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Archaeometric And Conservation Study Of A Belt Comprised Of Plant-Based Fibers In The Egyptian Museum (Sr2/11616 Gallery 49)[1]

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Abstract: Conservators from the Egyptian Museum. employed non-invasive archaeometric methods to identify the material composition, preparation, and construction of one specific plant-based ethnographic artifact and used this information to tailor conservation treatment efforts. The analytical techniques employed for the study of the belt SR 11616included USB microscopy, ultraviolet (UV) and infrared (IR) reflection, and raking light. The morphology of the belt's fiber structure was consistent with that of palm fonds. Conservators assessed various aspects of deterioration, including disintegration, cleavage, embedded debris, and dust accumulation, through microscopic images, multispectral data, and raking light. Understanding the extent of fiber deterioration through qualitative assessment allowed the conservators to choose conservation techniques and display methods that were compatible with the material's current chemical and physical state. This research also aims to develop a protocol for effective and efficient non-destructive investigation to provide treatment options for plant-based artifacts.

Keywords: Belt, plant fibers, non-destructive examination, multispectral imaging, conservation, museum display, Egyptian Museum.

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[1] We dedicate this article to Prof. Shafia Bedier in gratitude. Her studies on various themes related to the Egyptian Museum in Cairo have been guiding influences in shaping our current idea.

دراسة أركيومترية وترميم لحزام من الألياف النباتية في المتحف المصري (سجل خاص: 2/11616 – صالة عرض49)

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المتحف المصري، التحرير، مصر

الملخص: قام أخصائيو الترميم بالمتحف المصري بالقاهرة بتوظيف الطرق الأركيومترية غير المتلفة في التعرف على المواد وتقنيات تصنيع إحدى القطع الأثرية المصنوعة من الألياف النباتية، وهي عبارة عن حزام (رقم 2/11616) معروض بقاعة 49 بالمتحف المصري، ممَّا أسهم في تنفيذ عمليات الترميم والصيانة المناسبة لها.

ساهم الفحص المجهري، والتصوير بالأشعة فوق البنفسجية، والأشعة تحت الحمراء، والضوء الزاحف في دراسة وتحديد مورفولوجية الألياف النباتية المكوّنة للحزام) سعف النخيل. (كما تم تقييم مظاهر التلف المتعددة، مثل التفتت، والاهتراء، والتقصف، والتراكمات ذات الملمس الدهني. إضافة إلى ذلك، جرى تحديد درجة التلف في القطعة الأثرية بشكل كيفي،،وبناءً عليه تم اختيار منهجيات الترميم والعرض بما يتوافق مع الخصائص الكيميائية والفيزيائية للقطعة.

يسعى هذا البحث أيضًا إلى إرساء بروتوكول خاص للفحص غير المتلف يكون فعالًا وملائمًا للآثار المصنوعة من الألياف النباتية.

الكلمات الدالة: الحزام، الألياف النباتية، الفحص غير المتلف، التصوير متعدد الأطياف، الترميم، العرض المتحفي، المتحف المصري.

Introduction

Plant fibers from linen, palm leaves, and palm fronds were commonly used by ancient Egyptians for making clothes and accessories for use in their daily lives. (Zoffili et.al,1992).

Previous studies have determined that belts can be made from diverse Materials, including linen, wool, leather, palm leaves, palm fronds, silk, amulets, and gold. (Trassard et al., 2005; Rana et al., 2014.) Multiple studies of these ethnographic artifacts document the various material preparations (Florian,et.al, 1990), (Mannering et al, 2014;Maier, 2021;Hamed, 2023) (Badr, 2013; Medhat et al, 2015; Medhat, 2016) palm materials such as reeds, leaves and fronds have been used as whole parts or cut to do fine works. The process usually includes cutting, incising, and threading and cordage. The present study here focuses on belts, which are considered an essential part of ancient Egyptian clothing.

Both women and men used belts in Ancient Egypt. The belt was used to size the waist for the best fit and to emphasize the beautiful folds of narrow pleating for dresses. Moreover, wearing the belt was a symbol claiming power and protection for its wearer. (Schmidt, 1994; Eastwood,et al, 1995) The belts will vary depending on the gender of the user. The belt used by women can be placed directly under the breasts or lower on the torso at the natural waist. The length of the belt can be controlled by knotting the belt. The length of the belt will vary and can reach the knees. The Ancient Egyptian naming of the belt changed over the ages. Such meanings include: **Jdr- mss- Mtrt (Hieroglyph:** **)**. Other names for the belt depended on the materials, the final shape, and the use. (Wills and Hack, 2010).

This study fully investigated a belt made of plant-based fibers located in the Egyptian Museum for the first time. The research aims to provide technical information about the materials and techniques used. It includes an examination of the fibers, technology, and conservation, as well as a comparison with previously studied plant-fiber objects.

Aims and objectives:

The research objectives are as follows:

To study the plant fibers used in the production of belt SR 11616.

To investigate the strip used in the surface of belt SR 11616.

To examine the techniques employed in the manufacturing process.

To shed light on the aspects of deterioration of belt SR 11616.

To determine the most appropriate reinforcement materials to strengthen the original fibers used in the construction of belt SR 11616.

To determine the most compatible material for the exhibit support

The research objectives are as follows:

Visual and microscopic examination of the belt revealed the following:

· Thick layer of dust and dirt on the surface (**Figure 1**).

· Disintegration, separation, cleavage, and deterioration of the fibers **(Figure 1**).

· Changes in dimensions and depletion of the outer fabric frame **(Figure 1)**.

Documentation:

The research utilizes integrated documentation methods, including photographic techniques, USB microscope, UV imaging, IR imaging, and raking light. These methods assist in identifying materials and technology, assessing the degree of deterioration, and developing a compatible treatment plan for the object.

Photographic Documentation

Microscopic examination and photographic documentation **(Figure1)** were performed using a Dino-lite portable 85 USB digital microscope and an Olympus camera equipped with a zoom Lens EF-S 18-5586 mm. This method has been employed in analogous cases involving organic materials (Germer, 1992; Medhat, 2015)

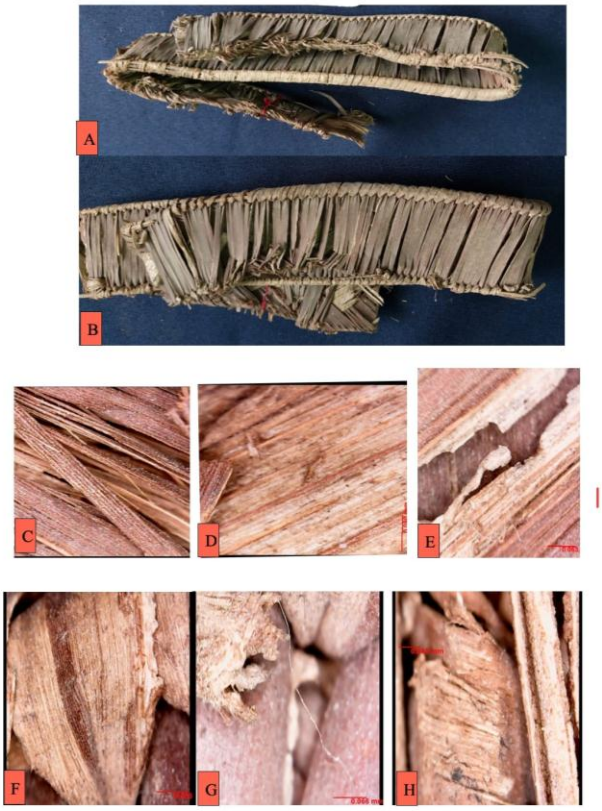

Fig 1: (A,B) Overall front and back of the belt materials SR 11616 before conservation by Dina Mohamed (C-H) USB microscope investigation by AbdelRaman Medhat and Tamer Maher:(C-D) shows the disintegration of the fibers; (E) cleavage of the fibers (F) morphology finger print for the palm fronds main component of the object (G) The dryness and folds of the palm fronds (H) fiber direction; (H) the direction of the cordage which shows the technology of the belt

UV Fluorescence

This examination was conducted using a portable UV light source (P-946-0160-12 LED). The digital camera used for recording images was the Olympus camera equipped with zoom lens EF-S 18-55 86 mm without barrier filter.

UV Fluorescence is a non-destructive, surface examnation that identifies the presence of one or more film-forming substances, such as varnishes, applied to the work (resins, oleoresins, proteins, etc.) and can help to identify previous interventions**. (Figure2)**. This technique allows assessing the condition of the belt by enhancing the presence of previous restorations, such as the presence of paraffin wax, old adhesives, and biological attacks, even when they appear indistinguishable to the naked eye (Hegazy,2005; Medhat, 2015). It can also provide information on pigments with specific fluorescence, such as how surface darkening indicates strong dust bonding. The UV technology reveals various features like the fine cordage used on the outer and edge of the belt, or the brownish hue indicating lignin in the plant-based materials.

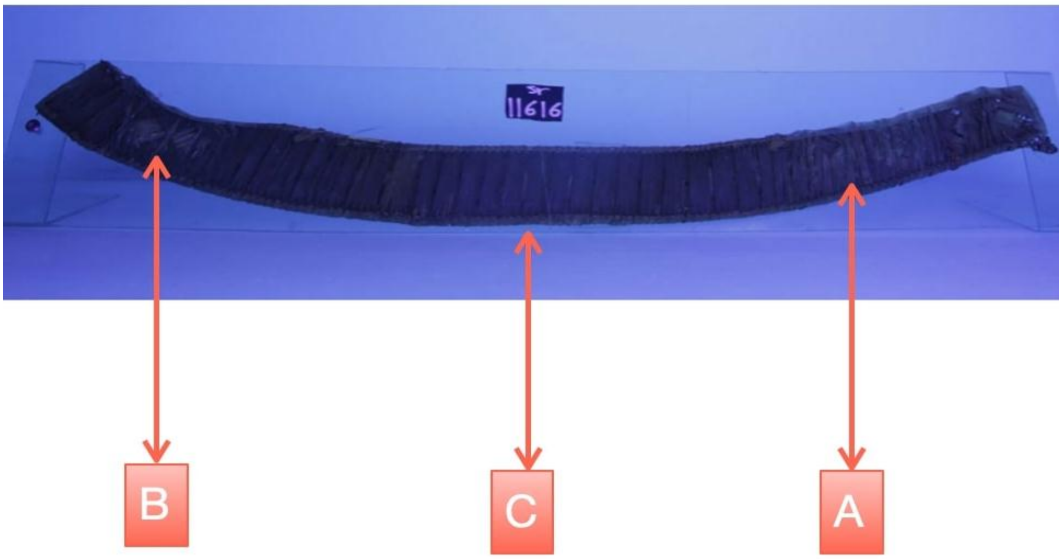

Fig 2: UV fluorescence documentation shows clearly: (A) fine cordage for the outer and edges of the belt; (B)brownish hue which confirms the presence of lignin in the plant-based materials,; (C)the maximum width of the belt in the middle of the belt and its decrease gradually towards the end of both edges. This shape guarantees the function and sustainability of the belt. (photo by Akram Atallah)

Raking Light Imaging

To capture the raking light images, a Sony Alpha 500 camera (macro E3.5/30) and halogen light were utilized. This documentation technique involves moving the light source to highlight the microstructure of the object’s surface. This method reveals details such as the tools used in creating the artwork. The raking-light examination validated various aspects of the technology employed, assessed the state of deterioration, and confirmed previous conservation efforts as described in earlier photographs. This technique demonstrated how several types of fine nails were used to create the edges of the belt, observable in the fiber cutting and cordage details **(Figure 3)** (Hegazy, 2005; Medhat, 2015).

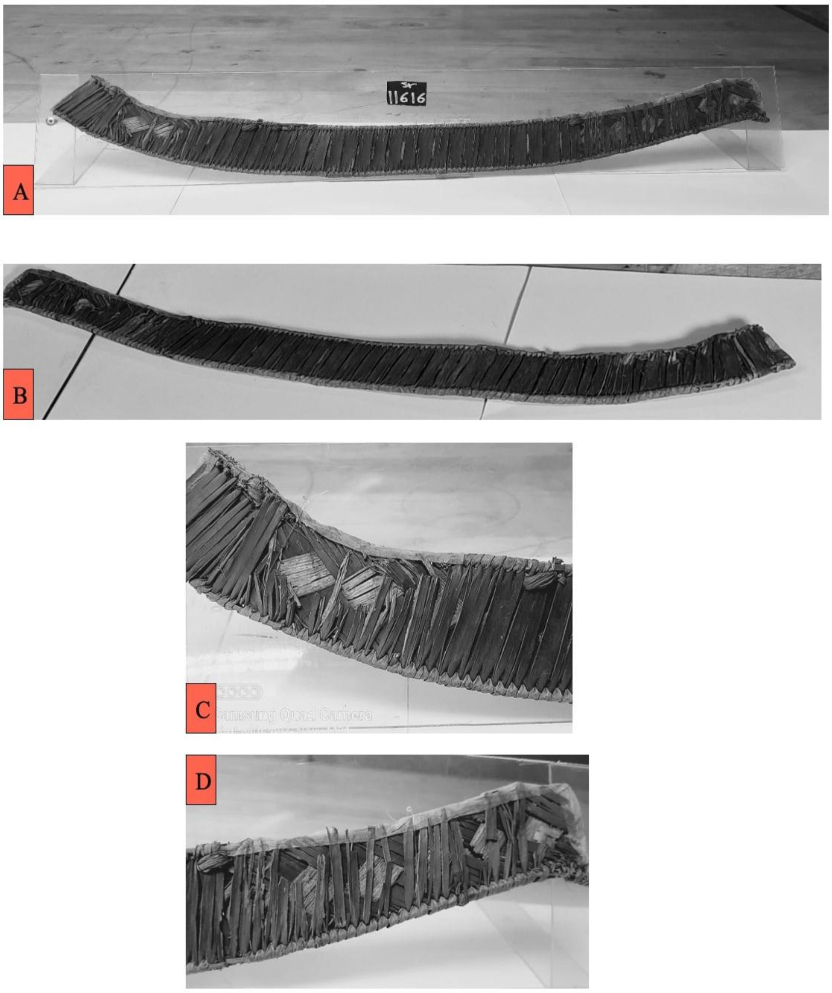

Fig 3: Raking light examination of the belt: (A) The order of strips for the belt and the fine edges (after conservation) (B) the uneven surface of the belt due to the dryness or because it used in the past (C) the sharply fine edges for the belt as frame which indicate using sharp and fine tools, (D) the Japanese tissue used to reinforcement the belt (Photos after conservation by AbdelRahman Medhat)

IR Documentation

For the IR imaging, a Sony Alpha 500 camera (macro E3.5/30) with a filter to allow the IR wavelength to pass, along with halogen lighting, was used. This documentation technique requires the movement of the light source to enhance the microstructure of the object's surface. The IR imaging examination confirmed various aspects of the technology used and the types of deterioration observed.**(Figure 4).**The IR images also revealed the fine strips and stitching on the outer part of the belt, thus confirming that several types of fine nails were used to weave the outer edge of the belt. Additionally, brownish stains appeared across the surface of the belt, which may be caused by lignin or extractives transferred to the surface, possibly due to cellulose degradation (Hegazy, 2005; Medhat, 2015)

Fig 4: The IR examination of the belt revealed fine strips and stitching on the outer part of the belt, thus confirming that several types of fine nails were used to weave the outer edge. Additionally, brownish stains appeared across the surface of the belt, which could be caused by lignin or extractives transferred to the surface, possibly due to cellulose depletion (Photo after conservation by Akram Atallah).

Conservation strategy

This section outlines a methodology for evaluating the conservation effectiveness of a belt made from plant-based materials at the Egyptian Museum. An integrated approach utilizes nondestructive, re-treatable techniques. Documentation showed the belt is composed of palm leaf, crafted with fine nails for the edges. The belt is wide in the middle and narrows towards the edges. Photos and multispectral images reveal deterioration such as dryness, cleavage, and disintegration.

- The conservation process was conducted by Dina Mohamed Amin under the supervision of Azza Fathy and included the following steps**. (Figure 5)**

1. Cleaning: This process was conducted using an air pump and a gentle brush. (Medhat, 2016)

2. Gradual, indirect humidification with a Gortex membrane moistened using water droplets relaxed the fibers of the belt, enabling reshaping and flattening of disrupted areas. The equilibration of water content was crucial and must be performed gradually (Badr, 2013).

3. The humidification process was crucial for relaxing plant fibers, reshaping them, and removing distortions. This process involved using weights on the slightly moistened material to realign the fibers and restore the object to its original shape and stable condition.

- Chemical cleaning to remove the thick dirt used water and ethyl alcohol with a percentage(v/v) 1:1(Seyr & Medhat, 2021)

5. The consolidation process involved using a brush to apply Klucel G dissolved in 1% Ethanol (Florian et al., 1990; Medhat, 2015)

6. Reinforcement was applied to the weak areas using toned Japanese paper and Klucel G at a 2% concentration dissolved in ethanol. The use of these repair materials aligns with the chemical and physical properties of the belt and ensures reversibility. (Nehring et al., 2023)

7. Displaying process: This mounting process involved creating compatible support from plexiglass to preserve the objects and prevent any loads or strains. The support was created by Hesham El Sheikh (Othman et al. 2015) **(Figure 6)**

Fig.5 The main steps of conservation of the Belt SR 11616: (A) cleaning using air pump; (B) cleaning using gentle brush; (C, D) chemical cleaning using distilled water and Ethanol. (E) Consolidation using Klucel G 1 %(F) Using Gortex with water spray to remove the distortions and equilibrium the water content (G) Reinforcement using Klucel G and Japanese tissue. (photos after conservation by AbdelRahman Medhat)

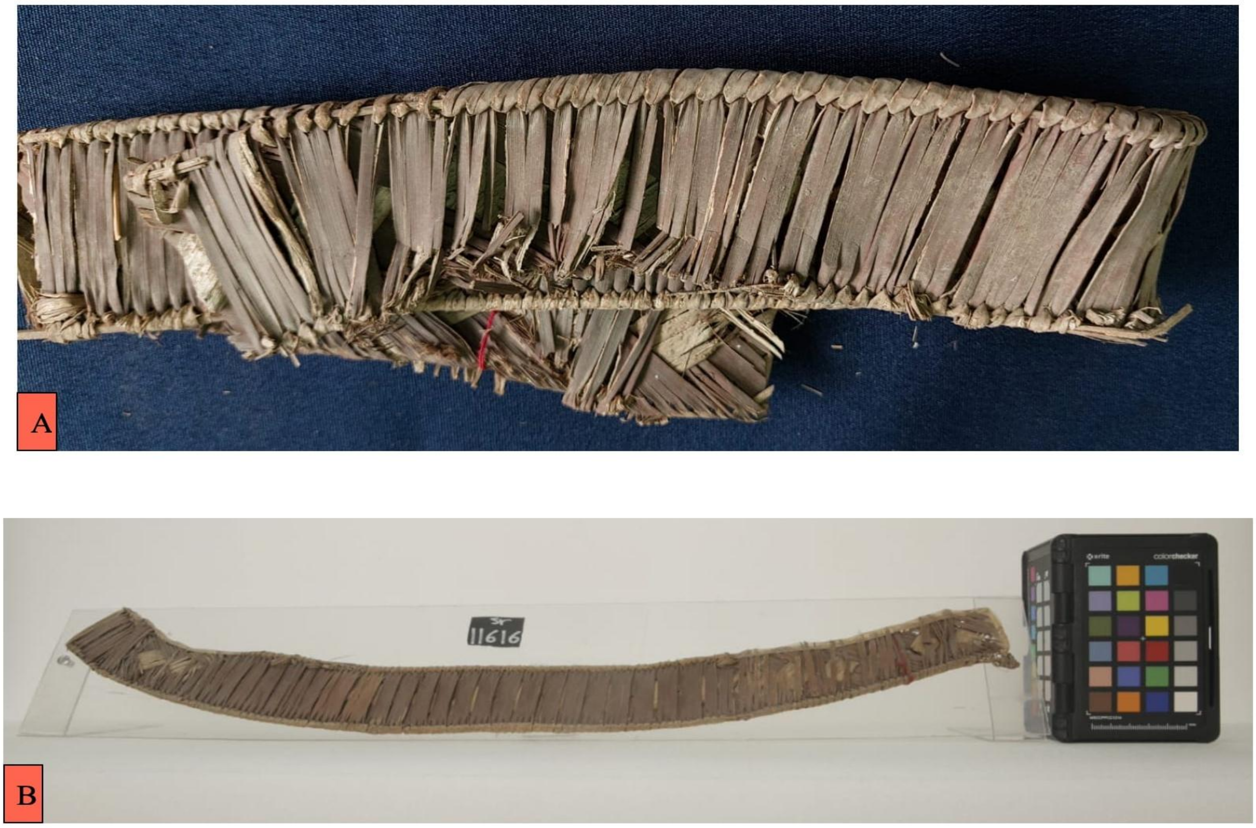

Fig.6: (A) shows the object before conservation (B) showing the object after conservation and displayed on Plexiglas support. (Photos by Abdel Rahman Medhat, Akram Atallah and Dina Mohamed Amen)

Conclusion

The examination of the belt SR 11616 housed in the Egyptian Museum by using non-destructive techniques such as USB microscopy, UV fluorescence, IR imaging, and raking light imaging revealed that the belt is constructed from palm fronds with varying strip widths to serve its function. This suggests its utilization in ancient times. Additionally, the observed fine stitching indicates the use of nails to create fine cordage. Dryness, the primary factor contributing to the deterioration of the material, led to depletion and cleavage of the object.

This research aligns with other literature reviews, indicating that Klucel G dissolved in ethanol is the most compatible treatment for preserving plant-based fibers. Furthermore, the reinforcement using Japanese paper and Klucel G proved compatible with the plant-fiber material. The new display of the belt ensures both the reversibility of treatment and the sustainability of the object.

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