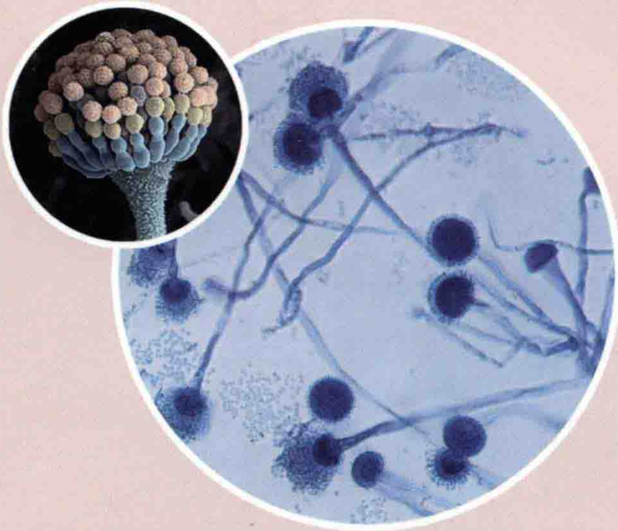
Scientific Research Monographs

Biodegradation of Mycotoxins in Swine Feed

霉菌毒素对猪危害及生物降解法研究

Chief Editor　Liu Di



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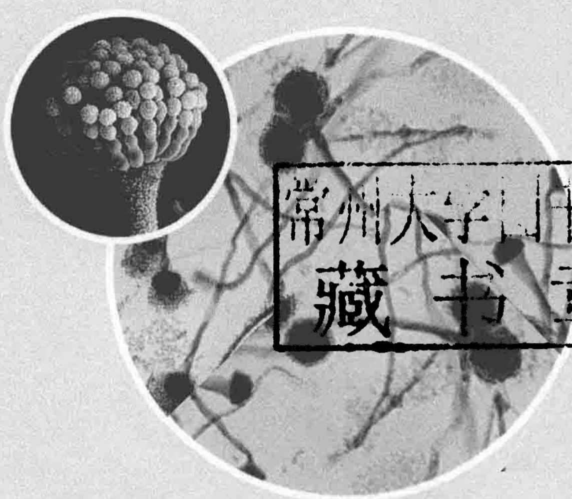

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Biodegradation of Mycotoxins in Swine Feed

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PREFACE

Research shows that 95% of mycotoxins in the presence of animal feed have been produced in the field, especially in wet or humid weather. Crops in harsh climatic conditions the occurrence of mycotoxins and its concentrations tend to be higher. Mycotoxins may occur during the storage of feedstuff or feed product. Currently, more than 200 mycotoxins are known in the presence of animal feed. In China, the most common and most harmful mycotoxins to hog industry are mainly aflatoxins, T-2, zearalenone, in addition to fumonisin and ochratoxin.

Pigs in all stages of production are very sensitive to mycotoxins. Mycotoxins can suppress immune function in pigs, resulting in decreased resistance to disease, inducing chronic infection and lower therapeutic response; furthermore, it has caused huge losses in hog industry. China is situatedin Asia with high occurrences of mycotoxins, the southern, eastern, and northern usually present more rainfalls. In harvest seasons, crops in the field under humid are prone to be contaminated by mold, especially aflatoxin widespread in corn, peanut meal and other feed ingredients. Deterioration of feedstuff not only irritates the health of pigs, but also ultimately affects human health. In recent years, moldy corn produced in northeastern China appeared to climb; potentially it may significantly damage productivity and efficiency of pigs.

The approach of mycotoxin detoxification is of particular importance. In comparison with the detoxification processes of mycotoxins, biodegradation is more preferable, so the study of mycotoxins, especially aflatoxins is necessary. We launched a joint program with other experts from Canada and Japan, conducted trials including biodegradation of mycotoxins applied probiotic fermentation and inhibition of lactic acid to *Aspergillus* parasitical. The research led to the development of a natural anti-mycotoxin feed additive, and evaluated the efficacy of this additive.

The authors would like to summarize and publish the results for your reference. The authors want to raise the attention of mycotoxins, in addition to take preventive measures.

Due to our knowledge and experience, there might be error or mistakes in this book. The authors will much appreciate your comments.

Editorial Board

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1 Introduction

1.1 Mycotoxin research progress

Any fungus living on a substrate grown as cotton wool, fluffy or cobweb-like mycelium are collectively known as molds. Molds exist in two forms in nature, namely the field mold and storage mold. The occurrence of mold can be in the field of harvest or under storage conditions. Molds can survive the winter and can breed under cold conditions[1]. Mold in feed will continue to consume the nutrients resulting in the consumption of nutrients and mold contaminated feed have poor sensory properties which will seriously affect the palatability. Mold will produce mycotoxins and other secondary metabolites in the process of contaminating feed. these toxins have strong side effects on animals. Livestock will appear stunted growth, reduced reproductive performance, immune function decline even if the content is very low in the feed. Currently three categories are known to produce mycotoxins, namely *Aspergillus*, *Penicillium* and *Fusarium*. These mycotoxin produced by fungi include *Aflatoxin*, *Ochratoxions*, *Fumonisin*, *Zearlenone* and *Trichothecenes*. *Trichothecenes* include DON, T-2 and DAS.

Feed ingredients, food, meat, DDGS were analyzed (Table 1 – 1) from 731 different regions worldwide by BIOMIN company in 2011. As can be seen from the data, fungal toxins have occurred and existed in Asia, South America, North America, Europe, Africa and other regions. The most serious contamination occurred in Asia and the mycotoxin contamination rate in Asia is higher than that in North America. Mycotoxins contents in Asia samples are several times to dozens of times higher than those in North America. Meanwhile, changes of the mycotoxins contents in the same feed samples were tested by BIOMIN company from July to September, 2010. The results showed that mycotoxin content increased from July to September, 2010, indicating that mycotoxin increased 30% to 62% in only three months and the fast changing speed is shocking[2].

1.1.1 Types of mycotoxins

Mycotoxins are poisonous substances produced by the fungus. Mycotoxins can be found in the soil and plants, including cereals, forage and silage. Mycotoxins can be formed at the time of harvesting and can also be formed on harvested crops under unfavorable storage conditions. These mycotoxins can cause impacts on feed and livestocks[3,4].

Table 1-1 BIOMIN's Asia and North America mycotoxin survey report in the first quarter of 2011

Toxin type	Asia				North America			
	Sample amount	Pollution rate (%)	Average content (μg/kg)	Max-D (μg/kg)	Sample amount	Pollution rate (%)	Average content (μg/kg)	Max-D (μg/kg)
Afla	267	36	94	677	14	14	2	2
ZON	272	51	511	511	17	35	197	506
DON	266	59	1 768	1 768	17	47	577	1 141
FUM	267	45	1 717	1 717	10	60	1 167	2 088
OTA	260	32	12	12	10	30	30	2

1.1.1.1 Aflatoxin

Aflatoxin (Afla) is highly toxic and highly carcinogenic toxins and is produced by the Aspergillus flavus (Aspergillus) microorganisms. Aflatoxin is a compound made up of two unequal dihydro-nitrofurantoin-ring, both are derivatives of furanocoumarins (Difuranocoum). Aflatoxin in contaminated food are only 4 species aflatoxins B_1, B_2, G_1 and G_2. The nomination of these mycotoxins is mainly based on the different colors they emitted under ultraviolet light. The color of AFB_1 and AFB_2 emitted is blue light while the color emitted by AFG_1 and AFG_2 is yellow-green. Almost all aflatoxin have the primary toxicity to animals liver in which

AFB_1 is the most toxic which is 10 times more toxic than the potassium cyanide and 68 times more toxic than arsenic. The order of the aflatoxin according to their toxicity from strong to weak is B_1, G_1, B_2 and G_2. AFB_1 has been identified as a class I carcinogen by IARC for human and livestock. Aflatoxin contamination in the daily feed is mainly AFB_1 which accounts for the largest amount and the most toxic. Therefore, AFB_1 is used as indicators for feed contamination of aflatoxin by the quality of supervision in our country[5].

Aflatoxins are very stable and their toxicity can only be destroyed at a temperature of 268 – 269℃. it is quite stable in acidic and neutral solution and it won't dissolve in acid solution until pH 1 – 3. It can be quickly decomposed to form a sodium salt in alkali solution of NaOH in pH 9 – 10 and the fluorescence also will disappear. But the process is reversible and it will restore the original structure under acidic conditions. Aflatoxin can be completely destroyed by 5% sodium hypochlorite solution, Cl_2, NH_3, SO_2 and other strong oxidants[6].

1.1.1.2 Trichothecenes

Trichothecenes is the secondary metabolites produced by Fusarium at low temperatures. It is widespread in nature and is more common in long-term storage of food crops. It will easily lead to serious illness and even death if eating by mistake. Trichothecenes are divided into four sub-categories, in which Class A and Class B are most important. Class A of trichothecene produced by Fusarium oxysporum and Fusarium pears, including T-2 toxin, HT-2 toxin, fusaric acid (NEO) and diacetoxymercury mariqueter ene alcohol (DAS). Class B trichothecene produced mainly by yellow Fusarium graminearum and Fusarium which include bacteria enolase deoxynivalenol toxin (deoxynivalenol, DON) and its three-acetyl or 15-acetyl derivatives, snow rot Fusarium enolase (NIV) and Fusarium ketene-X (Fusarenon-X, FX)[2]. T-2 toxin of type A and DON of type B are the most common toxins.

Trichothecenes are toxic to both humans and animals and can cause acute and chronic diseases which include vomiting, diarrhea, skin irritation, feed refusal, nausea, neurological disorders and abortion[7]. Furthermore, high doses of trichothecenes can accelerate apoptosis of leukocytes[8].

1.1.1.3 Zearalenone

Zearalenone (abbreviation ZEA), also known as F-2 toxin was first isolated from corn