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Conservation and analysis of a Qajar lacquered painting from the Faculty of Applied Arts Museum of Helwan University, Egypt

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ABSTRACT

A Qajar lacquered painting applied on pasteboard support from the Applied Arts Museum of Helwan University has been investigated and conserved. The painting support was manufactured from two distinct layers of which the thick underlayer was made of papier mâché and the thin upper layer was a finer layer of fibres. The support comprises cotton fibres with some additions such as kaolin (Al_2O_3•$2SiO_2$•$2H_2O$) and gypsum ($CaSO_4$) as revealed in FTIR analysis. Hair and straw enclosures were also added to the pulp to strengthen the support. Two pigmented preparation layers were applied, of which the main layer is a blue formed from indigo pigment. The other, a red preparation layer, was applied on the margins of the painting. The pigment palette, as revealed by Raman microscopy, is quite simple and comprises; Lapis lazuli, indigo as the blue pigments, orpiment as the orange pigment, and red lead as the red pigment. The FTIR spectra for the lacquer layer suggested the application of shellac resin admixed with linseed oil. The highly needed conservation treatment was carried out. It included cleaning with saliva and Isopropyl alcohol, securing the detached paint layer and splitting paper sheets with klucel G 4%, Deacidification of the verso of the painting with calcium hydroxide, retouching using acrylic paints and varnishing with paraloid B-72 in toluene. Finally, a museum-grade display box was created and labelled with the painting's documented information

KEYWORDS : Persian, lacquer, papier mâché, pigments, shellac, conservation, paint layer

1. INTRODUCTION

In the later years of 15th century, Parsian lacquered objects first came into fashion, starting with book covers (Khalili, 2005), and later delving further into society, in the form of playing cards and letter seals in the Qajar period (Robinson, 1989). More complex articles were manufactured during the later periods, such as pen cases (17th century), and mirror cases, as well as caskets (18th century). The best works, however, were found in the mid-19th century, most developed under Nasr al-Din Shah (Robinson, 1967).The museum of the Faculty of Applied Arts of Helwan University in Giza, Egypt, holds a treasured collection of lacquered Qajar objects applied on both papier-mâché and pasteboard supports. This collection includes paintings, caskets and scale boxes in various sizes. Among the treasures of the collection is a lacquered Persian painting depicted on papier-mâché representing a leisure scene and dating back to the 19th century [Qajar dynasty (1785-1926 AD), Iran].

In making papier-mâché objects, it was mentioned that paper was never reduced to a pulp but softened and laid within the mould as layers. Each layer was given time to dry before applying the next addition. The paste was spread between each layer and the process was repeated until the desired shape or size was obtained. While moist, the papier-mâché was covered with a thin muslin rag and then a layer of plaster was added. The object was next smoothed and rubbed down until it was given the required uniform surface to permit for the paint layer to be utilized. Transparent lacquer was then added (Watson, 1981; Khalili, 1988a). The application techniques of the decorations vary. It was mentioned that the decorations could have been applied either over a single gesso layer (Carvalho et al., 2001), or over a double ground layers of which the underlayer was made of plaster admixed with glue and grape treacle and the uppermost was an oil-resin varnish (Purinton and Watters, 1991).

Furthermore, other research results also revealed a complex layered structure made from transparent varnish layer followed by a plaster layer covered with a pigmented layer of lapis lazuli and orpiment and ended with black paint on which the decorations were applied (Genandry, 2004).

1.1 The studied object

The object under study is a rectangular Persian lacquered painting from the Qajar period, measuring 21 cm W x 9.4 cm L. The object does not have a known function, however, from its measurements, it may be assumed to be an album binding. It is exhibited in the Faculty of Applied Arts Museum, Helwan University (Giza, Egypt) with registration number 100/6 in the museum archives.

In the centre of the scene, a lobed medallion comprises a man repose on a big pillow and extending his legs putting one above the other. The characters in the scenes wear the famous Persian dress known as Qibaa in green. The main character, sitting on a white carpet decorated with floral implemented with thin black lines, wears a white shawl around his waist and another red shawl on his shoulder. He also wears the Safavid turban with folds. His left hand is extended to pick a Pomegranate from the tree standing in front of him. The background of the scene shows the front of a palace and its dome decorated with geometrical designs, consisting of parts of a star polygon, eight-pointed stars and others in the cross shape.

The main colours applied in the decorations are; red, black, green, white and yellow. The Khatai floral scrolls surround the medallion in the middle with light and dark green simple leaves and the lotus flowers by the blue, yellow, red and orange colour.

1.2 Conservation assessment

The painting was covered with dust accumulation

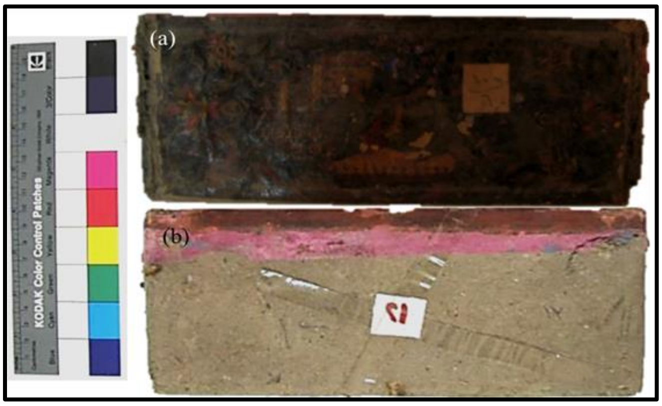

Figure 1. The images of the studied painting; a) the recto side, b) the verso side

Figure 2. Auto-Cad outline showing the main deterioration aspects of the paining

on the surface and the reverse as well as between the splitting papier-mâché and a disfiguring dull yellow varnish concealing the decorations underneath. Many areas of the ground layer were missing. Cleavage and loss of the paint layers in many areas along with lifting and splitting through the papier-mâché support were displayed. In addition to, buckling in the middle of the paint layer and first fine paper layer. Museum registration numbers were written on two yellow self-adhesive labels and were attached to the recto and verso with crossed stripes of adhesive tape. There is also evidence of old restoration treatment, which was apparent by the existence of a red strap of paper adhered to one side and through the thickness of the reverse side(figure1a,b & figure 2). Due to the spotlighting of Japanese and Chinese lacquer objects in recent years (Webb, 1998; Heginbotham et al., 2008; Pitthard et al., 2010), up-to-date analytical studies of the materials used in Persian paintings, as well as restoration/conservation studies of such artefacts, have become scarce (Purinton and Watters, 1991; McSloy, 1999; Abdel-Ghani, 2022).

This research is the second of the project concerning with examination and conservation of Qajar lacquered objects. It aims to study the technology and the materials employed on a small Persian lacquered painting, probably album binding and to conduct the required conservation treatment.

2. MATERIALS AND METHODS

Samples from damaged areas were taken using a scalpel. The samples under study comprise papier mâché support, lacquer, and paint samples including; red, orange, blue and green. The samples were studied non-destructively using Fourier transform infrared coupled with attenuated total reflectance "FTIR-ATR" and Raman microscope.

Raman spectra of the pigments were collected using a Senterra spectrometer (Bruker) coupled to a confocal Raman spectroscopy (20x - 100x objective lens), operating at near-IR laser diode emitting at 785 nm. The average spectral resolution in the Raman shift range of 100–2000 cm−1 was 4 cm^{-1}.

A Bruker FTIR spectrometer, model VERTEX 70 equipped with ATR was used. The IR spectra, in absorbance mode, were obtained using an aperture of 20–100 μm, in the spectral region of 600 to 4000 cm−1 with a resolution of 4 cm^{-1} and the number of co-added scans 64 for each spectrum.

3. RESULTS AND DISCUSSION

3.1 Technology and structure of the painting

Figure 3 shows the schematic structure of the examined painting. The substrate was created from papier-mâché, comprising two distinctive layers of which the uppermost was made of a finer paper

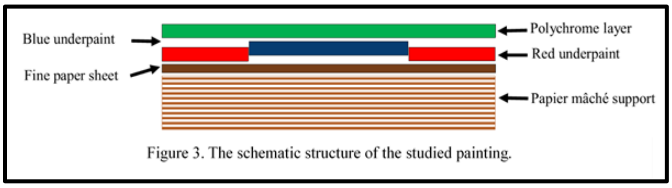

Figure 3. The schematic structure of the studied painting.

This structure meets the description of Khalili for papier-mâché making (1988) which emphasize placing a superior paper sheet on top of lower quality sheets (Khalili 1988). Straw and hair enclosures were added to the sheets for reinforcement. No white preparation layer was detected; instead, blue and red underlayers were distinctively executed on the lobed central medallion, and the outer floral decoration areas respectively.

3.2 The paper support:

Figure 4 shows the ATR-FTIR bands of the papier mâché and their assignments related to components (Pandey and Pitman, 2003; Ion et al., 2008; Saikia and Parthasarathy, 2010; Hospodarova et al., 2018). When revising the FTIR spectra, it was inveterate that the papier mâché support is made of pulped rags (cellulose 3333, 3288, 2902, 1642, 1536, 1426, 1370, 1333, 1316, 1279 and 1247 cm^{-1}) (Pandey and Pitman, 2003; Ion et al., 2008). Calcite (calcium carbonate $CaCO_3$) (~1426, 875 cm^{-1}), gypsum (calcium sulfate $CaSO_4.2H_2O$) (~1150 and 662 cm^{-1}) (Shearer, 1989) and kaolinite (Al_2O_3•$2SiO_2$•$2H_2O$) (3694, 1621, 1006 and 912 cm^{-1} (Saikia, 2010) were added as fillers to the pulp (figure 4).

3.3 The lacquer layer

According to literature, the Persian varnish used in papier mâché lacquered objects is shellac or sandarac resins (Khalili 1988, Abdel-Ghani 2022) and just recently, it was stated by Koochakzaei et al., 2021 that alkyd resin and Kaman oil were also used in some instances, in this particular case pen

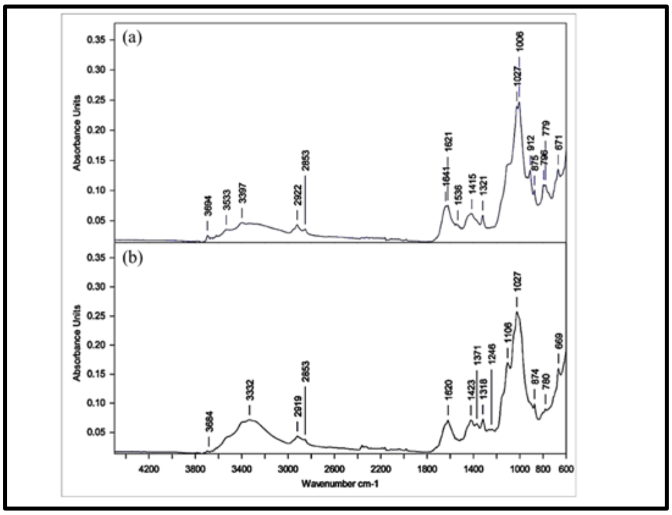

Figure 4. The FTIR bands of the papier mâché; (a) the upper fine sheet (b) the coarse papier mâché

boxes (Koochakzaei et al., 2021). The FTIR-ATR spectrum of the lacquer varnish matched well with the reference spectrum of shellac resin. The spectrum includes O–H stretching bands at 3413 cm^{-1}, CH2/CH3 stretching modes at 2926 and 2855 cm_{-1}, C=O stretching of carboxylic acid bands at 1709 cm^{-1}, and C=C stretching at 1631 cm^{-1}. At the fingerprint region, bands exhibited at 1453 cm^{-1} and 1378 cm^{-1} from CH2/CH3 bending and deformation (Derrick, 1999).

3.4 The paint layer

3.4.1. The red paint

The red pigment was used for two different functions (functioned in two different purposes); the first as an under-paint that served as a background at the edges of the paintings, and the second as a red paint depicting the flowers, fruits and the shawl on the shoulder of the main character. The Raman spectrum of the red paint gave the principle features of red lead Pb_3O_4 with its bands at 122, 149 and 548 cm^{-1}.

3.4.2. The orange paint

Orpiment was the pigment chosen for the orange hue applied to the painting. It was also used with the blue pigment, indigo, for creating the green of the garment. The Raman spectrum of the orpiment shows the distinctive bands at 137, 154, 179, 202, 294, 310 and 356 cm-1 (figure 5).

Orpiment is a yellow arsenic sulphide (As2S3) mineral which has been used extensively as a pigment both in its natural and synthetic forms. Purinton and Watters mentioned the availability of sulphide ores from local sources in Iran (Purinton and Watters, 1991).

2.4.3. The blue pigments

Raman analysis of the blue colour in several areas of the painting gave two different spectra attributable to indigo and lazurite. Indigo, was mainly used as an underpaint in the lobed central medallion and lapis-lazuli and was applied as the main blue pigment spread throughout the painting. Lapis-lazuli was distinguished by its strong band at 543 and weaker bands at 259, 1095, 1161 cm^{-1} (figure 6), while indigo showed its characteristic bands at 1016, 1247, 1307, 1365, 1571 and 1630 cm^{-1}. Indigo was manufactured from an assortment of plants of which the most distinguished is Indigofera tinctoria Indigotin $C_{16}H_{10}N_2O_2$, (Abdel-Ghani et al., 2012; Abdel-Ghani, 2022). Although indigo was cultivated in Iran, it was normally acquired from Bengal (Khalili, 1988b) as the industry of making indigo was not known in Iran (Barkeshli, 2013).

Lapis lazuli is a sulphur-containing sodium aluminium silicate mineral with the common formula ($Na_8[Al_6Si_6O_{24}]S$) (Abdel-Ghani, 2022). It was obtained, by the Persian painters, from northern Afghanistan mines (Barkeshli, 2013).

3.4.4. The green paint

Three shades of green were recognized. The green of the garment was found to be a mixture of indigo and orpiment as revealed by the Raman spectrum. The characteristic of the indigo show at 1016, 1221, 1307, 1365, 1571 cm^{-1} and the bands of orpiment 380, 351, 308 and 277 cm^{-1}. The same composition was revealed in other spots of darker green. The difference in the shade may be due to the proportion of the pigments present in each sample. The third shade of green was found to be the green chrome malachite, $CuCO_3.Cu(OH)_2$ with its well-identified Raman shifts at 155, 178, 265, 437 and 540 cm^{-1}.

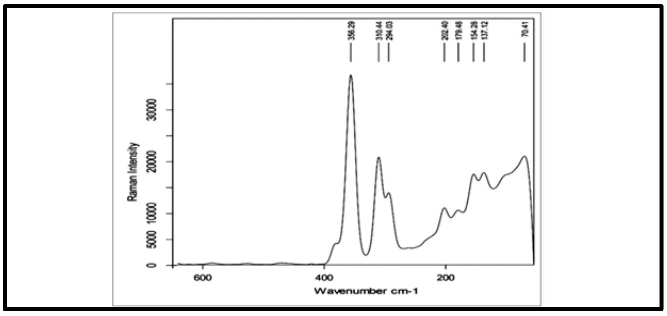

Figure 5. The Raman spectrum of the orange paint, orpiment.

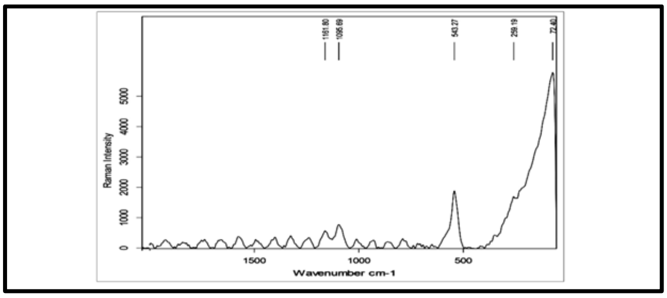

Figure 6. The Raman spectrum of the blue paint, Lapis lazuli.

Table 1 compares the results of this work (the small painting) with the individual painting depicted on the pasteboard from the 19th century (the big painting) (Abdel-Ghani 2022).

The small painting was depicted on papier mâché while the big painting was applied on the pasteboard. Both paintings were covered with a finer sheet, which was made of white pulp in the case of the big painting. Both supports were strengthened by adding straw along with hair in the small painting.

Table 1. Comparison between the studied painting (the small painting) and a previously studied painting (the big painting)

	This work (the small painting)	The previous work (the big painting) (Abdel-Ghani 2022)
Support	Papier mâché covered with fine paper sheet	Pasteboard covered with fine white paper sheet
Preparation layer	-	Blue and red paint layers
Varnish	Single lacquer layer	Multiple lacquer layers
Blue paint	Indigo, lapis lazuli	Indigo + lead white
Red paint	Red lead	Cinnabar
Yellow/ orange paint	Orpiment	Massicot
Green paint	Indigo + orpiment, mala-chite	Indigo + Massicot + lead white

No white ground layer was recognized in either case. Instead, a lacquer layer was applied under the paint layer in the big painting and two chrome pigmented underpaint in the small painting.

Indigo was the only common pigment in both instances. Although it was used mainly in mixtures, which is typical in Persian art (Chaplain, 2006; Muralha et al., 2012; Anselmi, 2015), for instance in the big painting, with massicot and lead white to create green or with lead white to adjust the shade of blue. It was also in the small painting as a sole pigment in the blue underpaint. Red lead, malachite, orpiment, and lapis lazuli were used in the small painting, in contrast to cinnabar, massicot and indigo in the big painting.

4. THE RESTORATION INTERVENTION

The main aim of the restoration treatment was to stabilize both the papier mâché and the paint layers without endangering the fragile and sensitive pigments. The treatment scheme included; Stabilizing and repairing the paint layer, deacidification of the verso of the support, removing the labels, cleaning and removing the old lacquer, retouching the paint, application of new varnish. A special handmade acid-free box was made for the final protection of the painting in the Museum display.

4.1 Cleaning

Cleaning was performed in two phases; at first, a swab lightly dampened with saliva was applied to the surface in a circular motion (figure 7a). This process was successful in removing the dirt layer without any effect on the varnish layer or the paint layer below. At this stage, it was possible to discriminate the different colours and proceed with the sample taking and cleaning process.

As stated by Romão et al., 1990, saliva is one of the most commonly used and most effective water-based cleaning materials. Its efficiency as a cleaning agent is credited to the existence of α-amylase, an enzyme that breaks down carbohydrates (Romão et al., 1990). And according to Wolbers, 2000, it contains a variety of constituents including a surfactant, pH buffers, a thickening agent, a chelating agent, enzymes, and an antibacterial preservative (Wolbers, 2000).

For the second phase, cleaning spot tests were essential to determine the solubility of unwanted materials and to find the differences between the solubility of the unwanted material and the main paint layer below. It was also important to know which solvents will remove dirt, varnish or overpaint without affecting the paint layer (Rivers and Umney, 2003)

It was shown that toluene and benzene had not affected the shellac layer. On the other hand, dimethylformamide had removed the shellac easily but it could also remove the black outlines over the gilded areas. Alcohol successfully removed the varnish but caused fading of the colour. Isopropyl alcohol was found to be the best solvent to remove shellac varnish without causing any damage to the paint layer.

The labels on the verso and recto sides as well as the red strap of paper adhered to one side and through the thickness of the reverse side were removed with a solution of alcohol and water (1:1). It was used to moisten the adhesive and dissolve it which then removed by scalpel (figure 7b, d, e).

4.2 Securing the detached paint layer and splitting paper sheets (consolidation)

The goal of the consolidation treatment is to enhance strength both to the fragile paint layer and to the painting support, sufficient for the painting to endure handling and tolerate the loads imposed by its structures (Rivers and Umney, 2003). The safe attributes of the consolidate used in this process are essential as it should prove colour stability, ageing resistance, chemical inactivity, reversibility and satisfactory bonding strength (Zervos and Alexopoulou, 2015).

Klucel G (4%), hydroxypropyl cellulose, dissolved in ethanol and water (1:1) was employed as an adhesive for fixing the papier mâché and the loose and fragile paint surface (7 f, g, h, i). The injection was employed to ensure deep penetration (7 f, i). The excess adhesive was removed using cotton swabs wetted with ethanol (figure 7 a, b, d). The consolidated areas were covered with small sandbags over silicon paper until drying.

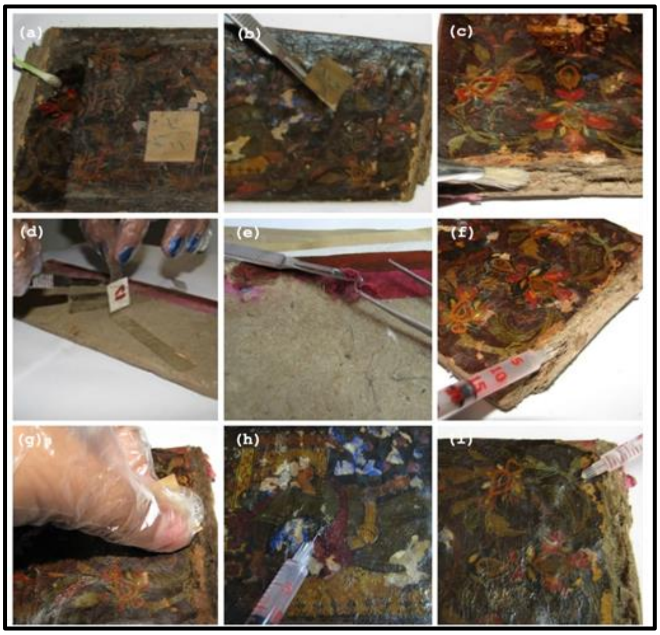

Figure (7). (a) cleaning with saliva, (b) removing the stamp, (c) cleaning dust with brushes, (d) removing the the tape from the back, (e) removing the added red strap of paper, (f) fixing separated edges of the support with klucel G 4%, (g) levelling with silicone paper, (h) (i) consolidation of the detached paint layer by injection.

4.3. Deacidification of the verso of the support

The pH value of the substrate was measured using non-bleeding pH indicator strips. A drop of distilled water was placed on the papier mâché then the pH strip was applied and left for about 3 minutes. The measured pH value was ~ 6. Therefore, deacidification treatment was essential in this case.

Deacidification is a vital chemical stabilization strategy for acidic paper due to the highly negative effect of acidity on the durability of the paper. The concept of deacidification is focused on removing the soluble acidic content of the paper, neutralizing the residual acidity and depositing a chemical substance into the paper to neutralize the prospective acidity (Blüher and Vogelsanger, 2001; Ahn et al., 2012; Zervos and Alexopoulou, 2015).

Non-aqueous deacidification using organic solvents is preferable because they wet paper more rapidly, dry faster from paper than water, and have a less swelling effect on the treated paper (Smith, 1971). In this study, a non-aqueous deacidification treatment was carried out using the alkaline buffer, calcium hydroxide $Ca(OH)_2$, dissolved in an organic solvent, isopropyl alcohol (figure 8, e) (Sequeira et al., 2006). It was applied by spraying to the reverse/recto of the painting (figure 8, b), and then plotter paper was used to absorb the excess buffering material (figure 8, c, d). Calcium hydroxide was chosen because of its easy application and good effects. It also has, according to Kolar and Novak, 1996, good DP retention after accelerated ageing (Kolar and Novak, 1996). Prior to this treatment, facing the painting was essential to secure the paint layer. Three layers of Japanese tissue paper were adhered to the paint layer using methylcellulose.

After the deacidification process, the support was consolidated with Klucel G 1%. A soldering iron was used to protect the support using a sheet of Japanese paper and polyethylene (figure 8, f).

4.4. Retouching and varnishing

No gap filling was performed and a very simple dotting retouching with Acrylic paints was undertaken to enhance the understanding of the painting. Using acrylic paints was confirmed by Umney, 1987, for its ease of use, various colour availability, and no special ventilation requirements. In addition, the right patina for the surrounding areas can be reached easily.
Paraloid B-72 dissolved in toluene was applied as a protective layer with a natural bristle brush. It was highly recommended because of its desired qualities such as reversibility and using toluene was a safe choice as it does not harm the paint layer. Figure 9 shows the painting before and after conservation treatment.

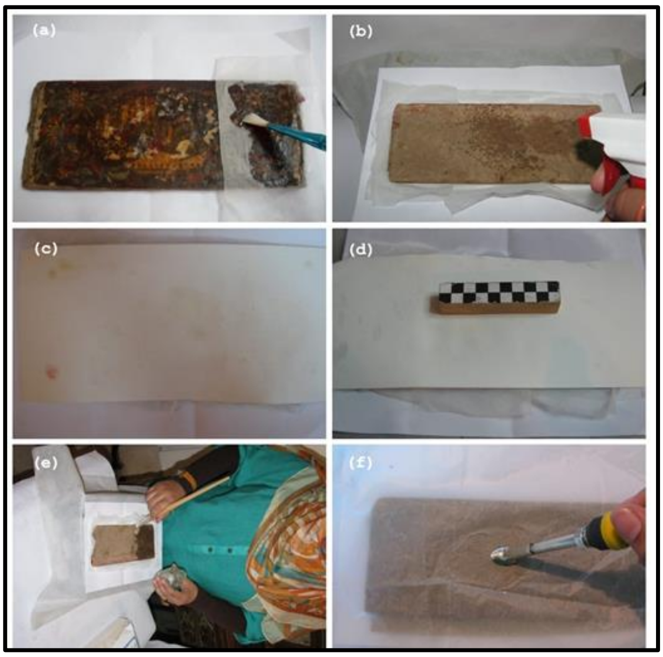

Figure 8. Deacidification the Verso of the support, facing the recto to protect the paint layers with Japanese tissue, (c) (d) plotter paper used to absorb the excess buffering material, (e) consolidate the support using Klucel G1% (f) Soldering iron was used to isolate the painting support using a sheet of Japanese paper and polyethylene

Figure 9. Shows the painting before and after conservation treatment (a) before treatment (b) after treatment

4.5. Display

The final stage in the conservation treatment was creating a special case to be utilized both in the storage and display of the painting (figure 10). It was made of archival cardboard with a transparent polyethylene window. A stainless-steel label was prepared to hold the painting information.

5. CONCLUSION:

A Qajar lacquered painting applied on papier mâché support from the Applied Arts Museum of Helwan University has been investigated and conserved. The conclusion of this study has provided a further grasp of the technique and materials used in this type of painting, as well as enhanced the fundamental knowledge of conservation treatment that should be followed in similar instances. The analytical instruments operated were the Raman microscope and FTIR.
The layered structure of the studied painting revealed its complex structure as the papier mâché support was concealed with a finer quality sheet of paper on which was applied the paint layer. Shellac resin was used as the lacquer layer. Red lead indigo, lapis lazuli, orpiment and malachite were the pigments revealed in this study, and were found to be characteristic of the Qajar period and

Figure 10. Steps of making the storage box and the final display,(a) (b) (c) step by step making the box, (d) the final box, (e) (f) (g) adhering the painting in the box with a sheet of Japanese paper and polyethylene, (h) (i) final display.

exhibited the common knowledge collected from the previously studied Persian manuscripts and the old treatises.

The conservation treatment comprised cleaning, consolidation, deacidification, retouching and varnishing. Cleaning of the dark lacquer layer was carried out with saliva and Isopropyl alcohol as it was shown that toluene, benzene, ethyl alcohol and dimethylformamide are not appropriate in this case study. However, further research might be needed to establish a concept in this matter. Consolidation was performed with Klucel G 4% dissolved in ethanol and water (1:1) while deacidification was executed with calcium hydroxide, dissolved in isopropyl alcohol. Retouching was applied with acrylic pigments and paraloid B-72 in toluene was employed as varnish for final protection. The final stage was displaying the painting in a handmade cardboard box with a transparent polyethylene window.

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