Discussion: Most of the pathogenesis of salmonellosis has been described in mice, chickens and calves. Few data exist on the interactions of Salmonella with porcine phagocytes. The lack of RNI production by the porcine monocytes demonstrates that not all data collected from mice can be extrapolated to other species. In mice, the production of NO by inducible NO synthase (iNOS) is important in controlling intracellular multiplication of Salmonella bacteria (Umezawa et al., 1997). In contrast with Riber and Lind (1999), the number of intracellular bacteria steadily decreased over the 6 h period, suggesting lack of intracellular bacterial multiplication. Interestingly, opsonization with complement increased the number of surviving salmonellae. Possibly, intracellular trafficking and thus survival of the Salmonella bacteria might be influenced by entry in the host cell through complement receptor binding (Ishibashi and Arai, 1996). The production of ROS by host macrophages is an important first defence mechanism (Vazquez Torres et al., 2000), which Salmonella must circumvent in order to survive intracellularly inside the host cell. The Salmonella Typhimurium strain was able to suppress the production of ROS in porcine monocytes. This suppression was abolished when chloramphenicol treated bacteria were used, indicating that suppression of monocytic ROS production requires active bacterial protein synthesis. Individual differences between pigs were noticed both in the production of ROS and in the ability to kill Salmonella. These individual differences might account for a different course of infection, for example the development of the carrier state in some but not in other pigs.

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References:

The stomach acts as a barrier against Salmonella in pigs fed a meal diet

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Summary: Finishing pigs fed a coarsely ground meal (CGM) diet showed increased in vitro death rate of Salmonella in the gastric content and a reduced number of enterobacteria in the small intestine and caecum compared with a finely ground and pelleted diet (FGP). The CGM diet resulted moreover in a slower gastric emptying rate, increased the DM content and established a pH-gradient in the stomach. This affected the microbiota in the gastric digesta resulting in more lactic acid
bacteria and fewer enterobacteria. Consequently *Salmonella* bacteria are killed in the stomach and do not enter and proliferate in other parts of the gastrointestinal tract. Furthermore the time after feeding a meal is of importance to whether or not *Salmonella* bacteria will survive transit through the stomach.

**Introduction:** Previous studies have repeatedly shown that feeding coarsely ground meal feed significantly reduced the incidence of *Salmonella* in finishers compared with finely ground heat-treated and pelleted feed. The occurrence of enterobacteria, such as *Salmonella*, in the gastrointestinal tract is strongly influenced by feed composition and processing. However, the mechanisms involved are not fully understood, but it has been suggested that the stomach plays a central role in preventing the establishment of *Salmonella* infections in finishing pigs (van Winsen et al. 2001). In the present study, the effects of feed processing on survival of *Salmonella* in gastric digesta and on the microbiota in the gastrointestinal tract with special emphasize on the stomach were investigated.

**Keywords:** Feed, Microbial flora, Rheological properties

**Materials and Methods:** Two groups of 30 commercial hybrid castrates were fed either a finely ground pelleted diet (FGP) or a coarsely ground meal (CGM). At approximately 100 kg liveweight, 6 pigs from each of the two diets were killed at 0.5, 2, 5, 8 and 9.5 h post feeding. The gastrointestinal tracts were immediately removed and divided into 5 segments: Distal and proximal stomach, small intestine, caecum and colon. The DM content, pH, SCFA and lactic acid concentration were measured in all segments, microbial enumeration was performed on content from the stomach, small intestine and caecum, and physico-chemical characterization was made of the stomach content. In addition, the gastric emptying rate was determined and the growth-/death rate of *Salmonella DT12* in the fresh content from the distal and proximal part of the stomach was determined by an *in vitro* method.

**Results and discussion:** The *in vitro* method revealed a significantly higher death rate of *Salmonella* in the stomach content from pigs fed the CGM diet, Figure 1. Furthermore time post feeding affected the death rate of *Salmonella*.

![Graph showing death rate of Salmonella DT12 in gastric content and density of enterobacteria in digesta from the proximal stomach (Sto1), distal stomach (Sto2), small intestine (SI) and the caecum (Cae).](image)

**Figure 1.** (A) In vitro death rates of *Salmonella* DT12 in gastric content and (B) density of enterobacteria in digesta from the proximal stomach (Sto1), distal stomach (Sto2), small intestine (SI) and the caecum (Cae). For both graphs: at different time post feeding in pigs fed a finely ground and pelleted (FGP) or a coarsely ground meal (CGM) diet. * indicates significant difference, P < 0.05.

In the pigs fed the CGM diet, a higher DM content was found in the gastric digesta, Figure 2. This might be one of the explanations for the clear pH-gradient that was determined in stomachs of pigs fed the CGM diet. Also it is noteworthy that the pH in the gastric digesta of the pig offered the FGP diet was significant higher compared with the pH in the distal stomach of the pigs fed the CGM diet for
more than 2 h post feeding. Moreover diet and time post feeding affected the bacterial populations in the stomach, Figure 2. In pigs receiving the CGM diet, more lactic acid bacteria were found in the proximal part of the stomach. In pigs fed the FGP diet, a higher density of enterobacteria was observed until 5 h post feeding in the gastric digesta. It is furthermore likely that the slower gastric emptying rate found in the CGM fed pigs also influenced the microbial eco-system in the stomach.

**Figure 2.** Dry matter, pH, lactic acid bacteria and enterobacteria in gastric digesta from the proximal and distal part of the stomach at different time post feeding in pigs fed a finely ground and pelleted (FGP) or a coarsely ground meal (CGM) diet.

In the small intestine and caecum of the pigs given the CGM diet, the number of enterobacteria was reduced compared with the pigs fed the FGP diet, Figure 1. This indicates that feeding CGM diets to pigs prevents *Salmonella* bacteria from proliferating in the lower parts of the gastrointestinal tract. The stomach acts as a barrier preventing harmful bacteria from entering the lower part of the gastrointestinal tract. Furthermore this study indicate, that in pigs fed a FGP diet, the time after a meal where *Salmonella* bacteria are able to survive passage through the stomach is prolonged compared with the pigs fed a CGM diet.

**References:**