QUANTIFICATION OF THE SPREAD OF SALMONELLA AND THE EFFECT OF 2 FEED ADDITIVES

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Summary: The aim of this experiment was to quantify the spread of Salmonella Typhimurium in weaned piglets by calculating R0 values. In addition, the effect of 2 feed additives, AROMABIOTIC® and Shiitake mushroom, on the spread of Salmonella Typhimurium was evaluated. Fifty-nine piglets were allocated to 4 groups: AROMABIOTIC® (A, n=16), Shiitake mushroom (B, n=16), positive (C, n=16) and negative controls (D, n=11). Half of the piglets of group A, B and C were experimentally inoculated with Salmonella Typhimurium, other piglets were used as susceptibles. Based on Salmonella isolation in faecal swabs, R0 values (95% C.I.) were 4.26 (1.40-34.69), 1.83 (0.86-9.38) and 4.29 (1.09-13.71) for group A, B and C, respectively. None of the measured parameters did indicate significant differences between the groups. Mortality rate was high in all 4 groups, what makes it necessary to repeat the experiment.

Introduction: Salmonella in swine is mainly transmitted by the faecal-oral route (Fedorka-Cray et al., 1994; 1995), although some authors believe airborne transmission is also possible (Proux et al., 2001). To our knowledge, R0 values for Salmonella have never been calculated before. The aim of this experiment was to calculate reproduction ratios (R0), defined as the mean number of new infections arising from one typical infectious case introduced in a totally susceptible population, for Salmonella in experimentally inoculated weaned piglets. In addition, the effect of 2 feed additives, AROMABIOTIC® and Shiitake mushroom (Nutrition Sciences N.V.), on the spread of Salmonella was investigated to evaluate whether these additives might be useful to reduce Salmonella prevalence.

Materials and methods: Fifty-nine weaned piglets were allocated to 4 groups: group A received AROMABIOTIC® (n = 16), group B received Shiitake mushroom (n=16), group C and D were the positive (n = 16) and negative (n = 11) controls, respectively. Piglets were housed with 4 pigs per pen. In each pen of group A, B and C, 2 randomly selected piglets were experimentally inoculated with 1.98 x 10⁹ CFU of a field strain of Salmonella Typhimurium. The 2 contact pigs were susceptibles. During the first 2 weeks, the feed for piglets from group A and B was supplemented with 0.3% of AROMABIOTIC and 0.2% of Shiitake mushroom, respectively, according to the recommendations of the manufacturer (Nutrition Sciences N.V.). The next 3 weeks the feed was supplemented with 0.3% AROMABIOTIC and 0.3% of Shiitake mushroom. The active part of AROMABIOTIC® is composed of medium chain fatty acids (MCFA), namely caproic acid (C6), caprylic acid (C8) and capric acid (C10) (Dierick et al., 2002). The second additive consists of complete ground Shiitake mushroom (Lentinus edodes), a basidiomycete. From day 0 until day 42 post exposure (PE), individual faecal swabs for qualitative Salmonella isolation were taken twice a week. After necropsy at day 42 PE, the mesenterial lymph nodes were collected for qualitative
Salmonella isolation using standard procedures. All piglets were blood sampled at day 0, 7, 14, 28 and 42 PE for determining the presence of Salmonella antibodies. Starting from day 0 PE, clinical and faeces scores were recorded from every piglet twice a week. In each group the number of dead piglets was recorded to calculate the mortality rate. At the end of the trial, at day 42 PE, all piglets were euthanised. The spread of Salmonella in the different groups (experimental unit) was quantified by calculating the basic reproduction ratio ($R_0$) following the maximum likelihood estimator. Piglets were included in the analysis if at least 3 faecal swabs were available. A pig was considered infected if at least 25% of the faecal swabs were bacteriologically positive, else the pig as considered as not infected.

Results: The $R_0$ values (95% confidence interval) in group A, B and C were 4.26 (1.40-34.69), 1.83 (0.86-9.38) and 4.29 (1.09-13.71), respectively. The overall $R_0$ for group A and C was significantly larger than 1, whereas the overall $R_0$ for group B was not significantly larger than 1. The $R_0$ values in the 3 different groups were not significantly different from each other. The proportion of lymph node positive animals in group A, B, C and D were 5/13, 5/11, 2/10 and 0/10, respectively ($p = 0.08$). All animals were seronegative at day 7 PE. In all groups, except for group D, a rise in S/P ratio was seen with a peak at day 28 PE. Diarrhea could be observed in all 4 groups during the first 3 weeks of the trial. Besides that, piglets suffered from a Streptococcus suis infection, causing arthritis and meningitis. For ethical reasons, all piglets were consequently treated with amoxicillin (Duphamox") and flunixin meglumin (Finadyne"). Mortality rate in group A, B, C and D was 3/16, 5/16, 6/16 and 1/11, respectively ($p = 0.33$).

Discussion: For the calculation of the $R_0$ values, an animal was only included if at least 3 faecal swabs were available, what we considered a period long enough to get infected with Salmonella. An animal was considered infected if at least 25% of the swabs were positive. This criterion was used to avoid false positive cases due to cross-contamination. Because the entire infectious period of Salmonella in pigs is not yet known, the experiment was limited to the nursery period (i.e., 42 days), which differs from the general definition of $R_0$ (in which $R_0$ is the average number of secondary infections caused by one typical infectious animal in its entire infectious period). The management and housing conditions of nursery piglets in commercial swine herds were simulated as well as possible, because in the field Salmonella infections often occur during the weaning period and feed additives are often used during that period.

During the trial, a high number of piglets became ill and the overall mortality rate was high. A combined Salmonella and Streptococcus suis infection was diagnosed, what made an overall treatment with amoxicillin necessary. The impact of this treatment on the spread of Salmonella is not known but because the Salmonella strain used in this experiment was resistant to amoxicillin, this treatment probably may not have influenced results.

Since the $R_0$ values were above 1, spread of Salmonella was continuing in all pens. Because pigs can easily get re-infected due to contact with contaminated faeces, the same situation in the field can be expected.

Conclusions: The results of this experiment indicated that it is possible to quantify the spread of Salmonella in pigs by calculating $R_0$ values. Shiitake mushroom tended to limit the spread of Salmonella spp. in weaned piglets, but further experiments are necessary to confirm these results.

References:
