
بسم الله الرحمن الرحيم

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AFLATXINS: AWARENESS AND CONTROL

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AFLATOXIN

Most references to “mycotoxin”, unspecified, refer to Aflatoxin.

Why to deal with aflatoxin ?

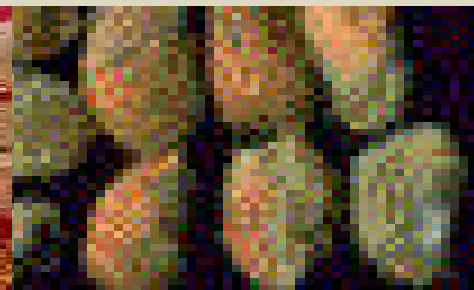
- **Mycotoxins are present in all stages of food production, processing and storage.**
- **These natural toxins occur primarily in those cereal crops (e.g. wheat, maize) which serve as main food items for the human population and as important raw materials of animal feeds.**
- **The risk posed mycotoxins consumed in low amount but continuously is not yet explored, however the danger is very high (‘hidden killers’).**

History of Aflatoxins

- **5,000 years ago in China.**
- **Early 1861, was reported in Russia.**
- **1891, there was a report of mouldy rice in Japan.**
- **1913, First describes but the toxin was not isolate.**
- **1940, Aflatoxicosis in swine had been reported due to ingestion contaminated Maize.**
- **1950, similar ingestion happened in Alabama, US.**
- **1960, is the time of the discovery of aflatoxin in England (Turkey X Disease).**

Sources of Aflatoxins

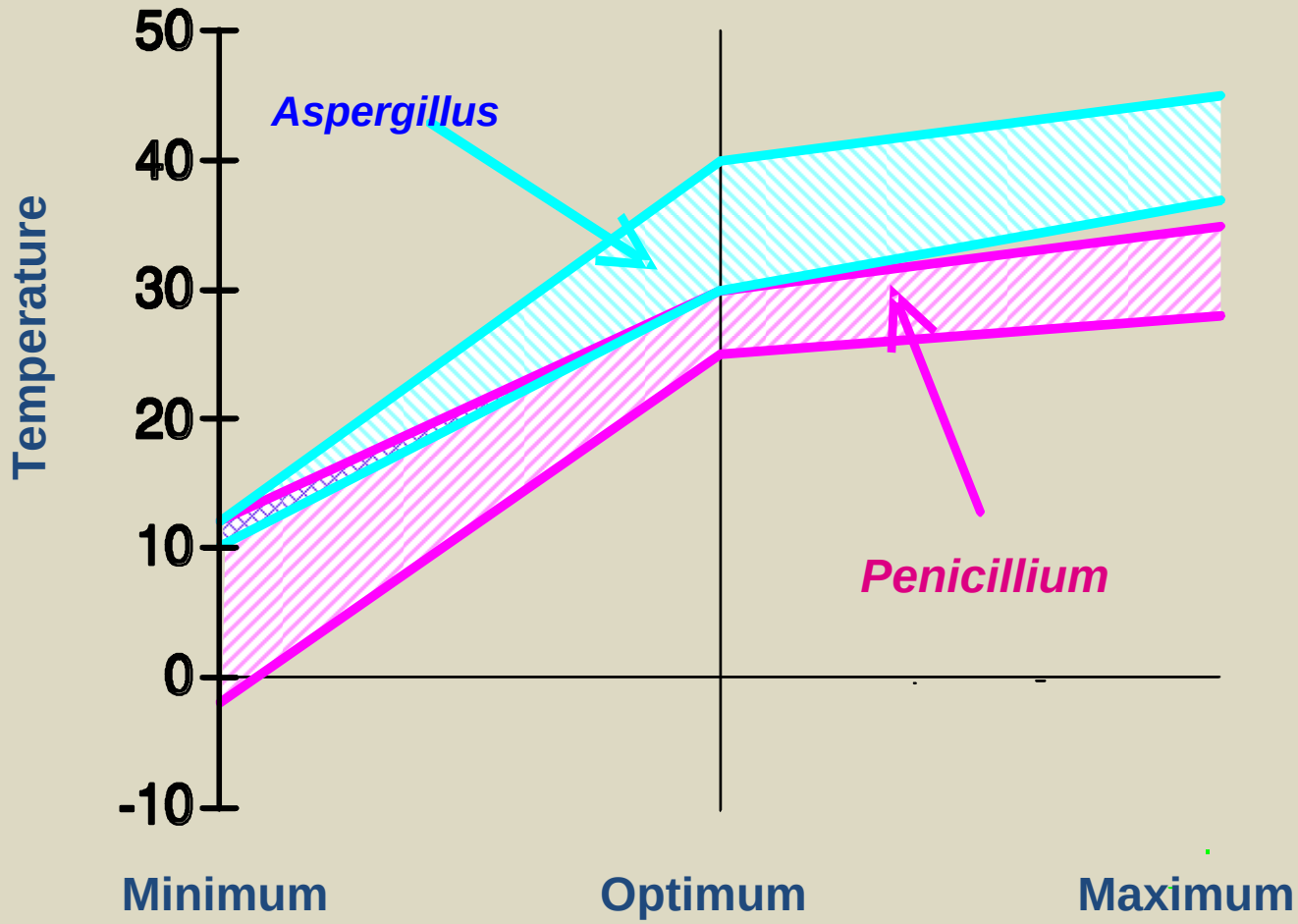
- **Produced by 3 species of *Aspergillus: A. flavus, A. parasiticus, A. nomius.***
- **Aflatoxin: A (*Aspergillus*) - fla (*flavus*) – toxin.**
- **Four toxins soon identified: Aflatoxin B_1, B_2, G_1, G_2 - blue or green florescence under UV-light.**
- **Aflatoxin B_1 most important - highly carcinogenic and widespread occurrence in foods**
- **($B_1 > M_1 > G_1 > B_2 > M_2 \sim G_2$).**
- **Aflatoxin M_1 : hydroxylated product of B_1 appears in milk, urine, and feces as metabolic product.**



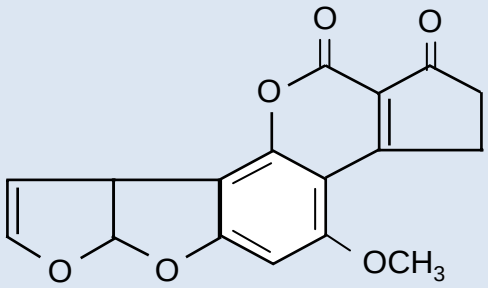
Physiological Characteristics of Fungi

- Growth temperature
  - **Opt. 25 ~ 30□., Min. 4º C**
- Water activity (a_w)
  - **a_W – 0.62 ~ 1.0 (If substrate RH = 95%, aw = 0.95).**
- pH
  - **pH 2 ~ 8.5 (pH 5.0 ~ 5.5).**
- Aerobic
  - **Oxygen (1-2%)**

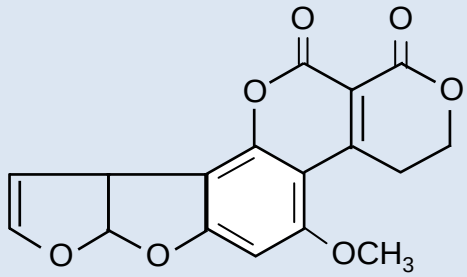
Temperature Range for Growth of Toxigenic Moulds



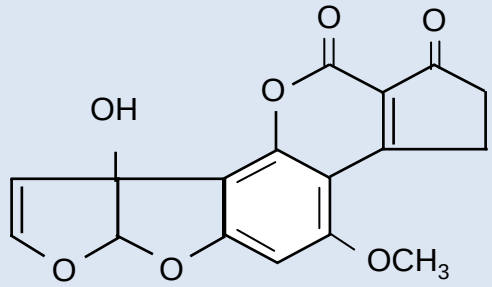
Aflatoxins



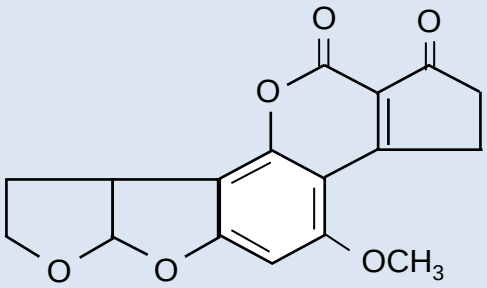
aflatoxin B_1



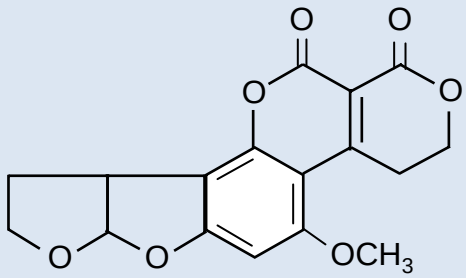
aflatoxin G_1



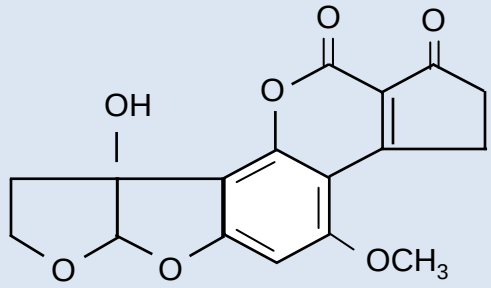
aflatoxin M_1



aflatoxin B_2



aflatoxin G_2



aflatoxin M_2

Chemical Properties

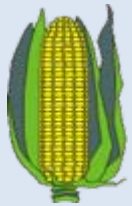
- **AFs are difuro-coumarin (hetrocyclic compounds), they are freely soluble in chloroform and methanol.**
- **Pure AFs are stable at High temp. and unstable when exposed to UV and air when dissolved in polar solvents.**
- **Chloroform and Benzene solution are stable for year if stored in dark cold place.**

The important sites in AFB_1 molecule are:

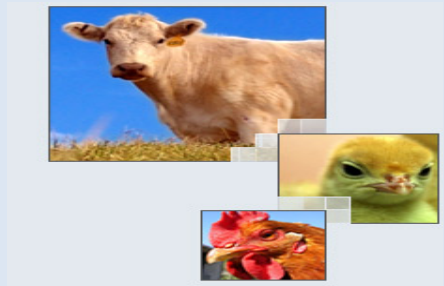
- **The 1st site: Double bound in position 8,9 of furofuran ring, (DNA and protiein)**
- **The 2ed site: Lacton ring in coumarin moiety**
- **Lacton ring is easily hydrolyzed (alkaline hydrolysis)**

Mycotoxins entering the food chain

Infection of plants by moulds



Contaminated feed



Toxin in the blood and organs

Contaminated food of plant origin

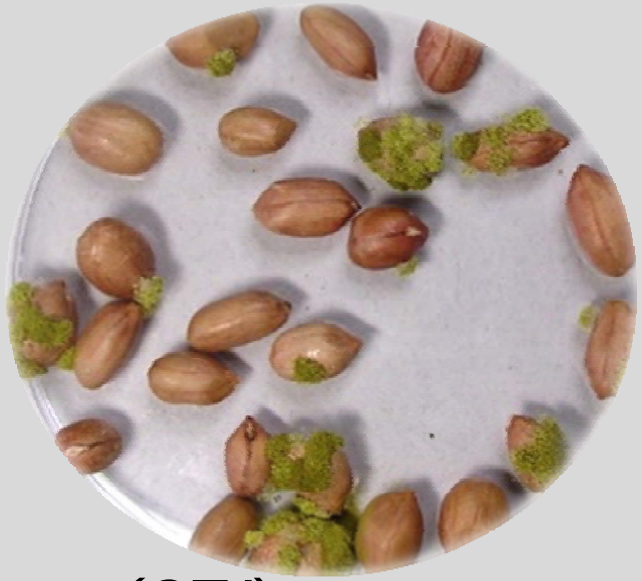
Contaminated food of animal origin

aflatoxins
ochratoxin-A
zearalenone
fumonisins

Meat
Milk

Egg

Occurrence of Mycotoxins in Foods



- **Milk and milk products** (*AFM_1, OTA*)
- **Meat and meat products** *(OTA*)
- **Egg** *(AFB_1, DON, CPA*)
- **Cereals** (*AFB_1, Fusarium toxins, OTA*)
- **Oilseed** (*AFB_1*)
- **Wine, grape juice and grape products** *(OTA*)
- **Beer** *(AFB_1, OTA, Fusarium toxins)*
- **Fruits, juices, vegetables**

(AFB_1, OTA, citrinin, patulin, Fusarium toxins)

- **Coffee and cocoa** *(AFB_1, OTA)*

Galvano et al., 2005

HEALTH EFFECTS of AFLATOXINS

- **The primary target of aflatoxins is hepatic system**
- **AFs induced Liver cancer and bile duct proliferation**
- **The chronic exposure to AFs lead to (on both humans and livestock):**

1- Impaired immunity **2-Reduce food intake**

3- Reduce growth rate **4- Reproductive disorders**

5- Increased susceptibility to infectious disease.

6- Disorder of protein and lipid metabolism.

7- Inhibits protein synthesis and stimulate lipid peroxidation

8- Disfunction of enzyme function and their synthesis.

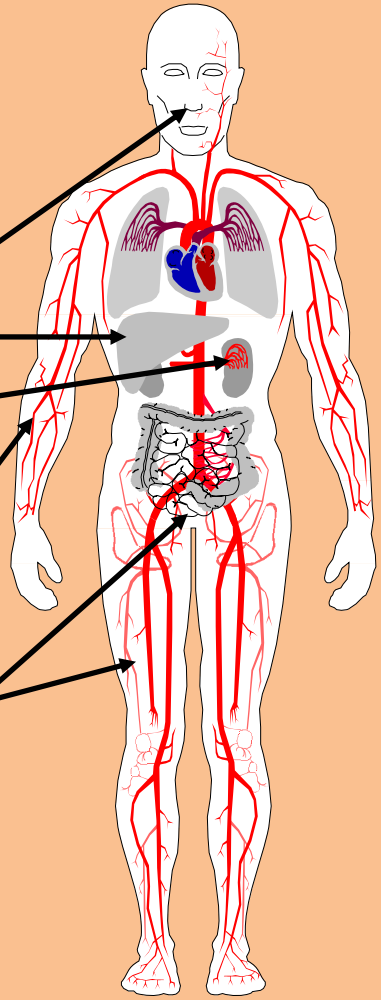
9- Depressed complement and interferon production.

Factors Influencing The Harmful Effects of AFLATOXINS

- **Chemical structure (accumulation)**
- **Concentration**
- **Time of exposure**
- **Multitoxic effect (interaction, synergism, additive effect)**
- **Individual sensitivity (Age, Sex, Species, Breed)**
- **Health status (Diseases)**
- **Nutritional status**
- **Vitamin supply**
- **Stressors**

Target Organs of Some Mycotoxins

Mycotoxin	*Target*
Aflatoxin	**Liver**
Ochratoxin A	**Kidney**
Trichothecenes	**Mucosa**
Ergot alkaloids	**Peripheral vascular system**
Zearalenone	**Uro-genital tract**



Aflatoxin Levels

- **Levels permissible in foods subject to legal limits in many countries**
- **Today, foods most frequently contaminated, routinely screened before processing or sale**
- **Permissible limits generally quite low (15-20 parts per billion)**
- **Some scientists feel that no detectable levels of aflatoxins should be permitted because of the carcinogenic effects**

Factors to Consider in Setting Regulatory Limits

- **Availability of data on incidence and occurrence**
- **Availability of toxicological data**
- **Availability of analytical methodology**
- **The need to maintain an adequate food supply at reasonable cost**
- **Knowledge of legislation in other countries involved in international trade**

Maximum Acceptable Levels for A Range of Aflatoxins In Foodstuffs for A Selection of Countries

Aflatoxins	Country	Limit (µg per	Matrix
Aflatoxin B_1	EU	2	Nuts or dried fruit intended for direct human consumption or as an ingredient in foodstuffs
Aflatoxin B_1, B_2, G_1, G_2	EU	4	Nuts or dried fruit intended for direct human consumption or as an ingredient in foodstuffs
Aflatoxin B_1, B_2, G_1, G_2	Canada	20	Feeding stuffs for animals
Aflatoxin M_1	EU	0.025	Infant formulae including infant milk. The maximum level for infant formulae refers to the product ready to use
Aflatoxin M_1	US	0.5	Milk for human consumption

Action or recommended maximum concentrations of aflatoxins in animal feeds*

Commodity	Animal	Maximum conc. in diet
Corn, peanut products, other products or feed ingredients	Finishing (feedlot) beef cattle	300 ppb
	Breeding beef cattle, breeding swine, mature poultry	100 ppb
	Finishing swine > 100 lb	200 ppb
Corn, peanut products, other products or feed ingredients, excluding cottonseed meal	Immature animals	20 ppb
Cottonseed meal	Beef, cattle, swine, poultry (regardless of age)	300 ppb
All feeds or feed Ingredients	Dairy animals, animal species not listed above, uses not listed above, intended use unknown	20 ppb

* From: Hawk (2004)

MAXIMUM LIMITS OF MYCOTOXINS PERMITTED IN FOODS AND ANIMAL FEEDS – AFLATOXINS
***In United Arab Emirates* (GSO 841 / 1997)**

Commodity	Maxmum limits of Total aflatoxins
Foods	
Infants and children foods	0.05 µg/kg
Dried milk not used for infant foods.	0.5 µg/kg.
Liquid milk and its products. (except dried milk).	0.2 µg/kg.
Grains, nuts, oil seeds and their products (e.g peanuts, peanuts butter, pistachio, almond, sesame, cotton seeds, sunflower seeds, corn, wheat, rice, soya bean).	20 µg/kg
Other foods	20 µg/kg
Animal feeds	
Feeds for dairy cattles and small calves.	10 µg/kg.
Poultry feeds and other animal feeds.	20 µg/kg.

Strategies for Prevention & Control of Aflatoxins

- **Use “clean” procedures.**
- **Prevent contamination**
- **Inhibit mold growth**
  - **–Drying**
  - **–Refrigeration**
  - **–Mold inhibitors**

Prevention of Aflatoxin Formation

- **Pre-harvest**
  - Resistant varieties (if practicable).
  - Crop rotation , irrigation
  - Insect management
  - Minimize kernel damage during harvesting
- **Post-harvest**
  - Clean and dry corn to <9 ,for oily crops, and 13.5% , for corn, moisture
  - Facility with temperature-moisture control
  - Insect and pest management

Decontamination Strategies

- **Physical separation**

  - Sorting, washing, crushing, dehulling, Remove contaminated portions.

  - Diluting contaminated food with uncontaminated food!!!!
- **Thermals Treatment**
- **Ammoniation**
- **Nixtamalization**
- **Radiation processing**
- **Binding Agents**
- **Sodium aluminosilicate, hdyrated sodium calcium aluminosislicate, bentonits and activated carbons**
- **MUCH BETTER TO PREVENT FORMATION**

Heating and Cooking

- **Food not largely affected by routine cooking temperature.**
- **Heating and Cooking under pressure can destroy 70% of AFs in rice.Extrusion process in combination with 0.3% lime and H_2O_2 reduced AFs level than lime and H_2O_2 alone.**
- **Roasting: dry and oil rousing can reduce 50 - 70% of AFB_1.**
- **AFs resists to higher temp. upto 260 ^{o} C.**
- **Over heating affected essential nutrients**

Nixtamalisation

- **Maize cooked and steeped in alkaline solution of lime (0.3% CaOH).**
- **AFs are reduced during Nixtamalization by 90%.**

Ammoniation

- **Treatment with aqueous NH_2OH (2%) at 121 ^oC. and 17 psi reduced AFB_1 by 99% in naturally contaminated yellow corn.**
- **Gaseous NH_3 (2%) showed lower efficiency at lower moisture content.**

Radiation Processing

Purposes of Food Irradiation

- **Low doses (< 1 kGy):**

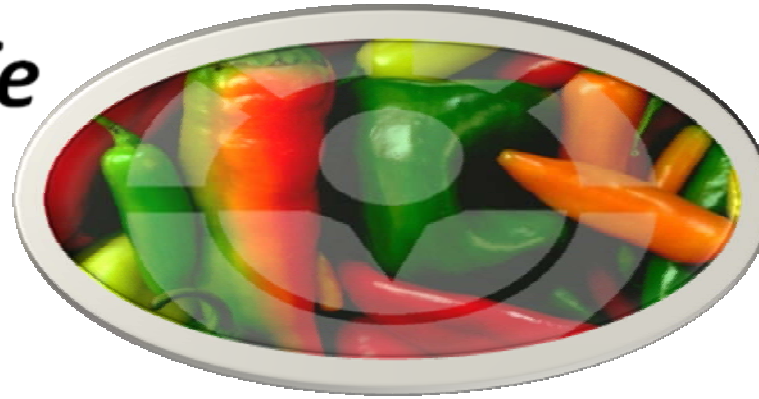
  control of insects and

  delay of ripening

- **Medium doses (1 - 10 kGy):**

  reduction of foodborne pathogens

  extension of shelf life



- **High dose (> 25 kGy):**

  sterilization

Purposes of Food Irradiation

- **Wheat flour – control of mold**

- **White potatoes – inhibit sprouting**

- **Pork – kill Trichinia parasites**

- **Fruit and Vegetables – insect control; increase shelf life**

- **Herbs and Spices - sterilization**
- **Poultry – bacterial pathogen reduction**

- **Meat – bacterial pathogen reduction**

Radiation Processing

- **Effective process, safe, and improve the safety of our food supply**
- **Inexpensive , approved by international organizations (WHO, FAO, IAEA, FDA and Others).**
- **Suppression and detoxified foodstuffs AFs in contaminated food.**
- **5 kGy significantly detoxified 44 - 48% of AFB_1.**
- **10 kGy detoxified AFB_1 by 62 – 88%.**
- **20 kGy was quite enough for complete detoxification.**

150 + irradiation facilities

40+ countries

Dietary Modification

- **The carcinogenic effect of AFB_1 is affected by dietary factor such as:**
- **Vit. Am C and riboflavin reduce the biding of AFB_1 to DNA.**
- **Sulfur containing AA^S inhibit AFB_1 mutagenicity in microbial systems**
- **Essential oil extracted, from Nutmeg, celery, black pepper and cardumon , Inhibit AFB_1-DNA formation.**
- **Micronutrient, such as copper, manganese, zinc and selenium, inhibit mutugenicity.**

Dietary Modification

- **Plant flavonoids, such as flavone, flavonol, isoflavon inhibit AFB_1-DNA formation.**
- **Butylated hydroxyanisole containd diet resulted in lower AFB_1-DNA formation.**
- **Butylated hydroxytoluene lower cancer incidence**
- **Broccoli sprouts, green tea, medicinal herbs lower cancer incidence.**

Control of Aflatoxins

Cooperation between:

Ministry of health

Ministry of Agriculture

Drug Administration

National Environment Committee board

Consumer Protection Committee Boared

Legislative body

International organizations

Awareness Campaigns

Information Dissemination to:

Farmer

Food and feed factories

Exporter

Middlemen

Non Governmental Organization

Public service association

Health care providers

School

Early Warning System

EWS is intended to be safety net as supplemented to quality management system like ISO 9002, HACCP,GMP

EWS helps to prevent future outbreaks.

EWS is able to detect potential food contamination

Any EWS should involve :

- **Monitoring AFs in food sources and individuals**
- **Response protocol to prevent further AF exposure**
- **inclusion of key members from various government agencies, health care sector and non governmental organization**

CONCLUSION

MUCH BETTER TO PREVENT FORMATION

- **Selection of fungal resistant hybrids of crops**
- **Dry of commodities after post harvest is most effective means**
- **Gamma irradiation of commodities**
- **Raising awareness of AFs and disseminating information to formers, traders and consumers**
- **Collaboration between agricultural and public health communities and also between local, regional, national and international governing bodies.**

Don’t forget who you heard this from!!!


Thank You