Heavy Metals Determination in Industrial Hemp by ICP-MS

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Introduction

- Plants retain and are unable to degrade heavy metals in their digestive cycle due to their long-lasting half-lives.[1]
- Because *Cannabis* plants are often used for phytoremediation, the genus accumulates and absorbs metals and pollutants with great efficiency.[2]
- With no federal testing regulations, state governments are setting protocols to determine permissible action limits for the testing of publicly sold marijuana products
- By using ICP-MS analyzation methods, it is hypothesized that trace levels of heavy elements such as mercury (Hg), lead (Pb), cadmium (Cd), arsenic (As), nickel (Ni), and chromium (Cr) will be found in industrial grade hemp.

Methods

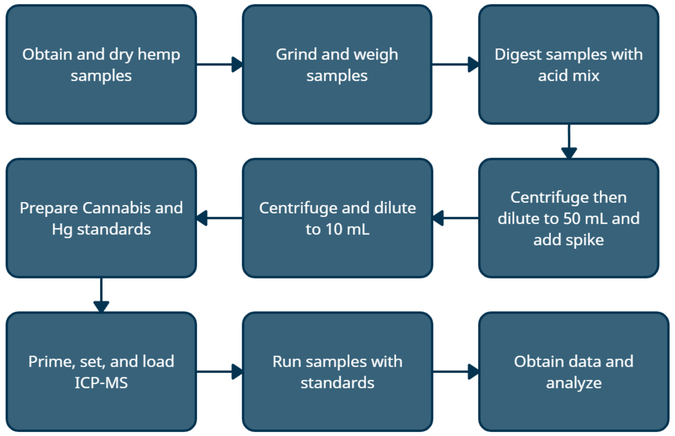

Figure 1: Hemp Analysis Methodology

Table 1: Preparation of Cannabis Standards [3]

	1	2	3	4	5	6	
Conc. (mg/L)	0	0.1	0.2	2	10	20	Mineral Elements
Conc. (mg/L)	0	0.0005	0.001	0.1	0.05	0.1	Trace Elements
Conc. (mg/L)	0	0.00005	0.0001	0.0005	0.001	0.002	Hg - Mercury

Table 2: ICP-MS Operating Conditions

Parameter	Value
RF power (W)	1600
Sampling depth (mm)	10
Carrier gas (L/min)	0.80
Dilution (HMI) gas (L/min)	0.15
Helium cell gas (mL/min)	4.3
Energy discrimination (V)	3.0

Results

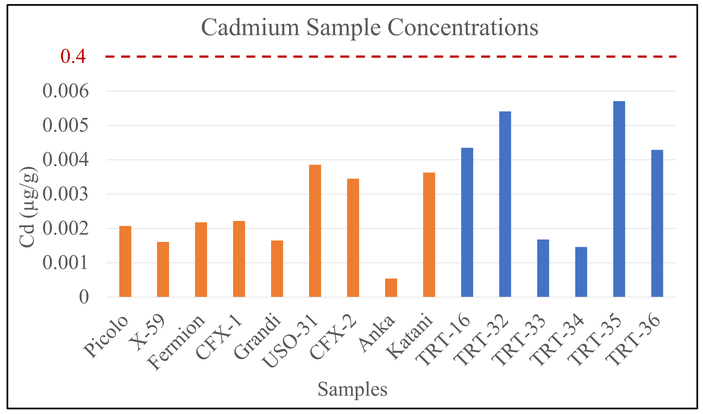

Figure 2: Trace cadmium comparison among samples

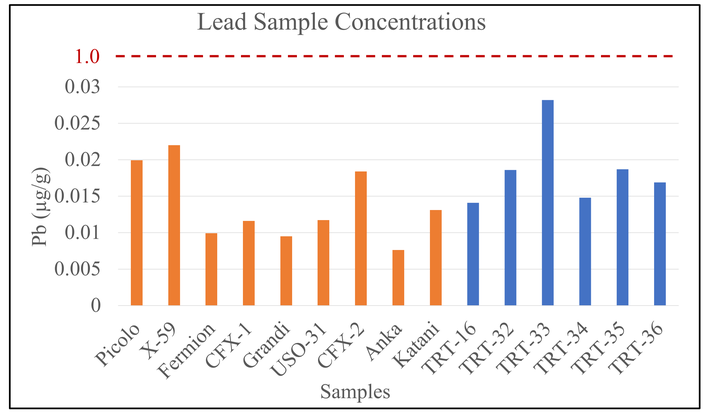

Figure 3: Trace lead comparison among samples

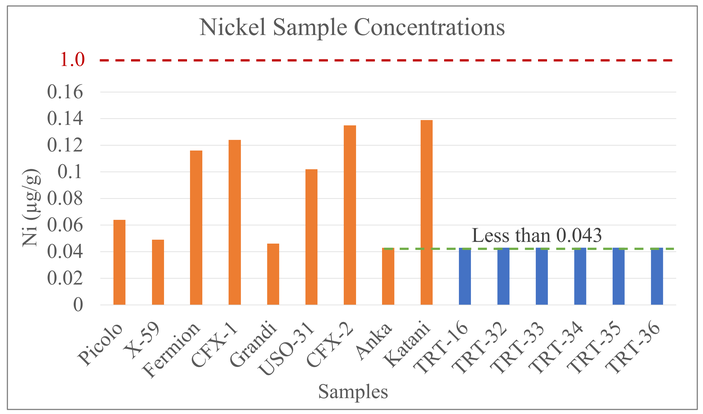

Figure 4: Trace nickel comparison among samples

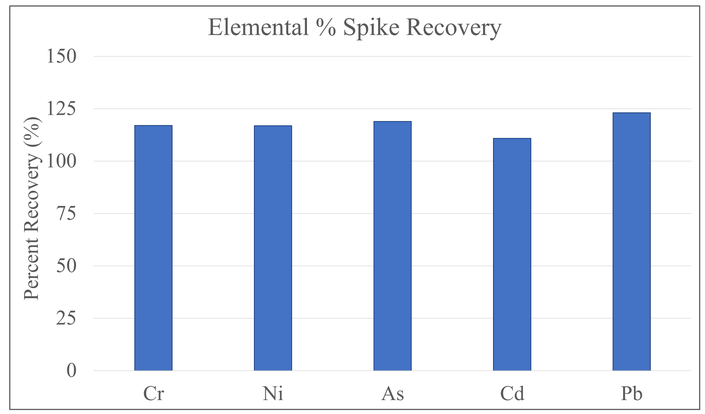

Figure 5: Elemental Comparison of Spike Recovery

- Less than 0.0017 µg/g of mercury was reported in all samples.
- Apart from 3 samples, less than 0.070 and 0.042 µg/g of arsenic and chromium, respectively, were reported in all other samples.
- The samples were separated into 2 batches; the samples were grown in Chatham, Michigan at Michigan State University – Upper Peninsula Research and Extension Center (MSU-UPREC). Batch 1, in orange, was obtained in Oct 2019 and Batch 2, in blue, was obtained in Oct 2020.

Discussion

- Issues regarding spike recovery values: difference in spike and regular sample masses.
- Systematic recovery error, may be due to dilution pipetting errors.
- Remedial methods may include individual elemental spike, adjustments in ICP-MS analysis programming, and mathematically correcting.
- In the future, cannabis method can be altered to include more isotopes

Conclusion

- Future work will include minimizing contamination issues, assessing interferences, and adjusting methods to be more thorough in results.
- Methodology associated with hemp can be directly applied to marijuana
- In the samples analyzed, all passed Michigan action limits for marijuana products

References

[1] Amaral, A.; Rodrigues, A. **2005**, BioMetals 18:199–206
[2] McPartland, J. M.; McKernan, K. J. *Cannabis sativa L. - Botany and Biotechnology* **2017**, 457– 474.
[3] DeDecker, J.; Stawara, A.; Bear, T.; Southwell, B.; Yanni, S.; Bear-Schnieder, R.; Kapp, C.; Bahrman, A. 202 Hemp TRIM – CBD Hemp Cultivar Trial. **2020**