

The depth of feed sanitation – Controlling what are unseen

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**GLOBAL FOOD
WASTE NOT,
WANT NOT.**

Institution of
**MECHANICAL
ENGINEERS**

“”

IN INDIA, 21 MILLION
TONNES OF WHEAT IS
WASTED EACH YEAR
DUE TO INADEQUATE
STORAGE AND
DISTRIBUTION SYSTEMS.

FEED and FOOD waste is a major problem

Preservation with organic acids

COMBATING FOOD AND FEED WASTE

LAHCO

Lückstädt, Technical Director, Feed, ADDCON GmbH

Major factors affecting microbial growth

- ✓ Temperature
- ✓ Composition of the gas atmosphere
- ✓ Substrate properties
 - water activity (a_w), water content (moisture)
 - pH
 - nutrient supply
- ✓ Competition (microorganisms, insects...)

⇒ Interactions between those factors very likely!

Contamination of feed components

	Bacteria CFU/g	Fungi CFU/g
Corn	5,000,000	40,000
Wheat	6,000,000	40,000
Rye	6,000,000	40,000
Barley	8,000,000	50,000
Oats	15,000,000	70,000
Soybean, heated	1,000,000	20,000
By-products of oil production	2,000,000	20,000

Schmidt, 1991

Spoilage & nutrient value

- **Effect of spoilage cannot be generalized**
 - Diverse nature of the various nutrients
 - Chemical heterogeneity within each class of compounds
 - Complex interactions of all variables
- **Microbiological changes**
 - Growth or presence of toxicogenic and/or infective microorganisms
- **Enzymatic changes**
 - Hydrolytic reactions (lipases, proteases, etc.)
 - Lipoxygenase activity
- **Chemical changes**
 - Oxidative rancidity
 - Non-enzymatic browning
 - **Nutrient losses**

Effect of mould contamination on nutritive value of feeds

decreased nutritional values of mouldy corn-depending on storage time

	Reduction in %
Corn-energy	-5%
Corn-crude protein	-7%
Corn-crude fat	-63%
Corn, stored 25 days	-37% to -40%
Corn, stored 50 days	-52% to -57%

Tindall, 1983; Bartov, 1985

Mycotoxins formation – Mycotoxins on the field

Field fungi like Fusarium are unavoidable

Too much rain increase the likelihood of field fungi

Too late harvesting time increases the likelihood of field fungi



Storage Mycotoxins

Primary factors influencing fungal growth in storage are moisture content (more precisely, the water activity) and temperature.

For this reason, water which becomes the main determinant of invasion and fungal growth.

When mycotoxins are produced they will prevail, but the fungus will be destroyed by heat or chemical sterilization!

Major storage mycotoxins are Ochratoxins and aflatoxins.



Hidden infections in Wheat



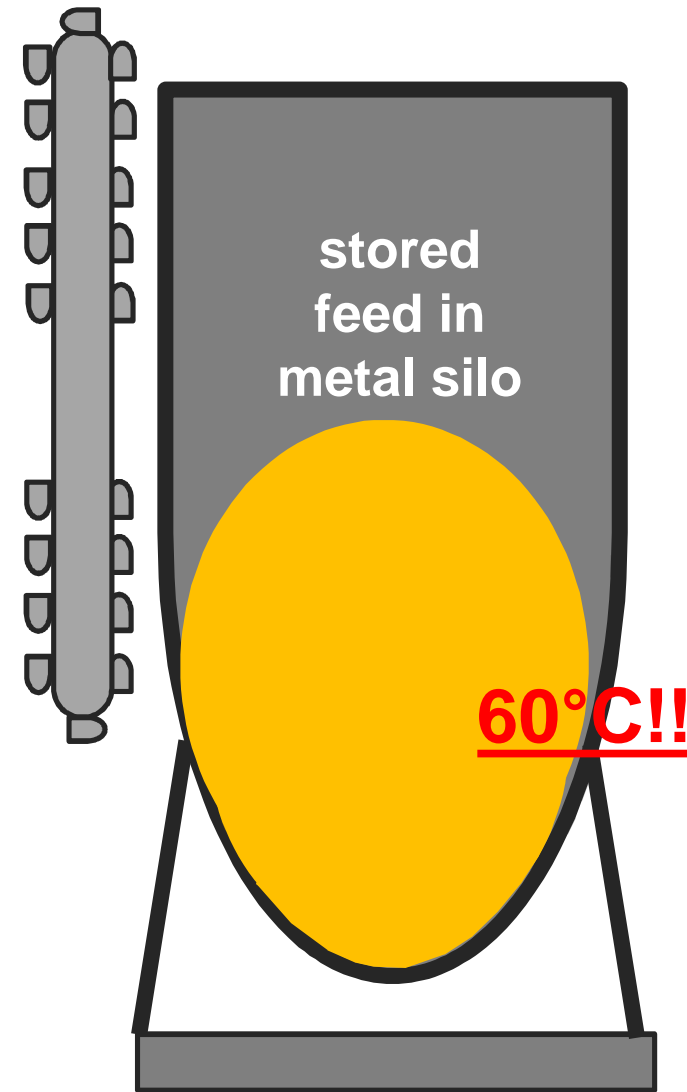
Storage fungi species of the *Aspergillus* and *Fusarium* also find protein spaces under the husk, which are more active in warm and humid conditions. The rapid development is due to the rise in temperature.

Metal silo - problem accelerator

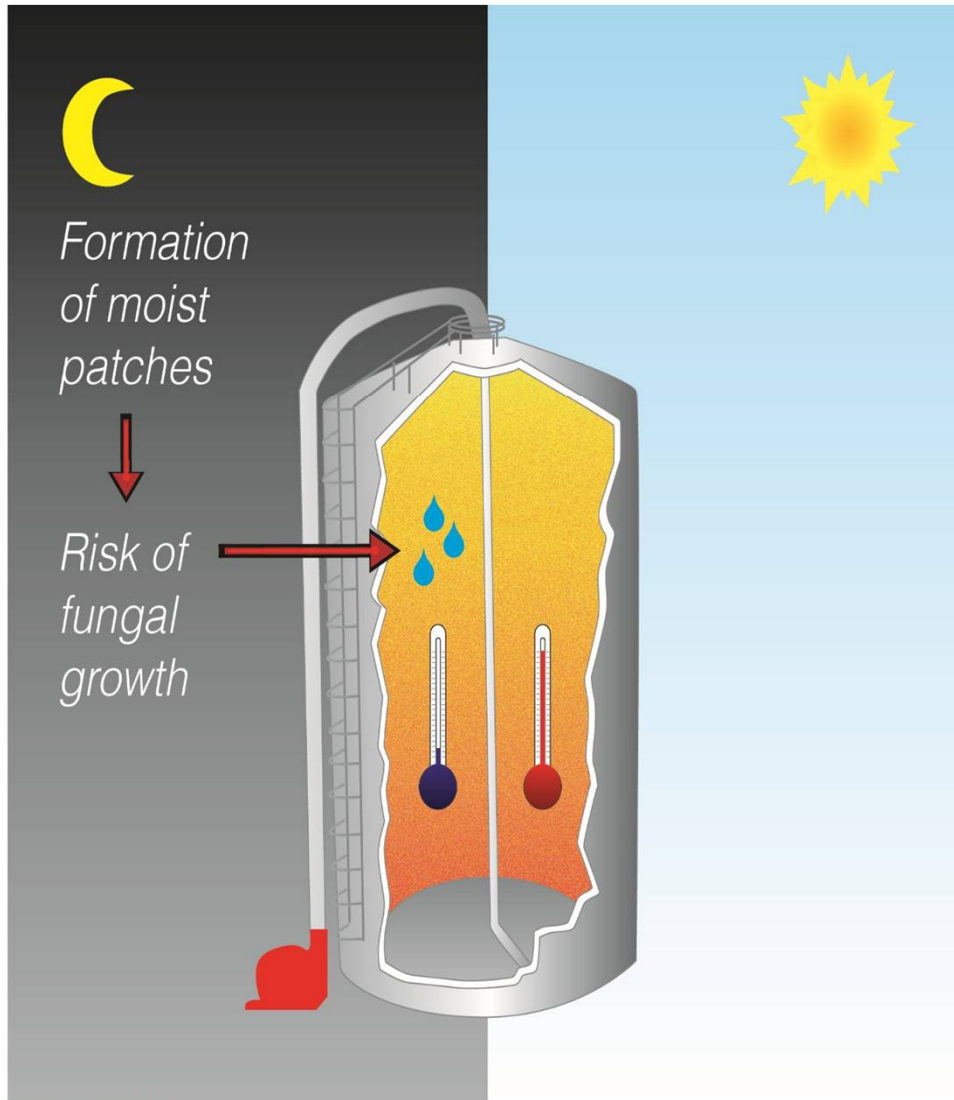
Heat acceleration:

Metal is a good conductor of heat → the external surface of a silo gets heated during sunshine hours.

- almost 60°C in the afternoon
- only 20-25°C at night

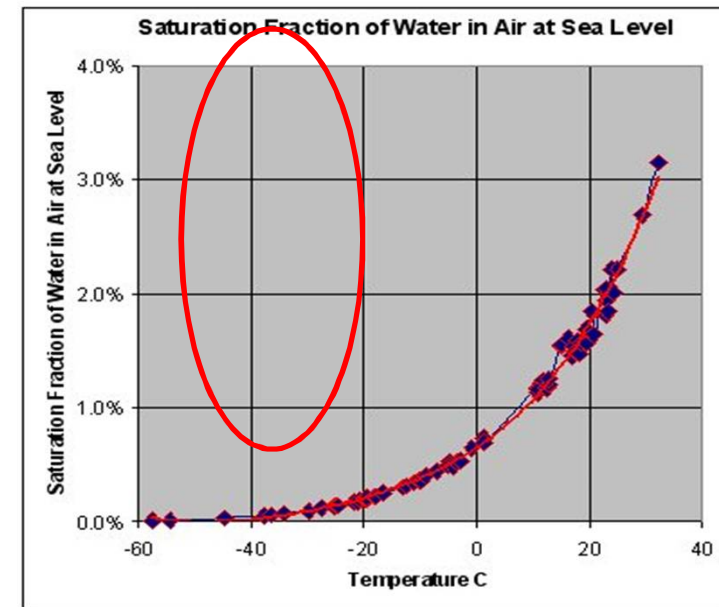


Contamination of feed during storage



Condensation of water at night!

Rule of thumb: at ambient temperature the water holding capacity of air is halved with a reduction of 7°C air temperature.



Condensation and temperature-dewpoint

Global trends – Contamination is the rule in 2022!

Cargill's 2022 World Mycotoxin Report

- More than 300,000 mycotoxin analyses
- 75% were positive and above detection limits



	DON	ZEN	FUM	T2	Aflatoxin
Corn-based ingredients	63%	55%	44%	33%	-
Cereal-based ingredients	66%	31%	-	28%	25%
Oilseeds-based ingredients	-	64%	-	24%	15%

Key Points

mycotoxin risk is high, especially in the region

vention of mycotoxins is not possible in all cases

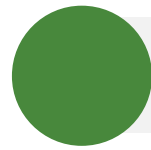
feed ingredients are contaminated with >1 mycotoxin

effects on the animals vary by the type of mycotoxins

o the stereochemistry of the mycotoxins, different
egies are needed to manage the threat!

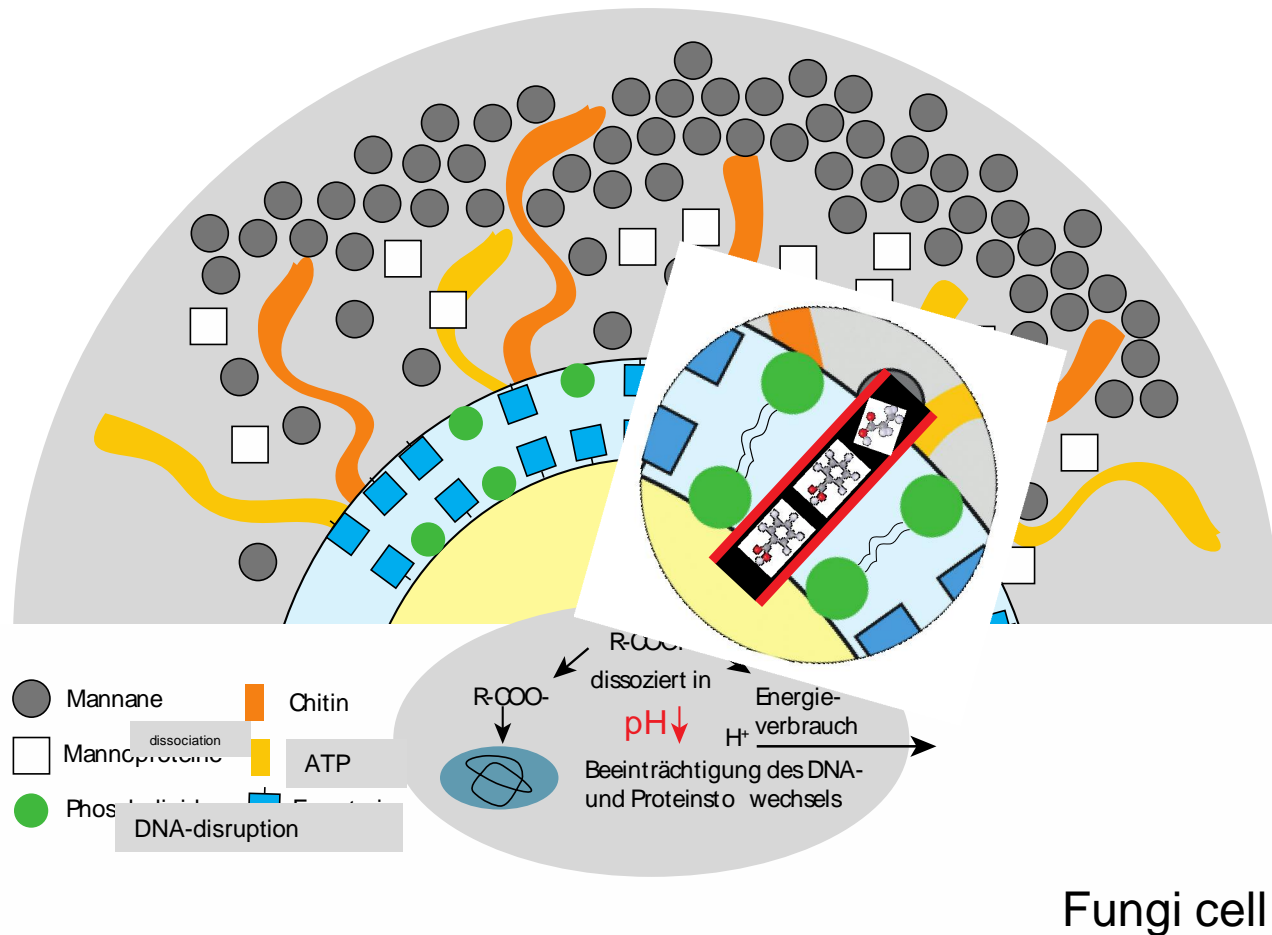


COTOXINS



Holistic Approach

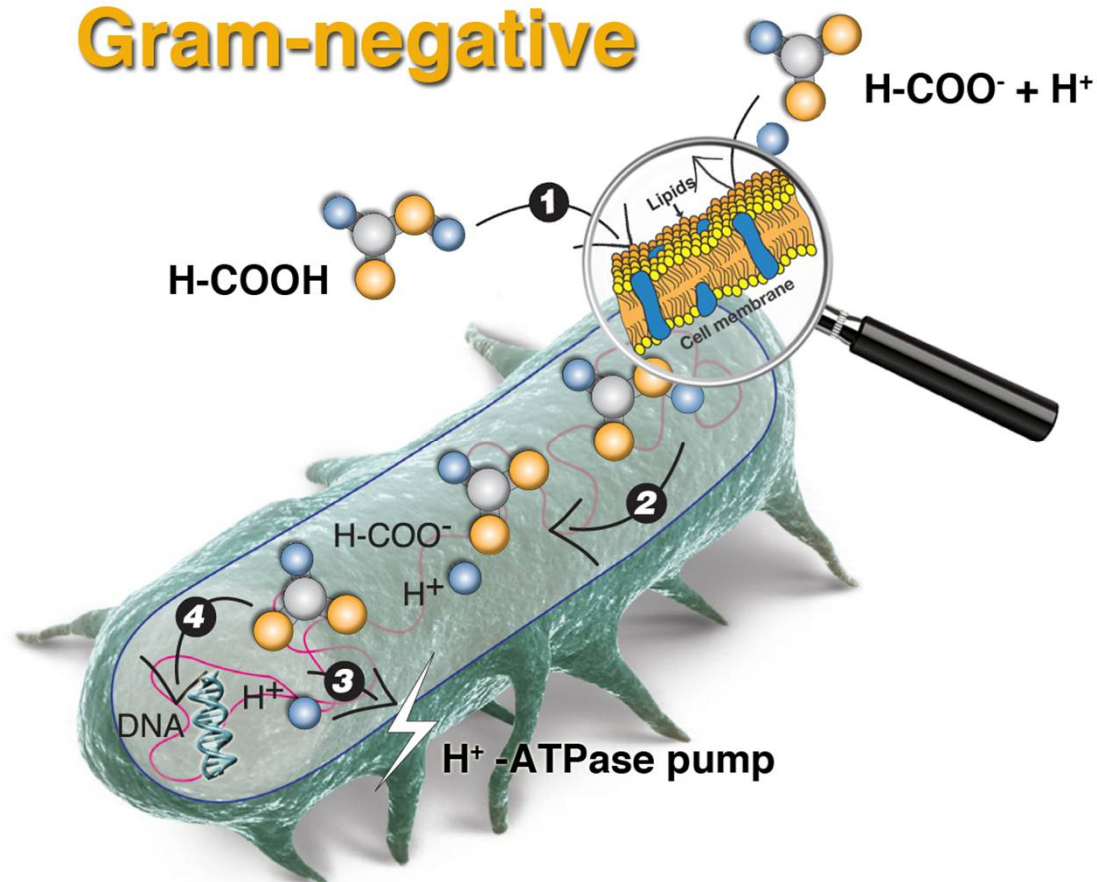
Propionic acid inhibits mycotic growth - thereby preventing fungal-degradation of feed...



Adapted from University of Marburg, Germany

Formic acid inhibits bacteria growth - thereby preventing bacterial degradation of feed...

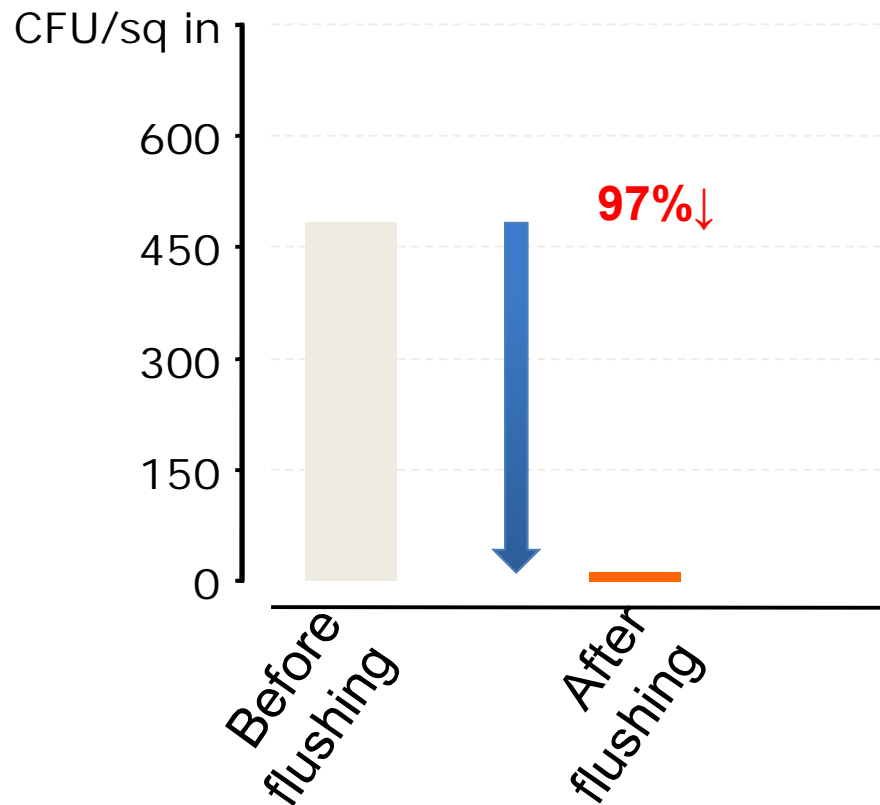
Gram-negative



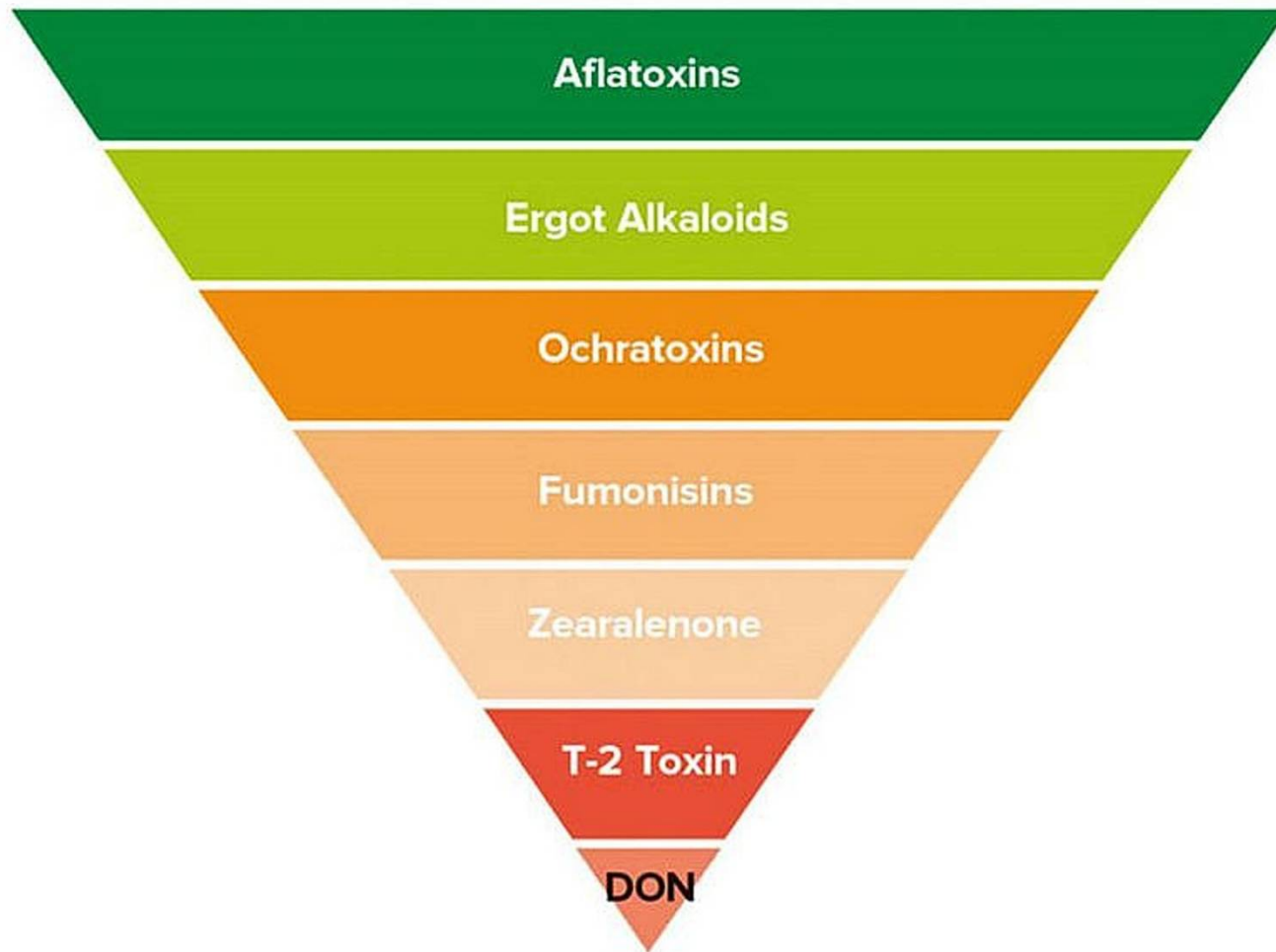
©ADDCON 2012, Germany

Production line cleaning - Philippines

Comparison of Total *Coliform* Count (CFU/sq inch) before and after cleaning the raw material pouring pit with a mixture of coarsely ground corn and feed hygiene enhancer



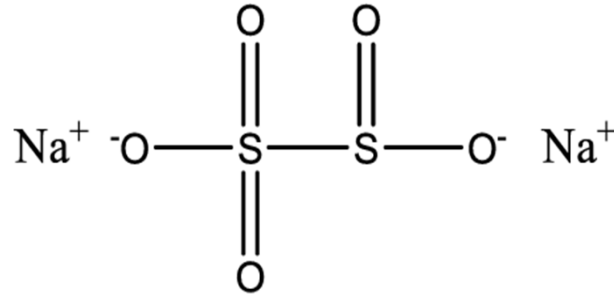
Binding Properties Mycotoxin Binders



Detoxification properties

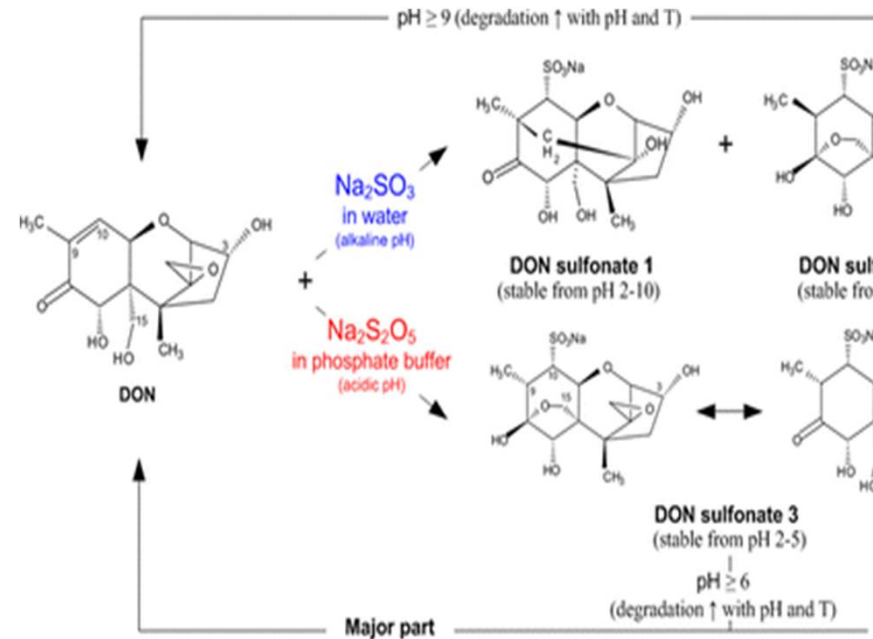
Sodium metabisulfite usage:

food industry as preservative,
antioxidant,
antimicrobial agent,
effect against mycotoxins.



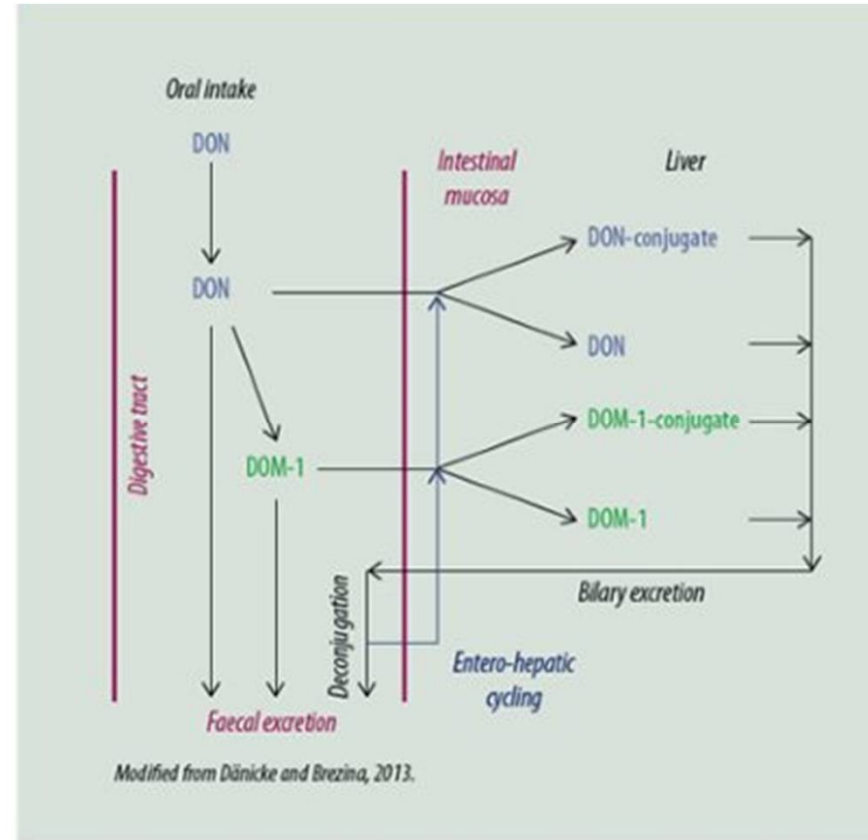
- ❖ Aflatoxins,
- ❖ Trichothecenes,
- ❖ **Deoxynivalenol.**

- Sodium metabisulfite (SMB; $\text{Na}_2\text{S}_2\text{O}_5$), a known bio-transforming agent of DON which, when hydrothermally processed with DON, forms a nontoxic DON sulfonate adduct.
- Impact of sodium metabisulphite (SMB) against DON has been widely tested within the last years-and it appears that the substance is very effective in detoxifying DON (Dänicke, 2020).



Impact of DON in pigs

Pigs are the most sensitive on DON among all animals, primarily because DON is rapidly absorbed and poorly metabolized (Stienne and Waché, 2008).
Reduced feed intake,
Complete feed refusal,
Weight loss,
General growth performance decreasing.



Metabolic path of DON in pigs

In-house accelerated storage trials

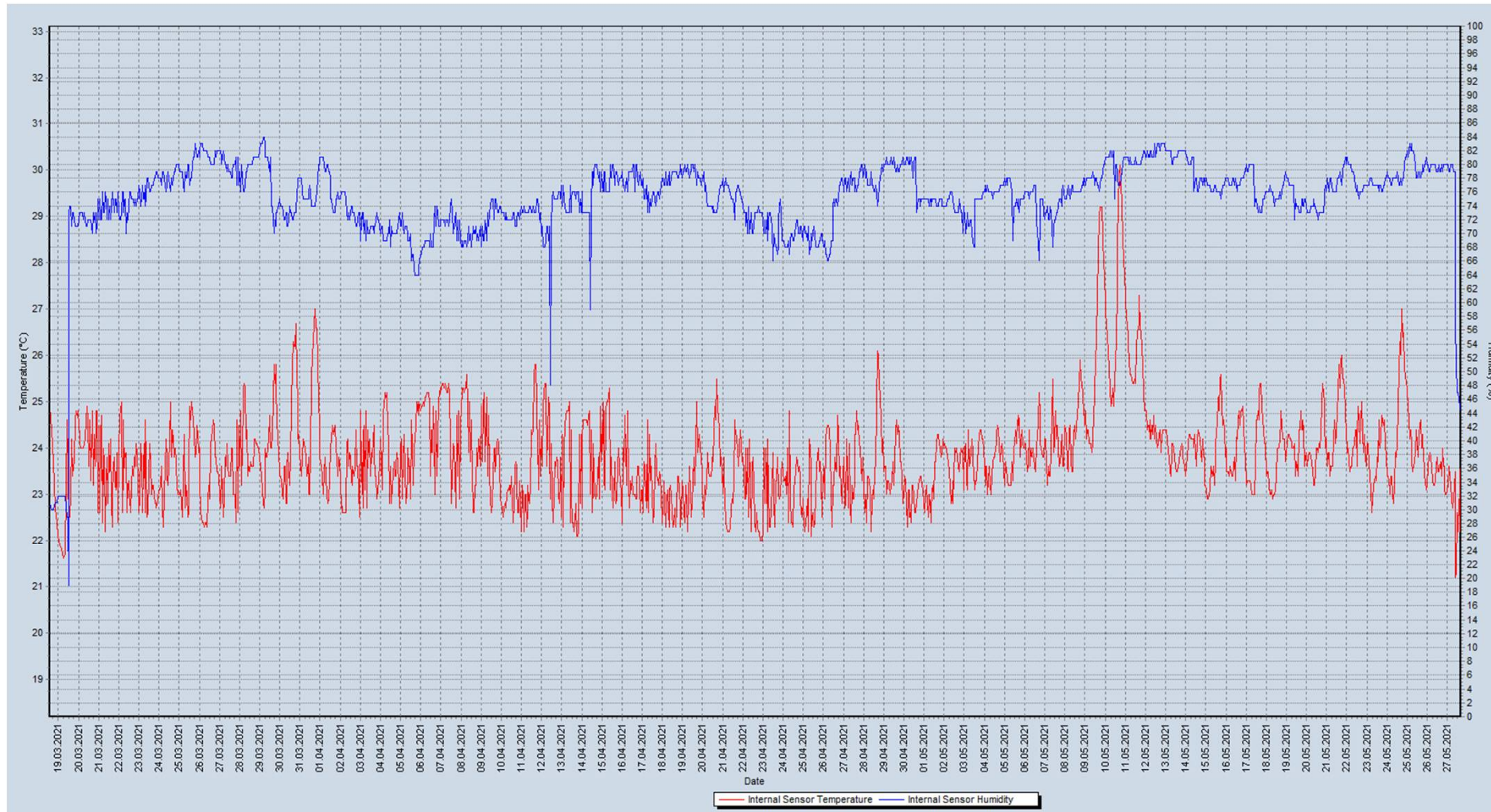


Accelerated storage trials:

- Raw material (clean wheat, moisture)–up to 2 months
- Compound feed (challenge: moisture and high microbiological load)–lasting 4 weeks

ADDCON-storage-climate chamber

➤ Climate chamber data—temperature and relative humidity—March-May 2021

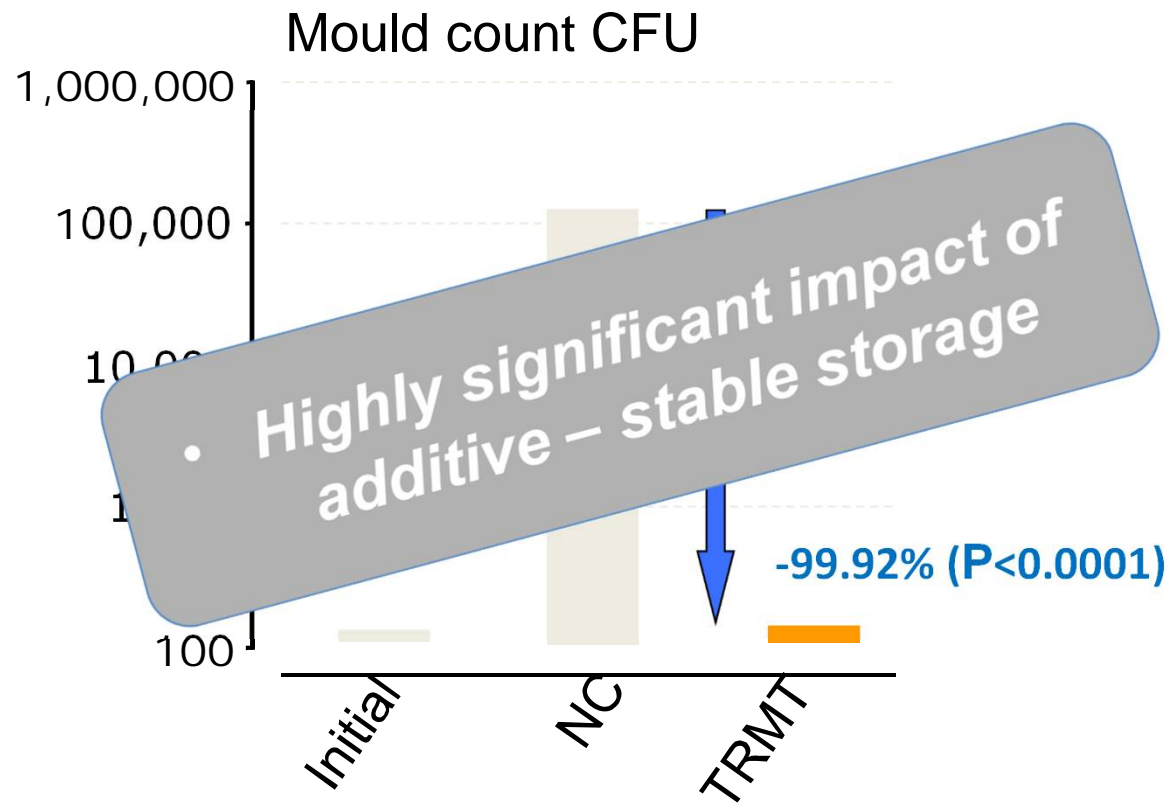


Compound feed storage—3rd week



Wheat storage – 66 days

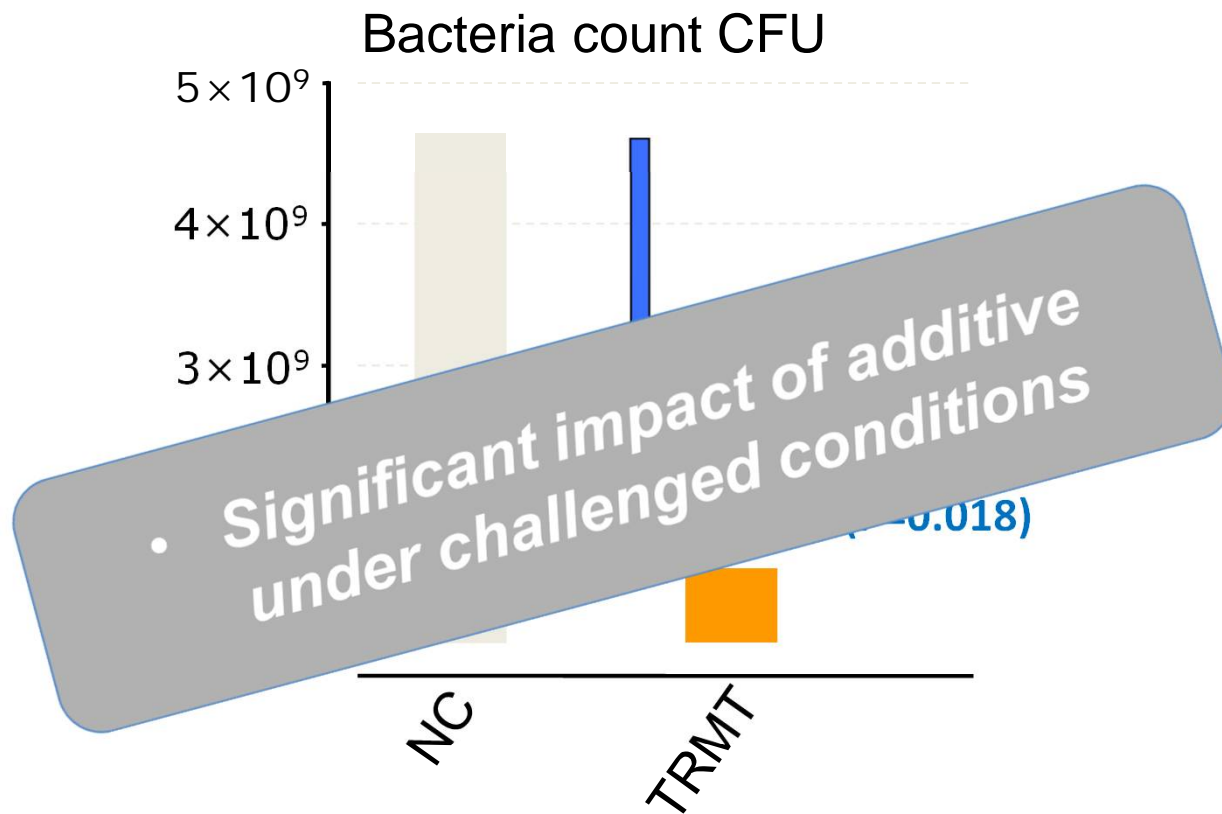
Final count of “clean wheat” stored for 66 days under accelerated conditions (12% moisture, 80% RH, 25°C)–with or without a feed hygiene product (3.0



ADDCON, Germany, 2021

Compound feed storage–2nd week

Bacterial count of compound feed stored for 14 days under accelerated and challenged conditions (15% moist feed, high microbial load, 80% RH, 25°C) with or without a feed hygiene product (3.0 kg/t)



Impact on animal performance

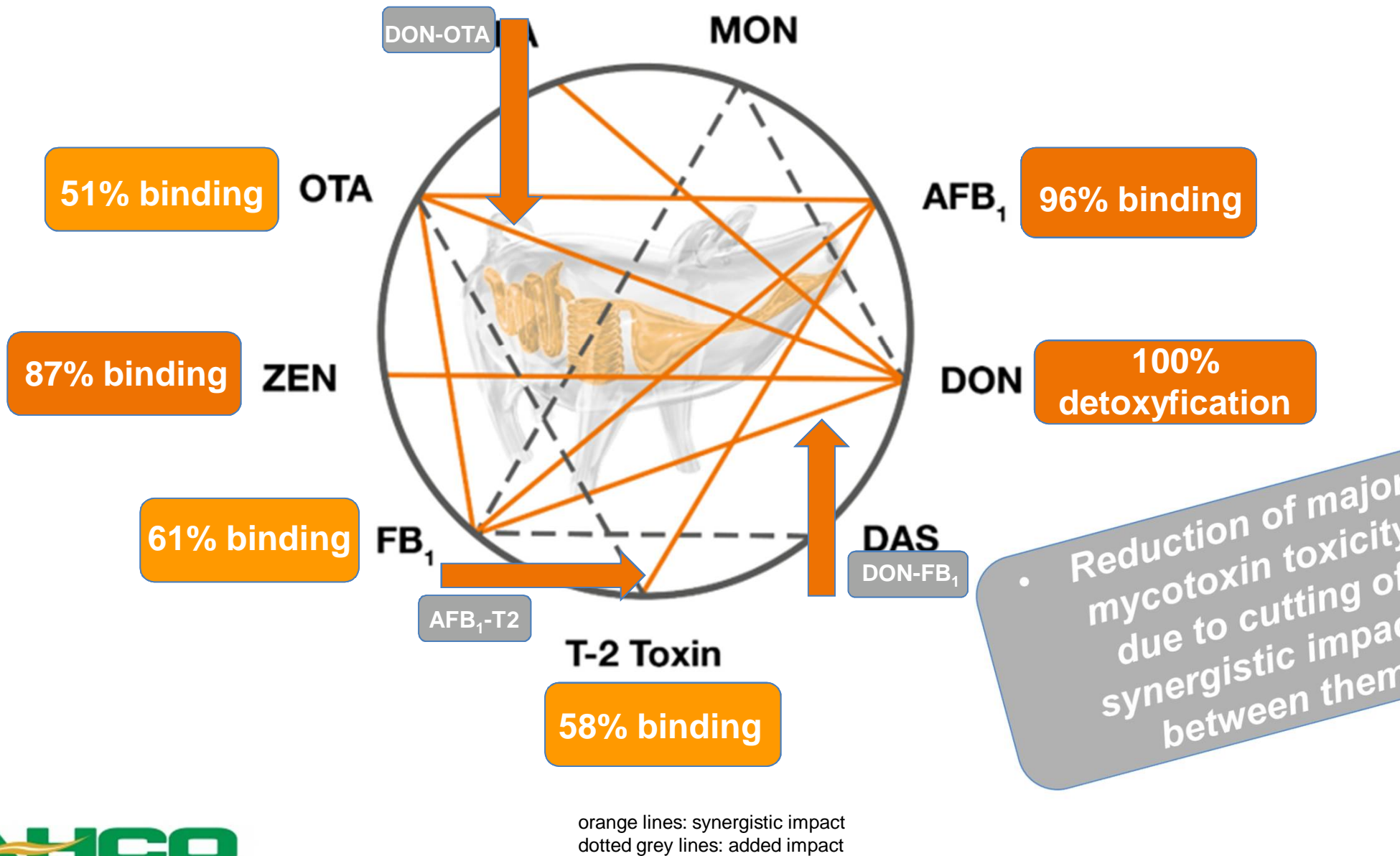
The positive effect on the use of SMB against DON in animal feed, and especially in pigs, has been repeatedly published by a group of researchers from Prof. Tokach's institute at Kansas State University,

Effects of 0.5% SMB on growth of weaned piglets (modified after Shawk et al. 2018)

	Product added, %	
	Control	Sodium metabisulfite
Day 0 to 21	-	0.50
Day 21 to 28	-	0.25
Day 0 to 21		
ADG, g	457 ^b	483 ^a
ADFI, g	589 ^b	608 ^a
G:F, g/kg	776 ^b	796 ^a
Day 21 to 28		
ADG, g	679 ^c	697 ^{bc}
ADFI, g	971 ^b	995 ^{ab}
G:F, g/kg	700 ^b	700 ^b
Day 0 to 28		
ADG, g	512 ^b	536 ^a
ADFI, g	684 ^b	704 ^a
G:F, g/kg	749 ^b	762 ^a
BW, kg		
day 0	7.0	7.0
day 21	16.8 ^b	17.3 ^a
day 28	21.6 ^b	22.2 ^a

Pigs fed SMB-based feed additives had improved ADG compared to pigs fed a control diet. It was furthermore found that higher inclusions and longer feeding of SMB resulted in the greatest benefit.

Cutting synergistic impacts of mycotoxins



The holistic approach to feed hygiene

