FDA’s Regulatory Program for Chemical Contaminants in Foods

2014 JIFSAN/FDA Food & Nutrition Webinar

Paul South, Ph.D.
Office of Food Safety
Center for Food Safety and Applied Nutrition
Food and Drug Administration
Discussion Outline

• Statutory Authority/Enforcement Options
• FDA’s Monitoring Programs (TDS and Compliance Programs)
• Examples of Chemical Contaminants addressed by OFS, including arsenic
• FDA International Efforts (Codex Alimentarius)
Federal Food, Drug and Cosmetic Act

- Provides FDA with regulatory authority with regard to adulterated foods that are in interstate commerce or delivered for introduction into interstate commerce
- Defines when a food is adulterated [Section 402 Federal Food, Drug, and Cosmetic Act]
Adulteration under § 402(a)(1)

1) Food bears or contains any poisonous or deleterious substance and…

2) If the substance is added, FDA must show that quantity of substance in food may render the food injurious to health

or

If the substance is not added, FDA must show that quantity of substance in food ordinarily renders it injurious to health
Enforcement Options for 402(a)(1)

• Case-by-case, using safety assessment
  – No levels established

• Tolerances
FDA Monitoring Programs for Chemical Contaminants

• FDA Compliance Programs
  – Total Diet Study
  – Toxic Elements in Food and Foodware, and Radionuclides in Food-Import and Domestic
  – Pesticides and Industrial Chemicals in Domestic and Imported Foods
  – Mycotoxins in Food
Total Diet Study (TDS)

- Initiated in 1961 due to concern over radioactive fallout from nuclear testing
- Measures levels of various substances in table-ready foods and to provide dietary intake estimates for these substances
- Study design:
  - 280 foods & beverages
  - Estimated dietary intakes for total US population and 14 age/gender population groups
  - About 400 analytes (pesticide residues, elements, industrial chemicals, nutrients)
TDS Analytes

- Pesticide residues (>400)
- Industrial chemicals (43)
- Radionuclides (13)
- Elements (4 toxic, 14 nutrient)
- Dioxin (since 1999); acrylamide (since 2003); perchlorate (since 2006)
TDS Sample Collections

- 4 regional market baskets each year
- 280 foods collected in 3 cities per region
- 3 samples are composited for analysis
TDS Intake Estimates

- Intake estimate = analyte concentrations in each food times amount of food consumed

- Intake estimates are calculated for 14 age-gender specific groups and for the total US population
TDS Intake Estimates

• TDS intake estimates used to
  – provide estimates of background dietary exposure
  – monitor the impact of regulatory actions
  – identify potential health hazards
  – assess national nutrition monitoring efforts
  – provide support for international development of food standards and risk assessments
Arsenic in Food

• Inorganic forms of As, tri- and pentavalent forms, are the As species of greatest toxicological concern

• Organic forms of arsenic which are the predominate forms present in fish demonstrate little toxicological potential

• Recent concerns have been raised regarding the occurrence of inorganic forms of As in certain foods (e.g., apple juice, pear juice, rice)
Arsenic in Food

• Arsenic is an element that occurs in the environment from natural causes and is also added from human activities
• Can be found in air, water, soil
• Organic (mostly non-toxic) plus inorganic (toxic) = total arsenic
• Arsenic exposure associated with cancers of skin, urinary tract and lung, skin lesions, developmental effects, neurotoxicity, diabetes
• Occurs in a wide variety of foods, including rice, vegetables, fruit, and fruit juices.
Arsenic in Apple Juice

• Concern about arsenic in apple juice raised by consumer groups and media, starting in 2011.
• FDA Hazard Evaluation for arsenic in apple juice in 2008
  – Established 23 ppb “Level of Concern” for inorganic As in apple juice.
Arсеник в яблочном соке

• Начиная с 2011 года, FDA начало:
  – Новый опрос образцов розничного яблочного сока
    • 94 образца натурального яблочного сока
    • Четыре образца с суммарным содержанием арсенита выше 10 ппб
    • Ни одного образца с неорганическим арсенитом выше 10 ппб
  – Новый проект оценки риска для арсенита в яблочном соке

• Новый проект оценки риска для арсенита в яблочном соке
Draft Quantitative Risk Assessment

• **Purpose**
  – To assess risk from consumption of lower levels of iAs typically seen in apple juice (i.e., < 23 ppb).
  – To inform development of an action level for arsenic in apple juice.

• **Endpoints**
  – Urinary tract and lung cancer (human cancer cases)
  – Chronic and lifetime exposure
Draft Guidance

• In July 2013, FDA released
  – Draft Quantitative Risk Assessment
  – Draft Guidance for Industry: Action Level

• Draft guidance
  – Identifies action level of 10 ppb iAs
  – States that FDA intends to consider action level, in addition to other factors, when considering whether to bring enforcement action in a particular case.
Increasing Interest in Arsenic in Rice

• Rice is high in arsenic relative to most foods
  – Inorganic arsenic comprises 25-90 percent of total arsenic in rice

• Advances in speciation technology has allowed measurement of inorganic arsenic in rice
FDA Rice Sampling

- In 2012 and 2013, FDA released new data on arsenic levels in rice
- Approximately 1300 results
- Rice grains: White, brown, jasmine, basmati, etc.
- Rice products: Includes infant and toddler cereals, pasta, grain-based bars, snacks, desserts and beverages, including beer and rice wine
## FDA Rice Sampling

<table>
<thead>
<tr>
<th>Product Subcategory</th>
<th>Average Total Arsenic (ppb)</th>
<th>Average Inorganic Arsenic (ppb)</th>
<th>Average DMA (ppb)</th>
<th>Average MMA (ppb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basmati</td>
<td>133 (53)</td>
<td>80 (53)</td>
<td>53 (51)</td>
<td>7 (8)</td>
</tr>
<tr>
<td>Brown</td>
<td>271 (99)</td>
<td>160 (99)</td>
<td>107 (99)</td>
<td>7 (80)</td>
</tr>
<tr>
<td>Instant</td>
<td>136 (14)</td>
<td>59 (14)</td>
<td>79 (14)</td>
<td>3 (10)</td>
</tr>
<tr>
<td>Jasmine</td>
<td>150 (13)</td>
<td>87 (13)</td>
<td>46 (13)</td>
<td>4 (1)</td>
</tr>
<tr>
<td>Parboiled</td>
<td>218 (39)</td>
<td>114 (39)</td>
<td>98 (39)</td>
<td>3 (35)</td>
</tr>
<tr>
<td>White, long grain</td>
<td>243 (149)</td>
<td>103 (149)</td>
<td>131 (149)</td>
<td>5 (82)</td>
</tr>
<tr>
<td>White, medium grain</td>
<td>208 (91)</td>
<td>81 (91)</td>
<td>106 (91)</td>
<td>4 (52)</td>
</tr>
<tr>
<td>White, short grain</td>
<td>123 (23)</td>
<td>79 (23)</td>
<td>38 (23)</td>
<td>1 (16)</td>
</tr>
</tbody>
</table>
Rice: Next Steps

• FDA is currently working on a draft quantitative risk assessment for rice and rice products
  – Peer review (government and external)
  – Will be released for public comment
  – Anticipated publication in 2014

• Risk assessment will help inform risk management and policy options
Arsenic: Possible Follow-up Activities

• Additional sampling for selected rice products, if needed
• Additional sampling
  – Other fruit juices such as grape, seafood, other grains, mushrooms, baby foods
• Cooking/preparation research
Arsenic at Codex

• Approved
  – Maximum level (ML) for inorganic arsenic in polished rice of 0.2 mg/kg adopted at CCCF8/CAC37

• Ongoing work
  – Draft MLs for husked (brown) rice of 0.25 mg/kg to 0.4 mg/kg considered. CCCF will consider MLs again next year.

• New work
  – Code of Practice for the Prevention and Reduction of Arsenic Contamination in Rice
Acrylamide

- Formed in certain foods during processing - fried, baked or broiled - variety of foods including potato chips, fries, bread, cereal, sweet potatoes, asparagus, cocoa, coffee
- Levels can vary in production lots and between lots, between products, between food types
- Genotoxic carcinogen
- Posted samples now total approximately 2600
## Top 20 Foods by Mean Acrylamide Intake

<table>
<thead>
<tr>
<th>Food</th>
<th>Mean AA intake (µg/kgbw-day)</th>
<th>Cumulative Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>French Fries (RF*)</td>
<td>0.070</td>
<td>0.16</td>
</tr>
<tr>
<td>French Fries (OB*)</td>
<td>0.051</td>
<td>0.28</td>
</tr>
<tr>
<td>Potato Chips</td>
<td>0.045</td>
<td>0.38</td>
</tr>
<tr>
<td>B. Cereal</td>
<td>0.040</td>
<td>0.47</td>
</tr>
<tr>
<td>Cookies</td>
<td>0.028</td>
<td>0.53</td>
</tr>
<tr>
<td>Brewed Coffee</td>
<td>0.027</td>
<td>0.60</td>
</tr>
<tr>
<td>Toast</td>
<td>0.023</td>
<td>0.65</td>
</tr>
<tr>
<td>Pies and Cakes</td>
<td>0.018</td>
<td>0.69</td>
</tr>
<tr>
<td>Crackers</td>
<td>0.017</td>
<td>0.73</td>
</tr>
<tr>
<td>Soft Bread</td>
<td>0.014</td>
<td>0.77</td>
</tr>
<tr>
<td>Chile con Carne</td>
<td>0.014</td>
<td>0.80</td>
</tr>
<tr>
<td>Corn Snacks</td>
<td>0.011</td>
<td>0.82</td>
</tr>
<tr>
<td>Popcorn</td>
<td>0.007</td>
<td>0.84</td>
</tr>
<tr>
<td>Pretzels</td>
<td>0.007</td>
<td>0.86</td>
</tr>
<tr>
<td>Pizza</td>
<td>0.006</td>
<td>0.87</td>
</tr>
<tr>
<td>Burrito/Tostada</td>
<td>0.006</td>
<td>0.88</td>
</tr>
<tr>
<td>Peanut Butter</td>
<td>0.003</td>
<td>0.89</td>
</tr>
<tr>
<td>Breaded Chicken</td>
<td>0.003</td>
<td>0.90</td>
</tr>
<tr>
<td>Bagels</td>
<td>0.003</td>
<td>0.90</td>
</tr>
<tr>
<td>Soup Mix</td>
<td>0.003</td>
<td>0.91</td>
</tr>
</tbody>
</table>

*RF, restaurant fries; OB, oven baked

Source: [http://www.fda.gov/Food/FoodSafety/default.htm](http://www.fda.gov/Food/FoodSafety/default.htm)
Research on Acrylamide Formation

French fries

- Acrylamide increases with
  - higher frying times, temperatures
  - degree of browning
- Acrylamide correlates highly with color

Toast

- Light toasting causes very low acrylamide formation, dark toasting causes low to moderate acrylamide formation
- Scraping toast to remove browned surface reduces acrylamide levels
Dioxin-like Compounds (DLCs)

- Dioxin and chemically-related compounds (referred to collectively as dioxin-like compounds or DLCs) can be found in food-producing animals.
- Because DLCs tend to accumulate in the fat of food-producing animals, consumption of animal-derived foods (e.g., meat, poultry, eggs, fish, and dairy products) is considered to be the major route of human exposure.
- Studies suggest that DLC exposure may lead to a variety of adverse health effects including reproductive and developmental problems, cardiovascular disease, increased diabetes, and increased cancer.
- Reduction of emissions from numerous combustion processes, have resulted in a significant decline in levels of dioxins and furans in the United States.
PCDD/PCDF Exposure Estimates from 2001-2004 TDS Foods

*In 2001, JECFA established a PTMI of 70 pg WHO-TEQ/kg body weight/month

Source: http://www.fda.gov/Food/FoodSafety/default.htm
EPA Dioxin Reassessment

• In February 2012, EPA released a dioxin hazard assessment addressing noncancer health effects associated with dioxin exposures.
• The EPA dioxin hazard assessment document includes a RfD of 0.7 pg/kg bw-day.
• A dioxin Qs and As document, is posted on the FDA website that provides general information on dioxin in food (http://www.fda.gov/Food/FoodSafety/FoodContaminantsAdulteration/ChemicalContaminants/DioxinsPCBs/ucm077524.htm).
Lead (Pb) - Hazards

- There is little to no margin of safety - there is some level of risk associated with low levels of exposure.
- In humans the incidence of lead induced effects is observable and verifiable.
- Placenta presents a minimal barrier to movement of lead from maternal to fetal circulation.
- Food consumption per body mass is greater in infants & younger children (approximately 7 years of age and younger) as compared to adults.
- Infants & younger children absorb lead from the GI tract more readily than adults by about a factor of four.
- Immature status of developing organs - brain, kidneys & liver - more sensitive to toxic effects.
Lead Intakes/TDS - 1976 to 1996
Lead in Candy

• In 1994 California authorities found imported Mexican candy contaminated with lead that had migrated from the ink used in defective packaging.
• FDA also discovered that, apart from the wrapper, some Mexican candy (e.g., with chili ingredient, salt-based, tamarind pulp) contained higher lead levels than were typically found in domestic candy.
• In 1995 FDA issued its first guidance level for candy of 0.5 ppm.
• In 2006 FDA issued a revised guidance level of 0.1 ppm for lead in candy likely to be consumed frequently by small children.
Perchlorate in Food

- Perchlorate is naturally occurring (e.g., Chilean nitrate fertilizers) and manmade (solid rocket propellant)
- Perchlorate detected in numerous surface and ground waters in the U.S. (e.g., Colorado River)
- Perchlorate can inhibit iodide uptake into the thyroid
- Relatively high (pharmacologic) doses - hypothyroidism
- Impairment of the thyroid may affect the fetus and newborn resulting in delayed development and decreased learning capacity
### TDS/Perchlorate Exposure Estimates

<table>
<thead>
<tr>
<th>Population Group</th>
<th>Exposure Estimate (µg/kg-bw/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infants 6-11 months</td>
<td>0.26-0.29</td>
</tr>
<tr>
<td>Children 2 years</td>
<td>0.35-0.39</td>
</tr>
<tr>
<td>Children 6 years</td>
<td>0.25-0.28</td>
</tr>
<tr>
<td>Children 10 years</td>
<td>0.17-0.20</td>
</tr>
<tr>
<td>Girls 14-16 years</td>
<td>0.09-0.11</td>
</tr>
<tr>
<td>Boys 14-16 years</td>
<td>0.12-0.14</td>
</tr>
<tr>
<td>Women 25-30 years</td>
<td>0.09-0.11</td>
</tr>
<tr>
<td>Men 25-30 years</td>
<td>0.08-0.11</td>
</tr>
<tr>
<td>Women 40-45 years</td>
<td>0.09-0.11</td>
</tr>
<tr>
<td>Men 40-45 years</td>
<td>0.09-0.11</td>
</tr>
<tr>
<td>Women 60-65 years</td>
<td>0.09-0.11</td>
</tr>
<tr>
<td>Men 60-65 years</td>
<td>0.09-0.11</td>
</tr>
<tr>
<td>Women 70+ years</td>
<td>0.09-0.11</td>
</tr>
<tr>
<td>Men 70+ years</td>
<td>0.11-0.12</td>
</tr>
</tbody>
</table>

*RfD = 0.7 µg/kg-bw/day

Mycotoxins and Control Strategy

- Low molecular weight, secondary metabolites produced by certain fungi during growth in the field, processing, transport or storage.
- Occur naturally and are difficult to avoid.
- Various toxicological outcomes from ingestion.
- Many stable to heat and food processing procedures.
- Monitoring activity consists of targeted sampling of susceptible commodities (e.g., aflatoxin and peanuts).
- Derive estimates of the incidence, levels of contamination and dietary exposure estimates for risk assessments and establishing guidelines.
## FDA Action Levels for Aflatoxin

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Action Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>All products for humans, except milk</td>
<td>20 ppb</td>
</tr>
<tr>
<td>Corn for immature animals and dairy cattle</td>
<td>20 ppb</td>
</tr>
<tr>
<td>Corn and peanut products for breeding beef cattle, swine, and mature poultry</td>
<td>100 ppb</td>
</tr>
<tr>
<td>Corn and peanut products for finishing swine</td>
<td>200 ppb</td>
</tr>
<tr>
<td>Corn and peanut products for finishing beef cattle</td>
<td>300 ppb</td>
</tr>
<tr>
<td>Cottonseed meal (as a feed ingredient)</td>
<td>300 ppb</td>
</tr>
<tr>
<td>All other feedstuffs</td>
<td>20 ppb</td>
</tr>
<tr>
<td>Milk (Aflatoxin M₁)</td>
<td>0.5 ppb</td>
</tr>
</tbody>
</table>

Source: FDA Compliance Policy Guides, Sections 527.400, 555.400, and 683.100
## FDA Action Level for Patulin

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Action Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple juice, apple juice concentrates and apple juice products based on</td>
<td>50 ppb</td>
</tr>
<tr>
<td>the level found or calculated to be found in single strength apple juice</td>
<td></td>
</tr>
<tr>
<td>or in the single strength apple juice component of the product.</td>
<td></td>
</tr>
</tbody>
</table>

Source: FDA Compliance Policy Guide, Section 510.150
### FDA Guidance Level for Deoxynivalenol (DON) in Human Food/Animal Feed

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Guidance Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>All finished wheat products, e.g. flour, bran and germ for humans</td>
<td>1 ppm</td>
</tr>
<tr>
<td>All grains and grain by-products for ruminating beef and feed lot cattle older than 4 months and for chickens</td>
<td>10 ppm</td>
</tr>
<tr>
<td>All grains and grain by-products destined for swine</td>
<td>5 ppm</td>
</tr>
<tr>
<td>All grains and grain by-products for all other animals; less than 40% of diet</td>
<td>5 ppm</td>
</tr>
</tbody>
</table>

Source: Letter to State Food Officials and Feed and Grain Trade Organizations from R.G. Chesemore, Associate Commissioner for Regulatory Affairs, Sept. 1993
## FDA Guidance Level for Fumonisín in Human Food

<table>
<thead>
<tr>
<th>Product</th>
<th>Guidance Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>De-germed dry milled corn products</td>
<td>2 ppm</td>
</tr>
<tr>
<td>Whole/partially de-germed dry milled corn product</td>
<td>4 ppm</td>
</tr>
<tr>
<td>Dry milled corn bran</td>
<td>4 ppm</td>
</tr>
<tr>
<td>Cleaned corn for masa production</td>
<td>4 ppm</td>
</tr>
<tr>
<td>Cleaned corn intended for popcorn</td>
<td>3 ppm</td>
</tr>
</tbody>
</table>

[http://www.fda.gov/food/guidanceregulation/guidancedocumentsregulatoryinformation/chemicalcontaminantsmetalsnaturaltoxinspesticides/ucm109231.htm](http://www.fda.gov/food/guidanceregulation/guidancedocumentsregulatoryinformation/chemicalcontaminantsmetalsnaturaltoxinspesticides/ucm109231.htm)
Codex Committee on Contaminants in Food

- Establish maximum levels for contaminants and naturally occurring toxicants in food and feed
- Elaborate codes of practice for prevention and/or reduction of contaminants and naturally occurring toxicants in food and feed
- Prepare priority list of contaminants and naturally occurring toxicants for risk assessment by the Joint FAO/WHO Expert Committee on Food Additives (JECFA)
Codex Committee on Contaminants in Food (CCCF) 8th session

• Recent meeting (April 2014) held in The Hague, Netherlands
• Issues addressed:
  – Maximum Levels for lead in infant formula
  – Maximum Levels for inorganic arsenic in polished rice
  – Maximum Levels for fumonisins in maize and maize products
• Meeting report posted on Codex website at: http://www.codexalimentarius.org/
Questions?

Paul.South@fda.hhs.gov