Double Trouble: the interaction between the mycotoxin deoxynivalenol and salmonellosis in the pig

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The contamination of food and feed with mycotoxins poses a worldwide problem with an acknowledged negative effect on human and animal health and significant economic and international trade implications. Deoxynivalenol (DON) is a trichothecene mycotoxin frequently contaminating maize and small grain cereals in temperate regions of Europe, North America and Asia[1]. The intake of DON contaminated food or feed can lead to adverse health effects in humans and animals. For humans, a large-scale European study on the occurrence of *Fusarium* toxins and the dietary intake showed that 57% of the tested cereals samples such as wheat were positive for DON and based on intake estimates, it is obvious that the presence of trichothecenes can pose a public health concern[2, 3]. A study on the prevalence and level of urinary DON in the United Kingdom population indicated that urinary levels of DON were positively correlated with cereal intake suggesting that the European Union recommended maximum tolerable daily intake of 1 µg DON/kg BW is likely be exceeded. Urinary DON levels can be a valuable tool as exposure biomarker in etiological studies of DON and human disease risks[4]. For human food products, the European Union sets maximum limits for DON in cereals and cereal-based products, ranging from 200 to 1750 µg/kg[5]. Anorexia, altered feed intake, reduced weight gain and immunologic alterations are associated with chronic low-doses ingestion of DON whereas acute high-dose exposure is characterized by emesis, diarrhea, vomiting and rectal bleeding. Among farm animals, pigs are considered particularly sensitive to the dietary intake of DON resulting in substantial economical losses[6].

Nontyphoidal *Salmonella* represents an important human and animal pathogen worldwide. Each year more than 90 million human cases of gastroenteritis occur due to *Salmonella* Typhimurium around the world[7]. In 2009, *Salmonella* was the most commonly reported bacteriological agent of human food borne diseases in the USA, causing approximate 44% of confirmed food borne bacterial infections[8]. *Salmonella* Typhimurium is, together with *Salmonella* Enteriditis, the most common serotype associated with human nontyphoidal salmonellosis in Europe and USA[9, 10]. In pigs, clinical salmonellosis is not a common problem as *Salmonella* infections are mostly subclinical. However, these carrier pigs are an important source of contamination for the environment, other pigs and carcasses in the slaughterhouse and as such they pose a serious public health problem being the most important reservoir of *Salmonella* Typhimurium for humans[11-13].

With DON and salmonellosis being emerging issues for animal and human health, our research aims at examining the effects of DON on the pathogenesis of a *Salmonella* infection and more specific on the intestinal and systemic phase of the infection.

To study the intestinal phase of infection, a porcine intestinal loop model was used. We were able to show that the intake of low and relevant concentrations of DON renders the intestinal epithelium more susceptible for *Salmonella* Typhimurium with a subsequent potentiation of the inflammatory response in the gut. In humans, this enhanced intestinal inflammation may be of importance for patients genetically predisposed for Intestinal Bowel Disease since both DON as *Salmonella* are mentioned as factors of potential etiological importance in the development of this chronic intestinal disorder[14-16].

By using porcine alveolar macrophages as an *in vitro* model for the systemic phase of infection, we have shown that low concentrations of DON could modulate the cytoskeleton of macrophages through ERK1/2 F-actin reorganization resulting in an enhanced uptake of *Salmonella* Typhimurium in porcine macrophages[17]. These results suggest that low but relevant concentrations of DON modulate the innate immune system and could also increase the susceptibility of pigs to infections with *Salmonella* Typhimurium.

In pigs, intake of DON contaminated feed might results in a higher infection level in the herd and consequently a higher public health risk for salmonellosis from the consumption of contaminated pork meat.

Considering the frequent occurrence of DON in cereal-based foods and feeds worldwide, the importance of these findings should be taken in consideration.

References

1.Bottalico A, Perrone G. European Journal of Plant Pathology. 2002;**108**(7):611-24.
2.Gonzalez-Osnaya L, Cortes C, Soriano JM, et al. Food Chem. 2011;**124**(1):156-61.
3.Schothorst RC, van Egmond HP. Toxicol Lett. 2004;**153**(1):133-43.
4.Turner PC, Rothwell JA, White KLM, et al. Environ Health Perspect. 2008;**116**(1):21-5.
5.Anonymous. Official Journal of the European Union. 2006.
6.Böhm J. Arch Tierernahr. 1992;**42**:95-111.
7.Majowicz SE, Musto J, Scallan E, et al. Clin Infect Dis. 2010;**50**(6):882-9.
8.Prevention CfDCa. MMWR Morb Mortal Wkly Rep. 2009;**59**(14):418-22.
9.International trends in Salmonella serotypes 1998-2003- a surveillance report from the Enter-net international surveillance network. Eurosurveillance monthly releases 9 issue 11 [database on the Internet]2004. Available from: http://www.eurosurveillance.org/index-02.asp.
10.Doyle E, Kaspar C, Archer J, et al. White paper on human illness caused by Salmonella from all food and non-food vectors2009: Available from: http://fri.wisc.edu/docs/pdf/FRI_Brief_Salmonella_human_illness_6_09.pdf.
11.Boyen F, Haesebrouck E, Maes D, et al. Vet Mic. 2008;**130**(1-2):1-19.
12.Donne E, Pasmans E, Boyen F, et al. Vet Mic. 2005;**107**(3-4):205-14.
13.Wray C WA, editor. Salmonella infections in pigs. Wallingford: CAD International; 2000.
14.Gradel KO, Nielsen HL, Schonheyder HC, et al. Gastroenterology. 2009;**137**(2):495-501.
15.Jess T, Simonsen J, Nielsen NM, et al. Gut. 2011;**60**(3):318-24.
16.Maresca M, Fantini J. Toxicon. 2010;**56**(3):282-94.
17.Vandenbroucke V, Croubels S, Verbrugghe E, et al. Vet Res. 2009;**40**(6).