24/26 for Farms A and B

<table>
<thead>
<tr>
<th>Farm A</th>
<th>Day 0</th>
<th>Day 12</th>
<th>Day 26</th>
<th>Farm B</th>
<th>Day 0</th>
<th>Day 12</th>
<th>Day 24</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pigs with Positive Faeces</td>
<td>Control</td>
<td>Acid</td>
<td>Control</td>
<td>Acid</td>
<td>Control</td>
<td>Acid</td>
<td>Control</td>
</tr>
<tr>
<td>No. Pigs</td>
<td>55</td>
<td>53</td>
<td>57</td>
<td>58</td>
<td>56</td>
<td>57</td>
<td>58</td>
</tr>
<tr>
<td>No. Pigs with Negative Faeces</td>
<td>Control</td>
<td>Acid</td>
<td>Control</td>
<td>Acid</td>
<td>Control</td>
<td>Acid</td>
<td>Control</td>
</tr>
<tr>
<td>No. Pigs</td>
<td>45</td>
<td>43</td>
<td>42</td>
<td>42</td>
<td>44</td>
<td>43</td>
<td>42</td>
</tr>
<tr>
<td>Total Pigs</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Salmonella Prevalence

- Control Acid Control Acid Control Acid Control Acid
- 17.65 41.67 50.59 63.10 55.29 33.33 19.54 5.56
- 85 84 85 84 85 84 87 90
- 15 35 43 53 47 28 17 5
- 22.22 22.22 22.22

Figure 1. The probability of detecting Salmonella in faeces (a, b), caeca and ILN/MLN (c) from finisher pigs in control versus acid treatment groups for Farms A and B

- p<0.001 (acid group on day 12 versus day 26)
- p=0.018 (control group versus acid group on day 26)

Abstract

Pork carcasses’ direct or indirect contamination by Enterobacteriaceae and E. coli (hygiene criterions), mainly by bacteria present in intestinal or skin faecal material, can occur at different stages of the slaughter line. In this study it was determined the level of Enterobacteriaceae and E. coli contamination on the skin of 100 pigs and in the corresponding carcasses. It was also analysed, for each pig, the skin visible level of faecal contamination (VLFC), recorded the holding time in lairage and the slaughter order (beginning or ending). In each animal, sponge swabs were performed on the skin and in the respective carcasses (approximate 1000 cm²). A total of 200 samples were microbiologically analyzed according to ISO 21528-2:2004 (Enterobacteriaceae) and ISO 16649-2:2001 (E. coli).

The achieved results showed that there was no significant correlation (p-value >0.05) between VLFC in the skin’s pig and its level of bacteria contamination which could be due to the shower, used before stunning, that maybe had a different effect on the removal of VLFC and bacteria from the skin (that could still adhered to the skin after shower). Increasing holding time in lairage leaded to a highly significant increasing level of Enterobacteriaceae and E. coli (p-value <0.001), both on swines’ skin and in the respective carcasses. Achieved results also showed that pigs mean time in lairage was significantly higher for pigs slaughtered at the beginning than for those ones slaughtered at the end of the session (p<0.001), which could help to explain why the average level of Enterobacteriaceae and E. coli on pigs skin’s and in carcasses was significantly higher for pigs slaughtered at the beginning than for those slaughtered at the end.

The results allows to underline lairage logistic and showers efficiency before slaughter as important processes that should be efficiently controlled in order to improve hygiene level of pork carcasses.

Introduction

According to Commission Regulation 2073/2005 (amended by Commission Regulation (EC) No 1441/2007), Enterobacteriaceae count is considered a process hygiene criteria (PHC) used to evaluate faecal contamination (FC) of fresh meat carcasses. It sets an indicative contamination value above which corrective actions are required in order to maintain the hygiene of the process in compliance with food law. Criteria for the mean Enterobacteriaceae counts on pigs are: satisfactory, if the daily mean log is ≤2.0 log cfu/cm², acceptable, if the daily mean log is between 2.0 log cfu/cm² and 3.0 log cfu/cm² and unsatisfactory, if the daily mean log is > unsatisfactory, if the daily mean log is >3.0 log cfu/cm².

Enterobacteriaceae and E. coli are two interchangeable indicators used to specifically target the level of faecal contamination (Barco et al., 2014). Indicator bacteria are considered an interesting target for microbiological analysis in order to obtain information about the hygiene of processes and products. Microbiological criteria can also be used in validation and verification of HACCP procedures and other hygiene control measures. Also, since pathogenic bacteria are infrequently present on carcass surfaces, generic E.