

Non-destructive multi-analytical preliminary characterization of a Giuseppe Sabatelli self-portrait and Natale Longoni inscription on a shaving bowl lid

Giulia Galli¹, Chiara Andrea Lombardi^{1,2}, Chiara Nenci³, Carlo Mariani⁴, Paola Fermo¹, Valeria Comite¹

¹ Department of Chemistry, University of Milan, Via C. Golgi, 19, 20133 Milan, Italy.
giulia.galli8@studenti.unimi.it chiara.lombardi@unimi.it paola.fermo@unimi.it
valeria.comite@unimi.it

² Department of Antiquities, Sapienza Università di Roma, Piazzale A. Moro, 5, 00185 Rome, Italy.

³ Accademia di Belle Arti di Brera, Via Brera, 28, 20121 Milan, Italy. chiaranenci@fadbrera.edu.it

⁴ Architect, Via Giuseppe Giusti, 21/B, 20831 Seregno (MB), Italy. cm@carlomariani.eu

Abstract – In the present study, a self-portrait by the painter Giuseppe Sabatelli (1813–1843) and an inscription written by Natale Longoni (1851–1930), respectively placed on the back and front side of a shaving bowl lid, were analyzed. Longoni received the object as a gift from Luigi Maria Sabatelli (1818–1899), also a painter and brother of Giuseppe, who is not to be confused with their father, Luigi Sabatelli (1772–1850), a professor at the Brera Academy. In particular, a non-invasive multi-analytical approach was carried out using the following techniques: Digital microscope, Ultraviolet radiation-induced Luminescence (UVL) and Scanning Electron Microscopy coupled to Energy Dispersive X-ray spectroscopy (SEM-EDX). The aim of the analysis was to evaluate the possible presence of reliefs and incisions as well as the elemental characterization of the materials used on the object. Thanks to the results obtained it was possible to identify the composition of the pictorial layer and to demonstrate that two different dark pigments were used in the front and the back sides of the object.

I. INTRODUCTION

The present study is focused on the study of a shaving bowl lid with a self-portrait by Giuseppe Sabatelli (1813–1843) (*Fig. 1a*) painted on the front, an inscription by Natale Longoni (*Fig. 1b*) on the back. The text recalls Giuseppe's premature death and his last acclaimed painting *Farinata degli Uberti nella battaglia d'Empoli*.

Full transcription of the inscription (front):

“Autoritratto/ a stecco sul coperchio/ del piattello della
barba/ fatto da Giuseppe Sabatelli/ Professore

dell'Accademia di Pittura di Firenze, / morto a soli 29 anni,
ed il di cui/ ultimo quadro Farinata degli Uberti/ nella
battaglia d'Empoli ebbe sommo/ plauso. Dono del
Pittore/Luigi Sabatelli al Sottosc.to/ Sac. Longoni Natale”.



Fig. 1. Shaving bowl lid: a) self-portrait by Giuseppe Sabatelli painted on the back; b) inscription by Don Natale Longoni on the front.

According to the inscription, the self-portrait was executed with a *stecco* technique (using a modeling stick) by Giuseppe Sabatelli, who was a professor at the Academy of Fine Arts in Florence and died prematurely at the age of 29. The inscription, later added on the back of the artwork by *Sacerdote* Natale Longoni (1851 – 1930), highlights that the shaving bowl lid was gifted to him by Sabatelli's brother, Luigi Maria Sabatelli (1818 – 1899), who was himself also a painter.

A non-destructive and non-invasive multi-analytical approach was carried out to study the surface of the artifact and determine the presence of possible incisions and reliefs and as well as to determine the elemental composition of the materials used.

II. EXPERIMENTAL

A Polarized light microscope (Dino-Light) with a 5 megapixels sensor and includable/excludable polarizing filter was used to preliminarily investigate the surface of the object.

UltraViolet radiation-induced Luminescence (UVL) measurements were carried out using a multispectral camera with a 28 megapixels APS-C BSI sensor 28mm 1:2.8 lens, a 365 nm LED UV source and the two following filters:

- No UV no IR “hot mirror” filter;
- UV band pass filter.

A Hitachi TM-4000 instrument equipped with backscattered electron (BSE) and secondary electron (SE) detectors and an Oxford-AztecOne EDX microprobe was used. SEM-EDX analysis were directly performed on the shaving bowl lid under low vacuum conditions using the charge reduction mode which enabled image acquisition without the need for sample metallization. Thanks to its high spatial resolution, the instrument allowed detailed investigation of surface morphology and the acquisition of false-color EDX elemental maps, providing insights into the spatial distribution of elements across the various samples.

III. RESULTS AND DISCUSSION

A. Polarized light microscopy

For an initial observation of the surface of the artwork, digital microscopy is essential. The use of Dino-Lite microscopy is a simple, low-cost and non-invasive technique that permits the identification of details invisible to the naked eye. It provides high-quality images with up to 200x optical magnification featuring a switchable polarizing filter allowing the study of reliefs and incisions on the surface of the object.

Analyses were carried out on both the front and back sides of the artwork.



Fig. 2. Central part of Sabatelli's face. a) Image acquired with non-polarized visible light; b) image acquired with polarized visible light.

As Fig. 2a shows, the use of digital microscope enhances the distinctive features of the strokes executed using the *a stucco* technique applied by the artist with a dark pigment. A loss of pictorial and preparatory layer can be noticed on the left cheek, becoming particularly evidenced under polarized light (Fig. 2b). Furthermore, yellowish stains can be observed in the background of the portrait, possibly attributable to the use of surface-applied

substances (protective or adhesive).

In addition, further lacunae were observed on the left side of the background (Fig. 3). In this lacuna, the absence of the entire pictorial film is evident and dark brush strokes are visible, possibly executed before the painting was applied.



Fig. 3. Detail of the lacuna present on the left side of the background (in the interior) acquired with visible light.

As regards the writing on the front, a higher intensity of black colour was observed on certain words, particularly on some initial letters of the sentences. The inscription was executed with a different black colour to that used for the decoration on the front. The study of the elemental composition by EDX analysis, reported below, will better clarify this aspect.

Some details obtained under the microscope with both non-polarized visible light and polarized visible light of some of the words on the front side are shown (Fig. 4).



Fig. 4. Detail of the writing “Sabatelli” reported on the front of the shaving bowl lid acquired with a) non-polarized visible light and b) polarized visible light.

B. UVL

UV light-induced luminescence analysis was also performed on both the front and back sides of the shaving bowl lid (Fig. 5).



Fig. 5. Shaving bowl lid acquired under UV light. a) back side and b) front side.

From the image of the front of the work (visible image taken under UV light), several dark brown lacunae are evident (Fig. 5a). The dark yellow-orange patinas and lumps observed in the visible appear dark brown in colour like the colour of the lacuna but distinguishable from the latter. Spots and small dots with blue fluorescence are observed along the entire outer edge of the lid. This fluorescence could be attributable to protein-based material [1].

The absence of fluorescence on almost the entire paint film could indicate the absence of sealing varnish on the work. Only small fluorescent areas are evident on the reverse side, one of which is located near the letter “d” next to the word “Firenze” in the central right-hand part of the item (Fig. 5b).

C. SEM-EDX

The use of Scanning Electron Microscopy made it possible to investigate the morphology of the surface of the object to micrometric resolutions and study the elemental composition of the pictorial surface of the artefact thanks to the Energy Dispersive X-ray probe.

In one of the areas analysed (Fig. 6) it was possible to determine a representative composition of the paint layer that is mainly composed of C, O and Pb. Lower concentrations of Ca, S, Si, Al and Fe were also detected as show in the summary spectrum (Fig. 7).

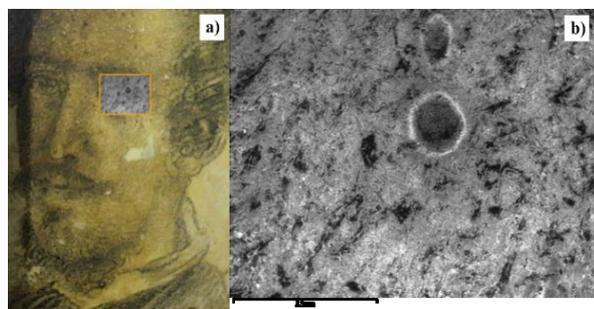


Fig. 6. a) Analysed area on the left eye of Sabatelli on the back side of the object; b) electron microscope image of the analysed area (3 mm x 3 mm).

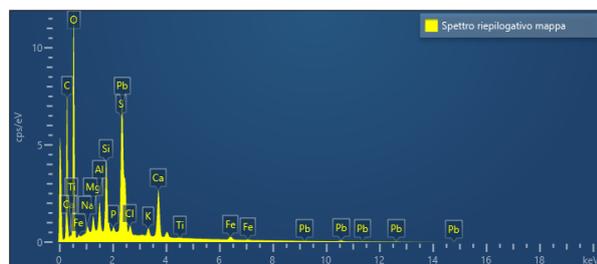


Fig. 7. Summary spectrum showing the elemental composition of the pictorial layer.

Thanks to the EDX probe it was also possible to obtain a semi-quantitative analysis of the investigated area (Table 1).

Table 1. Semi-quantitative results obtained on the analysed area.

Element	% weight	σ % weight
C	39.88	0.16
O	34.27	0.12
Na	0.34	0.01
Mg	0.58	0.01
Al	1.02	0.01
Si	2.41	0.02
P	0.21	0.01
S	2.96	0.02
Cl	0.27	0.01
K	0.57	0.01
Ca	3.78	0.02
Ti	0.03	0.01
Fe	0.87	0.03
Pb	12.81	0.09
Total	100.00	

This composition suggests the application of a lead-based white pigment perhaps mixed with gypsum. The chromophore element responsible for the coloration is likely to be iron (Fe), probably an iron oxide pigment was used. The presence of trace amounts of titanium (Ti) detected in the ceramic material of the analyzed shaving bowl lid is of particular interest. Before the mid-19th century, titanium dioxide (TiO₂) was not commonly used as a white pigment. Its systematic application as an opacifier in ceramics is only documented starting in the 20th century [2,3]. Therefore, the detection of titanium can plausibly be attributed to a natural impurity in the raw materials employed, such as unrefined clays or kaolins, which are known to contain rutile or ilmenite, both naturally occurring titanium-bearing minerals [4,5]. However, the hypothesis that small amounts of Ti may be related to later retouching or interventions carried out after the original execution of the portrait cannot be entirely ruled out, potentially occurring at a time when titanium-based pigments had begun to enter artistic and industrial use.

A further analysis was carried out on an area near a lacuna (Fig. 8).



Fig. 8. Analysed area on one of the lacunae present on the surface of the self-portrait.

As shown in the false-colour elemental distribution maps obtained from the analysed area (Fig. 9), the elements identified indicate that the lacuna is mainly composed of Si and O; while the area around it consists of C, O, S, Pb and Ca. The presence of silicon, one of the main components of ceramic, indicates that the lid may be made of this material, while the presence of the elements found in the surroundings confirms the previous hypothesis of the application of a mixture of a lead-based white pigment and gypsum [6].

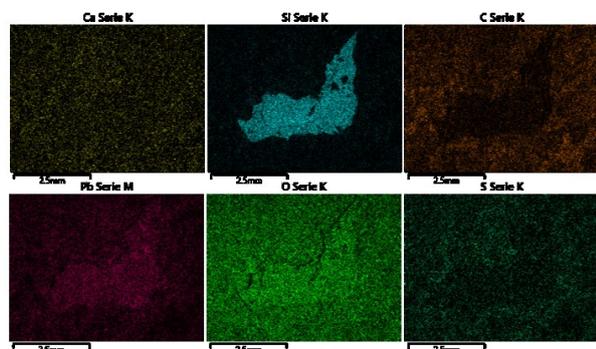


Fig. 9. False-colour elemental distribution map of the analysed area near a lacuna.

Subsequently, SEM-EDX analyses were also performed on the front side of the artefact. An image of one of the analysed areas of the inscription is reported below (Fig. 10). Some punctual analyses were carried out near the number “9”.



Fig. 10. a) Analysed area on the front side of the artefact; b) electron microscope image of the analysed area.

A punctual analysis performed on a lighter spot, showed higher concentration of O, C, Ca, Si and Pb (Fig. 11, Table 2).

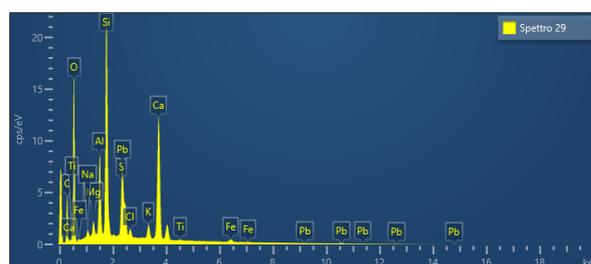


Fig. 11. Summary spectrum showing the elemental composition of a light spot near number “9”.

Table 2. Comparison table of semi-quantitative analysis conducted on the light and dark spots.

Element	Light spot		Dark spot	
	% weight	σ % weight	% weight	σ % weight
C	22.72	0.31	31.33	0.29
O	34.73	0.20	31.47	0.19
Na	0.46	0.02	0.55	0.02
Mg	0.71	0.02	0.59	0.02
Al	3.62	0.03	2.61	0.03
Si	10.21	0.06	7.79	0.05
S	1.61	0.03	2.27	0.03
Cl	0.44	0.02	0.67	0.02
K	1.24	0.03	1.49	0.03
Ca	12.73	0.08	11.07	0.07
Ti	0.10	0.03	-	-
Fe	0.86	0.05	1.18	0.05
Pb	10.58	0.14	8.38	0.14
Cr	-	-	0.14	0.03
Cu	-	-	0.34	0.06
Total	100.00		100.00	

A punctual analysis conducted on a darker spot reported O, C, Ca and Pb as major elements (**Errore. L'origine riferimento non è stata trovata.**, Table 2). These two latter elements were probably detected from the

background white surface of the artefact as also shown in the following summary spectrum (*Fig. 12* **Errore. L'origine riferimento non è stata trovata.**).

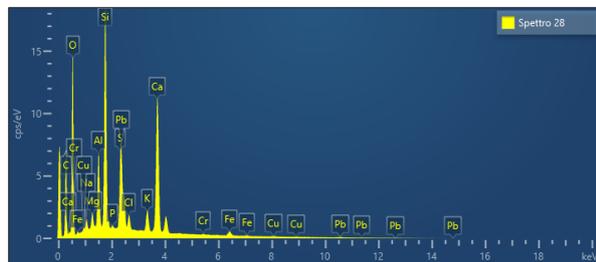


Fig. 12. Summary spectrum showing the elemental composition of a dark spot on number “9”.

Among the elements present in minor concentrations, Fe, Cu and Cr were detected. Despite their low concentrations, these are chromophore elements, likely indicating the use of iron-gall inks for the execution of the inscription [7]. This also reveals that a different substance was used compared to that applied for the creation of the self-portrait. This interpretation is further supported by the analysis of the lighter spot, where Cu and Cr were not detected among the minor elements. Only Fe was found, but at a lower concentration than that determined in the darker spot (*Table 2*).

CONCLUSIONS

Based on the results obtained through UVL and SEM-EDX analysis, it was possible to evaluate the elemental composition of the materials constituting the artefact. The pictorial layer on the front appear to consist of a lead-based white pigment mixed with gypsum. The material forming the lid is likely ceramic, as suggested by the analysis conducted on the lacuna. Furthermore, the investigation revealed the use of two different dark pigments applied on the front and back sides of the object. The self-portrait was executed with an iron-based dark pigment (probably iron oxide), whereas the inscription on the back was most likely made using iron gall inks, characterized by the presence of Fe, Cu and Cr.

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