Detection of Heavy Metals in Disposable Face Masks by Inductively Coupled Plasma-Mass Spectrometry

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Goal

- To determine the environmental impact of disposal face masks when disposed of incorrectly by detecting traceable amounts of heavy metals in disposable face mask leachates.

Introduction

- Disposable face masks (DFMs) have been used to reduce the spread of the coronavirus; however, they have also caused a significant generation of waste.
- Most DFMs are manufactured from plastic fibres and polymeric materials with the addition of chemical dyes to add color and patterns.
- Part of the environmental concern surrounding face mask waste is that the major chemical pollutant in dyes and textiles is toxic heavy metals.
- These dyes are leachable chemicals and can therefore readily release heavy metals and other organic pollutants when submerged in water.
- Reliable analytical methods are needed to investigate the environmental impact of DFMs when disposed improperly.

Figure 1. Image of littered disposable face mask.

Figure 2. Images of disposable face masks used in experiment.

Instrumentation

- Inductively coupled plasma-mass spectrometry (ICP-MS) is a powerful, multi-element technique for determining the elemental composition of a wide range of samples.

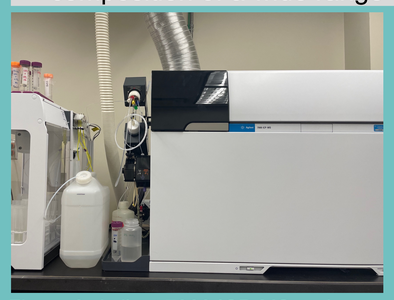

Figure 3. Agilent 7900 ICP-MS and autosampler.

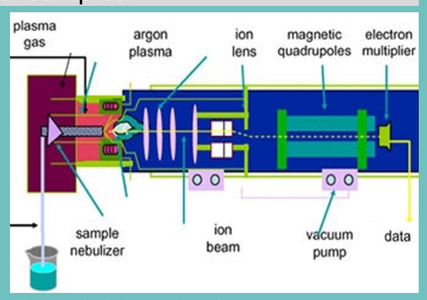

Figure 4. Schematic of major components of the ICP-MS.

Methodology

Table 1. Instrument parameters for Agilent 7900 ICP-MS.

Nebulizer	Micro Mist
Spray chamber	Quartz, double pass
RF power	1550W
Ar flow rate (L/min)	15
Auxiliary gas flow rate (L/min)	0.9
Nebulizer gas flow rate (L/min)	1.0
Sample uptake rate (rps)	0.1
Number of replicates	3
Autosampler	SPS 4
Probe depth	150mm

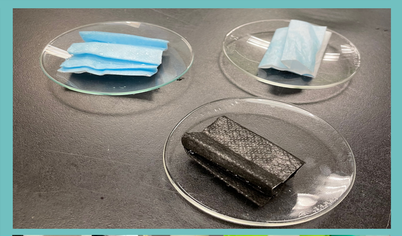

Figure 5. Images of center pieces of masks and when submerged.

- Multiple types of masks were selected and classified into 3 categories: Disposable (1), Cloth/Reusable (2) and Surgical (3).
- The center piece of the masks were cut out and 0.5 g was weighed before submerging in beakers of 18MΩ water for 24, 48 and 72 h.
- Leachates were subsampled and acidified with HNO_3 and HCl, then analyzed using the ICP-MS.

Results

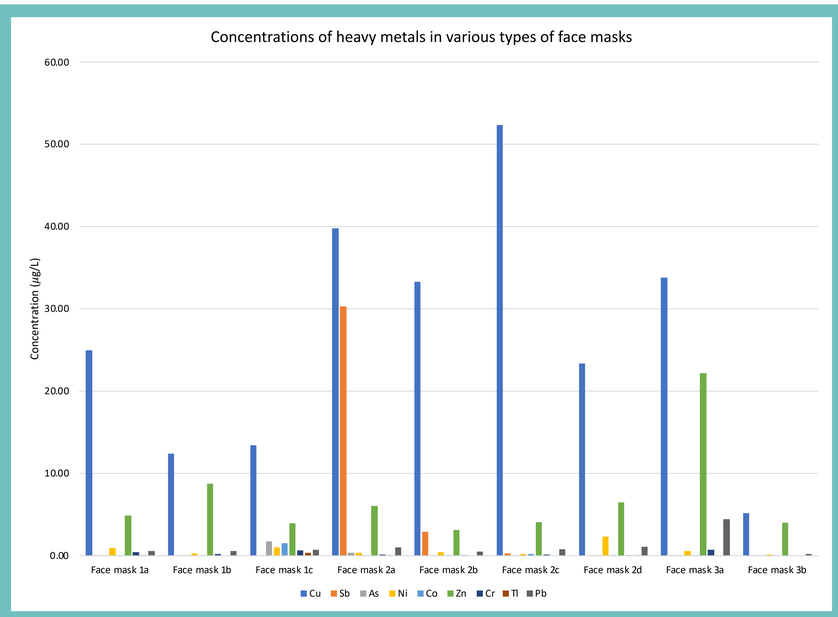

Figure 6. Levels of traceable heavy metals in various types of face masks after 24 hours.

Results (Continued)

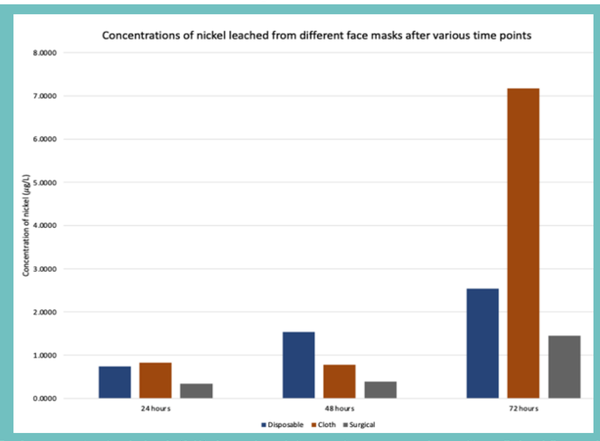

Figure 7. Amount of nickel (Ni) leached from face masks after 24, 48 and 72 hours.

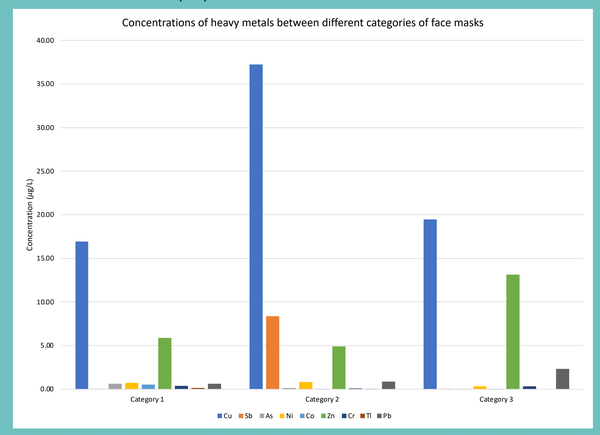

Figure 8. Levels of heavy metals leached after 24 hours between the 3 categories.

Conclusions

- Traceable levels of heavy metals were detected in all DFM leachates and were lower than allowable values.
- Concentrations of elements varied between categories of face masks and as time elapsed.

Acknowledgements

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References

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