

Dietary intake of aflatoxins from spices and risk assessment

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Presentation coverage

- Aflatoxin risk : **Cereals vs spices**
- Trends on worldwide regulations for aflatoxins:
Codex, EU, other countries.
- Risk assessment need: **dietary intake & exposure**
- Existing data on **dietary intake and levels of aflatoxins**
- Methodology of data collection
- Preliminary data on intake- **frequency/quantity consumed**
- Conclusions and Way ahead

The Food Aflatoxin Risk

Food	Use in the diet	Level of intake	Risk of exposure
Maize	Staple Snack Breakfast cereal	High Low Low	High Low Low
Rice	Staple	High	Low-Medium
Groundnut	Snack/sauce	Low, Medium	Low ,Medium, High
Spices	Flavouring	Low?	Low?

Spices & aflatoxin risk



$$\text{Risk assessment} = (\text{Hazard}) \times (\text{Exposure})$$

?Aflatoxin problem in different spices
?Intake of spices: How much? How often? How long?
Data available?

Trends on worldwide limits for aflatoxins in foods- evolution of a model for aflatoxin limits in spices

Codex model: Risk assessment/ regulatory limits on a commodity-by-commodity basis (Codex Agenda Item CX/CF 14/x/x 2014)

EU model : Group of spices (*Capsicum spp.*, *Piper spp.*, nutmeg, ginger, turmeric)

Switzerland model: Separate limits for nutmeg and other spices

Existing regulatory limits for mycotoxins in spices

Country	Component	*AFB1	*AFT	*OTA
Bulgaria	Spices	2	5	10
Czech Republic	Spices	20		-
Serbia & Montenegro	Spices	30		
EU Member states	<i>Spices (Capsicum spp., Piper spp, nutmeg, ginger, turmeric)</i>	5	10	-
Finland	All spices		10	-
Hungary	Spices	5	10	-
Switzerland	Nutmeg	10	20	20
	Spices	5	10	
Turkey	Spices	5	10	-
Uruguay	Spices	5	20	-

*AFB1: Aflatoxin B1; AFT: Total aflatoxins (B1, B2, G1, G2); OTA: Ochratoxin

Recent international deliberations on maximum limits (MLs)

Codex Alimentarius Commission- Risk assessment/ regulatory limits on a commodity-by-commodity basis
(Discussion paper on aflatoxins in cereals-Codex Agenda Item CX/CF 14/x/x 2014)

- *Proposal to fix 10ppb for all foods-no consensus by member countries.*
- *Difficult to establish single level for all foods.*
- *Maximum levels to be established on a commodity-by-commodity basis*

Risk assessment of aflatoxins in spices and fixing regulatory limits- Issues

Significance and risk of aflatoxin exposure from spices in comparison to cereals and other foods with higher quantities and frequencies of intake?

Fixing single ML for all spices- potential for overestimation of risk?

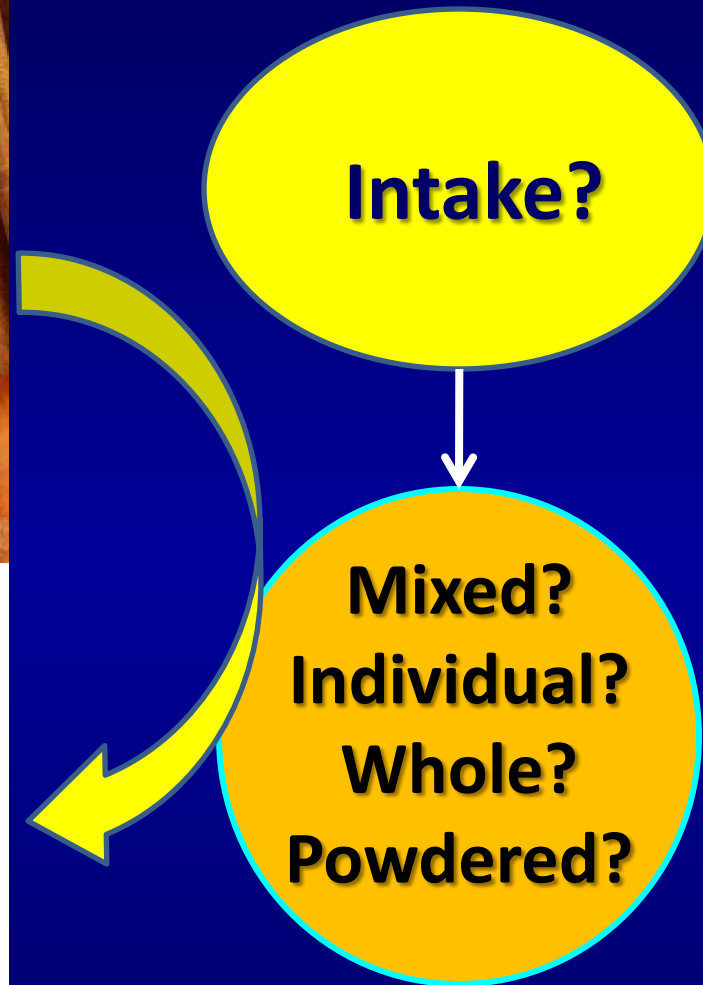
Significance/ quantity of various spices in the diet varies (E.g. red chillies vs nutmeg)?

Need to fix MLs on spice-by-spice basis?

Requirements for risk assessment of aflatoxins from spices

- Generation of consumption data on individual spices.
- Generation of aflatoxin data in various spices such as mace, cardamom, cinnamon, etc.
- Harmonization of methodologies for dietary intake and risk assessment of aflatoxins from spices based on JECFA & margin of exposure (MOE) procedures.

Challenges of measuring intake of spices



Currently used approaches used for estimating dietary intake of spices & applicability to estimating aflatoxin intake

Method

Applicability

1. Food frequency methods: **No. of times consumed (weekly/monthly).**

Simple, easy to collect information; Useful for screening consumers/non-consumers. Qualitative/semi-quantitative

2. Recall methods (24 hr)- **amount of spice used/consumed previous 24 hrs**

Relies on responders' memory, but more quantitative than (1).

3. Food records: record on type and amount of spices consumed during a defined period by respondent;

Relies on responders' ability to record correctly/literacy level

4. Estimating portion size consumed- **weigh amt of spice used per dish, total amount of dish prepared, portion size consumed and estimating intake of spice/portion consumed.**

More realistic quantification than (1) or (2), time consuming, restricted sample size (that is practical/convenient)

5. International food databases (GEMS/FAOSTATS)

Provide gross estimates of intake from consumption figures from different countries. Difficult to interpret at the individual level.

**Study on Dietary intake of aflatoxins from
spices and risk assessment (Initiated with
support from Spices Board GOI/ World Spice
Organization**

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International Food Safety Specialist

Dietary intake of aflatoxins from spices and risk assessment - Objectives

- To review relevant literature/databases on aflatoxin contamination in selected spices including dried red chillies, black pepper and nutmeg, in various countries.
- To review available literature on dietary intake of spices in various countries.
- To assess the dietary intake of spices through dietary survey in consumers belonging to different socio-economic groups (high, medium and low) in a selected region through a predetermined food frequency questionnaire.
- To perform risk assessment of aflatoxin exposure from spices from data obtained on aflatoxin levels and dietary surveys.

Methodology

1.Literature review: Search Public domain/international crop & food intake databases for available literature on aflatoxin contamination in selected spices and spice intake data in various countries.

2.Conduct a limited diet survey in different socio-economic population groups in a selected region in Hyderabad using a pretested food frequency questionnaire. Data collection on frequency and quantity of spice consumption in selected households.

3.Estimate intake of aflatoxin from spices based on the data obtained from food frequency surveys as in (2) and aflatoxin levels in spices as available from literature/government reports/international databases.

4. Perform risk assessment of aflatoxin exposure from spices according to JECFA and MOE approaches and evaluate in relation to tolerance limits established in selected countries in comparison to that obtained from cereals.

Progress of work done:

1.Literature review on available data natural occurrence of aflatoxins in spices, intake of spices & aflatoxin exposure from spices in various countries :

Reviewed

- i) 15 published reports/studies/databases available on spice intake from different countries;**
- ii) 85 published reports/reviews/studies on occurrence of mycotoxins in spices in different countries.**

Aflatoxin levels in spices-reported data

Spice	Aflatoxin levels ($\mu\text{g}/\text{kg}$)	No. of studies referred (1975-2013)
Chillies (red, paprika)	<1-969	28
Black pepper	<1-60	16
Nutmeg	<1-378	12
Ginger	<1-26	8
Cinnamon	<1-53	7
Cumin seeds	<1-35	6
Turmeric	<1-9	4
Coriander seeds	<1-15.6	4
Anise	28-38	1
Omum(Carum copticum)	4-7	1
Mace	Not available	Not available

EU Notifications from Rapid Alert Systems for Food & Feed (RASFF) on mycotoxins in spices imported from India (1999-2014)

Spice	No. of notifications	Aflatoxin levels ($\mu\text{g}/\text{kg}$)		OTA($\mu\text{g}/\text{kg}$)
		AFB1	AFT	
Chillies (red, paprika)	148	7-22	8-10	
Nutmeg	30	5-230; Max:700	6-249; Max: 1200	23-120
Curry powder	41	6-62	7-47	20-36
Turmeric	14	5-115	8-116	
Ginger	16	7-16	14-30	
Cloves	1		29	

Dietary intake of spices (g/person/day)-Available data

Country	Spice	Intake	Reference
India	R. chillies	0.8-10	Pradeep et al 1993, Thimmayamma et al 1983, Madhyastha 1985, Ferucci et al 2010;
	B.Pepper	0.1-3.3	
	Coriander seeds	0.1-1.4	
	Cumin seeds	0.1-0.8	
	Ginger	0.04-2.0	
	Total	6-20	
Thailand	Total	14.7	Tantipopipat et al 2010
Korea	Hot pepper	2.3	Chun et al 2006
Italy	Total	2.12	EU SCOOP 2002, EU 2007;
Sweden	Total	0.4-1.3	Thuvander et al 2001
Norway	Total	1.6	Carlsen et al 2011
N.Zealand	Total	0.5	Zhao et al 2013

Dietary intake of spices- European data from WHO GEMS database 2006; JECFA 2008;

Spice	Intake (g/person/day)			
	GEMS Cluster countries (Europe)			
	B	D	E	F
Hops dry	0.1	0.1	0.3	0.1
Anise Badian Fennel	0.2	0.1	0.3	0.1
Nutmeg Mace Cardamom	0	0	0.1	0.1
Parsley	2.8	2.0	3.0	1.0
Pepper white/long/black	0.1	0.1	0.4	0.3
Pimento Allspice	0.4	0.5	0.6	0.2
Spices Not elsewhere specified	0.3	0.1	0.1	0.3
Total spices	1.1	0.9	1.8	1.1

Aflatoxin exposure from spices(ng/kgbw/d)-Available data

Country	Spice	Intake (g/d)	Aflatoxin levels (µg/kg)	Aflatoxin intake	Reference
India	R.chillies	2.5-15	10-60	0.4-15	Madhyastha & Bhat 1985
	B.pepper	0.5-0.6	15	0.15	
	Turmeric	0.6-0.8	28.3	0.36	
Europe	Total	1-1.8	1.9	0.02-0.1	JECFA 2008
China	Total	0.5-14.7	0.26-28	0.003-0.082	Zhao et al 2013*
Korea	Curry powder	3.88	0.2	0.013	Chun et al 2006
	Hot pepper	0.4	2.3	0.015	
Turkey	Red pepper	2.5kg/p/year	23-97	147µg/year	Basaran & Bektes 2010

* Estimated on the basis of spice intake in Europe (0.5g/d), N.Zealand (1g/d), USA (4g/d), India (9.5g/d), Thailand (14.7g/d); Aflatoxin levels used : chilli, black pepper & prickly ash from China

2. Preparation of weights & measures chart for different spices used in Indian dietaries- Standardization under progress

- Determining unit weights of each spice with portable balance (YAMASA Japan) and validating with electronic balance.**
- Determining weights of household measures of spices (whole & powdered :tsp, tbsp, cup, etc.)**

Standardization of weights/household measures of various spices

Spice	Unit wt (g)*	Household measure (whole spice)*		Household measure (powdered spice)*		
		1tsp	1tbsp	1/4tsp	1tsp	1tbsp
Cardamom	0.230±41.3	2.8±0.16	8.9±0.89	0.72±0.04	2.43±0.06	-
Cloves	0.75±16.3	2.86±0.25	9.65±0.51	0.82±0.01	2.69±0.1	-
Cinnamon	1.144±0.56	-	-	0.62±0.03	1.91±0.09	-
R.Chillies	0.74±0.09	-	-	0.8±0.05	2.37±0.08	8.5±0.37
Nutmeg	4.4±0.52	-	-	0.63±0.04	2.35±0.17	-
Mace	0.93±0.36	-	-	-	-	-
B.pepper	-	4.38±0.28	11.4±0.55	0.88±0.03	2.86±0.12	-

**Means are for 6 weights*

3. Dietary intake of spices- development of questionnaire

- **A food frequency and quantity questionnaire prepared to collect information on:**
- **Frequency of usage of different spices in dietaries, qty purchased per time.**
- **Qty of spice used per preparation of a dish & portion size of dish consumed by weighment.**
- **Model form is given in the following slide** →

Food frequency questionnaire for estimating intake of spices

Dietary intake of aflatoxins from spices and risk assessment

Food frequency & quantity questionnaire for spices

Identification particulars:

S.No.

Date:

1. Name of locality

2. Address

3. Name of respondent

4. Language spoken

5. Socio-economic status:

6. Occupation

7. Family size/composition

Sex	0-1	1-5	5-12	12-18	≥ 18	Total	Family income
Male							
Females							
Total							

8. Usage of Spices:

Name of Spice	Frequency of usage						Source of purchase (retail, wholesale, local market)	Qty purchase d/time	Cost (Rs./-)
	Never	Daily	3/wk	2/wk	1/wk	1/month			
Chilli powder									
Black pepper									
Cloves									
Cardamom									
Nutmeg									
Mace									
Cinnamon									
Curry powder									
Rasam powder									
Sambar powder									
Garam masala									
Coriander seeds									
Cumin seeds									
Asafoetida									
Fenugreek seeds									
Omum									
Shahzeera									
Poppy seeds									
Turmeric									
Aniseed(Saunf)									
Any other (specify)									

9. Qty of spice used

Recipe	Spice *(Code)	Qty used (Tsp, Tbsp, gms)	Frequency of preparation	Amt of recipe made (No. of servings)	No. of Portions consumed (Adult)	Qty of spice consumed
Curry (Vegetable, other)						
Chutney						
Dhal						
Rice						
Salad						
Spice mix (curry powder, Rasam powder, sambhar powder, garam masala, any other)						
Snacks						
Sweets/desserts						
Festive occasions						

Estimation of dietary intake of spices from the diet survey

Mode of estimation	Data estimated
Frequency of use (daily/weekly/monthly/occasionally)	Freq of spice intake. Rank spices most used. Identify consumers.
Qty of spice purchased per time (once a week/fortnight/month)	Qty of spice intake (g/person/day) =(qty purchased/time)/no. of persons consuming)
Qty of spice used per preparation (weight in gms: tsp/ tbsp/cup). Weigh amt of spice used & portion size of dish consumed.	Qty of spice consumed (g/person/day) = (Qty of spice used/dish)/total qty of dish prepared x No. of portions consumed/person

Usage of spices-preliminary data from households in Hyderabad

Spice	Rank in order of use	Frequency of use(%households)			
		Daily	Weekly	Monthly	Never
R.chillies, turmeric	1	100			
Cumin seeds	2	86	14		
Coriander seeds	3	57	14		29
Fenugreek seeds	4	43	43		14
B.Pepper	5		86		14
Cardamom	6		86	14	
Cloves	7		71	29	
Cinnamon	8		57	43	
Caraway seeds	9		57	28	14
Carom seeds	10		14	43	43
Mace	11			29	71
Nutmeg	12			14	86

Intake of spices-Preliminary data using Food frequency & quantity questionnaire

Spice	Usage/household/day (g)		Intake/person/day (g)	
	Per day	Per week	Per day	Per week
R.chillies	1.0-13		0.7-4.0	
Turmeric	5-8.3		0.7-4.0	
Cumin seeds	3.3-8.3		0.5-3.0	
Coriander seeds	6.7-17		0.1-0.8	5.8
Fenugreek seeds	0.25-8.3		3	0.8
Black pepper		0.9		
Cardamom		0.1-2.4		0.01-0.4
Cloves		0.02-2.7		0.01-0.9
Cinnamon		0.04-3.4		0.01-1.14
Caraway seeds		0.3-2.5		0.13-0.84
Carom seeds		0.5-1.0		0.12-0.25

Salient observations from preliminary spice intake survey

- **Red chilli**- Frequency and quantity of consumption highest among spices surveyed.
- Consumption of **cloves, cardamom, cinnamon, caraway seeds** frequent but insignificant amounts, mainly through spice mixes.
- Consumption of **nutmeg and mace** limited/nil.

Further data needed/ to be included in the study:

- Intake of spices from commercially available spice mixes, snack items, RTE foods.
- Actual measurement of spices used per preparation and quantity of spice consumed in a sub-sample of households.

4. Estimating aflatoxin intake from spices

-Level of spice intake for each spice obtained from diet survey will be determined on individual basis based on income status.

-Aflatoxin levels from available studies will be used to estimate aflatoxin intake from each spices.

-Exposure estimation:

**Exposure (ng/kg bodyweight/day)=
(Contamination level) (Amount consumed)/ Body
weight(kg)**

5. Performing Risk assessment of aflatoxin exposure from spices-1

Risk assessment of aflatoxin exposure by JECFA risk assessment procedure:

Carcinogenic potency of AFB1 x AFB1 intake (ng /kg bwt/day

$$\text{Potency} = 0.01 \times (1-P) + 0.3 \times (P)$$

Where,

P=prevalence of HBV infection as per presence of HBsAg in serum.

In the absence of HBsAg: 0.01 cases /year/100,000 population per ng of AFB1/kg bwt/day

In the presence of HBsAg: 0.3 cases /year/100,000 population per ng of AFB1/kg bwt/day.

5. Performing Risk assessment of aflatoxin exposure from spices-2

Risk assessment as per MOE approach:

MOE : the ratio between a toxicological threshold (such as the BMDL) and the intake. MOE lower than 10000 may indicate a public health concern (EFSA, 2005 &2007).

Rodent BMD lower limit for 10% increased risk, taken as 170 ng/ kg body wt/day.

Human BMD lower limit for 10% increased risk, taken as 870 ng /kg body weight /day.

Human BMD lower limit for 1% increased risk, taken as 78 ng kg body weight /day

Conclusions

- Codex ,since the last two decades, has been suggesting **commodity by commodity basis** for **fixing MLs for aflatoxins** in foods. This may be more relevant & important to spices (**spice-by-spice basis**).
- Taking intake data for all spices together for estimating aflatoxin exposure would lead to over estimation. (**E.g. WHO GEMS data & Chinese data**)
- **Chilli is a high risk spice for aflatoxin contamination & consumption is universal vs other spices, where contamination is low, consumption is less frequent.**
- Data on aflatoxin exposure has to emerge based on intake/frequency/risk assessment of individual spices

Way Ahead for MLs of aflatoxins in spices

- 1. Position paper on aflatoxin in spices be prepared for submission to Codex by Dec 2014.**
- 2. Dietary intake of each spice/frequency data be generated.**
- 3. Proper risk assessment study be completed before Dec 2014.**
- 4. Data generated be published in a peer reviewed Journal**

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