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# How to Reduce Mycotoxin – induced Vaccination Failure

**Immunotoxic Substances such as Mycotoxins are Unsuspected Players in the Failure of Vaccines to Provoke a Proper Immune Response.**

Vaccines are commonly used to prevent various pathogenic challenges of viral, bacterial, and protozoan origins that usually lead to diseases affecting health and performance of livestock. Some of the disease challenges in swine where vaccines play a crucial role in preventing and controlling are listed in Table 1.

- Swine influenza
- Rotavirus A
- Porcine parvovirus
- Porcine reproductive and respiratory syndrome virus (PRRSv)
- Transmissible gastroenteritis (Corona virus)
- Hemolytic diarrhea (*Escherichia coli*)
- Erysipelas (*Erysipelothrix rhusiopathiae*)
- Ileitis (*Lawsonia intracellularis*)
- Pneumonia (*Mycoplasma hyopneumoniae, Actinobacillus pleuropneumoniae*)

*Table 1. Swine diseases commonly addressed through vaccination.*

**Three Types of Vaccines**

There are two major types of vaccines normally used in swine production – live and inactivated – while other types of vaccines are seldom used.

**Live, Attenuated Vaccines**

Live-type vaccines contain either virus or bacteria in small amounts with the objective to infect the host and multiply in its body to produce immunity, preferably with minimal reaction. This leads to the recognition of increased amounts of the same type of pathogen by the host's immune system, thus resulting in an enhanced immune response.

**Inactivated/Killed Vaccines**

Inactivated/killed vaccines have inactivated and processed virus or bacteria which then stimulates the immune system for a longer period of time inside the host. Inactivated vaccines are usually combined with an adjuvant (an oil or aluminum hydroxide) to increase their stability, and to stimulate the host immune response.

**Other**

These include toxoids (contain inactivated toxin of a bacterial pathogen), subunits/conjugates (contain pieces of the pathogen they protect against), and recombinant (contain virus with gene code for a vaccine protein against another virus) vaccines. Autogenous vaccines (autovaccines) are for therapeutic use, individually tailored for a host, made from cultures of pathogens isolated from the infection site.

**The Immune Response**

Two different mechanisms are involved in establishing an immune response: the inflammatory and acquired immune responses.

**The Inflammatory Response**

Inflammation is a non-specific response that occurs very rapidly and leads to the activation of phagocytes (macrophages and neutrophils). The activated phagocytes secrete many different molecules such as cytokines (involved in the recruitment and the activation of other cells).

**The Acquired Immune Response**

Acquired immune responses are associated with immunogenic memory carried out by B cells (humoral) and memory T cells (cellular). These cells are generated from naïve precursor cells after exposure to the microbial antigens. Upon interaction with the antigen presenting cells, B cells start to secrete specific antibodies. Naïve T cells rapidly proliferate and differentiate into effector T cells which target the host cells infected by pathogens.

This phase of proliferation is followed by a contraction phase during which about 90% of the effector T cells die, whereas the remaining cells differentiate into memory T cells. Thus, the immune response is highly complex and various cells interact with one another to produce the desired effect.

**Causes and Consequences of Vaccination Failure**

Factors leading to higher rates of vaccination failure result either from 1) a failure to provide potent vaccines properly to the host or 2) immune suppression in the host.

Vaccine delivery can be hampered by contamination, improper storage or procedural errors. The five factors causing immune suppression directly in the animal include stress, poor nutrition, infectious agents, maternal antibody interference, and mycotoxins.

These major causes and corrective measures are listed in Table 2. The good news is that these factors can largely be overcome by employing good management practices, including proper vaccine storage, handling and training.

| | Factor affecting vaccine efficacy | Corrective measure |
|---|---|---|
| Vaccine | Contamination | Purchase from trusted suppliers |
| | Storage, e.g.<br>• Break in cold-chain<br>• Exposure to heat/sunlight<br>• Expiration | Store according to written indication and use before expiration date |
| | Procedure<br>• Inappropriate sterilization<br>• Improper use<br>• Failure to vaccinate/animal missed<br>• Vaccine deposited in fat | Train personnel on proper vaccination procedure |

| | Stress factors | Corrective measure |
|---|---|---|
| Immune suppression | Nutrition | Ensure proper nutrition |
| | Infectious agents | Maintain an appropriate biosecurity and veterinary strategy |
| | Maternal antibody interference | Design vaccine protocols taking maternal antibodies into consideration |
| | Mycotoxins | Implement a comprehensive mycotoxin risk management program |

*Table 2. Factors affecting vaccine efficacy and corrective measures.*

**Stress (Physical or Psychological)**
Weaning, crowding, mixing, shipping, restraint, limit feeding, noise, and excess heat or cold are some of the common stressors proven to affect the immune response.

**Improper Nutrition**
Overfeeding or malnutrition can lead to impaired immune response as the nutritional cost of the activation and maintenance of acute immune response has been about 10% of dietary protein and 1.1 g/kg of metabolic body weight (BW) in pigs.

**Infectious Agents**
Certain infectious agents can predispose the animal to secondary bacterial infection by suppressing specific immune function. For example, PRRSv can increase the susceptibility to pneumonia in pigs.

**Maternal Antibody Interference**
Piglets without maternal antibodies can be vaccinated as early as one day of age. However, in herds where vaccination is routinely done, piglets will have circulating maternal antibodies that could block the immune response against the vaccine.

Researchers have found that 60% of pigs vaccinated at three weeks of age were found seropositive three months later; five weeks of age had 62%; six weeks of age had 79%; seven weeks of age had 96%; eight weeks of age had 100%, and at nine weeks of age had 87%.

**Mycotoxins**
Mycotoxins induce immunosuppression by depressing T- and B-lymphocyte activity, suppressing antibody production, and impairing macrophage/neutrophil effector functions. This results in vaccine failure and predisposes the animal to secondary bacterial infections as well. Specific mycotoxins and their influence on vaccine failure follow.

- Aflatoxin B1 has been reported as a cause of immunisation failure with *Erysipelothrix rhusiopathiae*
- bacterins, and also increased the severity of coccidiosis infection.
- Ochratoxin A increased the susceptibility of pigs to natural infection by *Salmonella cholerasuis*, *Serpulina hyodysenteriae* or *Campylobacter coli.*
- T-2 toxin has been found to increase the susceptibility to *Salmonella, Listeria monocytogenes, Staphylococcus aureus*, and *Cryptosporidium baileyi*.
- Deoxynivalenol (750 ppb) has been shown to increase *Salmonella* invasion 10 times in porcine epithelial cells, and is highly toxic to lymphocytes.
- Fumonisin (500 ppb) has been found to increase the intestinal colonisation of hemolytic *Escherichia coli* in piglets. Fumonisin has also been found to inhibit cell proliferation and alter cytokine production.
- The combination of deoxynivalenol and fumonisins, even at sub-clinical doses, can impair liver and intestinal integrity, resulting in impaired vaccine response (Figures 3 and 4).

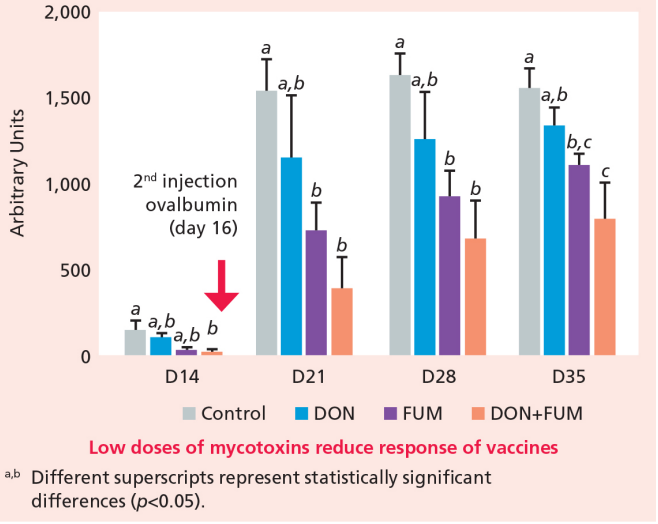


*Figure 3. Sub-clinical doses of FUM and DON result in decreased antibody production post-vaccination.*

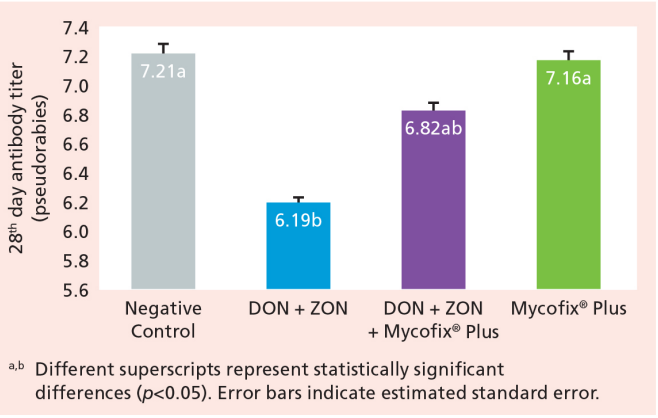


*Figure 4. Mycotoxins reduce the efficacy of pseudorabies vaccine in nursery pigs.*

**Summary**
Overall, proper vaccination programmes along with good management practices can help overcome most of the factors that cause vaccination failure. However, specific immunotoxic substances such as mycotoxins, while often overlooked, can inflict real harm and lead to higher treatment costs. Consequently, an effective and comprehensive mycotoxin risk management programme is advised.

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