Analysis of metal cations in tap water by inductively coupled plasma-optical emission spectroscopy (ICP-OES)

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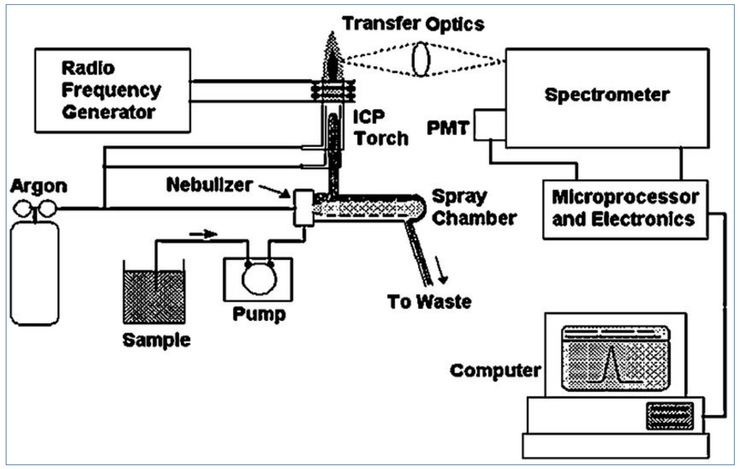
Abstract

Detecting and quantifying concentrations of metal cations in tap water is important to public health and environmental safety. Metal quantification through ICP-OES has been shown useful in detecting aluminum, manganese, cadmium, lead, arsenic, and mercury cations in water sources and is important so that further action can be taken to address metal cation concentrations and purify tap water. These metal cations, when present in tap water, affect the neurological system and signaling between neural pathways which can lead to higher risks of developing neurological disorders and diseases, intelligence and memory deficiencies, and developmental disorders.

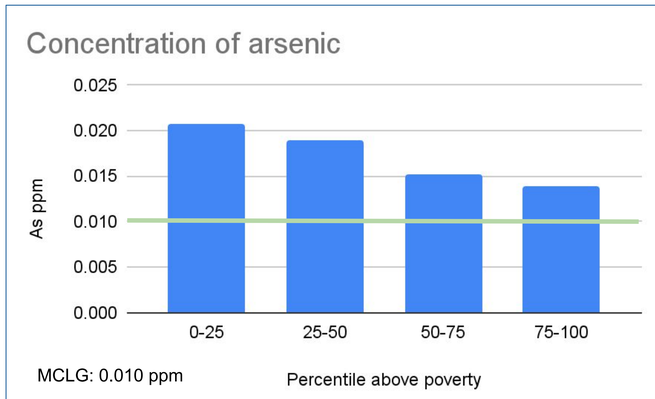
Methodology

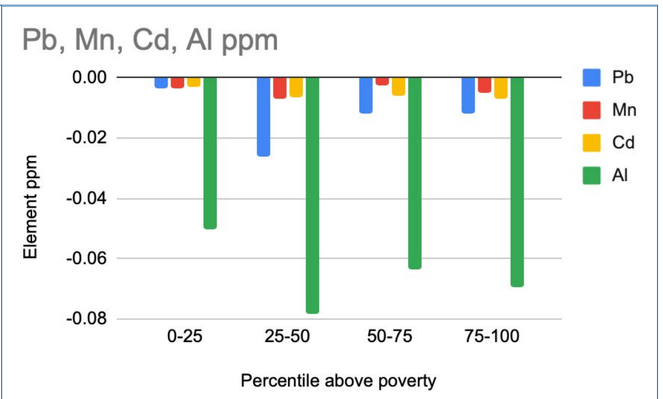
The experimental method used for the research conducted roughly follows the procedural outline of EPA Method 200.7 ICP-OES. Students of Chemistry 1B classes were asked to bring in tap water from their homes using any transportable container. The samples collected were acidified with HNO_3 and allowed to settle overnight. Standards of different concentration were used to calibrate the instrument at: 10 ppm, 5 ppm, and 1 ppm. After the samples acidified, the samples where then tested using the spectrometer. After the instrument finished running, detection amounts were collected and transferred to a separate document where analysis took place. Zip codes were collected from students and detection amounts were summarized by zip code. California Healthy Place Index was used to obtain general income of the zip codes provided.

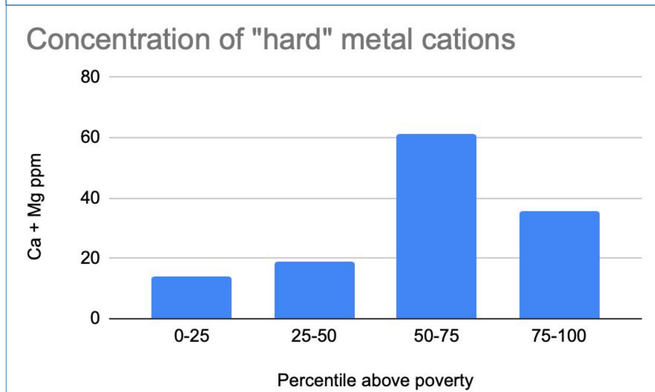


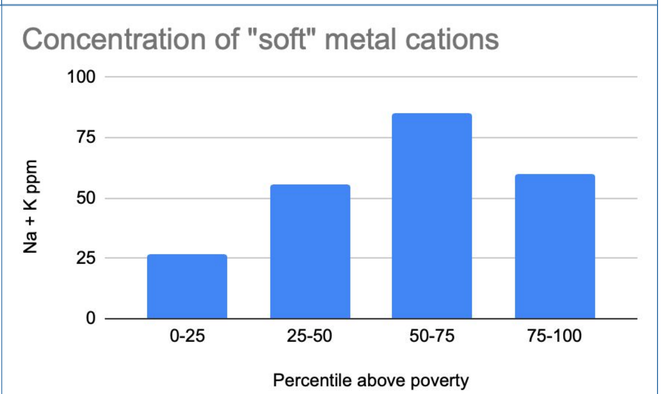
Inductively coupled plasma optical emission spectroscopy quantitatively measures concentrations of elements present in a sample. A water sample is pumped through a peristaltic pump into the nebulizer of the instrument where argon gas is used to convert the liquid into a fine aerosol. The sample then passes through a spray chamber to large water droplets, and the aerosol is then carried by argon gas through tubes coiled around and heated by an inductively coupled plasma torch. Constituent molecules are dissolved and electrons are excited to higher energy levels by the argon plasma. As electrons fall back to their ground state, they emit wavelengths of light specific to each atom and ion present in the sample. The emitted light is directed by mirrors and then captured and separated by the spectrometer into individual wavelengths. The detector then measures the light intensity at each wavelength and transmits this information to the computer and measures the concentration of each atom in the water sample using the ICP-OES computer software.

Results









Conclusions and Future Work

Most metal cations were under the detection limit of the instrument including lead, manganese, cadmium, and aluminum. While this is promising in terms of water safety for the public, further analysis at even lower detection limits would be beneficial. In addition, there are other studies that can be done as outlined below:

- Examine distance to which some of the zip codes are to agricultural areas of work
- Assess amount of specific metals present in pesticides that are commonly used in valley
- Ask students for any sources of water treatment in their home
- Obtain more data correlating zip codes with concentrations of various metal ions
- Run calibration standards at lower concentration

Acknowledgements and Additional Information

The ICP-OES and associated expendables used to collect the data were purchased by Clovis Community College with funding from the State Center Community College District. A big thank you to Tyler Johns for help with the instrument and the methodology

The raw data, averaged by zip code, can be obtained by scanning the QR code.
Please consider the caveats as presented prior to making conclusions from the raw data.

References

https://www.healthyplacesindex.org
https://www.epa.gov
https://doi.org/10.1080/00032710802013991