

Beauty Is Pain

Queen Elizabeth I (1533-1603) was considered one of the greatest English monarchs in history. England prospered under her 45-year reign as she promoted trade and art, and established the Church of England.¹ During the Elizabethan Era, displaying white skin was highly desired by women as it symbolized youthfulness and an elevated social class.²

In 1562, the Queen contracted smallpox which left severe and permanent scars on her face and she feared it may ruin her image of possessing seamlessly fair skin.² In order to conceal the damage caused by her illness, she used a heavy white face paint known as *Venetian Ceruse*.² The main ingredient of *Venetian Ceruse* was the mineral *cerussite*.³ This white lead-containing ore was ground into a fine powder and mixed with vinegar to create the white face paint.² The Queen's frequent use of *Venetian Ceruse* has led some historians to believe that lead poisoning could have resulted in her eventual death.²

It was reported that the Queen had exhibited various symptoms similar to those of lead poisoning. A few of these symptoms were loss of memory, nausea, irritability, fatigue, irritated skin, and loss of hair.² Historians have discovered the ingredients to create the Venetians Ceruse and sent it to you for further analysis of its potential for lead toxicity. The Food and Drug Administration (FDA), a government organisation that regulates products and their effects on the public health, currently states that the maximum limit of lead allowed in cosmetics is 20 parts per million (ppm) and continuous exposure to higher levels over time may lead to symptoms of lead poisoning and possibly death.^{4,6} You are a laboratory chemist and have been asked to determine whether Queen Elizabeth's continuous exposure to lead may have played a role in her death.



Figure 1. Painting of Queen Elizabeth I during her coronation. The painter is unknown.⁵



Dear Mr. Hammond,

Our team is very excited to reveal that we have discovered a small antique box hidden within a vanity closet at Richmond Palace, London! The box dates back to the Elizabethan era and happens to contain what we believe to be a genuine sample of *Venetian Ceruse*! It is a white foundation-like substance that Queen Elizabeth I was known for wearing during her reign. However, as we continue to study the various causes that may have led to her death, we would appreciate if you would accept our request to analyze the quantity of lead present in a sample of this substance and whether it may have been capable of causing lead poisoning. Additionally, we would like you to determine the exact composition of the substance, to help us understand how *Venetian Ceruse* was created by the palace maidens. We look forward to hearing back from you with your results!

Sincerely,

Ms. Rita Devinsky
History Uncovered
Headquarters
Toronto, ON, Canada

A handwritten signature in black ink that reads 'Rita Devinsky' in a cursive script.

Q1. Analysis of the sample using Mass Spectrometry (MS) indicated the presence of two major compounds and quantitatively measured the molecular mass of each.⁷ Energy Dispersive X Ray Spectroscopy (EDXS) was then used alongside MS to determine the elemental composition of each compound.⁸ You are asked to identify the compounds present in the sample. Based on physical testing, compound 1 appears to be weakly acidic.

Experimental Data:

Compound 1	
Molecular weight: 60.052 g/mol	
39.6%	C
53.9%	O
6.5%	H

Compound 2	
Molecular weight: 267.21 g/mol	
77.7%	Pb
4.4%	C
17.9%	O

Q2. The box contained a 30 mL of sample. Atomic emission spectroscopy was used to determine the lead ion content of the sample and further calculations concluded that 7.48 mmol of compound 2 was used to produce the sample of *Venetian Ceruse*. Determine the lead content in the sample in weight by volume (w/v) units and conclude whether the *Venetian Ceruse* imposed a risk of lead poisoning to Queen Elizabeth I.

Q3. This particular sample of *Venetian Ceruse* appears to have been extremely well-preserved having been sealed away in a cold, dark place in a tightly sealed container. Other samples that have been found will typically have lost their white colour. What chemical reaction could occur between the two major compounds in *Venetian Ceruse* after being exposed to high seasonal temperatures and very long periods of time. Why would this cause the white colour to disappear?

References

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