Productive performance and *Salmonella* seroprevalence in pigs supplemented with organic acids

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Abstract

The objective of this pilot study was to evaluate the productivity and *Salmonella* seroprevalence in pigs supplemented with organic acids (OA) compared to pigs given growth promoters in one farm in Colombia. Two groups of 60 pigs were studied during 4 months. The intervention group was provided with OA (Selko pH® and Selacid®), while the control group received antimicrobial growth promoters (zin bacitracin and tylosin). Pigs where weighted five to calculate daily weight gain (DWG) and feed conversion ratio (FCR). At three different times (T1-T3) blood samples were taken. At T2, the seroprevalence of the intervention group was significantly lower in contrast with the control group (19% vs. 47%, P<0.001), although at T1 and T3, the seroprevalence of the pigs did not present a significant difference between the groups (1,7%; P=1 and 62% vs 77%; P=0.075). The FCR was not significantly different between groups (2.80 vs. 2.77; P=0.144). The cumulative DWG was significantly higher in the intervention group (713g/day) compared with control group (667g/day; P<0.001). The study indicates that administrating OA and cleaning water pipes improve productivity in pigs and delay exposure to *Salmonella* spp. when compares with growth promoters.

Introduction

Control of *Salmonella* in swine production is important to protect public health, as pork is a major source of human infection (1). Comprehensive control of *Salmonella* throughout the food value chain can decrease the incidence of human salmonellosis (2). Although the use of antimicrobial growth promoters is banned in the EU, in Colombia they are still commonly used to control disease and improve livestock growth(3). However, the use of growth promoters leads to the development of antimicrobial resistance. For this reason, alternatives have been sought to replace growth promoters, focused on improving pig health while maintaining productivity (3). The objective of this study was to evaluate the productivity and *Salmonella* seroprevalence in pigs supplemented with organic acids (OA) compared to pigs given growth promoters.

Materials and Methods

A parallel clinical trial was performed at the selected herd including 120 pigs (60 pigs each group) (Fig.1). The follow-up period was 4 months and the trial started when the pigs were 6 weeks of age. The drinking water for the intervention group was supplemented with Selko pH® (0.8 ml/liter), during the first 4 hours of the day, every other day throughout the follow-

SafePork 2023: The 14th International Symposium on the Epidemiology and Control Biological, Chemical and Physical Hazards in Pigs and Pork, New Orleans, LA, United States, May 15–17, 2023
https://doi.org/10.31274/safepork.16325

up period. Likewise, Selacid® (Trouw Nutrition®, Tres Cantos, Madrid) was added to the feed (weaner feed 2kg per ton and grower and fattener feed 1.5kg per ton) during the entire study. In the control group, tylosin phosphate 10% (1 kg per ton) was added to the weaner feed for the first 7 days of the study. Moreover, 15% zinc bacitracin (300 g per ton) was added to the grower feed for about 1 month.

In September 2021, water samples were taken in the herd. The results showed a high degree of fecal contamination of the water (*E. coli* = 1,944 CFU/100 ml, fecal coliforms = 3,888 CFU/100 ml, *Salmonella* spp. = absence), that could affect the effect of OA administered in the water. It was therefore decided to disinfect the water pipes with 0.4 ml/l of citric acid solution (GREEN DAC® ECOLAB, Bogota, Colombia) before beginning the clinical trial. Subsequent water samples obtained after cleaning the pipes contained 0 *E. coli* CFU/100ml, 8 CFU/100 ml of fecal coliforms and absence of *Salmonella* spp. During the clinical trial, the pipes were cleaned every month in the same way as described above.

Before starting the intervention, initial (T1) blood samples were obtained from each 60 piglets of 6 weeks of age to determine the *Salmonella* seroprevalence. Blood samples were taken again when the pigs were 11(T2) and 23 (T3) weeks of age. Each pig was weighed when the pigs were 6, 9, 15, 17 and 23 weeks old (W1 to W5) and daily weight gain (DWG) and feed conversion ratio (FCR) were calculated. The serum of the blood samples was extracted to perform ELISA diagnostic kit IDEXX® Swine *Salmonella* Ab (IDEXX, Barcelona, Spain) to evaluate the seroprevalence of *Salmonella* spp., using a cut-off of 40 % optical density.

Statistical Analysis

A univariate analysis was carried out to describe the distribution of pigs included in the study according to their sex, age, weight, *Salmonella* seroprevalence and the line (breeder or finisher). To check for normality of the distribution of quantitative variables, Shapiro-Wilk normality test was performed. Next, bivariate analyses were undertaken investigating the association between the different variables, with a focus on the effect of treatment. Parametric tests were used for dependent quantitative variables that were normally distributed (T-student test), whereas non-parametric tests were used for the non-normally distributed variables (Mann-Whitney U test). Chi-square test was used for the count data variables, and the Fisher exact test was used when one or more of the expected cell values were less than 5. For all analyses, the P-value was reported using a significance value of α=0.05. For the statistical analyses, SPSS® version 21 CES University license was used.

Results

At T1 a *Salmonella* seroprevalence of 1.7% was found in both groups. At T2 a *Salmonella* significant seroprevalence of 18.3% was observed in the intervention group versus 47.7% in the control group (P<0.001). Finally, at T3 a *Salmonella* non-significant seroprevalence of was observed between groups (61.7% group with OA and 76,7% control group; P=0.075).

There was not statistically significant difference between groups at W1(14 kg/pig group with OA *vs* 15 kg/pig control group; P=0.1), W2 (28.0 kg/pig group with OA *vs* 26.0 kg/pig control group; P=0.08) and W3 (52.5 kg/pig group with OA *vs* 49.0kg/pig control group; P=0.9). A statistically significant difference between the groups was found at W4 (P<0.001) with a median weight of 65.0 kg per pig (IQR= 10.0) in the intervention group versus 61.0 kg in the control group (IQR= 9.5). Likewise, at W5 the growth performance was significantly higher (P=0.024) in the intervention group, with a median weight of 101.0 kg per pig (IQR 12.5) versus 97.0 kg in the control group (IQR 11.0). The median of the cumulative DWG was 743 g/pig/day (IQR 12) for the intervention group versus 666 g/pig/day (IQR 10) for the control group, showing a statistically significant difference (P<0.001). Regarding FCR, there was no significant difference (P=0.14) when the cumulative FCR was compared between groups, as the pigs in the intervention group used 2.8 kg of feed per kg weight gained (IQR 0.6 kg) versus 2.7 kg of feed (IQR 0.4kg) the control group.

Discussion

There was a significantly lower *Salmonella* seroprevalence in the group of pigs provided OA (18.3%) compared with the control group (47.7%) at T2 (11 weeks). Contrary, at T1 (6 weeks) and T3 (15 weeks), there was no statistical difference in seroprevalence. OA limit bacterial growth in the intestines; which decrease the probability of *Salmonella* colonization (5) and may delayed the excretion and spread of *Salmonella* during the post-weaning period, leading to the development of partial immunity to *Salmonella.* Achieving the core of a *Salmonella* reduction strategy as pigs at the time of slaughter will have a lower probability excreting *Salmonella* (6). However, the majority of the pigs were eventually exposed to *Salmonella* spp. at some point (5).

In our study, pigs provided OA had a better cumulative DWG and weight productively than pigs administered growth promoters. The OA improves the absorptive capacity of the intestine (5). Whereas, there was no significant difference in the cumulative FCR between the two groups. This may because the staff in charge of supplying the feed to the pigs did not fully take into account the pigs that died during the trial when calculating the feed to be administered.

The cleaning of the water pipes on the farm before and during the study improved the water quality, which likely also resulted in healthier pigs (4). The combination of cleaning of the pipes and the use of OA may be responsible for the higher overall productivity and apparently slower spread of *Salmonella* in the group with OA.

Salmonella antibodies can remain at measurable levels up to 3 months in the pig, for that reason, positive animals can be found even when they no longer are infected with *Salmonella* spp. (7). Hence, it is a limitation of our study that no other diagnostic tests were applied that could confirm whether pigs were excreting *Salmonella*. The different concentrations of Selacid® supplied during the study and slightly lower dosage (0.8 ml/L) of Selko pH® administered to the water compared with the technical data sheet (1-2 ml/L) from the manufacturer could affect the *Salmonella* seroprevalence in the intervention group (4).

Conclusion

This pilot study suggest that regular cleaning of water pipes and administration of OA can delay exposure to *Salmonella* spp. and improve productive parameters when compared with antimicrobial growth promoters. The replacement of growth promoters with OA will low antimicrobial resistance and use. However, the study should be repeated in order to draw firmer conclusions.

Acknowledgements and Funding

This received financial support by the Ministry of Foreign Affairs (Danida).

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Figures with legend

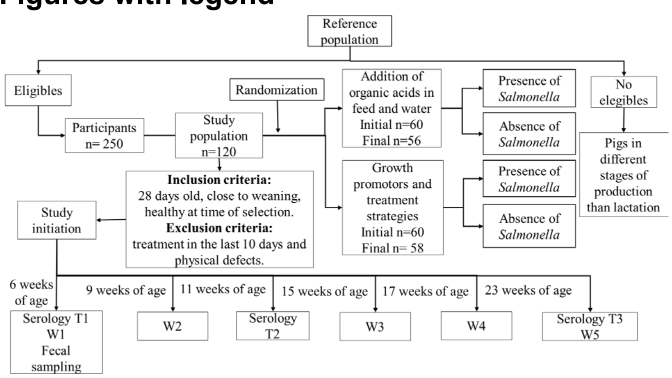

Figure 1. Study design. W1-W5: Weight of pigs. T1-T3: Age at blood sampling