The Importance of Measuring Heavy Metal Contaminants in Cannabis and Hemp Consumer Products

Robert Thomas, Scientific Solutions

Note: *This article has been summarised from the author's new book, Measuring Heavy Metal Contaminants in Cannabis and Hemp available from CRC Press/Taylor and Francis (https://www.routledge.com/Measuring-Heavy-Metal-Contaminants-in-Cannabis-and-Hemp/Thomas/p/book/9780367417376).*

The cannabis and hemp industry is moving at such an alarming rate that analytical testing is struggling to keep up. It is estimated that the demand for medicinal cannabis products will exceed $25 billion in the US by 2025. However, because the US FDA has not been actively involved in the regulatory process, it has been left to individual states to ensure products are safe for human consumption.

Unfortunately, many of the states where cannabis is legal do not have the expertise to fully-understand all the safety and toxicological issues regarding the production of cannabinoid products on the market today. Besides the need to characterise its potency, it's also important to measure heavy metals, because cannabis will avidly accumulate elemental contaminants from the growing medium, fertilisers, and even the equipment used to process the various concentrates. For that reason, it's critically important to monitor heavy metals in cannabis, hemp and the multitude of cannabinoid products on the market today.

Regulating Cannabis and Hemp

Medical cannabis is legal in 36 states in the US. However, there are many inconsistencies with heavy metal limits in different states where cannabis is grown and processed. The majority of states define four heavy metals (lead, arsenic, cadmium, and mercury), while others require more. Some base their limits directly in the cannabis, while others are based on human consumption per day. Others take into consideration the consumer's body weight, while some states do not even have heavy metal limits. Certain states only require heavy metals in the cannabis flower, while some give different limits for the delivery method used (oral, inhalation, or transdermal). This makes it extremely difficult to regulate, because currently all regulations apply only in the state where the cannabis is grown, processed, and sold. And since the United States Drug Enforcement Administration (DEA) still considers cannabis a Schedule I drug, there can be no interstate commerce.

What can be learned from the Pharmaceutical Industry?

So clearly there is a need for more consistency across state lines, particularly as the industry inevitably moves in the direction of federal regulation. The cannabis industry can learn a great deal from the pharmaceutical industry, as it went through the process of updating its 100-year old test for a small suite of heavy metals to eventually arrive at a list of 24 elemental impurities in drug products.

These procedures were described in United States Pharmacopeai (USP) Chapters <232>, <233 and the International Council for Harmonization of Technical Requirements for Pharmaceuticals for Human Use (ICH) Q3D) guidelines on elemental impurities. These new directives defined maximum permitted daily exposure (PDE) limits based on well-established elemental toxicological data for different drug delivery methods together with analytical methodology using either inductively coupled plasma optical emission spectrometry (ICP-OES) or inductively coupled plasma mass spectrometry (ICP-MS) to carry out the analysis. This meant that pharmaceutical manufacturers were required to not only understand the many potential sources of heavy metals in raw materials and active pharmaceutical ingredients (APIs), but also to know how the manufacturing process contributed to the elemental impurities in the final drug products.

The beginning of the journey to comprehensively regulate elemental impurities in pharmaceuticals began in the late 1990s, after the industry had been using a semi-quantitative colorimetric sulphide precipitation test for heavy metals for over 100 years. The cannabis industry is in a similar position today, where the source of elemental contaminants is not fully understood. In particular, the elemental toxicological guidelines to regulate the cannabis industry are being taken very loosely from pharmaceutical, food, cosmetics and environmental monitoring regulations. However, consumers of cannabis products are using them in very different quantities compared to drug products, which typically have a maximum daily dosage. The bottom line is that heavy metal toxicological data generated for drugs over a number of decades cannot simply be transferred to cannabis and its products. As an example, USP chapter <232> bases its maximum PDE limits for orally delivered drugs on 10 grams per day. This is a meaningless figure for someone who is consuming cannabis edibles where one brownie or cookie is probably in excess of 10 grams.

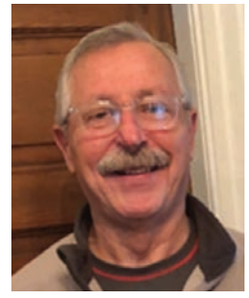
An added complication is that the cannabis and hemp plant can not only absorb heavy metals from the growing medium, but also from contaminants in fertilisers, and nutrients, as well as from other environmental pathways. Additionally, the process of cutting, grinding, and preparing the cannabis/hemp flowers for extraction/distillation/purification of the cannabinoid can often pick up other elemental contaminants. It has also been reported that some cultivators will use nutrients containing metal-based bud/flower enhancers, which would not be detected by the state regulatory process. It's also worth pointing out that the equipment used to deliver these products to consumers such as vaping pens/sticks, can often expose the user to additional sources of elemental contaminants from corrosion of metallic components inside these devices at elevated vaping temperatures.

Phytoremediation Properties of Cannabis and Hemp

Because cannabis and hemp are known to be hyper-accumulators of contaminants in the soil they have been used to clean up toxic waste sites where other kinds of remediation attempts have failed. In the aftermath of the Chernobyl nuclear melt down in the Ukraine in 1986, industrial hemp was planted to clean up the radioactive isotopes that had leaked into the soil and ground waters. Of course Chernobyl is an extreme example of elemental contamination, but as a result of normal anthropogenic industrial activities over the past few decades, heavy metal pollution has become one of the most serious environmental problems today. And with all the diverse and varied indoor and outdoor conditions used for growing cannabis, it will be very difficult to eliminate all these potential sources of contamination.

So there is no question that the current suite of four heavy metals being required by state-based regulators is totally inadequate to ensure cannabis products are fit for human consumption. Based on evidence in the public domain, there are about 15 heavy metals found in natural ecosystems and from industrial activities that could be potential sources of contaminants in the plant. Their levels of toxicity would need to be investigated further, but there is a case to be made that the majority of them could be the future basis of a federally regulated panel of elemental contaminants in cannabis…but will this actually happen…only time will tell!

About the Author



Robert (Rob) Thomas is the principal of Scientific Solutions, a consulting company that serves the educational needs of the trace ele¬ment user community. He has worked in the field of atomic and mass spectroscopy for more than 45 years, including 24 years for a manufacturer of atomic spectroscopic instrumentation. He has served on the American Chemical Society (ACS) Committee on Analytical Reagents (CAR) for the past 20 years as leader of the plasma spectrochemistry, heavy metals task force, where he has worked very closely with the United States Pharmacopeia (USP) to align ACS heavy metal testing procedures with pharmaceutical guidelines.

Rob has written over 100 technical publications, including a 15-part tutorial series on ICP-MS. He is also the editor and frequent contributor of the Atomic Perspectives column in Spectroscopy magazine, as well as serving on the editorial advisory board of Analytical Cannabis. In addition, Rob has authored 5 textbooks on the fundamental principles and applications of ICP-MS. His most recent book published in October 2020 focuses on the measurement of heavy metal contaminants in cannabis and hemp. Rob has an advanced degree in analytical chemistry from the University of Wales, UK, and is also a Fellow of the Royal Society of Chemistry (FRSC) and a Chartered Chemist (CChem).

Final Thoughts

I firmly believe that researchers who are trying to raise the bar today will be recognised when the FDA eventually starts to regulate the industry. The cannabis industry is both exciting and chaotic at the same time, but because of its unparalleled growth, there appears to be very little incentive to bring in sensible regulations. There clearly needs to be a more scrutiny of heavy metals being tested, as confirmed by a recent 3-day virtual ASTM workshop on measuring elemental contaminants in cannabis/hemp consumer products, which presented clear evidence that they are not being completely removed from commercially-available cannabinoid products [1]. For example, data presented by the Florida Department of Agriculture indicated that retail products purchased by customers for consumption may have a higher composition than when the product was originally manufactured. In particular, they found that lead in the hemp oil products tested was not only showing higher levels above the regulated limit in Florida but was also being leached out of the packaging materials over time.

Further Reading

1. Virtual Workshop on the Measurement of Elemental Contaminants in Cannabis and Hemp Consumer Products: Sponsored by ASTM Committees D37 on Cannabis , June 28-30, 2021; https://www.analyticalcannabis.com/articles/a-recap-of-astms-workshop-on-measuring-elemental-contaminants-in-cannabis-and-hemp-consumer-313229