Advanced Research in Conservation Science

Journal homepage: https://arcs.journals.ekb.eg

DOI: 10.21608/arcs.2021.49811.1011

Visualization, Documentation and Non-Destructive Investigation of an Ancient Egyptian Corn Mummy in a Falcon-shaped Wooden Coffin

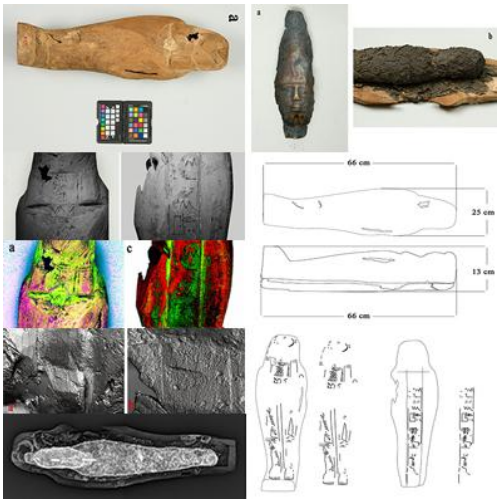
Ahmed Tarek[a*], Ibrahim A. Mohamed Ali[a], Mohamed Abdel Rahman[b]

[a.] Conservator, Conservation Center, Grand Egyptian Museum, Ministry of Tourism and Antiquities.
[b.] Director of Scientific Research, Projects Sector, Ministry of Tourism and Antiquities.

HIGHLIGHTS

- The 'corn-mummies' are grain-filled linen sacs.
- Use of nondestructive methods for the documentation and visual examination of a corn mummy coffin; its original decoration disappeared.
- Digital imaging was used to document all surface aspects.
- D-stretch was used to enhance surface details that were not clearly visible by digital imaging.
- X-ray Radiography was used to examine the contents inside the wrapped figure and the physical condition of the object components.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article History:
Received: 14 November 2020
Revised: 25 January 2021
Accepted: 19 March 2021
Available online: 28 June 2021

Keywords:
Corn Mummy, RTI, D-Stretch, Enhancement, Documentation, X-Ray Radiography.

ABSTRACT

'Corn mummies' were funerary objects in ancient Egypt that were served as sacred images of the god Osiris during the Khoiak feast. They are grain-filled linen sacs, usually filled with an emmer or barley specimen, the ingredients for staple food in ancient Egypt (bread and beer). In the fertility cult of Osiris, the function of Corn mummies was presumably for continuous prosperity of the land and healthy crop growth.

This paper focuses on the use of nondestructive methods for the documentation and visual examination of a Corn mummy coffin (No. 1242) dating back to the late period; but its original inscriptions are partially lost.

*** Corresponding author: a_tarek_a@hotmail.com**

Digital imaging and Reflectance Transformation imaging (RTI) were used to document all surface aspects. D-stretch was used to enhance surface details that were not clearly visible by digital imaging and RTI. Infrared imaging was used to reveal the details of hieroglyphic inscriptions and outline drawings on the wooden coffin. X-ray radiography was used to non-destructively verify the inside contents of the wrapped mummy inside the wooden coffin, and whether it includes any human remains or not. The methods provided a comprehensive documentation and examination of the various parts of the artifact.

1. Introduction

Corn mummies, which can be dated earlier than the mid-seventh century BC, are extremely rare. They are unknown in private burials outside the Valley of the Kings before 940 B.C, but after that date funerary objects, which can be described as Corn mummies, have been found in a small number of Third Intermediate Period tomb groups [1]. Osirian funerary wooden coffins, according to Aston, appear to have been a common part of burial equipment of upper-class private individuals during the Third Intermediate Period [2, 3].

These Corn mummies were manufactured to resemble a human body; in the form of a miniature Osiris which would ensure the following years' crop prosperity. These differ from the two-dimensional Osiris beds placed in New Kingdom royal tombs [4, 5]. Corn mummies serve as sacred images of the god Osiris during his festival. They were covered with a shroud or had a small wax mask in the image of Osiris wearing a crown, with tiny fists holding the crook and flail (representing kingship), or even an erect phallus [6]. The falcon-headed coffin does not contain an actual mummy but a symbolic Osiris mummy stuffed with grain and sand [7].

Corn mummies came in a falcon-headed coffin and lack attributes that link it to symbolic images of Osiris [8]; and it was initially mistaken for a falcon mummy which would also be wrapped in linen of similar size and appearance [4, 9]. The mummy form figures of Osiris and of several deities as Sokar were a symbol of their attributes as gods of death and afterlife [10]. Each year in the days leading up to the Khoiak feast [11], in the fourth month of inundation from day 12 to day 30, new figures of Osiris and Sokar were annually manufactured of soil and grain in molds [12, 13] and were used in ritual ceremonies during the Festival of Osiris [14]. According to the so-called Dendera mystery text, which is an inscription in 159 columns of hieroglyphs (early Roman Period) engraved on the walls of one of the Osiris Chapels in the temple of Hathor, sand and barley were mixed together and put in two mummiform golden molds. These two halves, constituting right and left of the Osiris body, were deposited in a basin and watered from day 12 to day 21 of Khoiak. The molds were then emptied and the mummiform figure obtained; regarded as the body of Osiris Khenty-imentet it was wrapped in linen bandages. Generally encased in a falcon-headed coffin, the mummy was first buried in the temple and one year later it was moved in its permanent burial. The Dendera text describes another kind of mummiform statuette, regarded as the body of Sokaris [15-18]. Corn mummies varied in size from 35–50 cm in length and were placed in falcon-headed coffins in cemeteries, while miniature varieties were encased within Ptah-Sokar-Osiris statues in Late Period burials [19, 20].

An example of these Corn mummies is in the Grand Egyptian Museum (no. 1242), which is preserved in a falcon-shaped wooden coffin with a metal (bronze) mask in the shape of Osiris (Fig. 1), and its length does not exceed 66 cm, as shown in the outline measurements in (Fig. 2). It dates back to the late period, and was found in the Muslim cemetery in Meidum, in Middle Egypt. Due to lack of documentation concerning the exact location of the find as well as the absence of any text, the dating of the artifact was somehow challenging. Obviously, five sites have been identified as burial places of Corn mummies, namely Meidum, Tehne, El Sheikh Fadl, Tuna el Gebel, and Wady Qubbanet El Qirud. The identification is based on excavation reports, even though the exact circumstance of discovery is not always

Fig. 1: General Images of the wooden coffin and the Corn mummy a) left side, b) right side, c) Top and bottom sides d) the Corn mummy inside the wooden coffin

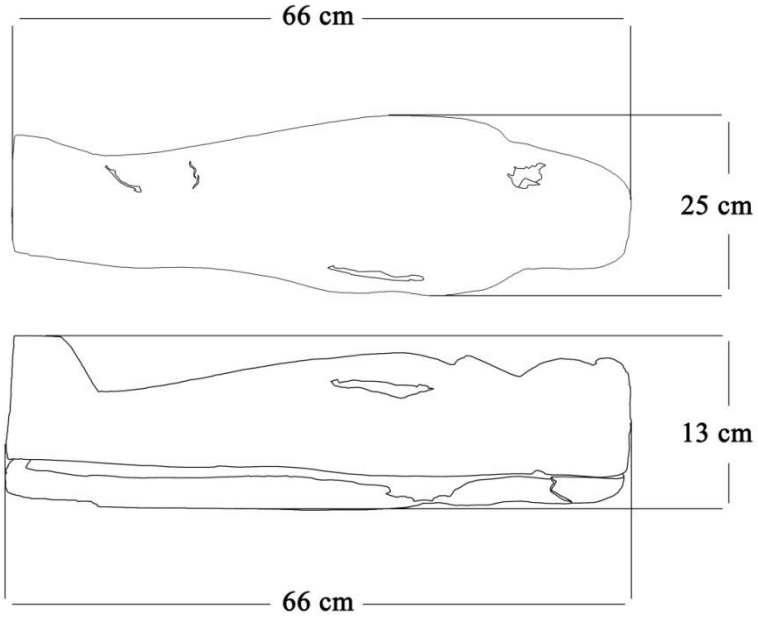


Fig. 2: Outer outline and measurements of the wooden coffin created with AutoCAD.

clearly stated. As far as Meidum and Tehne are concerned, the reasons that lead ancient Egyptians to choose specifically those two localities to bury the Corn mummies are related in local devotion to Osiris, although the phenomenon seems to be introduced in the religious history of sites only at very late period. In fact, Osiris, or rather Soker – Osiris is accompanied by the epithet, lord of shD, a locality proven to be in the Meidum area. In the late and Ptolemaic period the god worshipped in the area was Soker [9].

The Corn mummy inside a wooden outer coffin, which is currently at The Grand Egyptian Museum (GEM), was neither documented nor examined before, and this study aims to document and non-destructively examine the wooden coffin and the Corn mummy. This was achieved with high resolution digital imaging with general and detailed images, IR imaging, and the implementation of various advanced imaging-based surface examination techniques such as the Reflectance Transformation Imaging (RTI) and the D-stretch. Moreover, the study provides in depth investigation of the inside content of the Corn mummy through X-ray radiography, to reveal its inner components.

2. Materials and methods

2.1. Digital Imaging

Documentation of museum objects with digital imaging has been an essential documentation practice. Digital images for museum objects could be created, and used for various purposes (e.g. catalogues, websites, exhibitions, etc.), and they can deliberated for the documentation, study and conservation purposes of museum objects but would require more precise and consistent approaches to document and represent objects' details and aspects of preservation condition in a clear and accurate representation. For achieving these representative digital images, guidelines for the tools and procedure to be used should be followed. Several imaging guidelines have been already published for this purpose [21, 22]. As an initial step in this study, the wooden coffin and the Corn mummy were documented with digital imaging from all sides for the first time. In addition to the general images of the wood coffin and the Corn mummy, detailed images of all remarkable details were captured as well. A Canon DSLR 7D with a Sigma 17-50mm, f/2.8 EX DC OS HSM lens were used for the imaging. Two studio-flash (strobes) were used as light sources with two soft boxes installed for all images. For a better color management, color checker was used during imaging. Then, all images were processed with the Color Checker and Adobe Photoshop software for better and accurate representation of colors and details.

2.2. Reflectance Transformation Imaging (RTI)

Reflectance Transformation Imaging has been widely used for enhancing the surface details of cultural heritage objects. Surface details are emphasized through utilizing the digital imaging with a directed lighting from various angles in multiple digital images of the same captured area with the camera fixed in the same position. The captured surface details are then processed mathematically with the RTI builder software. The results are an interactive digital image with all lighting positions used. Several filters could be applied in the viewer version of the RTI software for better enhancement and visualization of the surface details [23]. In this study, Reflectance Transformation Imaging (RTI) was used after an initial visual examination of the falcon-shaped wooden coffin to emphasize the details of some areas of interest which show signs of valuable archaeological details in two selected areas.

2.3. Infrared Imaging (IR)

Infrared imaging, a commonly used technique for enhancing details visibility on artifacts through the contrast between the reflective ground layer and the details made by inks and pigments which absorb the infrared [24], was conducted on the partially lost and faded black inscriptions on the wooden coffin, that were not very clear in the digital imaging with visible light.

2.4. (D-stretch)

Decorrelation Stretch (D-Stretch) plugin to Image J software, which was upgraded by Jon Harman (Image Enhancement using D-Stretch 2019) for color enhancement of rock art images, was applied to enhance the high-resolution photographs of surfaces of the wooden coffin, aiming to enable obscure or faded details to be viewed by artificially highlighting traces of remaining text [25].

High resolution images from the digital imaging documentation with DSLR camera were used for further processing with D-Stretch software. Different color spaces have been applied (e. g. crgb, lab, lbk, yre..etc). The obtained images highlighted more surface details based on the very fine color rendering differences of the surface details of the wooden coffin. Similar areas are represented with similar color tone.

2.5. X-ray Radiography

X-ray radiography has been widely used to study the structures of archaeological objects [26]. In this study, X-ray radiography was used as a non-destructive tool to examine and document the inner components and structure of the wrapped mummy figure. More information and details about the instrument and the experimental setup are reported in **(Table 1)**:

Table 1: X-Ray Generator Specifications

X-Ray Generator Specifications : Radioflex RF-200SPS	
Tube Voltage	80 KV to 200 KV
Tube Current	Fixed at 3 mA
Tube X-Ray	Ceramic Tube
Weight	Generator 15 Kg
	Controller 14.5 Kg
Wireless Digital Detector	
Image Size	16" ×16"
Active Area	405 mm×405 mm
Flat Panel Type	Amorphous Silicon
Scintillator Material	Gadolinium Oxysulfide (GOS)
Weight	5 Kg

3. Results and Discussion

3.1. Digital Imaging

The images (Fig. 1, 3, 4, 5) represent and document the general condition and details of the various parts of the wooden coffin and the Corn mummy. Digital images created through this study will be a valuable addition to the digital records of the artifacts within the museum collections database as it will serve as a visual documentation record for the artifact with all its details. In addition to the artifact details, high resolution digital images document the preservation condition of the artifact (e. g. wood, white ground layer, and the black inscriptions condition). Details from the manufacture process including the addition of a white filling material to cover some gaps in the wood structure have been documented very clearly with general and detailed images.

3.2.Reflectance Transformation Imaging (RTI)

RTI has been widely used for clarifying the fine surface details of tool marks, inscriptions and other surface details on archaeological artifacts [27-29]. In this study, RTI images of the selected areas on the surface of the wood coffin (Fig. 6, 7) show very valuable details highlighting some manufacture related details of the wooden coffin. Some marks that might be from the tools used for the carving of the wood were revealed and documented. These details could be very useful in identifying the tools and methods used for the production of the wooden coffin. Details of the deteriorated wood surface condition, where the white ground layer is missing were also very well documented.

3.3. Infrared Imaging (IR)

A Sony camera (ILCE-5000 - APS-C format 23.2 mm × 15.4 mm CMOS sensor -20MP- with E16-50mm lens), modified for IR imaging and a LED infrared lamp as the light source were used for the IR imaging (Fig. 8). It was notice that enhanced details of the black inscriptions on the falcon head and the hieroglyphic letters on the bottom side were documented.

Fig. 3: Images of the wooden coffin a) top side, b) bottom side showing its general condition; missing parts of the wooden coffin, major loss of the white ground layer and the faded and lost black inscriptions on the top and bottom sides of the wooden coffin.

Fig.4: Detailed images of the wooden coffin a) detailed image of the falcon head (representing Horus) b) Left side of the falcon head, details of partially preserved traces of the white ground layer and black line inscriptions could be observed.

Fig.5: a) Detailed image of the bronze mask (height 17.5 cm), b) detailed image of the corn mummy and its outside textile wrapping.

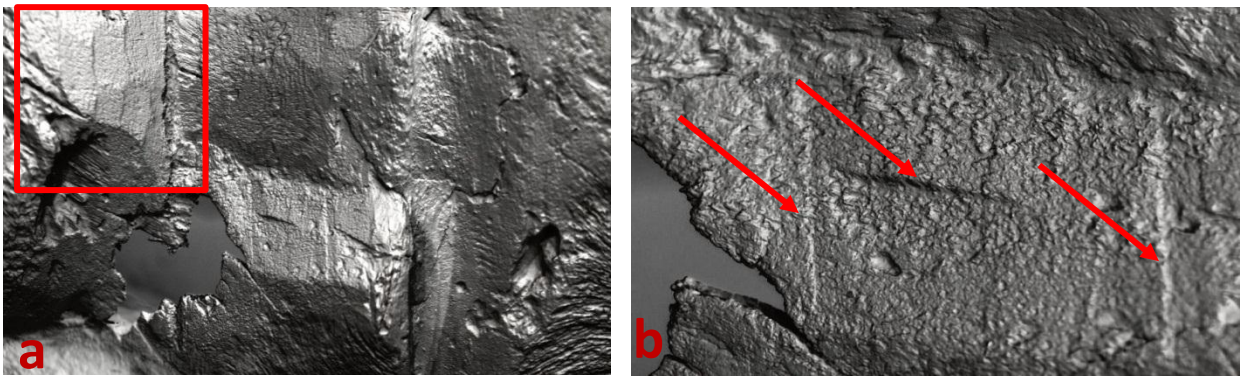


Fig. 6: RTI images (with specular enhancement) for the wooden coffin showing tool marks which give some indications to the tools that have been used for carving the wooden coffin.

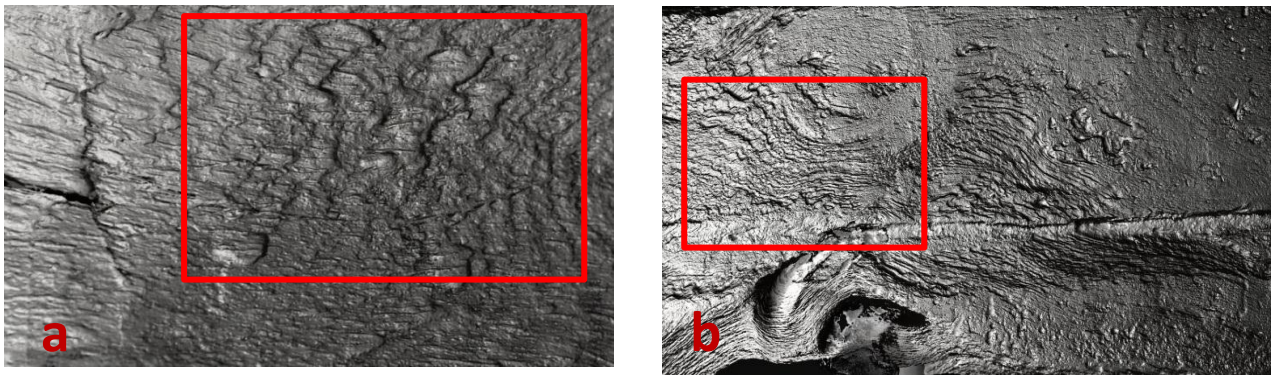


Fig. 7: RTI images (with specular enhancement) for the wooden coffin showing details of the wood surface condition where the white ground layer is lost.

Fig. 8: IR images of the falcon-shaped wooden coffin top and bottom sides. Enhanced details of the black inscriptions on the falcon head and the hieroglyphic letters on the bottom side were documented.

3.4.D-stretch images and digital epigraphy drawing

From the D Stretch images the text is enhanced (Fig. 9) and helped clarify some of the inscriptions that were not clear in some parts. It was complemented with IR imaging for clarifying the inscriptions and hieroglyphs on the object. The final phase was to produce the digital epigraphy for the coffin sides by using Adobe illustrator by combining all images "D-Stretch images and visible images" in multi Adobe illustrator layers (Fig. 10) [30-33].

A short and fragmented inscription on the lid, a single column of hieroglyphs in the center of the coffin, starting just below the hands and ending at feet level is an Osirian offering text was legible. The Third Intermediate Period is meagre, we notice the presence of Khenty Amentet figure in private burial and of miniature three-dimensional Corn mummies deposited on private mummies [4].

3.5.X-ray Radiography

Although X-radiography does not identify the composition of artifacts, it can often provide clues to the nature of the material or materials based on the visible micromorphology, especially for organic materials such as bone and wood. X-rays show size, shape and details of construction of the items under examination that contribute to their characterization, technical description, classification and dating [34].

X-ray radiography was used to verify the inside content of the wrapped mummy and end a scientific debate, because the artifact had been recorded in the excavation register book as a child mummy. Based on the examination, it was confirmed that it is not a mummy of a child or any living creature, not even a remnant, and it is a symbolic Corn mummy [19, 35, 36], that was made out of plant-based materials that had been covered with textile strips and coated with black resin and inserted inside the falcon-shaped wooden coffin. Based on comparison with previously published drawings and photographs of previously examined Corn mummies by Archaeobotanists at the Archaeological Museum of Cracow, the Mummy at the GEM is definitely a Corn mummy (Fig. 11) [37].

Conclusion

Through this study it was possible to provide a full documentation for one of the Corn mummies and its falcon-shaped wooden coffin. In addition to general digital imaging used for the documentation of the wooden coffin and the Corn mummy, various advanced imaging methods have been intergraded for the examination of all the surface details. Faded black inscriptions and hieroglyphics were enhanced and documented through IR imaging and D-stretch application. The images were then used for digital epigraphy, to document all the inscriptions. Some tool marks that have been revealed through RTI imaging might help in the identification of the tools and methods used for the production. The inside of the Corn mummy has been thoroughly investigated with X-Ray radiography. It was stated in the excavation record that it was a child mummy, but through X-ray radiography it was confirmed that the mummy does not include any human remains, and that it is just an example of Corn mummies which were popular as funerary objects in ancient Egypt. Based on this valuable and confirmed information, the artifacts identification was corrected in the new digital records within the museum collection database.

The approaches used in the study could be used for the documentation and non-invasive investigation of similar artifacts, and further studies on similar artifacts would increase our knowledge about Corn mummy's production methods and use in ancient Egypt. This information could be then used for a better integration of the Corn mummies in exhibitions and museum collections, and would provide essential information for the conservation decisions based on a better knowledge of the materials included, production methods and the current preservation condition.

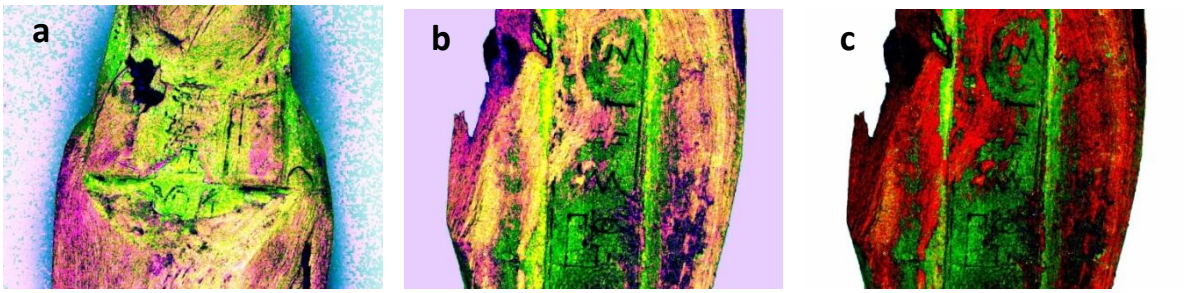


Fig. 9: Corn mummy coffin front side, (a) (ybl) enhancement, (b) (yxx_1.50_0.20_1.60) enhancement, (c) (lwe) enhancement.

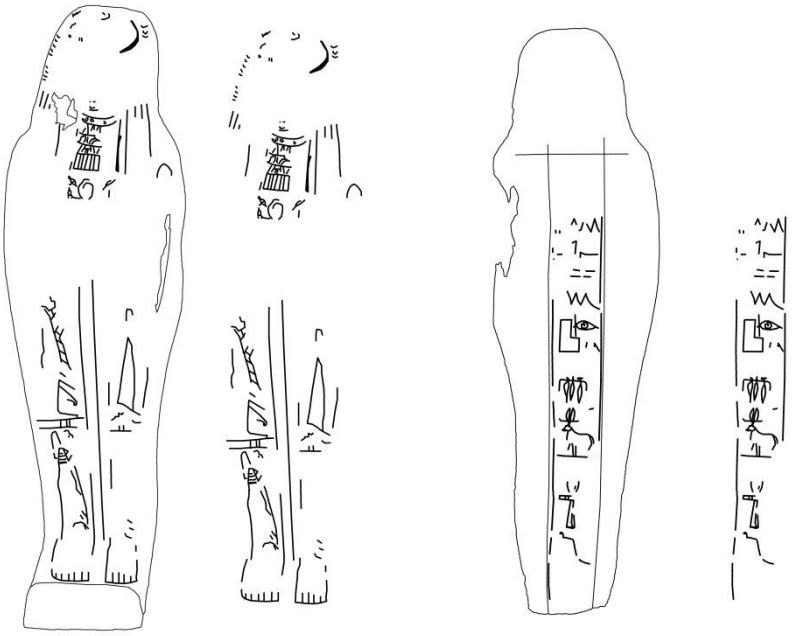


Fig. 10: Corn mummy coffin after digital epigraphy by Adobe illustrator.

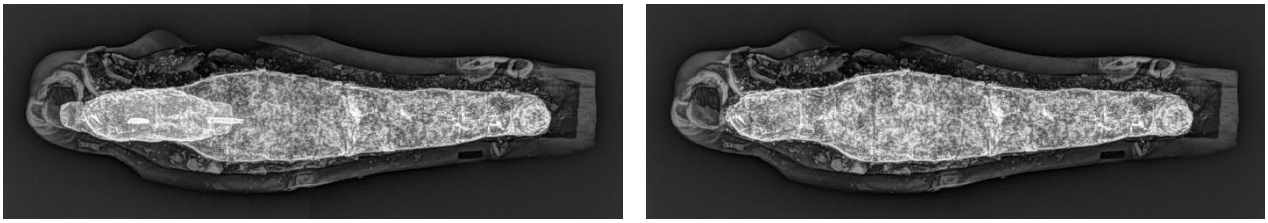


Fig. 11: X ray Radiography photos of corn mummy.

References

1. Aston, D.A., Burial Assemblages of Dynasty 21–25: Chronology, Typology, Developments, Vienna, 2009, p.302.
2. Dewsbury, L.M., Invisible religion in ancient Egypt: a study into the individual religiosity of non-royal and non-elite ancient Egyptians, Doctoral dissertation, University of Birmingham), 2017, p. 64.
3. Coulon, L. 'Du périssable au cyclique: les effigies annuelles d'Osiris', in S. Estienne, V. Huet, F. Lissarrague, et al. (eds.), Figures de dieux: construire le divin en images. Rennes, 2014, Pp.295-318.
4. Centrone, M. C., "Corn-mummies, Amulets of Life", in Kasia Szpakowska, (ed.), through a glass darkly: magic, dreams & prophecy in ancient Egypt, The Classical Press of Wales, Swansea, 2006, pp. 32, 46.
5. Centrone, M.C., 'Behind the Corn-mummies', in K. Piquette and S. Love (eds.), Current research in Egyptology 2003: proceedings of the fourth annual symposium which took place at the Institute of Archaeology, University College London, 18-19 January 2003. Oxford, 2005, Pp. 11-28 .
6. West, G., The Tekenu and Ancient Egyptian Funerary Ritual. Archaeopress Publishing Limited, 2019.
7. Cauville, S. and Lecler, A., Le temple de Dendera: guide archéologique. Institution Franc. d'Archéologie Orientale, 1990.
8. Mikhail, L. B. Dramatic aspects of the Osirian Khoiak festival. Uppsala, 1983, pp. 98-113.
9. Centrone, M.C. 'Corn-mummies: a case of "figuring it out"', in J.-C. Goyon and C. Cardin (eds.), Proceedings of the Ninth International Congress of Egyptologists, Grenoble, 6-12 September 2004 Leuven, Paris, Dudley, 2007, pp. 293-301.
10. Raven, M, Papyrus-sheaths and Ptah-Sokar-Osiris statues, OMRO, Vols. 59-60, 1978-9, pp: 251-296 .
11. Chapman, S.L., The embalming ritual of late period through Ptolemaic Egypt (Doctoral dissertation, University of Birmingham), 2017, P. 112
12. Eaton, K., The festivals of Osiris and Sokar in the month of Khoiak: The evidence from nineteenth dynasty royal monuments at Abydos, SAK, Vol. 35, 2006, pp: 75-101 .
13. Quirke, S, Going out in Daylight prt m hrw the Ancient Egyptian Book of the Dead, translation, sources, meanings, GHP Egyptology 20, 2013.
14. Chassinat, E., Le mystère d'Osiris au mois de Khoiak. l'Institut Français d'Archéologie Orientale, 1966.
15. Daumas, Fr., Lexicon der Ägyptologie, Wiesbaden, Band 1, 1975, 958-960 .
16. Raven, M.J., "Corn-mummies", Oudheidkundige mededelingen uit het Rijksmuseum van Oudheden Vol. 63, 1982, pp. 7- 38.
17. Cauville, S., Dendera, Les chapelles osiriennes, Vol. I-III, Cairo, 1997.
18. Picchi, D., Rossi, M., Casali, F. and Romani, D., Analysis of an Egyptian Corn-Mummy by Means of Computed Tomography. Walthew and Mayberger, ANAGPIC, Vol. 1, 2014.
19. Wasylikova, Krystyna & Jankun, A., Identification of Barley from Ancient Egyptian Corn-Mummies in the Archaeological Museum in Cracow, in: Materialy Archeologiczne 30، 1997.
20. Veiga, P.A., ÄS 0310: A small Osiris Coffin in Munich. CIPEG Journal: Ancient Egyptian & Sudanese Collections and Museums, 3, 2019, pp.26-35.
21. Allen, S., The AIC Guide to Digital Photography and Conservation Documentation. Collections, 7(3), 2011, pp.353-356.

22. Bigras, C., Choquette, M., and Powell, J., Lighting Methods for Photographing Museum Objects. CCI publications, Canada, 2010.
23. http://culturalheritageimaging.org.
24. Cosentino, A., Infrared Technical Photography for art examination-Morana RTD, e-preservation science, 2016, 13, Pp. 1-6.
25. Piquette, K. E., Revealing the Material World of Ancient Writing: Digital Techniques and Theoretical Considerations. In The Materiality of Texts from Ancient Egypt: New Approaches to the Study of Textual Material from the Early Pharaonic to the Late Antique Period, ed. Hoogendijk, F.A.J. and S.M.T. van Gompel.94-95. LEIDEN-BOSTON: Brill, 2018.
26. Uda, M., Characterization of pigments used in Ancient Egypt. In X-rays for Archaeology, 2005, pp. 3-26. Springer, Dordrecht.
27. Piquette, K.E., Reflectance transformation imaging (RTI) and ancient Egyptian material culture. Damqatum: The CEHAO newsletter–El boletín de noticias del CEHAO, Vol 7, 2011.
28. Coules, H.E., Orrock, P.J. and Seow, C.E., Reflectance Transformation Imaging as a tool for engineering failure analysis. Engineering Failure Analysis, 105, 2019, pp.1006-1017.
29. Cultural Heritage Imaging., Reflectance transformation imaging: Guide to highlight image capture, v. 2.0, 2013, P. 32 San Francisco, CA: CHI
Cultural Heritage Imaging. http://CulturalHeritageImaging.org/downloads/ (accessed 10 October 2019).
30. Image Enhancement using DStretch. Posting article by Harman, J. http://www.DStretch.com (accessed 14 November 2019).
31. Evans, L. and A. L. Mourad., DStretch® and Egyptian tomb paintings: A case study from Beni Hassan. Journal of Archaeological Science: Reports 18, 2018, Pp. 78-84.
32. Greene, H. A., and D. J. Madden., Adult age differences in visual acuity, stereopsis, and contrast sensitivity. American Journal of Optometry and Physiological Optics 64, 1987, Pp. 749–753.
33. Lianos, L. and Diaz L., The 'Book of Going Forth by Day' in the funerary chamber of Djehuty (TT 11): past, present, and future. In the XI International Congress of Egyptologists, Florence, August 2015, Pp. 23-30. ed. Cristina, M., and G. Rosati. Italy: International Congress of Egyptologists.
34. Fell, V., Mould, Q. and White, R., Guidelines on the X-radiography of archaeological metalwork. English Heritage, 2006.
35. Hamdy, R. and Fahmy, A.G., Study of Plant Remains from the Embalming Cache KV63 at Luxor, Egypt. In Plants and People in the African Past, 2018, pp. 40-56. Springer, Cham.
36. Manniche, L., An ancient Egyptian herbal. University of Texas Press, 1989.
37. Walthew, J., and Mayberger, E., "Radiography and Replication as Investigative Tools for Conservation Research: The Dummy Mummy Project", ANAGPIC, Institute of Fine Arts New York University, NY, 2, 2014.