EFFECT OF BENZOIC ACID IN THE FEED ON SALMONELLA TYPHIMURIUM IN WEANED PIGS

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Abstract The effect of benzoic acid on Salmonella Typhimurium was compared to formic acid + lactic acid in naturally infected weaners. Addition of 1% benzoic acid or 0.5% lactic acid + 0.5% formic acid did not result in a significant reduction of Salmonella prevalence, neither bacteriological nor serological, after 5 weeks of administration, compared to a control diet consisting of pelleted feed without organic acid. In contrast, adding organic acid to the diet improved average daily gain and other production parameters, irrespective of the type of acid.

Introduction Reduction of Salmonella infection pressure in pig herds can be achieved in different ways, e.g. through feed intervention strategies. Many studies have shown a decrease in Salmonella prevalence in pigs following the use of meal feed instead of pelleted feed, inclusion of barley in the diet, coarse grinding, and addition of organic acids (e.g. Jørgensen et al., 2003). Especially addition of organic acids such as formic acid and lactic acid have proven very fast and effective means to reduce Salmonella prevalence rapidly in problem herds.

Recent experimental work at the Danish Institute of Agricultural Science (DIAS) has shown very promising effects of benzoic acid on Salmonella. In vitro studies showed that benzoic acid was much more potent in the reduction of Salmonella compared to the documented effects of formic acid and lactic acid. Therefore, it was decided to carry out an intervention study with the aim to measure the effect of benzoic acid on natural Salmonella infections in weaned pigs and to compare its effect with an often used and well documented combined feed intervention of formic and lactic acid.

Materials and Methods The study was performed at an experimental farm in Jutland, with facilities for raising pigs from 7 to 30kg. Pigs were purchased weighing 6-8kg (one week after weaning) from a farm that had been experiencing recurring problems with Salmonella Typhimurium during a one-year period. Repeated fecal sampling and bacteriological analysis using pen floor samples had revealed a persistent high prevalence in weaner pigs of 40-50%. Upon arrival at the experimental farm, the pigs were randomly assigned to one of three experimental groups:

1) Pelleted feed without organic acids (control)
2) Pelleted feed with addition of 0.5% lactic acid + 0.5% formic acid
3) Pelleted feed with addition of 1% benzoic acid

Each group contained 226 pigs, which were housed pen-wise in groups of 6 pigs, i.e. 37 pens per treatment group. All pigs were fed a standard weaner diet during the first two weeks after arrival. Subsequently, from week 3 to week 7 the pigs were fed the experimental diets as described above.

Excretion of Salmonella was monitored at pen level by examining rectal fecal samples from 5 pigs in each pen as a pooled sample five weeks after the start of the experimental diets. To improve the probability of detection, this procedure was carried out in duplicate in each pen, and at the laboratory all samples were incubated for 48 h instead of 24 h. In addition, blood samples were collected from all pigs 5 weeks after the start of the experimental diets and examined for antibodies against Salmonella enterica using the Danish mix-ELISA.

Finally, average daily gain and feed units per pigs (FUp) were recorded to assess the effect of organic acids on production parameters. Disease, medical treatment and mortality were also recorded at pen level.

Results The prevalence of Salmonella-positive pen

<table>
<thead>
<tr>
<th>Group</th>
<th># of pens</th>
<th>% Salmonella-positive pens</th>
<th>Relative Risk</th>
<th>95% C.I.</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lactic+formic acid</td>
<td>37</td>
<td>43.2</td>
<td>1.07</td>
<td>0.62-1.83</td>
<td>0.81</td>
</tr>
<tr>
<td>Benzoic acid</td>
<td>37</td>
<td>40.5</td>
<td>1.00</td>
<td>0.58-1.74</td>
<td>1.00</td>
</tr>
<tr>
<td>Control</td>
<td>37</td>
<td>40.5</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Prevalence of Salmonella in weaners fed diets with or without organic acids.
Fecal samples following 5 weeks on control or acid-containing diets is shown in Table 1. *Salmonella* prevalence was approx. 40% in all three groups, resulting in very minor and non-significant relative risk estimates in both acid groups compared to the control group.

When instead the number of positive samples in each group was compared (because two pooled samples had been analyzed per pen), *Salmonella* prevalence varied from 35.1% to 37.8% but again this difference was non-significant. In 22% of *Salmonella*-positive pens, *Salmonella* was only detected in one of two samples, whereas in the remaining positive pens both samples were positive for *Salmonella*. In the majority of positive samples (70%) *Salmonella* was detected already after 24 h of incubation. Neither the number of *Salmonella*-positive samples/pen nor the incubation time (24 h vs. 48 h) was significantly different between the three groups.

The results of the serological testing showed slightly reduced seroprevalences in pigs fed formic acid + lactic acid (19.6%) and benzoic acid (18.6%) compared to pigs fed the control diet (24.5%). However, these differences were not significantly different.

The effect of diet on the production parameters is shown in Table 2. Adding 1% organic acid to the feed significantly improved production parameters in weaned pigs, irrespective of the type of acid used. There was no significant difference in productivity between the two types of organic acids.

**Discussion** The results of our study did not show a significant effect of either lactic acid + formic acid or benzoic acid on the prevalence of *Salmonella* in weaner pigs. This is in contrast to a previous study, where addition of 2.8% lactic acid in the feed resulted in a significantly reduced *Salmonella* prevalence in weaners (Jørgensen *et al.*, 2001). Furthermore, the promising in vitro effect of benzoic acid observed at DIAS (Bent Borg Jensen, personal communication) could not be shown in naturally infected pigs. It cannot be excluded that a 1% mixture of organic acid is too low a dosage to have any measurable effect on *Salmonella*, especially when the infection pressure in the farm of origin is high. Another explanation may be that the effect would first become apparent after the 5-week study period, but then at least a decreasing trend would have been expected during the first five weeks in the groups fed acidified feed.

Productivity was improved significantly by adding organic acids to the diet of the pigs. This is in concordance with other studies using organic acids in feed for pigs. Addition of organic acids resulted in a 5.2% increase in average daily gain and an improvement of FUp/kg growth of 1.7%. This means that the extra cost of adding organic acid to pig feed to combat *Salmonella* will be compensated by improved productivity.

**Conclusions** Addition of 1% lactic/formic acid or 1% benzoic acid to a weaner diet during a 5-week period after weaning did not result in a reduction of *Salmonella* prevalence in pigs bought from a naturally infected farm. Addition of organic acids increased pig productivity significantly.

**References**


<table>
<thead>
<tr>
<th>Parameter</th>
<th>Control</th>
<th>Lactic+formic acid</th>
<th>Benzoic acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average daily gain</td>
<td>630</td>
<td>655</td>
<td>691</td>
</tr>
<tr>
<td>FUp/pig/day</td>
<td>1.06</td>
<td>1.08</td>
<td>1.15</td>
</tr>
<tr>
<td>FUp/kg growth</td>
<td>1.67</td>
<td>1.63</td>
<td>1.67</td>
</tr>
<tr>
<td>Index</td>
<td>100**</td>
<td>105*</td>
<td>108*</td>
</tr>
</tbody>
</table>

Table 2. Effect of *Salmonella*-reducing feed containing organic acids on pig productivity

*Values with different subscripts differ significantly at the 95% confidence level*