INTERNATIONAL JOURNAL OF CONSERVATION SCIENCE
ISSN: 2067-533X Volume 15, Issue 1, 2024: 391-402 www. ijcs. ro
DOI: 10. 36868/IJCS.2024.01.01

CONSERVATION OF A PAINTED WOODEN COFFIN AT DAHSHUR ARCHAEOLOGICAL AREA

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Abstract

This paper aims to document the conservation processes of a polychrome wooden coffin in the Dahshur archaeological area dating back to the late period. The exterior part of the coffin is decorated with a painted layer. Visual observation, 2D Program, and Optical Microscopy (OM) were used. wood identification. The coffin was in a bad condition. It was covered with a thick layer of dust, losing parts of the painted and gesso layers, as well as other parts of these layers, were lost. Some parts were missing from the head area of the lid coffin. The conservation processes of the wooden coffin included mechanical and chemical cleaning, reattachment of the separated parts of the ground layer and painted layers, filling the edge of the painted layer, and consolidating the painted layer. The conservation process included mechanical cleaning using soft brushes, chemical cleaning using ethyl alcohol and distilled water for painting, stabilization of the separated gesso layer using Paraloid B72, filling cracks of the gesso layers using glass microballoon with Paraloid B72 and consolidating the painted layer with calcium oxide nanoparticles with Klucel G (hydroxypropyl cellulose) 0. 5%

Keywords*: Polychrome wooden coffin; Restoration; Nano materials; Reshaping*

Introduction

Wood, as a natural composite material, has been mainly used in exterior construction and construction applications [1], being one of the key materials in archaeological research [2]. Degradation mechanisms of archaeological wood are active during exposure and long-term storage due to temperature, humidity and light effects, a stable (controlled) environment must be provided for wooden objects [3]. The preservation of a coffin and other wooden archaeological artifacts is of great importance for future generations [4]. The materials used for these processes proved to be stable and retrieval by many researchers. The general requirements of wood consolidation materials include apart reversibility, compatibility, and re-treatability [5]. The use of nanosized metal preservatives allows for deeper penetration and more homogenous uptake of particles in the wood [6]. The main reason to use nanotechnology in wood science

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and technology is the unique characteristic of nano-based materials to penetrate deeply into wood substrates in an effective way, which, in turn, results in the alteration of the wood's surface chemistry. This subsequently causes an improvement in the wood properties [7-9].

The present study was conducted to diagnose and evaluate the deterioration of archaeological wooden coffins that underwent complex alteration and degradation, and how to conserve it. And inventing a device to straighten the coffin lid and assisting the conservator in restoring other coffins.

Materials and methods

The critical eye of the conservator can help diagnose the deterioration factor and choose the best technique for the conservation process of the coffin [10].

The coffin was documented using computer software to illustrate the decoration of the painted layer. The structure of the painted layer fragments was studied using a Veho digital USB microscope with a 1. 3 MP visible light digital camera (variable magnification of 20–200×, depending on the working distance and the sample) [11] was used to study the stratigraphic structure of the painted layer [12].

Results and discussion

The coffin was in a bad condition, and it was previously restored by primal AC33, and missing parts from the head area because of the bad condition of the coffin that suffered from bad storage (Fig. 1).

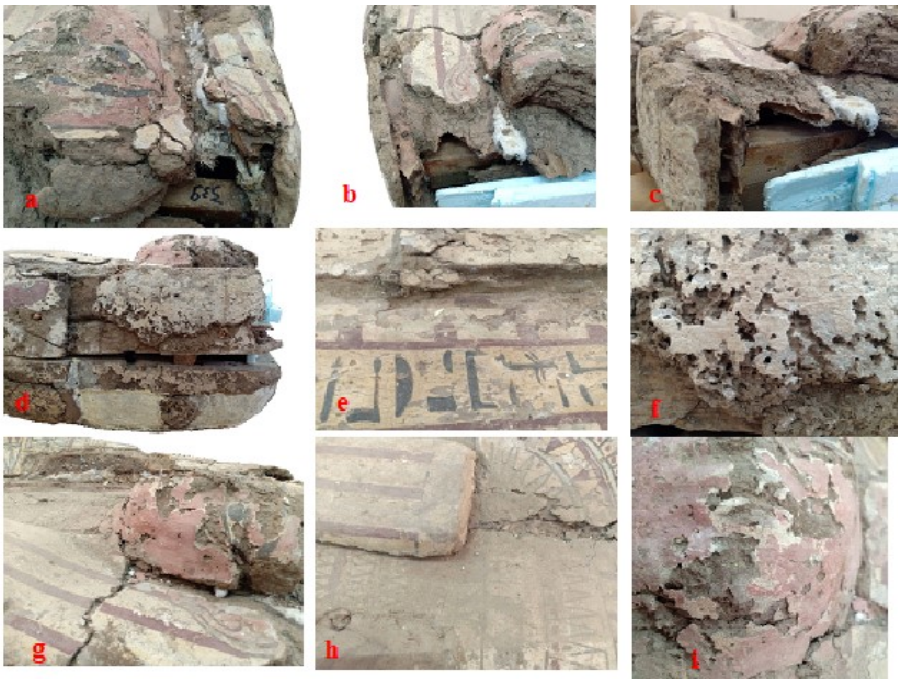

Fig. 1. Deterioration aspects of the coffin: a, b and c) flaking and missing parts, d) previous consolidation materials saturated the painted layers; e) wrong reassembled and missing parts; f) insect tunnels; g) cracks; h) thick layer of dust; i) fallen parts

Because of bad storage plays a major role in deterioration Because wooden artifacts undergo complex alteration and degradation during aging [13]. There was a lot of damage to the coffin, e.g. separations, loss of the ground and painted layers (Fig. 1c and i), previous restoration intervention (Fig. 1d and e), insect tunnel (Fig. 1f), cracks (Fig. 1g) It was covered with a thick layer of dust (Fig. 1h).

Documentation of the decoration by 2D program

Adobe Illustrator was used to highlight the decoration of the decoration and painted a layer on the lid of the coffin (Fig. 2).

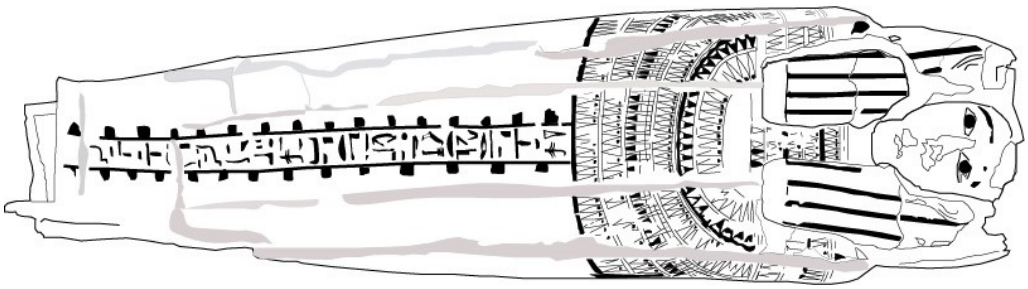

Fig 2. 2D documentation of the decoration of the lid of the coffin

Painted layer

The inhomogeneous composition of the pigment grains, fading of the color in some areas and was coated with previous consolidation material. The colored materials were strengthened in the previous restoration before a good cleaning of the surface. Upon examination of the surface of the colored materials, some sand grains were found sticking to the surface with a consolidation material (Fig. 3).

The red painted layer material, in the area of the coffin hull shows cracks and the extent of their deterioration; There is a white layer on the surface of the red pigment, it possibly caused by the previous restoration material (Fig 3c and d). The blue-colored materials show heterogeneity of the surface grains, with a glossy layer; due to the presence of previous restoration material (Fig. 3e and f). The black pigment shows missing parts of painted layer (Fig. 3g), and the ground layer shows cracks (Fig. 3h), the mud ground layer, showing the plant materials used in the mud ground layer (Fig. 3i) [14].

The painted layer consists of two layers: the first was made of clay, the second was gypsum, and then the layer of colored materials. The crystallization of salt granules on the surface of the red-painted layer (Fig. 4a and b). The ground layer has a dark color due to the reinforcing material used in the previous restoration (Fig. 4e and f) [15].

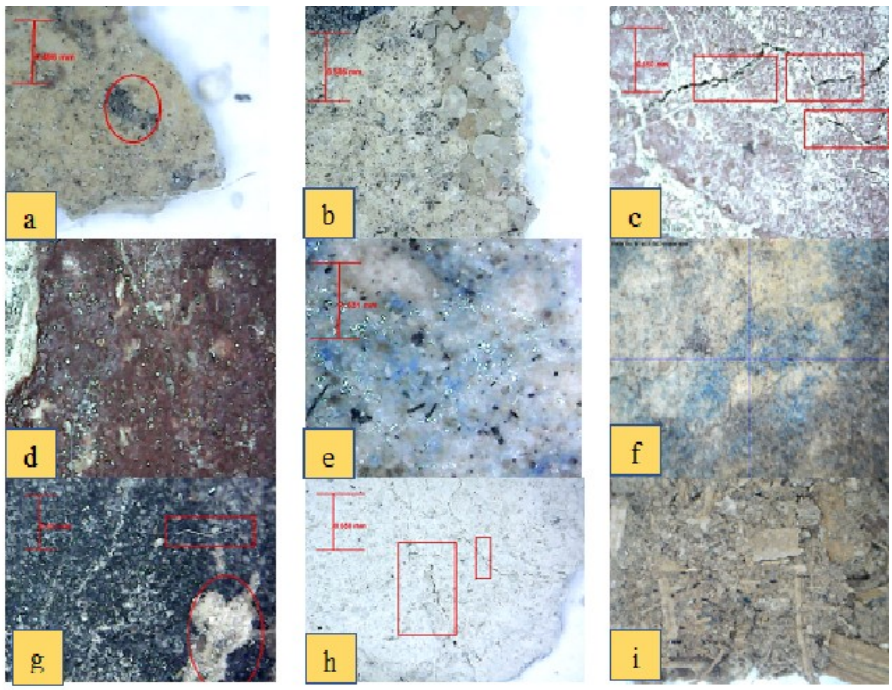

Fig. 3. Optical photomicrographs showing the course morphology of the painted layers surface used in the coffin: a and b) Yellow pigment; c and d) Red pigment; e and f) - Blue pigment; g) - black pigment; h) – Ground layer;i) mud ground layer.

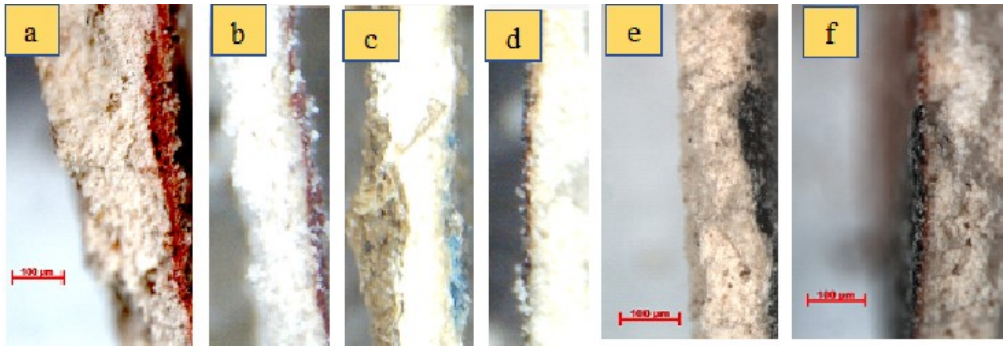

Fig. 4. showing the stratigraphic structure of the painted layers: a-b) red pinted lyer; c) blue painted lyer; d-f) black painted layer

Wood Identification

A light microscope was used to identify the type of wood and samples were compared to standard samples [16, 17]. It was found that the wood species was *Faidherbia albida* (Delile) A. Chev. (Fabaceae).

Growth ring boundaries are indistinct or absent. Wood diffuse-porous. The mean tangential diameter of vessel lumina is 100–200µm; 5–20 vessels per square millimeter. Fibers are thin- to thick-walled, arranged in broad discontinuous bands. Axial parenchyma bands more

than three cells wide (3–4) cells per parenchyma strand. Axial parenchyma aliform-confluent type (Fig. 5a and b).

Axial parenchyma, fibers, and vessel elements are all storied, and all ray cells are procumbent. Prismatic crystals are present in non-chambered axial parenchyma cells [18-20] (Fig. 5c and d).

Rays are uniseriate or have a width of 1–3 cells. There are 10 to 12 rays per mm. Acacia is a local wood, and its properties are solid and strong wood, dark in color, water resistant especially when given, insect resistant, with low vulnerability to temperature and moisture changes, it is used in furniture, coffins, nuclei, agricultural machinery, thrust work, conveyors, and tongues [21] (Fig. 5e-g) .

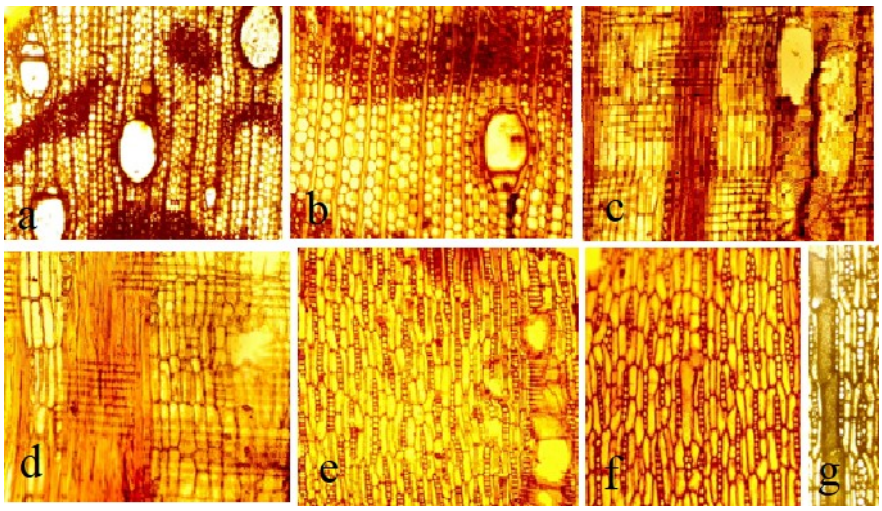

Fig. 5. The anatomical characteristics of *Faidherbia albida* by OM in transmitted light:
a and b) Transverse section (TS); c and d) Radial section (RLS); e, f and g) Tangential section (TLS)

Sterilization of the Coffin

The application of environmentally friendly and easy-to-use materials to preserve cultural heritage is beneficial not only to the works of art themselves but also to human health and the environment. and its compatibility with wood is a new trend in wood preservation [22, 23].

In the treatment of microbial infections, nanochitosan with 1% benzocryazole concentration is used to combat fungal growth. Therefore, some essential oils were used as insect repellents. and traps were placed inside the tent to catch insects and identify the type of infestation [24-26].

The tent was first designed with a 3D model using a sketch up progrm before being implemented to isolate the coffin (Fig. 6a), and then the tent was constructed using pine wood and polyethylene on the site and the tent process. to isolate the coffin for the sterilization process.

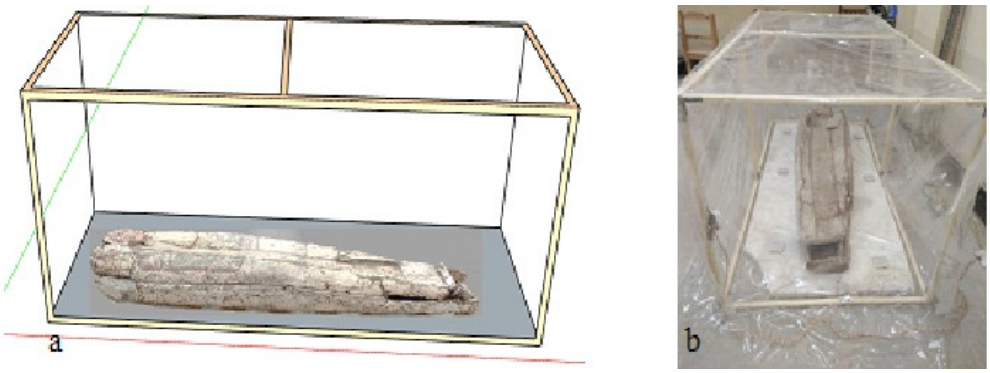

Fig. 6. The tent used for Sterilization process; a) three-dimensionality of the tent before being implemented to isolate the coffin; b) the tent used to isolate the coffin for the sterilization process

Identified Insects

American cockroach - larger than Blatta orientalis, reddish brown, thorax brown with pale margin, adults fully winged. The body length of adults is 28-44mm [27] (Fig. 7a and b). Silverfish have a distinct body form called *Thysanura* form. They are spindle-shaped: broad at the front ends and taper to the rear. They are wingless and covered with scales (except when very young). The name silverfish or fish moth comes from their fish-like appearance. They have long, slender antennae and three long, antennae like appendages at the tapered end of the body, hence the name bristletail [28]. The body is covered with more or less silvery scales which are easily rubbed off. They have 6 legs, and the antennae and tail filaments are long, slender, and segmented. Body length is up to 20mm (Fig. 7c).

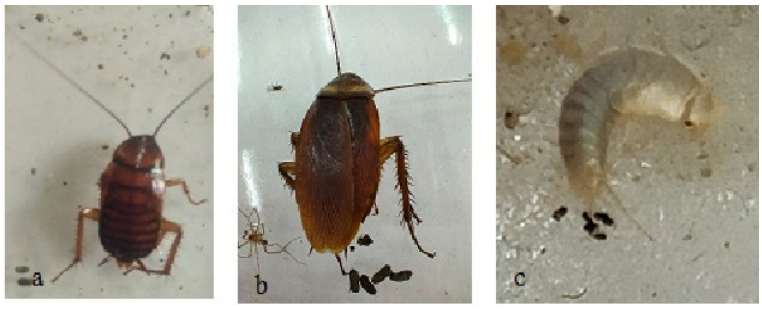

Fig. 7. The identified insects; a) nymph of the American cockroach near the door of the storeroom, b) of the juvenile stage of the American cockroach next to the tent, c) Silverfish insect next to the left wall of the warehouse door

Reshaping the lid of the coffin

The wooden coffin suffers from a bend in the coffin lid after the previous restoration process, and it has modern wooden parts, to install the lid from the inside. Despite this, the coffin lid still has a noticeable degree of subsidence that affects its appearance. To reshape the lid of the coffin to its original shape, some iron pieces of different sizes were designed to fit the size of the wooden coffin, which is two pieces from the outside and two from the inside. There are eight pieces of size 20cm and eight pieces of 25cm, so that a piece of wood of size 10 ×

10cm^2 is placed at the end of the iron screw to fix the lid of the coffin when doing the straightening process, and a hole was made in the middle of the wooden piece to install the beginning of the screw used in the device to install the screw with it so that it does not come out on the specified path. Klucel G was used in alcohol at a concentration of 1% to reshape the process of the coffin lid. The Klucel G was too reshaped using a brush, then silicon paper was placed to act as an insulating material between the lid of the coffin from the inside and the loads that are used for reshaping.

Treatment and Conservation

The phases of restoration are documentation, mechanical and chemical cleaning, consolidation, reattaching of the ground layer to the support, and filling the ground layer edges.

Mechanical cleaning

Cleaning is one of the most complex and delicate steps in a restoration project. The dust on the surface and base of the coffin was removed using soft brushes and a rubber pump (Fig 6a and b).

Chemical cleaning

Ethyl alcohol and distilled water (1:1) were used for chemical cleaning and removing the previous conservation primal (AC33) it was decided to opt for chemical cleaning of the painted layer after making several tests. It was very difficult to completely remove the previous conservation because it was embedded in the paint surface and wood substrate, and it could not be removed without damage to the original surface [29].

Sterilization

From the experimental study of nanomaterials used to inhibit growth, the best material for inhibiting microbial growth was found, which is nanochitosan with 1% benzocryazole concentration [30]. This material was applied by spraying before the final consolidation process (Fig. 6).

Stabilization of the separated painted gesso layers

The painted gesso layer lost its adhesion to the support in many places of the coffin. Primary fixation of the separated painted gesso layer flakes [31]. Thus, Paraloid B72 was used in these processes (Fig. 8. and 9). A solution of 15 % Paraloid B72 in acetone was used for the reattachment of the separated parts to the wooden support by injection [32].

Filling the edges of the ground layer

Filling cracks and small voids between the wooden support and ground layer, cotton fibers were applied, and injected by Paraloid B72 (Fig. 10a and b) Glass microballoons with Paraloid B72 in acetone 15W/V were applied with a spatula, and earth pigments were applied to the microballoons (Fig. 10b).

Consolidation of the painted layer

The experimental samples for consolidation of colored materials, and after making suitable tests. showed that the best consolidation materials were calcium oxide nanoparticles with Klucel G (hydroxypropyl cellulose) 0.5%. So soft brushes were used to apply solutions of calcium oxide nanoparticles with Klucel G (hydroxypropyl cellulose) 0.5% W/V in ethyl alcohol for the consolidation of the painted layer because of its good penetration [33, 34].

Fig. 8. Imaging while using the device on reshaping the coffin lid

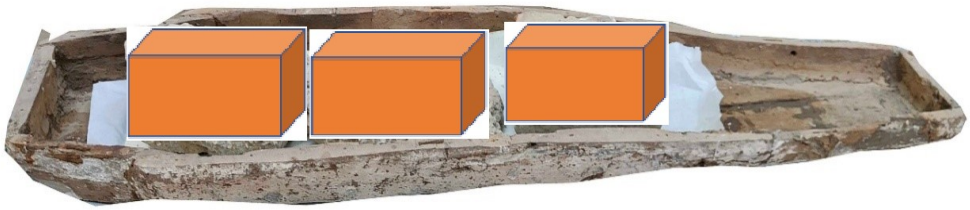

Fig. 9. Straightening the lid of the coffin by placing loads in the lid from the inside after using silicon paper to isolate the coffin wood from the loads used

Fig. 10. conservation process of the lid of the coffin; a) the coffin lid after removing the previous restoration: b) applying Paralloid with 72, 25% concentration on the cotton used to fill the joints between the wooden panels

Reinforcement

When using plexiglass to reinforce the lid of the coffin from the inside, holes were made in the plexiglass material, and on the sides of the coffin in some areas, to put coils inside the plexiglass and the coffin without using chemicals for the possibility of removing them in the future if necessary (Fig. 11a and b).

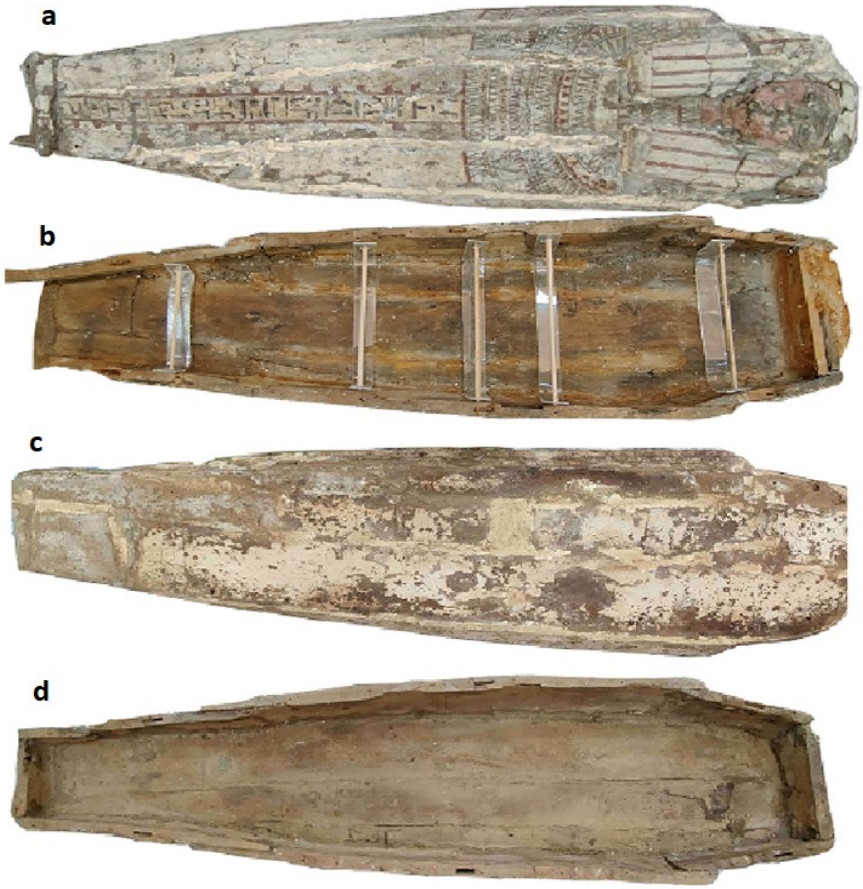

Fig. 11. The coffin after restortion; a) the lid of the coffin after restoration; b) the lid of the coffin from inside after restoration and Reinforcement by using plexiglass; c) the base of the coffin after restoration; d) base of the coffin from the inside after restoration

Conclusion

A polychrome wooden coffin dating back to the late period from Dhashour storage, consisting of a lid and base. The coffin suffered from several deterioration phenomena including bad storage and previous conservation. Therefore, a 2D program was utilized to illustrate the decoration of the coffin. Investigation using OM for characterizing the original materials, helped us to choose the most appropriate cleaning and consolidation measures and to decide the removal of previous conservation. The coffin wood species was *Acacia albida*. Indicating that the ancient Egyptian carpenter was aware of the wood properties. Paraloid B72

was used for the reattachment of the ground layer, while a mixture of microballoon, Paraloid B72 and earth pigments were used to maintain the edge of the ground layer. Calcium oxide nanoparticles with Klucel G (hydroxypropyl cellulose) 0. 5% W/V in ethyl alcohol was used for consolidating the painted layer.

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Received: April 02, 2023
Accepted: February 24, 2024