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TECHNICAL INVESTIGATION AND CONSERVATION OF A TAPESTRY TEXTILE FROM THE EGYPTIAN TEXTILE MUSEUM, CAIRO

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ABSTRACT

This paper presents the method of treatment of tapestry textile from the Coptic period. It deals with a selected piece of The Egyptian textile museum in Cairo. Treatment procedure was performed in several stages; starting examination by Scanning Electron Microscopy (SEM) associated with EDAX (SEM–EDAX) for identification of the fibers, the deterioration, and analysis the mordant in dyed samples. The results showed fiber damages, while FTIR used to identify dyes. The treatment of a tapestry piece was performed by removing old support, and finally consolidates the object by fixing it on a new support of natural blue linen which was stretched on a foam frame according to the requirements of the museum.

KEYWORDS: tapestry; scanning electron microscope; morphology; FTIR; treatment; consolidation; support; foam frame.

1. INTRODUCTION

The Coptic textile is one of the ancient Egyptian textiles, which is closely related to the Christianity. The Egyptian artisans were the Christian Copts (Abdel-Kreem, et al., 2005, G. U., 1926; Jungim, 2011). Coptic textile in tapestry style which called "kabaty" is one of the most important techniques for decoration of textile (Kamal, 2013). The tapestry depending on used weft thread does not extend through the loom (Amin, et al., 2013). The preparation process begins with proper design before starting weaving, where specialists work sketches of designs for their religious symbols and portraits spread at Coptic art through this period, and apply the design on the cartoons already prepared (Kamal, et al., 2017). The fabric is a balanced plain-weave natural linen with decorative wool (Arthur, 1986, Jungim, 2011). Linen and wool are very different in their structure characteristics (Jungim, 2011). Although these fibers can be quite resilient in certain circumstances, they are still susceptible to degradation (Rebecca, 2008). The deterioration of tapestries can be attributed to the combined effects of external environmental conditions such as humidity, temperature, pollutants, soiling and exposure to light accelerate the chemical breakdown (Abdel-Kareem, 2010; Khennouf, et al., 2010; Odlyha, et al., 2007). Another reason for degradation is the loading imposed on the tapestry by its own weight; in the direction of its weakest components, across discontinuities in the woven wefts (Cybulska, 2007; Khennouf, et al., 2010). The unwanted effect is a significant loss of tensile strength and a strongly increased brittleness, loss of their elastic properties (Muller, et al., 2007). Thus, the tapestry requires additional attention and intervention with the treatment and conservation processing. The conservation of textile includes the entire range of treatment, without tampering directly into the item's structure and changing its shape. Restorations are combined with conservation and represent the methods and procedures which are applied directly, in order to return a textile item or material into satisfactory form, where its original shape and preserved aesthetic, historical and physical integrity can be perceived (Djordjević, et al., 2017). Supporting the tapestry is considered among the range of treatment. Supporting the back of the tapestries onto linen would enable us to preserve what was left of both color and design and still make the tapestry safe to hang. Also the use of foreign material on the front of the tapestry so that inevitably fading and color changes would be less noticeable and cause minimal interference with any part of a design by using neutral color for the stitching (Boersma, 1997). The paper reports the conservation treatment of the object by removing the old restoration, fixing separate and loss parts, supporting the object on linen fabric and making new display (Ahmed, 2011).

2. DESCRIPTION AND CONDITION

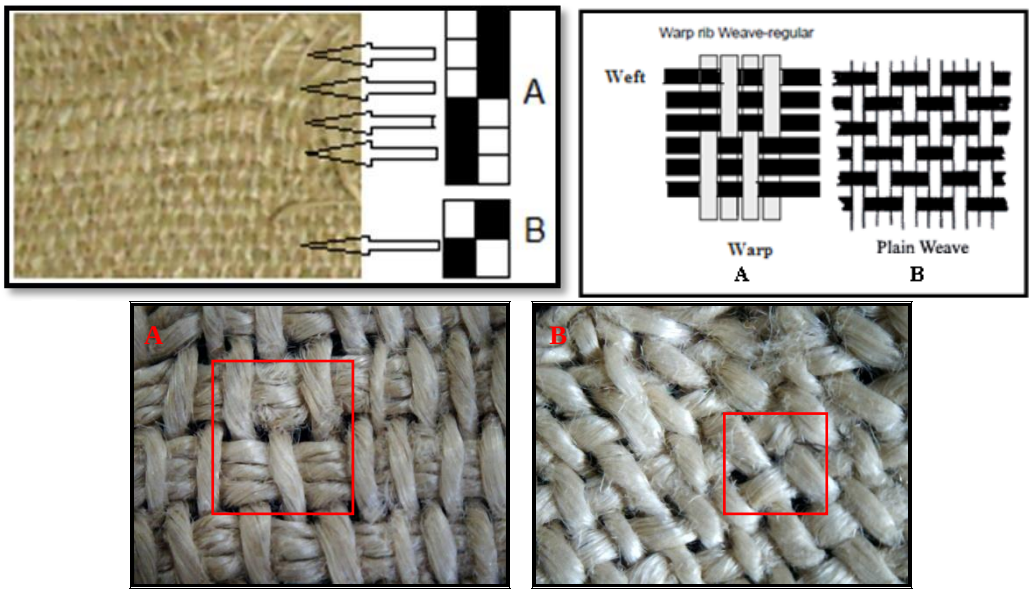
2.1. Historical Context

The object was stored in Egyptian museum textile under no.552. It dates to Coptic period 4th-5th century. the piece was waved by tapestry technique. The piece is 14x20cm (see Fig. 1). No. of the warp 16. No. of the weft 13.

Figure. 1: Textile object dates back to Coptic age (14x20 cm).

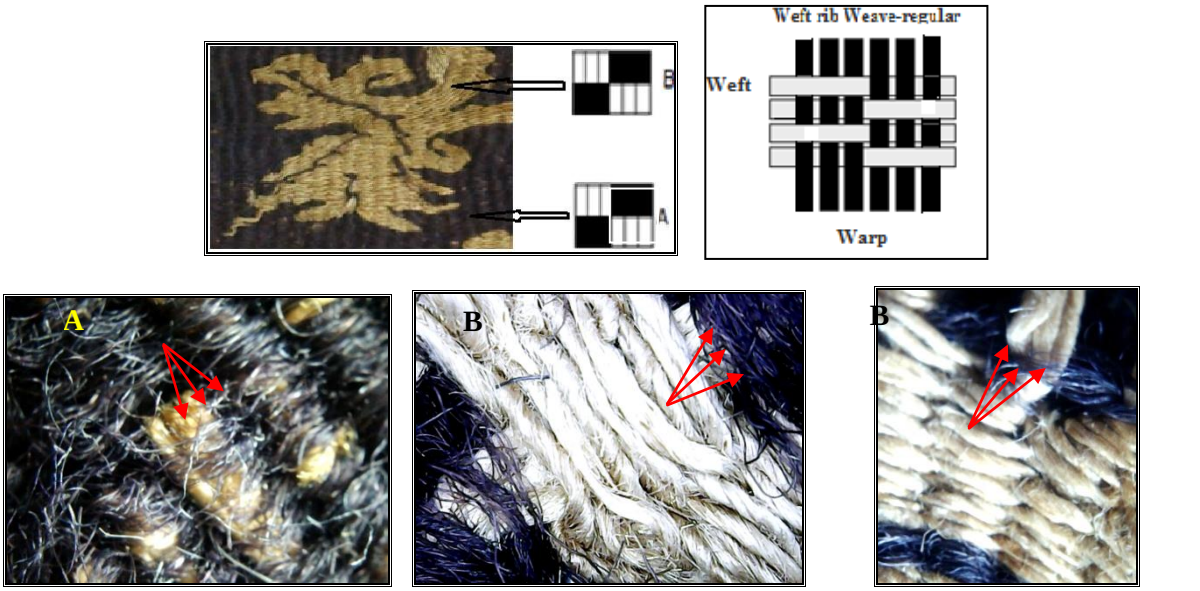
TECHNICAL INVESTIGATION

This piece is combine several types of plain weave structure. The ground was waved with undyed linen yarn with the plain weave 1/1, it is interposed by 8 horizontal lines 4 in the top and 4 in the bottom with the same yarn which was weaved with 3/3 warp rib Weave-regular (Figs 2 A, B). Then comes the geometric decoration is uncompleted eight pointed stars were waved of brown dyed wool with 3/3 weft rib Weave-regular (Fig. 3 A). The star was surrounded with undyed linen yarn and was weaved with 3/3 weft rib and separated it from the ground (see Fig. 4 A). The geometric shape was interposed with plant decoration which was weaved with undyed linen yarn and was weaved with the same weave of engineering shape (Fig. 3 B) and it has an embroidery by brown wool with stem stitch. The weaver has succeeded in reducing the slits resulting from the change wefts by overlap the curved wefts in the decoration.



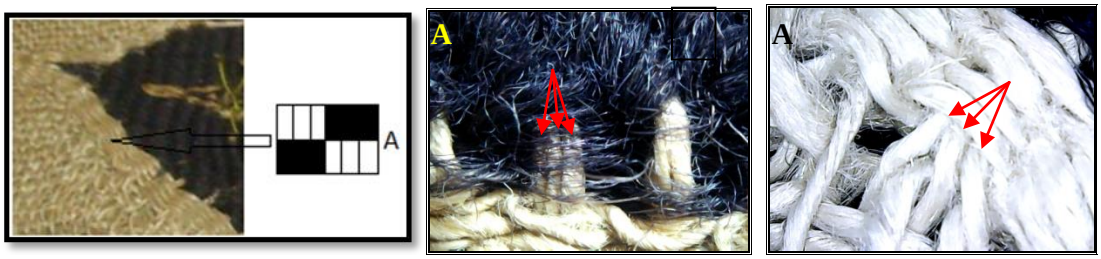
Digital microscope images (x200)

Figure 2. Upper: The ground weaves structures
A: The ground was interposed by 8 horizontal lines and weaved with 3/3 warp rib weave-regular, B: The ground was waved with undyed linen yarn with the plain weave 1/1.



Digital microscope images(x200) Digital microscope images(x400) Digital microscope images(x200)

Figure 3. Upper: The decoration weaves structures
A: The geometric decoration was waved of brown dyed wool with 3/3 weft rib weave-regular, B: The geometric decoration was interposed with plant decoration was weaved with the same weave.

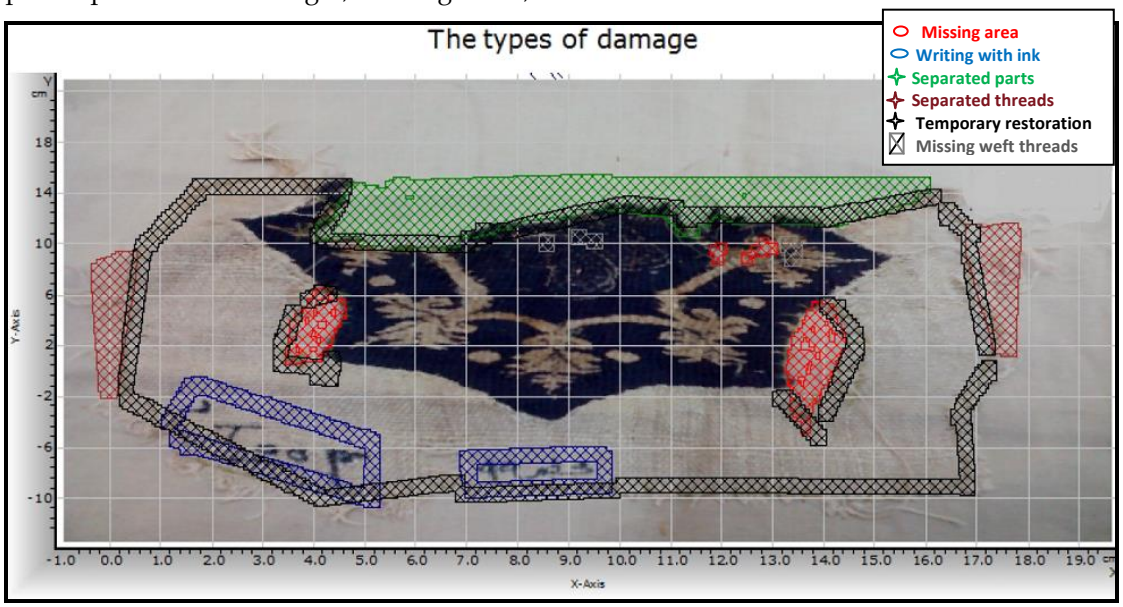


Digital microscope images(x200) Digital microscope images(x400)

Figure 4. Left: The star weaves structures
A: The star was surrounded with undyed linen yarn was weaved with 3/3 weft rib and separated it from the ground.

VISUAL INVESTIGATION

The visual investigation showed there are many signs of damage on this object due to the surrounding natural aging environment (Helmi, 2008) such as, many separate parts from the edges, missing areas, weakened fibers, missing weft yarns, separated yarns, temporary restoration (green yarn used in fixing the object at the excavation site), and writing the number of object with ink on the face of the piece (Figs 5,A,B,C,D,E,F).



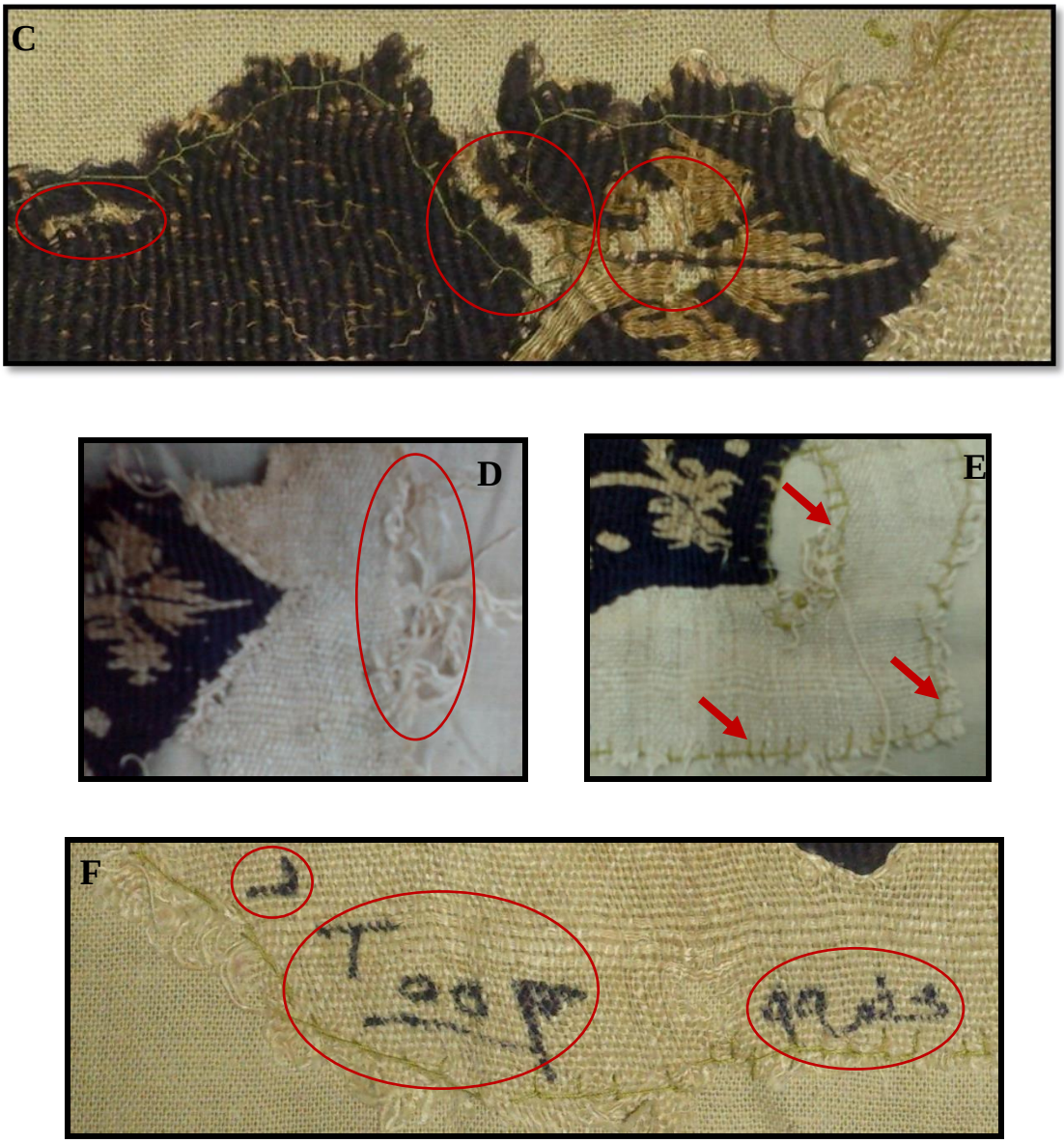


Figure 5. Tapestry in scale (cm), Upper. Lower (A-F): There are many signs of damage on this object such as, A. Many separated parts from the edges, B. Missing area, C. Missing weft yarns, D. Separated yarns, E. Temporary restoration on acotton fabric, F. Writing the number of object with ink on the face of the piece

3. EXPERIMENTAL INVESTIGATION

3.1. SEM

The conservation of ancient textiles requires an understanding of the morphology and technology of the object (Camille, 1993). The samples from the ground and the decoration yarns were investigated by using Scanning Electron Microscope (SEM) (FEI-QUMTA 200SEM) to identify the surface morphology and the damage aspects on these fibers. SEM images of examined yarns are illustrated in Figs 6 (A,B,C,D,E), showing that the brown yarns (Fig.5) are wool and the undyed yarns are linen, the both fibers are extremely damaged with longitudinal splitting characterized and broken.

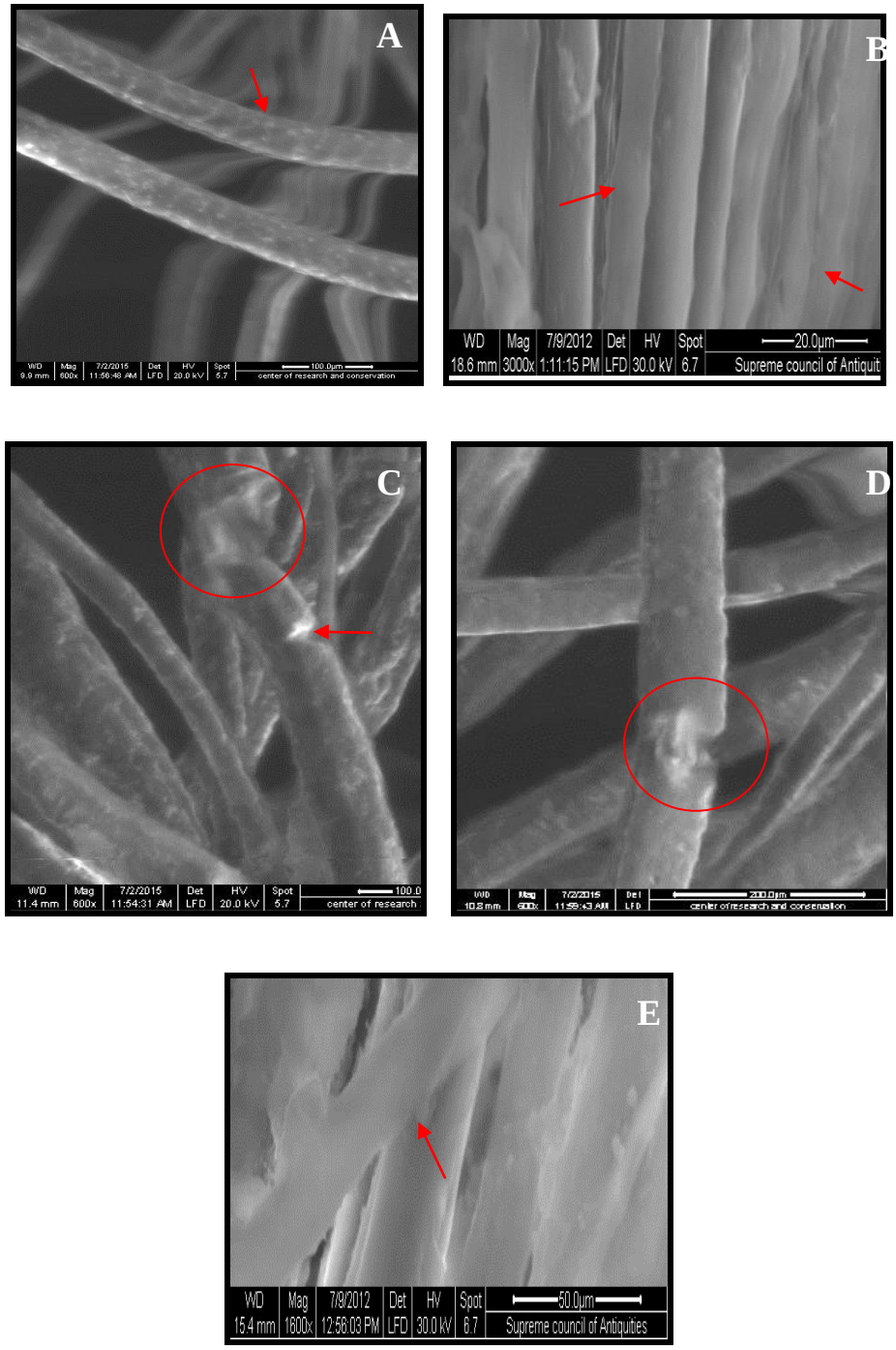


Figure 6, The figure shows SEM images of examined Coptic textile

A: The brown fibers of Fig.5 are wool, B. The undyed fibers are linen, C. D. The wool fibers are extremely damaged, broken with transverse cracking, E. The linen fibers are extremely damaged also, broken with longitudinal cracking

3.2. Fourier Transform infrared spectral analysis (FTIR)

The first objective of archaeological textile reconstruction is identification of fibre constitution. The modern technology of Fourier Transform Infrared Spectroscopy (FTIR) allows determining fibre constitution of textiles and former colour of archaeological textiles (Žemaityte, 2006). The FTIR analysis was carried out for samples using FTIR Type VERTEX 70, in spectral range (wave numbers cm^{-1}) from $4400cm^{-1}$ to $600cm^{-1}$.

The comparison of FTIR spectra of the brown dye of the piece and the Indian cutch standard dye showed that the peaks of both spectra are in the same frequency region. So the results show that the source of this color is Indian cutch as evidenced in Figure 7(A,B). FT-IR spectra were recorded which showed bands at 3275 cm^{-1} in the archeology cutch corresponds to the 3234 cm^{-1} in the standard, due to ami-

no -NH stretching vibrations. But bands at 2927 cm^{-1} and 2874 cm^{-1} in the archeology cutch corresponds to the 2924 and 2852 cm^{-1} in the standard, due to O–H and aromatic C–H stretching vibrations, respectively; presence of bands at 1627 cm^{-1} and 1517 cm^{-1} in the archeology cutch corresponds to the 1608 cm^{-1} and 1520 cm^{-1} in the standard, is due to C=C and C=O stretching vibrations, respectively. Stretching vibrations at 1230 cm^{-1} and 1039 cm^{-1} in the archeology cutch corresponds to the 1241 and 1077 in the standard, are for C–O stretching peaks. (Table 1) (Abdel-Kreem et al, 2005; Amin, 2011;Chang et al, 2013; Kamal, 2013; Mortazavi et al, 2012; Shabbir et al, 2016).

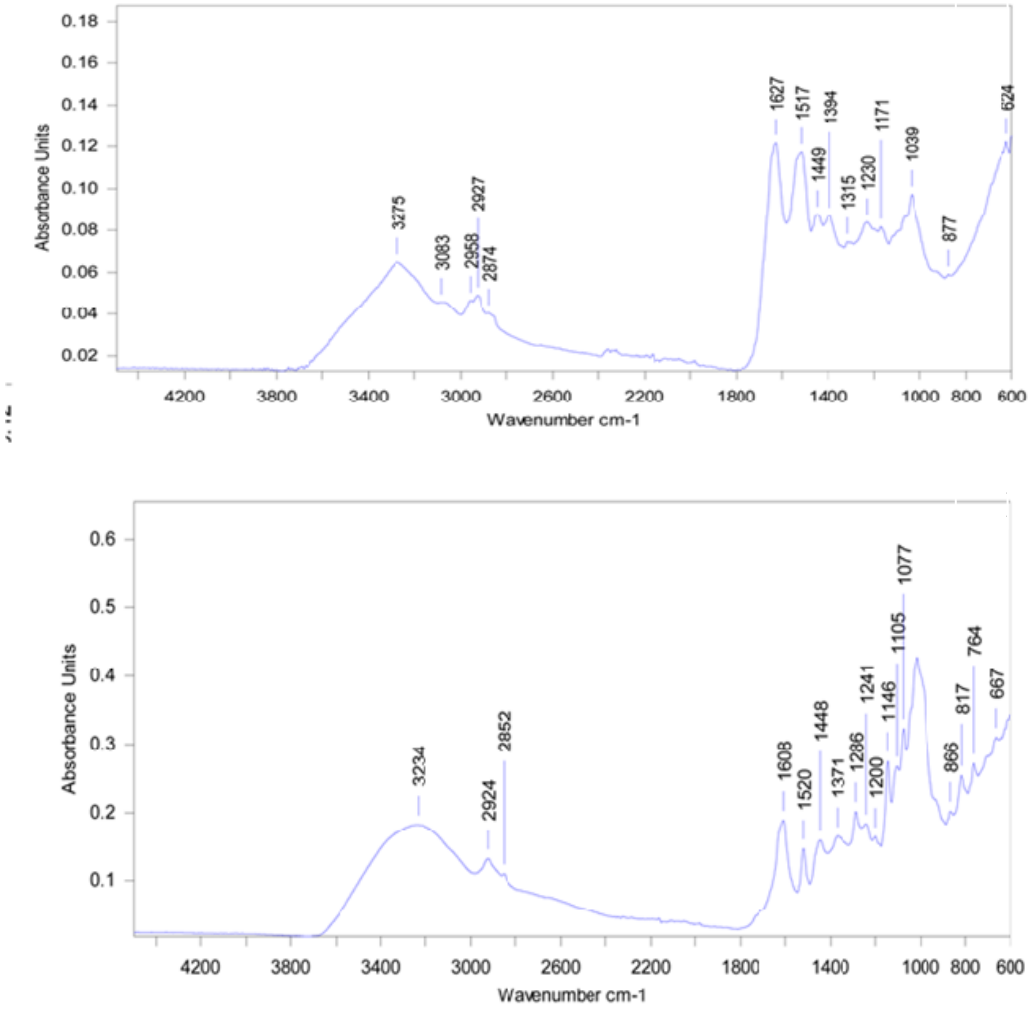


Figure 7. A: The correspondence between the patterns of infrared analysis of a brown sample of a piece, B: infrared analysis of a sample of Indian cutch standard dye.

Table 1. The correspondence between the patterns of infrared analysis of a brown sample of the piece and infrared analysis of a sample of Indian cutch dye

Absorption peaks No . of Archeology Cutch (cm-1)	Absorption peaks No . of standard Indian Cutch (cm-1)	Functional Group
3275	3234	NH stretch over laps
2927	2924	OH-stretch=Broad band
2874	2852	CH stretch
1627	1608	C=C ring stretch couples with NH ,OH Band
1517	1520	C=O Stretch

3.3 Scanning Electron Microscope (SEM) equipped with EDX analysis

Samples of brown wool were analyzed by EDX. EDX is the most frequently used analytical technique to determine the chemical composition. The X-rays can be analyzed with an energy-dispersive system (EDX), and they provide qualitative and quantitative information. (The investigation was carried in the Egyptian Mineral Resources Authority, Central Laboratories Sector). The SEM had Field Emission Gun attached with EDX Unit (Energy Dispersive X-ray Analyses), and K550X sputter coater, England), with accelerating voltage 30 K.V., magnification 14x up to 1000000 and resolution for Gun.1n**.** The analysis revealed various chemical elements, such as C, N, O, Mg, Al, Si, S, Ca (Fig. 9). The Al found in the sample representing alum mordant was used in the dyeing (Baek, 2012) to obtain fast colors, aluminum salts do not change the colors of dyed textiles (Otłowska, 2018). These results are in agreement with the previous work reported by (Abdel-Kareem et al, 2005) which showed that alum is the most mordant was used in dyeing of Coptic textiles from 2nd - 7th A.D. centuries. But the other elements rather represent the components of the wool yarn and the dust.

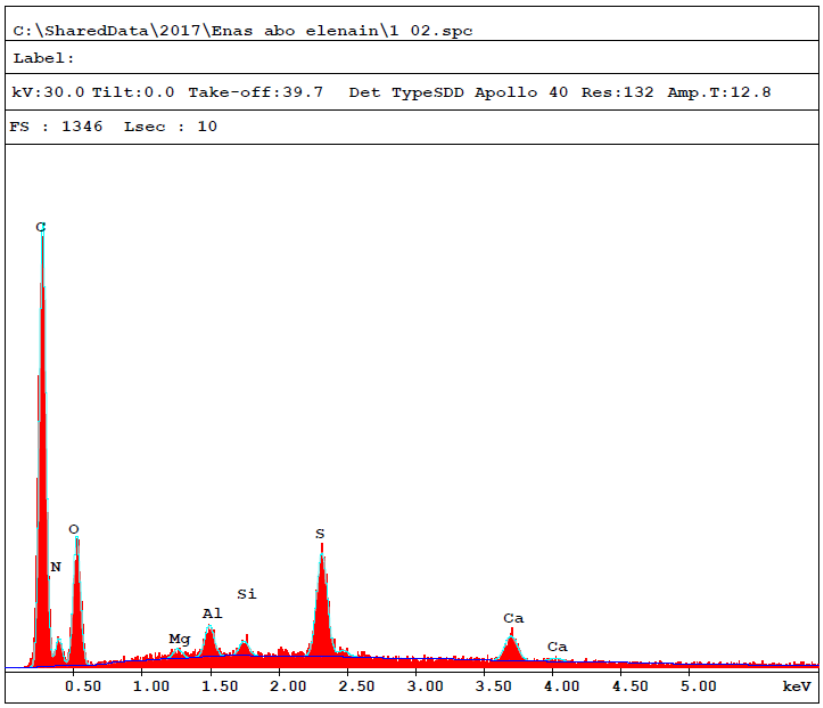


Figure 9: The SEM analysis provider unit EDX evident that the elements found in the sample representing mordant used in the dyeing or represent one of the components of the wool yarn and the dust

4. CONSERVATION PROCESSES

4.1 Cleaning of the object

Due to cleaning the piece at the excavation site and the yarns were fragile, the piece wasnt cleaned to avoid the increasing damage. So final support process was conducted it was divided into the following stages:

4.2. *Preparation of wooden frame and textile support*

Blue linen textile was used (1/1 Plain Weave). The linen fabrics are very strong, and give a good heat conductor. When linen fibers get wet, their strength increases by 20% (Bo Ejstrud, 2011). Its surface was cleaned using hot water with a few drops of detergent solution (Synperonic N), to remove chemical residues and prevent shrinkage at a later time due to humidity changes (Ahmed, 2013), then the textile was rinsed with distilled water for several times to ensure that its disposal of any detergent, as well as to ensure that there is no future shrinkage for it and then was dried with iron. The textile size is 45×50 cm to tighten it on the wooden frame which was chosen with good quality of wood with size (35×40 cm). The textile was pulled on a wooden frame by using pins with the province to keep its warps and wefts on a right direction.

4.3. *Temporary supporting*

At the beginning the old temporary restoration with green yarn at the excavation site was removed (Fig. 10). Then the piece was temporary fixed on the textile support by using needle work, precisely using thin needle with blue cotton yarn. The piece was put on the textile support with taking into account put-

ting the piece correctly in the middle. The piece was fixed by worked longitudinal, straight and parallel lines and each line length 5 cm and far from the next line to it a distance of about 5 cm, the work starts in the lines of the first row and after completed it the second row comes to mediate the distance between the first lines row, then the third row comes as the first alternately until fixation was completed and also fixing the weak places of the piece, as shown in (Fig. 11).

Figure 10: Removing the old temporary restoration

Figure 11: The temporary supporting of the piece

4.4. *Permanent supporting*

The term "support" can refer to materials that used to stabilize weakened areas of a textile, and safely transport a textile. It is an integral to the object structure. Added to protect the original fabric from abrasion from handling or display A support often is a piece of new fabric used as a patch or backing. The fabrics are chosen for their visual and chemical compatibility with the original, as well as light and wash-fastness (National Park Service (NPS), 2002). It is important to choose an appropriate yarn or support fabric and to use the correct sewing technique (The staff of the CCI Textile Lab, 2008). Therefore after completion of the temporary fixing. The couching stitches were used to fix some places in the piece with a very fine needle and fine undyed silk yarn. The edges of the object all around and the edges of the missing parts were attached by sewing with a small stitch technique (blanket stitch) and afterwards the weak parts were attached by small stitches. The separated yarns was fixed in true place with couching stitches after it get wet. Couching stitches were taken over the yarn on the face to keep it in place (Batigne, et al., 1953). Stitching should be relaxed so that tension is not created in the fabric. Tension causes buckling or gathering, which can break old yarns (The staff of the CCI Textile Lab, 2008)(see Figs 12-A,B,C,D).

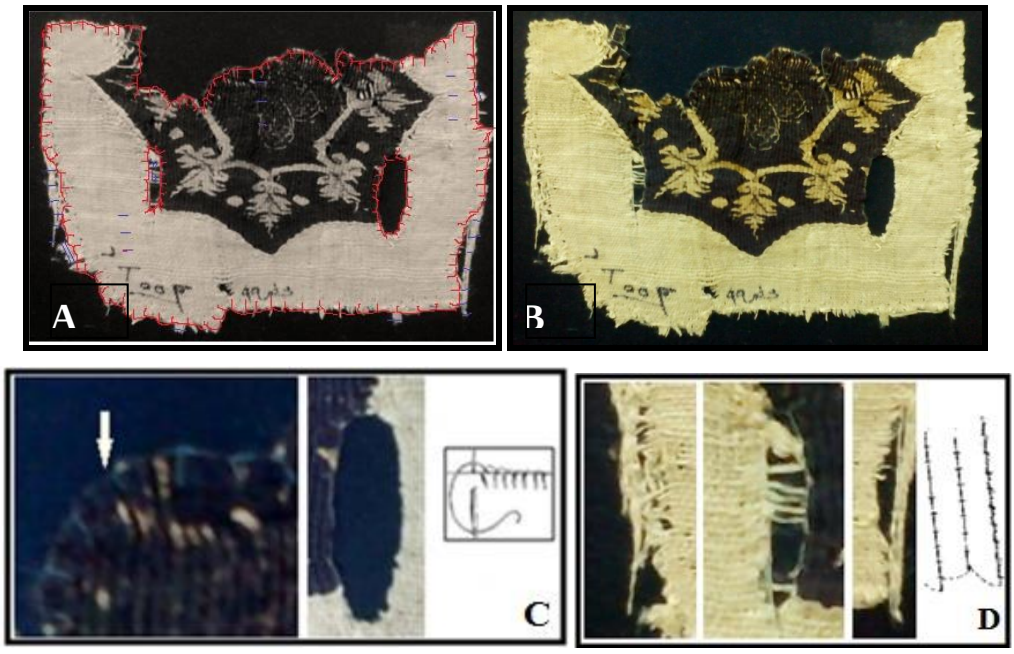


Figure 12. A: Elaborately figure for the types of the stitches which used in permanent supporting, B. The piece after permanent supporting, C. Using the blanket stitch to fix the edges of the object all around and the edges of the missing parts, D Using the couching stitches to fix and keep The separated yarns in true place.

4.5 Preparation for the museum display

After completing the object fixing, it was displayed in a suitable manner according to the museum requirements. by using the foam frame because of its good characteristics against the moisture and biological deterioration, in addition to its lightness and easily moving. This procedure was achieved according to the following steps:

The 1st step, a piece of foam has been cut with size 25×30 cm leaving about 5 cm from each side. The 2nd, a piece was taken far from the wooden frame and was put in the middle of the foam frame. The 3rd step, the edges of the textile support have been adhered from behind with peva. Finally, two sheets of foam have been cut with sizes 4 × 30 cm, and two sheets have been cut with sizes 4 × 17 cm to paste it with peva on the clear textile support as shown in, (see Figure 13). The object in the final stage is shown in (see Fig. 14) (Amin, 2018).

Figure 13: The stages of prepare the museum display on a foam frame

Figure 14: The object in the final stage

5. DISCUSSION AND CONCLUSION

This study included treatment and conservation of an archaeological textile dates back to the Coptic period. The piece was waved by tapestry technique, it's have a geometric decoration is uncompleted eight pointed star was waved of brown dyed wool and it interposed with plant decoration which was weaved with undyed linen yarn. The object suffers from fiber damage especially at the edges, terminal fringes, missing areas, weakened fibers, separated yarns and temporary restoration with green yarn which used in fixing the object at the excavation site. The piece was analyses by using (SEM) which shown that the brown yarns are wool and the undyed yarns are linen. The object surface is very weak and brittle. FTIR analysis has been performed showed that the source of the brown color is Indian cutch and the kind of

mordent is Alum. The EDAX for x-ray microanalysis also was used and the results showed that the mordent is Alum. Due to cleaning the piece at the excavation site, the piece wasn't cleaned to avoid the increasing damage. The old temporary restoration was removed then final support process was conducted with needle work on a blue linen textile. Finally, the piece has been prepared to museum display according to the museum requirements by using foam sheet as a lightly material.

In conclusion, The paper presents restoration method for a piece of tapestry weaving. The archaeological documentation had been explained, scientific examination and analysis had applied on specimen of selected piece to record the weave structure and deterioration levels of object, the consolidation of objects has been performed by removing the temporary restoration which had been carried out at the excavation site and fixed with different stitches and final display.

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