Mycotoxins in spices, requirements for moving towards global harmonization of standards

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Significance of mycotoxins

- Mycotoxins such as aflatoxins and ochratoxins are naturally occurring contaminants in foods
- They are of considerable health and economic importance
- Mycotoxin contaminations in spices have considerable international trade significance
- Both exporting and importing countries have fixed standards for mycotoxin contamination and implementing them in international trade

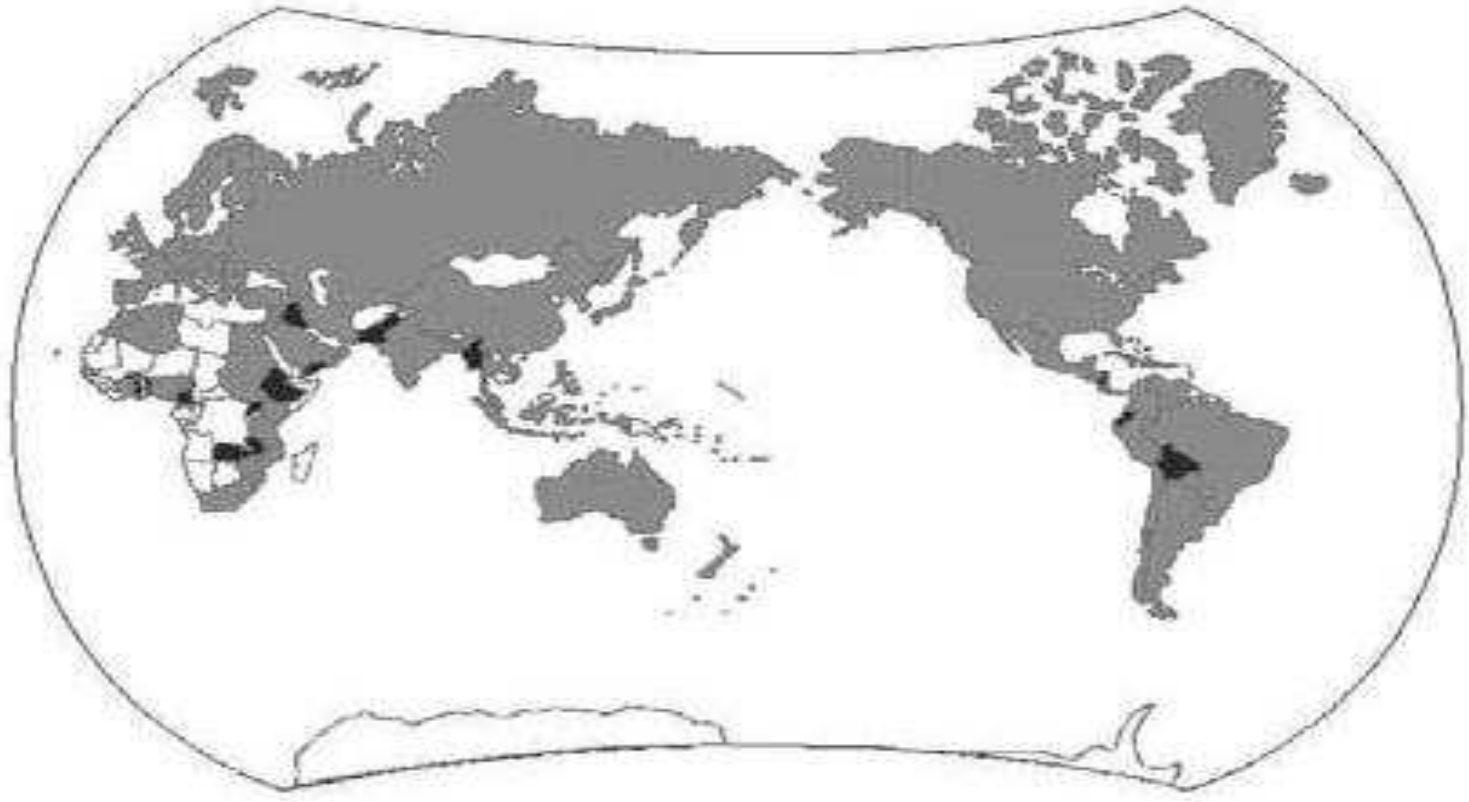
Aflatoxin contaminated corn cob

Health burden due to aflatoxins

- **> 5 billion people in Developing countries at risk of chronic exposure to aflatoxins through contaminated foods.**
- **Aflatoxin associated health effects pervade the developing world.**
- **Stringent measure in EU countries to control aflatoxin in food and feed/feed ingredients through import restrictions.**

Mycotoxin regulations worldwide

- Approximately 100 countries have specific limits for mycotoxins in foodstuffs



Worldwide limits for total aflatoxins in food

- **0 µg/kg** **two countries**
- **1 µg/kg** **three countries**
- **3 µg/kg** **one country**
- **4 µg/kg** **twentynine countries**
- **5 µg/kg** **three countries**
- **10 µg/kg** **eight countries**
- **15 µg/kg** **eight countries**
- **20 µg/kg** **seventeen countries**
- **30 µg/kg** **three countries**
- **35 µg/kg** **two countries**

Source : FAO publication on worldwide regulations of Mycotoxins in food and feed

Regulatory limits of Mycotoxins for spices

Country	Component	AFB1	Total Afs	OTA
Bulgaria	Spices	2	5	10
Czech Republic	Spices	20		-
EU Member states	Spices	5	10	-
Finland	All spices		10	-
Hungary	Spices	5	10	-
Switzerland	Nutmeg Spices	10 5	20 10	20
Turkey	Spices	5	10	-
Uruguay	Spices	5	20	-

Rationales for the establishment of limits and regulations for mycotoxins

- Many countries have enacted or proposed regulations for control of aflatoxins in food or feed
- Some countries have regulations for permitted levels of contamination by other mycotoxins
- Very few countries have formally presented the rationale for the need to regulate
- Mostly based on a vague, unsupported statement of the carcinogenic risk for humans
- General consensus is that exposure to a potential human carcinogen that could not be totally avoided and should be limited to the lowest practical level (ALARA)

Rationales for the establishment of limits and regulations for mycotoxins (Contd..)

- The definition of practicality (ALARA) depended on whether the country was an importer or producer of the potentially contaminated commodity
- Claim to a hazard evaluation was made by some countries without providing specifics
- Atleast in one country patulin is regulated for quality control purposes only
- Either the scientific basis for regulation of mycotoxins is nonexistent, or the science has not been fully utilized

Factors affecting the constitution of mycotoxin regulations in food

- availability of toxicological data
- availability of data on the occurrence of mycotoxins in various commodities
- knowledge of the distribution of mycotoxin concentrations within a lot
- availability of analytical methods
- legislation in countries with which trade contacts exist
- need for sufficient food supply

Risk assessment/ Risk analysis

- **Hazard identification & hazard characterization** Regulations primarily made on the basis of toxic effects. For aflatoxins, ochratoxin A, etc – the JECFA, a scientific advisory body of FAO and WHO, evaluates their hazards.
- **Exposure assessment-** GEMS data, Scientific Cooperation on Questions relating to Food (SCOOP) project data used by EFSA for its evaluation and advisory work on the risks to public health arising from dietary exposure, national data through research workers

Case study of mycotoxins in Nutmeg

- **Nutmeg & Mace are two distinctly different spices produced from a fruit of an evergreen tree *Myristica fragrans***
- **Nutmeg: nutmeg is the dried seed kernel of the fruit**
- **Mace: Mace is the dried reticulated 'aril' that surrounds the seed within the fruit**

Nutmeg fruit, seed and mace

Nutmeg

Mace drying

Uses of nutmeg and mace

- used as condiment particularly in sweet foods and as a standard seasoning in many dishes . Mace used in savoury dishes
- Nutmeg oleoresin is used in preparation of meat products, soups, sauces, baked foods, confectionaries, puddings, seasoning of meat and vegetable etc.
- fleshy outer cover of the fruit is crystallized or pickled or made into jellies.
- used as a drug because of its stimulant, carminative, astringent and aphrodisiac properties.
- it is used to flavor many kinds of baked goods, meats, sausages, sauces, vegetables, and such beverages as eggnog.

Uses of nutmeg and mace

- India: sweet as well as savory dishes Mughlai cuisine, temple rituals
- Indonesia : into jam, or is finely sliced, cooked with sugar, and crystallized to make a fragrant candy (nutmeg sweets)
- Europe : potato dishes ,processed meat products; soups, sauces, and baked goods, added to vegetables such as Brussels sprouts, traditional ingredient in mulled cider, mulled wine, and eggnog used for Italian stuffed noodles, e.g., ravioli. Used for characteristic flavouring of sauce Béchamel (white sauce)
- Caribbean: in drinks such as the Bushwacker, Painkiller, and Barbados rum punch. Typically a sprinkle on the top of the drink. To make a jam called *morne delice*

Side effects of higher intake

- contains an essential oil called myristicin that has hallucinogenic properties. Higher consumption leads to hangover and nasty side effects e.g.: fever, palpitations, hallucinations, dry mouth, nausea, abdominal spasms, convulsions, dizziness, body pain, dehydration, constipation, insomnia, vomiting, irritation of skin, lack of energy and motor skills, lack of speaking skills / social withdrawal, seizures
- Contains safrole, a carcinogen affecting the liver

Dose related effect of Nutmeg

- **In amounts of 1.0 g or more it is a mild to medium hallucinogen, producing visual distortions and a mild euphoria**
- **Ingestion of as little as 5 g may cause dry mouth, fast pulse, fever and flushing**
- **Large doses of 7.5 g or more are dangerous, potentially inducing convulsions, palpitations, nausea, eventual dehydration, and generalized body pain**
- **Nutmeg can also cause liver damage if used regularly in large quantities. Used as an abortifacient. May be fatal if used regularly in large quantities**

Fixing tolerable limits based on risk

- Risks associated with mycotoxins depend on both hazard and exposure.
- While risk could be same around the world, exposure is not the same, because of differences in levels of contamination and dietary habits in various parts of the world.
- In a country, where the maize consumption is approx. 15 g per capita per day, a legal limit of 8 mg/kg would suffice to prevent that the fumonisin TDI is exceeded. However, in another country, where the maize consumption is approx. 125 g per capita per day, a legal limit of 1 mg/kg would be required to reach the same level of protection

- Hans von Egmond , M A Jonker 2007 ARI The Bulletin of the Istanbul Technical University Volume 54 (4)

Dietary intake GEMS regional data

- **Total cereals 221.9-450.6 gms /cu/person/ day**
- **Total nuts 12.8 – 57.5 gms /cu/person/day**
- **Total spices 0.5-3.1 gms /cu/person/day**
- Total spices consumption in Italy is 1.41 gm/person/day (Italian data)

- Based on Food balance sheet compiled by FAO
- Regional diets include Middle East, Far East, Africa, Latin America and European diets (Europe/Canada/USA and Australia)

Consumption pattern of spices

- Red chilies 3.08 +_2.06
- Black pepper 0.33+_ 0.30
- Coriander 1.37+_1.30
- Cumin 0.80+_0.77
- Garlic 2.49+_2.78
- Asfoetida 0.06+_0.10
- Ajowan 0.11+_0.17
- Dry ginger 0.04+_1.01
- Turmeric 0.87+_0.56
- Caraway 0.08+_0.19
- Fennel 0.31+_0.54

all in consumption unit/day in gm

Total consumption 9.54+- 10.11

-Pradeep,Geervani,Eggum

Pl Fd Human Nutr 44-137, 1993

Ochratoxin intake through various diets

- Cereals 50%
- Wine 13%
- Coffee 10%
- Spices 8%
- Others 6%
- Beer 5%
- Cocoa 4%
- Dried fruit 3%
- Meat 1%
- Meat and spices contribute to a low extent to the total intake in the EU

Why contribution to dietary intake is low?

- **Varieties of spices consumed – large** e.g. basil, black pepper, chili, cumin, turmeric, ginger, cardamom, cinnamon/cassia, curry spice blend, caraway, clove, oregano, paprika, piri piri,rosemary, sage, thyme, barbeque spice blend, and taco spice blend;
- **Frequency of consumption – Less**
- **Susceptibility of spices for mycotoxin contamination - Low**

Maximum Levels for Mycotoxins as regulated by Commission Regulations in EU

- **Foods subjected to sorting, or other physical treatment, before human consumption or use as an ingredient in foodstuffs**

  - tree nuts, hazelnuts AfB1 5 ug/Kg Total AF 10 ug/kg

  -Groundnuts AfB1 8 ug/Kg Total AF 15 ug/kg

  - Almonds, Pistachio 12 ug/Kg Total AF 15 ug/kg

  -Dried fruits, Maize 5 ug/Kg Total AF 10 ug/kg

- **intended for direct consumption/ use as an ingredient in foods**

  - Nuts (tree/ groundnuts , dried fruit, cereals

  2 ug/Kg Total AF 4 ug/kg

  - Hazelnuts 5 ug/Kg Total AF 10 ug/kg

  -Almonds, pistachio 8 ug/Kg Total AF 10 ug/kg

- **Spices: *Capsicum* spp. Pepper, nutmeg, ginger, turmeric**

  5 ug/Kg Total AF 10 ug/kg

- Are not spices used as an ingredient in foods or used for extraction of oleoresins?

- If nuts are treated individually, why not spices?

EC proposes different cadmium levels for milk and dark chocolate - December 2, 2011

- **According to the European Commission, cadmium is linked to the total dry cocoa solids in cocoa beans.**
- **Cocoa beans take cadmium naturally up from the soil, therefore cadmium levels can be different in cocoa beans grown in different geographical areas.**
- **The Commission has proposed higher maximum cadmium levels for dark chocolate as more of the heavy metal is found in chocolate with high cocoa content , while a lower level would be permissible for milk chocolate.**

- ***If different levels of contaminants are suggested for a single item viz., chocolates then why not different levels for different spices depending on their intake/ chances of the contaminant occurring?***

Available data on dietary intake of aflatoxins describes three scenarios

- A high level of dietary aflatoxin intake resulting from consumption of maize with high aflatoxin levels in for a short period, resulting in acute disease outbreaks
- A low level of dietary aflatoxin intake resulting from consumption of maize with low aflatoxin levels in for prolonged periods, resulting in occurrence of liver cancer in regions of Africa, Thailand and China
- A low level of dietary aflatoxin intake resulting from consumption of food with low aflatoxin levels in relatively low quantities, observed with foods such as spices with little evidence of risk to human health

Risk based MATRIX to assign priority for regulatory/utilization of aflatoxin contaminated commodity: Proposed by Bhat 2012

Aflatoxin occurrence	Food intake		
	High	Medium	Low
High	Maize as staple 1	Maize as breakfast cereal/snack, Peanut in Africa 2	Peanut in India 3
Medium	Parboiled Rice 4	Normal rice 5	Chilies tree nuts 6
Low	Sorghum In Africa, rural India 7	Sorghum flour used in urban areas 8	Nutmeg, mace, cinnamon 9

Aflatoxins in food commodities in order of risk

Risk Level
1.Very High
2. High
3. Moderately high
4. Medium
5. Low
6.Very low
7. Least
8. Almost Nil
9. Non existent

CODEX

- Strategic Vision Statement

"The CAC envisages a world afforded the highest attainable levels of consumer protection including food safety & quality. To this end, the Commission will develop internationally agreed standards & related texts for use in domestic regulation & international trade in food that are ***based on scientific principles*** *and fulfil the objectives of consumer health protection & fair practices in food trade"*

Scientific basis of CAC decision-making given in the Procedural Manual

"Principle on the role of science in the Codex decision making process & the extent to which other factors are taken into account and in the Working Principles for Risk analysis for application in the framework of the Codex Alimentarius"

Provision of scientific advice: Science for safe food strategy (2010-2013)

- **The Core principles**
  - **Soundness** – scientific excellence
  - **Responsibility** – efficiency & accountability
  - **Objectivity** – neutrality & independence of advice
  - **Fairness** – ethical conduct
  - **Transparency** – broad access to information – comprehensive, understandable, timely
  - **Inclusiveness** – a multidisciplinary & global approach

Areas of harmonization needed

- Regulatory limits
- Analytical methods
- Sampling methodology
- harmonization of methodology for the survey on consumption data
- harmonization of scientifically sound methodologies for risk assessment

Global harmonization of standards

- **could be achieved by attempting harmonization of standards at the sub region and regional levels.**
- **The requirements include standards setting based on scientific approach**
- **Providing independent scientific advice to food safety control**
- **Stakeholders (regulatory agencies, producers, trade, consumer bodies) to work together**

Sampling

- **Mycotoxins are often distributed in food commodities in a very heterogeneous manner because they are formed by moulds that occur in isolated pockets in bulk materials, or in individual nuts.**
- **Tested and validated sampling plans that provide a final sample that is truly representative must be harmonized**
- **Factors required to achieve "representative sampling" include taking of samples by qualified trained persons, using appropriate tools, drawing incremental samples from various spots randomly, and Good sampling practices like labeling, storing, transporting properly have to be harmonized**

Analytical methods harmonization

- **Use of Good Laboratory practices**
- **Accreditation of the laboratory**
- **Using methods of analysis with comparable levels of performance**
- **Analytical quality assurance programmes**
- **Quality control measures in place**
- **Use of reference materials**
- **Validation study**

Initiative in ASEAN countries

- **Support to Capacity Building and Implementation of International Food Safety Standards in ASEAN Countries GCP/RAS/280/ JPN in ASEAN Countries funded by Government of Japan**
- **Preparation of Guidance documents**
- **Implementing e-learning activities on international food safety standards and Codex activities- project supported by ADB in GMS countries**

Outputs of the project

- **Enhanced regional capacity building and collaboration among senior government officers for implementation of international food safety standards and Increased participation in Codex standards setting in ASEAN countries**
- **Strengthened regional capacity building of technical government officers for Codex standards setting based on scientific approach and for proving independent scientific advice to food safety control**
- **Strengthened national capacity building for implementation of Codex standards primarily in LDC ASEAN countries**

Way ahead

- Generate data on individual spice intake. *Consumption data are available for group and not for individual spices.*
- The frequency of intake also need to be considered
- More data on worldwide occurrence of aflatoxins/ochratoxins in spices need to be generated
- Risk assessment by JECFA on mycotoxins in spices needed
- Working group paper on aflatoxns/ochratoxins in individual spices viz., nutmeg and mace need to be prepared
- Leading spice producers need to work together in generating data and preparation of background document
- Risk based MATRIX to assign priority for regulatory/utilization of mycotoxin contaminated commodity need to be evolved
- Initiate project on harmonization efforts in SAARC countries

THANK YOU