APMP Food safety measurement activities and capacity building for pesticide in China

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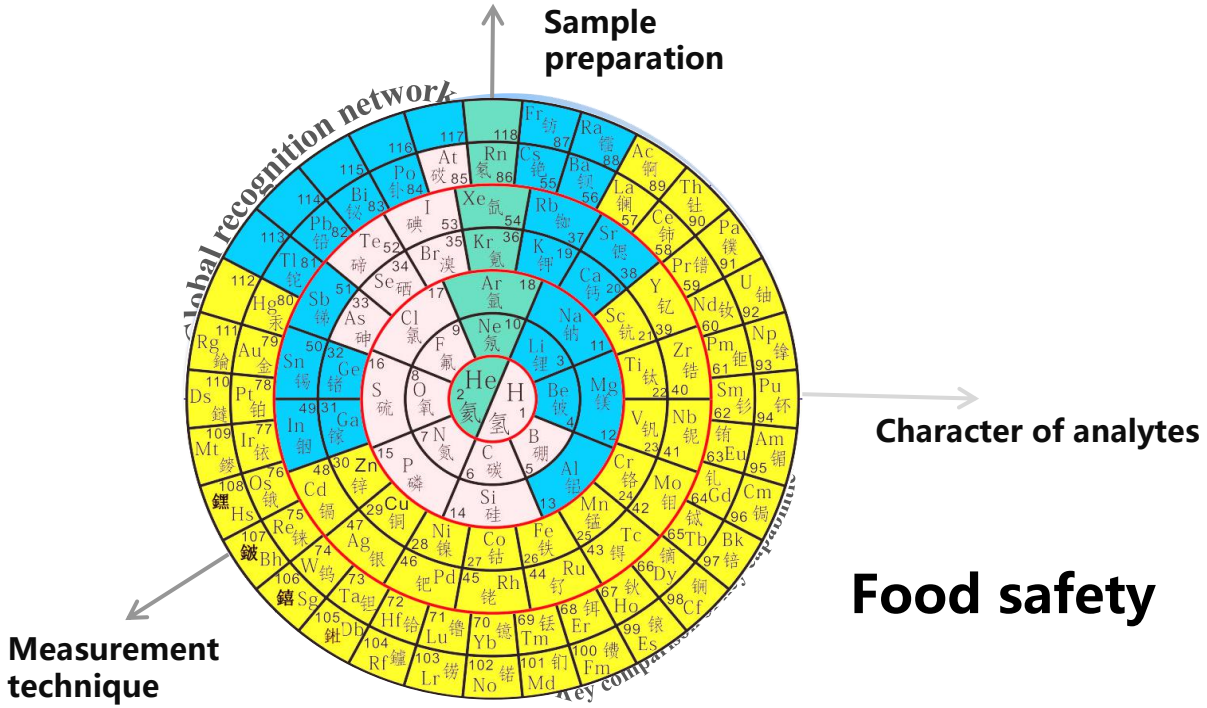
Content

1. Metrological traceability of food safety measurement
2. Activities and achievements in APMP
3. Pesticide CRMs and measurement techniques in NIM
4. Future plan

Tracebility system: massive，multiple and delayering



Content

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2. Activities and Achievements in APMP

15 members:

GLHK (HK China), HSA (Singapore),
KRISS (South Korea), NIM (China), NIMT(Thailand), MSL-IRL (New Zealand),
NIS (Egypt), NMIA (Australia),
NMIJ (Japan), NML-ITDI (Philippines) ,
TISTR (Thailand), NMIM (Malaysia) and CSIRNPL (India)
NRC (Canada), NMISA (South Africa)

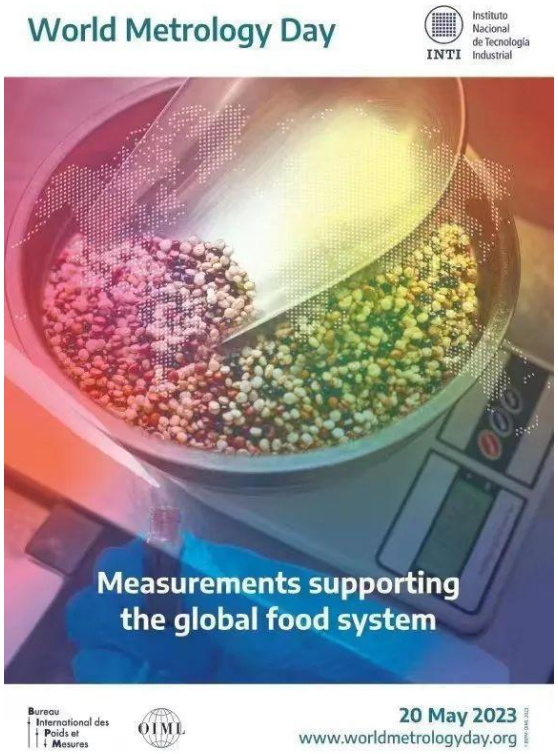
2. Activities and Achievements in APMP

2.1 CCQM is celebrating World Metrology Day on 20 May 2023.

The theme this year is "Measurements supporting the global food system".

The presentation titles from APMP FSFG are as following:

Presentation title	Name	NMIs
Capacity building of pesticide measurement	*Hongmei Li*	*NIM*
Food certified reference materials	*Byungjoo Kim*	*KRISS*
Development of standard solutions for diarrhetic shellfish toxin	*Taichi Yamazaki*	NMIJ
Accuracy-based proficiency testing programmes	*Tang Lin Teo*	*HSA*



2. Activities and Achievements in APMP

2.2. CCQM/TCQM Food Safety Comparisons

CCQM OAWG:

- CCQM-K148.b/CCQM-K179 Purity of oxytetracycline
- CCQM-K148.c purity study of digitoxin
- CCQM-K154 mycotoxin calibration solution
- BIPM capacity building project on organic purity assessment for pesticides and veterinary drugs

TCQM:

- APMP.QM-S16 Fipronil-sulfone in chicken egg powder
- APMP.QM-S19/P40 Toxic elements in seafood
- APMP.QM-P33 Cadmium in milk powder
- APMP.QM-P36 Trace elements in river water

APMP-APAC:

- APAC T111: Event specific quantitative analysis for genetically modified maize of line MON87427
- APAC T112: Non-polar analytes in high carbohydrate food matrix: trans-ZEN in maize powder
- APAC T113: Benzoic Acid in fish sauce

2. Activities and Achievements in APMP

2.3 Stakeholders Engagement： ACRM

ACRM: ***22st Asian Collaboration on Reference Materials (ACRM) meeting will be organized on July 18-21, 2023,in Beijing***

WG1: CRMs for Food Analysis

Technical presentations from Dr. Li Xian Jiang, NIM, "Impurity profiling for neonicotinoid pesticides： the common foundation for MB and qNMR"

Summary of WG1 activity

Status	Number
Finished (finalized)	*20*
Finished (to be finalize)	*2*
In progress	*3*
New proposal	*4*

New proposal

- ✓ Analysis of pesticide residues in husked wheat by QuEChERS method (NMIJ proposed)
- ✓ Perchlorate in infant formula (NIM proposed)
- ✓ Bisphenol A in milk powder (NIM proposed)
- ✓ Multiple nutrients in infant formula (NIM proposed)

2. Activities and Achievements in APMP

2.3 Stakeholders Engagement: BCEIA

BCEIA 2023: ***The 20th Beijing Conference and Exhibition on Instrumental Analysis (BCEIA 2023) will be held on September 6-8, 2023 at China International Exhibition Center (Tianzhu New Hall), Beijing.***

The 'Chemical Metrology & Reference Materials' sub-session was organized by NIM, with Prof. Li Hongmei being the Chair.

Presentation title	Name	Organization
Preparation of Fumonisins Purity Reference Materials	*Dr. Songxue Wang*	*Academy of National Food and Strategic Reserves Administration*
Accelerating the Development of Agricultural Reference Materials, Facilitating High-Quality Advancement of Agriculture in China	*Dr. Liang Li*	*Chinese Academy of Agricultural Sciences*

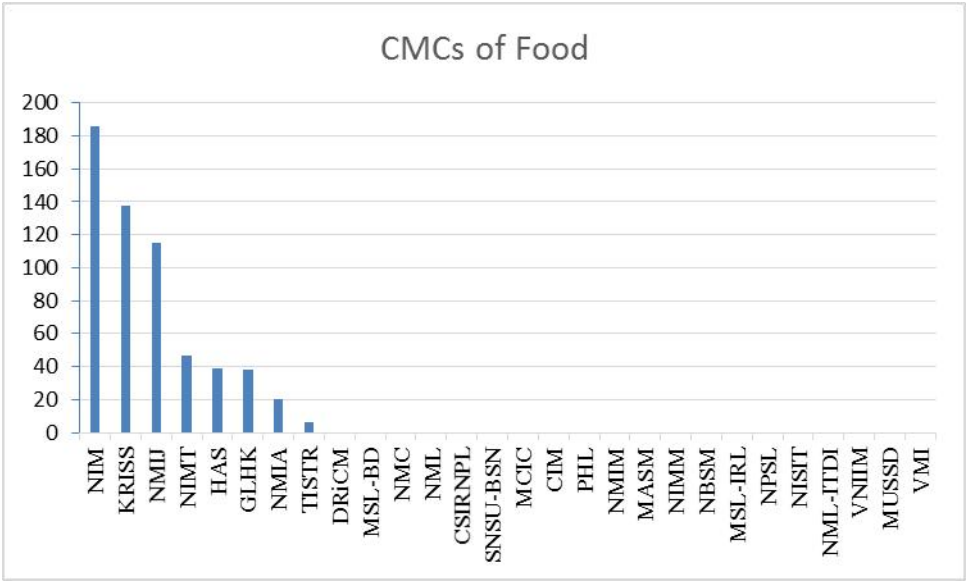
2. Activities and Achievements in APMP

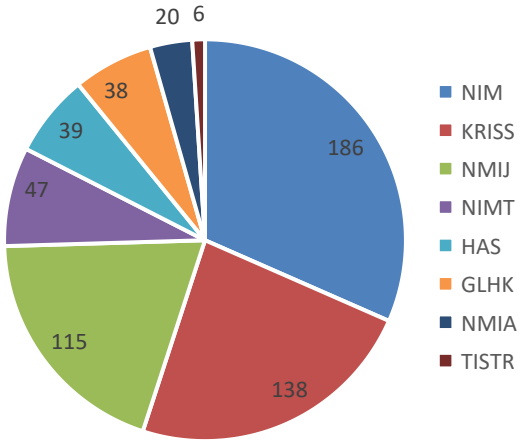
2.4 CMCs from APMP

Calibration and Measurement Capabilities (CMCs)

1, Under CCQM, there were a total of 904 food-related CMCs, while APMP accounted for 589 issued in KCDB.

2, NMIs or DIs with CMC and their number are ranked as: NIM, KRISS, NMIJ, NIMT, HAS, GLHK, NIMA, TISTR.





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1) Food quality and food safety standards in China

➢Food quality standards

- Voluntary, some mandatory however
- Focus on quality items
  - Definition: composition and process
  - Texture and color
  - Nutrition requirements
  - Purity
  - Net weight
  - Analytical methods
  - Food labeling
- Around 5,000 +
- Developed by industry association, approved by SAC (Standard Administration Commission)

➢Food safety standards

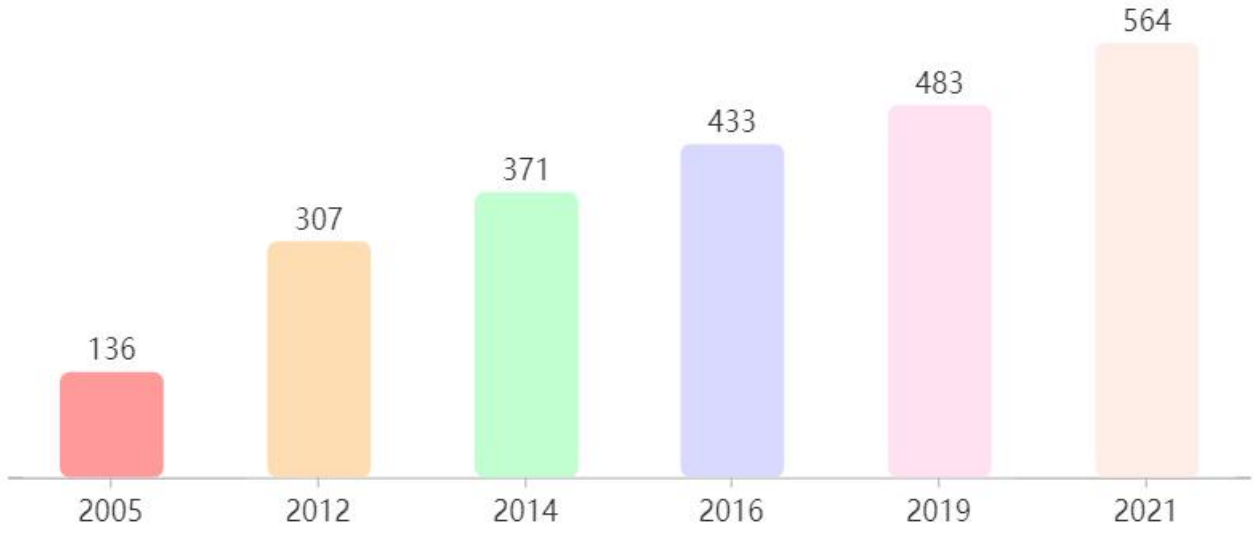
- Mandatory
- Focus on safety aspects
  - Contaminants
  - Pathogens
  - Pesticide residues
  - Veterinary drugs
  - Food additives
  - Good manufacturing practices
  - Analytical methods
  - Food labeling
- Around 1,000 +
- Issued by NHC (National Health Commission)

National Food Safety Standards System in China

- ✓ Horizontal standards 13
- ✓ Product standards 70
- ✓ Special dietary food standards 10
- ✓ Food Additive specifications 646
- ✓ Nutritional fortification 53
- ✓ Substances specifications 29
- ✓ Food related product standard 15
- ✓ Good practices 34
- ✓ Physical-chemical detection Method 234
- ✓ Microbiological detection Method 32
- ✓ Toxicology detection Method 29
- ✓ Pesticide residue detection Method 120
- ✓ Veterinary drug residue 74
- ✓ Detection Method 29

National food safety standards development

GB2763-maximum residue limits for pesticides in foods



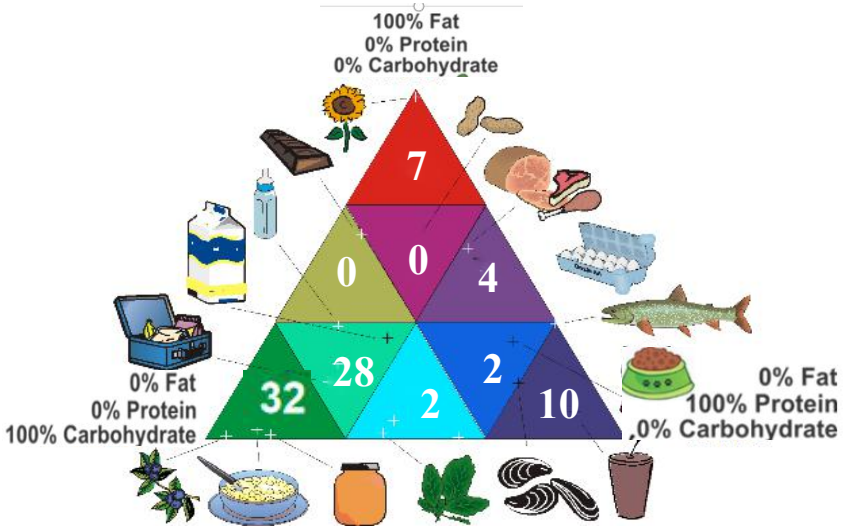
- GB2763-2021 stipulates **10092** items of MRLs from **564** pesticides in 376 food matrix. Compared with the 2019, 81 pesticides and 2985 items of MRLs were added.
- approved 428 kinds of registered pesticides, 49 prohibited pesticides, 87 pesticides that have not been registered, and 44 kinds of low-risk pesticides.

2) Food-related CRMs produced by NIM

China's food safety RM system & strategy for future development

1、Food safety RMs system

NIM has 661 food-related RMs, of which 128 are matrix RMs, 269 are purity RMs and 264 are solution RMs.

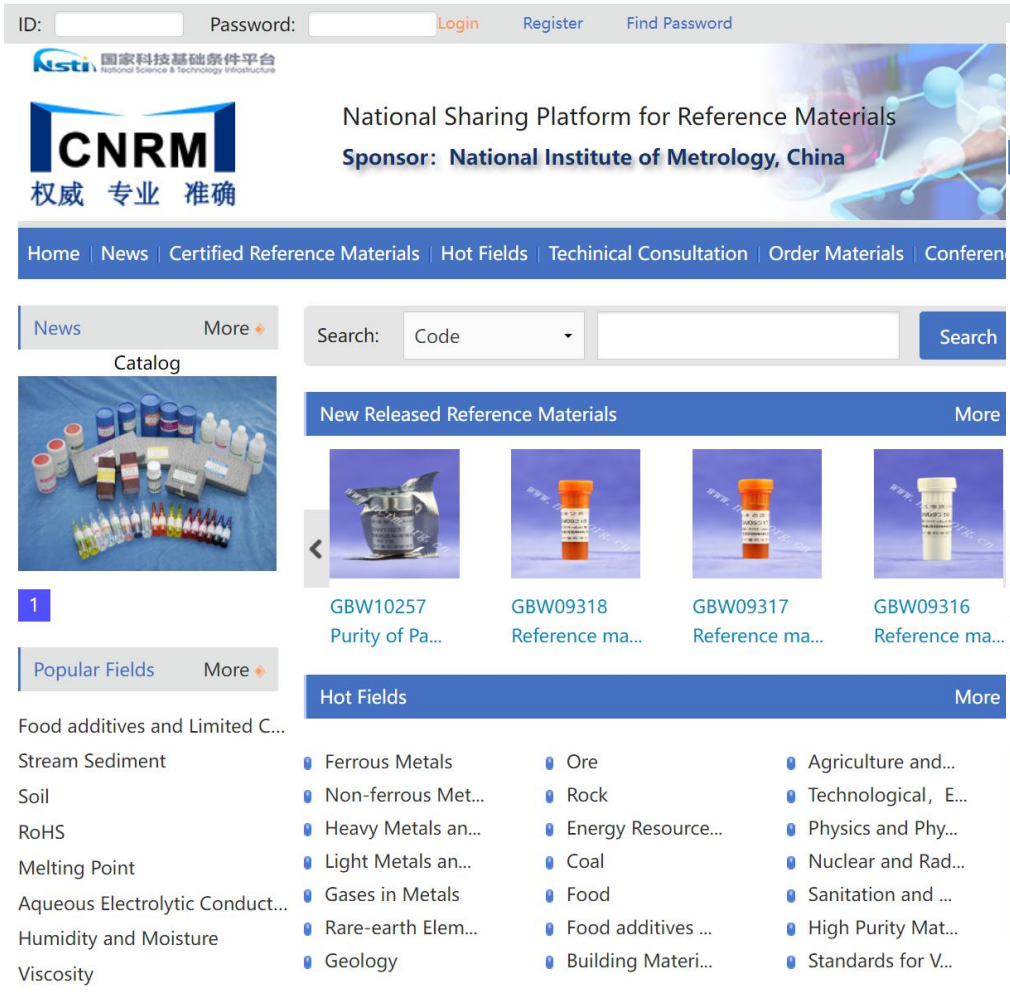


Distribution of NIM Food matrix RMs in food safety area

CRMs produced by NIM

National Sharing Platform for Reference Materials

https://www.ncrm.org.cn/



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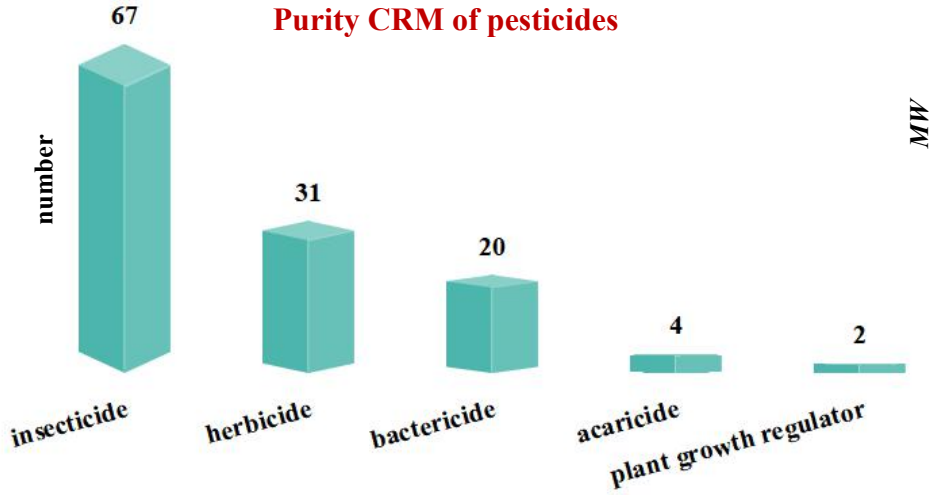
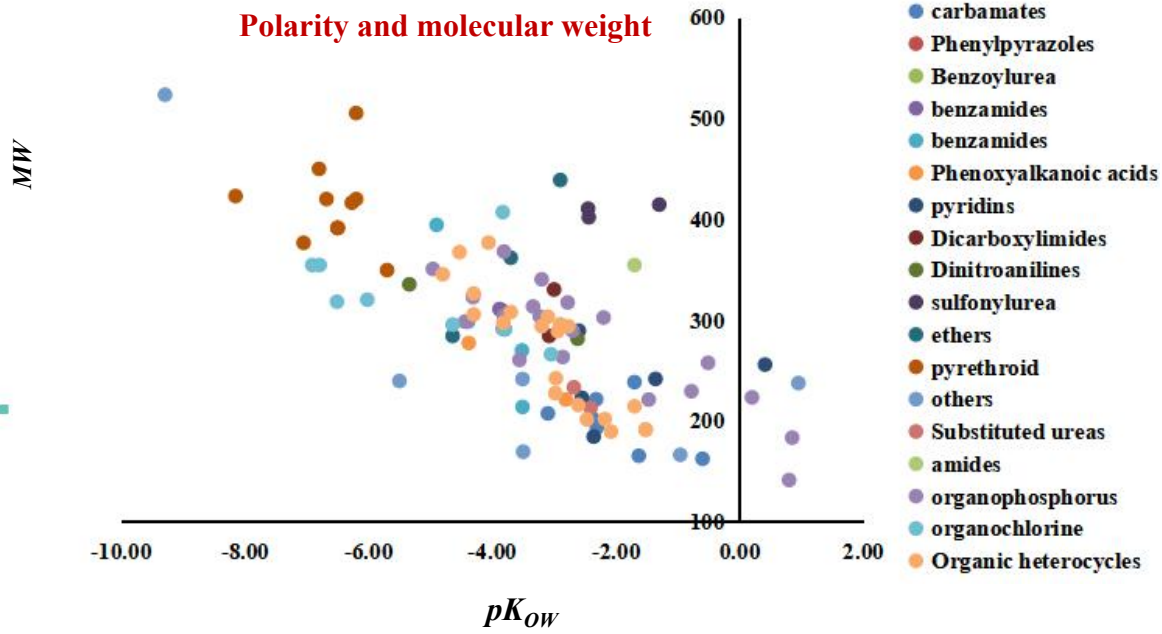
Pesticide CRMs produced by NIM

Pure CRMs produced by NIM

124 purity CRMs, 70 solution CRMs





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Pesticide CRMs produced by NIM

Purity CRMs

CRM NO.	Name	CAS号	purity (%)	*U* （%，k=2）
GBW(E)060007	Trichlorfon	52-68-6	99.8	0.3
GBW(E)060008	Metolcarb	1129-41-5	99.7	0.3
GBW(E)060009	Methamidophos	10265-92-6	100	0.3
GBW(E)060134	Parathion	56-38-2	99.6	0.5
GBW(E)060135	Dichlorvos	62-73-7	98.7	1
GBW(E)060136	Dimethoate	60-51-5	99.3	0.6
GBW(E)060138	Deltamethrin	52918-63-5	99.6	0.4
GBW(E)060139	Cypermethrin	52315-07-8	99.8	0.2
GBW(E)060140	Fenvalerate	51630-58-1	99.6	0.2
GBW(E)060223	Carbaryl	63-25-2	99.8	0.3
GBW(E)060224	Isoprocarb	2631-40-5	99.8	0.3
GBW(E)060225	Carbofuran	1563-66-2	99.7	0.4
GBW(E)060543	Monocrotophos	6923-22-4	99.9	0.2
GBW(E)060544	Isocarbophos	24353-61-5	99.4	0.5
GBW(E)060545	Fenamiphos	22224-92-6	99.4	0.5
GBW(E)060546	Methomyl	16752-77-5	99.9	0.5
GBW(E)060547	Buprofezine	69327-76-0	99.5	0.5
GBW(E)060548	Bifenthrin	82657-04-3	99.6	0.5
GBW(E)060549	Permethrin	52645-53-1	99.6	0.3
GBW(E)060550	Amitraz	33089-61-1	99.9	0.5
GBW(E)060551	Paclobutrazol	76738-62-0	99.7	0.5
GBW(E)060552	2,4-D	94-75-7	99.4	0.5
GBW(E)060613	Nitrofen	1836-75-5	99.9	0.4
GBW(E)060614	Prometryn	7287-19-6	99.7	0.3
GBW(E)060615	Atrazine	1912-24-9	96.4	0.7
GBW(E)060616	2,4-D butylate	94-80-4	99.2	0.3
GBW(E)060617	Pentachloronitrobenzene	82-68-8	99.5	0.3
GBW(E)060618	Triadimefon	43121-43-3	99.8	0.4
GBW(E)060619	Chlorothalonil	1897-45-6	99.8	0.4
GBW(E)060870	Methidathion	950-37-8	99.8	0.3
GBW(E)060871	Chlorpyrifos	2921-88-2	99.8	0.3
GBW(E)060872	Fomesafen	72178-02-0	99.7	0.5

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GBW(E)060007	Trichlorfon	52-68-6	99.8	0.3
GBW(E)060008	Metolcarb	1129-41-5	99.7	0.3
GBW(E)060009	Methamidophos	10265-92-6	100	0.3
GBW(E)060134	Parathion	56-38-2	99.6	0.5
GBW(E)060135	Dichlorvos	62-73-7	98.7	1
GBW(E)060136	Dimethoate	60-51-5	99.3	0.6
GBW(E)060138	Deltamethrin	52918-63-5	99.6	0.4
GBW(E)060139	Cypermethrin	52315-07-8	99.8	0.2
GBW(E)060140	Fenvalerate	51630-58-1	99.6	0.2
GBW(E)060223	Carbaryl	63-25-2	99.8	0.3
GBW(E)060224	Isoprocarb	2631-40-5	99.8	0.3
GBW(E)060225	Carbofuran	1563-66-2	99.7	0.4
GBW(E)060543	Monocrotophos	6923-22-4	99.9	0.2
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GBW(E)060616	2,4-D butylate	94-80-4	99.2	0.3
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GBW(E)060618	Triadimefon	43121-43-3	99.8	0.4
GBW(E)060619	Chlorothalonil	1897-45-6	99.8	0.4
GBW(E)060870	Methidathion	950-37-8	99.8	0.3
GBW(E)060871	Chlorpyrifos	2921-88-2	99.8	0.3
GBW(E)060872	Fomesafen	72178-02-0	99.7	0.5

Pesticide CRMs produced by NIM

Solution CRMs

CRM No.	Name	Concentration (μg/ml)	*U* (%, k=2)
GBW(E)060081	α-BHC in Methanol/Toluene (4:1)	50	1
GBW(E)060082	β-BHC in Methanol/Toluene (4:1)	50	1
GBW(E)060083	γ-BHC in Methanol/Toluene (4:1)	50	1
GBW(E)060084	δ-BHC in Methanol/Toluene (4:1)	50	1
GBW(E)060102	p,p'-DDT in Toluene/Methanol	50	1
GBW(E)060103	o,p'-DDT in Toluene/Methanol	50	1
GBW(E)060104	p,p'-DDE in Toluene/Methanol	50	1
GBW(E)060105	p,p'-DDD in Toluene/Methanol	50	1
GBW(E)060133	Organochlorine Pesticides Mixture	50	2
GBW(E)061387	Fenbuconazole in Methanol	0.10	4
GBW(E)061388	Isoprothiolane in Methanol	0.10	4
GBW(E)061389	Anilazine in Acetonitrile	1.00	1
GBW(E)061390	Flusilazole in Methanol	1.00	2
GBW(E)061391	Fenarimol in Methanol	0.10	5
GBW(E)061392	Propiconazol in Methanol	1.00	4
GBW(E)061393	Imidacloprid in Methanol	1.00	1
GBW(E)061394	Benfuracarb in Methanol	0.10	4
GBW(E)061395	Phenthoate in Methanol	0.10	4
GBW(E)061396	Carbosulfan in Methanol	1.00	4
GBW(E)061397	Diazinon in Methanol	1.00	4
GBW(E)061398	Phosalone in Acetone	0.10	5
GBW(E)061399	Methamidophos in Methanol	1.00	2
GBW(E)061400	Phorate in Methanol	1.00	2
GBW(E)061401	Pirimiphos-methyl in Methanol	0.10	5
GBW(E)061402	Malathion in Methanol	1.00	4
GBW(E)061403	Triazophos in Acetone	1.00	2
GBW(E)061404	Methidathion in Methanol	1.00	1/2
GBW(E)061405	Phoxim in Methanol	1.00	1/4
GBW(E)061406	Bromopropylate in Methanol	1.00	3
GBW(E)061407	Ethion in Methanol	0.10	5
GBW(E)061408	Acephate in Acetone	1.00	1/2
GBW(E)061409	Propanil in Methanol	0.10	4
GBW(E)061410	Propanil in Methanol	1.00	2
GBW(E)061411	Pretilachlor in Methanol	1.00	4

CRM No.	Name	Concentration (μg/ml)	*U* (%, k=2)
GBW(E)061412	Butachlor in Methanol	0.10	5
GBW(E)061413	Molinate in Methanol	1.00	4
GBW(E)061414	Fluazifop-P-butyl in Acetonitrile	1.00	4
GBW(E)061415	Bentazone in Acetonitrile	1.00	2
GBW(E)080482	Parathion-methyl in Methanol	1.00	4
GBW(E)080483	Dichlorvos in Methanol	1.00	4
GBW(E)080484	Trichlorfon in Methanol	1.00	4
GBW(E)080485	Parathion in Methanol	1.00	4
GBW(E)080486	Dimethoate in Methanol	1.00	4
GBW(E)081141	Chlorpyrifos in Methanol	1.00	1/4
GBW(E)081142	Monocrotophos in Methanol	1.00	1/4
GBW(E)081143	Acephate in Methanol	1.00	4
GBW(E)081144	Fenamiphos in Methanol	1.00	1
GBW(E)082211	8 Organochlorine Pesticides in	1	3
GBW(E)083347	6 Organophosphorus Pesticides in	100	5
BW3469-2	Fenitrothion in Methanol	1.00	4
BW3553	Vamidothion in Methanol	0.10	5
BW3564	Hexythiazox in Methanol	1.00	4
BW3566	Fenobucarb in Methanol	1.00	4
BW3567	Fenthion in Methanol	1.00	4
BW3571	Metolachlor in Methanol	1.00	4
BW3572	Cadusafos in Methanol	1.00	4
BW3574	Propargite in Acetonitrile	1.00	4
BW3575	Ethoprophos in Methanol	1.00	4
BW3577	Aldicarb in Methanol	0.10	5
BW3578	Tau-fluvalinate in Acetonitrile	1.00	5
BW3580	Fluazifop-butyl in Methanol	0.10	5
BW3582	Dicofol in Methanol	1.00	5
BW3583	Edifenphos in Methanol	0.10	5
BW3584	Flucythrinate in Methanol	1.00	5
BW3701	7 Organochlorine Pesticides in	0.288~0.485	2.4~4.6
BW3702	15 Organochlorine Pesticides in	0.3	2.4~4.6
BW3703	Indutrial Chlordane in Isooctane	98.9~476	5.0~13.6
BW3704	Indutrial Toxaphene in Isooctane	10	10
BW3705	5 Organochlorine Pesticides in	0.3	2.6~4.6

Pesticide CRMs produced by NIM

Matrix CRMs

Leek Powder for 24 Pesticide Residues Analysis

Leek

100% Fat
% Protein
0% Carbohydrate

Fipronil-sulfone in **Chicken Egg Powder**

GBW 10217
Chicken Egg Powder

Cucumber Powder for 24 Pesticide Residues Analysis

GBW 100925/100926/100927
Cucumber

GBW(E)100129
Spanish Mackerel

8 OCPs in **Spanish Mackerel**

0% Fat
0% Protein
100% Carbohydrate

Pyrethroid Pesticides in **Apple Juice**

GBW 10084
Apple Juice

Cabbage

GBW 10083
Tea

Pesticides and Elements in **Tea**

0% Fat
100% Protein
0% Carbohydrate

GBW 10069
Mussel

Organochlorine pesticides and PCBs in Mussel

Cabbage Powder for 18 Pesticide Residues Analysis

supported by National Key Research and Development Project (2019YFC1604800) —"Development of Common Key Technologies for Preparation of Food Matrix Reference materials and International Mutual Recognition"

MOST

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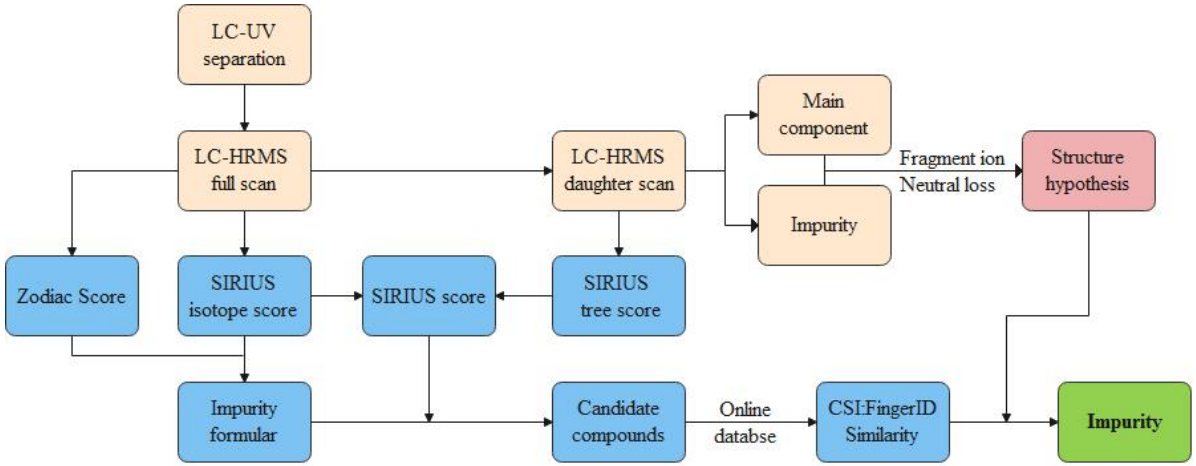
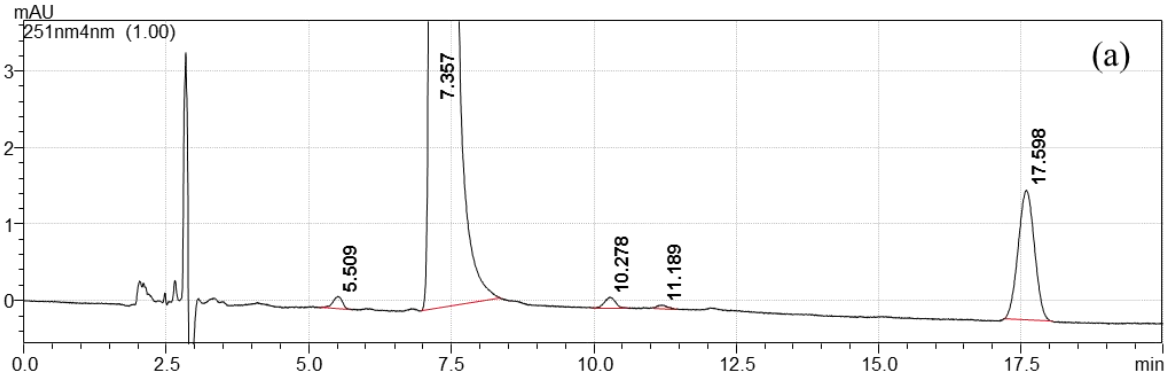
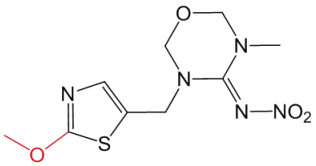
3) Pesticides Measurement techniques

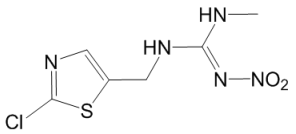
① Impurity profiling of structural related impurities in pesticides by orbitrap and de novo identification tool



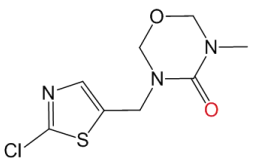




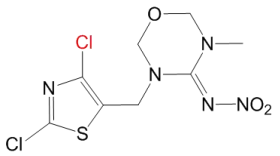
Impurity 1
$C_9H_{13}N_5O_4S$
TMX-OCH_3



Impurity 2
$C_6H_8N_5O_2SCl$
CLO



Impurity 3
$C_8H_{10}N_3O_2SCl$
TMX-urea



Impurity 4
$C_8H_9N_5O_3SCl_2$
TMX-Cl

***Anal. Bioanal. Chem.* 2022,** *414* (24), 7203-7210.
***Microchem. J.* 2023,** *193*, 109123. ***Microchem. J.* 2023,** *191*, 108874.
***Molecules* 2022**, *27* (16), 5251. ***Molecules* 2023**, *28* (9), 3884.

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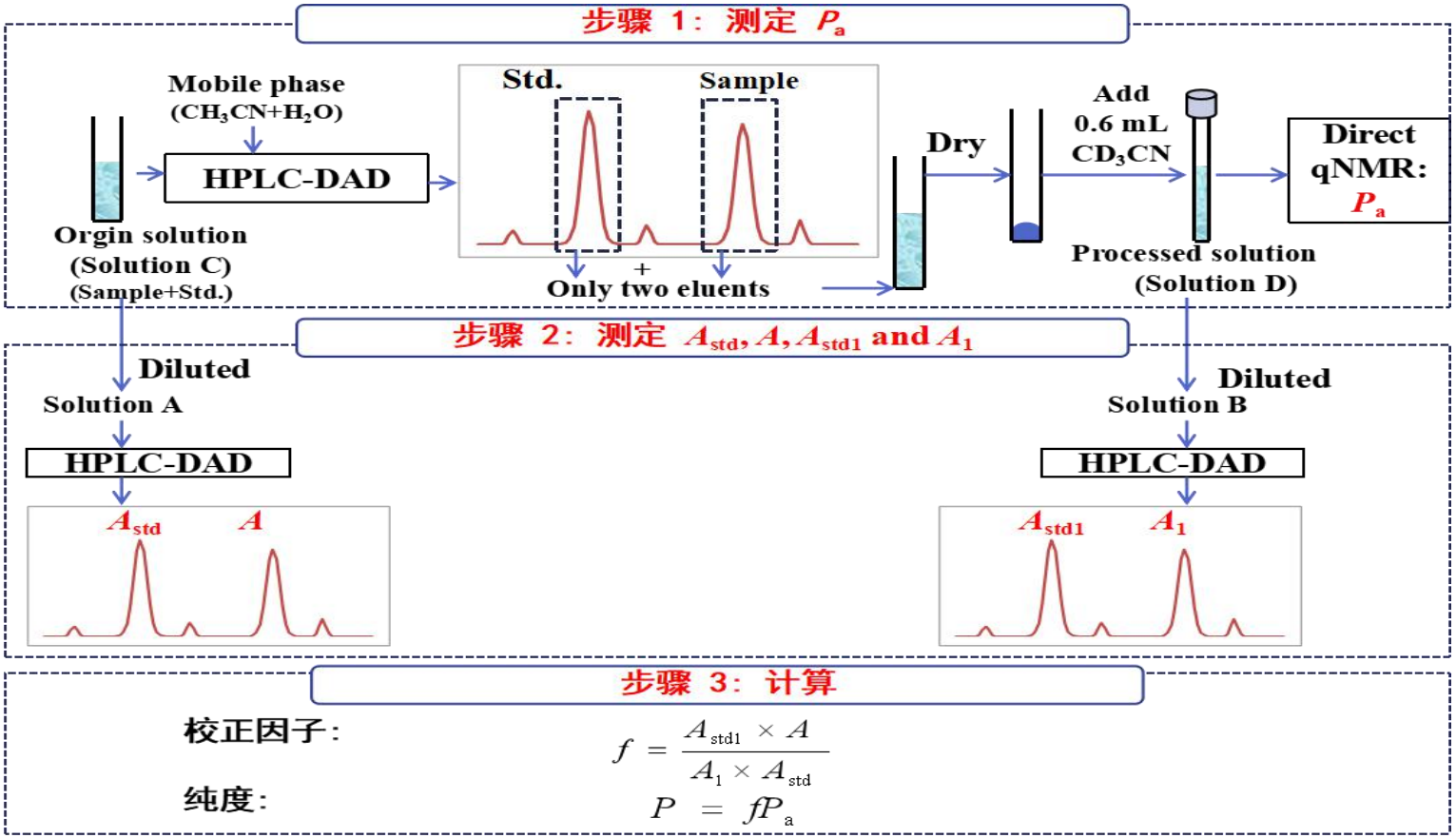
3) Pesticides Measurement techniques

② Impurity profiling of structural related impurities in pesticides

Internal standard recovery correction qNMR quantification



Isomer impurity measurement deviation decreased from

8.0% to 0.2%

Talanta 2017, 172, 78–85. *Anal. Bioanal. Chem.* 2020, *412* (25), 6983-6993.

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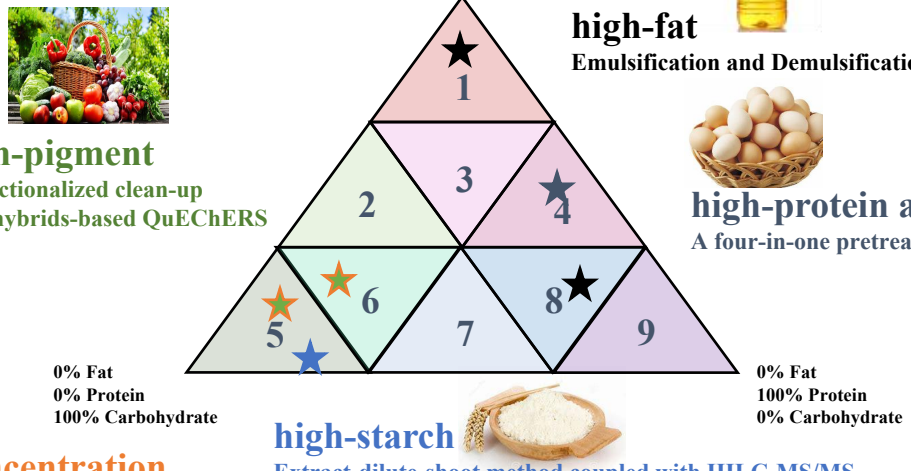
Pesticides Measurement techniques

Methods for pesticide residues



high-pigment
A functionalized clean-up nanohybrids-based QuEChERS

high-fat
Emulsification and Demulsification strategy

high-protein and fat
A four-in-one pretreatment method

high-starch
Extract-dilute-shoot method coupled with HILC-MS/MS

low concentration
Self-Assembled Three-Dimensional nanomaterial based MSPE
Single-drop LLLmicroextraction coupled with LC-MS/MS

Food Chem. 2022, 379, 132098.
J. Chromatogr. A 2020, 1631, 461526
Food Chem. 2022, 387, 132935.
Food Chem. 2023, 406, 135030.

Trends Anal. Chem. 2020, 131, 116015
Appl. Sci. 2020, 10(16), 5665.
Foods 2023, 12 (4), 699.
Separations 2021, 8 (11), 197.

Patent
ZL 2020 1 0037758.8
ZL 2019 1 1032295.X
CN202210017714.8

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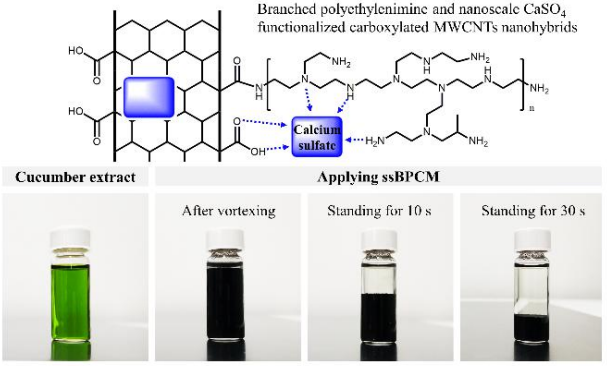
Pesticides Measurement techniques

Development of new nanomaterials and pretreatment methods

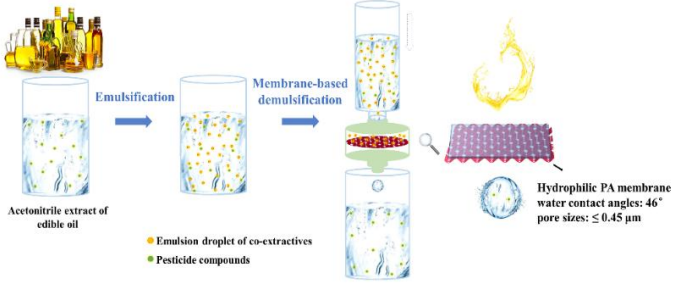
- **Method 1：A functionalized nanohybrids-based QuEChERS method, the first self-separating clean-up material without sample loss**
- **Technical difficulty: Multi-class analysis and matrix interference in high-pigment samples**



Patent.：ZL 2020 1 0037758.8

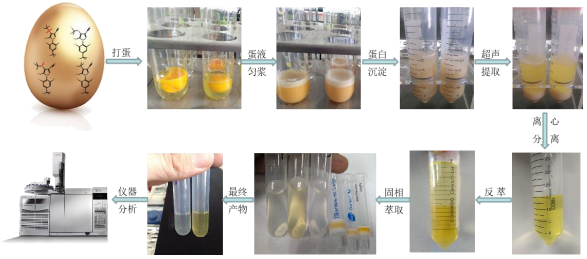
J. Chromatogr. A **2020**, *1631, 461526*

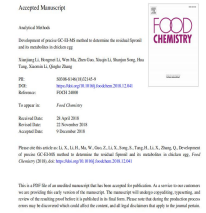
- **Method 2：Emulsification and Demulsification Method，the first application of water-oil separation for the edible oils**
- **Technical difficulty：Multi-class analysis and matrix interference in high-fat samples**



Food Chem. 2022, 379, 132098.

- **Method 3：A four-in-one pretreatment method，the first GC-EI-MS method**
- **Technical difficulty：Multi-class analysis and matrix interference in high-protein and fat samples**





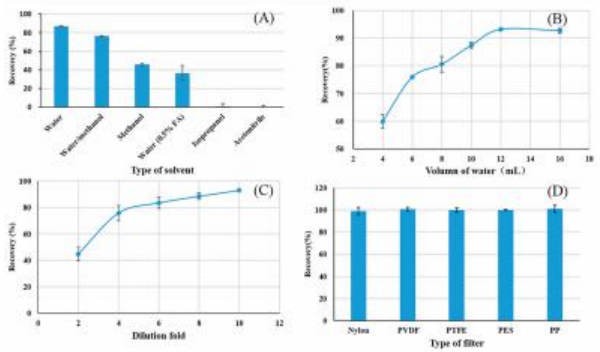
CRM: fipronil in egg powder

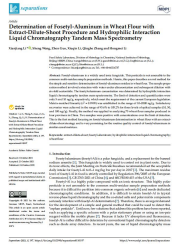
Food Chem. **2019**, 281, 85-90.

Pesticides Measurement techniques

Development of new nanomaterials and pretreatment methods

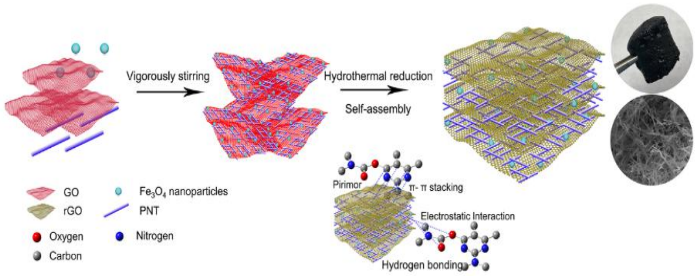
- Key technique 4：Extract-dilute-shoot method coupled with hydrophilic interaction LC-MS/MS method, accurate and sensitive
- Technical difficulty：Analysis of ionic type of pesticides in high-starch samples





Separations, 2021, 8(11): 197

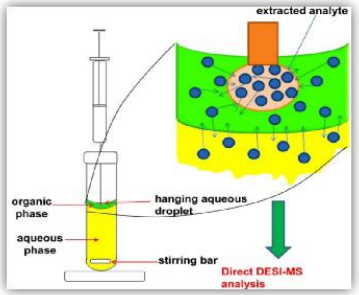
- Key technique 5：Self-Assembled Three-Dimensional nanomaterial based magnetic solid phase method. Sensitivity: ppt
- Technicall difficulty：Analysis of Multi-class residues in low concentration

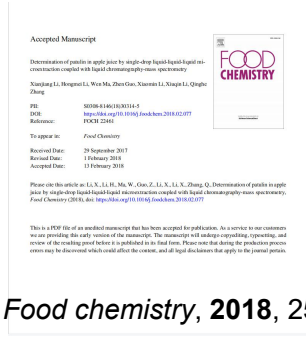


Patent: ZL 2019 1 1032295.X

Appl. Sci. **2020**, 10(16), 5665.

- Key technique 6：Single-drop liquid-liquid-liquid microextraction coupled with liquid chromatography-mass spectrometry.
- Technical difficulty：Residue analyses in low concentration

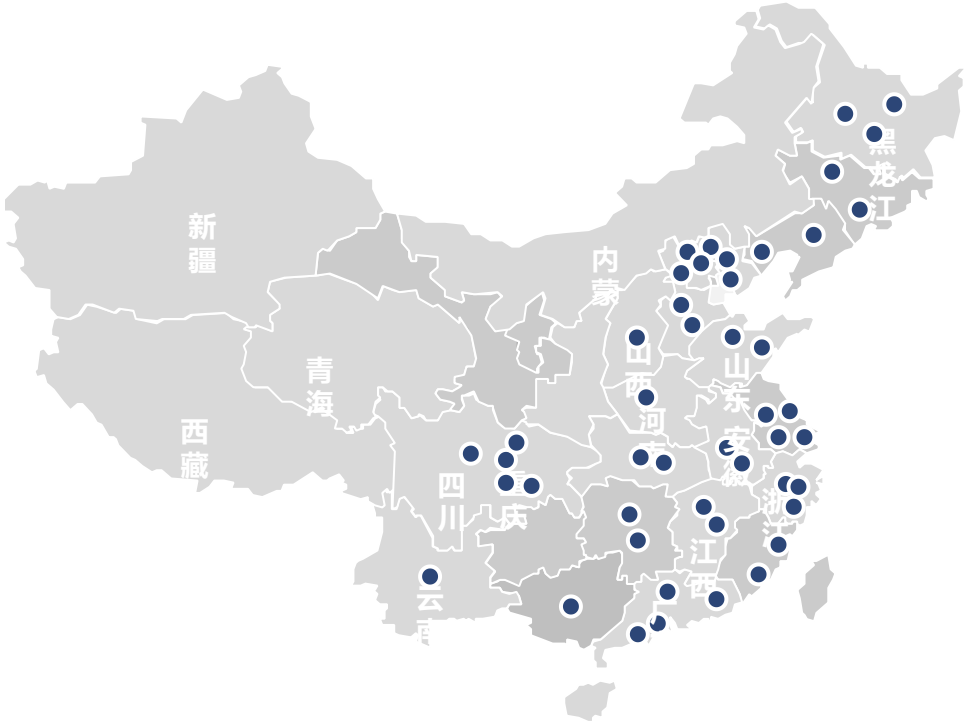


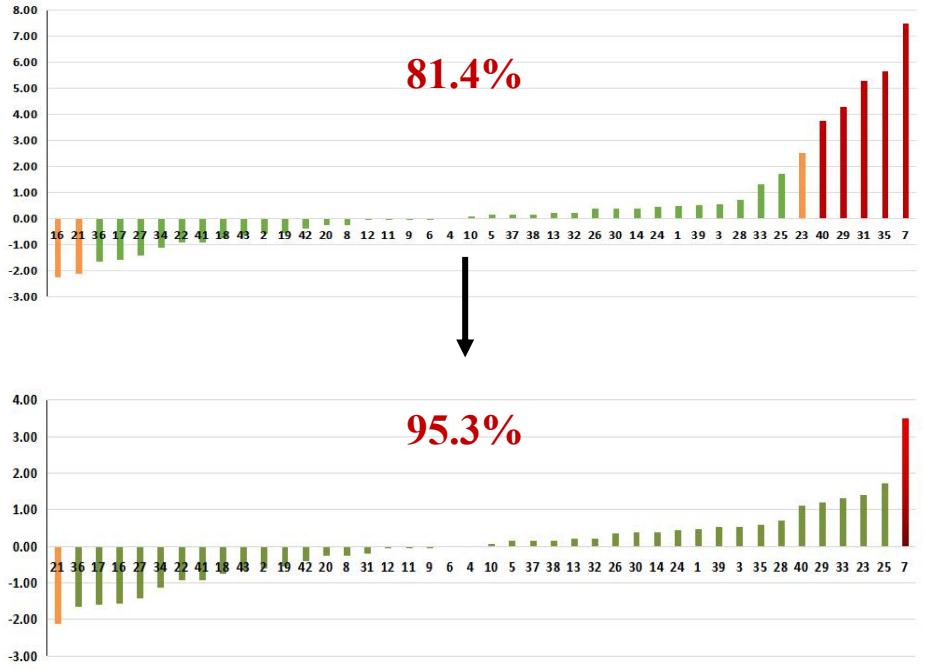


Food chemistry, **2018**, 257, 1-6.

4) Applications

The application of pesticide RMs significantly improves the accuracy of laboratory test results





Blind sample assessment & proficiency testing：over 600 labs in 20 provinces/cities in China
Qulified rate for pesticide residues blind sample assessment: 81.4 % to 95.3%

4) Applications

Support the promotion of national standardization and widely used in test labs

- widely used in nearly 1,000 food safety inspection laboratories
- Provide measurement standards for 31 provinces/cities in China

Content

1. Metrological traceability of food safety measurement
2. Activities and Achievements in APMP
3. Pesticide CRMs and Measurement techniques in NIM
4. Future Plan

Future expectations

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Combined with international hot spots and national strategies, innovative traceability technology in key food areas

《CIPM 2030+ Strategy》
Seven emerging metrological needs: Health and Life Sciences, food safety

《National nutrition program 2017-2030》
《Outline of Healthy China 2030 Plan》
National strategy

Central Committee《Proposals for formulating the 14th Five-Year Plan for National Economic and Social Development and the long-range goals for 2035》
Special action on disease prevention and health promotion

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Key research areas

- Pesticides
- Functional nutrients
- Biosynthesis of new foods

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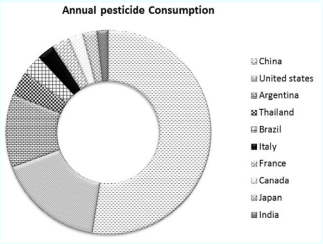
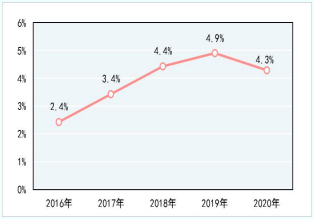
1. Focus on pesticides-realted generic tracibility techniques

Pesticide residue has become a hot topic of social concern in China





- ✓ Pesticide use in crop in China exceeds the world's total by **50%, ranking first**
- ✓ 2020, unqualified food for pesticide residues in the national risk supervision and inspection **ranked first (35.3%)**.
- ✓ 2012-19 National survey of pesticide residues in fruits, vegetables and tea, according to the European Union and Japan MRL standards, the pass rate was only **58.7%** and **63.2%**
- ✓ 《The Outline of the "Healthy China 2030" Plan》, the CPC Central Committee, State Council stressed efforts to control pesticide and veterinary drug residues

"Massive" detection demand

- ✓ 2022, more than 3,400 food detection institutions, with a testing scale of **92.7 billion** RMB
- ✓ More than **1,200** risk monitoring institutions, with an annual investment of **420 million** RMB
- ✓ National risk supervision and inspection **6.38 million** batches
- ✓ Detection of pesticide residues is the **key** content

Future expectations

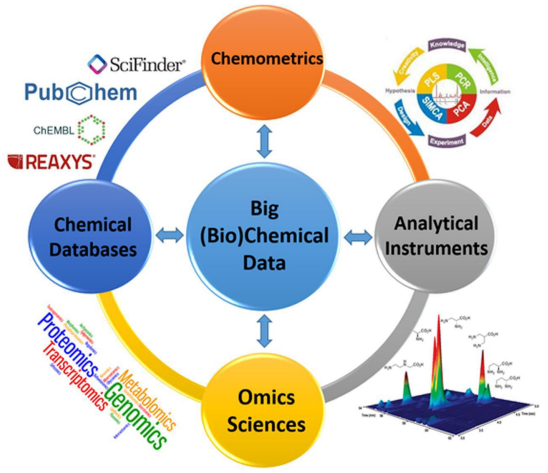
1. Focus on pesticides-realted generic tracibility techniques

Pretreatment techniques	Measurement techniques	Reference material development	International mutual recognition	Application
Key technology				
• Selective clean-up • Efficient enrichment • Automate	• Impurity identification using AI algorithm • Matrix effect evaluation • Digital correction	• Multiple target • Digitized full spectrum	• International comparison	• Proficiency testing • Lab assessment

✓ **Multiple target, technical characteristics, high throughput, high sensitivity**

✓ 1. Modern chemical measurements combining analytical instruments, chemical databases, computational chemistry, and omics techniques

✓ 2. Target analysis and non-target screening, multi-technology method data analysis, etc



✓ **Digitized full spectrum reference material**

✓ 1. Standard value - Reference value - Information value

✓ 2. Full spectrum information Library - qualitative identification and quantitative measurement

Future expectations

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2. Focus on nutrition and health

National strategic planning

2016, 《the Outline of the "Healthy China 2030" Plan》, raise the national health to the national strategic level.

2017, 《the National Nutrition Plan (2017-2030)》, accelerate the transformation of agriculture, food processing industry and catering industry to nutrition

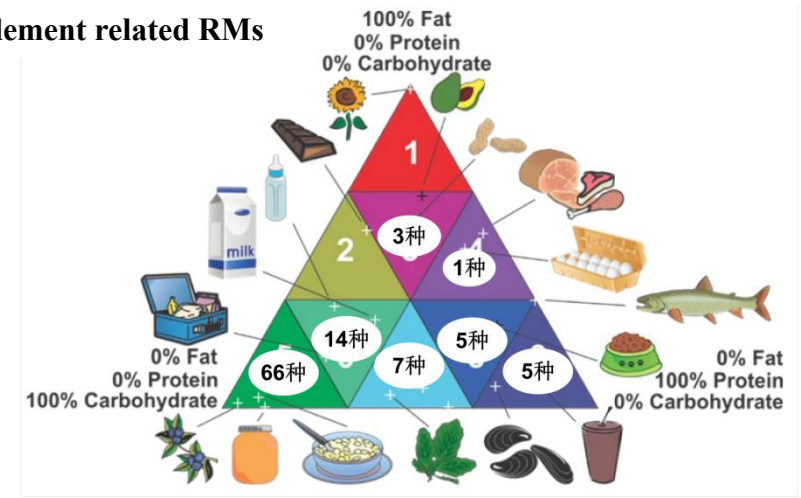
2022, 《The 14th Five-Year Plan for Food Science and Technology》, focus on nutrition targeting design, precision manufacturing of healthy food

Future expectations

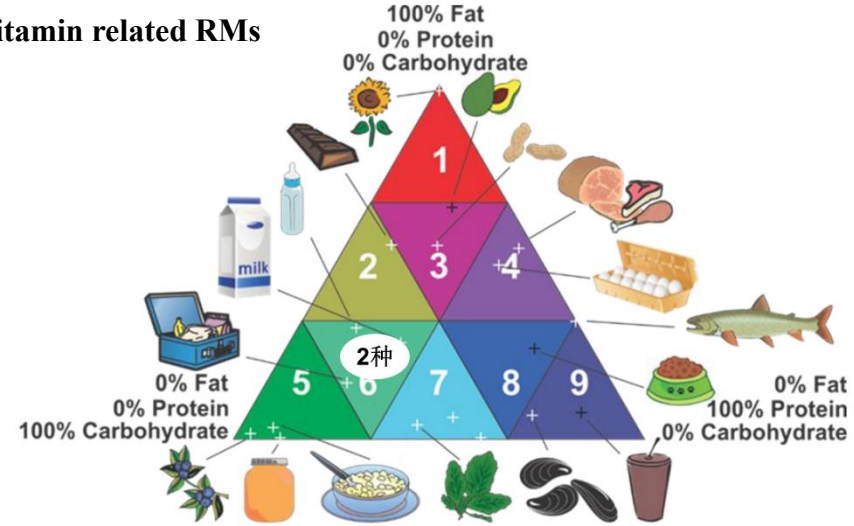
2. Focus on nutrition and health

As of 2022, there are 132 kinds of nutrient-related matrix reference materials in China, including edible oils, fruits and vegetables, cereals and potatoes, eggs, dairy products, aquatic products, livestock and poultry meat.

Element related RMs



Vitamin related RMs



- **80% of RMs are elements-related, and repeated development was common**

① **The high-fat and high-protein in regions AOAC triangle are less studied**

② **Vitamin, fatty acids in complex food matrix are less studied**

③ **The matrix variety and analyte target number is small**

3. Focus on biosynthesis of new foods

New foods driven by synthetic biology

Type	Paraphrase	Project type
Replacement protein	Substitution of animal protein sources by food technology	• Cell culture meat • Microbial fermentation protein: such as yeast protein • Artificial milk: such as whey protein, loprotein • Myoglobin • Fish meat
Food additives	Chemical synthetic or natural substances that improve the quality of food	• Sweetener: erythritol, stevioside, aloxone • Sky protein: Somatame • Nutritional fortifier: breast milk oligosaccharides • Pigment: Carotene, anthocyanin • Vitamin: vitamin E • Others: Antioxidants, preservatives
New food raw material	Newly developed food raw materials without traditional eating habits	• Hyaluronic acid, pseudochlorella, Chlamydomonas Rhine
Funtional food raw material	A food component that nourishes or regulates physiological activity	Ginsenosides, collagen, ergothionein

Present (-2022)	Short term (2023-2030)	Mid term (2030-2040)	Long term (2040-)
• Food additive production • Genetically engineered crop • Food traceability	• Replacement protein • Products based on microalgae • Microbiome application	• Functional nutrient component • Cell culture meat • Food quality control • Reduce carbon emissions	• Enhance the products of photosynthesis

THANK YOU

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