

# The „**Big Four**“ Elements in **Cannabis** Determination of Arsenic, Cadmium, Lead and Mercury using ICPMS-2030

Introduction, Method Development, Results

# Background: Accumulation



**Contamination by:**  
 Groundwater  
 Industry (exhaust gases/sewage sludge)  
 Environmental pollution  
 Fertilizers / Pesticides

- Bioaccumulation during growing
- **Chernobyl**
  - Plants/animals:  
High levels of Cs-137 and Sr-90 as well as Pu
  - Phytoremediation:  
Targeted accumulation in plants
  - Besides corn and sunflowers, hemp was also used for bioremediation

# Background: Accumulation



Contamination by:  
Groundwater  
Industry (exhaust gases/sewage sludge)  
Environmental pollution  
Fertilizers / Pesticides

- Bioaccumulation during growing
- **Consumer goods** require steady quality monitoring
- „Big four“
  - Arsenic (As)
  - Cadmium (Cd)
  - Mercury (Hg)
  - Lead (Pb)
  - ...and more...

# Sample Preparation: Crushing

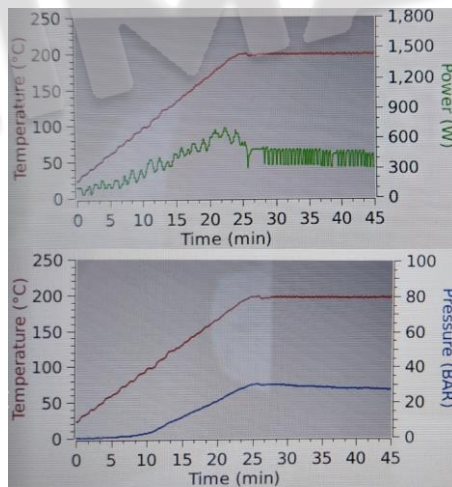
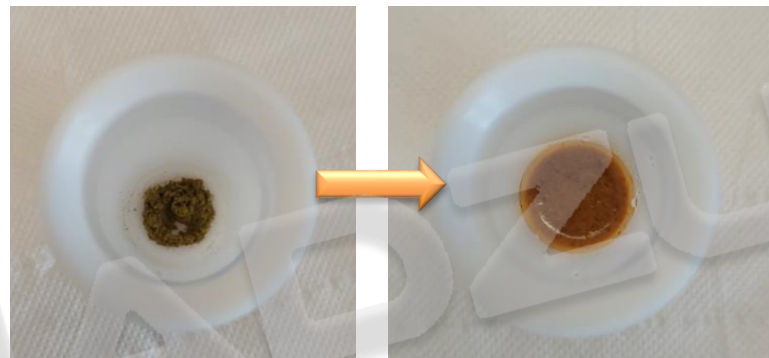
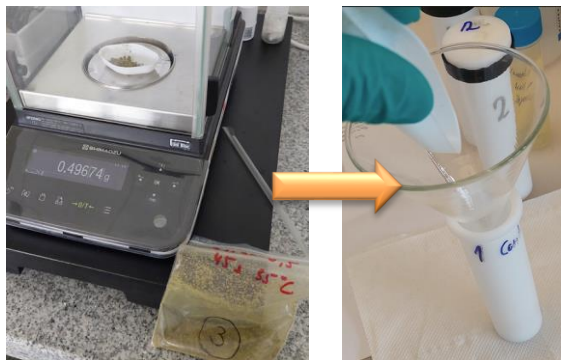


„GM“  
10 sec. 4000 rpm



„GM+X“  
10 sec. 4000 rpm  
+ 10 sec. 10000 rpm

# Sample Preparation: Digestion



## Digestion Method

0.5g sample

6ml H<sub>2</sub>O-HNO<sub>3</sub>-HCl-mix

# Method Development: **ICPMS-2030**



# ICPMS-2030: Safe Ressources



## 30-40% Argon Reduction

Conventional torch: 15~20 L/min => **Shimadzu Mini torch: < 11 L/min**

## 25% Less RF-Power

Conventional RF-Power: 1.6 kW => **Shimadzu Mini torch: 1.2 kW**



## Further savings by Eco-Mode “pause mode”

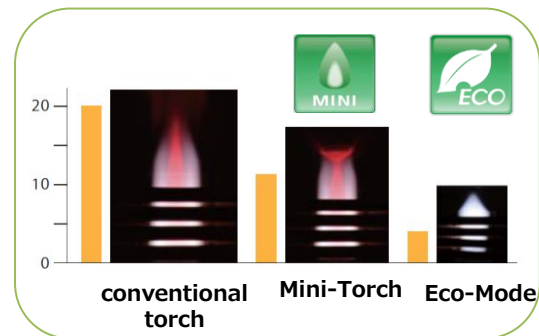
RF-Power 0.5kW and  
Plasma gas at 5 L/min



## Low Argon quality required

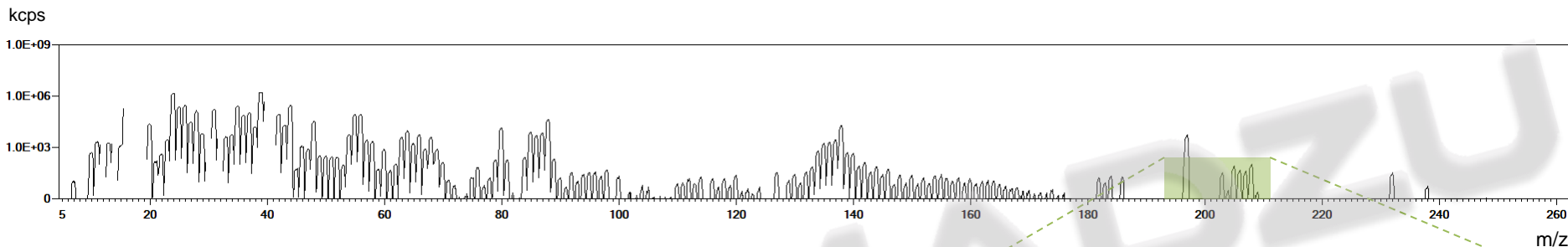
Industrial grade is sufficient (Ar > 99.95%)

Expensive 99,999%-Argon (Ar 5.0) can be avoided





# Full Spectrum Scan (qualitative mode)

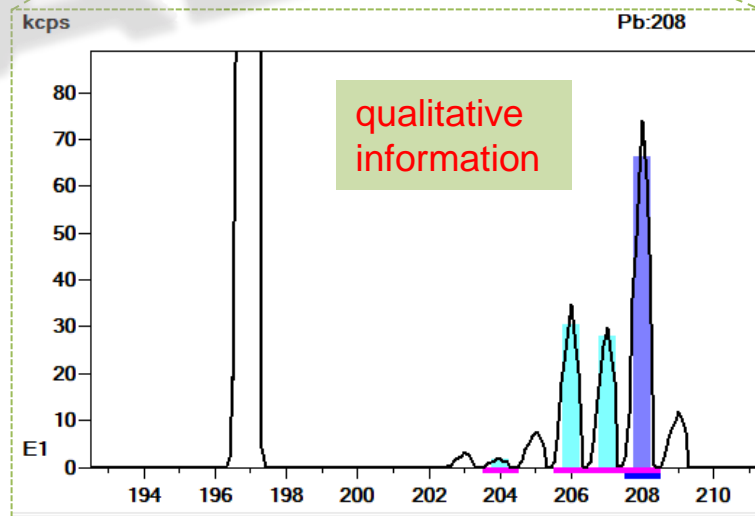


Class	Repeat Num	Sample Name	Pos
UNK	3	Blank	R1
UNK	3	GM	002
UNK	3	GM+X	003



Database:  
semi-quantitative!

Sample Name	Ag Qual uo/L	Al Qual uo/L	As Qual uo/L	Au Qual uo/L	B Qual uo/L	Ba Qual uo/L	Be Qual uo/L	Bi Qual uo/L	Br Qual uo/L	Ca Qual uo/L	Cd Qual uo/L
Blank	< 0.074	(0.14) +	< 0.29	54	4.7	< 0.044	< 0.047	< 0.0086	(6.0)	< 210	< 0.068
GM	< 0.074	590 +	< 0.29	54	230	130 +	< 0.047	(0.012)	< 5.3	55000 +	(0.65) +
GM+X	< 0.074	540 +	< 0.29	52	230	130 +	< 0.047	(0.012)	(20) +	61000 +	(0.57) +





# Method Development Assistant



Development Assistant - Select Analysis Elements

Start

Blank Sample:

Analysis Statistics:

	Element	Maximum Concentration	Detection
1	Ag	(0.12) ug/L	YES
2	Al	1500 ug/L	YES
3	As	<0.29 ug/L	NO
4	Au	54 ug/L	YES
5	B	230 ug/L	YES
6	Ba	140 ug/L	YES
7	Be	(0.048) ug/L	YES
8	Bi	(0.53) ug/L	YES
9	Br	(20) ug/L	YES
10	Ca	61000 ug/L	YES
11	Cd	(0.85) ug/L	YES
12	Ce	2.2 ug/L	YES
13	Cl	2700000 ug/L	YES
14	Co	(1.6) ug/L	YES
15	Cr	99 ug/L	YES
16	Cs	(0.15) ug/L	YES
17	Cu	94 ug/L	YES
18	Dy	(0.17) ug/L	YES
19	Er	(0.068) ug/L	YES
20	Eu	(0.053) ug/L	YES
21	Fe	1000 ug/L	YES
22	Ga	<0.96 ug/L	NO

Elements to be Analyzed:

	Element	Quantitation Upper Limit	Unit
1	As	3.000000	ug/L
2	Cd	2.000000	ug/L
3	Pb	6.000000	ug/L
4	Hg	0.7000000	ug/L

Select an element to analyze from [Analysis Statistics] and click [Add].  
When the upper limit concentration of the calibration curve is changed, correct the concentration value of [Upper Limit].

1. Analysis Elements

2. IEC Standards

3. Internal Standards

4. Calibration Curve

5. Create Method

Finish

Add>>

<<Delete

< Back Next > Cancel

# Method Development Assistant



1. Analysis Elements

2. IEC Standards

3. Internal Standards

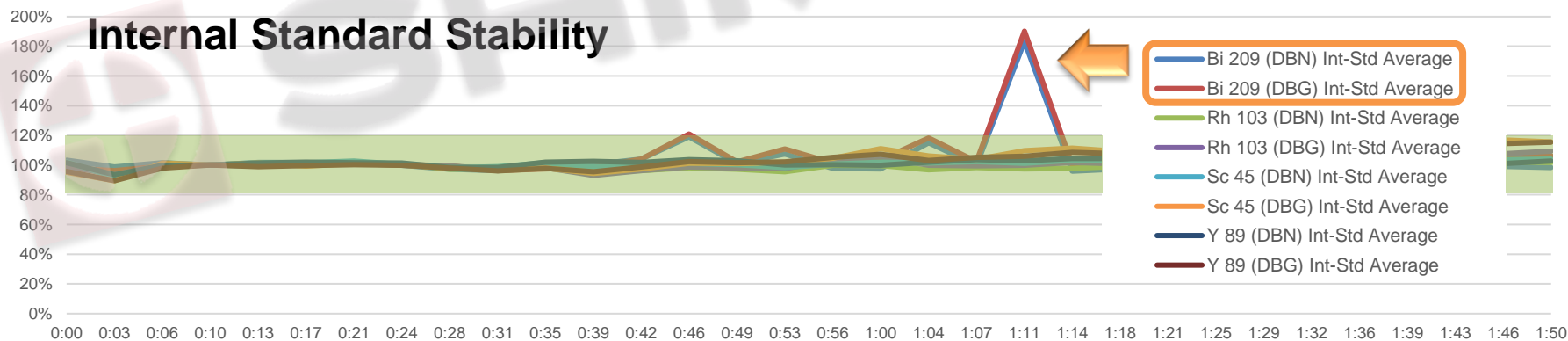
4. Calibration Curve

Internal Standard Element Recommended Concentration:

	Element	Recommended Concentration	Use
1	Sc	200.0000 ug/L	<input checked="" type="checkbox"/>
2	Co	-	No Use
3	Ga	100.0000 ug/L	<input type="checkbox"/>
4	Ge	100.0000 ug/L	<input type="checkbox"/>
5	Y	-	No Use
6	Rh	5.000000 ug/L	<input checked="" type="checkbox"/>
7	In	10.000000 ug/L	<input type="checkbox"/>
8	Te	200.0000 ug/L	<input type="checkbox"/>
9	Tb	5.000000 ug/L	<input type="checkbox"/>
10	Ho	5.000000 ug/L	<input type="checkbox"/>
11	Lu	5.000000 ug/L	<input checked="" type="checkbox"/>
12	Ti	-	No Use
13	Bi	-	No Use

IntStd:

Quantitation Element	Internal Standard Element
1	As Rh Sc
2	Cd Rh Lu
3	Pb Lu
4	Hg Lu



# Method Development Assistant



Number of Calibration-Curve Standards: 5

Name / Concentration of Calibration-Curve Standards:

	Element	Measurement Mass	Unit	CAL1	CAL2	CAL3	CAL4	CAL5
1	As	75	ug/L	0.000000	0.500000	1.000000	2.500000	5.000000
2	Cd	114	ug/L	0.000000	0.200000	0.400000	1.000000	2.000000
3	Pb	208	ug/L	0.000000	1.000000	2.000000	5.000000	10.000000
4	Hg	198	ug/L	0.000000	0.100000	0.200000	0.500000	1.000000
5	Hg	199	ug/L	0.000000	0.100000	0.200000	0.500000	1.000000

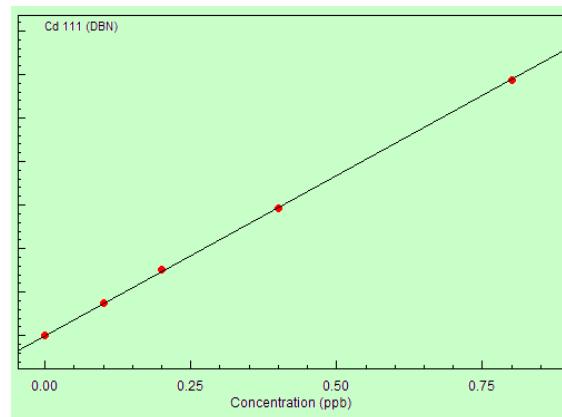
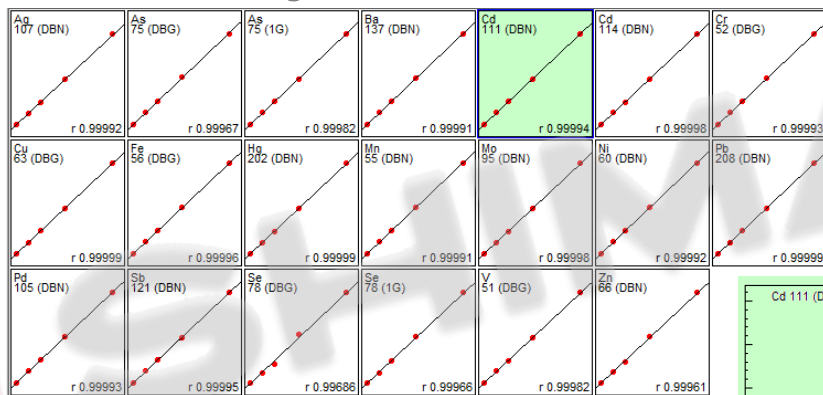
File name: 01\_Cannabis Method

Save as type: ICP Method file (\*.imm)

Hide Folders

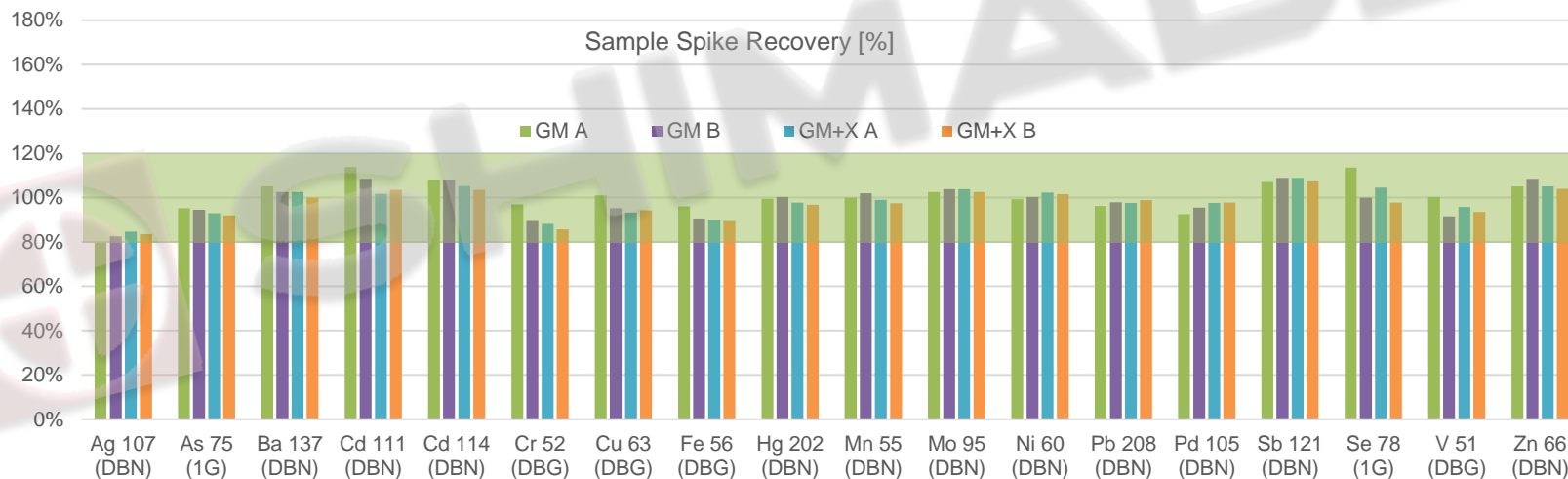
# ICPMS-2030 Cannabis Method

- Besides „**Big four**“ in total **17 elements** are determined
- Overall Linearity  $r > 0.999$



# ICPMS-2030 Cannabis Method

- Further elements can be added upon requirements
- Successfull spike-recovery
  - Usual 80%-120% recovery criterion



# ICPMS-2030 Cannabis Methode

- The method sensitivity is many times below the requirements of most strict regulations:

Element	inhalable* [ppm]	Other application types* [ppm]	ICPMS-2030 MQL** [ppm]
As	0.2	1.5	<b>0.040</b>
Cd	0.2	0.5	<b>0.015</b>
Hg	0.1	3.0	<b>0.015</b>
Pb	0.5	0.5	<b>0.005</b>

\*limit value for cannabis in State California (US), in accordance with typical pharmaceutical guidelines like USP<232>

\*\*Sample dilution of sample preparation is considered. Criterion: Necessary concentrations to reach 1500 counts

# ICPMS-2030 Results

- The results fall below the limit values

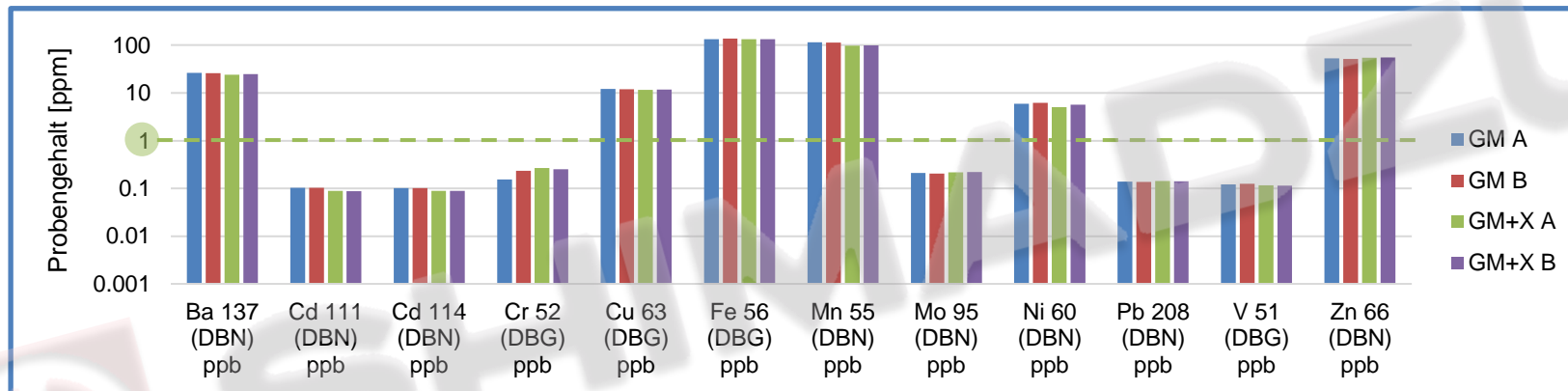
Element	inhalable [ppm]	Other application types [ppm]	Sample „GM“	Sample „GM+X“
As	0.2	1.5	<b>0.01 &lt; X &lt; 0.04</b>	<b>0.01 &lt; X &lt; 0.04</b>
Cd	0.2	0.5	<b>0.103</b>	<b>0.089</b>
Hg	0.1	3.0	<b>0.005 &lt; X &lt; 0.015</b>	<b>0.005 &lt; X &lt; 0.015</b>
Pb	0.5	0.5	<b>0.138</b>	<b>0.142</b>





# ICPMS-2030 Results

- Duplicates shows perfect matching for elements > MQL



0.5 g  
 „GM“  
 10 sec. 4000 rpm



0.5 g  
 „GM+X“  
 10 sec. 4000 rpm  
 + 10 sec. 10000 rpm

# Take care by grinding selection

- **Result of further evaluation of different milling types:**
  - **Mercury:** When not using kryo-conditions the level was decreased to 30% compared to manual shredding (achat mortal),
  - **Arsenic:** Using Zirkon-based grinding tool showed slightly increased As-levels
  - Using Steel-based grinding tools affects **Chromium, Molybdenum** and **Antimony**
- **Use the mill for similar applications!**
  - Some effect might be present due to multiple use of the mills (even the grinding tools were pre-cleaned)
- **Kryo-conditions are indispensable**

# Disclaimer



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