Fayoum University
Faculty of Archaeology

Investigation and Conservation of a Rare and Colourful Woollen RUG Belongs to The Iraqi Royal Rule (1921AD)

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ABSTRACT
The importance of this research is due to the study of a unique and multi-colored woolen rug, dating back to the modern Iraqi royal era (1921AD) preserved in the Museum of the Faculty of Archeology at the University of Samarra in Iraq.The main objective of this research is to present the scientific analyses that were carried out in order to identify the material constituents of the historical rug, methods of manufacture and their deterioration state. The investigations were achieved by using USP Digital Microscope, Scanning Electron Microscope equipped with an Energy Dispersive X-ray unit (SEM with EDX) and Attenuated Total Reflectance-Fourier Transform Infrared Spectroscopy [FTIR-ATR]. The dyes of the rug fibres were identified chemically in the lab. The examination results demonstrated that the Iraqi rug is made of wool fibres dyed with synthetic dyes as weft threads and the warps are cotton fibres, a weave structure is a tapestry weave. The rug fibres suffer from weakness and severe damage as dirt, dust and accumulations that obliterated its features, in addition to tears, cuts and separation in some of its parts. Moreover, this paper presented the treatment and conservation processes that were carried out on the historical rug for the first time, which included documentation, cleaning, assembling and strengthening, finally displaying on a new support.

INTRODUCTION:

There are many terms of the meaning of rug in the Arabic language such as ALrafrf, ALabkari, tanafs, darnaka and zuliya (Embi and Abdullahi 2012). The craft of weaving rugs in Iraq, like other industries and folk crafts continued and developed until it is now and considered one of the most important folk crafts. They reflect the sense and popular taste of Mesopotamian people. Weaving Iraqi folk rugs has gained sophistication and flexibility over time (Oppenheim 2019). It is not known how much time passed before Iraqi man was guided to the woven rugs from thick twisted wool threads and that the conversion to such a matter, may have been influenced or affected by the manufacture of woven clothes from threads, thus, it can be said that the appearance of the rug industry in its first form before or very soon after the manufacture of woven garments from threads. Therefore, the discovery of a piece of rug during excavations does not mean that is the first evidence of the manufacture of rugs because they are organic materials that are

greatly affected by chemical and biological damage (Kourkoumelis et al. 2013). After the Islamic conquests of Iraq, Muslim Arabs transferred the weaving methods of the rug to other countries (Saoud 2004).

There are several literatures on the handmade Iraqi rug materials and manufacture passed through several phases until it had its final shape as it is today. Of these, (Saoud 2004), (Van de Mieroop 2017), (Podany and Nemet-Nejat 2003), (Hassan, Bian, and Xin 2013) and (Oppenheim 2019) they shed light on the history and development of the manufacture of Iraqi rug from ancient time till modern royal rule, materials, size and weave structure. As they mentioned that the Iraqi artist used the tapestry weave with a thick and tightly woven wool weft fibres and cotton warp suitable for bedding on the ground such as we sleep on mats. As well as (Embi and Abdullahi 2012), (Abdel-Kareem 2012), (Hassan, Bian, and Xin 2013), , (Jackson 2017) (Al-Gaoudi and Aly 2021,118) and (Saoud 2004) , presented methods and value of dyeing fibers, decorative elements of the Mesopotamian rug art industry. As the rug contains almost all colours and after the advent of Islam, Muslims took care of and developed the visual decoration units of the art according to Islamic thought, whether they are plant or geometric. Also (Paul 2011,384-85) mentioned different kind and resources of the dyes and the most common favourite colours used in dyeing the rug fibres through the Sumerian, Babylonian and Assyrian periods. (Oppenheim 2019) and (Roux 1990) presented weaving tools that were used by the ancient Mesopotamians , as a spindle made of wood, they also knew the spindles made of bone and metal . There were two types of looms, vertical and horizontal. The vertical loom was usually used for weaving light fabrics and some small pieces of fabric. In contrast weaving by horizontal loom is more complicated, it is characterized by the ability to weave large and thick pieces of textiles, including gowns, rugs and carpets. The handmade rugs and carpets industry continued during the national rule, it is moved to neighborhood countries after the craftsmen of this industry migrated to those countries during the occupation of Baghdad by the Mongols and the fall-down of the Abbasid state. The modern mechanical carpet production methods did not enter Iraq until many years after the end of the Second World War (Çetinsaya 2006).

Archaeological and historical Textiles often present complex structures and represent the highest technological achievements of a culture, but because of their fragile and organic composition, they often don't survive (Shehata, Marouf, and Ismail 2020).

They are highly vulnerable to damage from light, dirt, air pollution, microorganisms, and mechanical damage. All these factors cause debilitating in both fibers and dyes, harden and stain fibers, separates parts and eventually some parts are lost. They require carefully controlled, reliable temperature and humidity conditions as they are extremely vulnerable to damage when displayed or stored in inappropriate environmental conditions(Al-Gaoudi 2020, 50).

Identifying and analysis the materials and properties of textile objects can greatly help in their caring and preserving. The identification of the coloring materials can help the conservators to choose the proper cleaning conditions as well as to understand the degradation processes taking place on selected areas of the textiles. The relevant scientific analytical processes to ancient textiles have been reported in many researches as (E.Amin 2017), (Attia et al.2022) and (Mahmoud Abo-Elmaaref et al. 2021). Attenuated Total Reflectance-Fourier Transform Infrared Spectroscopy [FTIR-ATR] technique provides information about the chemical bonding or molecular structure of materials, whether organic or inorganic, also it is considered a powerful tool for the study of fibres and their deterioration processes. The use of the portable FTIR-ATR analysis method allowed obtaining fast and accurate results without the need to take a sample of the object (Keheyan et al. 2018). Scanning Electron Microscopy coupled to Energy Dispersive X-

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ray Spectrometer (SEM-EDS), a microstructural invasive and partially destructive technique can be even more reliable for the observation of the morphological and structural features, due to the ability to obtain images of a better resolution. More information is retrieved on the fibre surface, preservation state, and nature of deterioration, presence of salts, dust, dirt and other deposits (Karydis et al. 2019).

The conservation aims to improve the properties of textile objects and improving their long their stability. Also, aims to slow down the rate of the further deterioration of textile artefacts as much as possible (Abdel-Kareem, et al., 2010), to pass on to future generations (Nabil, Khattab, and Kamel 2021).

For the significance which mentioned above, this research was carried out for studying and identifying the material constituents and deterioration profiles of the historical rug which date back to the Iraqi modern royal rule (1921AD), stored in the Museum of the Faculty of Archeology at the University of Samarra in Iraq. Scientific analysis and investigations were carried out using USP digital Microscope, Scanning Electron Microscope equipped with Energy Dispersive X-ray unit (SEM with EDX) and Attenuated total Reflectance-Fourier Transform Infrared Spectroscopy [FTIR-ATR]. Furthermore, The treatment and conservation processes of the rug object are presented in this paper, including the documentation of the rug's condition, followed by cleaning, strengthening, finally, displaying on a new support.

1. Background of the Object

The object under study is a historical rug, dating back to the Iraqi monarchy (national rule (1921AD)). The children inherited it from the parents and grandparents until it arrived as a gift to the Museum of the Faculty of Archeology, University of Samarra, with the aim of restoring and preserving it. This date based a lot on what was mentioned by the collectors of the rug piece and on the technical, artistic and decorative style used in its manufacture, as no other information is available in the museum records.

2. MATERIALS AND METHODS

2.1. Documentation Process

Photography is one of the most important methods of recording and documenting visually. It is one of the most effective ways, in which cameras and different lenses are used to photograph the object with all its contents and dimensions, and it gives a detailed close-up of the object from all sides and the parts that show various deterioration aspects (Moore 2001). The photographic documentation continued at all stages of the treatment of the object before, during and after the completion of the treatment.

2.2. Characteristic and Technical Analysis

It is noticed from the visual examination and technical analysis by using different lenses for analyzing textiles that the piece is rectangular in shape, its dimension 190 x 84 cm, with geometric decorations consisting of triangles, squares and lozenges shapes. The decorations were executed with fibres dyed in various colours such as dark blue, white, orange, red, purple, yellow, pink and light brown. The rug piece is woven using the dovetail Tapestry weave, that is, the wefts do not extend into the width of the weaving (Amin 2018, 36), figure (1,B).

2.3. Scientific Investigations and Analysis

Scientific examinations and analyses were conducted on the Iraqi rug object, with the aim of identifying its condition and its various deterioration profiles, as well as identifying the

constituent materials such as the type of fibres, dyes and their stability, In addition to identifying the method used in the manufacture of the object.

2.3.1. USP Digital Microscope

USP digital microscope examination was used to identify manufacture and weaving techniques of the rug. This examination also helps in identifying the accumulated dirt on the surface and between the interspaces of the warp and weft threads. The examination was carried out with Dino-Lite USP digital microscope, 2.0 interface, type RK-10A with Version 1.5.12 and a maximum magnification of 500x.

2.3.2. Scanning Electron Microscope (SEM- EDX)

SEM- EDX was carried out using ZEISS LEO 1530 Gemini Optics Lens SEM of 30 kV scanning voltages. EDX measurement conditions were 20 kV accelerating voltage, 21 mm working distance and 1 nA sample. It is used to examine the morphology of rug fibres, whether they are warp or weft threads, in order to identify the type of the fibres and determine the profiles of their deterioration (Mahmoud Abo-Elmaaref et al. 2021,33-36). EDX analysis also helps in identifying the type of the accumulated dirt, dust and other deposits.

2.3.3. Attenuated total Reflectance-Fourier Transform Infrared Spectroscopy (FTIR - ATR)

FTIR spectra were examined using the transmission mode on FTIR spectrophotometer (Nexus 670; Nicolet, United States) in the range of 4000–400 cm-1 with a spectral resolution of 4.0 cm-1. All spectra were acquired with an ATR single reflection diamond module.

B

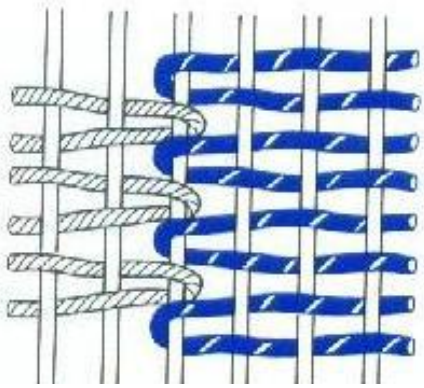

Fig.1 (A) Iraqi rug before restoration**,** (B) dovetail Tapestry weave structure of the rug (Marouf 2008, 21)

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2.3.4. Chemical Analysis of Dyes

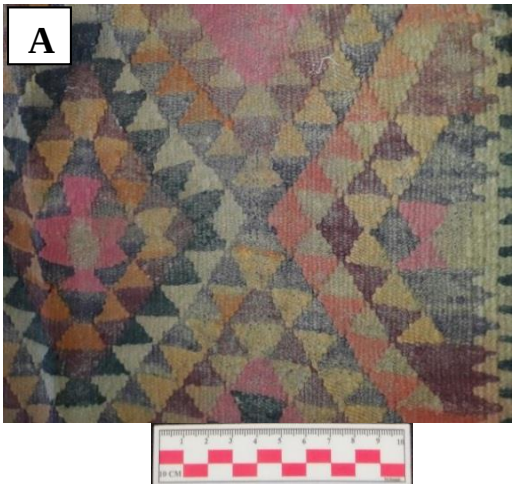
The decorations of the studied rug object are based on the use of fibres dyed with different colours, ranging from yellow, red, blue, creamy white, orange, purple and pink. These colours are still retaining their stability and colour intensity. Some of these colours were examined and analyzed chemically. Approximately 1 cm of dyed fibres was boiled in test tubes, each containing 5 ml of water and the same amounts of ethanol, acetic acid, and ammonia for about one minute, the extract was filtered into a second test tube. Then the solution of the extracted
colours was examined, the extent and the amount of the solubility of the dye were evaluated (Schweppe 1988,1-2)

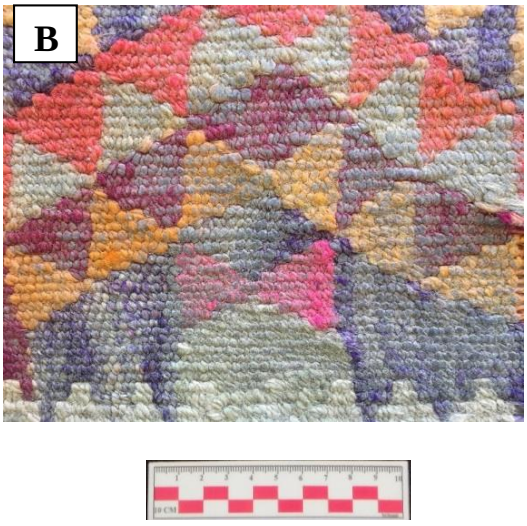
3. RESULTS AND DISCUSSION

3.1. Visual and Microscopic Examination

It is clear from the examination with a scanning electron microscope equipped with an EDX unit as well as a USP digital microscope that the rug warp threads are made of cotton fibres, and appear under the microscope as cylindrical in shape with thick-wall. The coloured weft threads are made of wool, as it is clear from the SEM images that they have surface scales characteristic of the wool fibres. It is also clear from the examination that the rug is woven by the dovetail tapestry weave. It is also clear how thick the woollen threads are, as the diameter of the thread is 5 mm compared to the cotton warp threads, which have a diameter of about 3

mm, and the twisting direction of the threads is from right to left (S-shape) Figures 4, 5. it is also shown from the visual examination, using different zoom lenses, digital and scanning electron microscope that there are various deterioration profiles of the object fibres, as it is covered with dust and dirt in large quantities, as well as some different spots on the surface and between the fibres, in addition to the presence of many cuts, tears and separated parts of the rug in different places. The rug fibres also suffer from severe dryness, ease of tearing, fragility and the presence of superficial cracks and erosion in the scale's characteristic of wool fibres, Figures 2, 3.





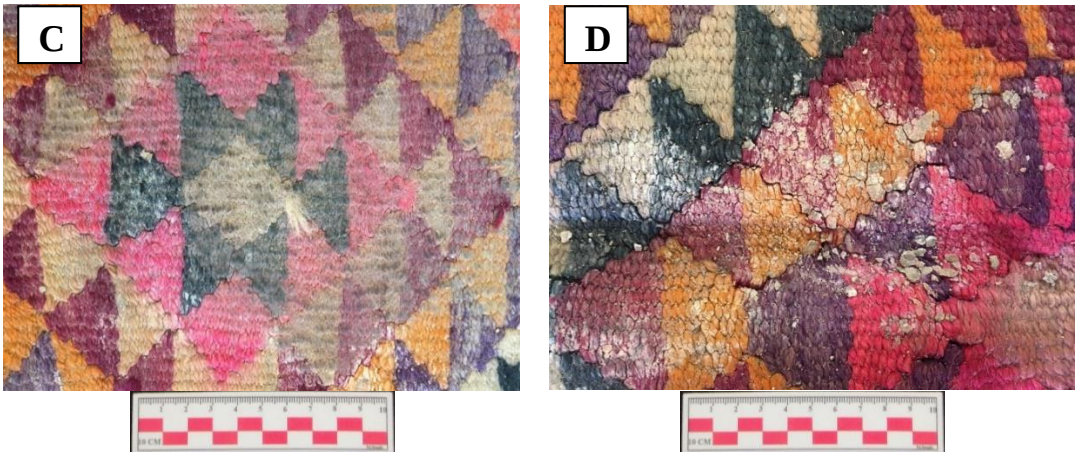


Fig. 2, Details of the deterioration profiles of the rug as (A, B) dust and dirt,(C,D) calcifications, and Stains

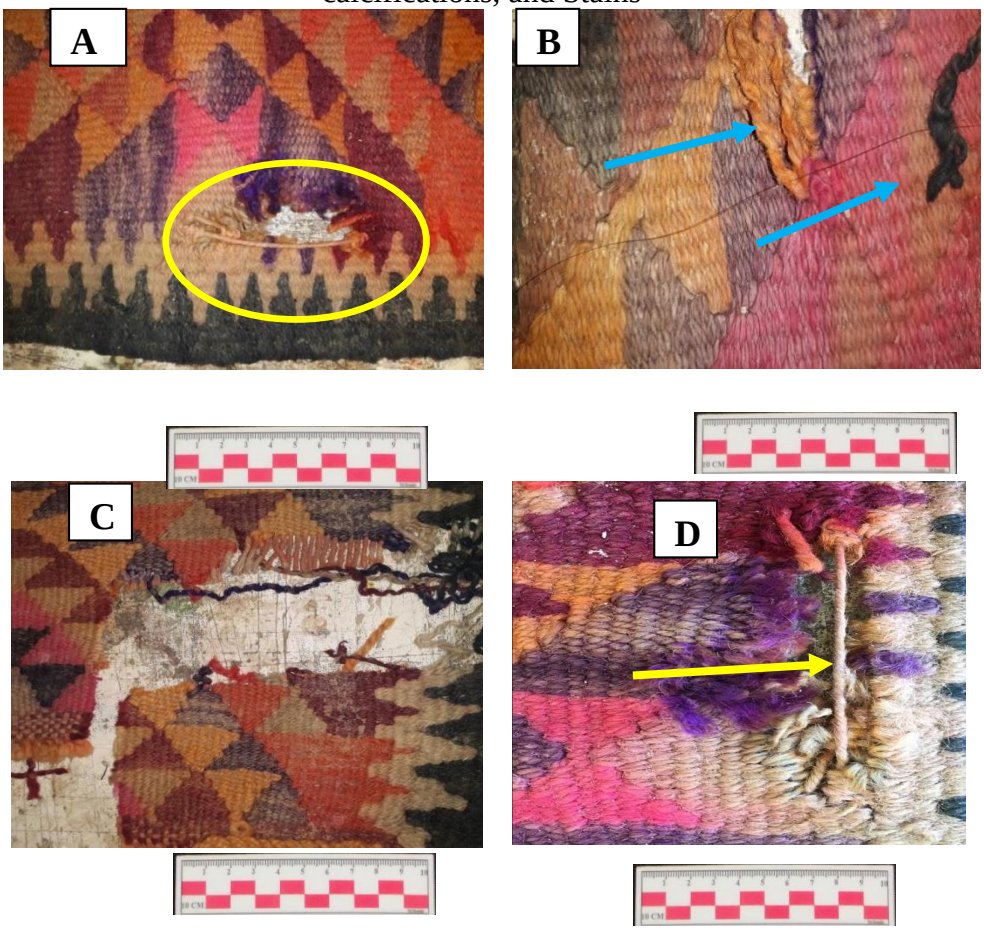


Fig.3, Details of the deterioration profiles of the rug as (A, B, D) cuts, tears and (C) detachment parts

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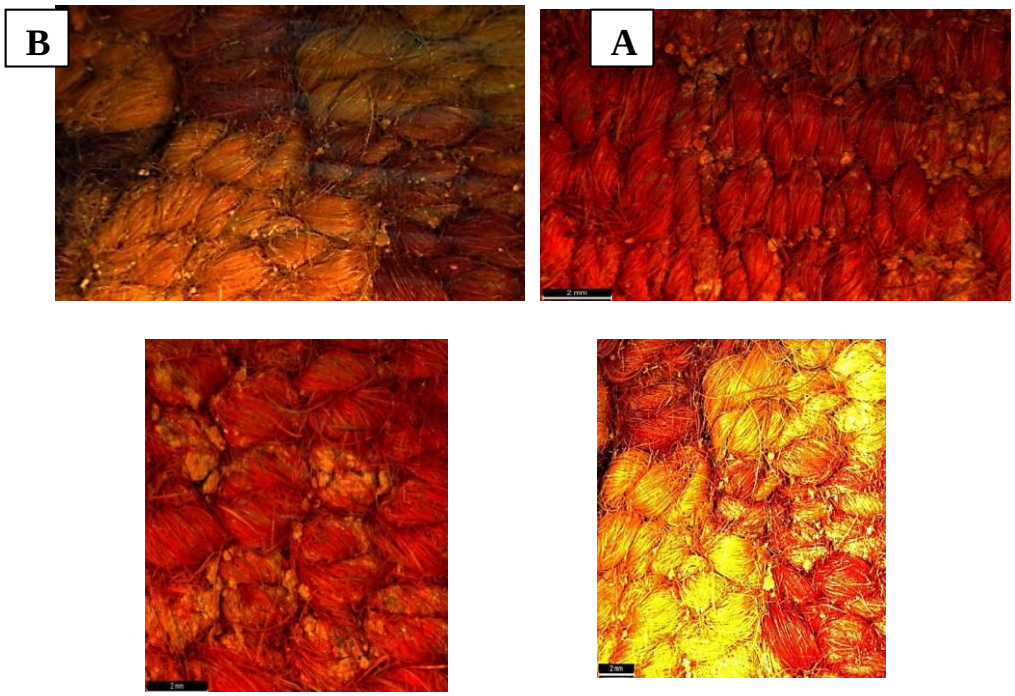
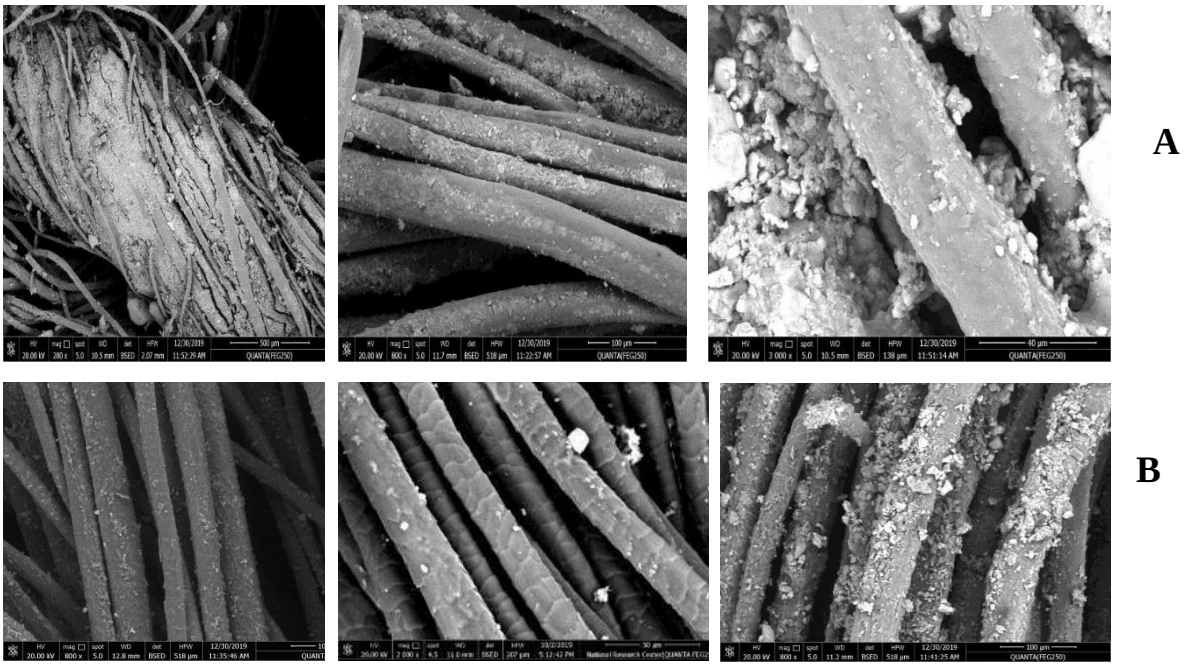
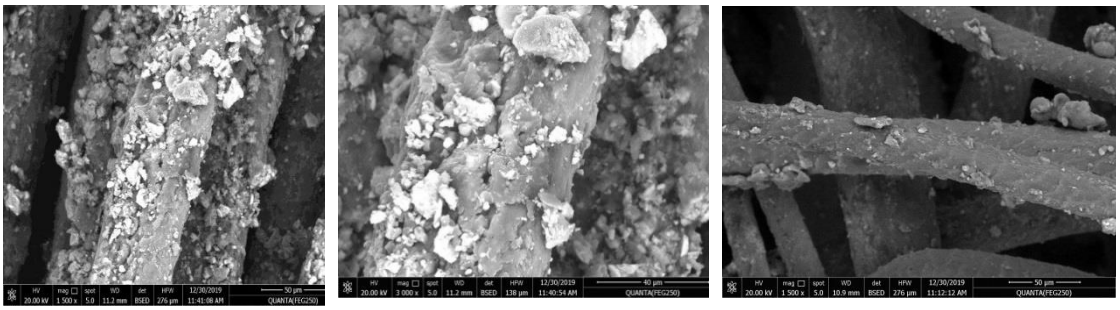


Fig.4, USP digital microscope images of the rug's fibers, (A) shows the weave structure of the object is tapestry weave, (B) the twisting direction of the threads is (S- shape), (C,D) deposits of dirt on and between the fibers and threads.



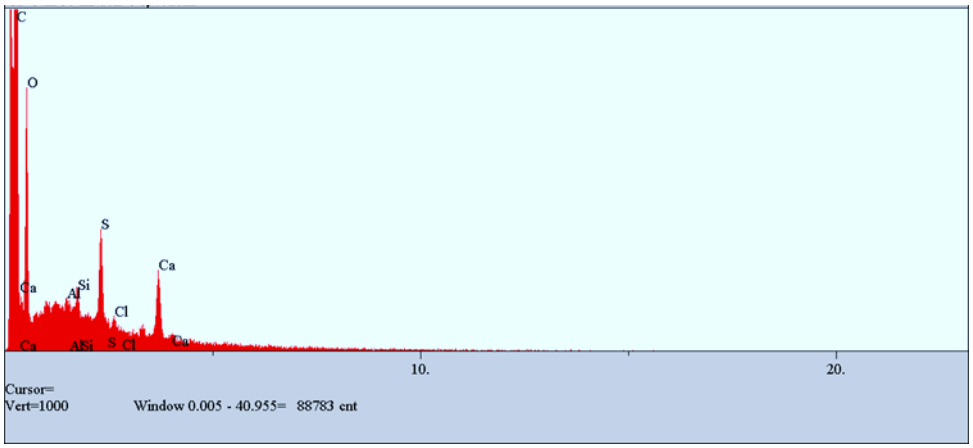


C

Fig.5, SEM Images show (A) warp fibers is a cotton, (B, C) samples of weft fibers are made of wool. The SEM Images also show the extent of fiber damage due to the deposition of dirt and calcifications on the surface and between the fibers, as well as the damage to the fibers as longitudinal and transverse surface cracks and the loss of the distinctive characteristics in some of the wool fibers (scales).

EDX results also showed the presence of the elements constituting sand, dust and dirt particles deposited on the surface of the fibres, as the analysis revealed the presence of chemical elements (C, O, Al, Si, S, Ca, Na, Mg), which are among the important elements of silicate minerals composition in the form of calcium and aluminum silicate. The sulfur element (S) is one of the elements in the wool fibres (Al-Sharairi et al. 2020,1675) and the presence of elements (S, Ca) may also indicate the presence of white gypsum calcifications on the surface of the rug and the element (Cl) may be due to the Chlorine ion in the presence of humidity or may be related to sodium chloride (NaCl) from soil dirt that covered the fibre (Badr et al. 2018). Figure 6

The different deterioration profiles of the object may be due to the fact that it was originally used as a carpet for the floor, as well as the poor storage in a wooden box. In addition, the rug has not been any treatment or conservation before**.**



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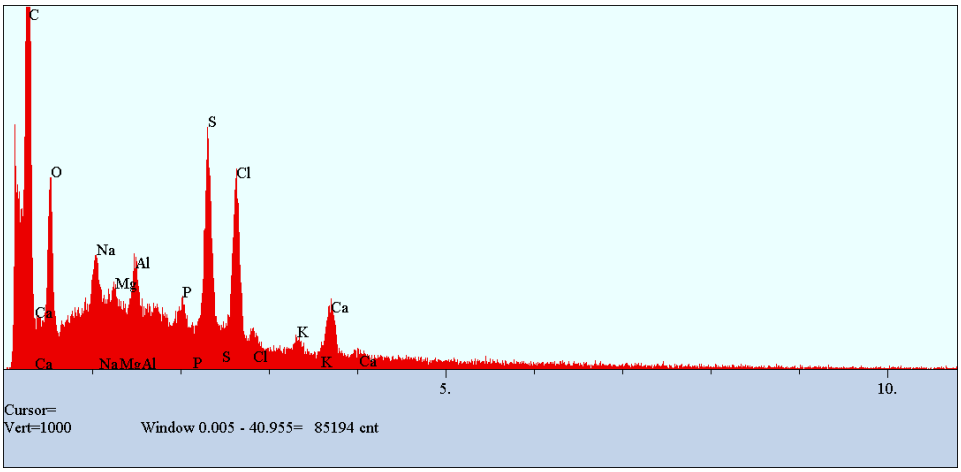


Fig.6, EDX results show the presence of the chemical elements of sand, dust and dirtparticles also the analysis revealed the presence of chemical elements of silicate minerals composition in the form of calcium and aluminum silicate and the presence of elements (S, Ca) may also indicate the presence of gypsum calcifications on the surface of the fibres.

3.2. FTIR -ATR

Infrared spectroscopy results of warp and weft threads of the rug fibres and their comparison with a standard sample showed that the warp yarns are made of cotton, and the coloured weft threads are made of wool. Tables (1,2) and figures7(A,B) show the Functional groups and wavelengths of the ancient fibre samples and their conformity with the standard samples.

In Fig. 7 (A) the most intense bands are more similar in the wavenumbers. The bands at 3279, 3275, 2959, 2912 cm^{-1} are attributed to ν(N–H) amide bond. The bands at 1634, 1633 cm^{-1} are assigned to ν(C=O) amide I bond. The bands at 1516, 1514 cm^{-1} are related to δ(N–H) amide II bond. The bands at 1449, 1448 cm^{-1} are attributed to O-H Bending (Amide III) (Odlyha, Theodorakopoulos, and Campana 2007).

The most intense bands in Fig. 7 (B) are more similar in the wavenumbers as follows: The bands at 3279, 3328 cm^{-1} respectively, are assigned to ν(O-H) of hydrogen bond of Cellulose. The bands at 2959, 2912cm^{-1} are attributed to ν(C–H) bond, indicative of polysaccharides. The bands at 1634, 1638 cm^{-1} are assigned to ν(C=C) (lignin compounds (δ(OH), and ν(CO) bonds (derived from carbonyl or aldehydic, or carboxyl groups (Kourkoumelis et al. 2013). The bands at 1439, 1426, 1377, 1365cm^{-1} are attributed to δ(C–H) bond in cellulose. The bands at1040, 1024 $cm^{-1}$are assigned to ν(C–OH) bond in cellulose. The disappearance of some effective groups of ancient fibres and the decrease in the intensity of some of them compared to the standard fibres indicates the extent of deterioration to the archaeological one (AL-Gaoudi 2021,3).

Table1. Functional groups of standard cotton fibre and ancient warp fibers.

Functional Group	standard cotton	ancient warp fibres
ν(O-H) of hydrogen bond of Cellulose	3279	3328
ν(C–H) bond, indicative of polysaccharides	2959	2912
ν(C–H) bond, indicative of polysaccharides	2927	----
ν(C=C) (lignin compounds) δ(OH), and ν(CO) bonds (derived from carbonyl or aldehydic, or carboxyl groups	1634	1638

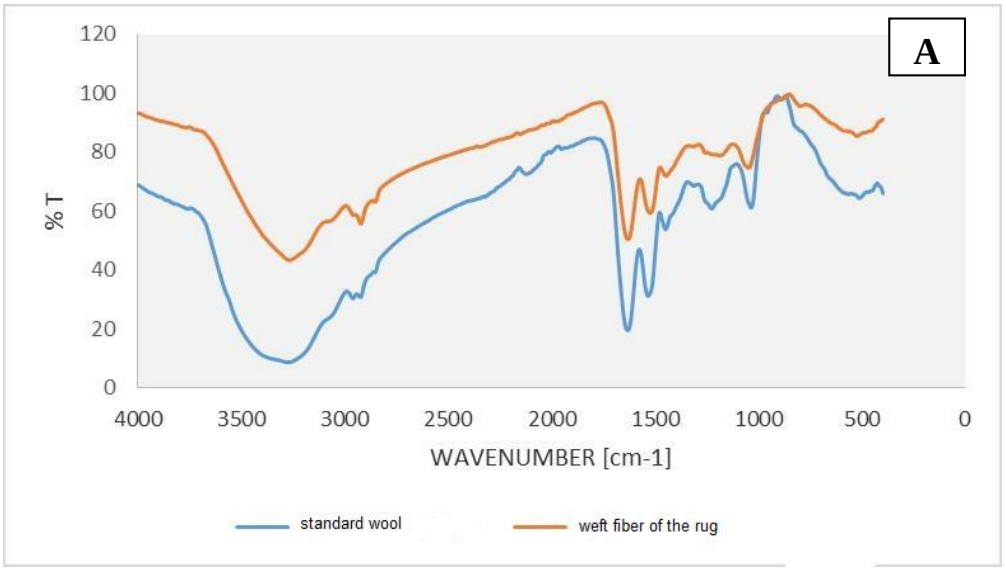
δ(C–H) bond in cellulose	1439	1426
δ(C–H) bond in cellulose	1377	1365
ν(C–OH) bond in cellulose	1040	1024

Table2. Functional groups of standard wool fibre and ancient weft fibers.

Functional Group	standard wool	ancient weft fibres
ν(N–H) amide bond	3279	3275
ν(N–H) amide bond	2959	2934
ν(C=O) amide I bond	1634	1633
δ(N–H) amide II bond	1516	1514
O-H Bending (Amide III)	1449	1448
ν(C–N) amide III bond	1313	----

3.3. Identification of the Dyes

Chemical analysis of ancient dyes revealed that they dissolved or faded very much in ammonia solution and very little in water, which indicates that the fibers were dyed with Synthetic Acid Dyes, as this type of dyes dye wool fibers with deep and intense colors (Schweppe 1988,2).



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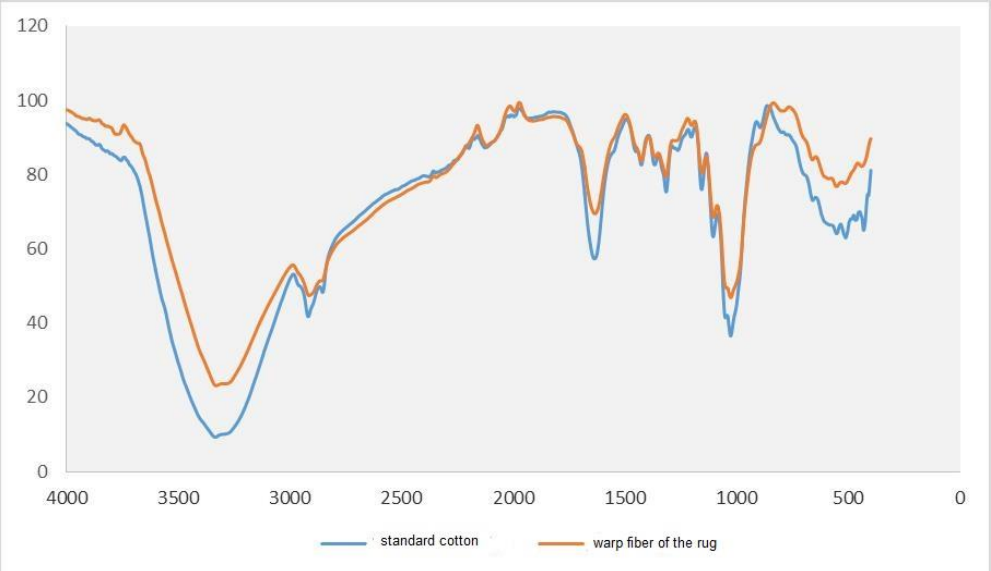

Fig.7, Spectra of the FTIR-ATR analysis of the object fibers shows their conformity with the standard fibres. (A) A sample of weft fibers and a standard of wool fiber. (B) A sample of warp fibers and a standard of cotton fiber.

4. TREATMENT AND CONSERVATION PROCEDURES OF THE STUDIED IRAQI RUG

4.1. Mechanical Cleaning

The aim of the mechanical cleaning process is to remove different dirt from the surface of the rug. This dirt was mostly dust as well as remains of insect droppings, which are mechanically connected to the rug, as this dirt was intertwined in the spaces between the warp and weft threads and at the folds of the rug. The surface cleaning process was carried out with different types of brushes, vacuum cleaners, and air blowers. Some of the dirt sticking to the surface of the fibers was moistened using water-dampened brushes to facilitate mechanical removal Figure (8.B).

4.2. Testing of Dyes Stability

A piece of cotton wrapped around a wooden stick was immersed in the cleaning solution and was rubbed on a small part of the different colored dyed fibers. This test was done for each color separately. The result of the test showed the stability of all dyes to the wet cleaning solution (mentioned below).(Ahmed 2018,344)

4.3. Primary supporting process

In this process, the fragile and worn parts of the rug were fixed before the cleaning process. The supporting process was carried out using running stitching with fine needles and colored cotton yarns with different color of the object fibers so that it is easier to remove the stitches after completing the cleaning operations without causing further damage to the object (Amin 2018,240). Figure(8,A).

4.4. Wet Cleaning and Stain Removal

Selection of the appropriate cleaning solution depends on the nature of the dirt present, and on the materials, structure, and condition of the rug object. The EDX analysis carried out by this study showed that the most dirt are dust and sand as the analysis revealed the presence of their chemical elements. Therefore, the wet cleaning process was done by using moving distilled water current with an ionic detergent (Synperonic N, provided from C.T.S. Co.). The ratio was one part of the detergent to 100 parts of distilled water to remove mud's and sand dirt and other accumulations that are still stick to the fibers even after mechanical cleaning. The water bath was agitated by the hand to allow it to penetrate between the fibers to release the dirt particles, for 15 minutes. The water temperature was 30ºC to increase the effectiveness of the cleaning. Then a second bath with distilled water only for 10 mins and then a third bath with distilled water only, for 10 mins. It also reduced the soiling, relaxed the fibers, flattened the creases and brightened the colors (Ahmed 2011,160). The Investigation showed that the rug object contains some oily soils and remains of gypsum accumulations that the wet cleaning is ineffective to remove them. Thus, there has been an attempt for using pure ethyl alcohol in localized way for the soiling parts by using smooth brushes to help remove spots. Bath of distilled water for five minutes to remove any undesired remnants of ethyl alcohol on fibers was done. Ethyl alcohol has the ability to remove many stains, as well as being a sterile (Abdel-Kareem et al. 2008,13-14).

4.5. Drying Process

The object was placed flatten completely in its correct position on the top of a free-acid blotting paper sheet, the excess water was absorbed with blotting paper from the top until it was completely removed from the fibers. The separate parts and fibers were set in their correct position with placing glass weights so that they would dry on the correct position, then the rug was left to dry at room temperature.

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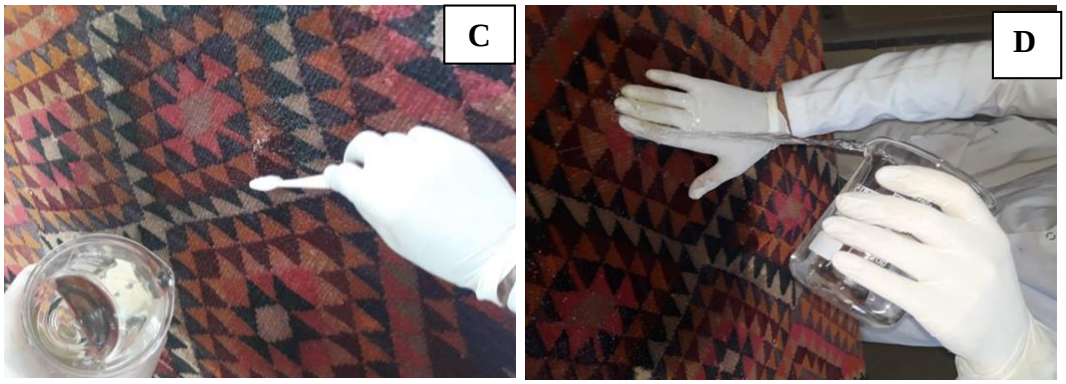

Fig.8, Shows the treatment steps of the rug (A) Preliminary fixation of the separated parts and fibres,(B) mechanical cleaning with brushes to remove dust and dirt, (C, D) wet cleaning to remove stuck dirt and stains. (E) Show parts of the object after cleaning process.

Fig .9 Show parts of the rug after cleaning process.

4.6. Assembly and Support Process

The studied rug is full of many holes, cuts and missing parts, and these areas represent places of weakness and stress in the structure of the object. These gaps, cuts and ruptures may increase in area over time as a result of the continuation of the various factors of damage that led to its occurrence from the beginning, as well as its distortion and decreasing its aesthetic characteristics value. The cuts and ruptures as well as the assembly of the separated parts in their correct position have been fixed with woolen threads of similar colors to the rug threads using the appropriate thin needle (Abdel-Kareem 2011,8-9) Figure 10.

Fig.10, Shows the final Reinforcement of the cuts and ruptures of the rug.

4.7. Supporting and Displaying

After completing all the restoration processes of the rug, it was prepared for the displaying. Taking into account that choosing the appropriate display method, is a part of the future maintenance of the object. Therefore, the displaying method was done by using the needle work, as it is commensurate with the large size and weight of the rug, as follow:

- A board of wood was prepared; the surface is cleaned by using pure Ethyl alcohol to remove any element of dust or biological infections which may exist on the surface of the wood. After that it was treated with Paraloid B-72 (ethyl methacrylate/methyl acrylate copolymer) with concentration of 20% for isolating and protecting the wood holder from the impact of the humidity during displayed in the museum. As well avoid the migration of acids from the wood to the rug object. Then it was left until dry completely Figure (11, A).
- The wood holder was covered with acid-free paper sheet, then with a pressed and non-woven cotton cloth, to serve as a cushion down the object. So that the area of the cotton cloth must be larger than the area of the wood holder by about 8 cm on each side, and it was fixed on the back side of the wooden support Figure (11, B,C).
- 100% raw linen cloth was boiled in water with 1% soda ash (sodium carbonate) added to it, in order to rid it of any impurities and give the linen a stable color. Then the linen was rinsed with distilled water for several times, in order to ensure that there were no traces of soda ash on the fabric, followed by straightening and drying the linen on a glass sheet.

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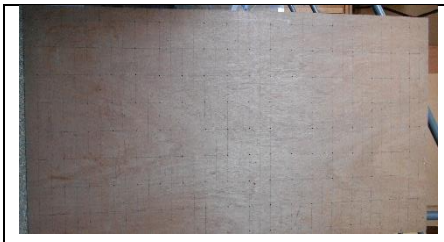
- The previously prepared wooden support was covered with the linen fabric, so that the area of the linen cloth was about 10 cm larger than the area of the holder on each side. It was fixed on the back side of the wood support Figure (11, D).
- The rug object was placed flat on the previous holder, with the distance between it and the holder about 5 cm on each side, and the installation process was done by stitching with thin, bent needles**.** Two types of stitches were used: the first type, an overcast stitch, was used to support the edges of the object; and the second type, a running stitch, was used to support the internal and damaged areas. Figure12.

5. CONCLUSION

The study presented the scientific methodology for the restoration and conservation of a wool rug dating back to the Iraqi national rule and was stored in the Museum of the Faculty of Archaeology at the University of Samarra in Iraq, starting with scientific documentation, investigations and analysis, followed by various cleaning operations, drying, and primarily fixation, then assembling the separate parts, consolidating with needlework and finally displayed on a new support. Examinations and analyzes were carried out before starting the restoration procedures using usp digital microscope and scanning electron microscope equipped with EDX unit, as well as Attenuated total Reflectance-Fourier Transform Infrared Spectroscopy (FTIR -ATR). The results revealed that the fibres of the rug are made of cotton and wool and are in a poor state of condition due to weakness, fragility and ease of tearing. As well as cuts, tears, separate parts, dirt and various calcifications in the object. Examinations and chemical analysis also revealed that the ancient rug is woven in the dovetail tapestry weave with coloured woollen wefts dyed with acidic synthetic dyes in black or dark blue, red, orange, yellow and purple colours. It is hoped that the study's results will help textile historians, academics and others interested in the antiquities of Mesopotamia to better understand their skills, cultural and economic life, and to help reconstruct the rug folk industry of that area as possible. Further studies, including the HPLC analysis of the dyes, will be considered in future investigations.



A

B

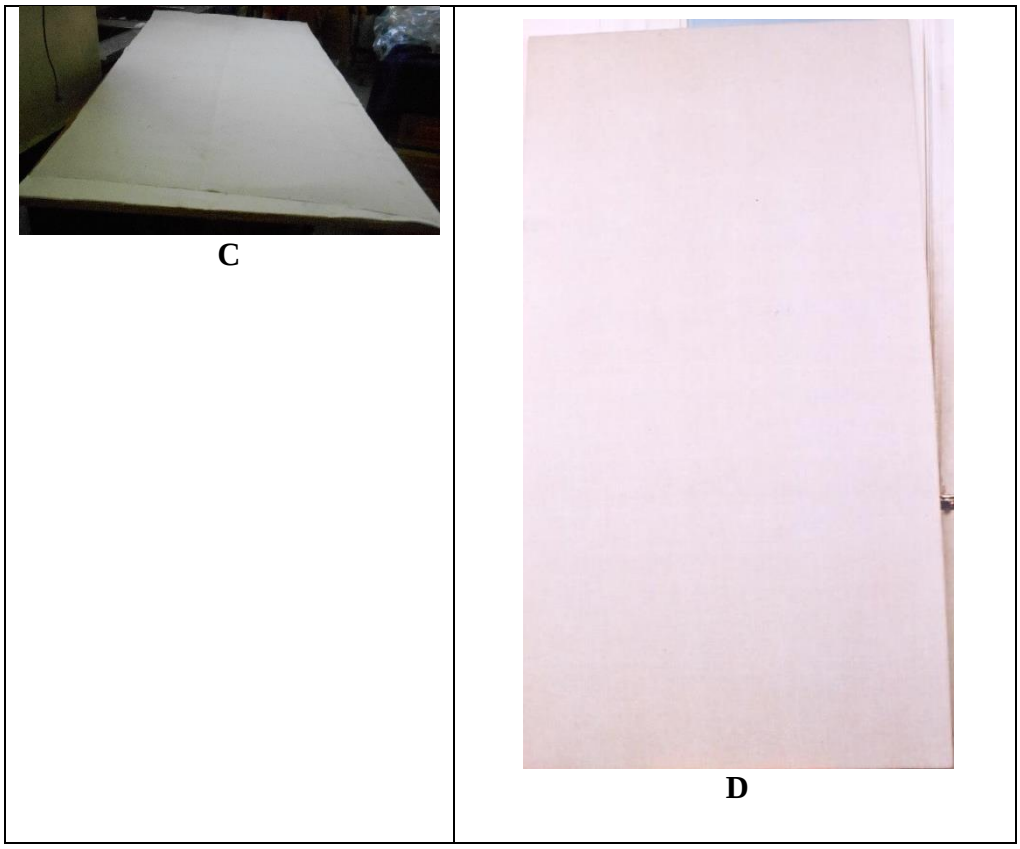


Fig.11, shows the steps of preparing the new wooden support, (A) wood board (B) covered with acid-free paper sheet (C) covered with cotton cloth (D) covered with linen sheet

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Fig 12 shows the historical rug after treatment and displaying on a new support.

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فحص وصيانة بساط من الصوف النادر المتعدد الالوان يرجع إلى الحكم الملكي العراقي (١٩٢١م)

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الملخص

ترجع أهمية هذا البحث إلى دراسة بساط من الصوف متعدد الألوان وفريد من نوعه، يعود إلى العصر الملكي العراقي (١٩٢١)م ومحفوظ في متحف كلية الآثار بجامعة سامراء بالعراق. الهدف الرئيسي من هذا البحث هو عرض للفحوصات والتحاليل العلمية التي تم إجراؤها باستخدام المجهر الرقمى ، والمجهر الإلكتروني الماسح المزود بوحدة تشتت الأشعة السينية (SEM-EDX) وكذلك التحليل باستخدام مقدار الانعكاس الكلى بالأشعة تحت الحمراء FTIR- ATRوذلك للتعرف على المواد المكونة للبساط موضوع البحث وطريقة صناعته وحالته من التلف. كما تم النعرف على اصباغ القطعة بالتحليل الكيميائى فى المعمل. ولقد أظهرت النتائج أن البساط العراقي مصنوع من ألياف الصوف المصبوغة بأصباغ صناعية والتى تمثل خيوط اللحمة،ومن الياف القطن والتى تمثل خيوط السدى، والبساط منسوج بطريقة التابسترى. كما أوضحت النتائج أن ألياف البساط تعاني من الضعف والتلف الشديد المتمثل فى الأوساخ والأتربة والتراكمات التي تطمس معالمه الفنية ، بالإضافة إلى التمزق والقطوع والانفصال فى بعض أجزائه. علاوة على ذلك ، قدمت هذه الورقة البحثية مراحل عمليات العلاج والصيانة التى تمت على البساط العراقى لأول مرة، والتى تضمنت التوثيق ، عمليات التنظيف ثم التجميع والتدعيم ، وأخيراً عرض القطعة على حامل جديد.

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