Factors contributing to the distribution and incidence of aflatoxin producing fungi in stored maize in Benin

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VI. Illustrations of storage types

List of Abbreviations:

a_w	Water activity is numerically equal to relative humidity, but expressed as a decimal value rather than a percentage
BGYF	Bright greenish yellow fluorescence
CARDER	Centre d'action rurale et developpement rurale
DAP	Double ammonium phosphate
DAPS/MDR	Direction agriculture et promotion sociale/Ministére de developpement rurale
FMS	Forest Mosaic Savanna
IITA	International Institute of Tropical Agriculture
INRAB	Institute National de la Recherche Agronomique du Benin
NGS	Northern Guinea Savanna
SGS	Southern Guinea Savanna
SONAPRA	Societé National sur la Promotion Agricole
SS	Sudan Savanna

Abstract (Deutsch)

Kerstin Hell: Factors contributing to the distribution and incidence of aflatoxin producing fungi in stored maize in Benin

Key Words: Aflatoxine, Mykotoxine, Benin, West-Afrika, Lagermethoden.

Ziel dieser Studie war es, einerseits eine Übersicht über die Bedeutung von gelagertem Mais als Quelle der gesundheitlich äußerst relevanten Mycotoxinbelastung in der menschlichen Nahrung, insbesondere durch Aflatoxin, in Westafrika zu gewinnen. Andererseits sollten Erkenntnisse über Ursachen und mögliche Vermeidungsstrategien gewonnen werden. Über einen Zeitraum von zwei Jahren wurde der Aflatoxingehalt in 300 traditionellen Maislagern in den vier agroökologischen Zonen von Benin ermittelt. Parallel dazu wurde versucht, mittels einer Bauernbefragung, die Ernte- und Lagermethoden zu identifizieren, die einen Einfluß auf Aflatoxine in den einzelnen Ökozonen hatten.

Die Infektionsrate mit *Aspergillus flavus* in gelagerten Mais in 1993-94 waren vergleichsweise gering und betrugen kurz nach der Ernte zumeist nur 10 bis 20%. Im Verlauf von sechs Monaten Lagerungsdauer stieg der Befall allerdings erheblich an, so daß bis zu 55% der Körner infiziert waren. In 1994-95 lag der Prozentsatz der Körner die *A. flavus*-Befall aufwiesen zwischen 8 und 47%. In dem Beprobungszeitraum waren 25% der Proben Aflatoxin positiv, hiervon wiesen 60% wiederrum Gehalte von mehr als 20 ppb auf.

Verschiedene Faktoren beeinflußten den Aflatoxingehalt der Maisproben. Das Befallsrisiko wurde erhöht, durch den Anbau von Mais nach Mais und wenn Kulturen in die Fruchtfolge aufgenommen wurden, die das Wachstum von *A. flavus* begünstigten. Gleiche Effekte entstanden, bei Beschädigungen des Maises entweder im Feld, während der Ernte oder im Lager durch anthropogene Einflüsse oder Schädlinge. Insbesondere Schäden durch den Kornbohrer *Mussidia nigrivinella*, den Nitiduliden *Carpophilus spp*. und dem Maiskornkäfer *Sitophilus zeamais* waren mit erhöhten Aflatoxingehalten korreliert.

Indessen führte die Anwendung von Insektiziden oder Rauch im Lager zu reduzierten Pilzinfektionen. Mit niedrigeren Aflatoxingehalten waren folgende Maßnahmen assoziert: Ernte zum Reifezeitpunkt mit den Lieschblättern, Trocknung der Maiskolben außerhalb des Feldes ohne die Lieschblätter sowie Aussortierung der beschädigten und verdorbenen Kolben nach der Trocknung.

Bei Betrachtung der Lagerungsform, ergab die Lagerung als Körnermais die höchsten Aflatoxingehalte. Wesentliche Effekte gingen auch von den Lagerstrukturen aus. Es kam zu erhöhten Aflatoxingehalten, wenn Mais über dem Dachboden, auf dem Dach, im „Ago“ in der nördlichen Guinea-Savanne oder in Lagerbehältern, die älter als 5 Jahre waren, gespeichert wurden. Hingegen waren Lagerstrukturen wie der „Ago“ aus Bambus oder Lagerung in Jute oder Plastiksäcken mit niedrigen Aflatoxingehalten assoziert waren.

Abstract (English)

Kerstin Hell: Factors contributing to the distribution and incidence of aflatoxin producing fungi in stored maize in Benin

Key Words: Aflatoxin, mycotoxin, Benin, West-Africa, farming practices.

The aim of this study was to get an indication about the importance of stored maize as a source for the health threatening contamination with mycotoxins, especially aflatoxins in Benin, West-Africa. Information was also gathered about the possible cause of high contamination levels and strategies to reduce these adverse effects were evaluated. The aflatoxin incidence of 300 farmers' stores in four agroecological zones was evaluated over a two year period. At the time of sampling in the storage bins, a questionnaire was used to identify production, harvest and storage practices that had an effect on aflatoxin across agroecological zones.

In 1993-94 *A. flavus* development in stored maize shortly after harvest was comparatively low, with 10 to 20% of the grains contaminated. Six months later it increased to over 55%. In 1994-95 the percentage of grains that showed *A. flavus* presence was between 8 to 47%. Over the survey period 25% of all the samples were aflatoxin positive and out of these samples 60% had levels of more than 20 ppb.

There were several management practices that were positively related with aflatoxin contamination. Planting of maize in the same field consecutively, and in a crop rotation that incorporated crops that supported growth of *A. flavus*, increased the risk of contamination. Harvest practices associated with lower aflatoxin load were: harvest at maturity with the husk, drying outside the field without the husk, drying followed by sorting of damaged or spoilt cobs. Use of insecticides and smoking in storage reduced fungal contamination. Damage to maize, either biotic or man-made in the field, during harvest, or in storage had negative effects. Insects have long been implicated in the spread of *Aspergillus* spores and the development of aflatoxins. In this study a relationship was found between the presence of insects and aflatoxin.Damage due to the cob borer *Mussidia nigrivinella*, the nitidulid *Carpophilus* spp. and the maize weevil *Sitophilus zeamais* correlated with high aflatoxin incidence.

In a trial, the influence of storage form on aflatoxin contamination was evaluated. Maize that was stored as grains showed the highest aflatoxin content. Storage types that increased the risk of fungal development are storage on the ceiling, on roof tops, in the Ago (used in the Northern Guinea Savanna) and in storage containers that were more than 5 years old. Farmers' practices that were linked to lower aflatoxin contamination were: storage in either the Ago (made from bamboo) or use of jute or polyethylene bags as secondary stores.