The NIST Food Quality Program: Measurements and Standards to Support the Global Food Industry

Katrice A. Lippa

Leader, Organic Chemical Metrology Group

National Institute of Standards and Technology (NIST)

Gaithersburg, MD USA

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The National Institute of Standards and Technology

The U.S. National Metrology Institute (NMI) and U.S. Industry's National Laboratory

NIST's Mission:

To promote U.S. innovation and industrial competitiveness by **advancing measurement science, standards, and technology** in ways that enhance economic security and improve our quality of life



3,400 +5 **2 CAMPUSES** GAITHERSBURG, MD [HQ] NOBEL PRIZES FFDFRAL BOULDER, CO **EMPLOYEES** 10 400 +3,500+COLLABORATIVE **BUSINESSES USING** ASSOCIATES **INSTITUTES** NIST FACILITIES 51 14 U.S. BALDRIGE MANUFACTURING NATL OFFICE FOR **EXTENSION** MANUFACTURING ENCE PROGRAM lanufacturingUSA PARTNERSHIP CENTERS INSTITUTES

Non-Regulatory Federal Agency of

the Department of Commerce



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NIST Products and Services





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1,200 Standard Reference Material (SRM) products

100 Standard Reference Data (SRD) products

600 measurement services

Every year:
32,000 SRM units sold
13,000 calibrations and tests
800 accreditations of testing and calibrations laboratories





NIST Measurement Services to Support Food Quality



- Reference Materials (SRMs, RMs)
- Definitive Measurements/Methods
- Quality Assurance Programs (QAPs)
 - continuous interlaboratory studies
 - guidance/feedback to improve measurement comparability





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Some examples, addressing regulatory drivers...



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US Regulatory Drivers for Safe Food



- Food Safety Modernization Act of 2011 (FSMA)
- Nutrition Labeling and Education Act of 1990 (NLEA)



Interplay with State Regulatory Agencies

e.g., pesticides https://www.epa.gov/safepestcontrol





US Regulatory Drivers for Safe Food

FDA U.S. FOOD & DRUG

- Food Safety Modernization Act of 2011 (FSMA)
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National Marine Fisheries Service

Food

Fisheries: inspections of processing plants









- Prevention
- Protection Agency (EPA)

- Meat, some egg products: processing plant inspections, food safety and defense, quality grades
- Food-borne illness: investigates outbreaks, establishes prevention strategies and policies
- **Contaminants, pesticide residues**: establishes enforceable tolerances, pesticide registrations with states



Interplay with State Regulatory Agencies

e.g., pesticides https://www.epa.gov/safepestcontrol





Regulatory Drivers for Food Industry: Nutrition Facts



- Established what we know today as the Nutrition Facts Label
- Some nutrients are required; others are optional
- Anything that is declared must be accurate
- Proposed changes to Nutrition Facts Labels in 2014 are going into effect currently

https://www.fda.gov/food/food-labeling-nutrition/changes-nutrition-facts-label

Original Label			I	New Label		
Nutrit	ion	Fa	cts	Nutrition Fa	cts	
Serving Size 2/3 Servings Per Co	ontainer Ab	out 8		8 servings per container		
				Serving size 2/3 cu	p (55g)	
Amount Per Servi	ng		5-1-70			
Calories 230	Ca	lories from	n Fat 72	Amount per serving	220	
		% Dail	y Value*	Calories A	30	
Total Fat 8g	1.4.0		12%	% Dai	ly Value*	
Saturated Fat	t ig		5%	Total Fat 8g	10%	
Chalasteral Og	ma		0%	Saturated Fat 1g	5%	
Sodium 160mg	niy 1		70/	Trans Fat 0g		
Total Carboh	vdrate 3	70	12%	Cholesterol 0mg	0%	
Dietary Fiber	40	9	16%	Sodium 160mg	7%	
Sugars 1g	.9			Total Carbohydrate 37g	13%	
Protein 3g				Dietary Fiber 4g	14%	
				Total Sugars 12g		
Vitamin A			10%	Includes 10g Added Sugars	20%	
Vitamin C			8%	Protein 30	2070	
Calcium			20%	- Totolin og		
Iron			45%	Vitamin D 2mcg	10%	
* Percent Daily Value Your daily value may	s are based o be higher or	on a 2,000 ca lower depen	lorie diet. ding on	Calcium 260mg	20%	
your calorie needs.	Calories:	2,000	2,500	Iron 8mg	45%	
Total Fat Sat Fat	Less than Less than	65g 20g 300mg	80g 25g 300mg	Potassium 235mg	6%	
Sodium Total Carbohydrate Dietary Fiber	Less than	2,400mg 300g 25g	2,400mg 375g 30g	* The % Daily Value (DV) tells you how much a serving of food contributes to a daily diet. 2 a day is used for general nutrition advice.	a nutrient in 2,000 calories	







Infant Formula SRMs

US Infant Formula Act (1980): Requires manufacturers to include specific nutrients at tightly regulated levels

INTERNATIONAL FOOD STANDARDS

Codex STAN 72: Adopted as a worldwide standard in 1981

STANDARD FOR INFANT FORMULA AND FORMULAS FOR SPECIAL MEDICAL PURPOSES INTENDED FOR INFANTS CODEX STAN 72 – 1981

Adopted as a worldwide Standard in 1981. Amendment: 1983, 1985, 1987, 2011 and 2015. Revision: 2007.







Infant Formula SRMs

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NIST Response:

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94 STAT. 1190 PUBLIC LAW 96-359-SEPT. 26, 1980

Public Law 96–359 96th Congress

[H.R. 6940]

Infant Formula Act of 1980. 21 USC 301 note.

Adulterated formulas. 21 USC 350a.

Leverage existing food SRM capability

elements, proximates, fatty acids)

Released in 1996 as SRM 1846 (vitamins,

Authorized FDA to adjust required levels of nutrients
 based on best available scientific knowledge
 Beguired manufacturers to tost products and report to

whether they are

Required manufacturers to test products and report to FDA when specifications are not met

"B ated..." "(A) such infant formula does not provide nutrients as required by subsection (g). The subsection (g) and a does not meet the quality factor requirements prescribed by the Secretary under this section; or "(C) the processing of such infant formula is not in compliance with the quality control requirements prescribed by the Secre-



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Formula II (soy, whey, and mill protein concentrate



MATERIAL MEASUREMENT LABORATORY

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Pesticide Residues in Foods

US tolerance levels (akin to MRLs) established for various pesticide residues and commodity combinations

Challenges for global measurement solutions:

- Very few naturally-incurred matrix RMs available
- Maximum Residue Limits (MRLs) per country may vary significantly
- Drivers for product testing (e.g., organic) different from MRLs





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NIST Response:

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Launch with glyphosate in oat flour RM (low/high levels)

• Oat flour RM developed well below tolerances levels



Prioritization of Pesticide RM Development

- Difficult to measure pesticides •
- Pesticides residues/commodities with the • highest violation and/or occurrence rates
- Multiresidues representing different classes
- Combination of two or more approaches •



MRLs/tolerance levels for glyphosate in oat commodities

(data from BCGlobal MRL database)

higher

aspirated arain fractions

Cannabis Measurement Services for a Diverse Community

Agriculture Improvement Act "Farm Bill" (2018): Defined hemp as *Cannabis* with [THC] < 0.3 %







	Legal	
	Legal for medical use	•
	Legal for medical use (limited THC content)	•
	Illegal for any use	•
D	Decriminalized	

- **Current Status of Cannabis Legalization in US**
 - Notes:

 Cannabis remains a Schedule I drug under federal law
 - Includes laws which have not yet gone into effect
 - Some local jurisdictions and Indian reservations have decriminalization or legalization policies separate from
 - the states they are located in
 - Cannabis is illegal in all federal enclaves (other than hemp)



National Conference of State Legislatures (<u>www.nscl.org</u>) Wikipedia (<u>https://en.wikipedia.org/wiki/Legality_of_cannabis_by_U.S.jurisdiction</u>)

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Notes:

hemp)

NIST Response:

- Launch CannaQAP to gauge capability of community
- Develop cannabis-based RMs (plant, hemp oils, extracts, edibles)







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Legal for medical use

Legal for medical use

Illegal for any use

Decriminalized

(limited THC content)

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decriminalization or legalization policies separate from

CannaQAP: Analytical Methods and Materials







Preparation of CannaQAP Exercise 2 materials (and towards RM development)





Selection of plant parts





Grinding (cryo, blender)



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PFAS in Meat

Exposure Limits/Pending Regulations: For PFOS/PFOA, reference doses based on toxicity data exist; regulatory limits for drinking water proposed in 2020.

Driven by Local (State-based) Policies

- 11 states considering policies to ban PFAS in food packaging (2021)
- at least 19 states considering legislation to restrict PFAS in water & drinking water (2021)





Drinking water Food Environment (fish, fruit, eggs, meat) (carpet/dust)







H.R.2827 - Keep Food Containers Safe from PFAS Act of 2019 116th Congress (2019-2020)						
BILL Hide Ove Sponsor: Committees:	Rep. Dingell. Debbie (D-MI-12) (Introduced 05/17/2019) House - Energy and Commerce	CONGRESS, GOV				



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Per- and Polyfluoroalkyl substances (PFAS) Exposure Pathways

Drinking water Food Environment (fish, fruit, eggs, meat) (carpet/dust)







NIST Approach:

- Develop matrix RMs (meat, silage, fish) to harmonize measurements and support toxicity/monitoring studies
- Provide quality, confident data to regulatory agencies









Measuring PFAS in Meat Materials



Cryogenic Grinding





Modified QuEChERS



NIST reference method: LC-MS/MS



	Dairy Cow		Beef Bull		Adult Sow	
Compound	Mean (ng/g)	RSD(%)	Mean (ng/g)	RSD(%)	Mean (ng/g)	RSD(%)
FOSA	<blank< td=""><td></td><td><blank< td=""><td></td><td>0.3</td><td>20</td></blank<></td></blank<>		<blank< td=""><td></td><td>0.3</td><td>20</td></blank<>		0.3	20
PFBA	<blank< td=""><td></td><td>1.5</td><td>>25</td><td>2.3</td><td>>25</td></blank<>		1.5	>25	2.3	>25
PFDA	2.7	7	1.4	6	0.3	>25
PFHpS	0.5	19	<black< td=""><td></td><td><blank< td=""><td></td></blank<></td></black<>		<blank< td=""><td></td></blank<>	
PFNA	2.5	9	1.1	4	0.2	23
PFOA	0.2	9	0.3	6) <loq< td=""><td></td></loq<>	
PFOS	95	10	15	02	6	20
PFUnDA	0.3	15	0.3	5	0.2	22

Screening Results (not value assignment!)

Still under Development:

- Method extraction efficiency
- Homogeneity/stability
- Calibrant feasibility/ SI traceability issues



In Summary...

- Artifact/matrix-based CRMs/RMs commonly developed as a response to regulations
 - Limited coverage across needs for food safety and quality
- Challenges persist to develop 'fit-for-purpose' measurement services ahead of regulations
 - Flexibility to modify RMs to support regulations as they are developed
 - Partnerships with both regulators and industry are critical
 - QAPs offer insight to capabilities of community and their current needs





NIST Food Safety Workshop

- Over 150 experts (industry, regulatory bodies, RM producers, NMIs, academia) convened in October 2019
- Explored measurement challenges in four focus areas of food safety:
 - ✓ Microbiological Contaminants
 - ✓ Chemical Contaminants
 - ✓ Allergens

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- ✓ Authenticity & Adulteration
- Reports available online
 - <u>NIST SP 1251</u>
 - <u>NIST SP 1252</u>

HARNESSING MEASUREMENT SCIENCE TO ADVANCE **FOOD SAFETY FINAL REPORT APRIL 2020** findings from the **FOOD SAFETY** WORKSHOP NIST Special Publication 125



Common Needs Identified in the Workshop

• Reference Materials • Updated Analytical Methods

- Laboratory QA/QC Education and Training
 - Global Collaboration and Harmonization

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HARNESSING MEASUREMENT
SCIENCE TO ADVANCE
FOOD SAFETY
FINAL REPORT APRIL 2020
findings
from the
FOOD SAFETY
WORKSHOP
NIST Special Publication 1251
NIST
Nerisnal Institute of Standards and Technology
U.S. Deportment of Commerce

Microbiological Contaminants	Chemical Contaminants	Allergens	Authenticity & Signature Adulteration
 Repositories for validation data RMs for method verification studies New approaches that reduce analysis time & cost 	 Incurred matrix RMs and PTs Calibration materials (metabolites, isotopically labeled) RMs for metal species 	 Understanding what test are measuring, testing limitations Support for a suite of complementary approaches Commodity and finished product RMs 	 Authentic materials Isotope ratio CRMs Controls for rapid and handheld monitoring Data and repositories and analysis tools



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Karen Andrews Jim Harnly **Kris Patterson** Janet Roseland



Grocerv Manufacturers Association

William Koshute Dan Howell Brent St. Amant

(NIST Federal Employee, NIST Associate, Highlighted staff's work included in this presentation)







For more information,

please contact Katrice A. Lippa <u>katrice.lippa@nist.gov</u>

foodsafety@nist.gov • cannabis@nist.gov

SRM Program Website: https://www.nist.gov/srm

Quality Assurance Program Website: <u>https://qa.nist.gov</u> (Click 'Current Programs') Food Nutrition and Safety Website: https://www.nist.gov/foodsafety

Cannabis Program Website: <u>https://www.nist.gov/programs-projects/nist-tools-cannabis-</u> laboratory-quality-assurance

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