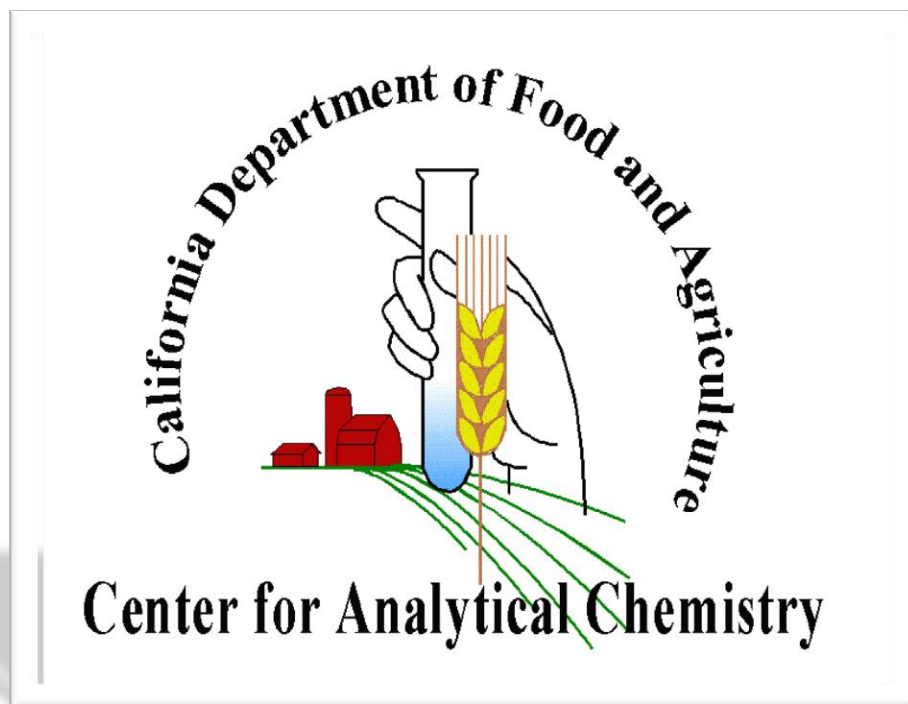


ANALYTICAL TESTING IN U.S. AND FOREIGN LABORATORIES

MRL Workshop 2013
June 6, 2013

Disclaimer: The views expressed here are strictly my views and should not be construed as the views of any State, Federal or Private entity- Nirmal K Saini

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Outlines



- ❑ Food Security
- ❑ Pesticide Use and Laws regulating them
- ❑ Sample Types Analyzed at CDFA
- ❑ Residue Methods- Historical Perspective
- ❑ Multi Residue Screening Procedure
- ❑ Residue Data

Food Security-

A Threat to The Survival of Human Race

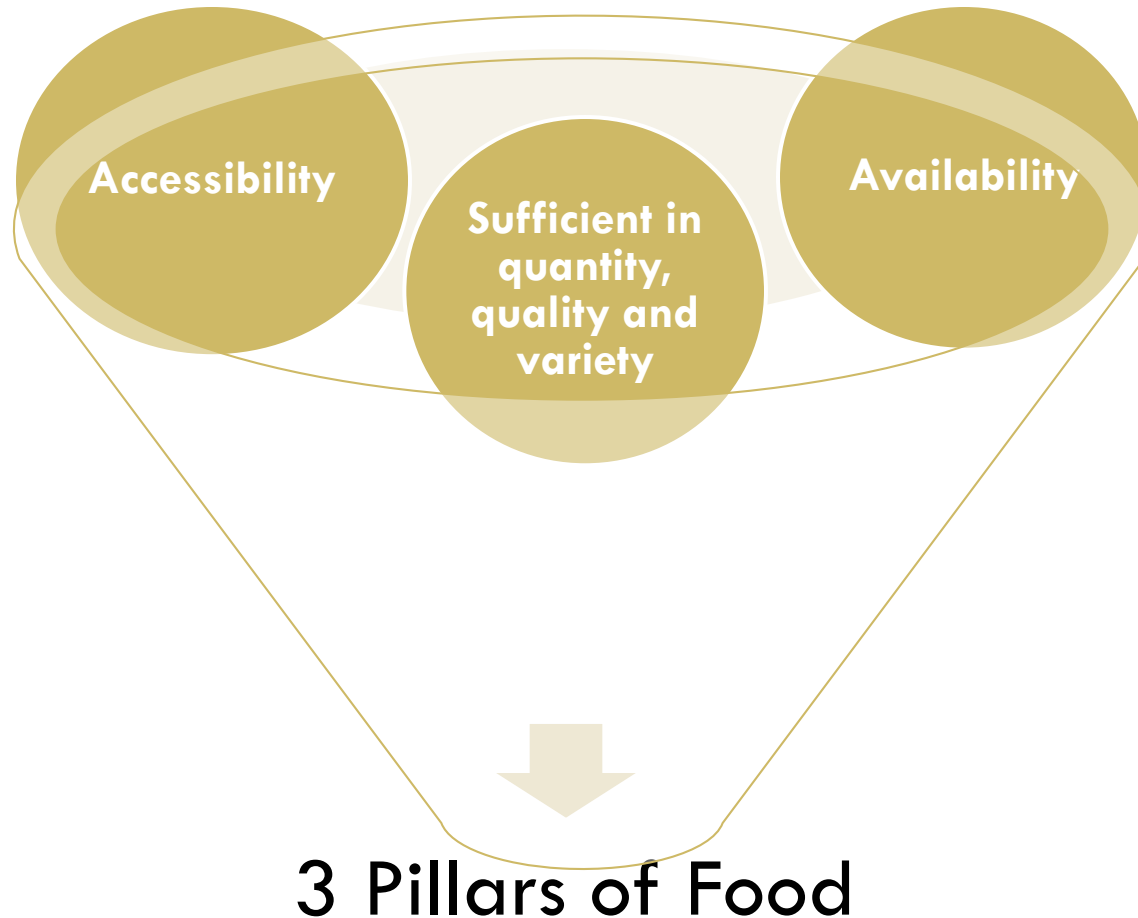
“Civilization as it is known today could not have evolved, nor can it survive, without an adequate food supply.” – Norman Borlaug



What are the Issues?

- Increasing world population
- Increasing world Hunger and poverty
- Fixed or decreasing land mass and other resources
- Challenges: *How to feed the growing world population with limited resources*

Three Pillars of Food Security



Three Ways to Increase Food Production

- Expansion of arable land (15% increase between 1961-1999)
- Increase in cropping intensity (frequency with which crops are harvested from a given area) (7% increase)
- Improvements in yield (78% increase)
 - e.g.: *Use of pesticides has improved crop yields and increased the quantity of fresh fruits and vegetables in the diet, thereby contributing to improvements in public health in the United States.*

Definition of Pesticides under FIFRA

- *“any substance or mixture intended for preventing, destroying, repelling, or mitigating any insects, rodents, nematodes, fungi, or weeds, or any other form of life declared to be pests, and any substance or mixture intended for use as a plant regulator, defoliant, or desiccant.”*

Pesticides Use

- In ancient times ashes, common salts and bitters are used as herbicides.
- 1st century AD – Roman naturalist Pliny advocates the use of arsenic as an insecticide; soda and olive oil for the treatment of legumes.
- 16th century- Chinese farmers were using arsenicals and nicotine in the form of tobacco extracts as insecticides.
- By 1850 pyrethrum and soap were in wide use.
Tobacco, sulfur and lime used to fight insects and fungi.

Pesticides

- 19th century-
 - Natural pesticides- pyrethrum (chrysanthemums) and rotenone (roots of tropical vegetables)
 - Bordeaux mixture applied to kill weeds in grape vines –a selective chemical herbicide
 - Sulfuric acid, copper nitrates, potassium salts used.

Pesticides

- 1910-39: Several carbamate fungicides used in the US
- 1939: Muller discovered DDT, leading to the synthesis of several OC such as BHC, dieldrin, aldrin...
- 1960s: Herbicides became common in the 1960s led by triazine and other nitrogen based compounds
- Mid-1970s: Several OPs and carbamates were widely used.
- 1990s and beyond: Integrated pest management techniques, research on biological control methods, greater understanding of host-pest interactions, genetically engineered microbial agents, pest-resistant crops and biological control methods have gained attention.

Regulation and Control

- First law was enacted granting federal authority in 1910
- 1960- “Silent Spring” by Rachel Carson published
- EPA was established in 1970, with amendments to pesticide law
- 1972 EPA revoked the use of DDT.....

Federal Laws

- Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA): Enacted in 1910, modified in 1947 to address the potential risks to human health. This law gives the EPA authority to regulate the sale, use and distribution of pesticides.
- Federal Food, Drug, and Cosmetic Act (FFDCA): Enacted in 1938, modified in 1954 gives EPA the authority to set tolerances .

Federal Laws

- Food Quality Protection Act of 1996 (FQPA):
<http://www.epa.gov/pesticides/regulating/laws/fqpa/>
Act increased the safety standards for new pesticides used on foods. FQPA also required older pesticides and previously established tolerances to be periodically re-assessed using the new, tougher standards.
- Pesticide Registration Improvement Act (PRIA) of 2003: Establishes the fees and time-lines associated with pesticide registration actions.

Federal Laws

- Endangered Species Act (ESA) of 1973:
<http://www.epa.gov/lawsregs/laws/esa.html>
- Requires EPA to assess the risk of pesticides to threatened or endangered species and their habitats
- Food Safety Modernization Act (FSMA)
<http://www.fda.gov/Food/FoodSafety/FSMA/ucm247548.htm>
Signed into law on January 11, 2011

Pesticide Testing at CDFA

- Division of Chemistry was created in CDFA in July 1920 to support Fertilizer Law and Insecticide and Fungicide Law to check for label compliance
- CDFA analyzed 25,000 samples in 1935
- 22,000 were for voluntary certification and 3000 for enforcement
- In 1991 CDFA closed the Berkeley laboratory
- In 2002 Fresno laboratory was closed.
- We maintain laboratories in Sacramento & Anaheim

Sample Types at CAC

- ❑ Market Surveillance Samples: Produce Samples for EPA Tolerance Violations
- ❑ County Ag. Commissioners: Mis-Use Investigations
- ❑ Pesticide Data Program: Commodities Mostly Consumed by Infants and Children- Risk Assessment Calculations, FQPA
- ❑ Environmental Monitoring: Environmental Fate Studies of Pesticides
- ❑ Workers Protection Program: Field Workers Illnesses, Re-entry, exposure studies
- ❑ Product Quality: FIFRA compliance
- ❑ FERN Laboratory

Sample Types

- Feed/Fertilizers: Label guarantees, Livestock drugs, Proximates, Aflatoxins in Nuts, Antibiotics, BSE Screening
- CDFA Eradication Projects: Diaprepes, Med. Fruit Fly, Japanese beetle, Pierce's Disease (GWSS), Hydrilla Eradication, Light Brown Apple Moth etc.
- Department of Boating and Waterways: Aquatic weed control

Multi Residue Screening Methods

□ Mills-Onley-Gaither Method- 1963

- ▣ High Moisture ($>30\%$ moisture) F & V
- ▣ Non Fatty ($<2\%$ fat) F & V
- ▣ fatty foods ($> 2\%$ fat)

□ Luke Method- 1985

- ▣ Non fatty- High moisture F & V
- ▣ Non Fatty - Low moisture F & V

□ Krause Carbamate Method: 1983

- ▣ Acetone Extract coupled with LC

Multi Residue Screening Methods

- CDFA MultiResidue Method
 - ▣ Wide range of commodities (both polar and non polar compounds)
- QuEchERS: 2003
 - ▣ Wide range of commodities F & V
- ELISA (Enzyme Linked Immuno Sorbent Assay)
- Super critical fluid extraction and chromatography (SFE/SFC)

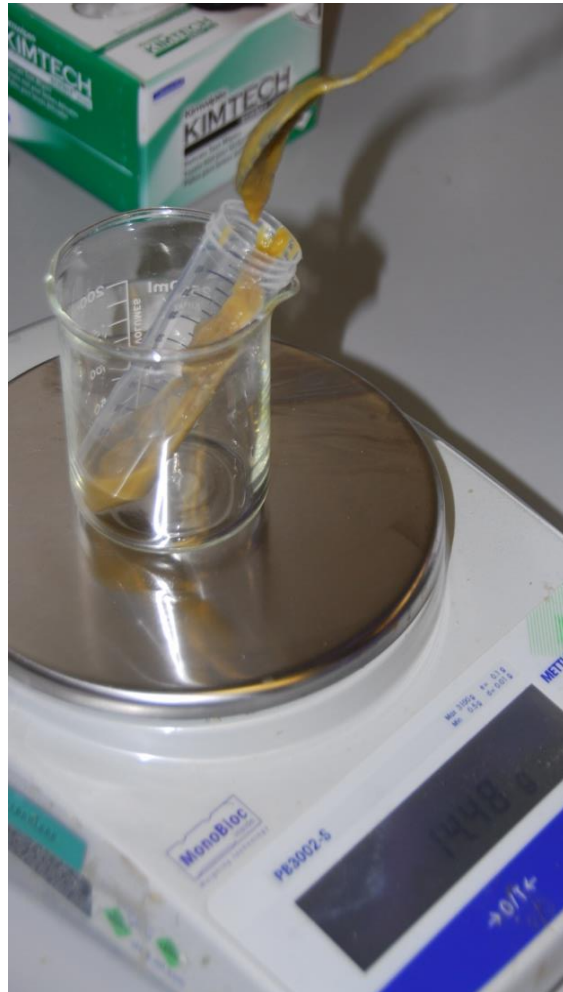
Multi Residue Screening

- July 2012 Sacramento Residue Lab switched to Multi Residue method using QuEChERS approach.
- Sample is extracted in ACN, PSA cleanup is done and determination is done by LCMSMS and GCMSMS.
- Agilent GC-MS 7000-QQQ: TSQ-Triple Sector Quadrupole mass spectrometer system to do multi-reaction monitoring(MRM).
- Thermo Quantum _TSQLCMS: Selected Reaction Monitoring (SRM).

QuEChERS

- **Qu:** Quick
- **E:** Easy
- **Ch:** Cheap
- **E:** Effective
- **R:** Rugged
- **S:** Safe

Extraction Procedure



- Homogeneity of sample is very critical
- We start with 15 gm of homogenized sample

Extraction Procedure

- Add 15mL ACN
- Shake 2 minutes
- Add Extraction salts:
MgSO₄ and
NaOAc
- Shake and Centrifuge
- Approximately 8 mL ACN from extraction tube is transferred to PSA tube
- Shake (by hand and using vortex)
- Centrifuge

Analyses

- LCMS: No cleanup or evaporation steps. Simply dilute 125uL sample extract with 405uL H₂O and 95uL ACN, vortex, filter and analyze. Sample conc.=0.2g/mL
- GCMS: No Cleanup or Evaporation Steps. Simply Dilute 250uL sample with 20uL Internal Standard, 10uL Analyte Protectant and 20uL ACN.

2011 Data- Market Surveillance

- Total Samples analyzed= 2707
- Samples with no pesticide residues= 1647 (60.8%)
- Samples with residues within tolerances=968 (35.8%)
- Violative residues= 92 (3.4%)
- 988 samples were California grown and 97.9% of them were in compliance

2012 Data- Market Surveillance

- Total Samples analyzed 3535
- Number of Commodities analyzed >130
- No residue detected on 57% samples
- Residue within tolerance on 39% samples
- Violative samples 4%
- Of the violative samples 34% domestic and 66% imported

Selective Data

Commodity	# Samples	violations
Garlic	24	0
Onions	30	0
Ginger	62	3 (China)
Apples	183	0
Apricot	13	0
Avocado	53	0
Cantaloupe	33	1 (C. Rica)
Carrots	69	1 (US)
Cherries	41	1 (Chile)

Commodity	# Samples	violations
Lemon	27	0
Lime	91	0
Tangerine	35	0
Oranges	48	0
Pears	91	0
Peaches	181	CA(4), US (3), Chile (2)
Peppers, Chile	43	0
Peppers, Bell	99	0

Selective Data

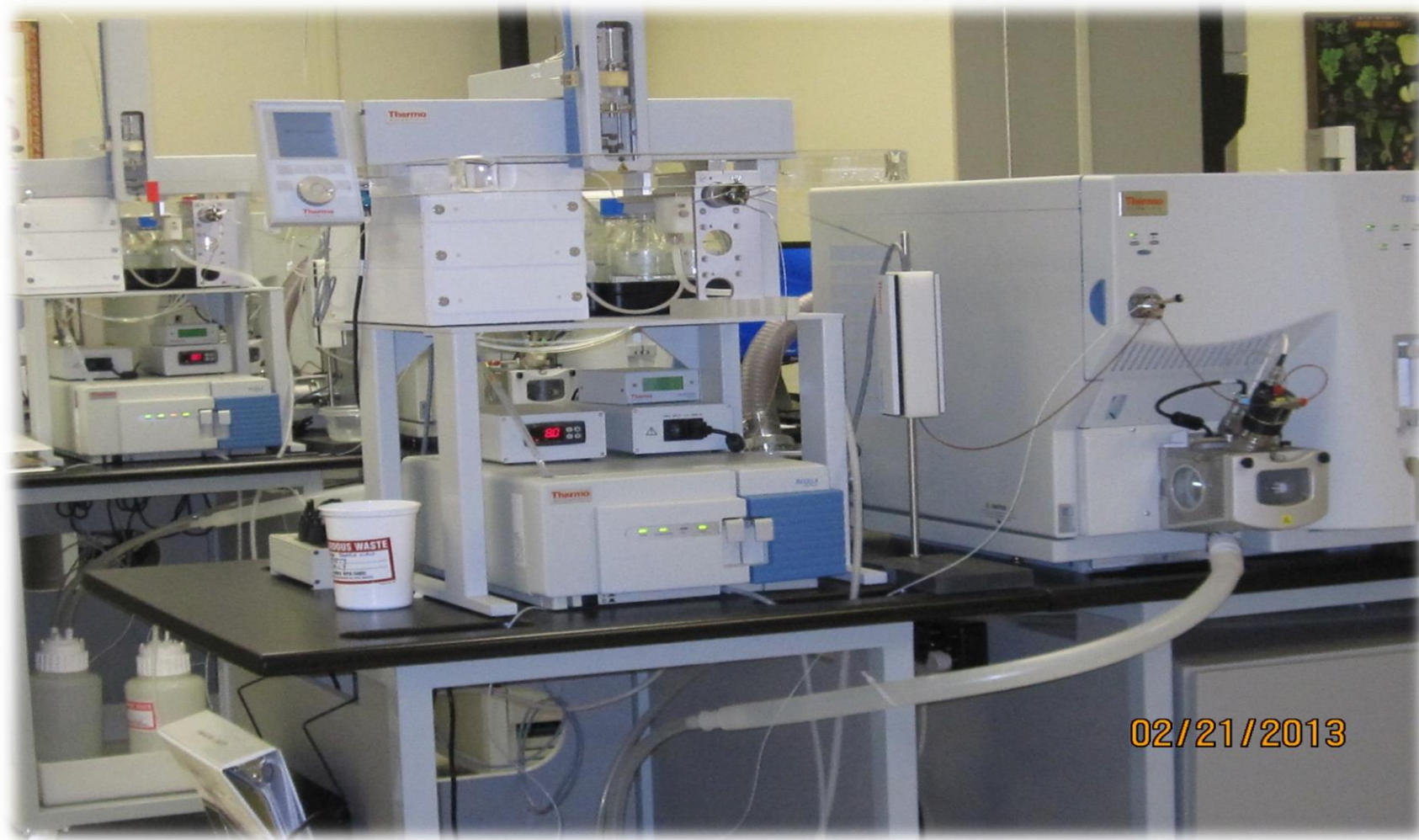
Commodities	Number Samples	Violations
Green Beans	30	1(Guatemala)
Blue berries	49	0
Broccoli	41	0
Cabbage	37	0
Dates	6	0
Figs	5	0
Nectarines	38	2(CA)

Commodities	Number Samples	Violations
Plums	40	3(CA)
Strawberries	171	5(CA), 2(US)
Sweet Potatoes	44	0
Tomatoes	93	0
Tomatoes, Processing	13	0
Watermelon	7	0

2012 PDP Data from California

Commodity	Samples Analyzed	Samples with Violations	Domestic Samples with Violations	Imported Samples with Violations	Total Violative Residues	
Baby Food Peaches	406	6	6	0	6	
Onions	279	1	1	0	1	
Plums	697	51	19	32	56	
Snap Peas	372	125	15	110	212	
Summer Squash	94	2	2	0	2	
Winter Squash	742	26	9	17	27	
Total	2590	211	52	159	304	

Thermo- LC-MS TSQ



Agilent- GC-MS Triple Quad



Future Trends

- Triple TOF
- UPLC coupled with FT Orbitrap
- LC –HRMS (High Resolution Mass spectrometer)
- Quadrupole Orbitrap Mass Spectrometer
- ❖ Benefits:
 - ❖ Broader screening capabilities
 - ❖ Targeted/non targeted analysis
 - ❖ Higher sensitivity/selectivity
 - ❖ Higher mass accuracy
 - ❖ Greater quantitation power

Japanese Regulations

- Imported Foods Monitoring and Guidance Plan:
 - ▣ <http://www.mhlw.go.jp/english/topics/importedfoods/>
- List of contaminants:
 - ▣ <http://www.mhlw.go.jp/english/topics/importedfoods/12/s08.html>
- Targeted Inspection:
 - ▣ <http://www.mhlw.go.jp/english/topics/importedfoods/13/schedule01.html>

Ministry of Health Labor and Welfare

- Positive List System for Agricultural Chemical Residues in Food:
 - <http://www.ffcr.or.jp/zaidan/FFCRHOME.nsf/pages/MRLs-p>
- Analytical Methods:
 - [http://www.ffcr.or.jp/zaidan/FFCRHOME.nsf/7bd44c20b0dc562649256502001b65e9/f8fe989fdf1d16464925713300188247/\\$FILE/analytical%20methods.pdf](http://www.ffcr.or.jp/zaidan/FFCRHOME.nsf/7bd44c20b0dc562649256502001b65e9/f8fe989fdf1d16464925713300188247/$FILE/analytical%20methods.pdf)

Pesticide Issues in China

- Pesticide regulations fall under the Institute for the Control of Agrochemicals (ICAMA) affiliated with Ministry of Agriculture (MOA)
- ICAMA in a meeting held in March, 2013 identified work priorities for 2013
- Deputy Director General Wei Qiwen of ICAMA gave opening remarks at Global Minor Use Summit II (GMUS II) held in Rome, Italy in February 2013 and was attended by FAO, USDA and IR-4

GMUS II Goals

- Formulate the standard for MRLs, crop groupings, residue trials and efficacy tests
- Set up projects for minor crops, organize joint trials
- Establish a working group to implement global priority procedure, expand existing database, a global steering committee for reinforcement
- Promote risk communication and benefit sharing
- Set up incentive mechanism in national and international standard setting

Inspection in China

- General Administration of Quality Supervision, Inspection and Quarantine of PRC is responsible for testing imported fruits and vegetables.
- Pesticide residues for imported fruits and vegetables are inspected at the port where they are imported
- Every port has a lab to inspect the pesticide residues

Inspection in China

- Inspected pesticides can be a few to hundreds based on the requirements from Chinese government and the contracts between China and the country that exports the fruits and vegetables
- They have their own inspection methods mainly based on the State Inspection Standards. In addition, they also create SOPs following EU standards, Japanese standards, and AOAC methods

Food Safety in China

- CFSAN Constituent update, December 2012
 - ▣ <http://www.fda.gov/Food/NewsEvents/ConstituentUpdates/ucm331518.htm>
- FDA-AQSIQ Agreement on Safety of Food and Feed
 - ▣ <http://www.fda.gov/InternationalPrograms/Agreements/MemorandaofUnderstanding/ucm107557.htm>

CAC in The News- March 12, 2013

- Pesticides - Pesticide Produce Testing Goes High Tech
California has one of the toughest programs in place to test for illegal levels of pesticides in produce. NBC Bay Area went with inspectors on a recent visit to the Oakland produce market. Stephanie Chuang reports.
 - <http://www.nbcbayarea.com/news/local/Pesticide-Testing-Goes-High-Tech-197577461.html>





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Thank you!



Questions & Answers

