Issue 44 • Swine
A magazine of Biomin®

Science & Solutions

Introducing Digestarom® DC

The Feed Converter

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How to Reduce Mycotoxin-induced Vaccination Failure

The Meaningful Work of Science-Based Solutions

Editorial

Tackling Challenges in a Shifting Landscape

The livestock industry is a constantly evolving landscape as producers, nutritionists, and integrators seek to improve production efficiency and profits while safeguarding animal health and providing high quality products. Optimizing farm performance relies on refining management, utilizing innovations in genetics and nutrition, and implementing new knowledge on the diagnosis, prevention and treatment of diseases.

In this issue of **Science & Solutions**, we visit a new feed additive technology and aspects of risk and disease management on the farm. Since January, a new veterinary feed directive (VFD) in the United States has removed the use of antibiotics as growth promoters, resulting in increased usage of feed additives such as phytogenics. BIOMIN has more than 30 years of experience in this field, providing innovative solutions in the Digestarom® product line. In the first article, Dr. István Csutorás introduces Digestarom DC, which utilizes a new technology to optimize the effects of a unique phytogenic formulation.

In a topic of interest article, Dr. G. Raj Murugesan provides information on the factors and causes that can contribute to vaccine failure, and the management strategies that can be implemented to reduce this risk. In our client story, Mr. Doug Taylor from the USA shares his experience in the field working with a farm with a year-long vaginal prolapse issues in sows. Through educational and technical support from BIOMIN, the customer was able to identify mycotoxin challenges in the feed. Such challenges reveal how mycotoxin risk management programs are paramount to maintain the feed quality in modern livestock production. Lastly, in our differential diagnosis column, Dr. Diego Padoan takes an in-depth look at the causes of icterus, providing resources to troubleshoot challenges with liver health in swine.

I hope you enjoy this issue of **Science & Solutions** and it adds to your toolkit on approaching improving animal performance in your system!

Erika Hendel VMD, PhD
Swine Technical Manager

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Improving Feed Efficiency with

By **István Csutorás**, Product Manager Phytogenics

Limited digestibility is a well-known problem for pig producers all around the world; a problem that feed additives may be able to address. A novel phytogenic from BIOMIN, Digestarom® DC, is aimed at improved feed intake, better performance and optimized feed conversion.

Flavoring

Substance

1. Appetizing & Endogenous Secretions

The appetizing and endogenous secretion module in the coat of the Biomin® Duplex Capsule supports palatability and feed intake.

Biological Active

Substance

2. Gut Microbiota Modulation

The gut microbiota modulation module in the core of the Biomin® Duplex Capsule supports gut performance.

Extracts & Herbs

3. Gut Protection

Alongside the Biomin® Duplex Capsule, the extracts and herbs module supports gut protection.

Better Encapsulated Phytogenics

This article originally appeared in Pig Progress

Feed conversion improvement is tied to a host of modern production of alternative feed ingredients, reducing antibiotics, counteracting

The key to addressing many of the current challenges facing the industry is better feed efficiency. Feed conversion improvement is tied to a host of modern production issues, including profitability, improving the limited digestibility of alternative feed ingredients, reducing antibiotics, counteracting stressors, and overcoming environmental challenges. In further confirming its pivotal role, 1,140 industry respondents in 100 countries indicated that enhanced feed efficiency or a better feed conversion ratio (FCR) was the most important potential benefit of phytogenic feed additives (PFAs) to their operation, as captured by the BIOMIN 2017 Phytogenic Feed Additives Survey.

At BIOMIN, improving feed efficiency has been the main thrust of its research and product development around phytogenics in recent years. The company has built upon the Digestarom® product line, which dates back to 1989, and recently introduced a new phytogenic product, Digestarom® DC, which is designed to deliver improved feed intake, better performance and optimized feed conversion.

What's new?

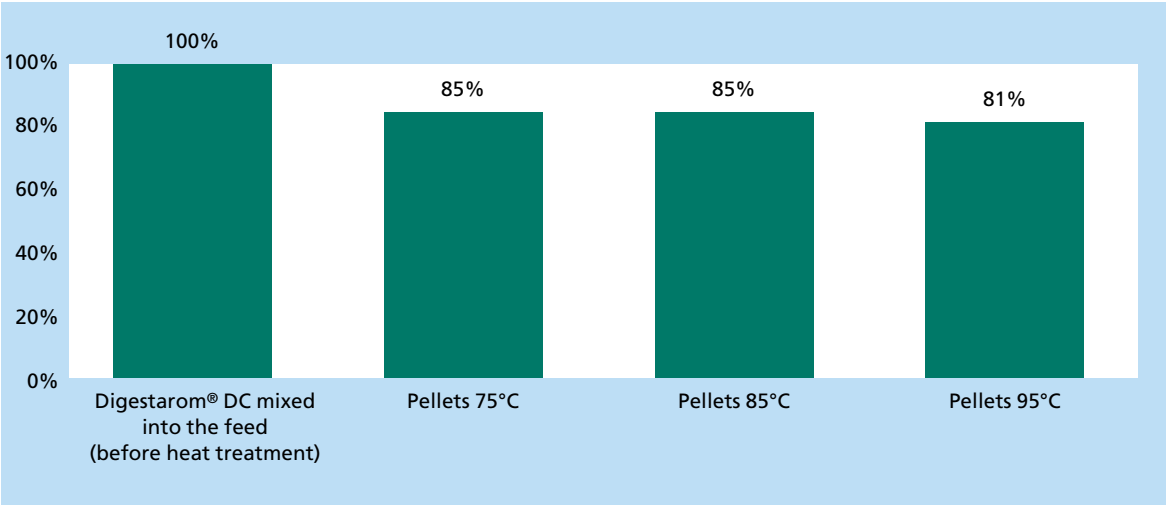
The new phytogenic is based on a special encapsulation technology for essential oils and phytogenic active compounds: the Biomin® Duplex Capsule (hereafter called 'the capsule'), which combines two encapsulation techniques: matrix and core-shell encapsulation. It offers four key advantages:

- Improved thermostability;
- Continuous delivery of active substances;
- Targeted, controlled release; and
- Enhanced product handling.

❶ Better thermostability

Essential oils and their active compounds are highly volatile and heat sensitive—less than ideal characteristics in the context of modern feed production and pelleting. The capsule gives the phytogenic enhanced pelleting stability over 90°C, as shown by the amount of product recovered after conditioning in a cascade mixer with steam addition, followed by pelleting for another 20-30 seconds (*Figure 1*).

Figure 1. Recovery of active compounds.



Source: BIOMIN

István Csutorás
Product Manager Phytogenics

issues, including profitability, improving the limited digestibility stressors, and overcoming environmental challenges.

❷ Continuous delivery

The new technology results in double capsules with a uniform and narrow size distribution ranging from 120 to 500 µm, allowing for more homogeneous distribution of active compounds in the phytogenic and in the feed, resulting in continuous delivery of active substances in the animals.

❸ Targeted, controlled release

With core-shell encapsulation, a protective coat surrounds a core comprising essential oils and active compounds. The coat and the core contain different essential oils for appetizing and gut modulation modules. Both layers are matrix encapsulated, meaning that the active compounds are finely dispersed in a solidified matrix, providing a targeted, controlled release along the gastrointestinal tract. The particles in the phytogenic have a very high essential oil content compared to other commercially available products. *Figure 2* illustrates how the capsule permits the targeted delivery of essential oils in an *in vitro* gastrointestinal model.

❹ Better handling

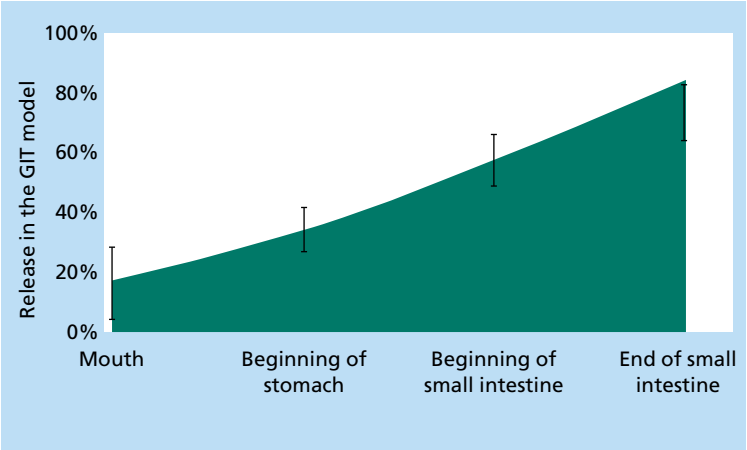
Thanks to the capsule, the phytogenic has a shelf life of 18 months, reduced dustiness and improved handling. While certain commercially available phytogenic feed additives have a high dusting potential of up to 20 g/m³ according to the Stauber-Heubach test, an acknowledged and official method for testing dusting potential, this novel phytogenic has a much lower dusting potential of 1.6-2.4 g/m³, representing an 8-fold improvement.

Triple action formulation

The triple action formulation of the phytogenic exploits the advantages of the Biomin® Duplex Capsule to optimize feed conversion. The three modules are formulated to optimize feed conversion:

1. Appetizing and endogenous secretions
2. Gut microbiota modulation
3. Gut protection

Figure 2. Release of essential oil actives from BIOMIN Duplex Capsule.



Source: BIOMIN

Trial results

Recent results of four consecutive trials in piglets demonstrate the ability of Digestarom® DC to improve performance.

The trials were conducted with a total of 351 weaned piglets, (Landrace x Large White) x Piétrain. The animals were held in two identical, climate controlled, slatted floor houses.

Piglets fed the phytogenic supplemented diets over 42 days showed a statistically significant improvement in average daily weight gain (567.53 g) versus piglets fed the control diet (550.44 g). Similarly, a difference was observed in the feed conversion ratio (FCR) of the two groups: 1.78 for the control versus 1.76 for the phytogenic group.

Overall, supplementation of feed with Digestarom® DC resulted, in a significant increase of average daily feed intake compared to the control (998.10 g vs. 978.52 g, respectively), a significant increase in weight gain (+3.1%) and a decrease in FCR. The efficiency gains translate into direct economic benefits for the producers.

How to Reduce Mycotoxin-induced Vaccination Failure

By **G. Raj Murugesan**, Technical & Marketing Director and **Erika Hendel**, Swine Technical Manager

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*.

3 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.

❶ Live, attenuated vaccines

Live-type vaccines contain either virus or bacteria in

Photo: iStockphoto_Rawpixel

Overall, proper vaccination programs along with good management practices can help overcome most of the factors that cause vaccination failure.

Table 1. Swine diseases commonly addressed through vaccination.

• 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*)

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.

❷ 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.

❸ 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.

❶ 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)

❷ 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.

Factors leading to higher rates of vaccination failure result either from 2) immune suppression in the host.

Table 2. Factors affecting vaccine efficacy and corrective measures.

	Factor affecting vaccine efficacy	Corrective measure
Vaccine	Contamination	Purchase from trusted suppliers
	Storage, e.g. • Break in cold-chain • Exposure to heat/sunlight • Expiration	Store according to written indication and use before expiration date
	Procedure • Inappropriate sterilization • Improper use • Failure to vaccinate/animal missed • 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

Source: BIOMIN

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.

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 3 weeks of age were found seropositive 3 months later; 5 weeks of age had 62%; 6 weeks of age had 79%; 7 weeks of age had 96%; 8 weeks of age had 100%, and at 9 weeks of age had 87%.

Mycotoxins

Mycotoxins induce immunosuppression by depressing T- and B-lymphocyte activity, suppressing antibody

G. Raj Murugesan, Technical & Marketing Director
Erika Hendel, Swine Technical Manager

1) a failure to provide potent vaccines properly to the host or

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.

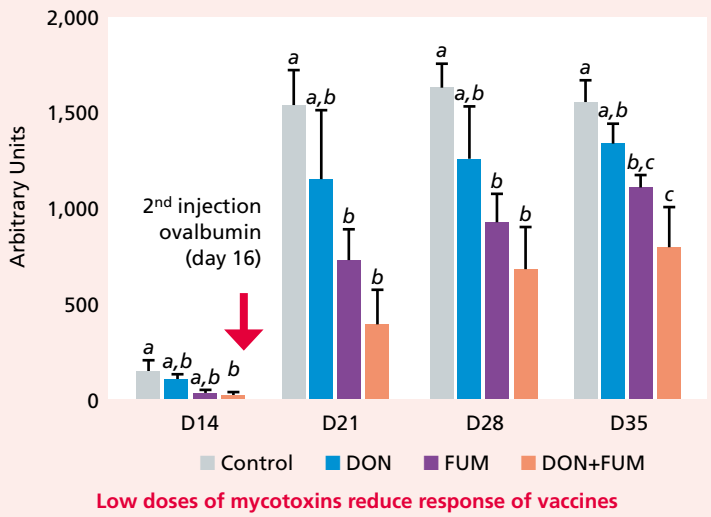
- Aflatoxin B_1 has been reported as a cause of immunization failure with *Erysipelothrix rhusiopathiae* bacterins, as well as increased the severity of coccidiosis infection.
- Ochratoxin A increased the susceptibility of pigs to natural infection by *Salmonella cholerasuis*, *Serpulina hyodysenteriae* 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 colonization 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*).

Summary

Overall, proper vaccination programs 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 program is advised.

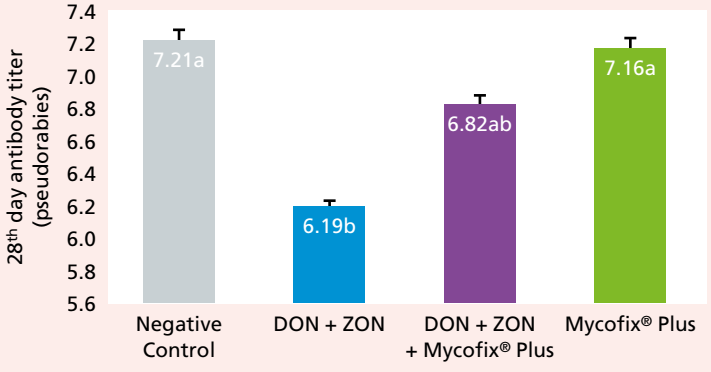
Figure 3. Subclinical doses of FUM and DON result in decreased antibody production post vaccination.



[a,b] Different superscripts represent statistically significant differences ($p<0.05$).

Source: modified from Grenier et al., 2011

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



[a,b] Different superscripts represent statistically significant differences ($p<0.05$). Error bars indicate estimated standard error.

Source adapted from Cheng et al., 2006

The Meaningful Work of Science-Based Solutions

By **Douglas Taylor, Jr.,** Key Account Manager

Addressing one client's on-farm challenge is a clear example of what motivates the employees of BIOMIN to work towards better customer outcomes each day.

Photo: iStockphoto_RGtimeline

When John* --the 2nd generation owner of a farrow-to-finish operation of 1500 sows and about 40,000 pigs marketed per year in the Midwestern United States, called me on a Friday in February he was, in his words, 'desperate for a solution' to a major prolapse issue. He had tried several products* sold by companies who claimed that they were 'just as good as BIOMIN' though they were seemingly unable to address the challenge that his farm faced. John asked me to send him enough product to feed 1500 sows for one month. A week later, he had already used half of the product and ordered 4 times as much as the initial order. I called him to arrange a meeting so that I could fully understand the issue on his farm and offer a tailored solution to his challenge.

Farm visit

When I had a chance to visit him on his farm, again on a Friday, we both instantly recognized each other from the

* Names have been changed and competitor products omitted out of respect for those involved.

Iowa Pork Congress, where he had stopped by the booth to discuss mycotoxins. He runs a family operation. His daughter works with all the sows in gestation and lactation, and his son does the crops and walks the finishing barns.

All four of us met that day. An hour and a half into our visit, John confided in me that the number of butcher hogs they had sold in the last year was down by 22% of production. I saw in his face the way that affected him emotionally. He needed a solution to his problem to stem his loses—though it was not just about the money. He was nearly in tears when he explained the number of sows he had to euthanize due to vaginal prolapses. He respects those animals as the living, breathing beings that they are.

Mycotoxins detected

His supplier of his premix and the competitor product had done some mycotoxin testing that had uncovered deoxynivalenol and zearalenone contamination in the feed. This firm had been telling him for months that their product would solve his problem.

We arranged further testing through Romer Labs® which confirmed the deoxynivalenol and zearalenone contamination, and detected fumonisins as well. During our visit, I went over the results with him. Using the BIOMIN Mycotoxin Compendium, I explained characteristic signs of those mycotoxins symptoms in his sows and pigs.

A few weeks later

Not long after our meeting, John called me to ask if I thought that he should use the BIOMIN product in his finishers, and, if so, at which dosage. He was using a different competitor's product. I offered a recommendation that I felt would be most cost-effective for him—and he ordered the necessary quantity of product right away. Then I asked him how the sows were doing. He said that the prolapse issue had dramatically improved. Sows were cycling normally and that overall health of the herd had improved enormously. His daughter has cautioned him about being too enthusiastic about the results, because she had seen things improve before only to deteriorate again. He felt that his problem is solved—and he is very happy.

Closing thoughts

One of the things that I find so rewarding about working at BIOMIN is that I get to help people solve problems every day and I get to work with a great team of people who also care about helping people solve those same problems.

Troubleshooting tips

At BIOMIN we have put together a series of practical 1-page articles on common issues in modern pigs production. Each differential diagnosis identifies potential cause, description of problem, checklist and corrective actions to help you to maintain production performance. You can find "A Practical Guide to Differential Diagnosis in Swine" on www.biomin.net

Cut & Keep Checklist

What's Wrong with My Pigs? Part 8: Jaundice

Jaundice, or icterus, is an increase of biliary salts in the blood that takes one of three forms. Pre-hepatic jaundice, or hemolytic icterus, occurs due to massive blood destruction that overwhelms the detoxifying capacity of the liver.

Hepatocellular icterus comes from direct liver injury, and post-hepatic icterus is caused by obstruction of biliary drainage. The main symptom is yellow colouration of white connective tissue in the body, skin or eye sclera, the latter being the only sign in pigs.

Several infections can affect directly the blood or the liver: Leptospira (mainly fetuses), mycoplasma, *E. coli* and *Salmonella*. In all cases other signs can help to address infective causes. *Ascaris suum* can also cause icterus through direct parasitosis of the liver with later migration to the lungs. At the abattoir white spots are evident in the liver.

Toxicoses such as copper excess and mycotoxins that primarily target the liver can lead to jaundice, particularly when aflatoxin and fumonisin concentrations reach high levels in feed.

Symptoms	Detection
Factor: Mycotoxins: Aflatoxins & Fumonisins	
Aflatoxins: Reduced protein synthesis, lower productivity and immune function; coagulopathy; depression, anorexia, anemia, ascites, hemorrhagic diarrhea, rough hair coat, elevated alkaline phosphatase; claycolored liver with centrilobular hemorrhage, fatty change, subserosal petechial to ecchymotic hemorrhages, intestinal and colonic hemorrhage; hepatomegalocytosis, interlobular fibrosis, biliary hyperplasia. **Fumonisins**: Reduced feed intake, hepatosis, pulmonary oedema, liver necrosis, bile retention, characteristic increased serum AST-GGT-bilirubin-cholesterol levels.	
Factor: Leptospirosis (fetal)	
Fever, anorexia, depression, infertility, mummification, abortion, stillbirth, weak born piglets, hemoglobinuria.	Epidemiology, serology (MAT-OIE 2008), PCR
Factor: *Mycoplasma suis*	
Pallor, fever, cyanosis of extremities (ears), anemia, poor growth, anorexia, decreased milk production, poor maternal behavior.	PCR, ELISA
Factor: Postweaning Multisystemic Wasting Syndrome (PMWS)	
Growth retardation, dyspnoea, enlargement of inguinal lymph nodes.	Multifactorial
Factor: Ascaris suum	
Major cause of icterus in swine; liver milk spots, pancreatic duct obstruction, cholangitis.	Eggs in feces (flotation), liver milk spots
Factor: Copper (Cu) excess	
Anorexia, bloody faeces, reduced weight gain, hemoglobinuria, nephropathy with hemolytic crisis.	
Factor: Haemolytic anaemia	
Immune-mediated mechanism, erythrocyte parasitism (*Mycoplasma suis*), erythrocyte fragmentation: Hemoglobinuria	
Factor: *E. coli* (ETEC) septicaemia	
Petechial hemorrhages serosal membranes, splenomegaly, secretory diarrhoea, dehydration	IHC, indirect immunofluorescence, ELISA, PCR
Factor: *Salmonella choleraesuis*	
Cyanosis of ears-feet-tail-ventral abdominal skin, enlargement of mesenteric lymph nodes, spleen: enlarged-purple-pulpy.	PCR, ELISA

References are available on request

For more information, visit **www.mycotoxins.info**