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AN ANALYTICAL STUDY OF MAGICAL WAX FIGURINES FOUND IN THE MUMMY OF TJANEFER FROM THE THIRD INTERMEDIATE ERA USING CT SCANNING AS A NON-DESTRUCTIVE TOOL.

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Abstract:
This paper aims to explore the discovery of magical wax figures in the mummy of Tjanefer from the third intermediate era, and the insights obtained through the use of advanced methods such as CT scanning and Gas Chromatographic analysis. Through these methods, researcher has been able to uncover the various techniques used by ancient Egyptian embalmers to mummify bodies, including the use of wax figurines to protect the internal organs of the deceased. Computed Axial Tomography (CT) scan was an essential tool in the non-destructive detection of archaeological findings inside Egyptian mummies, enabling scholars to determine the methods used by embalmers in mummification operations. In this research, Fourier transform infrared spectroscopy (FTIR), Gas chromatography GC/MAS, and Scanning electron microscopy (SEM) were used in addition to a CT scan to analyze the data related to the function of these figurines and to examine some samples of the materials used in making them. The results of these analyses provided valuable insights into the religious beliefs and funerary practices of ancient Egyptians, particularly with respect to the role of wax figurines in these practices. The examination of the CT scan of Tjanefer's mummy revealed that the mummification process adhered to the traditional Egyptian practice of removing internal organs, embalming them separately, and then returning them to the body cavity. The discovery of four wax statues representing the four sons of Horus within the body cavity suggests that these figurines were believed to have a protective role for the deceased in the afterlife. The analysis of the wax samples revealed that the production of these figurines likely did not require highly skilled craftsmanship. Furthermore, scanning electron microscopy analysis showed that the wax sample was impure with resins in a neutral mixture, suggesting that the production was of good quality..

1. Introduction

The third intermediate period (c.1076-c.723 BC) continues to be extensively studied and published. It is considered one of the most important historical phases in the development of mummification [1], with several technical methods developed during ancient Egyptian times. Through both ancient and modern studies of mummification, scientists and scholars have confirmed that this period was ideally developed in terms of mummification techniques [2]. In 1912, Elliot Smith [3]

published an extensive study of the royal mummies housed in the Cairo museum. His descriptions of the mummification techniques were considered a significant step forward in the development of the scientific study of mummies [4]. Later, the scientific findings of Egyptian mummies greatly expanded with the use of radiographic technology, which was developed by 1895. Radiographic examination of mummies is a non-destructive and fundamental procedure in any multidisciplinary study of mummified remains. It provides vital archaeological and medical evidence [5]. The CT images taken of Tjanefer provided information regarding the manufacturing techniques of the wax figurines. With some slight intrusion of the artifact, clear evidence and images of the inner surface of the case study were revealed through the well-defined CT images [6]. Wax was one of the most important materials used by the Egyptians during the mummification process, and it was used throughout all periods of ancient Egyptian times, from the early dynastic times until the late period. Abeer [7] indicated that in the twentieth century, archaeologists used destructive methods for mummies, such as extracting wax and clay figurines from the mummy of Hor in the British Museum. At the beginning of the twentieth century, E. Smith examined mummies using a destructive method, fig. (1)

Figure (1) Shows the archeologists extracting of the wax figure from the mummy of Hor during as a destructive examination from (*After: Abeer, 2011*).

Since there were no modern non-destructive devices for examining and analyzing mummies, such as an X-ray machine or others were undiscovered. [8]. To reveal the process of mummification, Smith had to make incisions in the mummy that was not linen-wrapped [9], in order to expose the method and materials used in mummification during ancient Egyptian times. Fortunately, wax figurine statues of the four sons of Horus were found inside one of the mummies, and these statuettes are currently well-maintained in the Egyptian Museum in Cairo [10]. One of the fragments was acquired as a sample in this research, fig. (2).

Figure (2) Shows one of the wax figurines Smith extracted from one of mummies in the Egyptian Museum. It is a wax figurine in the form of a jackal.SR 8953 (a-d) TR 24. 12. 31. 2.

After treating and wrapping the viscera separately with linen wrappings, embalmers of the XXIst dynasty placed the internal organs back into the abdominal and chest cavity [11]. Each organ had a wax figurine of one of the four Sons of Horus wrapped around it [12]. These figurines were usually made of beeswax, but other examples were made of other materials such as resin, clay with an ext-ernal layer of wax, or even resin with a wax layer. Some figurines in the Cairo Museum included layers of resin and clay covered in wax [13]. This practice provided evidence for the widely accepted association of each organ with one of the sons of Horus, although it was not inscribed on the Can-opic jars [14] or in any other ancient text dating back to the third intermediate period. The liver was assigned to Imsety, the lungs to Hapy, the stomach to Duamutef, and the intestines to Qebehsenuef [15]. The

thoracic and abdominal cavities were found to be packed with white sand, linen, sawdust, and natron. The reasons behind adopting this new trend are unclear, but the intention of preserving the whole body as one unit [16], including the treated organs, was essential to achieve a successful resurrection. The latter could have been a major element for these changes, such as the addition of white sand, sawdust, and linen wrappings. One of the earliest examples of this procedure is found in the royal mummy of Ramesses Vth of the XXth dynasty, and it became a standard practice during the third intermediate period [17]. Different variations were also discovered in the mummy of Irtyru, a woman who lived during the XXVth dynasty. Remarkably the wax figurines were placed within her linen wrappings and not inside body cavity [18]. H.E. Winlock surprisingly discovered seven bundles within the thoracic and abdominal cavities of the XXIst dynasty mummy of Henutway, daughter of Isetemkheb. The bundles were unwrapped, and four wax figurines representing the four sons of Horus were found inside four of these bundles [19]. Winlock describes these bundles unexpectedly enclosed a piece of rope instead of the intestines, a fragment of cowhide instead of the liver, as well as different pieces of both leather and linen to form the seven bundles mentioned above. Furthermore, Winlock insinuated that either the organs decomposed while being treated or they were discarded by the embalmers.

1.1. *Wax figurines in ancient Egyptian funerary practice*

Wax figurines have been found in tombs ranging from the Old Kingdom to the Late Period, and were often placed in the coffin or burial chamber alongside the mummy. Archaeologists suggest that wax figurines were used for a variety of purposes, including protection, magical purposes, and as representations of the deceased or deities. The symbolism of certain types of wax figurines, such as those depicting the god Bes, who was associated with fertility and childbirth, and those depicting the goddess Isis, who was associated with magic and protection, is noteworthy. Wax figurines were often accompanied by inscriptions or spells, which further emphasize their protective or magical functions [20]. In some cases, these figurines were placed inside the body of the deceased, either in the chest cavity, where the heart was believed to reside, or in the abdomen area, where the internal organs were removed during the mummification process. The use of wax figurines inside the body of the deceased was likely intended to provide additional protection in the afterlife. The figurines may have been seen as a sort of magical amulet that would accompany the deceased on their journey through the underworld. By placing the figurines inside the body, the ancient Egyptians may have believed that they were ensuring the continued well-being and protection of the deceased in the afterlife [21]. In some cases, wax figurines found inside the body of a mummy were created to resemble specific deities. For example, a wax figurine in the form of the god Osiris might have been placed inside the chest cavity of a mummy, as Osiris was associated with rebirth and the afterlife. The placement of wax figurines inside the body of a mummy was a relatively rare practice, and it is not entirely clear why some individuals were given this treatment while others were not. However, the use of figurines in this way provides additional evidence of the importance of wax figurines in ancient Egyptian funerary practice and their role in facilitating the journey of the deceased through the afterlife [22]. One possibility is that the use of wax figurines inside the body was reserved for individuals who held a particularly important role in society or who were believed to have a special connection to the gods. For example, one of the most famous examples

of a wax figurine inside a mummy is that of Queen Nefertari, the wife of Ramses II. Her mummy was found to contain a small wax figurine in the shape of the goddess Selket, which was placed inside her chest cavity. Another possibility is that the use of wax figurines inside the body was reserved for individuals who were believed to be at particular risk in the afterlife. For example, individuals who had suffered from illness or injury during their lifetime might have been seen as particularly vulnerable in the afterlife, and so might have been given additional protection in the form of wax figurines. Regardless of the reason for their placement, the use of wax figurines inside the body of a mummy provides additional evidence of the complex beliefs and rituals surrounding death and the afterlife in ancient Egypt. These figurines were seen as powerful talismans that could help to ensure the continued well-being and protection of the deceased in the afterlife, and were an important part of the funerary rites of the ancient Egyptians. The "four sons of Horus" were a group of deities in ancient Egyptian religion who were associated with the internal organs of the deceased. Each deity was associated with a different organ, and they were believed to help protect and preserve the organs in the afterlife. Wax figurines of the four sons of Horus were often placed inside the body of the deceased, alongside the corresponding organ, in order to provide additional protection in the afterlife. These figurines were often small and intricately detailed, and were sometimes accompanied by inscriptions or spells intended to further enhance their protective powers [23]. The use of wax figurines of the four sons of Horus in ancient Egyptian funerary practice provides additional evidence of the complex beliefs and rituals surrounding death and the afterlife in ancient Egypt. These figurines were seen as important talismans that could help to ensure the continued well-being and protection of the deceased in the afterlife, and were an integral part of the funerary rites of the ancient Egyptians [24].

1.2. *Historical background*

Tjanefer (1070-712 B.C.) was a fourth prophet of Amun during the reign of king Psusennes I, and was later promoted to third or even second prophet of Amun before his death. He was the son of the fourth prophet of Amun, Nespaherenmut, and a woman named Istemkheb. Tjanefer's mummy was discovered at Bab el Gasus, part of the Deir el Bahari complex, and is currently located at the Egyptian Museum of Cairo (TR 28.4.26.13(a)). Although Elliot Smith examined and unwrapped most of the mummies of the Bab el Gasus cache, he only provided a detailed description of a few of them. Therefore, a CT scan of Tjanefer's mummy was conducted to obtain more precise evidence [25,26]. More than 150 priests of Amun and temple officials were buried in the tomb of Bab el Gasus, also known as the "Second Cache," which was discovered in January 1891. Large numbers of coffins and funerary items were crammed into two chambers and two passageways, fig (3) [27, 28]. After the discovery, the mummies were first transferred to the Giza museum and were examined by D. Fouquet. Later, they were relocated to the Anatomical museum of the Cairo school of medicine, where further examination was carried out by G. Maspero, M. Daressy, A. C. Mace, G. E. Smith, and others. However, to avoid internal damage, E. Smith did not open the cavity of some mummies. A considerable number of the mummies were found without figurines, either due to the deterioration of the corpses or because they were not included in the first place. Most of the figurines in the collection are made of wax, with a few exceptions of faience and mud. The Egyptian museum's temporary registrations reveal that four figurines were brought from the

school of medicine in Cairo, discovered by G. E. Smith within the wrappings of an unspec-ified mummy.

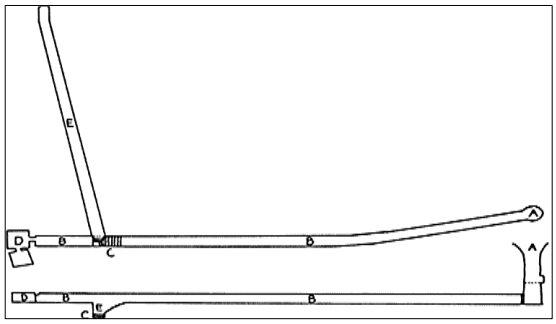

Figure (3) Shows the plan and elevation view of Bab el Gasus tomb at Deir el Bahari where the mummy of Tjanefer was discovered, in which wax figurines were discovered inside. (*After: Niwinski 1984*).

2. Materials and Methods

This research relied on advanced scientific methods to study wax figurines through examination using a CT scan located in the Egyptian museum. During the examination of the mummy of Tjanefer, wax figurines were discovered inside the thoracic and abdominal cavity of the mummy [29], which necessitated their study from an archaeological and scientific point of view. According to established scientific and archaeological foundations and standards, these wax figurines cannot be extracted from inside the mummy as it would cause deterioration of the mummy. Therefore, the researcher searched for a similar case from which wax figures had already been extracted. Through the researcher's reading of ancient Egyptian mummies, it was discovered that Smith [30] had extracted many of these figurines from mummies dating back to the third intermediate period, and the same work was done by extracting wax statues from mummies dating back to the era of transition in the British museum. The wax figures that Smith extracted and are preserved in the Egyptian museum in Cairo have already been studied, and some of them were made of wax, clay, or wax and clay together. The agricultural museum in Cairo includes models of wax figurines extracted from the bodies of mummies. The researcher obtained a falling and dilapidated sample from one of the wax figurines. The samples were investigated and analyzed using Scanning electron microscope (SEM), Fourier transform infrared spectroscopy (FTIR), and gas chromatography (GC). Through these advanced scientific methods, the researcher was able to gain a deeper understanding of the composition and structure of the wax figurines found inside the mummy of Tjanefer.

2.1. *Computed axial tomography scan (CT Scan)*

This examination aimed to elucidate the nature of the beeswax figurines using a CT scan with 6-slice Siemens Emotion 6 (Florsheim, Germany) located in the Egyptian museum in Cairo. Table (1) & fig. (4) provide the system operating conditions of the CT scanning. The CT scan provided detailed images of the wax figurines inside the mummy of Tjanefer, allowing for further analysis of their composition and structure. These results contributed to a better understanding of the figurines and their significance in ancient Egyptian culture.

Table (1) System operating conditions of CT scan when examining the mummy of Tjanefer at Egyptian Museum in Cairo.

Physician	scan	KV	Mass/ref	CTDLvoL	DLP	TI	eSL
Pation position H-	-	130	-	-	-	-	-
Topo gram	1	130	-	-	-	11.0	0.5
Head	2	130	130	17.63	416	0.8	0.5
Control scan	3	130	45	9.85	1	0.8	1.0
Dental	4	130	45	12.36	148	0.8	1.0
Operation body scan	5	130	58/124	7.70	506	1.5	1.0
Add scan	6	130	79/124	10.8MAS	2463	1.5	0.5

Figure (4) Shows the mummy of Tjanefer during the 3D CT scan, where discovered wax figurines, the subject of research, were revealed inside the mummy (*Cairo Museum, 2010*)

2.2. *Scanning electron microscope (SEM)*

Samples were analyzed using a Jeol JSM-6400 LV scanning electron microscope (SEM) equipped with an Oxford energy-dispersive X-ray (EDX) system, detector model 6587. Prior to analysis, the sample was plated with gold.

2.3. *Fourier transform infrared spectroscopy (FTIR)*

Fourier transform infrared (FTIR) spectroscopy of the sample was carried out using a Nicolet 6700 spectrometer with a Continuum IR microscope equipped with MCT/A detectors. Approximately 0.5 mg of a powder sample was dispersed and ground into approximately 70 mg KBr and pressed into granules of less than 10 mm.t/cm^2. The KBr pellets were screened for powder samples between 4000 and 400 cm^{-1} with a resolution of 4 cm^{-1}. Spectra were obtained between 1000-4000 cm^{-1} [31].

2.4. *Gas chromatography analysis*

Gas chromatography (GC) is an analytical technique used to separate and detect the chemical components of a sample mixture to determine their presence, absence, and/or quantities. These chemical components are usually organic molecules or gases. For GC to be successful in their analysis, these components need to be volatile, typically with a molecular weight below 1250 Da, and thermally stable so they do not degrade in the GC system [32]. The use of these advanced scientific methods allowed for a thorough analysis of the composition and structure of the wax figurines found inside the mummy of Tjanefer. The results of these analyses contributed to a deeper understanding of the significance of the figurines in ancient Egyptian culture.

3. Results

Through the above mentioned analytical techniques, the following data were obtained.

I. The examination of the CT scan of Tjanefer mummy from the 3rd intermediate period revealed that the internal viscera were extracted from the body of the mummy, embalmed outside of the body, and then wrapped and returned to the thoracic and abdominal cavity of the mummy.

II. Four wax statues representing the four sons of Horus were found in the thoracic and abdominal cavity. Through examination by scanning electron microscopy, gas chromatographic analysis, and Fourier transform infrared spectroscopy analysis, it was confirmed that these figurines are made of wax with resins. The degree of attenuation of the CT scan indicated that the figurines are of organic material.

III. The scanning electron microscope showed that the wax sample was impure with impure wax and resins in a neutral mixture. The wax statues were made using the casting method.

IV. The linen wrappings contained the internal organs of the body, separate from the wax statues. It was also revealed that the four wax statues were not attached to the thoracic or abdominal cavity.

V. These findings provide valuable insight into the embalming practices and use of wax figurines in ancient Egyptian culture, shedding new light on the significance of these artifacts in the context of mummification and religious beliefs.

4. Discussion

4.1. *CT scan examination*

CT scanning is an essential tool for detecting the methods and materials used in mummification during ancient Egypt, particularly during the third intermediate period. In this study, a CT scan was used as a non-destructive analysis method for the mummy of Tjanefer. The scan revealed the position of four wax figurines of the sons of Horus

in their original setting. The CT scan images indicate that the baboon-headed Hapy was placed in its usual position by the left lung. A figurine with unclear head details, likely that of the falcon-headed Qebehsenuef, was placed upside-down in the left side of the abdomen below that of Hapy by the intestines. The other two figurines, however, do not seem to follow the usual positioning. A human figurine representing Imesty, the guardian of the liver, was found near the center of the abdomen, slightly to the right, in the position of the stomach. Meanwhile, a seemingly jackal-headed figurine representing Duamutef, the guardian of the stomach, was mistakenly found in the place of the liver. These findings provide valuable insights into the ancient Egyptian mummification process and the significance of wax figurines in their culture. Further research could shed more light on the significance of the positioning of these figurines and their significance in ancient Egyptian beliefs. The Four Sons of Horus were a group of four deities in ancient Egyptian religion who were associated with the internal organs of the deceased. They were often depicted in funerary art, including wax figurines, which were commonly used in ancient Egyptian funerary practices [33]. The four sons of Horus were named Imsety, Duamutef, Hapi, and Qebehsenuef. Imsety was associated with the liver, Duamutef with the stomach, Hapi with the lungs, and Qebehsenuef with the intestines. Each deity was represented by a specific animal: Imsety by a human, Duamutef by a jackal, Hapi by a baboon, and Qebehsenuef by a falcon. Wax figurines depicting the Four Sons of Horus were often placed inside the Canopic jars that held the internal organs of the deceased, fig. (5) [34]. The figurines were believed to protect the organs and ensure their preservation for the afterlife. The wax used to create these figurines was often mixed with other materials, such as resin or honey, to make it more durable. In addition to their use in Canopic jars, wax figurines of the four sons of Horus were also placed in tombs and used in funerary rituals. They were sometimes depicted in scenes of the weighing of the heart ceremony, where the heart of the deceased was weighed against the feather of truth to determine their worthiness for the afterlife [35].

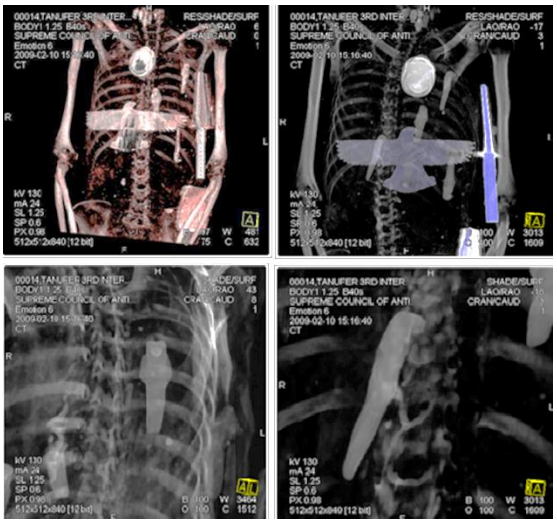

Figure (5) Shows the CT image of Tjanefer mummy with the wax figurines of the “four sons of Horus” in the thoracic and abdominal cavity of mummy, Hapy, Qebehsenuef, Imesty and Duamutef figurine.

4.2. *SEM Examination*

An SEM examination of a sample taken from one of the wax statues revealed that the material used was beeswax mixed with resins. The examination also showed that the texture of the wax was consistent. The casting method was used to manufacture this type of statue, as there were no gaps or cracks, indicating that great care was taken during the manufacturing process, fig. (6). These findings provide valuable insights into the materials and manufacturing techniques used to create the wax figurines found in the mummy of Tjanefer. Further research could explore the significance of the use of beeswax and resins in ancient Egyptian culture and their role in mummification practices.

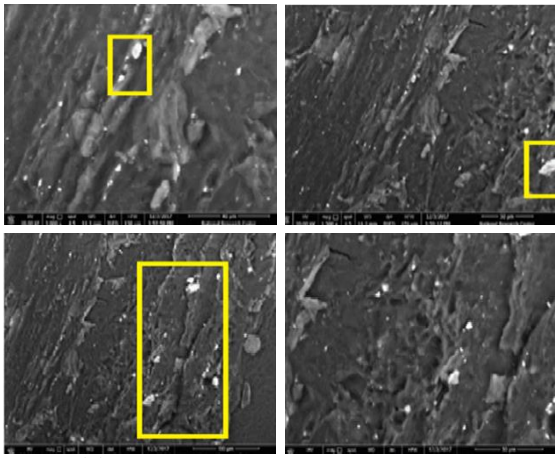

Figure (5) Shows SEM photomicrographs of a sample from one of the wax figurines, in good mixing and interconnected texture between wax and resins, the yellow rectangles indicate the presence of silica, as one of the materials used in the inner packing of the mummy which the wax statue was extracted.

4.3. *FTIR analysis*

The obtained FTIR analysis, fig. (7) was interpreted by comparing it to an already published infrared database and through the previous discussions of Wells [36], Mills, and White [37]. FTIR analysis revealed that the sample contains organic compounds, as listed in tab. (2), which includes the following organic components of beeswax:

- **Esters:** The sample of beeswax contains various esters, which are compounds formed by the reaction of an alcohol and a carboxylic acid. FTIR can identify the characteristic ester bond, which appears as a strong peak in the FTIR spectrum.
- **Alcohols:** The sample of beeswax also contains various alcohols, which are organic compounds containing a hydroxyl (-OH) functional group. FTIR can identify the characteristic peak for the hydroxyl group.
- **Hydrocarbons:** Beeswax contains long-chain hydrocarbons, which are organic compounds made up of carbon and hydrogen atoms. FTIR can identify the characteristic peaks for the C-H bonds in the hydrocarbon chain.
- **Fatty acids:** Beeswax also contains some fatty acids, which are organic compounds containing a carboxylic acid functional group. These findings provide valuable information about the constituents of beeswax and their potential role in the creation of the wax figurines found in the mummy of Tjanefer. Further research could explore the significance of these compounds in ancient Egyptian culture and their use in mummification practices.

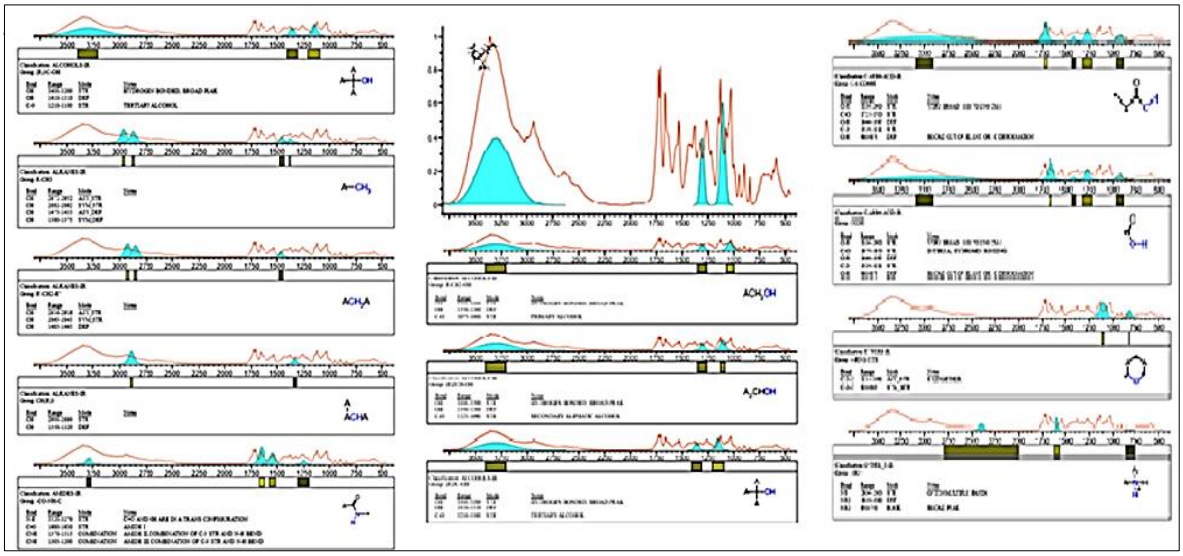

Figure (7) Shows ATR-FTIR spectra of the wax sample to identify the functional groups present in the multiple wax compounds, including alcohols, hydrocarbons, and esters. This confirms that the sample is beeswax, which the material used in the manufacture of wax figurines is found in the components of mummies dating back to the third intermediate period.

Table (2) FTIR spectra data analysis for the functional groups that appeared after conducting the analysis and it includes groups of alcohols and alkanes in addition to two groups of hydroxyl acids and organic compounds of hydrocarbons

No	Classification	Group	Bond	Range &Mode
1	Alcohols-IR, Hydrogen bonded, Primary Alcohol	R-CH2-OH	OH	3400-3200 STR
		ACH_2OH	OH	1350-1260 DEF
			C-O	1075-1000 STR
2	Alcohols-IR, Hydrogen bonded, Secondary Aliphatic Alcohol	(R)2CH-OH	OH	3400-3200 STR
		A_2CHOH	OH	1350-1260 DEF
			C-O	1125-1090 STR
3	Alcohols-IR, Hydrogen bonded, Broad Peak Tertiary Alcohol	(R)3C-OH	OH	3400-3200 STR
		A_3OH	OH	1410-1310 DEF
			C-O	1210-1100 STR
4	Alkanes-IR	R-CH3	CH	2972 2952 ASY_STR
			CH	2882-2862 SYM_STR
			CH	1475-1435 ASY_DEF 1380-
			CH	1375 SYM_DEF
5	Alkanes-IR	R'-CH2-R"	CH	2936-2916 ASY_STR
		ACH2A	CH	2863-2843 SYM_STR
			CH	1485-1445 DEF
6	Alkanes-IR	CH(R)3	CH	2900-2880 STR
		A ACHA	CH	1350-1320 DEF
7	Amides-IR	-CO-NH-C	N-H	3320-3270 STR
	{C=O and NH are in a Trans Configuration}		C=O CNH	1680-1630 STR
	{ Amide I}		CNH	1570-1515 COMBIN
	{Amide II, Combination of C-N STR and N-H Bend}			1305-1200 COMBIN
	{ Amide III, Combination of C-N STR and N-H Bend}			
8	Carbo-Acid-IR	COOH	O-H	3100-2900 STR
	{Very broad 3100 to 2500 CM^{-1}}		C=O	\670-1650 STR
	{Internal Hydrogen bonding }		O-H	1440-1395 DEF
	{Broad out of Plane OH...O Deformation}		C-O	1320-1211 STR
			O-H	960-875 DEF
9	Ethers-IR	6-RING ETH	C-O-C	1110-1090 ASY_STR
	6 Ring Ether		C-O-C	820-805 SYM_STR
10	Other_N-IR	NH2^	NH	2800-2000 STR
	Often Multiple Bands Broad Peak		NH2	1620-1560 DEF
			NH2	850-750 ROCK

4.4. *Gas chromatography analysis*

Gas chromatography/mass spectrometry (GC/MS) methodologies were combined to identify a range of organic materials in a beeswax sample. The method described in the method section was adapted to identify wax compounds. A 2-3 mg sample of beeswax was weighed into a glass vial, and 1 mL of n-hexane was added to the vial and vortexed for 30 seconds. The vial was then centrifuged at 3000 rpm for 5 minutes, and 0.5 mL of the supernatant was transferred to a GC-MS vial. For GC-MS analysis, 1 µL of the sample was injected onto a GC column (30 m×0.25 mm, 0.25 µm film thickness) using a temperature program starting at 50°C and ramping up to 300°C at a rate of 10°C/min. Helium was used as the carrier gas with a flow rate of 1 mL/min. A mass spectrometer was used in scan mode (m/z 40-550) to detect and identify compounds in the sample. Compounds were identified by comparing their mass spectra with reference spectra or library databases. Figure (8) shows a typical result for beeswax, which was identified by a characteristic pattern of odd- and even-numbered hydrocarbons that resembled a skewed bell-shaped curve. Eight portraits contained high amounts of beeswax, as shown by the Butyl Prep GC/MS total ion chromatograms (TIC) for the beeswax sample. Beeswax is a relatively stable material, as shown by the consistent amounts of palmitic acid (C16), tetracosanoic acid (C24), and beeswax esters (C40-C48). Other than a reduction in hydrocarbons and fatty acids in the sample, the composition is dominated by beeswax, indicated by the range of abundant wax esters [W40-50],

accompanied by long-chain fatty acids [F20-F34] and odd-carbon-number n-alkanes [C25-C33] [38]. Shorter-chain fatty acids [F12-F18] are also present in both samples. At least some of the palmitic acid [F16] is most likely of beeswax origin, arising from hydrolytic degradation of the wax esters, although the fact that none of the even-carbon-number n-alkanol products of this process were detected implies that hydrolytic degradation is minimal. This would be consistent with a dry preservation environment and has been noted in beeswax from other ancient Egyptian contexts, fig. (8) [39]. These findings provide valuable information about the composition of beeswax and its potential use in the creation of the wax figurines found in the mummy of Tjanefer. Further research could explore the significance of these compounds in ancient Egyptian culture and their role in mummification practices.

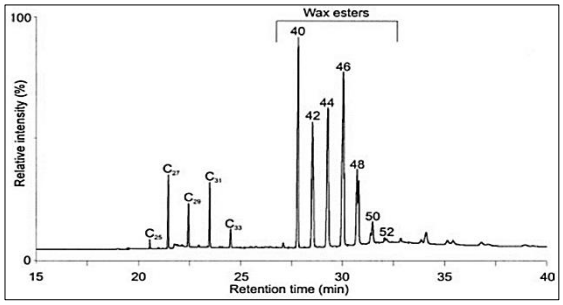

Figure (8) Shows a distinctive gas chromatogram of tri-methyl-isolated beeswax sample from a figurine from wax figurines from one of mummies which extracted by smith. Cx corresponds to the n-alkanes containing x carbon atom, Cx corresponds to free fatty acids with Y-carbon atoms

5. Conclusion

One of the most significant aspects of mummification during the third intermediate period was the inclusion of archaeological findings inside the mummy's body, along with the internal viscera, which were returned to the thoracic and abdominal cavity of the mummy. Among these archaeological findings, the four magical wax figurines of the four sons of Horus were added to protect the mummy. Many scholars of mummies in the third intermediate era believed that each of the internal organs of the mummy's body was wrapped around each of the four wax figurines of the sons of Horus. However, this study has shown that this was not always the case, as demonstrated through a CT scan. The figurines were separate from the mummified internal organs, which were returned to the mummy. The researcher conducted a CT scan on one of the mummies found at Bab el Gasus, belonging to the "Second Prophet of Amon Tjanefer," which was one of the mummies that Smith left with the four wax figurines in-situ. CT scan revealed the location, material, and technique of the production of the figurines. Further examination was carried out on a sample of one of the wax figurines, which was investigated by a microscope (SEM JEOL JSM 6400) coupled with energy dispersive microanalysis (EDX) and was systematically analyzed by infrared spectrometry (FTIR) and gas chromatography. These examinations revealed that the figurines within the mummy were made from pure beeswax with resins and were cast in metal molds. When inspecting the figurines, the researcher found that wax was the favored material due to its magical protective symbolism. Overall, this study has provided valuable insights into the materials and techniques used in the creation of the wax figurines found in the mummy of Tjanefer and their role in ancient Egyptian culture and mummification practices. Further research could explore the significance of these findings and their cultural and historical implications.

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