# Supporting Information for Development of an Alternative Analysis Method to Determine Lead in Eyeliner Cosmetics

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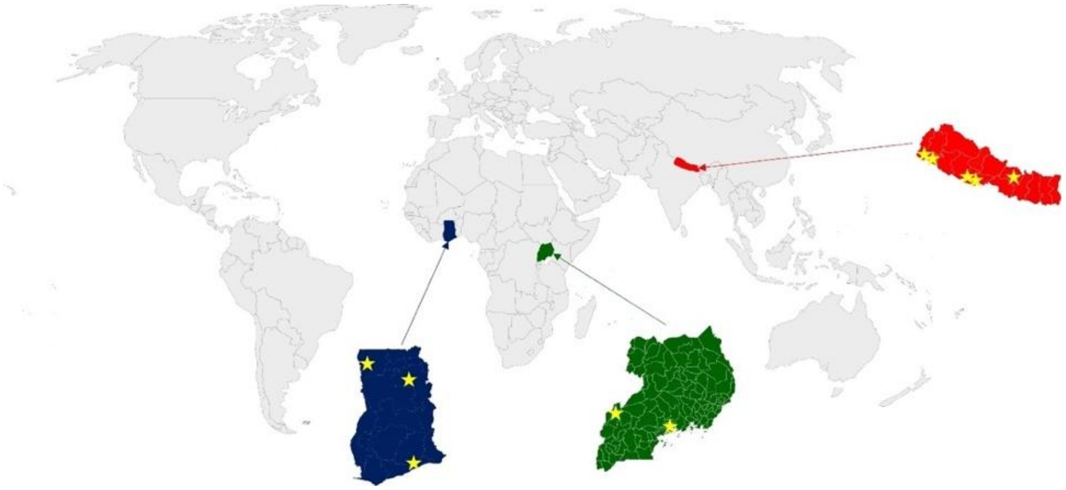


**Figure S1**: Map of the three countries where eyeliner cosmetic samples were collected. Stars represent the regions in each country where the sample was obtained.

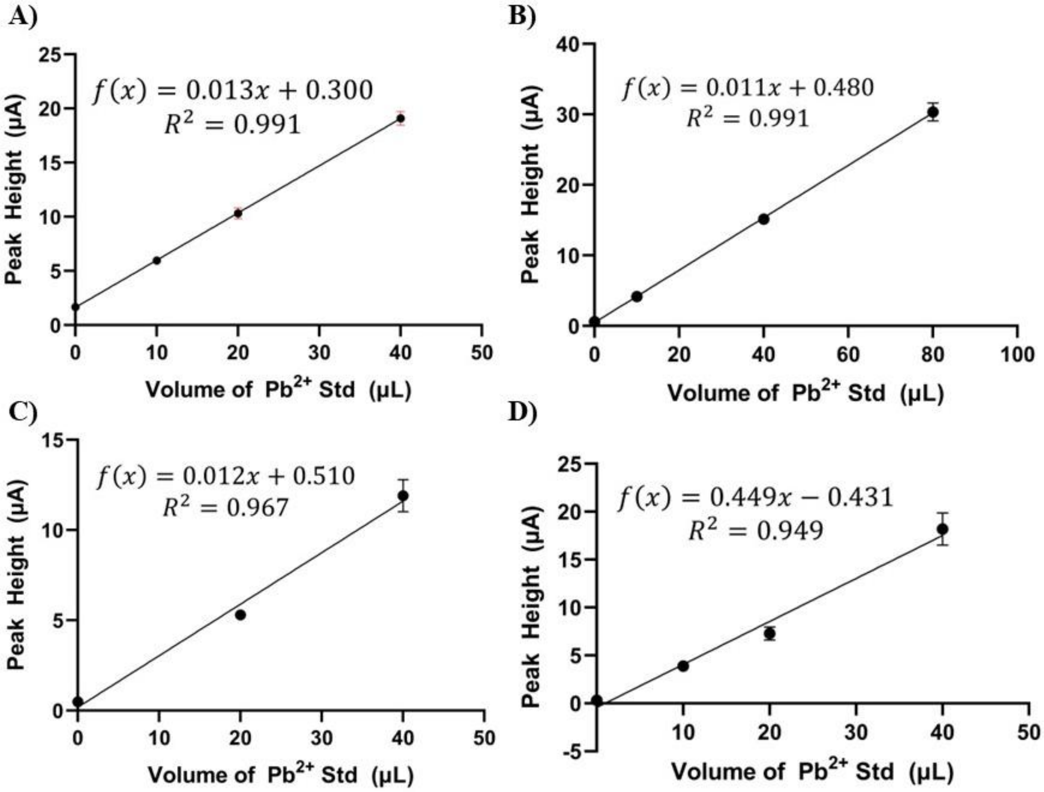


**Figure S2**: Standard addition plots of A) Sample 1, B) Sample 2, C) Sample 3, and D) Sample 4. Linear regression lines of best fit were used to calculate the x-intercept. The x-intercept was then used to calculate the concentration of the unknown using the concentration and volume of the standard used using **Equation 1**. All data have error bars, but points with small standard deviations are hard to see.

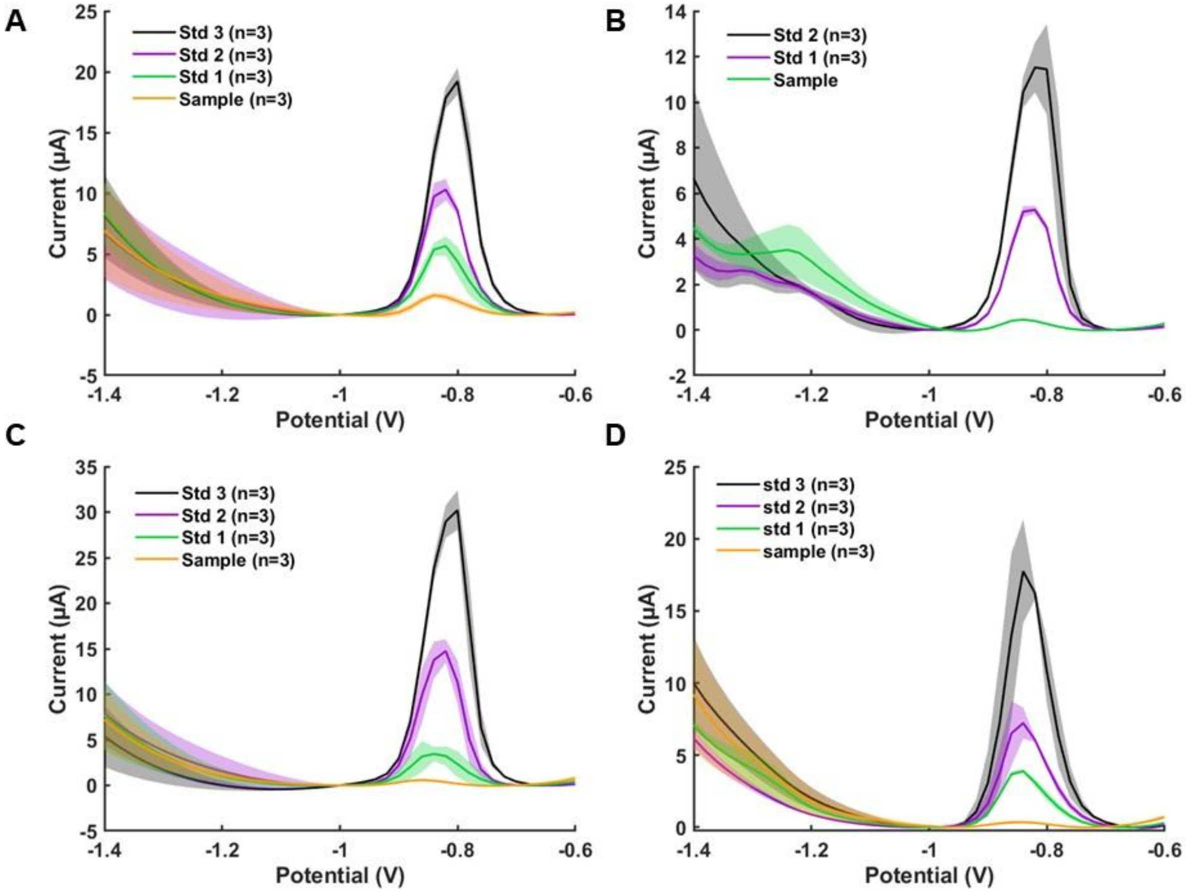
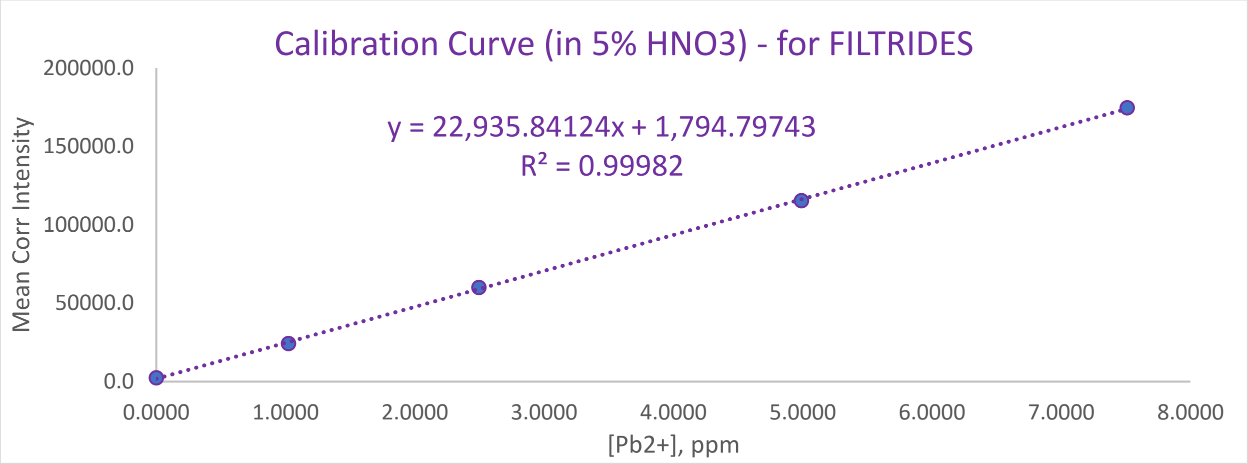


**Figure S3**: Voltammograms of $Pb^{2+}$ deposition of the lead standards and sample with 2 ppm of $Bi^{3+}$ for **A)** Sample 1, B) Sample 2, **C)** Sample 3, **D)** Sample 4. Analysis was performed in 0.1 M acetate buffer pH 4, 360 s deposition time, -1.4 V deposition potential. Shaded area represents the standard deviation for the voltammograms for n=3.



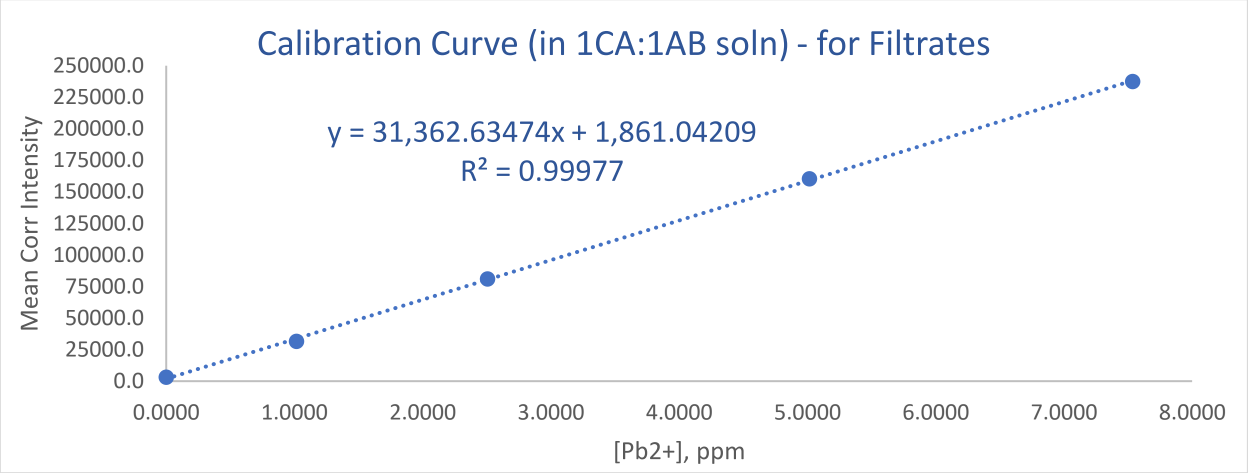


**Figure S4**. Representative calibration curves for the ICP-OES analysis of $Pb^{2+}$ in the cosmetic samples filtrides (top) and filtrates (bottom). $Pb^{2+}$ concentrations ranged from 0 – 7.5 ppm.

**Table S1**: Information about the 24 eyeliner cosmetics collected in Nepal, Ghana, and Uganda, including the XRF results, and ICP-OES results. Brands are reported as seen on the label of the cosmetic, and the matrix was determined from the label and physical examination.

| **Country** | **Brand** | **Matrix** | **Elemental Composition (via XRF)** | **ICP-OES Measured $[\mathrm{Pb}^{2+}]_{\mathrm{avg}}$, ppm** |
|---|---|---|---|---|
| **NEPAL** | S.O.N.A.T.A. Eye Liner Selfish (KTM-4, Sample 2[c]) | Liquid | - | 8±2 (n=3) |
| | S.O.N.A.T.A. Premium Eye Liner | Liquid | - | 2±2 (n=3) |
| | Surma Mamira[b]<br>(S-3, Sample 6[c] and Sample 1[d]) | Solid/powder | Ca, Pb, Fe, Zn, Ti, As/Pb | 1058±10 (n=1) |
| | Perfect Eyeliner | Waxy paste | - | 26±2 (n=1) |
| | Sheetal (SW-2, Sample 4[c]) | Waxy paste | - | 18±2 (n=3) |
| | Homemade child eyeliner<br>(SW-3, Sample 3[c]) | Dried solid | Ca, Pb, Fe, Zn, Ti, As/Pb | 7±2 (n=1) |
| | Ashok | Solid/powder | Ca, Fe, Ni, Zn | 15±1 (n=3) |
| | Eye Improvement Powder | Solid/powder | S, Ca, Fe, Co, Cu, Zn | 153±4 (n=1) |
| | Surma Mamira[a,b]<br>(SW-6, Sample 1[c] and Sample 2[d]) | Solid/powder | Ca, Fe, Mn, Zn, Ti, As/Pb, K | 1939±30 (n=3) |
| **GHANA** | Al-Asmad | Solid/powder | Ca, Zn, Cl, Fe, K, Mn | 16±2 (n=3) |
| | Kohl Al-Sherifain (N-2, Sample 3[d]) | Solid/powder | Si, S, Zn, Fe, Ca | 136±3 (n=3) |
| | Lateef Surma | Solid/powder | Zn | 3±2 (n=3) |
| | Mumtaz Delux Kajal Cold (Special Quality) | Waxy paste | - | 2±2 (n=3) |
| | Mumtax Delux Kajal | Waxy paste | - | 19±2 (n=3) |
| | Khojati Surma No. 13 Black | Solid/powder | Zn, Fe | 84±2 (n=3) |
| | Hind Noor Eye Liner | Solid/powder | Ca, Ti, Zn, Fe, K | 70±3 (n=3) |
| | Hashmi Kohl Aswad[b]<br>(N-2 child(2), Sample 4[d]) | Solid/powder | Pb, Zn | >100,000 (n=3) |
| | Hashmi (Natural) Kajal[b] | Waxy paste | - | >500,000 (n=3) |
| | Hashmi Kohl Aswad[b] | Solid/powder | Pb, Zn | 449±58 (n=3) |
| | Mumtaz Delux Kajal[b] | Waxy paste | - | >100,000 (n=3) |
| | Mumtaz Delux Kajal Cold (Special Quality) | Waxy paste | - | 441±30 (n=3) |
| | Natural rock[a,b] (N-2 stone) | Solid/rock | S, Pb | 63±2 (n=5) |
| **UGANDA** | Starlet Kojal | Waxy paste | - | 35±2 (n=3) |
| | Starlet Kojal | Waxy paste | - | 40±2 (n=3) |

[a] *SW-6 (commercial eyeliner sample) and N-2 stone (natural eyeliner sample) were analyzed via XRF.*

[b] *Due to the very high concentrations of Pb in these commercial and natural eyeliner cosmetics, these seven samples were not tested via the alternate extraction and electrochemical analysis method.*

[c] *Six samples from Nepal analyzed via ICP-MS. Due to low sample size, KTM-4, Sample 5 (gel eyeliner) was only analyzed via ICP-MS.*

[d] *Four samples analyzed via ASV.*

## DETAILED MATERIALS AND METHODS FOR ICP-MS:

**Sample Preparation:** Approximately 50mg of sample was weighed into pre-cleaned 15mL Savillex® Teflon beakers. 4.0mL of double-distilled (DD) concentrated (16N) $HNO_3$ (Sigma Aldrich) was added to each sample and placed on a hotplate to reflux at 200ºC for 48h. Samples were subsequently removed from the hotplate and cooled for 1h. Any sample residue adhered to the sides of the beakers was rinsed with 18 MΩ $cm^{-2}$ water. The samples were then placed on the hotplate at 110ºC to dryness. 2.0ml of DD 16N $HNO_3$ was added to the dried samples, and beakers were recapped and placed on the hotplate at 200ºC for 48h. Samples were again removed from the hotplate and cooled. Two or three drops of 30% $H_2O_2$ were added to each sample. Once the reaction subsided, the samples were placed on the hotplate again for 60min. This process of removing the sample to cool and adding $H_2O_2$ and DD concentrated $HNO_3$ was repeated until there was no further reaction. Samples were placed on the hotplate at 110ºC to evaporate to dryness. Subsequent to this last evaporation cycle, 3mL of DD 16N $HNO_3$ was added and then diluted to a final volume of ~100mL with 18 MΩ $cm^{-2}$ water. Aliquots from the digested solutions were used for both trace elements and isotopic measurements.

**ICP-MS Analysis:** Trace element concentrations of all solution aliquots were collected on a Nu Instruments AttoM High Resolution (HR) inductively coupled plasma mass spectrometer (ICP-MS). All trace element analyses were conducted in wet plasma mode in medium mass resolution ($M/\triangle M \approx 2500$), and at the start of each analytical session the instrument was tuned and calibrated using a multi element solution (Li, B, Na, Si, Sc, Co, Ga, Y, Rh, In, Ba, Lu, Tl, and U; 1 ng/g). In and Rh were used as an internal standard to monitor and correct for instrument drift and matrix effects. Trace element abundances were calculated based on an external calibration technique.