Microwave-assisted Acid Digestion of Cannabis Products

Due to the continuously growing prevalence of cannabis not only for medical use the quantitative measurement of element contaminations is also increasingly required.

The use of HVT vessels with SMART VENT technology offers a convenient and reliable sample preparation option prior to spectroscopic analysis.

1 Introduction

Cannabis, one of the earliest cultivated plants, originates from central Asia or northern parts of south Asia.

Being quite robust, the plant has since not only been used as medicine, but also for food-, textile-, and many other industries. Starting in the 19th century the significance of cannabis as medication increased considerably having shown beneficial effects in the treatment of pain, mood disorders, and inflammatory diseases.

However, when other medicinal products such as morphine or opium were found to be harmful for the human metabolism and thus considered poisonous, the use of cannabis was also declared illegal in 1925.

In the last decades the prohibition of cannabis has been scrutinized and meanwhile sanctioned for medical use in Germany, the Netherlands, the Czech Republic, the UK, Israel and in some US states. Uruguay, Canada and Georgia are the first countries to already fully legalize the use of cannabis.

Since most of the final products of cannabis are designed for human consumption, cannabis-based products such as oral medications, edibles, oils, tinctures and salves as well as the plants and plant materials itself must therefore be tested for the presence of heavy metals and other elements to ensure consumer safety and product quality.

In order to demonstrate the suitability of HVT vessels with SMART VENT technology for sample preparation of cannabis prior to element analysis the recovery rates of spiked samples were determined by BloomLabs by Perennia Food and Agriculture Inc., which is a Health Canada approved Cannabis QA facility that provides quality assurance on cannabis for licensed producers in Canada.

2 Instrumentation

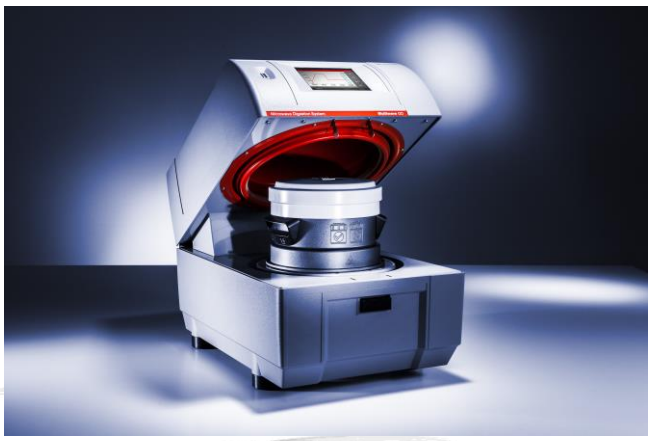

Figure 1: Multiwave GO

The digestions were carried out in HVT50 vessels using Rotor 12HVT50 in Multiwave GO.

The digestion solutions were measured with an ICP-MS system equipped with a micromist nebulizer and a Peltier cooled spray chamber.

Figure 2: Rotor 12HVT50

3 Experimental

3.1 Samples

Several strains of cannabis products:

- Dried bud (four different samples)
- Kief
- Trimmings
- Shake

3.2 Digestion Procedure

All samples were immersed in liquid nitrogen until the gassing calmed down and afterwards were milled into a fine powder.

For the unspiked samples approximately 0.2 g of the respective material were weighed into the HVT vessels and covered with 5 mL of conc. nitric acid.

For the spiked samples approximately 0.1 g of the respective material was taken. Additionally 0.1 mL of a 10 ppm solution of Be, Ti, V, Cr, Co, Ni, As, Se, Mo, Ag, Cd, Sn, Sb, Cs, La, Ce, Nd, Sm, Eu, Dy, Gd, Ho, Er, Lu, Hg, Tl, Pb, Th, and U as well as 0.1 mL of a 100 ppb solution of Hg and again 5 mL of conc. nitric acid were pipetted into the vessel.

After the digestion 1 ml of conc. hydrochloric acid was added to each vessel. The solutions were transferred to a sample tube and filled up to 45 mL with deionized water and measured on the ICP MS (n=3).

For the preparation of all solutions trace metal grade acids were used.

For calculating the recovery rates the experimental spike concentrations (spiked sample value minus unspiked sample value) were calculated in percent in relation to the theoretical spike concentrations (0.222 ppb for Hg and 22.2 ppb for all the other elements).

3.3 Temperature Program

Step	Ramp [min]	Temperature [°C]	Hold [min]
1	20:00	180	10:00
2	---	70	---

Table 1: Temperature Program "Organic A"

4 Results

All samples were completely digested as well as clear and colourless upon dilution.

The results are presented in relation to the classification mentioned in the respective chapters of the United States Pharmacopoeia (USP), the European Pharmacopoeia (Ph. Eur.) as well as the respective guideline of the International Conference on Harmonisation of Technical Requirements for Registration of Pharmaceuticals for Human Use (ICH).

The respective documents (USP <232> Elemental Impurities - Limits, Ph. Eur 5.20. Elemental Impurities and ICH Q3D, Guideline for Elemental Impurities) divide a certain number of elements into 4 classes (class 1, 2A, 2B and 3). Particular attention is given to the ubiquitously occurring impurities of Class 1, the so-called "big four" - Cd, Pb, As and Hg - and the metals of Class 2A - Co, V and Ni since all of them are highly toxicologically relevant.

USP <233> Elemental Impurities - Procedures, Ph.Eur. 5.20 and ICH Q3D state that the recovery rates of spiked samples have to be between 70 % and 150 % and the relative standard deviations (RSD) have to be not more than 20 %.

Regardless of the respective kind of cannabis all individual values lie well within the mentioned specifications. On average the recovery rates lie at 100.5 % for Class 1 and Class 2A elements and at 100.9 % for all elements whereas the lowest value is 85.2 % and the highest 119.3 %. On average the relative standard deviations lie at 1.8 %, with 7.3 % as the highest value.

Sample		Cd [µg/]	Pb [µg/]	As [µg/]	Hg [µg/]
Dried Bud 1	Measured Value	24.4	22.4	24.4	23.6
	Theoretical Value	22.2	22.2	22.2	0.222
	Recovery [%]	**110**	**101**	**110**	**106**
	RSD [%]	**1.0**	**0.4**	**0.6**	**1.7**
Dried Bud 2	Measured Value	21.3	20.0	21.6	22.4
	Theoretical Value	22.2	22.2	22.2	0.222
	Recovery [%]	**95.8**	**90.0**	**97.3**	**101**
	RSD [%]	**1.9**	**2.4**	**2.2**	**1.2**
Dried Bud 3	Measured Value	23.3	21.9	24.2	23.1
	Theoretical Value	22.2	22.2	22.2	0.222
	Recovery [%]	**105**	**98.4**	**109**	**104**
	RSD [%]	**0.8**	**1.2**	**1.9**	**2.4**
Dried Bud 4	Measured Value	23.5	22.0	23.8	25.6
	Theoretical Value	22.2	22.2	22.2	0.222
	Recovery [%]	**106**	**99.0**	**107**	**115**
	RSD [%]	**0.5**	**1.2**	**0.6**	**3.5**
Kief	Measured Value	20.7	20.9	22.4	22.5
	Theoretical Value	22.2	22.2	22.2	0.222
	Recovery [%]	**93.3**	**94.1**	**101**	**101**
	RSD [%]	**2.3**	**3.9**	**2.5**	**5.7**
Trimmings	Measured Value	21.6	21.4	22.6	0.3
	Theoretical Value	22.2	22.2	22.2	0.222
	Recovery [%]	**97.1**	**96.4**	**102**	**111**
	RSD [%]	**1.3**	**2.5**	**1.3**	**0.6**
Shake	Measured Value	22.5	22.2	23.3	23.6
	Theoretical Value	22.2	22.2	22.2	0.222
	Recovery [%]	**101**	**100**	**105**	**106**
	RSD [%]	**0.6**	**0.4**	**1.2**	**2.0**

Table 5: Recovery Rates and RSDs (n=3 measurements per sample) for Class 1 Elements

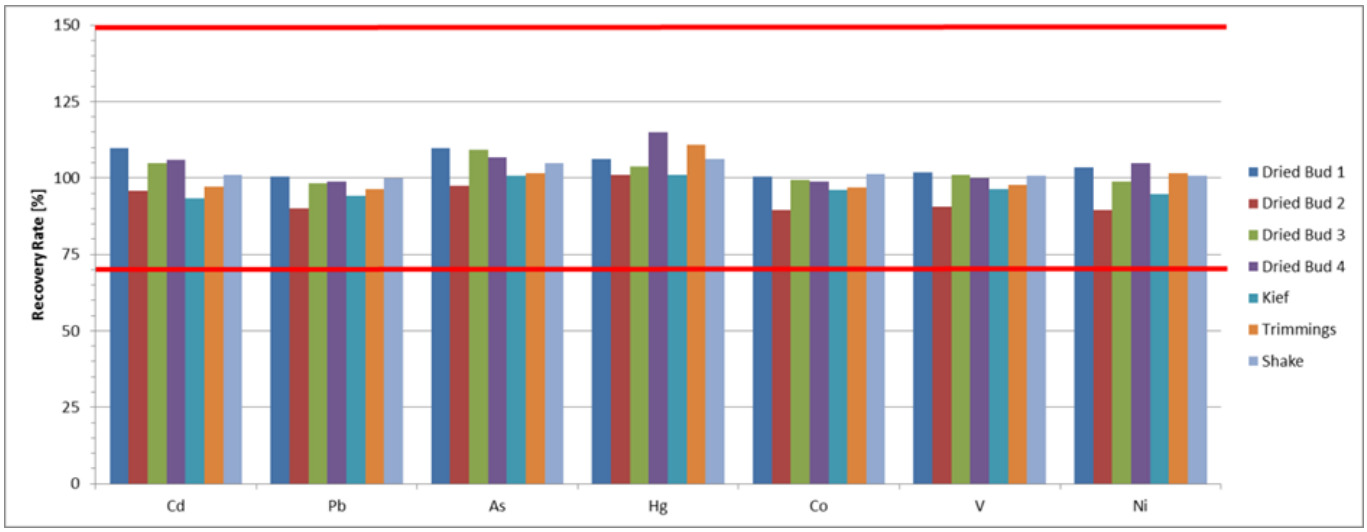

Figure 3: Recovery Rates for Class 1 and 2A Elements

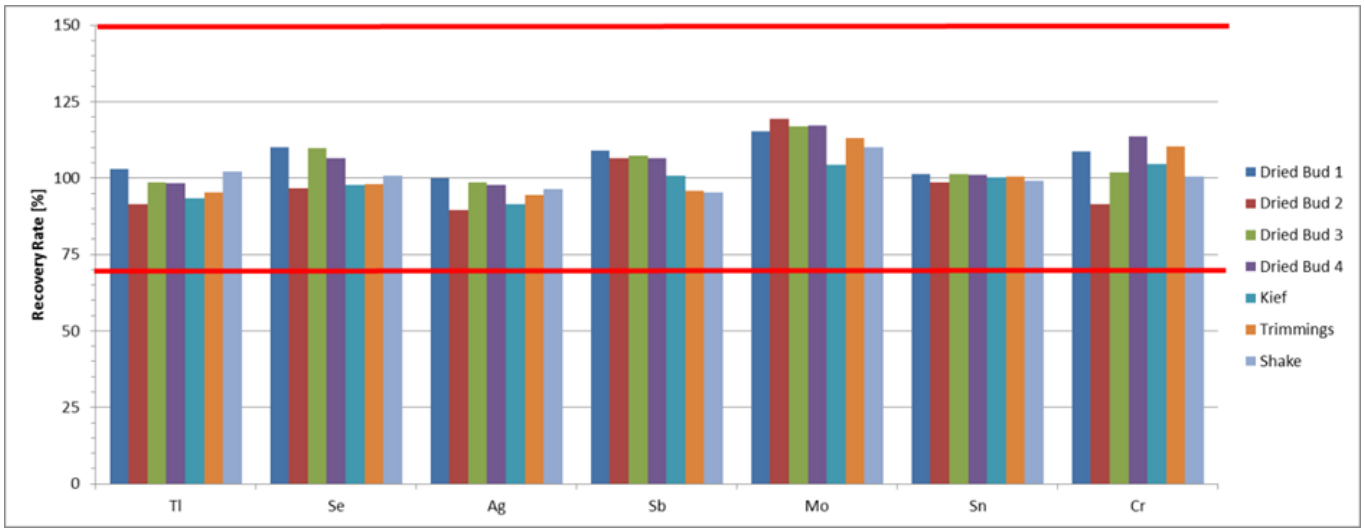

Figure 4: Recovery Rates for Class 2B and 3 Elements

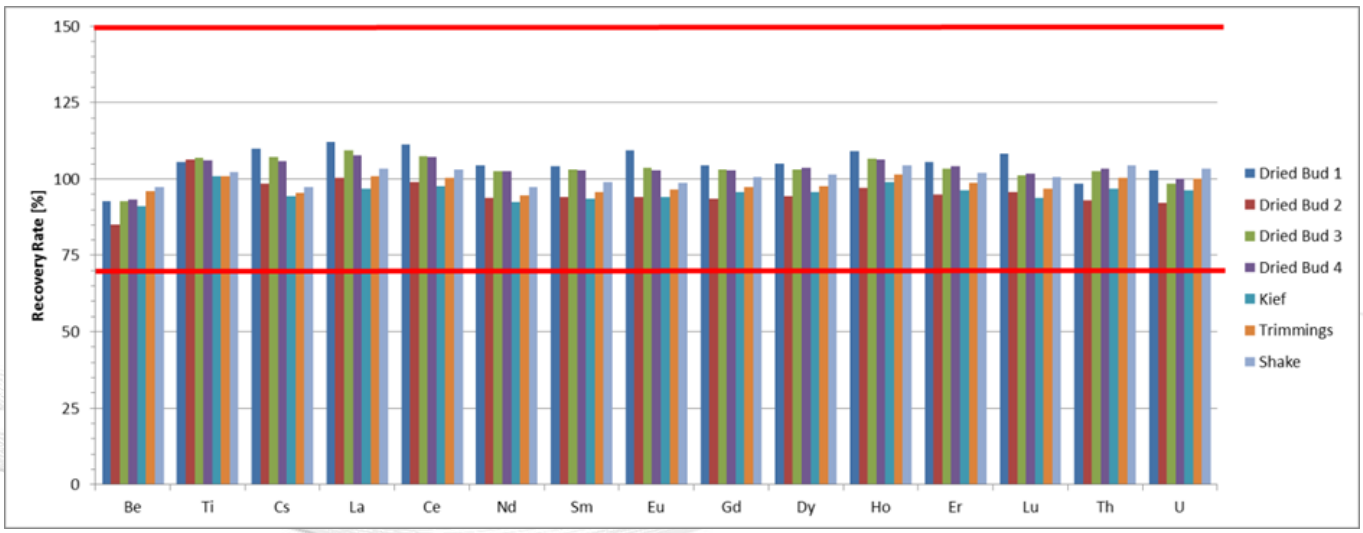

Figure 5: Recovery Rates for Other Elements

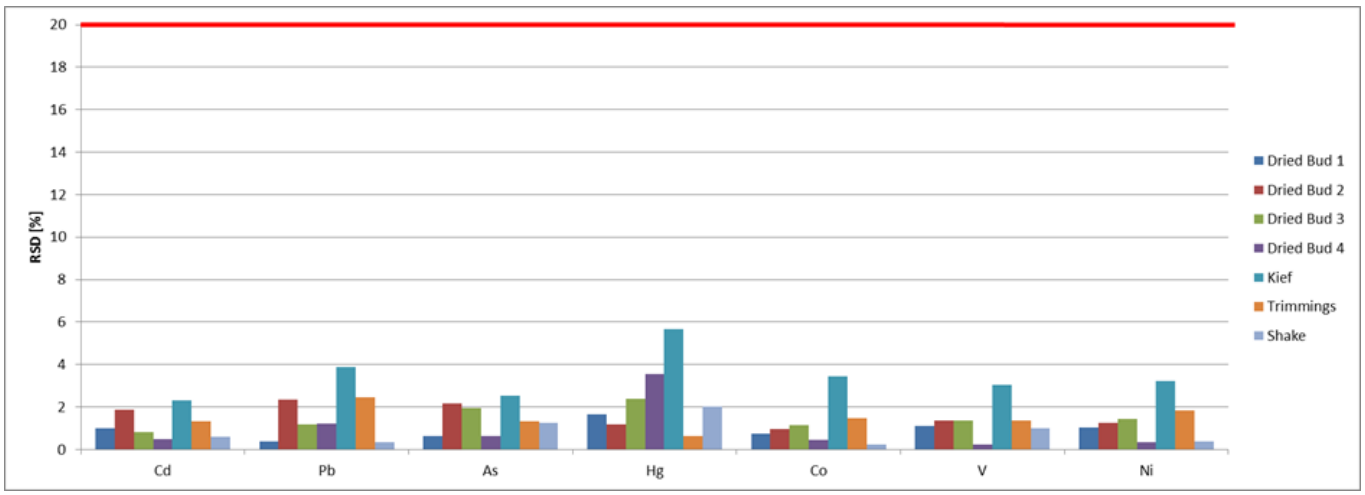

Figure 6: Relative Standard Deviations for Class 1 and 2A Elements

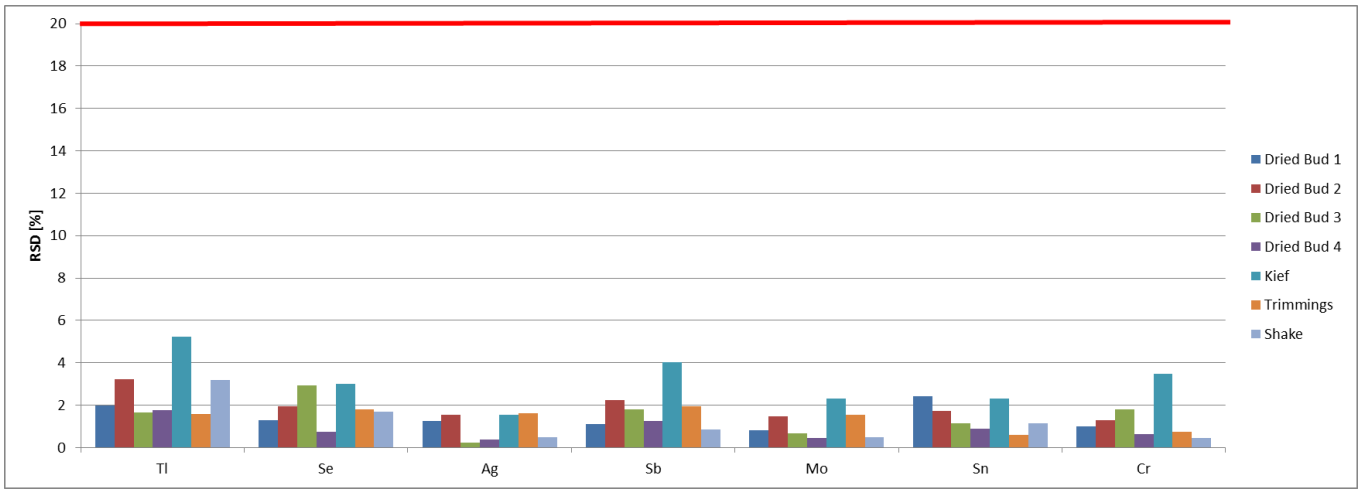

Figure 7: Relative Standard Deviations for Class 2B and 3 Elements

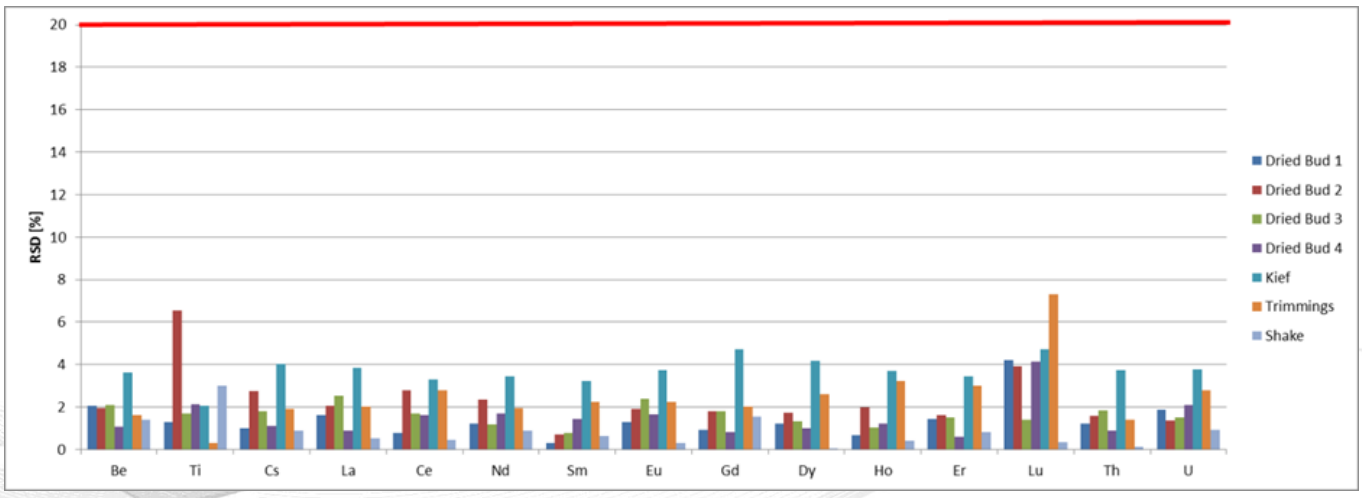

Figure 8: Relative Standard Deviations for Other Elements

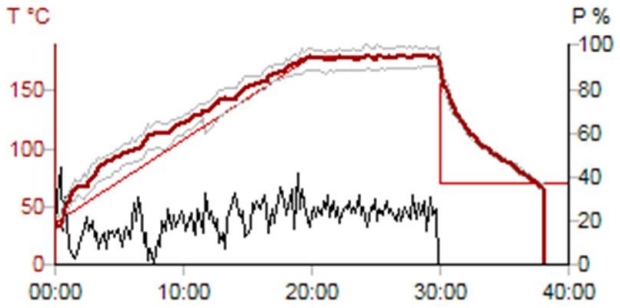

Figure 9: Run Data, Cannabis Sample

5 Conclusion

The suitability of microwave-assisted closed vessel digestion using HVT vessels with SMART VENT Technology on Multiwave GO combined with ICP-MS was successfully verified on seven different strains of cannabis.

Recovery rates of spiked samples (29 elements) between 85 % and 119 % combined with low variations (average RSD of 1.8%) were achieved. These values lie well between the defined limits of USP <233>, Ph. Eur. 5.20 and ICH Q3D (70 to 150 % for the recovery and NMT 20% for the RSD).

The mentioned procedure can be easily transferred to Multiwave PRO using HVT vessels in Rotor 24HVT50 and 41HVT56 enabling even higher throughput (24 and 41 samples per run).

6 References

We acknowledge BloomLabs by Perennia Food and Agriculture Inc., 173 Bernie MacDonald Drive, Bible Hill, NS, B6L 2H5, Canada greatly for doing all the experiments.

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