FOOD NUTRITION AND PUBLIC HEALTH

FOOD SAFETY

Lecture 1

Saadia Zahid, PhD
Assistant Professor
Types of Challenges in food safety

- Emerging microbiological threats
- Emerging chemical threats
- Emerging physical threats
- Adulteration threats
INVISIBLE (MICROBIOLOGICAL) HAZARDS IN FOOD

- Bacteria
- Yeasts
- Protozoa
- Viruses
- Molds
Macro-biological Hazards

Visible Biological Hazards in Food

- Worms
- Fly
- Cockroaches
- Weevils
- Caterpillars
INVISIBLE CHEMICAL HAZARDS IN FOOD

PESTICIDES RESIDUES

CLEANING CHEMICALS

VETERINARY RESIDUES

ADULTERANTS

NON PERMISSIBLE FOOD ADDITIVES

EXCESS OF PERMISSIBLE FOOD ADDITIVES
Physical Hazards in Food

- Bidis & Cigarettes
- Hair
- Stones
- Stems & Seeds
- Bone, Fragments, Feathers
- Strings, Jute Fibres
- Nails, Nuts & Bolts
- Matchstick
Contamination in Foods

- Agricultural raw materials
- Water
- Air / dust
- Soil
- Garbage and sewage
- Rodents
- Insects
- Packaging materials
- Animals and birds
- Food handlers/ people
Emerging Foodborne Pathogens

- Bacteria
- Viruses
- Parasites
- Prion
Emerging foodborne bacteria

- *Salmonella* (multidrug resistant strain)
- *Campylobacter jejuni*
- *E. coli*
- *Listeria monocytogenes*
- *S. aureus* MRSA
- *Vibrio vulnificus*
- *Yersinia enterocolitica*
- *Arcobacter spp.*
- *Mycobacterium paratuberculosis*
Emerging foodborne viruses

- Hepatitis A and E
- Norovirus
- (Avian influenza, AI)
Emerging foodborne parasites

- Cryptosporidium parvum
- Cyclospora cayetanensis
- Anisakis spp.
Emerging Pathogens

- *Listeria monocytogenes*
  - Sources
    - Ready-to-eat meats, soft cheeses
  - Signs
    - Human abortions and stillbirths
    - Septicemia in young or low-immune
FUNGAL TOXINS ??

Secondary metabolites

- Low mw organic compounds
- Produced in stationary phase of life-cycle
- 300 fungal toxins have been identified
- Fairly Heat stable
- Resistant to inactivation
- Wide range of toxic effects

- **Mycotoxicosis**

Aflatoxin
*(Aspergillus flavus)*

Patulin
*(From Apple)*
TOP-10 MYCOTOXIC FOODS

- Alcoholic beverages (Wine, beer, cider) (Ochratoxin, Aflatoxins)
- Corn (Flakes, chicken nuggets, syrup) "universally contaminated” (Aflatoxin, fumonsin, ochratoxin)
- Wheat (Breads, cereals, pasta)
- Barley (Cereals and alcoholic beverages)
- Sorghum (Cereals and alcoholic beverages)
- Peanuts (Peanut butter, roasted peanuts)
- Rye (Bread)
- Milk products
- Apple juice (Patulin)
- Fresh fruits
Occurrence of aflatoxins in selected processed foods from Pakistan.

Mushtaq M, Sultana B, Anwar F, Khan MZ, Ashrafuzzaman M.

Department of Chemistry and Biochemistry, University of Agriculture, Faisalabad 38040, Pakistan; E-Mail: mmushtaq_doc@yahoo.com.

Abstract

A total of 125 (ready to eat) processed food samples (70 intended for infant and 55 for adult intake) belonging to 20 different food categories were analyzed for aflatoxins contamination using Reverse Phase High Performance Liquid Chromatography (RP-HPLC) with fluorescent detection. A solvent mixture of acetonitrile-water was used for the extraction followed by immunoaffinity clean-up to enhance sensitivity of the method. The limit of detection (LOD) (0.01-0.02 ng·g(-1)) and limit of quantification (LOQ) (0.02 ng·g(-1)) was established for aflatoxins based on signal to noise ratio of 3:1 and 10:1, respectively. Of the processed food samples tested, 38% were contaminated with four types of aflatoxins, i.e., AFB1 (0.02-1.24 μg·kg(-1)), AFB2 (0.02-0.37 μg·kg(-1)), AFG1 (0.25-2.7 μg·kg(-1)) and AFG2 (0.21-1.3 μg·kg(-1)). In addition, the results showed that 21% of the processed foods intended for infants contained AFB1 levels higher than the European Union permissible limits (0.1 μg·kg(-1)), while all of those intended for adult consumption had aflatoxin contamination levels within the permitted limits.
Aflatoxin M$_1$ contamination in milk from five dairy species in Pakistan

Imtiaz Hussain$^a$*, Jamil Anwar$^a$, Muhammad Rafiq Asi$^b$, Munawar Ali Munawar$^a$, Muhammad Kashif$^c$

$^a$ Institute of Chemistry, University of the Punjab, Lahore 54590, Pakistan
$^b$ Nuclear Institute for Agriculture & Biology (NIAB), Faisalabad 38000, Pakistan
$^c$ Department of Mathematics and Statistics, University of Agriculture, Faisalabad 38000, Pakistan

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**Abstract**

Aflatoxin M$_1$ (AFM$_1$) in milk samples of five different species of mammals from the area of Faisalabad district of the Punjab province of Pakistan was determined by using high-performance liquid chromatography (HPLC) with fluorescent detection. Immunoaffinity columns were used for clean-up purposes which are based on the principle of affinity chromatography. The present study has been designed to find the milk which is safe from aflatoxin contamination point of view. Total 169 milk samples were analyzed and these were taken from five species made up of 55, 40, 30, 24, and 20 samples of buffaloes, cows, goats, sheep, and camels respectively. The percentage of AFM$_1$ contamination in buffalo milk, cow milk, goat milk, and sheep milk has been found to be 34.5%, 37.5%, 20%, and 16.7%, respectively. AFM$_1$ contamination has not been detected in the camel milk.
Monitoring of Aflatoxin M₁ in Market Raw Milk in Lahore City, Pakistan

Khushi Muhammad*, Muhammad Yasin Tipu, Mateen Abbas, Abdul Muqeeet Khan and Aftab Ahmad Anjum

Department of Microbiology, Faculty of Veterinary Science, University of Veterinary and Animal Sciences, Lahore 54000, Pakistan (KM, AAA), and Quality Operations Laboratory, UVAS, Lahore 54000, Pakistan (MYT, MA, AMK)

Abstract.- Aflatoxin M₁ (AFM₁) was determined in market raw milk samples collected from four towns of city Lahore, Pakistan. Total 84 samples were collected during a period of 4 months (April through July 2007) and were processed for purification of AFM₁ through an immunoaffinity column. Each sample was analyzed for AFM₁ using fluorescent detector of high performance liquid chromatography (HPLC). Eighty one percent milk samples contained AFM₁ levels exceeding the American and European tolerance limits. The mean value of AFM₁ was 17.38 μg/L ranged from 0.69 to 100.04 μg/L. High levels of AFM₁ in the raw milk samples is an enormous health risk factor for end consumers. There is need to improve storage conditions of feed ingredients that will mitigate the AFB₁ production in the feed/ration and ultimately decrease the AFM₁ levels in the animal milk.

Key Words: Aflatoxin M₁, HPLC, fluorescent detector, market raw milk samples.
Assessment of hot peppers for aflatoxin and mold proliferation during storage.

Iqbal Q, Amjad M, Asi MR, Ariño A.
Institute of Horticultural Sciences, University of Agriculture, Faisalabad-38040, Pakistan. qumer_uaf@yahoo.com

Abstract
Aflatoxin contamination and mold proliferation in three hot pepper hybrids (Sky Red, Maha, and Wonder King) were studied during 5 months of storage at three temperatures (20, 25, and 30°C) and under different packaging conditions (low-density polyethylene bags and jute bags). The presence of aflatoxins in hot pepper samples was determined by high-performance liquid chromatography with a UV-Vis detector. Sampling for analysis of aflatoxins, total mold counts, and Aspergillus counts was carried out at 0, 50, 100, and 150 days of storage. Hot peppers packed in jute bags were more susceptible to aflatoxin contamination than those packed in polyethylene bags. Aflatoxin concentrations were 75% higher in peppers stored in jute bags. The effect of storage temperature resulted in aflatoxin concentrations that were 61% higher in hot peppers stored at 25 and 30°C than in those stored at 20°C. Of the three pepper hybrids, Wonder King was more susceptible to aflatoxin contamination, with a maximum of 1.50 µg/kg when packed in jute bags and stored at 25°C for 150 days. However, no sample exceeded the maximum permitted level for total aflatoxins in spices established by European Union regulations (10 µg/kg). Total mold counts and Aspergillus counts increased with storage duration, but all counts were significantly lower in peppers stored in polyethylene bags. A gradual increase in temperature during prolonged storage of hot peppers in combination with aeration may be the main reasons for increases in fungal biomass and Aspergillus proliferation with the subsequent aflatoxin production.
The effect of substrate, season, and agroecological zone on mycoflora and aflatoxin contamination of poultry feed from Khyber Pakhtunkhwa, Pakistan.

Alam S, Shah HU, Khan H, Magan N.

Department of Agricultural Chemistry, Khyber Pakhtunkhwa Agricultural University Peshawar, Peshawar, Pakistan. dralam@aup.edu.pk

Abstract
To study the effects of and interactions among feed types, seasons, and agroecological zones on the total fungal viable count and aflatoxins B1 (AFB1), B2 (AFB2), G1 (AFG1), and G2 (AFG2) production in poultry feed, an experiment was conducted using three-factorial design. A total of 216 samples of poultry feed ingredients, viz. maize, wheat, rice, cotton seed meal (CSM), and finished products, that is, starter and finisher broilers' rations, were collected from Peshawar, Swat, and D. I. Khan districts of Khyber Pakhtunkhwa, Pakistan, during the winter, spring, summer, and autumn seasons of the year 2007/2008. Analysis of variance showed that there was a complex interaction among all these factors and that this influenced the total fungal viable count and relative concentrations of the aflatoxins produced. Minimum total culturable fungi (6.43 × 10⁸ CFUs/g) were counted in CSM from D. I. Khan region in winter season while maximum (26.68 × 10⁸ CFUs/g) in starter ration from Peshawar region in summer. Maximum concentrations of AFB1 (191.65 ng/g), AFB2 (86.85 ng/g), and AFG2 (89.90 ng/g) were examined during the summer season whereas the concentration of AFG1 was maximum (167.82 ng/g) in autumn in finisher ration from Peshawar region. Minimum aflatoxins were produced in the winter season across all the three agroecological zones.
Impact of sewage contaminated water on soil, vegetables, and underground water of peri-urban Peshawar, Pakistan.

Ullah H, Khan I, Ullah I.
Department of Chemistry, Gomal University, Dera Ismail Khan, Pakistan. hidayatk2@yahoo.com

Abstract
The use of sewage-contaminated municipal water for irrigation of crops is an old practice in many big cities of Pakistan. Since the wastewater is rich in nutrients, it increases crops yield substantially but at the cost of food quality. The objective of this study was to investigate sewage water irrigation as a source of accumulation of heavy metals in soil and its subsequent transfer to crops and underground water. Sewage water, soil, groundwater, and crop samples were collected from selected areas around Peshawar city and analyzed for heavy metals concentration by atomic absorption spectroscopic method.

Analysis of data revealed a considerable impact of the irrigation practices in the peri-urban Peshawar. Statistical analysis of the data showed a positive correlation between heavy metals concentration and soil carbon contents on the one hand and cation exchange capacity on the other. A strongly negative correlation was observed between metal contents and soil pH. The vertical movement of heavy metals from contaminated soil has polluted crops and underground water. The results indicated higher concentration of toxic metals in soil accumulated due to long-term sewage-contaminated water irrigation and their subsequent transfer to our food chain. The practice, if continued un-noticed may pose a threat of phytotoxicity to the local population.
**FURTHER READING ON AFLATOXIN**

K. Muhammad *et al.*, 2010, Monitoring of Aflatoxin M1 in Market Raw Milk in Lahore City, Pakistan

I Hussain , 2010, Aflatoxin M1 contamination in milk from five dairy species in Pakistan

Q Iqbal, 2011, Assessment of hot peppers for aflatoxin and mold proliferation during storage.
Target organs of some mycotoxins

<table>
<thead>
<tr>
<th>Mycotoxin</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aflatoxin</td>
<td>liver</td>
</tr>
<tr>
<td>Ochratoxin A</td>
<td>kidney</td>
</tr>
<tr>
<td>Trichothecenes</td>
<td>mucosa</td>
</tr>
<tr>
<td>Ergot alkaloids</td>
<td>peripheral vascular system</td>
</tr>
<tr>
<td>Zearalenone</td>
<td>uro-genital tract</td>
</tr>
</tbody>
</table>
Codex – International Food Standards
Regulatory Levels

Aflatoxins 20 ppb
Aflatoxin $M_1$ 0.5 ppb
Patulin 50 ppb
Ochratoxins 50 ppb
Zearalenone 500 ppb
Deoxynevalenol (DON) 1 ppm
Fumonisins 2 ppm
Food Safety Issues in developing nations

- **Food systems:**
  - Food production, processing, marketing systems quite complex
  - Highly fragmented
  - Large number of small producers
  - Food pass through large number of middlemen, food handlers
  - Increased risk of exposure to unhygienic conditions, contamination & adulteration
  - Inadequate infrastructure – water, electricity, sanitation, storage, cold chain etc.
Food processing industry:

- State-of-art factories to small shops
- Highly variable size – scale of operation
- Highly variable quality
- Lack of resources for upgrading technology base
- Reliability and timely delivery of raw material
- Traditional foods – lack of processing and packaging equipments
• Street foods
  • Cater to ethnic taste and preferences
  • Reasonably priced
  • Conveniently available
  • **Food safety is a major concern** – as it poses high risk for *food poisoning*
Food control Infrastructure and resources:

- Food labs. are inadequate
- Lab. Infrastructure is very poor
- Lack of qualified and trained manpower in subjects like food science & technology, chemistry, microbiology, veterinary sciences, medicine, epidemiology, agricultural sciences, quality assurance, auditing, food laws.
- Lack of opportunities to take advantage of scientific resources in International community.
Components of National Food Safety Control Systems....

- Food Control Management
- Food legislation
- Food inspection services
- Food analytical capabilities & food control laboratories
- Information, education and communication
Food Processing & Preservation Methods

Major Methods:

- Thermal processing (heating),
- Refrigeration & freezing,
- Water activity control (dehydration),
- Fermentation,
- Chemical control & additives,
- Irradiation, and
- Non-thermal treatments.