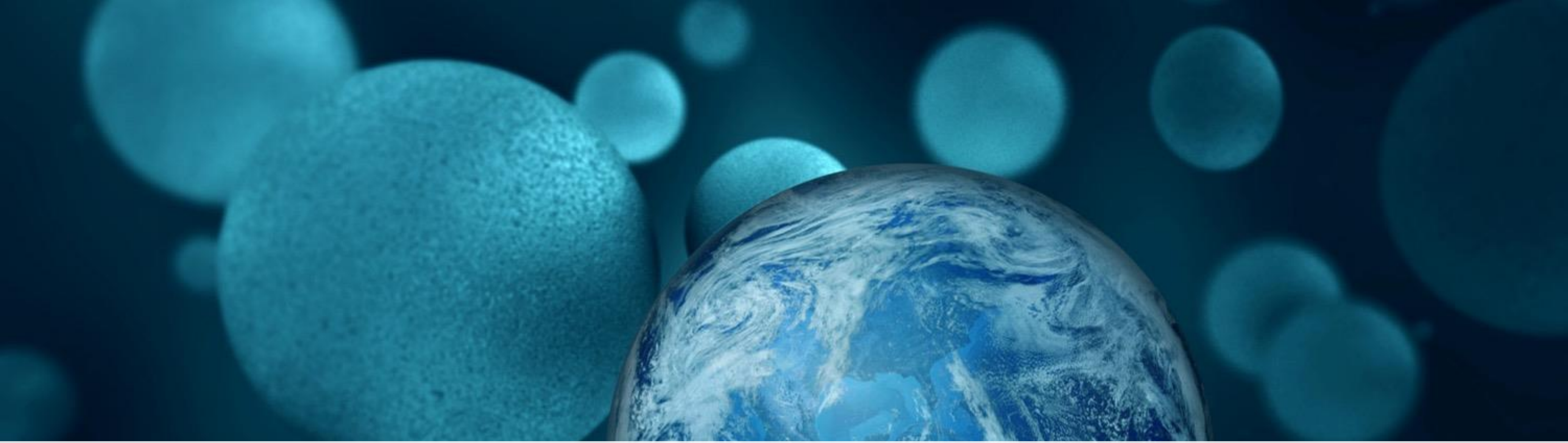

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Inductively Coupled Plasma – Mass Spectrometry

Piyush Deokar, Ph. D.
Product Manager – TEA & IOMS (CHNS)

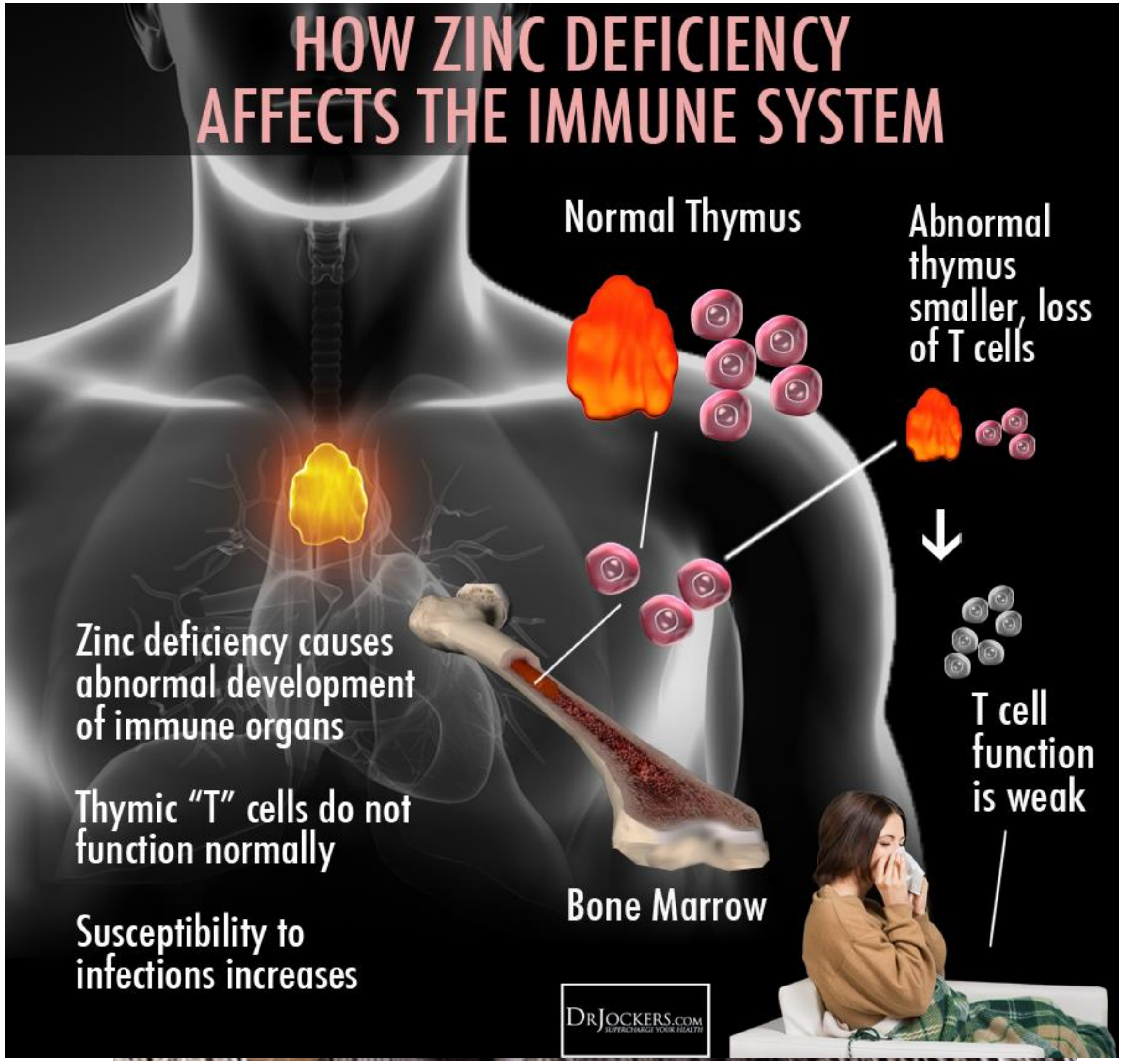
Suresh Murugesan
Application Development Scientist,
Food Safety Solution Center (FSSC) Ghaziabad- India

Agenda

1. Elemental Analysis & Sample Preparation
2. Basics of ICP-MS
3. Interference Removal
4. Speciation Studies
5. Application

Minerals in Day to Day Life

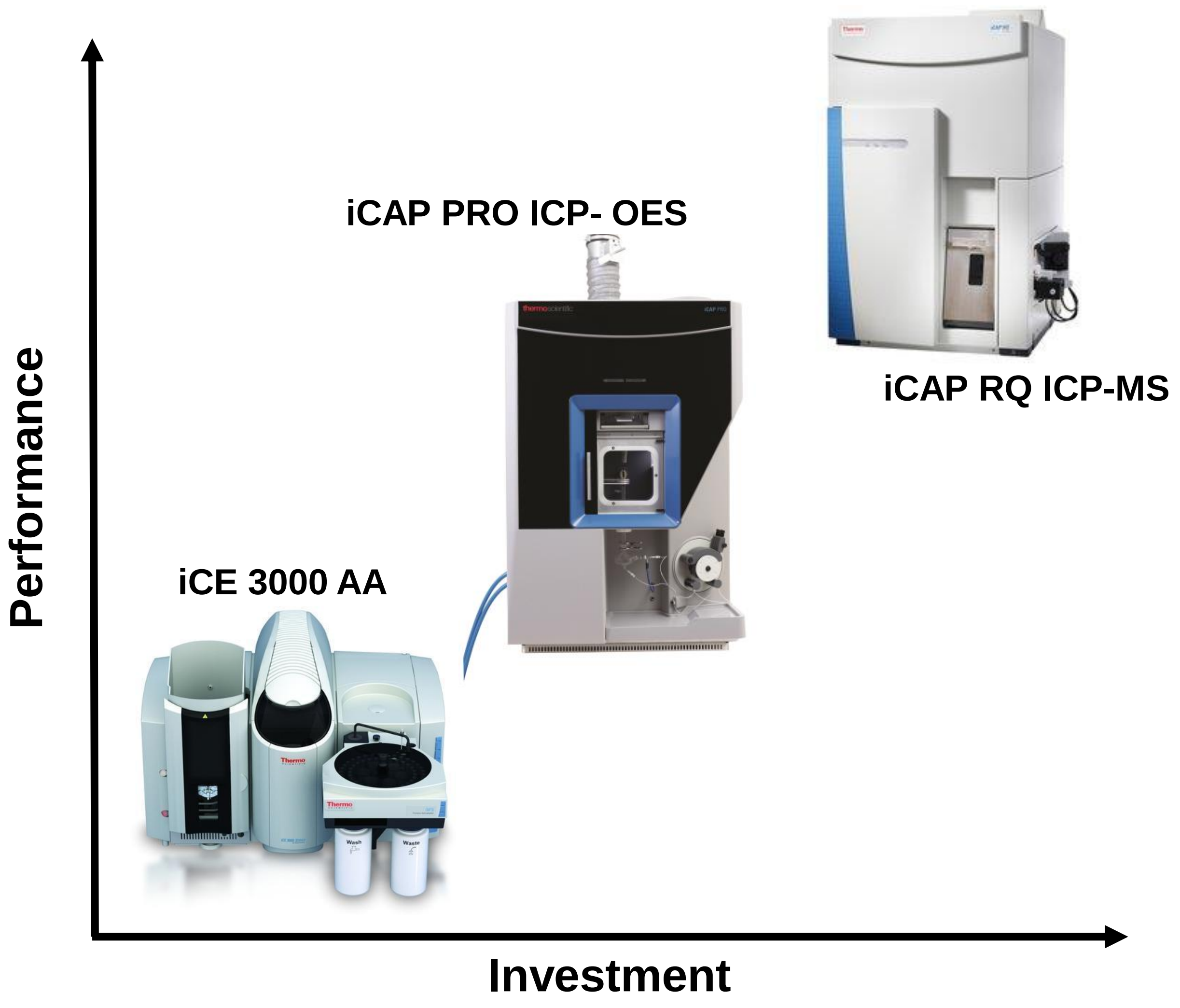
- **Calcium** helps to build strong bones and teeth and regulate your heartbeat. It also ensures your blood clots normally, important for healing.
- **Iron** helps your body make red blood cells to carry oxygen around your body.
- **Potassium** helps the body control the balance of fluids and keeps your heart healthy and functioning correctly.
- **Trace elements** are also essential nutrients, however, you need them in smaller amounts than vitamins and minerals.
- **Iodine** helps your body make the thyroid hormones that keep your cells and metabolic rate healthy.
- **Zinc** helps your body make new cells and enzymes, process carbohydrate, fat and protein in food and also with the healing of wounds



Metal Toxicity

- Lead: Brain/ Kidney damage/Central Nervous system
- Cadmium: Lung Cancer/ Stomach Irritation/Prostate
- Chromium $^{+6}$: Carcinogenic in lungs/Dermatitis
- Arsenic: Skin Damage/Carcinogenic/Chromosomes
- Mercury: Nervous Centre -Brain/Kidney/Fetuses

Elemental Analysis & Sample Requirement



How the Samples should be?

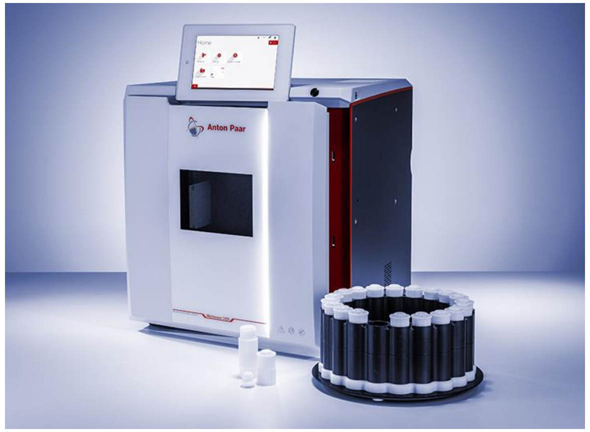
- Homogeneous
- Representative of Bulk
- Free of suspended particles
- Free flowing
- Uniform Introduction of Standards / Samples

Sample Preparation

Acid Digestion

- Preferred for sample preparation for AAS – flame
- Larger Sample quantity
- Total digestion time is between 30 min. to 2 hours;
- Digestion temperature ~130deg c;
- Corrosive acidic fumes are evolved
- Volatiles may be lost
- Close supervision is normally required, to prevent charring of samples.

Microwave Digestion



- Fast, about 30 - 40 minutes;
- Digestion Temp. up to 280 deg c
- Up to 48 samples can be digested at any time
- Minimum volatiles losses and contamination
- Pressures range from 20 - 80 bars
- Suitable for organics as well as Inorganics
- Fully automatic, user's supervision not required

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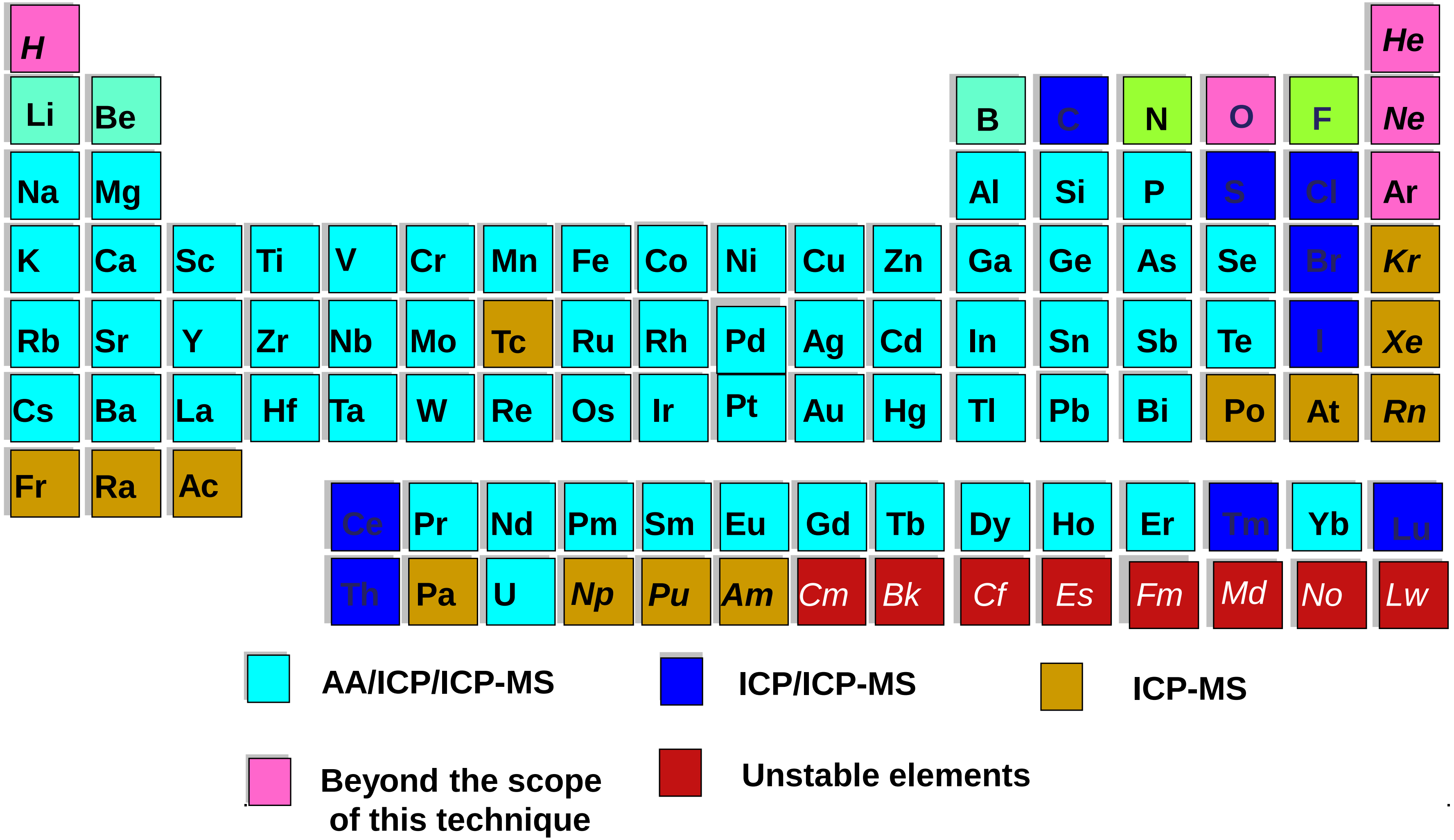
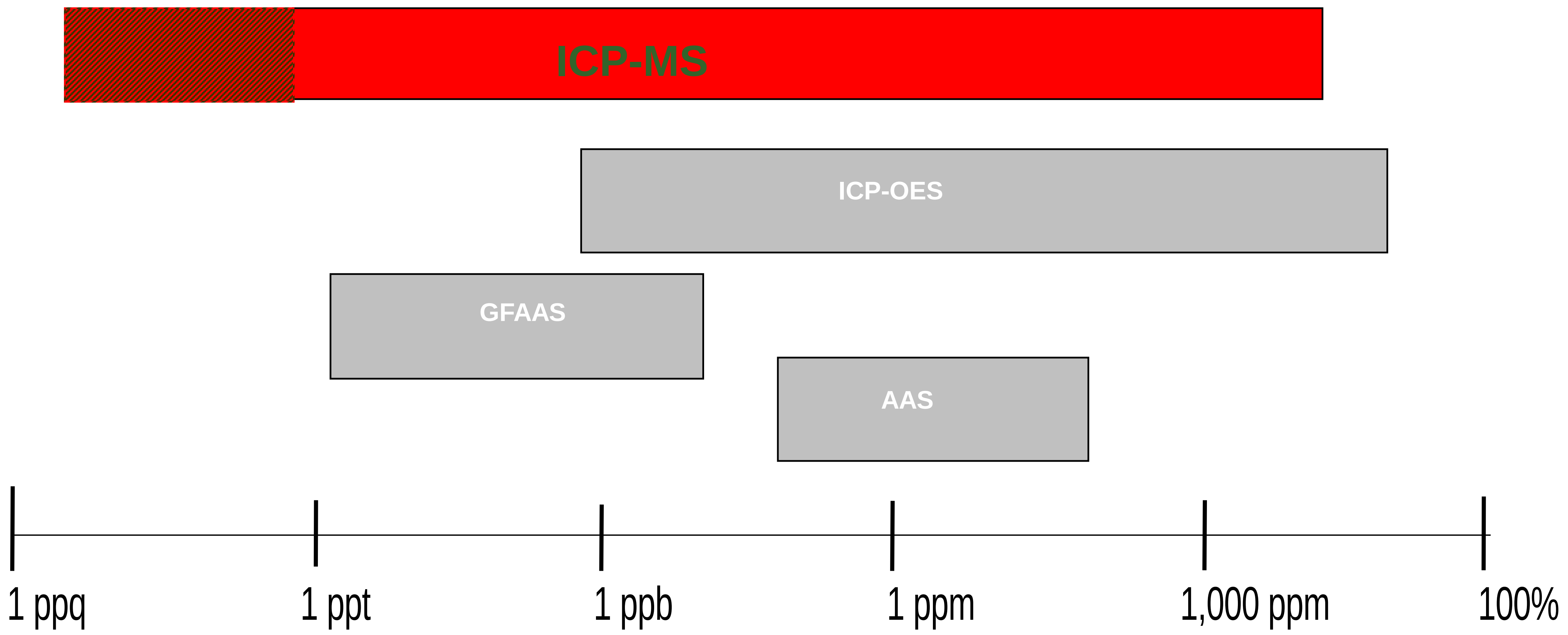
The Periodic Table; Our Common Language

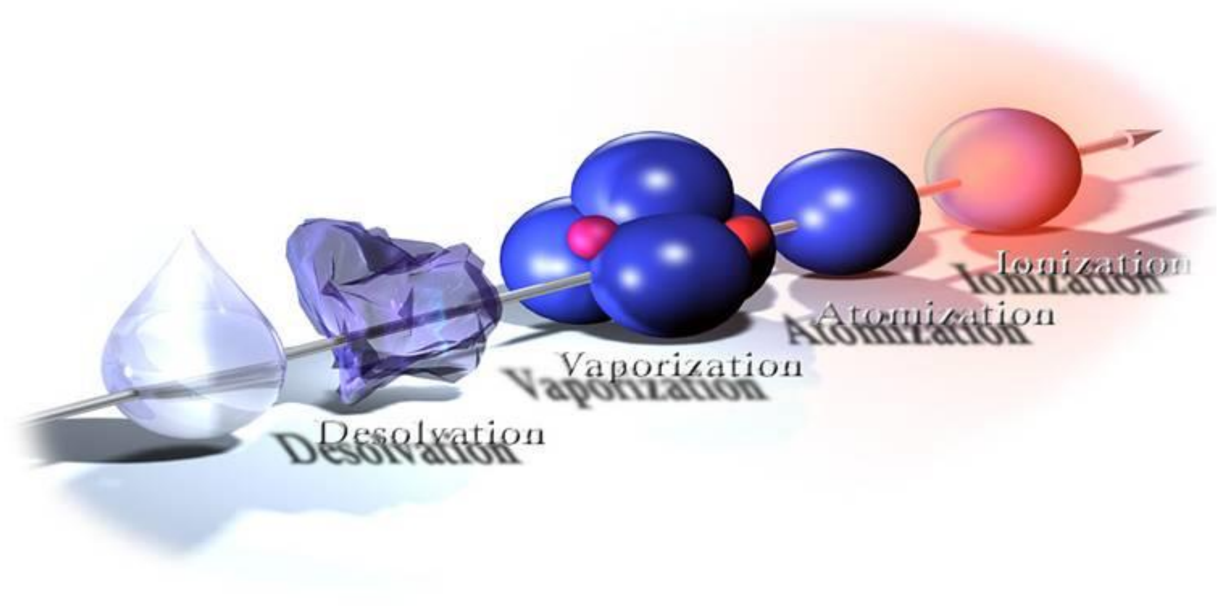


Dynamic Range Comparison



Inductively Coupled Plasma

- High voltage spark acts as initial ion generator
- The RF field causes the gaseous ions to oscillate with the field which results in heat.
- The temperature developed inside a plasma reaches 10,000 K.
- A plasma is a stream of highly ionized gas containing an equal number of electrons and positive ions



Nebulizer Gas

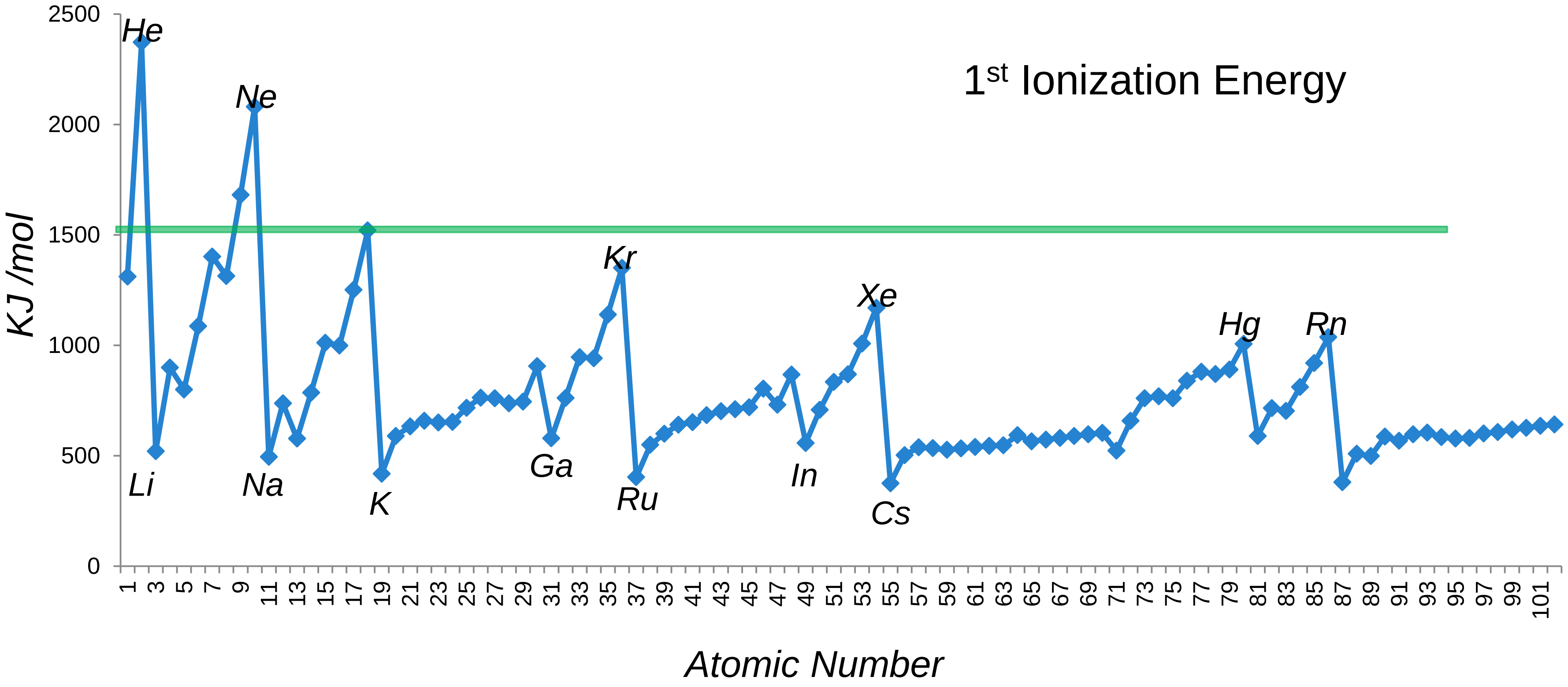
Coolant Gas

Auxiliary Gas

Why Argon?

Argon has an ionization energy of ~ 1500 KJ/mol

4th highest ionization energy in the periodic table after helium, neon, & fluorine



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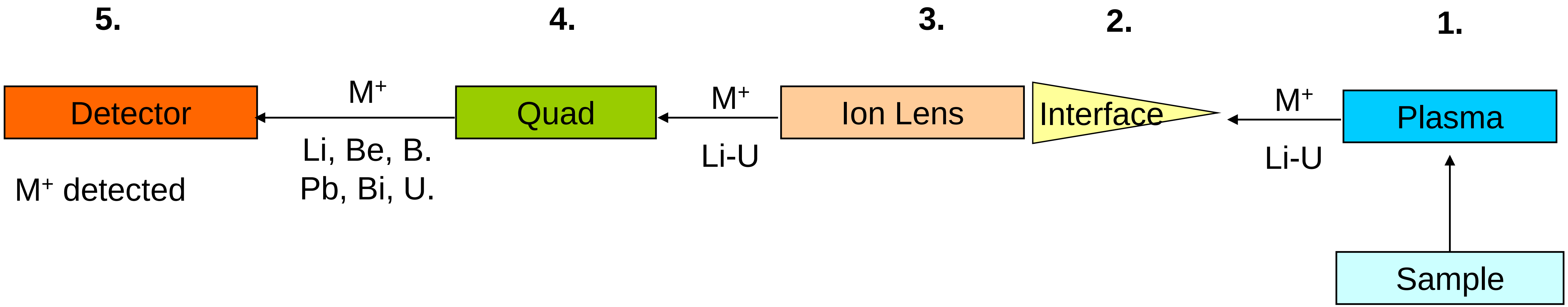
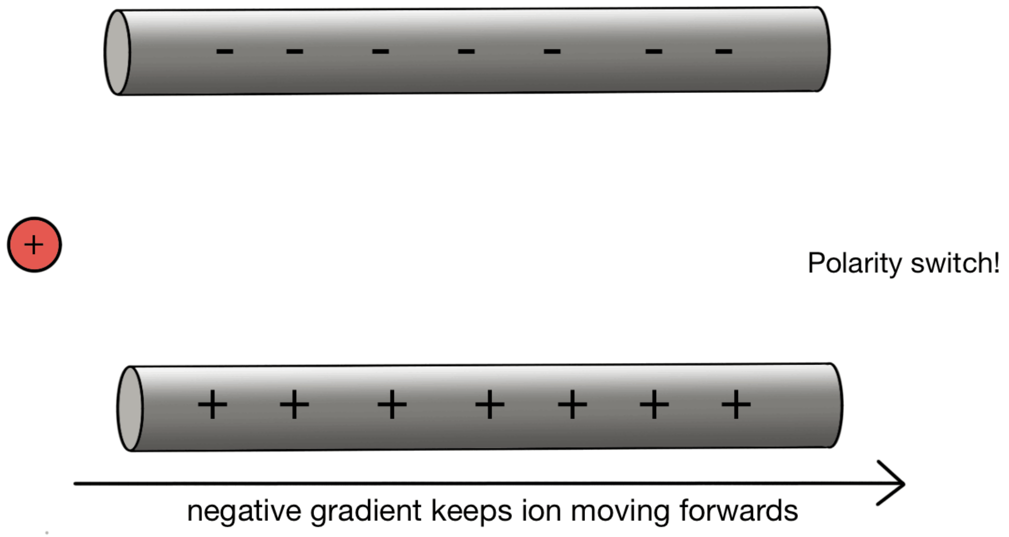
The ICP-MS Technique

- 5 Basic Stages
  - 1. Sample Introduction and Ion Generation
  - 2. Ion Sampling (Ion Extraction)
  - 3. Ion Focusing
  - 4. Separation of Analyte Ions in Quadrupole Mass Filter
  - 5. Ion Detection

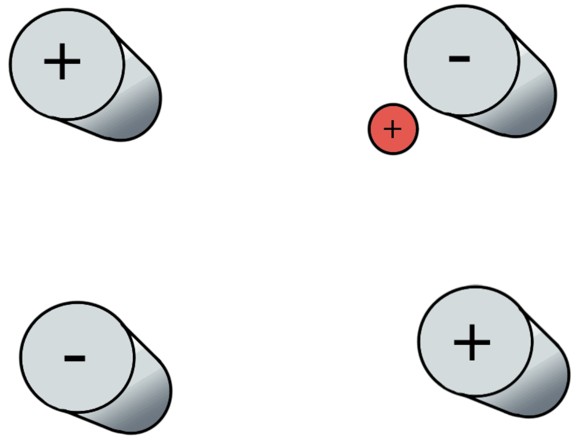


Quadrupole Mass Filter

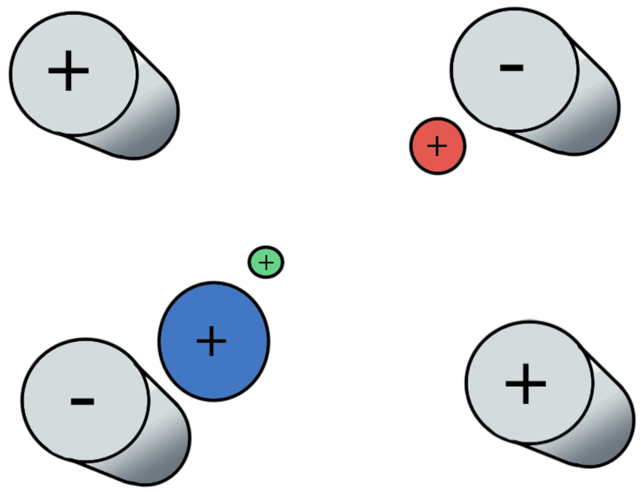
If we have two poles and switch polarity as the ion approaches, then we control how the ion moves.



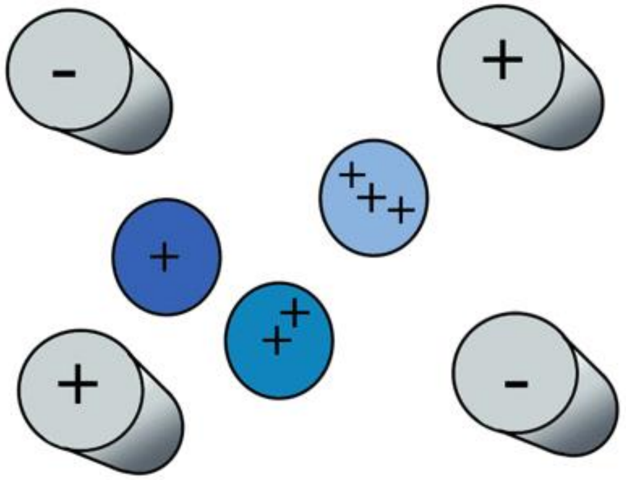
But we need to control how an ion moves in 3D space,
Four poles work well for this



Quadrupole Mass Filter

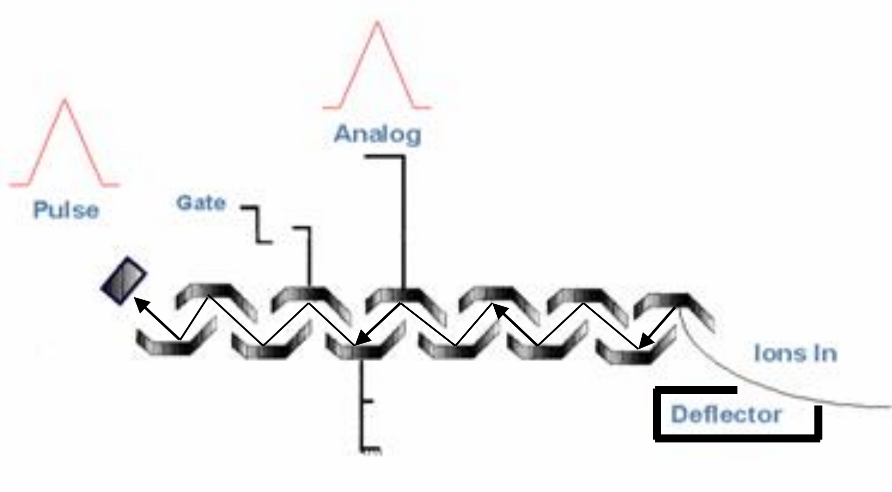


So if we have three ions of different m/z in the quadrupole, they will have different stable paths



It is the mass to charge ratio (m/z) that determines how an ion moves in an electromagnetic field

- Ions leaving the quadrupole can't be detected directly - their signal must first be amplified
- Most instruments use 'discrete dynode' ion multipliers to achieve this



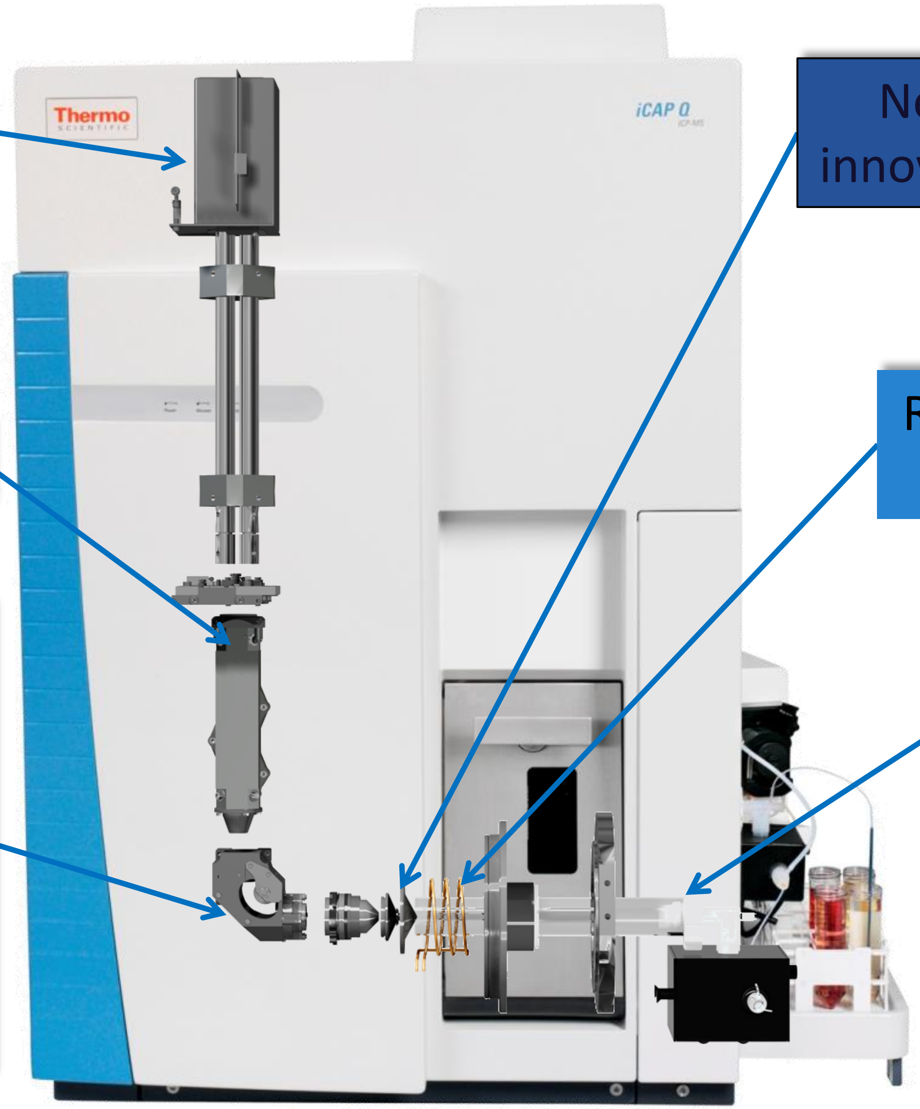
Schematics

New SEM for improved life time

New Electronics and Software

New Cell (QCell)

RAPID Lens – A novel 90° deflection for removal of neutral gas molecules



New Interface with innovative skimmer cone

RF generator without plasma shield

New torch design for easy handling

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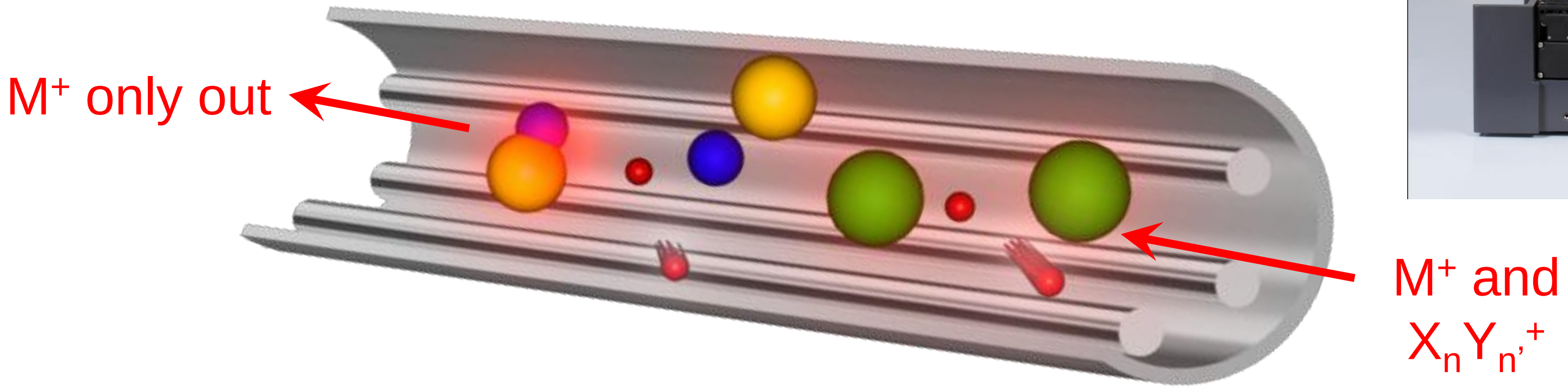
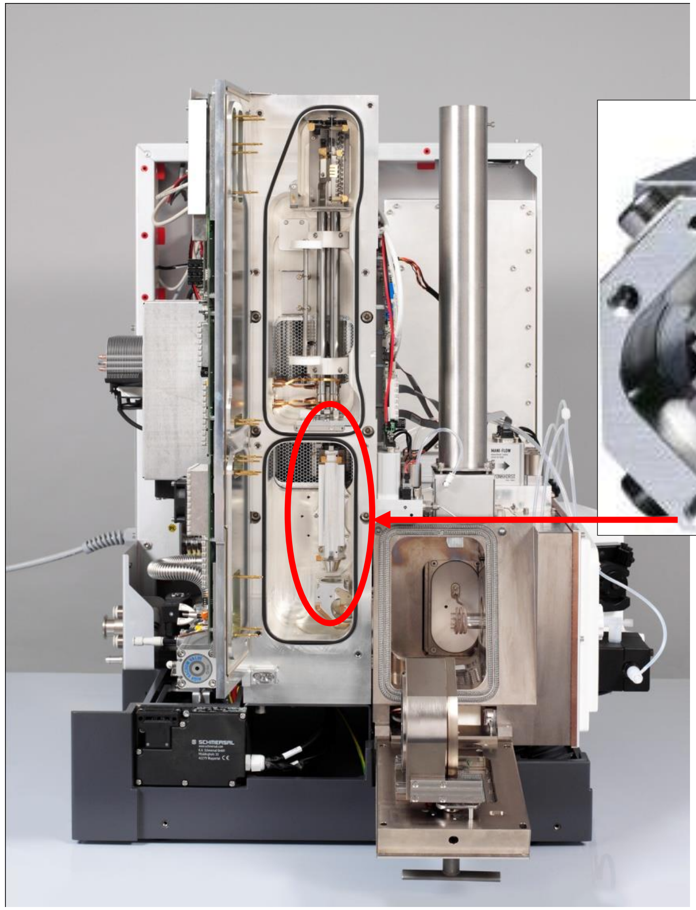
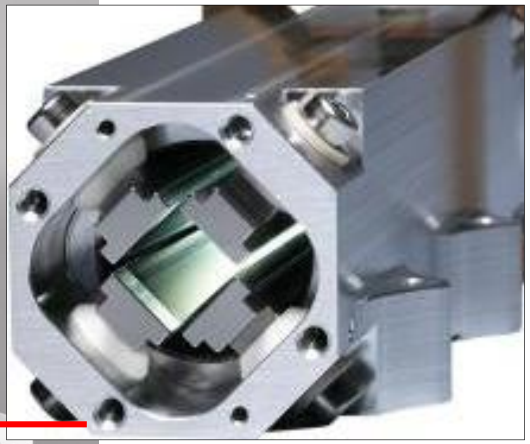
Collision-Reaction Cell (CRC) Technology

- A multipole enclosed in a cylinder
- Controlled flow of gas into the cell
- Interaction of ions with the gas
- If reactive gas used, reactions occur
- All cells are reaction cells







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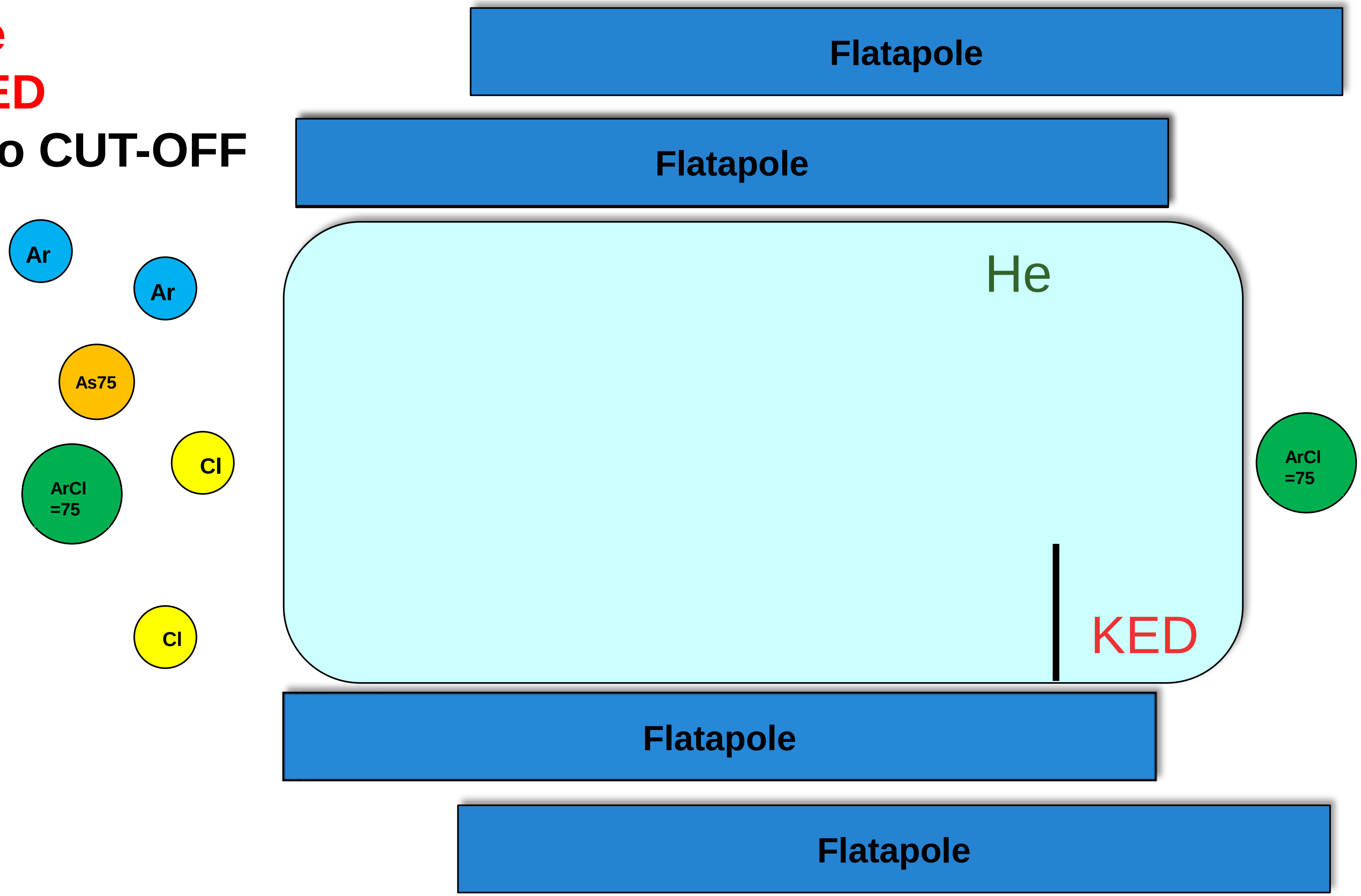
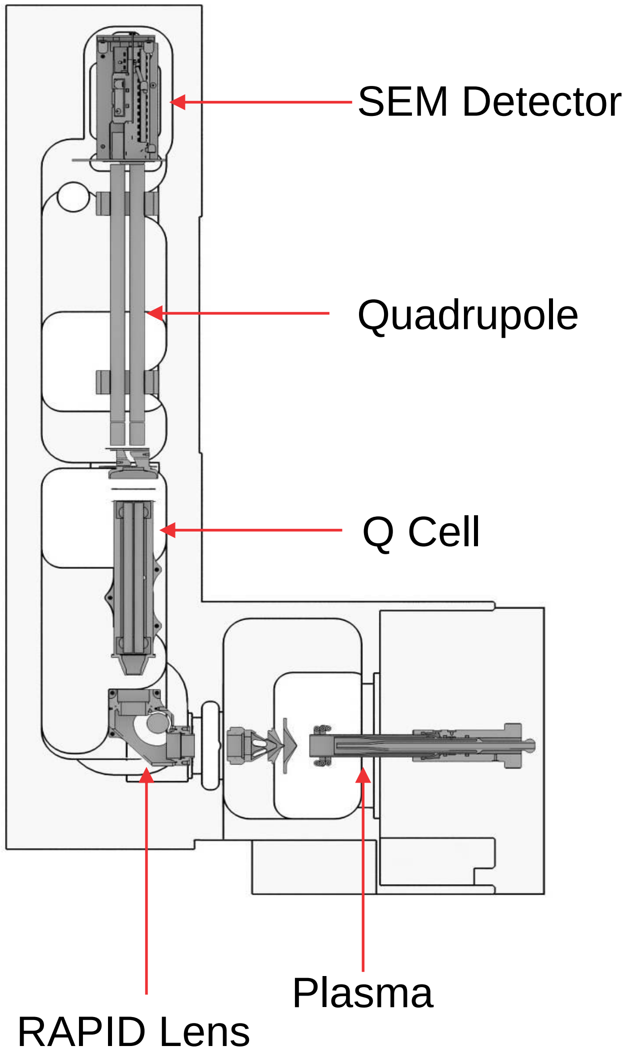
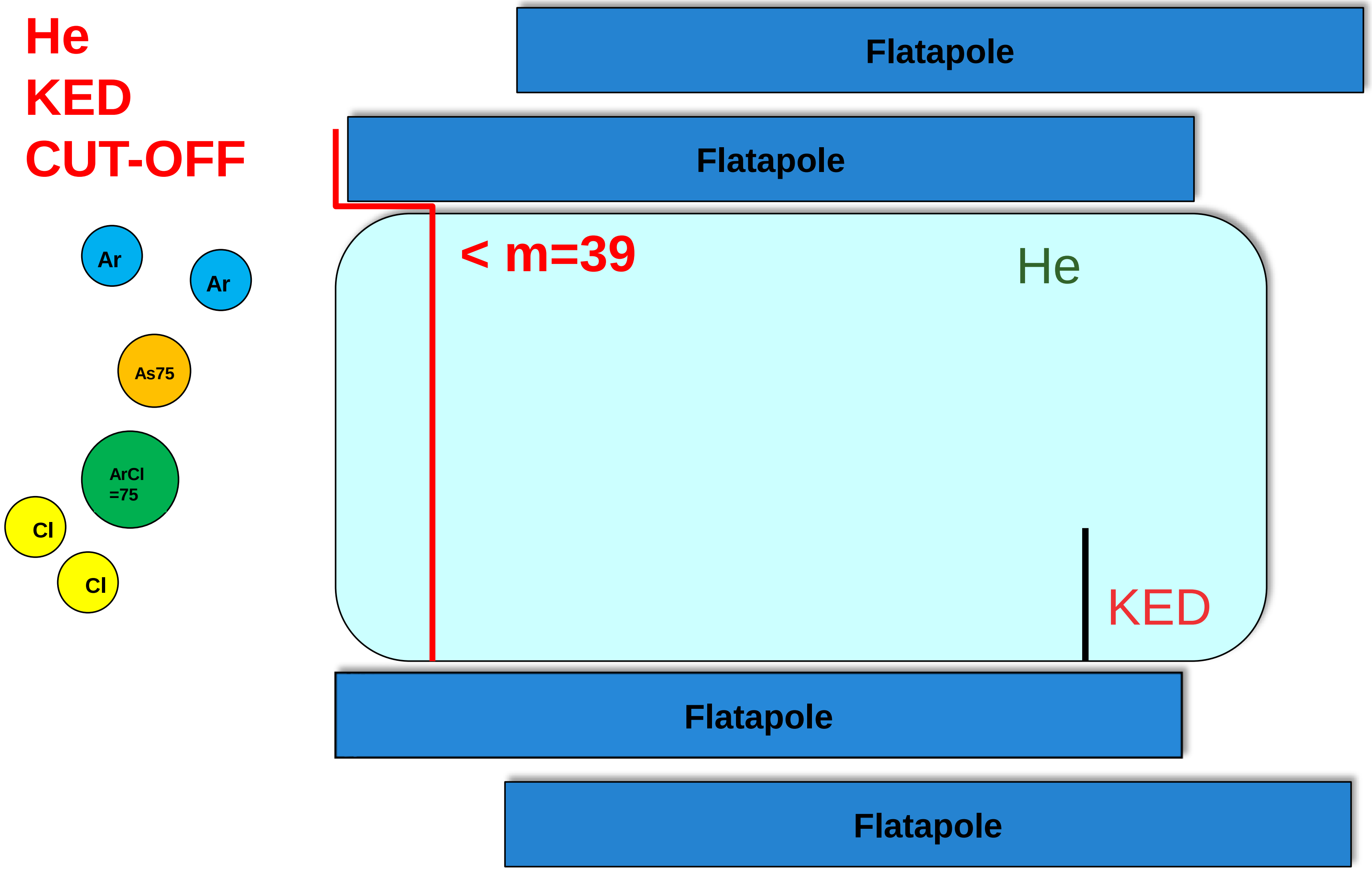
Collision Cell Without Low-Mass Cut Off

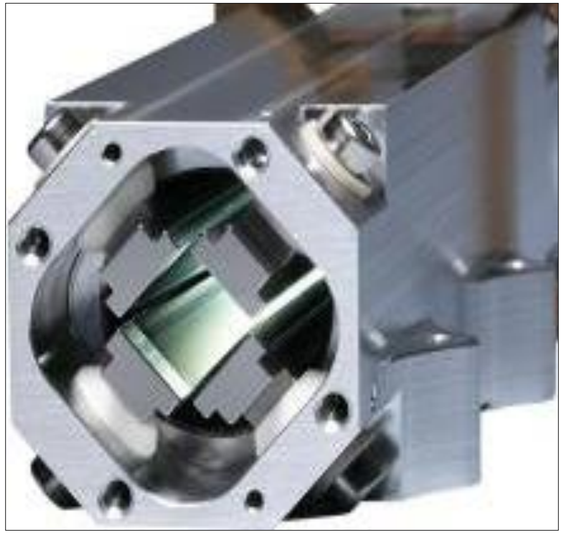
He
KED
w/o CUT-OFF





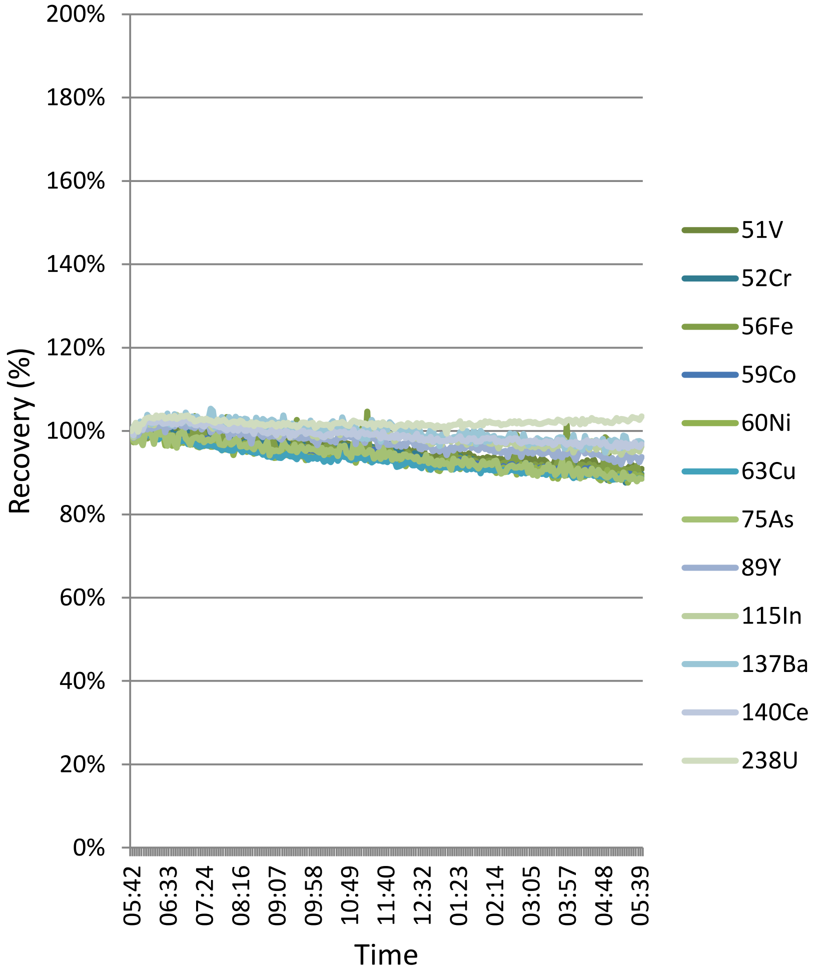
Collision Cell Without Low-Mass Cutoff



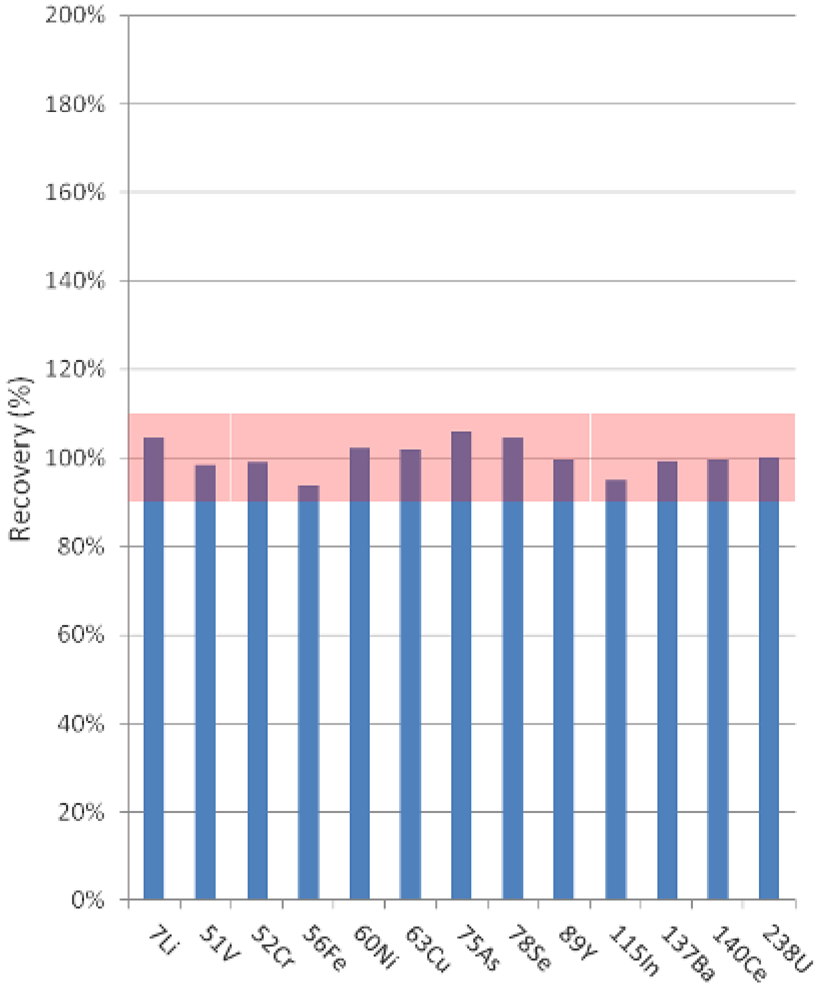


Use of 100% Organic Solvents

Stability over 12 Hours All <5% RSD



Spike Recovery (1ppb) in 100% ACN) All 90-110% Recovery



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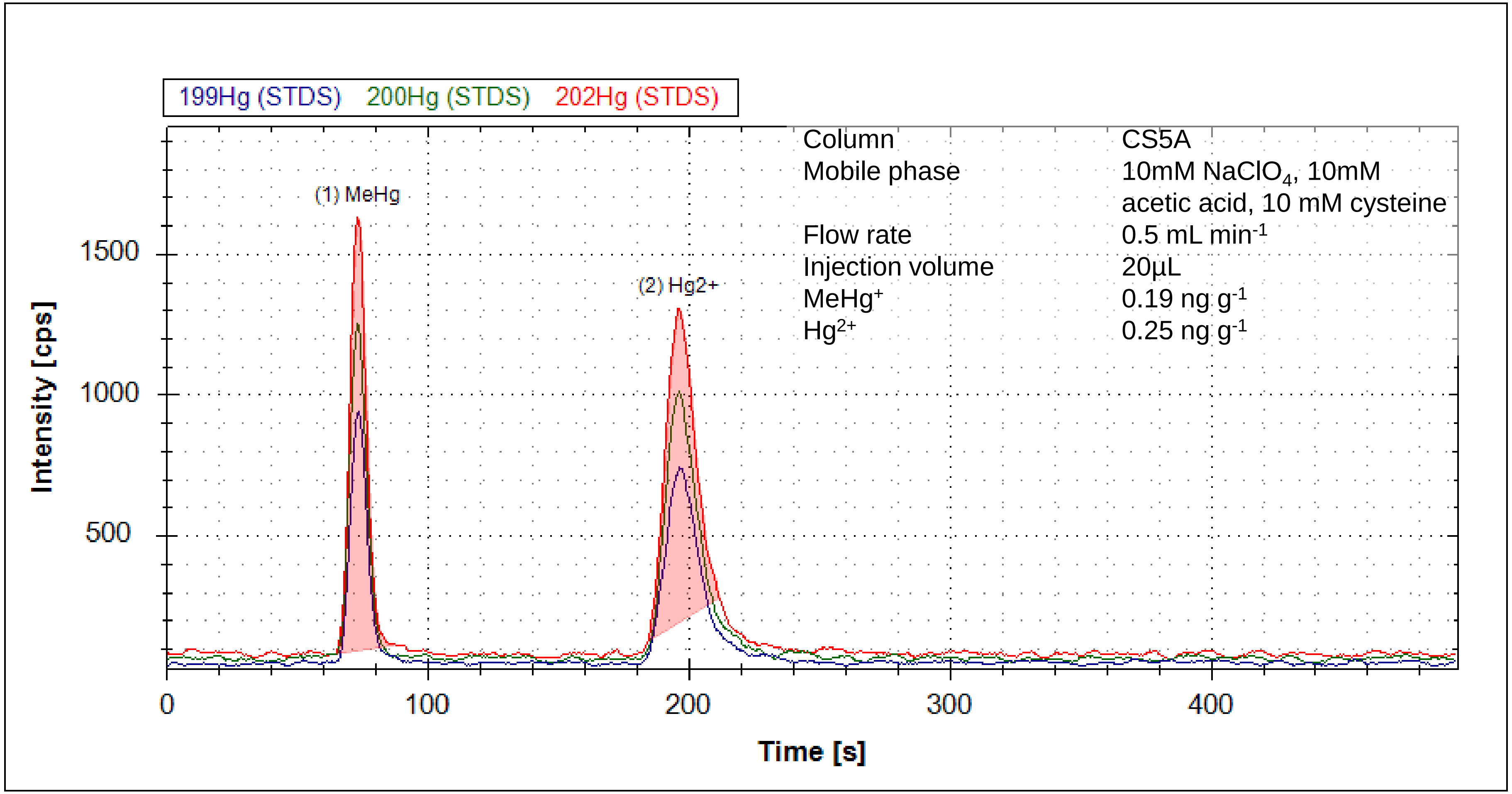
Hyphenation Technique: IC-ICP-MS

- Metal-free systems
- Powerful separation chemistries
- Reagent-Free Ion Chromatography (RFIC)
- Extensive IC product line for full flexibility

- $MeHg^{+}$ and Hg^{2+} standards



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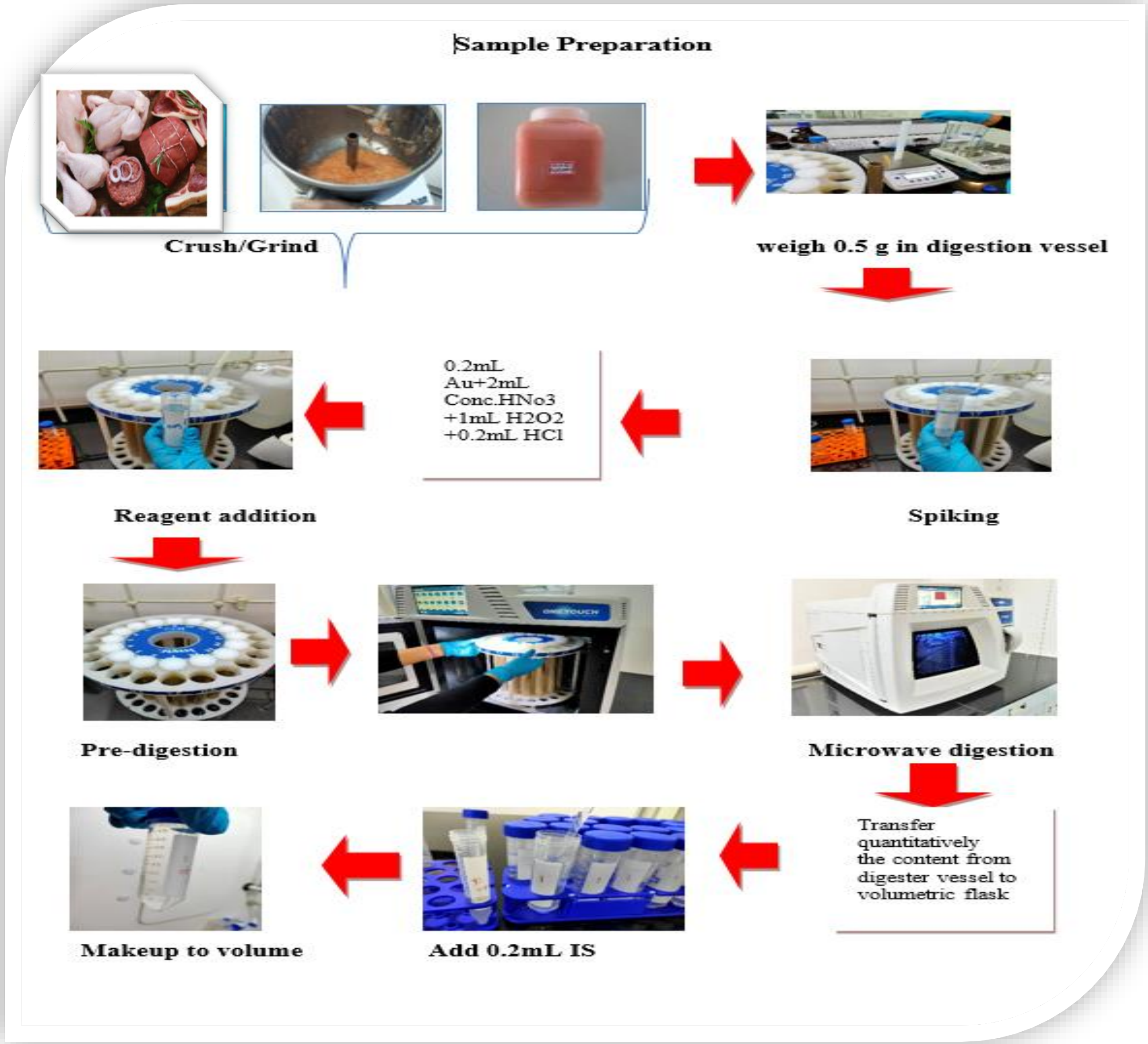
Method Performance in Different food matrices

Butter

Meat

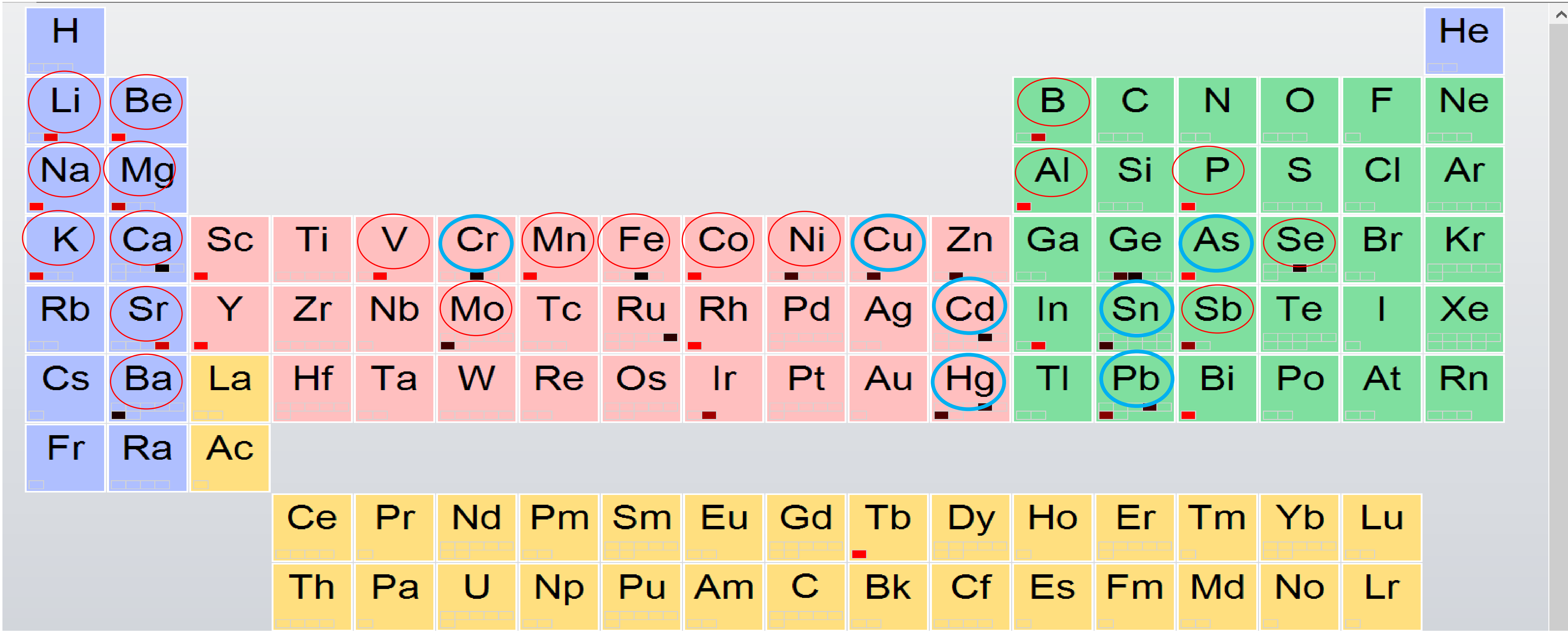
Spices

Fruits and Vegetables



Parameters	Rice	Wheat	Milk and milk products	Meat and Meat products	Spices	Fruits and vegetables
sample weight (g)	0.25	0.25	0.5	0.5	0.2	0.5
Final volume made up (mL)	50	50	50	50	50	50
DI water (mL)	1	1	1	NA	1	NA
HNO3 (mL)	4	2	2	2	2	2
H2O2 (mL)	2	1	1	1	1	1
HCl (mL)	0.4	0.2	0.2	0.2	0.2	0.2
Gold solution (ug/L)	200	200	200	200	200	200
Internal standard mix	20	20	20	20	20	20
Pre-digestion time (min)	10	10	10	60	60	60

Target Analytes



Linearity

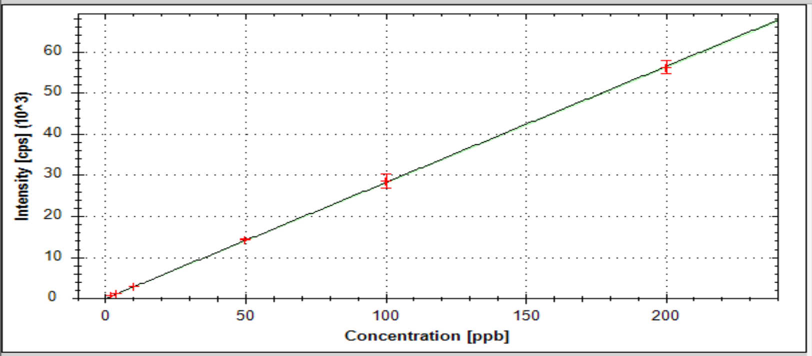
Elements	Working standard concentration ($mg.L^{-1}$)	Volume made up (mL)	Stock solution/certified standard ($mg.L^{-1}$)	Volume taken (mL)
Pb, Sb	0.1	25	10	0.25
Al, Fe, Cu, Zn, Sn	30		1000	0.75
Hg, Co	0.02		1	0.5
Cr, As, Se	0.5		10	1.25
Li, B, Be, V, Mn, Ni, Mo, Ba	1		10	2.5
Cd	0.05		10	0.125

Elements	Std-1	Std-2	Std-3	Std-4	Std-5	Std-6	Std-7
Pb, Sb	0.05	0.1	0.25	0.5	1	2	4
Al, Fe, Cu, Zn, Sn	15	30	75	150	300	600	1200
Hg, Co	0.01	0.02	0.05	0.1	0.2	0.4	0.8
Cr, As, Se	0.25	0.5	1.25	2.5	5	10	20
Li, B, Be, V, Mn, Ni, Mo, Ba	0.5	1	2.5	5	10	20	40
Cd	0.025	0.05	0.125	0.25	0.5	1	2
Volume prepared (mL)	25	25	25	25	25	25	25
Volume taken from mixed working standard (μL)	12.5	25	62.5	125	250	500	1000

Linearity

Details

7Li (KED) - IS:45Sc (KED)



Calibration Properties

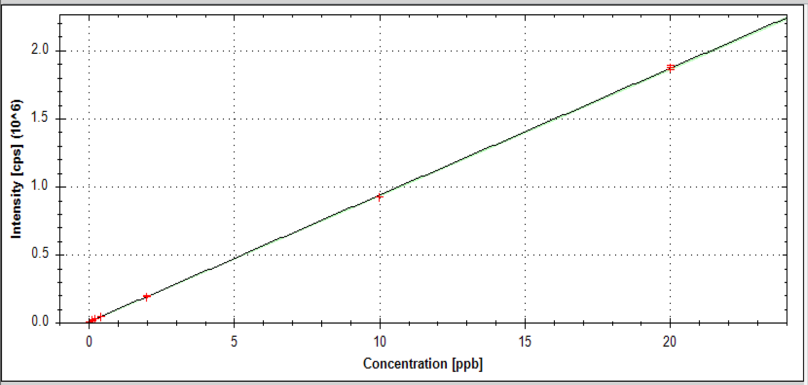
- FitType: Linear
- Weighting: None
- Forcing: Blank
- Use for SemiQuant: Yes

f(x) = b*x + a

Parameter	Value	Confidence Delta a	StdErr	Rel. StdErr [
b	281.823	+/-1.193	0.828	0.294
a	9.275	+/-0.000	0.000	0.000
R²	1.000			
BEC	0.033 ppb			

Details

206Pb (KED) - IS:209Bi (KED)



Calibration Properties

- FitType: Linear
- Weighting: None
- Forcing: Blank
- Use for SemiQuant: Yes

f(x) = b*x + a

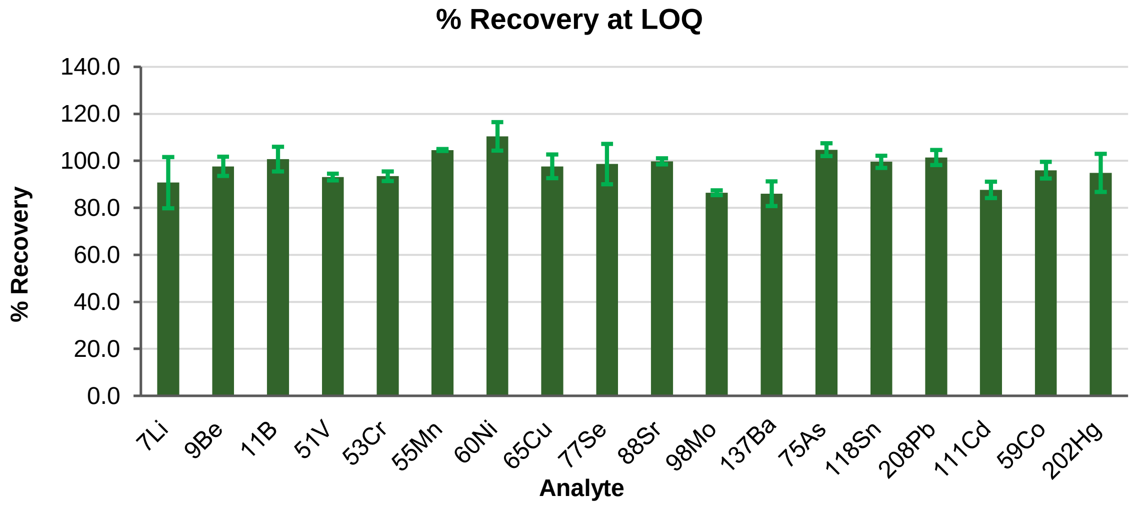
Parameter	Value	Confidence Delta at 90%	StdErr	Rel. StdErr [%]
b	92,955.837	+/-362.479	251.756	0.271
a	8,023.232	+/-0.000	0.000	0.000
R²	0.99994			
BEC	0.086 ppb			

Element	R2	Intensity %RSD	IDL in ppb
Li	0.99985	0.3	0.06
Be	0.99999	4.1	0.02
B	0.99988	2.2	0.27
Al	0.99993	2.6	0.07
V	0.99998	4	0.01
Cr	1.00000	3.9	0.05
Mn	0.99996	1.8	0.003
Fe	0.99999	2	0.75
Co	0.99994	5.3	0.0006
Ni	0.99998	2.2	0.01
As	0.99998	3.2	0.004
Se	0.99995	5.4	0.17
Sr	0.99983	4	0.004
Mo	0.99528	1.4	0.001
Cd	1.00000	3	0.003
Sb	0.99999	4.1	0.002
Ba	0.99978	2	0.005
Hg	0.99943	2.7	0.0006
Cu	0.99973	0.7	0.01
Sn	0.99990	1.3	0.002
Pb	0.99996	2.4	0.002

Accuracy & Precision-Rice

Mass	Element	Level 1 (LOQ) mg·kg-1	% Rec.	% RSD	Level 2 mg·kg-1	% Rec.	% RSD	Level 3 mg·kg-1	% Rec.	% RSD
7	Li	0.4	91	10.9	0.8	98	6.2	2	101	2.4
9	Be	0.4	98	4.1	0.8	99	1.6	2	99	3.4
11	B	0.4	101	5.3	0.8	110	3.7	2	95	2.4
51	V	0.4	93	1.5	0.8	95	2.6	2	93	1.7
53	Cr	0.4	93	2	0.8	103	5.8	2	99	3.2
55	Mn	0.4	105	0.4	0.8	112	1.3	2	98	1.7
59	Co	0.01	96	3.5	0.02	96	1.8	0.05	105	1.1
60	Ni	0.4	110	6.1	0.8	98	2.2	2	94	1.6
65	Cu	0.4	98	5	0.8	113	1.8	2	90	1.2
75	As	0.1	105	2.7	0.2	103	1.7	2	104	1.6
77	Se	0.4	99	8.6	0.8	101	5.8	2	102	3.8
88	Sr	0.4	99	1.3	0.8	105	1.8	2	99	1.2
98	Mo	0.4	86	1.1	0.8	89	2.5	2	90	2.4
111	Cd	0.01	88	3.5	0.02	94	6.1	0.05	98	1.2
118	Sn	0.1	99	2.6	0.2	97	1.2	2	103	2.3
137	Ba	0.4	86	5.2	0.8	99	1.5	2	97	2
202	Hg	0.01	95	8.1	0.02	84	2.9	0.05	86	1.6
208	Pb	0.1	101	3.2	0.2	97	2.3	2	101	1.1

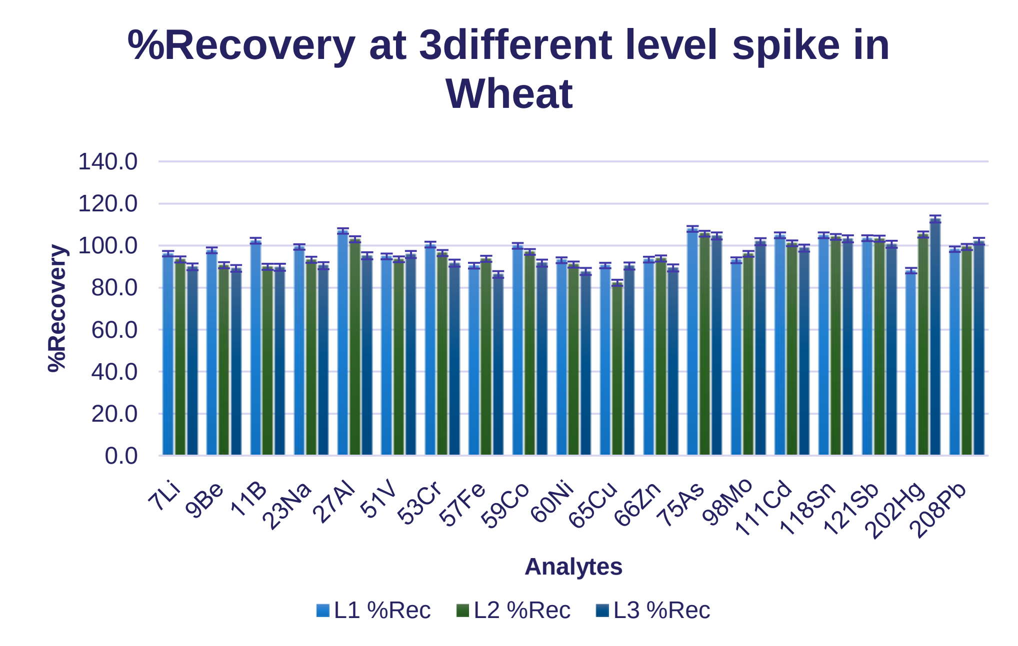
Accuracy @ LOQ is 86-110%
Precision @ LOQ is <11%



Accuracy & Precision-Wheat

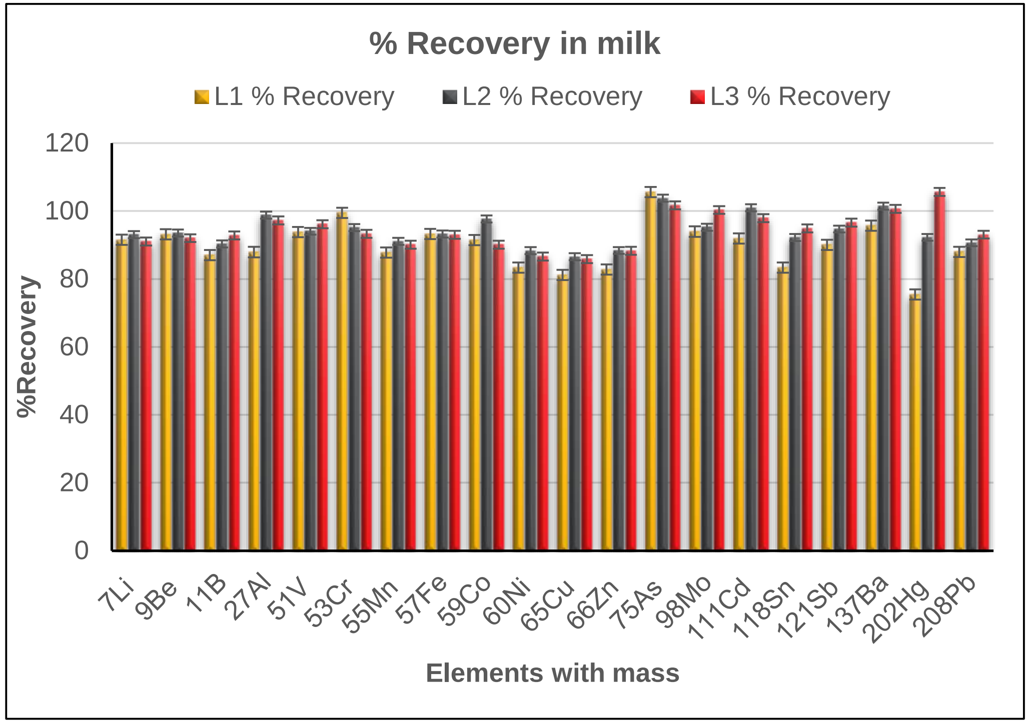
Element	L1 (LOQ) mg·kg-1	%Rec	%RSD	L2 mg·kg-1	%Rec	%RSD	L3 mg·kg-1	%Rec	%RSD
7Li	0.4	96.1	3.1	2	93.4	1.7	20	89.9	1.4
9Be	0.4	97.8	4.2	2	90.7	1.8	20	89.1	1.1
11B	0.4	102.3	3.5	2	89.9	2.5	20	89.7	1.7
23Na	10	99.3	0.7	50	93.3	1.6	200	90.5	0.7
27Al	10	106.9	0.7	50	103.0	2.3	200	95.2	1.0
51V	0.4	94.9	1.1	2	93.5	1.2	20	95.8	0.7
53Cr	0.4	100.5	1.0	2	96.4	1.6	20	91.6	0.7
57Fe	20	90.4	2.1	50	93.7	0.8	200	86.3	1.0
59Co	0.01	99.9	1.1	0.05	97.0	2.0	1	91.7	0.8
60Ni	0.4	93.0	1.4	2	90.9	0.9	20	87.7	0.9
65Cu	0.4	90.5	3.2	2	82.3	1.8	20	90.3	0.5
66Zn	10	93.4	0.4	50	93.8	1.0	200	89.4	0.9
75As	0.1	107.9	3.9	0.2	105.7	1.4	2	104.6	1.0
98Mo	0.4	93.1	0.6	2	96.1	1.1	20	101.9	0.7
111Cd	0.01	104.9	1.8	0.05	101.1	2.2	1	98.8	0.7
118Sn	0.1	104.9	0.9	0.2	104.1	1.3	2	103.2	1.0
121Sb	0.1	103.5	1.4	0.2	103.3	1.7	2	100.6	1.1
202Hg	0.01	88.1	1.6	0.05	105.2	2.3	1	112.7	0.3
208Pb	0.1	98.3	2.0	0.2	99.3	5.1	2	102.0	1.0

Accuracy @ LOQ is 88-108%
Precision @ LOQ is <5%



Accuracy & Precision-Milk and milk products

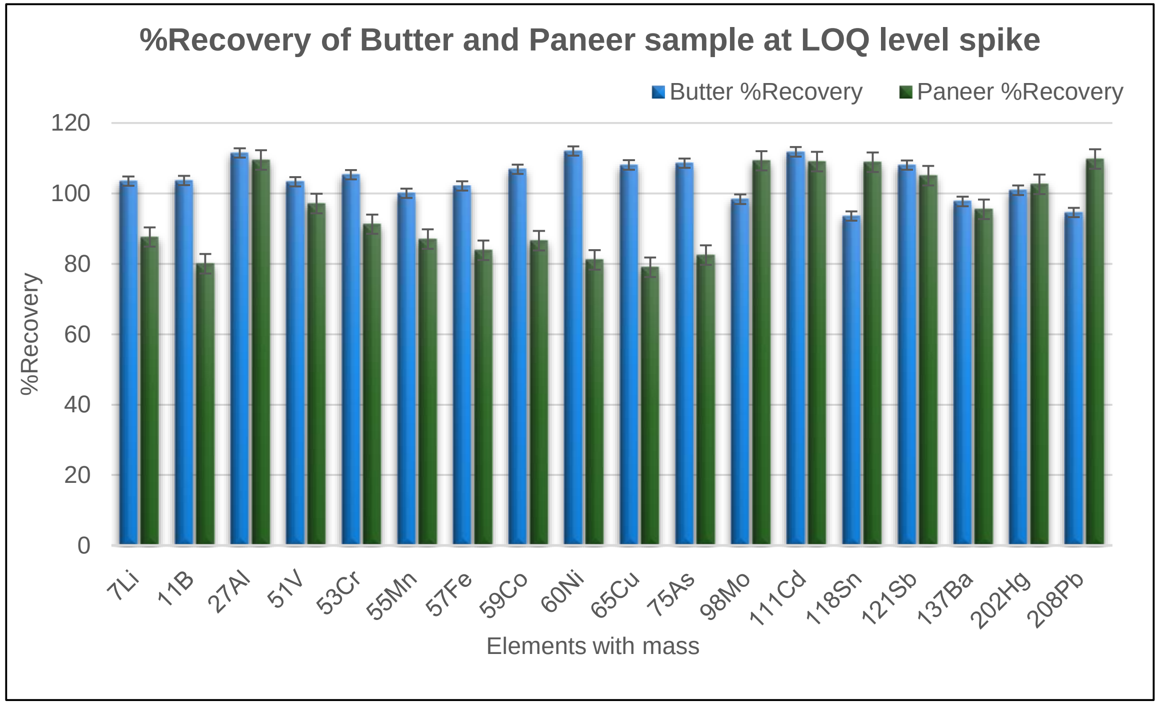
Isotope	L1 mg·kg-1	% Recovery	% RSD	L2 mg·kg-1	% Recovery	% RSD	L3 mg·kg-1	% Recovery	% RSD
^{7}Li	0.10	92	2.3	0.50	93	2.4	5.00	91	1.5
^{9}Be	0.10	93	4.7	0.50	94	1.7	5.00	92	1.9
^{11}B	0.20	87	2.4	0.50	90	2.4	5.00	93	2.1
^{27}Al	2.50	88	1.2	12.50	99	1.5	50.00	97	1.9
^{51}V	0.10	94	2.0	0.50	94	1.7	5.00	96	1.2
^{53}Cr	0.20	99	6.4	0.50	95	2.6	5.00	93	1.4
^{55}Mn	0.10	88	1.8	0.50	91	2.3	5.00	90	1.7
^{57}Fe	2.50	93	3.6	12.50	93	1.5	50.00	93	1.7
^{59}Co	0.005	91	0.9	0.0125	98	2.6	0.50	90	1.4
^{60}Ni	0.10	83	1.5	0.50	88	1.5	5.00	87	1.5
^{65}Cu	0.10	81	1.5	0.50	87	1.7	5.00	86	1.8
^{66}Zn	2.50	83	1.4	12.50	88	1.4	50.00	88	1.5
^{75}As	0.005	106	2.3	0.02	104	1.8	0.50	102	2.3
^{98}Mo	0.10	94	1.2	0.50	95	2.0	5.00	100	1.5
^{111}Cd	0.003	92	5.1	0.0125	101	1.4	0.50	98	1.0
^{118}Sn	0.005	83	2.7	0.02	92	1.6	0.50	95	1.9
^{121}Sb	0.005	90	6.8	0.02	95	1.8	0.50	97	1.7
^{137}Ba	0.10	96	1.0	0.50	101	1.9	5.00	101	1.7
^{202}Hg	0.005	75	4.5	0.0125	92	2.0	0.50	106	1.1
^{208}Pb	0.01	88	4.8	0.02	91	2.0	0.50	93	2.7



Milk
Accuracy @ LOQ is 81-108%
Precision @ LOQ is <7%

Accuracy & Precision-Milk and Milk Products

Isotope	Measured spiked sample conc. in Qtegra ISDS Software (mg·kg^{-1})	Corrected conc. with dilution factor (mg·kg^{-1})	Butter (n=6)		Cheese (n=6)	
			% Recovery	% RSD	% Recovery	% RSD
^{7}Li	0.0020	0.1000	103	0.8	88	4.6
^{11}B	0.0020	0.1000	104	3.0	80	1.2
^{27}Al	0.1000	5.0000	111	2.8	109	1.4
^{51}V	0.0020	0.1000	103	1.1	97	1.3
^{53}Cr	0.0040	0.2000	105	3.2	91	1.9
^{55}Mn	0.0040	0.2000	100	2.5	87	1.0
^{57}Fe	0.0500	2.5000	102	1.5	84	1.7
^{59}Co	0.0001	0.0025	107	1.0	87	1.5
^{60}Ni	0.0020	0.1000	112	1.1	81	1.9
^{65}Cu	0.0040	0.2000	108	2.3	79	1.2
^{75}As	0.0003	0.0150	109	2.0	82	3.4
^{98}Mo	0.0020	0.1000	98	1.3	109	1.4
^{111}Cd	0.0001	0.0050	112	2.6	109	2.3
^{118}Sn	0.0001	0.0050	94	2.2	109	3.0
^{121}Sb	0.0002	0.0100	108	1.2	105	1.4
^{137}Ba	0.0020	0.1000	98	1.0	95	1.9
^{202}Hg	0.0001	0.0050	101	2.4	103	1.3
^{208}Pb	0.0001	0.0050	95	1.7	110	1.5



Butter
Accuracy @ LOQ is 94-112%
Precision @ LOQ is <4%

Paneer
Accuracy @ LOQ is 80-110%
Precision @ LOQ is <5%

Spike concentrations in Meat products

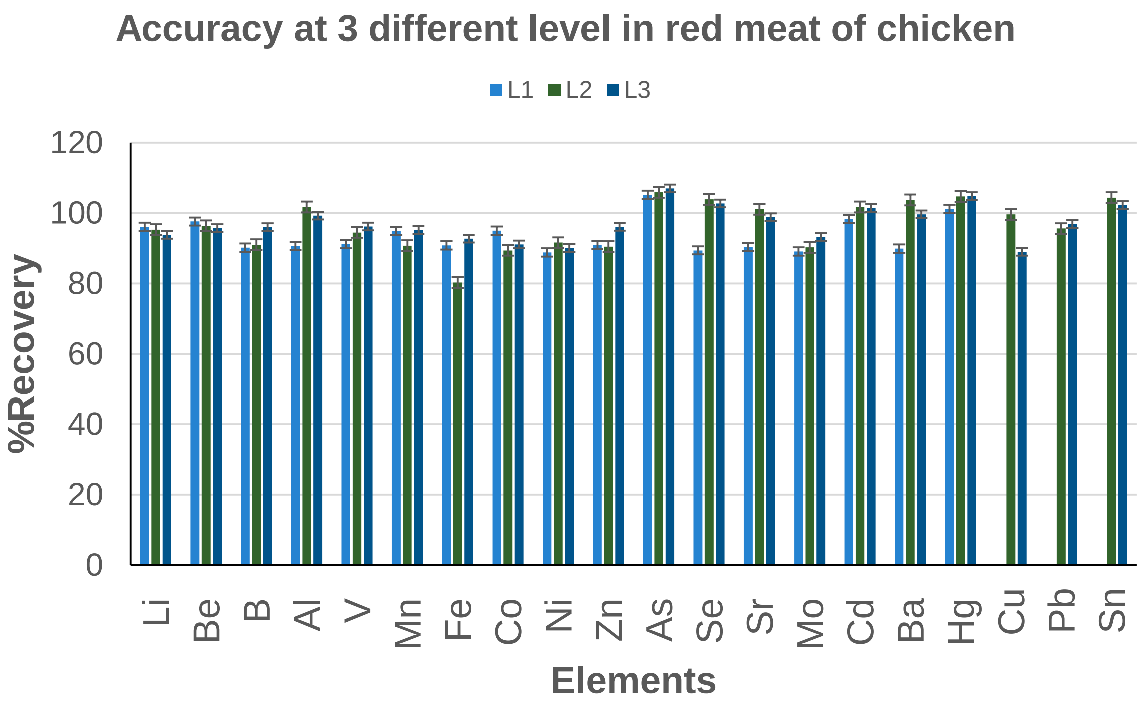
Element	Spike concentration level in $mg.kg^{-1}$		
	L1	L2	L3
Li , Be, B, V, Mn, Ni, Se, Mo	0.2	0.4	10.0
Al	5.0	10.0	100.0
Cr , Sr, Ba	0.4	1.0	10.0
Fe	10	25.0	100.0
Co, Cd	0.005	0.01	1.0
As, Sb	0.01	0.02	1.0
Hg	0.01	0.025	1.0
Pb, Sn	0.02	0.04	1.0
Cu	0.2	0.4	10.0

**Note: All the concentration values given in the table are calculated back to sample taken with a dilution factor of 100 fold.*

Accuracy and precision in Meat products

Element	L1		L2		L3	
	Recovery (%)	RSD (%)	Recovery (%)	RSD (%)	Recovery (%)	RSD (%)
Li	96.1	4.7	95.3	5.0	93.8	3.0
Be	97.6	6.2	96.4	2.7	95.7	2.2
B	90.2	9.4	91.0	8.0	96.0	2.7
Al	90.6	1.4	101.7	2.6	99.3	3.3
V	91.2	1.5	94.5	2.0	96.2	2.3
Mn	94.9	2.5	90.7	2.1	95.2	1.5
Fe	90.8	3.9	80.3	4.6	92.7	2.7
Co	95.0	1.5	89.4	1.4	91.1	1.5
Ni	88.8	2.1	91.6	1.8	90.1	2.4
Zn	90.9	5.9	90.5	1.5	96.1	1.4
As	105.2	7.2	105.9	4.9	107.0	1.3
Se	89.4	6.5	103.9	5.6	102.7	2.4
Sr	90.4	6.4	101.1	4.8	98.8	3.2
Mo	89.1	5.7	90.3	2.3	93.2	3.5
Cd	98.3	7.0	101.7	2.9	101.5	3.0
Ba	89.9	2.6	103.7	4.6	99.6	4.5
Hg	101.2	5.3	104.7	4.1	104.8	3.2
Cu	NA	NA	99.6	0.9	89.0	2.7
Pb	NA	NA	95.6	7.9	96.9	2.1
Sn	NA	NA	104.4	6.4	102.3	1.9

Chicken meat



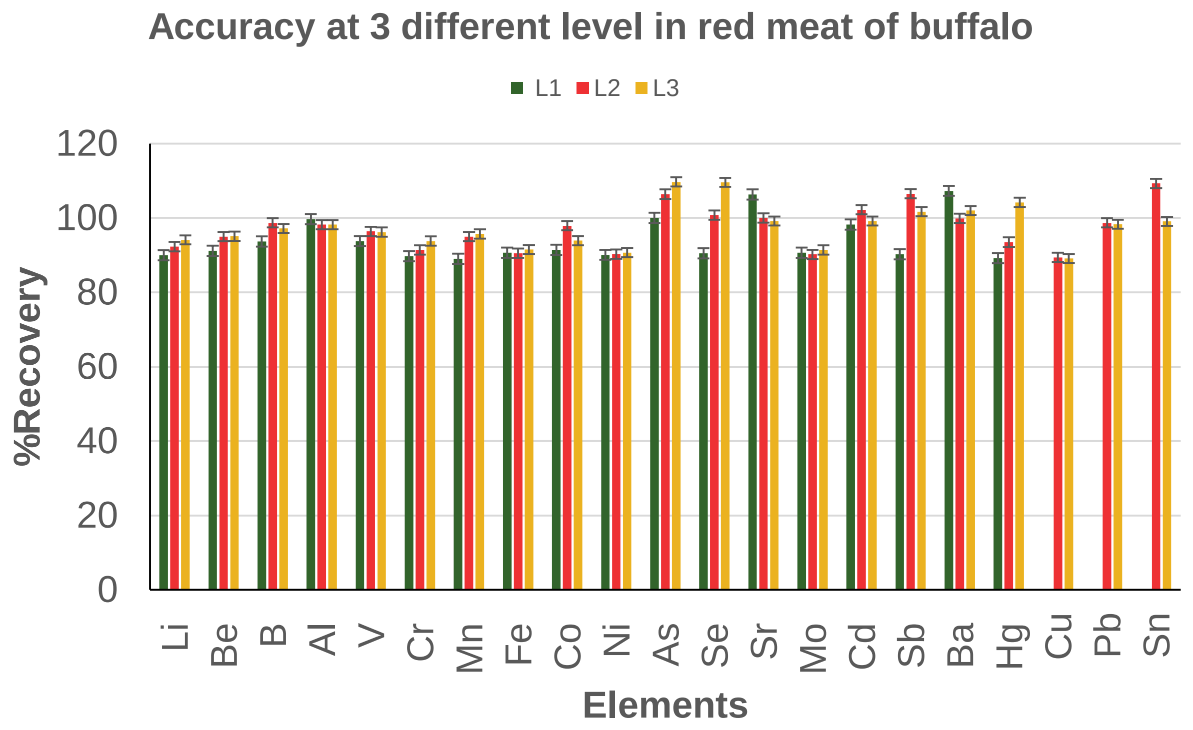
Chicken meat
Accuracy @ LOQ is 89-107%
Precision @ LOQ is <10%

Accuracy and Precision in Meat products

Element	L1		L2		L3	
	Recovery (%)	RSD (%)	Recovery (%)	RSD (%)	Recovery (%)	RSD (%)
Li	90.0	5.0	92.3	4.1	94.1	3.4
Be	91.2	7.9	95.0	2.5	95.1	0.6
B	93.7	6.6	98.7	3.5	97.2	3.4
Al	99.7	4.3	98.2	2.9	98.2	1.6
V	93.8	1.7	96.4	1.8	96.2	1.3
Cr	89.7	1.8	91.4	0.5	93.8	1.1
Mn	89.0	1.9	95.0	2.1	95.7	1.9
Fe	90.7	1.8	90.5	2.6	91.5	1.6
Co	91.4	1.8	97.9	1.4	93.9	1.7
Ni	90.1	2.0	90.3	2.7	90.7	1.4
As	100.0	6.7	106.4	3.4	109.7	1.7
Se	90.5	4.3	100.8	2.9	109.6	1.3
Sr	106.3	6.1	100.0	3.0	99.2	4.3
Mo	90.7	2.0	90.2	1.2	91.4	2.4
Cd	98.2	5.1	102.2	4.1	99.2	1.7
Sb	90.2	3.8	106.5	9.4	101.7	1.9
Ba	107.3	7.5	99.9	4.3	102.0	3.8
Hg	89.2	3.4	93.5	2.8	104.2	1.4
Cu	NA	NA	89.4	1.6	89.1	0.7
Pb	NA	NA	98.7	2.4	98.3	2.9
Sn	NA	NA	109.3	5.3	99.1	3.4

**NA: Incurred sample concentration is greater than the spiked concentration*

Buffalo meat

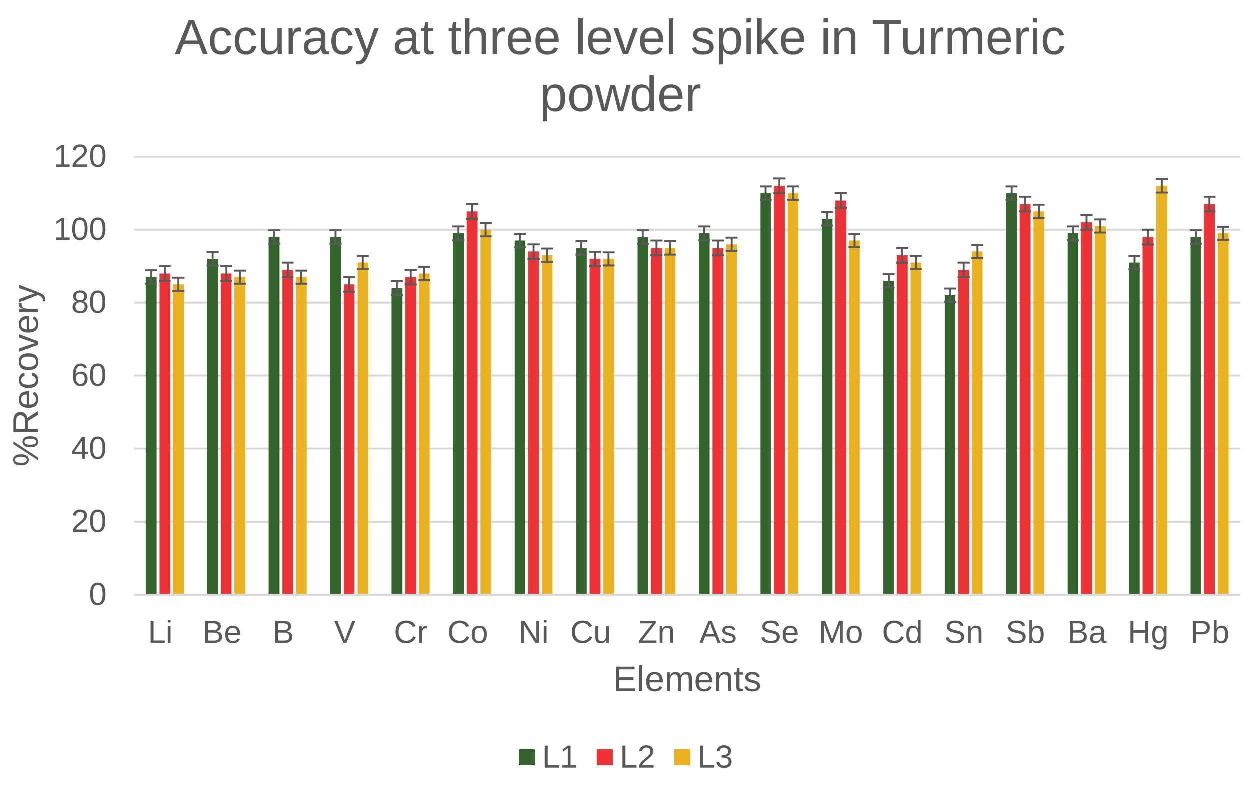


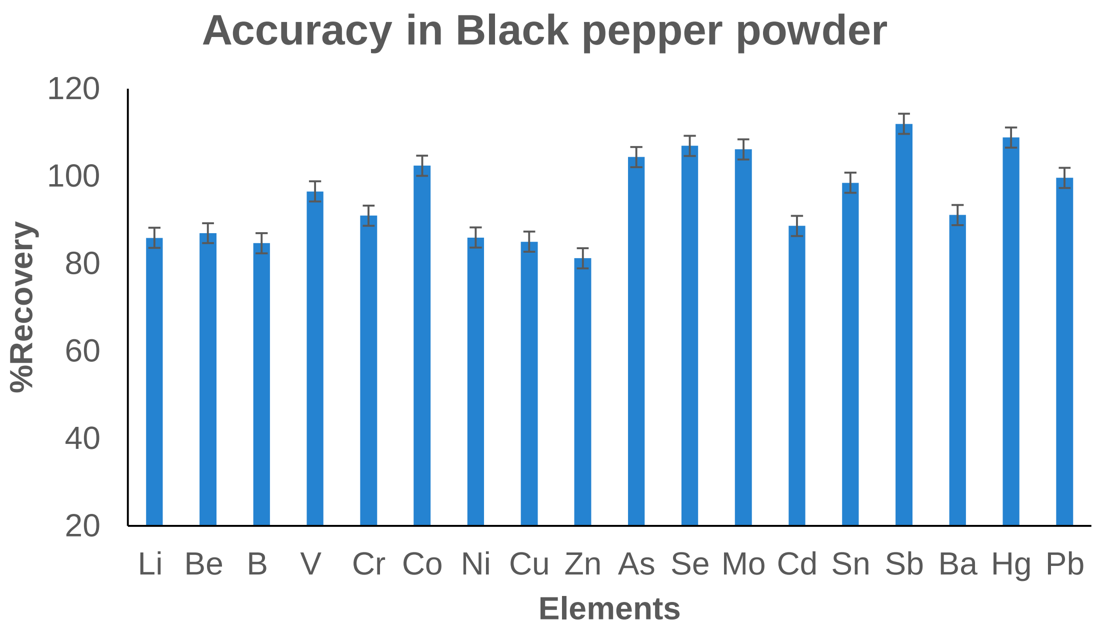
Buffalo meat
Accuracy @ LOQ is 89-110%
Precision @ LOQ is <10%

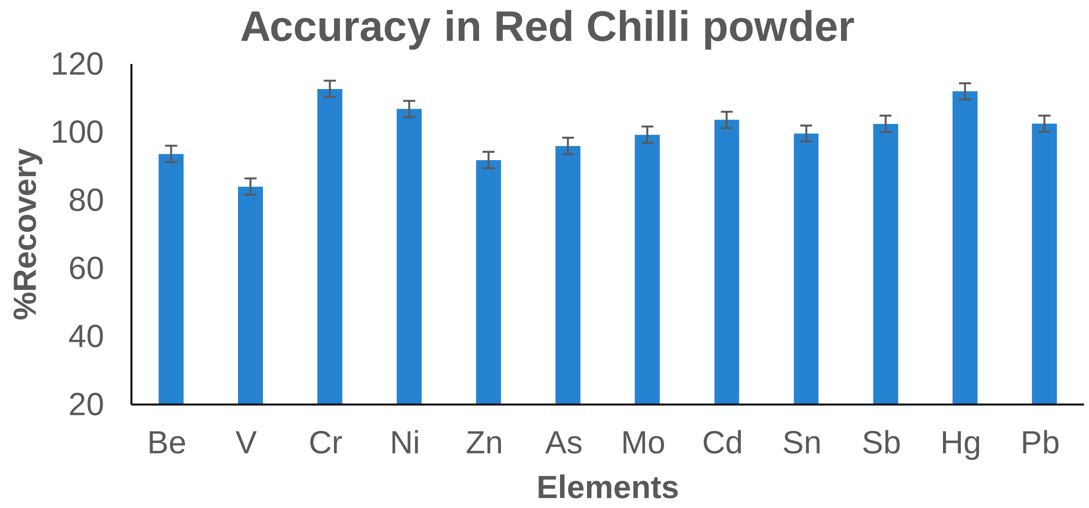
Spike Concentrations in Spices

Elements	Spike concentrations in $mgkg^{-1}$		
	L1 (LOQ)	L2	L3
Li, Be, B, V, Cr, Ni, Se, Mo	0.40	0.8	20.0
Co	0.125	0.25	1.0
Cu	1.5	3.75	30
Zn	10	20	200
As, Pb, Sb	0.02	0.04	2
Hg	0.02	0.05	1.0
Cd, Sn	0.01	0.02	1.0
Ba	0.8	2.0	20

Spike Concentrations in Spices







Turmeric powder, Black pepper powder, Red chilli powder
Accuracy @ LOQ is 80-112%
Precision @ LOQ is <10%

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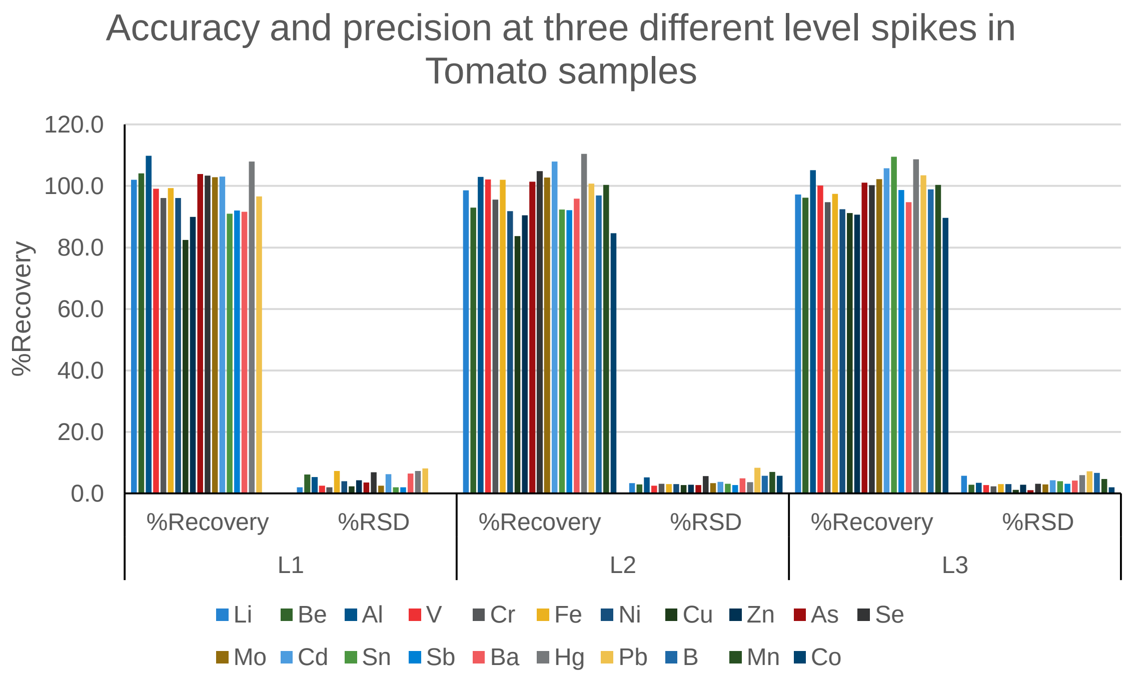
Spike Concentrations in Fruits and Vegetables

	Spike Conc (mg/kg)		
Element	**L1**	**L2**	**L3**
Li,Be,Ni,Mo,B, Ba	0.1	0.25	2
As	0.05	0.125	1
Al, Sn	3	7.5	60
V	0.25	0.5	2
Cr, Se	0.125	0.25	1
Fe, Cu, Zn	7.5	15	60
Co, Hg	0.002	0.005	0.04
Cd	0.005	0.0125	0.1
Sb, Pb	0.01	0.025	2

Spike Concentrations in Fruits and Vegetables

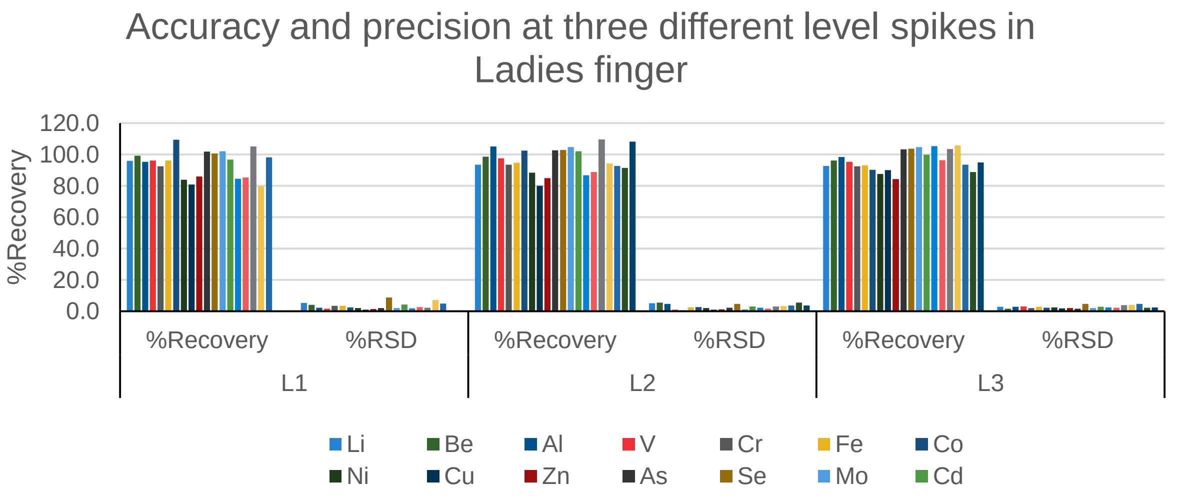
Elements	L1		L2		L3	
	%Recovery	%RSD	%Recovery	%RSD	%Recovery	%RSD
Li	102.0	2.0	98.6	3.4	97.2	5.7
Be	104.0	6.2	93.0	2.9	96.2	2.8
Al	109.9	5.4	103.0	5.3	105.1	3.4
V	99.1	2.6	102.1	2.5	100.1	2.8
Cr	96.1	2.0	95.6	3.1	94.7	2.3
Fe	99.3	7.3	102.0	3.0	97.5	3.0
Ni	96.1	4.0	91.8	3.0	92.4	3.0
Cu	82.4	2.3	83.7	2.7	91.2	1.2
Zn	89.9	4.3	90.5	2.8	90.7	2.9
As	103.9	3.5	101.3	2.7	101.1	1.1
Se	103.4	6.8	104.8	5.6	100.3	3.1
Mo	102.8	2.5	102.8	3.3	102.2	2.9
Cd	103.1	6.2	107.9	3.8	105.8	4.3
Sn	91.0	2.0	92.3	3.2	109.5	4.0
Sb	92.0	2.0	92.1	2.7	98.7	3.2
Ba	91.6	6.5	95.9	4.9	94.7	4.2
Hg	108.0	7.3	110.5	3.6	108.7	5.9
Pb	96.6	8.1	100.7	8.3	103.5	7.3
B	NA	NA	96.9	5.7	98.9	6.7
Mn	NA	NA	100.4	7	100.3	4.7
Co	NA	NA	84.6	5.7	89.7	2.0



Accuracy @ LOQ is 80-111%
Precision @ LOQ is <10%

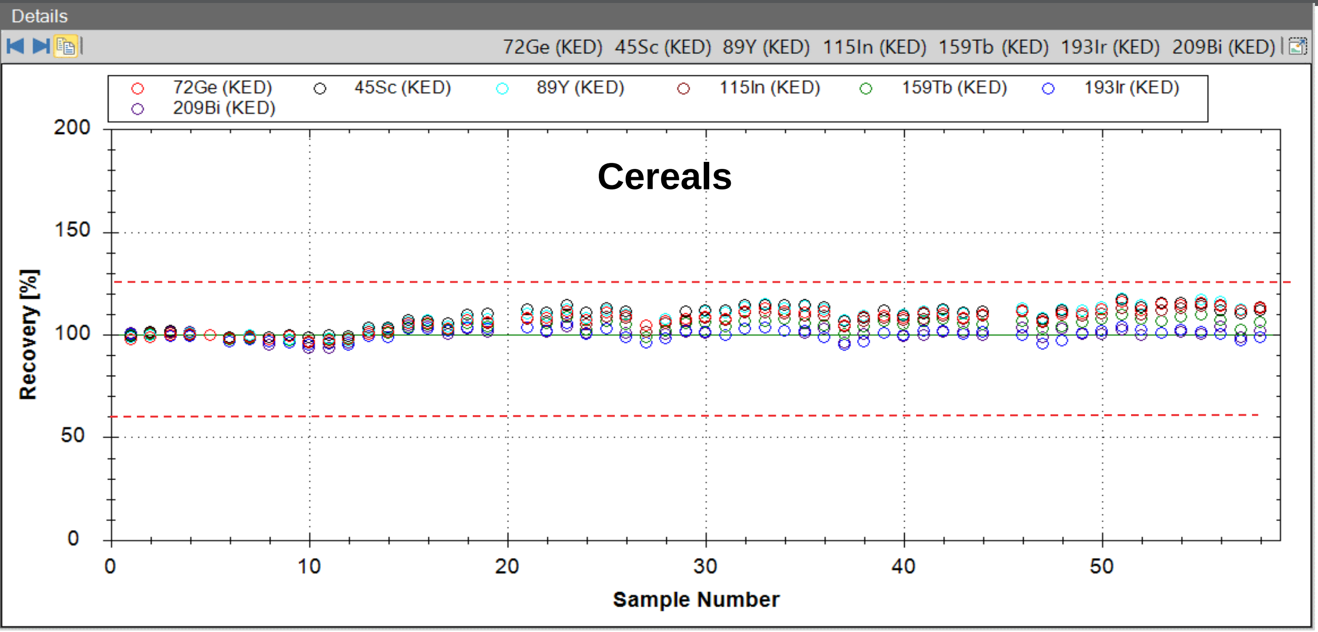
Spike Concentrations in Fruits and Vegetables

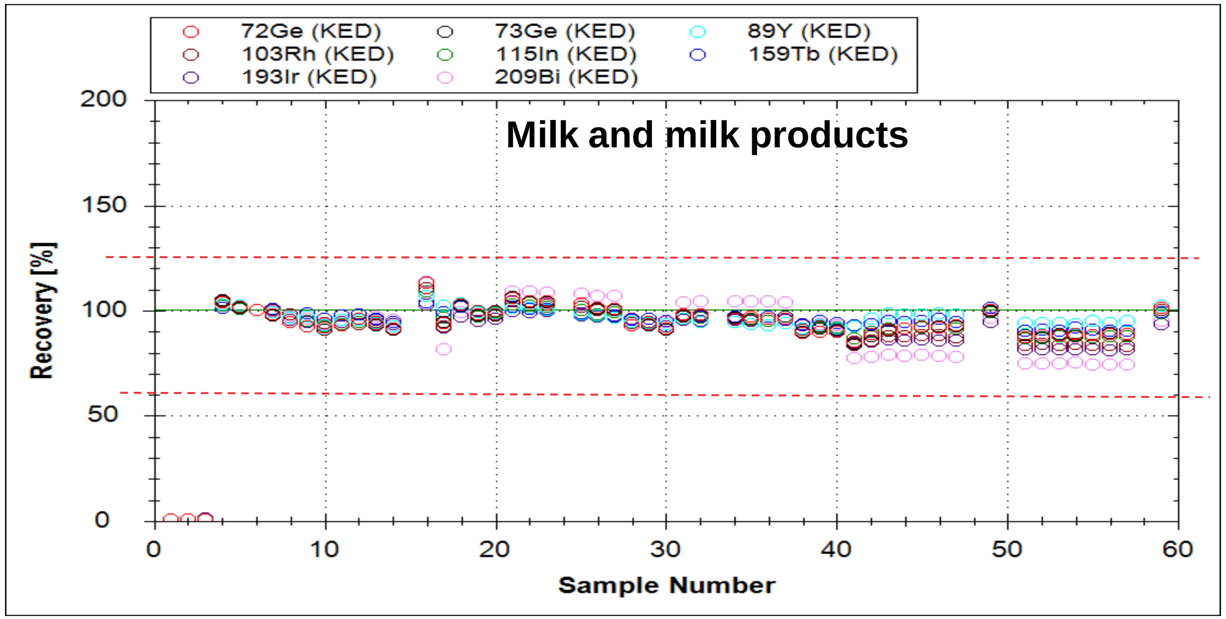
Ladies finger	L1		L2		L3	
Element	**%Recovery**	**%RSD**	**%Recovery**	**%RSD**	**%Recovery**	**%RSD**
Li	96.0	5.3	93.4	5.1	92.7	2.9
Be	99.3	4.1	98.6	5.5	96.3	1.7
Al	95.4	2.4	105.1	4.8	98.5	3.0
V	96.2	1.7	97.7	1.0	95.4	3.0
Cr	92.6	3.6	93.5	0.7	92.4	2.1
Fe	96.3	3.5	94.8	2.6	93.2	2.8
Co	109.4	2.4	102.5	2.8	90.3	2.3
Ni	84.0	2.1	88.5	2.0	87.7	2.5
Cu	81.0	1.2	80.0	1.1	90.1	1.9
Zn	86.0	1.5	84.9	1.2	84.3	2.0
As	101.9	2.2	102.7	2.2	103.4	1.8
Se	100.7	8.9	103.0	4.8	103.8	4.9
Mo	102.2	2.1	104.7	1.3	104.8	2.1
Cd	96.9	4.4	102.1	3.1	99.9	2.9
Sn	84.6	1.9	86.8	2.3	105.4	2.5
Sb	85.5	2.6	88.8	1.7	96.5	2.3
Ba	105.2	2.3	109.7	3.0	103.6	3.9
Hg	80	7.1	94.4	3.3	105.8	4.2
Pb	98.2	4.9	92.7	3.8	93.6	4.8
B	NA	NA	91.5	5.7	88.9	2.3
Mn	NA	NA	108.3	3.6	94.9	2.5

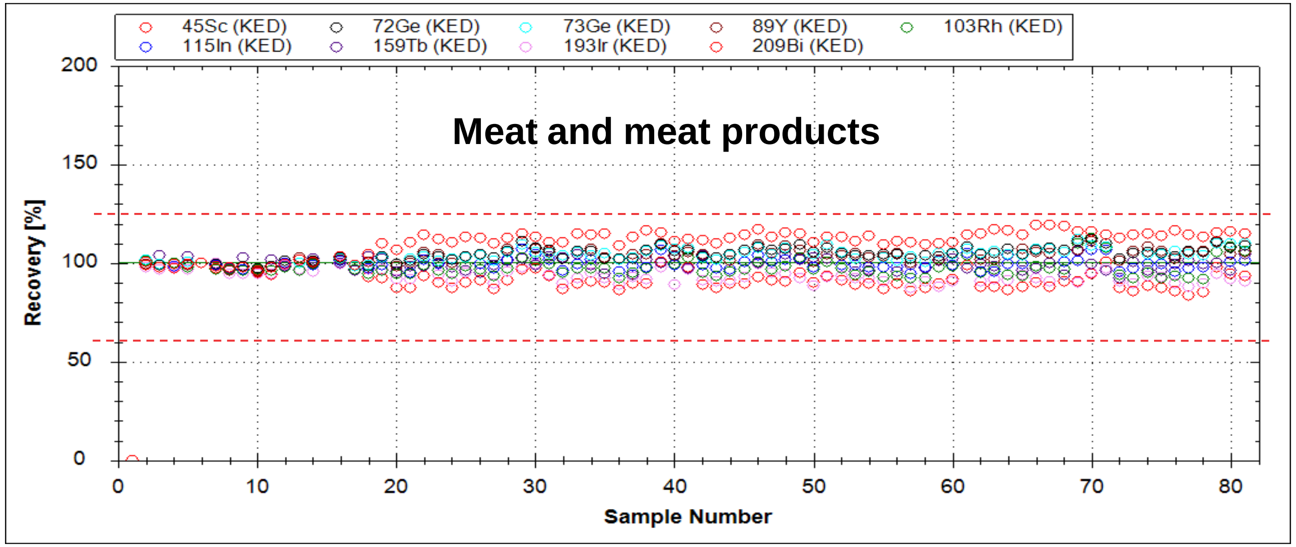


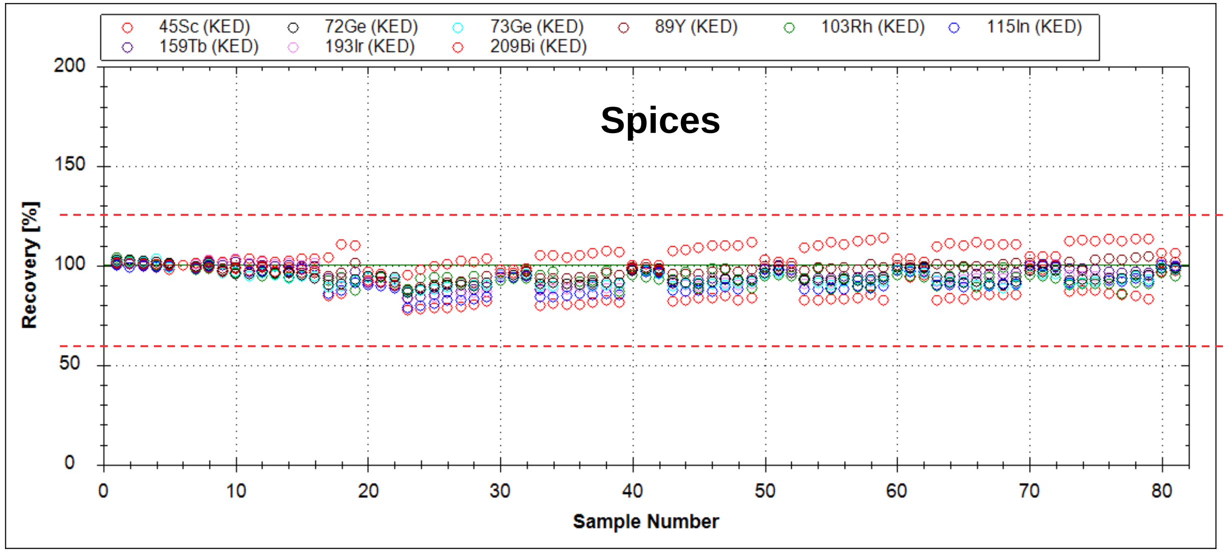
Accuracy @ LOQ is 80-110%
Precision @ LOQ is <10%

Internal Standard Response

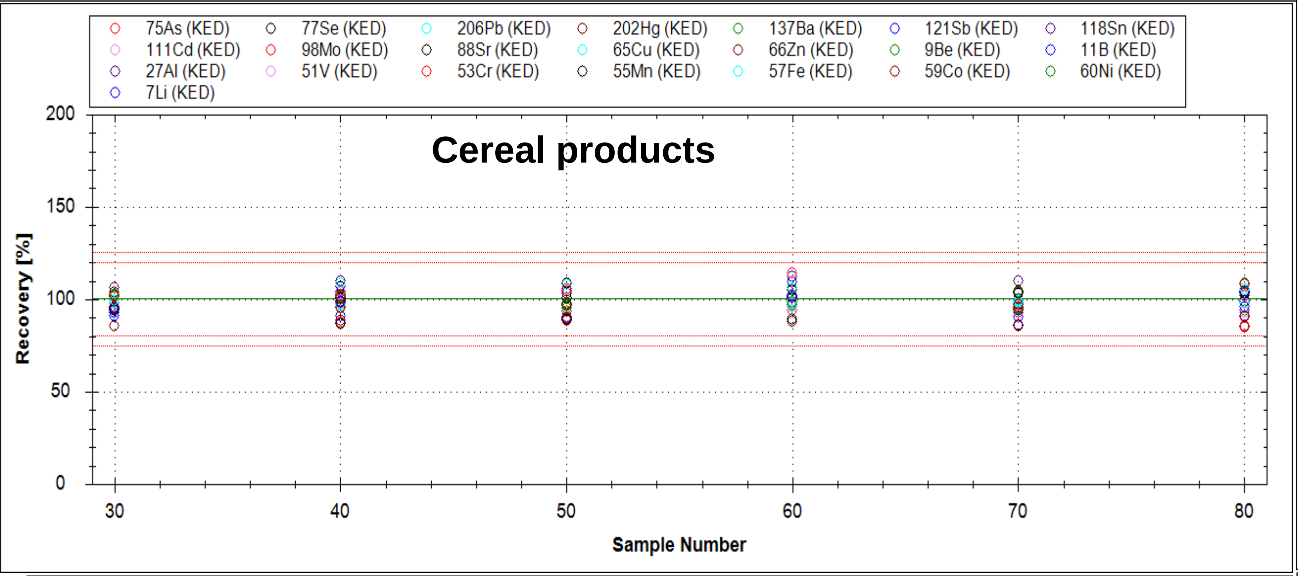


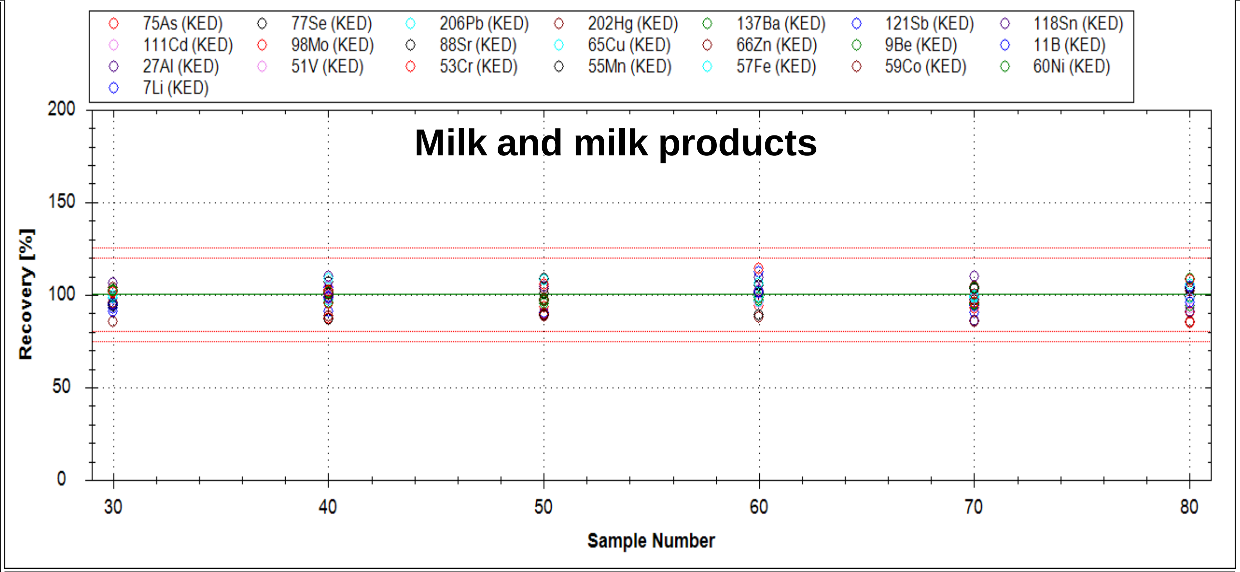


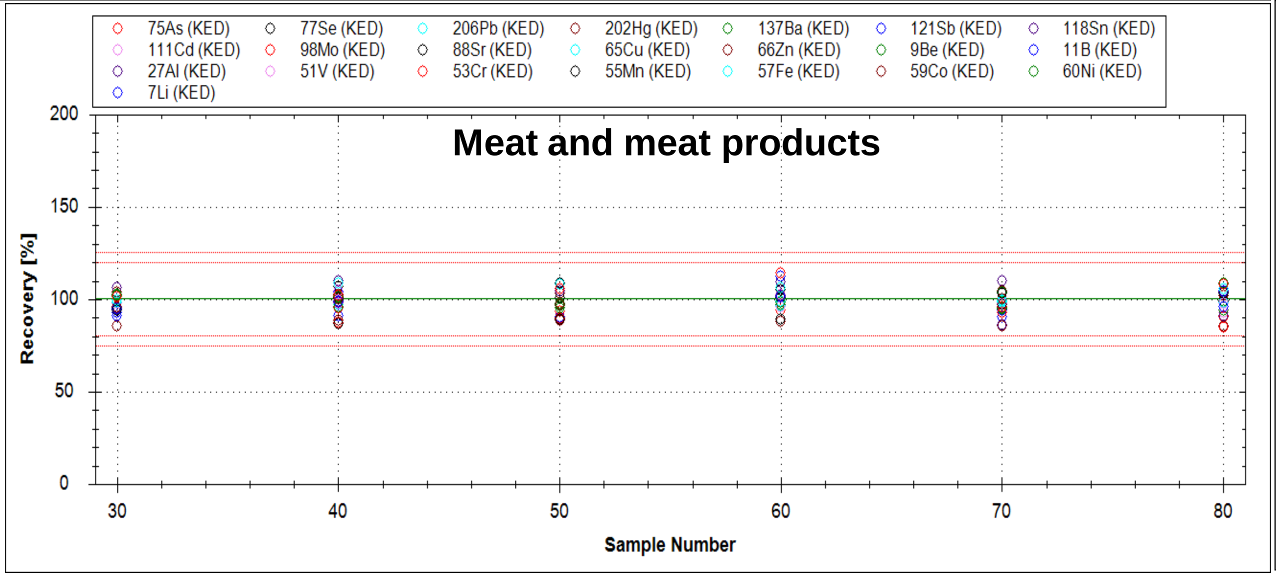


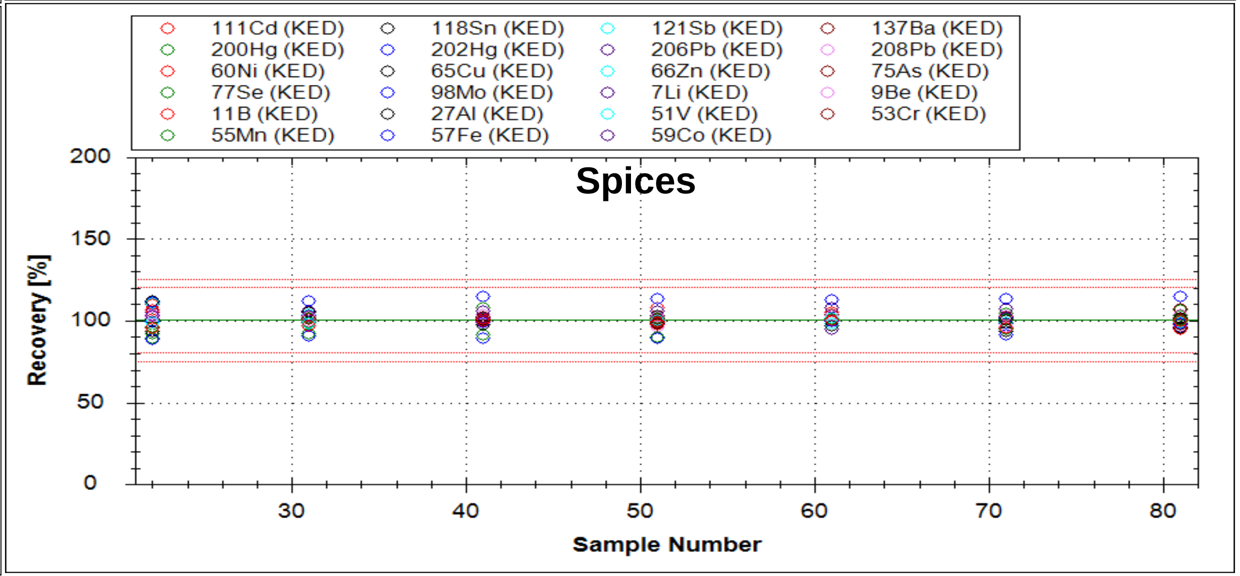


Sequence Accuracy with CCV Standard









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APPLICATION NOTE 73020

Low level quantification of trace metals in rice using ICP-MS

Authors
Suresh Murugesan and Dasharath Oulkar
Customer Solution Center, Ghaziabad,
Thermo Fisher Scientific, India

Keywords
Trace metals, rice, ICP-MS, KED, iCAP RQ, Qtegra

Goal
To demonstrate the capability of an ICP-MS for trace elemental analysis in rice in compliance with the AOAC Official Method 2015.01 validation guidelines and the Food Safety and Standards Authority of India (FSSAI), China Food and Drug Administration (CFDA), and European Union (EU) MRL requirements.

Introduction
Rice is an important staple food with global consumption of 518 million tons in 2016.[1] The main countries in which rice is a major part of the human diet are India and China. Consequently, the FSSAI, CFDA, and the European Commission (EC), have set maximum residue limits (MRLs) for heavy metals in rice as listed in Table 1.[2-4] Heavy metals can occur in rice as a consequence of uptake from agricultural soils contaminated by mining activities and sludge disposal. Processes such as milling and polishing, packaging, and transportation may also be a source of contamination. Contamination with toxic heavy metals in rice is a concern because of the possible adverse effects on human health. Scientists have reported health issues including coughing, anemia, and kidney failure, ultimately leading to death due to heavy metal contamination.[5,6] To verify and quantify the amount of toxic elements in rice, commercial food testing laboratories widely use a procedure based on

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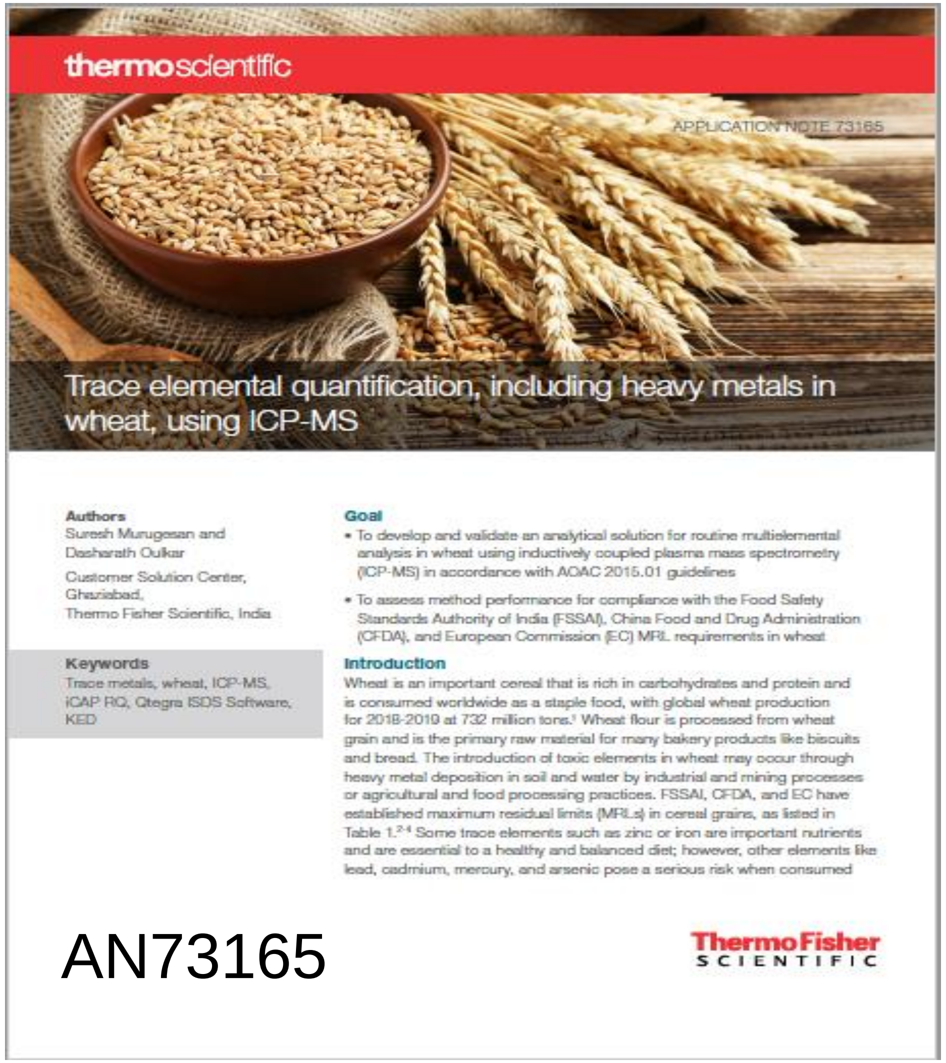

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APPLICATION NOTE 73165

Trace elemental quantification, including heavy metals in wheat, using ICP-MS

Authors
Suresh Murugesan and Dasharath Oulkar
Customer Solution Center, Ghaziabad,
Thermo Fisher Scientific, India

Keywords
Trace metals, wheat, ICP-MS, iCAP RQ, Qtegra ISDS Software, KED

Goal
- To develop and validate an analytical solution for routine multielemental analysis in wheat using inductively coupled plasma mass spectrometry (ICP-MS) in accordance with AOAC 2015.01 guidelines
- To assess method performance for compliance with the Food Safety Standards Authority of India (FSSAI), China Food and Drug Administration (CFDA), and European Commission (EC) MRL requirements in wheat

Introduction
Wheat is an important cereal that is rich in carbohydrates and protein and is consumed worldwide as a staple food, with global wheat production for 2018-2019 at 732 million tons.[1] Wheat flour is processed from wheat grain and is the primary raw material for many bakery products like biscuits and bread. The introduction of toxic elements in wheat may occur through heavy metal deposition in soil and water by industrial and mining processes or agricultural and food processing practices. FSSAI, CFDA, and EC have established maximum residual limits (MRLs) in cereal grains, as listed in Table 1.[2-4] Some trace elements such as zinc or iron are important nutrients and are essential to a healthy and balanced diet; however, other elements like lead, cadmium, mercury, and arsenic pose a serious risk when consumed

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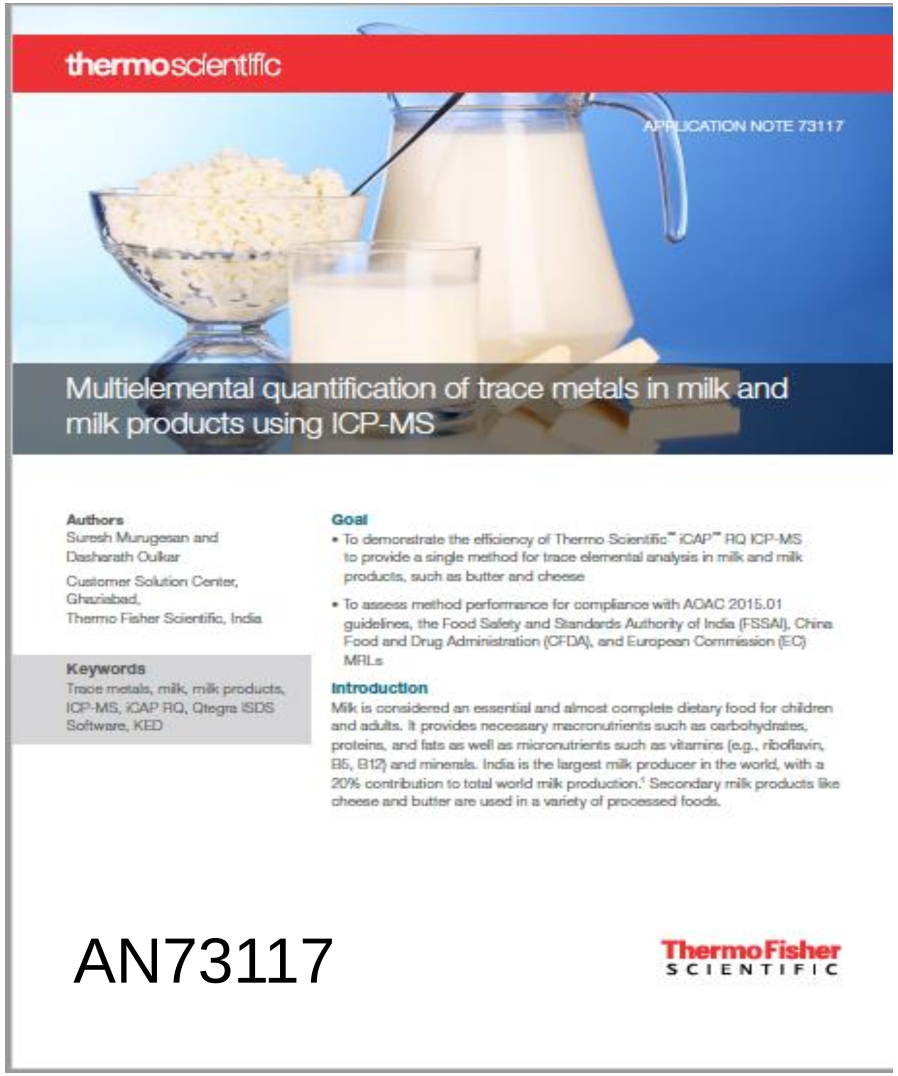
Application Notes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APPLICATION NOTE 73117

Multielemental quantification of trace metals in milk and milk products using ICP-MS

Authors
Suresh Murugesan and Dasharath Oulkar
Customer Solution Center, Ghaziabad, Thermo Fisher Scientific, India

Keywords
Trace metals, milk, milk products, ICP-MS, iCAP RQ, Qtegra ISDS Software, KED

Goal
- To demonstrate the efficiency of Thermo Scientific™ iCAP™ RQ ICP-MS to provide a single method for trace elemental analysis in milk and milk products, such as butter and cheese
- To assess method performance for compliance with AOAC 2015.01 guidelines, the Food Safety and Standards Authority of India (FSSAI), China Food and Drug Administration (CFDA), and European Commission (EC) MRLs

Introduction
Milk is considered an essential and almost complete dietary food for children and adults. It provides necessary macronutrients such as carbohydrates, proteins, and fats as well as micronutrients such as vitamins (e.g., riboflavin, B5, B12) and minerals. India is the largest milk producer in the world, with a 20% contribution to total world milk production.[1] Secondary milk products like cheese and butter are used in a variety of processed foods.

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APPLICATION NOTE 44459

Trace level quantification of multiple elements in meat and meat products using ICP-MS

Authors: Suresh Murugesan, Piyush Deokar, and Dasharath Oulkar
Customer Solution Center, Thermo Fisher Scientific, Ghaziabad, India

Keywords: Trace metals, meat, red meat, beef, chicken, goat meat, ICP-MS, Qtegra ISDS Software

Goal
The objective of this application note is to demonstrate the applicability of the Thermo Scientific™ iCAP™ RQ ICP-MS for the quantification of trace elements in meat and meat products at trace levels in compliance with the AOAC 2015.01 guideline, the Food Safety and Standards Authority of India (FSSAI),[1] China Food and Drug Administration (CFDA),[2] and European Commission (EC)[3] MRLs.

Introduction
The Food Outlook Report from FAO (Food and Agricultural Organisation) contains detailed information on the production, consumption, and price indices of meat. As per the report, in the year 2018, total meat production, including poultry, bovine, ovine, and pig meat, was 335 million tons, which is a 1.5% increase compared to 2017. Meat is an essential nutritional source of protein for humans and provides high biological protein, vitamins, and essential minerals such as iron and zinc. A diet containing 20 g of protein per day is considered a healthy diet. Though India is the second-largest vegetarian country after Bangladesh, the consumption of meat is rising as the result of increasing average income and urbanization. It is expected that per capita consumption will grow to 50 kg in 2050 globally. Poultry meat production alone is increasing annually greater than 4%. The overall meat production in India is 7.5 million tons, which is 2.2% higher than the year 2017.[4]

It is crucial to assure food safety while reducing malnutrition by increasing meat consumption. Expanded industrialization and urbanization are introducing more pollution to water bodies, and livestock may be prone to heavy metal contamination through contaminated water and feeds that grown in contaminated soil.

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Thank you

piyush.deokar@thermofisher.com

suresh.murugesh@thermofisher.com