

# Effects of high fumonisin B1 concentrations in corn on performance parameters and health status of fattening pigs

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## Introduction:

*Fusarium verticillioides* occurs almost everywhere that corn is grown, supported by high temperatures, drought and heavy insect damage. Worldwide, an estimated 59 % of the corn or corn products are contaminated with fumonisins, of which fumonisin B1 (FB1) is the most toxic. Various diseases caused by fumonisins have been reported in animals, such as liver and kidney cancer in rodents, leukoencephalomalacia in equines, pulmonary oedema in pigs. No EU limit values exist yet for the fumonisin content in feed; the designated reference value in supplementary and sole feed for pigs amounts to 5 ppm, in Switzerland 10 ppm.

## Objectives:

1. Effects of high fumonisin B1 concentrations (43 ppm FB1) on fattening performance and health parameters of fattening pigs over a period of 6 weeks.
2. Efficiency of a surface-modified three-layer phyllosilicate (FIXAT®, Süd-Chemie AG) for compensation of the fumonisin-initiated effects.

## Material and methods:

- ◆ Corn incubated in the laboratory with *Fusarium verticillioides* was artificially contaminated with fumonisin B1 (360 mg/kg). Further groups of mycotoxins could be excluded under these defined conditions.
- ◆ The test animals were 32 male fattening pigs with an average weight of 25.6 kg. For each treatment variant, 4 animals/bay were deployed with respectively one repetition.
- ◆ After a 2-week settling-in period, the pigs received a corn-soy test feed ration (17.7 % protein) and water ad libitum.
- ◆ To record clinical symptoms (respiratory problems, fever, diarrhea, etc.), the marked animals were permanently monitored. For assessment of histopathological alterations, internal organs were removed. Furthermore, the flora of the small intestine was tested for coliform germs. Using blood samples, analyses were executed for renal insufficiency (urea and creatinine), and a hepatic profile (AST and ALT) was generated. The concentrations of the sphinganine and sphingosine (Sa:So) in the urine were determined using HPLC.
- ◆ **Test groups:**  
T-1 positive control, contaminated feed ration (43 ppm FB1)

T-2 negative control, uncontaminated feed ration

T-3 test group, contaminated feed ration (43 ppm FB1 + 0.2 % FIXAT®)

T-4 test group, contaminated feed ration (43 ppm FB1 + 0.4% FIXAT®)

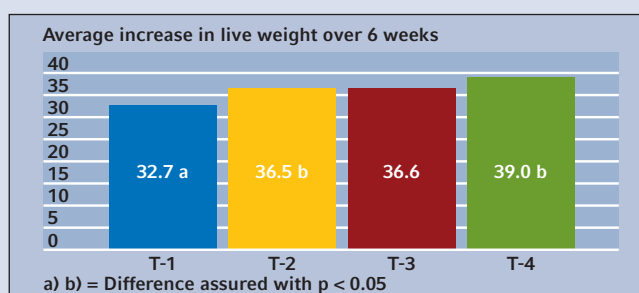
## Results:

In the positive control group (T-1), the high FB1 concentrations resulted in significantly reduced increases in live weight (average increase reduced by approx. 6 kg), which could be completely compensated using FIXAT® (T-4) (Fig. 1). Simultaneously, the feed conversion rate also increased (Tab. 1).

**Table 1: Performance parameters for pigs during 6 weeks of fattening**

	T-1	T-2	T-3	T-4
	Positive control FB1 (43 ppm)	Negative control without FB1	FIXAT® 2 kg/to+FB1 (43 ppm)	FIXAT® 4 kg/to+FB1 (43 ppm)
Start eight, kg	27.6	25.3	26.5	24.1
End weight, kg	60.3	62.0	63.1	63.1
Weight gain, kg	32.7a	36.5b	36.6	39.0b
Feed conversion	3.0	2.8	2.9	2.7

a) b) = Difference assured with  $p < 0.05$ ,  $n=8$



T-1 reacted with diarrhea events from the first week of the test on, and towards the end of the test, approx. 75 % of the animals in this group were affected (Tab. 2). This was accompanied by significantly increased concentrations of coliform germs in the duodenum. In comparison to T-2, the concentrations were higher by a factor of 143, compared to T-3 by 287, and compared to T-4 by 102. From the third week on, respiratory rate and heart rate in T-1 were higher for 60 % of the animals, while in the FIXAT® groups (T-3, T-4) neither diarrhea nor respiratory problems occurred.

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**Table 2: Clinical symptoms**

	T-1	T-2	T-3	T-4
	Positive control FB1 (43 ppm)	Negative control without FB1	FIXAT® 2 kg/to+FB1 (43 ppm)	FIXAT® 4 kg/to+FB1 (43 ppm)
Pneumonia	5/8 pigs	0/8 pigs	0/8 pigs	0/8 pigs
Diarrhea	6/8 pigs	0/8 pigs	0/8 pigs	0/8 pigs

**n=8, relation sick/healthy pigs**

FB1 only effected an increase in organ blood flow and hyperplasia in the liver of one third of the pigs in group T-1, and approx. 15 % of these animals showed alterations of the renaltissue. The biochemical analysis resulted in substantially more serious, FB1-initiated alterations in T-1, and showed significant increases in urea and creatinine concentrations as an indication for the onset of renal insufficiency (Tab. 3). The statistically assured increase of the liver enzymes AST and ALT was a clear indication for acute hepatitis. Using the mycotoxin adsorber FIXAT® (T-3, T-4), all tested parameters could be kept, dose-dependent, at an almost normal level (T-2), and thus a renal- and hepatoprotective effect against harmful poisons could be verified.

**Table 3: Biochemical kidney and liver analyses**

	T-1	T-2	T-3	T-4
mg/100 ml	Positive control FB1 (43 ppm)	Negative control without FB1	FIXAT® 2 kg/to+FB1 (43 ppm)	FIXAT® 4 kg/to+FB1 (43 ppm)
Urea	58.5a	32.5b	37.0b	33.0b
Creatinine	1.7a	0.8	0.9	0.7b
ASAT <sup>1)</sup>	216a	145b	160b	139b
ALAT <sup>2)</sup>	132a	85b	101b	98b

a) b) = Difference assured with  $p < 0.05$ , n = 8

1) Aspartate aminotransferase; 2) Alanine aminotransferase

More significant than in liver and kidneys were the histopathological damages caused by FB1 in lungs and heart (Tab. 4-5). Tissue solidification and capillary bleeding of the lungs, accumulation of fluid in the heart bag and organomegaly in the T-1 group could be avoided by FIXAT® (T-3, T-4), independent of the dose, for the lungs at 85 %, and for the heart entirely.

**Table 4: Histopathology of the lungs**

	T-1	T-2	T-3	T-4
	Positive control FB1 (43 ppm)	Negative control without FB1	FIXAT® 2 kg/to+FB1 (43 ppm)	FIXAT® 4 kg/to+FB1 (43 ppm)
Induration	5/8 pigs	0/8 pigs	1/8 pigs	1/8 pigs
Capillary bleeding	8/8 pigs	0/8 pigs	1/8 pigs	1/8 pigs

**n = 8, relation sick/healthy pigs**

**Table 5: Histopathology of the heart**

	T-1	T-2	T-3	T-4
	Positive control FB1 (43 ppm)	Negative control without FB1	FIXAT® 2 kg/to+FB1 (43 ppm)	FIXAT® 4 kg/to+FB1 (43 ppm)
Hydropericardium	8/8 pigs	0/8 pigs	0/8 pigs	0/8 pigs
Cardiomegaly	8/8 pigs	0/8 pigs	0/8 pigs	0/8 pigs

**n = 8, relation sick/healthy pigs**

Due to the enzyme inhibition caused by FB1, the intracellular concentrations of sphinganine (Sa) and sphingosine (So) rise up to a toxic level, and an increased ratio of Sa:So in the urine can also serve as a diagnostic marker for fumonisin exposure (Table 6).

The significantly increased Sa:So ratio in the positive control (T-1) indicates an inhibition of the enzyme ceramide synthetase. These toxic effects of the fumonisin could be compensated by its adsorptive deactivation at the specific surface structure of FIXAT®, depending on the dose (T-3, T-4).

**Table 6: Ratio Sphinganine:Sphingosine**

	T-1	T-2	T-3	T-4
	Positive control FB1 (43 ppm)	Negative control without FB1	FIXAT® 2 kg/to+FB1 (43 ppm)	FIXAT® 4 kg/to+FB1 (43 ppm)
Reference value	1.9	0.12	0.5	0.2

### Summary:

High fumonisin B1 concentrations (43 ppm FB1), fed over a period of 6 weeks, massively affect the fattening performance and health parameters of fattening pigs.

Using the mycotoxin adsorber FIXAT® (T-3, T-4), all parameters tested could be kept, depending on the dose, at an almost normal level (T-2), and thus a renal- and hepatoprotective effect against high FB1 concentrations could be verified.

Histopathological damages in lungs and heart could likewise be avoided almost entirely. The mycotoxin adsorber FIXAT® thus provides effective protection for fattening pigs against fumonisin B1 in the feed.