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Temi, Metodi, Ricerche.

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Nota per gli Autori

Gli Autori possono proporre i loro contributi inviando il materiale a
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Reproducing the perfume-making process: the case of the rock crystal *unguentarium* from *Carmo* (Sevilla, Spain).

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Abstract

La scoperta di un unguentario in cristallo di rocca all'interno di una tomba a camera ipogea dalla necropoli di Carmona ha fatto emergere nuovi interrogativi riguardo alla produzione profumiera nel mondo romano, data la probabile[1] presenza di *Pogostemon cablin* Benth. (patchouli) all'interno del contenuto.
Il lavoro qui proposto si occupa di esprimere il potenziale che i profumi possiedono a livello sperimentale, aspetto che fa fatica a trovare il proprio posto all'interno del panorama archeologico, nonostante l'applicazione – seppur recente – dei più moderni metodi di indagine archeometrica (Agozzino *et alii* 2007; Belgiorno 2007; Ribechini 2008; Colombini *et alii* 2009; Koupadi *et alii* 2021).

The discovery of a rock crystal unguentarium inside a hypogeal chamber tomb from the necropolis of Carmona has raised new queries about perfume-making production in the Roman world, given the probable presence of Pogostemon cablin Benth. (patchouli).
*The work presented here aims to highlight the potential that ointments possess from an experimental perspective, an aspect that struggles to find its place within the archaeological field, despite the recent application of the most modern archaeometric investigation techniques (*Agozzino *et alii 2007;* Belgiorno *2007;* Ribechini *2008;* Colombini *et alii 2009;* Koupadi *et alii 2021).*

Parole chiave: *unguentarium*, oil, enfleurage, patchouli, ointment.

1. Introduction

The history of perfume-making production spans millennia, a form of art that transcends all cultures, from the Far East to the West, and all eras, up to the present day. It is still impossible to pin-point the beginning of this endless process, which likely has its roots in very ancient times, in the lands of the East, from where it gradually spread to the West as well.

[1] The authors (Cosano *et alii* 2023, p. 4485) affirmed that the spice utilized for the perfume production was part of the genus *Pogostemon*, but they couldn't ensure it was actually *Pogostemon cablin* Benth. The identification with such a spice came from its wide use in modern days perfumery.

As for the West, there are three works that supply us with the most information regarding perfumery production: *Περὶ ὀσμῶν* by Theophrastus, *Naturalis Historia* by Pliny the Elder, and *Περὶ ὕληϛ ἰατρικῆϛ* by Dioscorides Pedanius, on which much of our knowledge on the subject is based. Even these works are related to two different cultural scenarios and two chronologically distant periods, they appear to move along the same substructure, outlining a process that can be broken down into the following phase: heating the oil, adding the species and, at the end, adjoining all those ingredients with coloring functions – such as *Alkanna tinctoria* L. and *chroma* – or stabilizers – such as salt or resins.

Even though literature provides us with many recipes and just as many names of different perfumes, we must assume that most of this reality was filled with a variety of productions we do not find in the literature, such as local productions, imitations and all those ointments that survived for a small amount of time. Additionally, perfume-making production was a craft that involved a *know-how* that could vary from one artisan to another.

Roman production is, to date, the best known, thanks to the numerous accounts provided by various authors, including those who touched on the subject for purely social reasons, as well as the numerous archaeological finds, especially those of a funerary nature.

2. The crystal-rock *unguentarium* from Carmo

The case study at the center of this experiment will be the content of an *amphoriskos* made of rock crystal (COSANO *et alii* 2023) (*fig.* 1) – likely chosen for its apotropaic nature (DEVOTO, MOLAYEM 1990) – from a Roman-era hypogeal chamber tomb located in *Calle Sevilla* (RODRÍGUEZ *et alii* 2019), the road that skirts the current southern boundary of the necropolis of *Carmo*, a settlement in the province of Baetica.

The *unguentarium* was enclosed inside a glass urn with omega-shaped handles, previously wrapped in a fabric of unknown material, with the lid upside down, in whose cavity a small rock crystal sphere was found, set in bronze with a small silver chain. The urn was in turn contained in a larger, ovoid-shaped lead container. The *unguentarium* rested directly on the remains of the deceased along with small fragments of leather and textiles, and three circular stone, probably made of amber or other resins. The burial assemblage was completed by a glass vessel placed next to the lead container, both located in niche no. 7, placed on the eastern wall of the chamber (RODRÍGUEZ *et alii* 2019, p. 208).

Figure 1: The rock crystal amphoriskos *(COSANO* et alii *2024, p. 4474).*

At the time of discovery, its content appeared to be perfectly preserved, due to the material of the container and the double sealing system – a dolomite stopper and bitumen (COSANO *et alii* 2023).

The analyses revealed a structure characterized by two components: an unidentified oil of vegetable origin and patchouli alcohol, identified by the authors as *Pogostemon cablin* Benth (*Ibid*.).

3. Introduction to the experiment

As previously stated, the creation of each individual ointment constitutes a distinct process, dependent on certain variables whose nature remains unknown, and for this reason is impossible to fully understand how complex the process might have been. Therefore, it is believed that the mechanism involved multiple distinct phases, an idea supported by the failure to identify the essential oil, which could be due to the blending of multiple oils – the one used for making the perfume's essence and the one for producing the essential oil itself, which might have been created in a separate phase – as well as the possibility that the oil may have undergone an astringent treatment.

From classical sources, the idea emerges is that oil, having its own characteristic scent, must be subjected to an astringent process to remove its heavier components, where the scent resides (Theophr. *Od.* 18), and this is only possible through the involvement of certain specific spices (which, although not explicitly mentioned by the authors, must have been associated with a particular fragrance for some reason[2]). The use of different spices depends on the desired product. But what happens when we are even unable to speculate which spice was used to astringe the oil?

In short, the creation of this ointment may have included a preliminary treatment of the oily component, upon which certain spices – either dried or mixed in water or wine (Theophr. *Od*. 23) – may have acted, added while the oil was heated, without direct contact with the flame (Theophr. *Od*. 22). This experimentation, in both of its phases, considers the possibility that the patchouli may not have been pre-treated, but we are entirely unable to associate any type of spice with the fragrance, a factor that ruled out the possibility of using the oil while hot.

Following these premises, the experiment aims to answer the following questions:

1. What happens if the oils are left structurally free, without any treatment, as in our specific case?
2. How much does the scent of each oil affect the final product?
3. Which oil turned out to be the best from a receptive point of view?

Since the analyses have revealed the possibility that the patchouli may have been cold treated (Cosano *et alii*, p. 4486), this method will be used. Additionally, for the squeezing phase, the twisting press technique, documented in iconographic sources from Egypt, will be applied.

The protocol will be structured into the following phases: the experiment will proceed on multiple parallel fronts, adopting the same procedure for each of the oils used.

1. Fill each ceramic container with one of the selected oils. The amount of oil poured into each container – which should never be replaced – will be 100 ml[3], into which the required amount of patchouli for each phase will be placed on top of a raw linen cloth.
2. Place the required amount of patchouli into the cold oil and allow it to absorb the essence.
3. Repeat the same procedure three more times, until reaching the total needed for complete *enfleurage.*
4. When the oil has absorbed the substance, pour the obtained liquid into the ampoules.

At this point, the procedure splits into two phases:

- Phase I: The contents of each container, once placed inside the ampoule, will be sealed with bitumen and left to rest in a cool, dry place for at least three weeks[4].
- Phase II: The contents of each container will be placed inside the ampoules without any preservation element, ready to be used as needed.

PHASE I[5]. This phase involves the use of three different oils: the one extracted from *Balanites aegyptiaca* (L.) Delile, 1812, olive oil, and *Moringa oleifera* Lam. Oil. The issue of moringa oil is particularly controversial because, although modern literature exclusively mentions *Moringa peregrina* (Forssk.) Fiori oil, native to Sudan (Zohary 1966, p. 340) or perhaps Egypt (Lucas 1962, p. 331), it is not entirely excluded that Romans were also familiar with *Moringa oleifera* Lam. oil, native to India (Ramachandran, Peter, Gopalkrishnan 1980; Mahmood, Mugal, Haq 2010). This oil was also used to produce perfumes and cosmetics, as well as for medicinal purposes (Ortega, Campos 2019), confirmed by studies conducted in modern medicine (Abd Rani *et alii* 2018; Kou *et alii* 2018). From a pragmatic standpoint, the difficulty in sourcing *Moringa peregrina* oil led to the use of *Moringa oleifera* Lam. oil, which is considered the most exotic natural oil

[2] In the case of rose oil, for example, the chosen aromatics are *juncus*, *aspalathus*, and *calamus aromaticus* (Theophr. *Od*. 25), which are macerated directly in the oil to produce the astringent effect. To produce Cyprus oil, the chosen aromatics are cardamom and *aspalathus* (Theophr. *Od*. 25), and so on.

[3] The doses considered for the experiments represent a small-scale process, given that the quantities of oil used for production had to be much larger, as demonstrated by Theophrastus' account concerning the production of iris-based ointment, in which "six *congii* of oil" (Theophr. *Od*. 23) are mentioned, equivalent to 20-25 l, a *medimnos* (52 l), and two half-*sextarii* (a *sextarius* is one-sixth of a *medimnos*) of iris.

[4] At the beginning, it was planned to divide the contents from each container into two phials, one with bitumen and one without it, to test their preservative properties and, at the same time, the possibility that it might have been part of the actual process. However, the drastic reduction in quantities did not allow this to happen.

[5] Phase I took place from 11-12-2023 to 13-12-2023.

mentioned by the authors and could be well connected to the equally exotic nature of patchouli.
Since the authors tend not to provide details about the dosage of the components used in the production process of any ointment in general, we attempted to solve this problem by assuming that the oil and patchouli were perfectly balanced in terms of internal composition, in a 1:1 ratio. Thus, for 100 ml of oil, we assumed a corresponding 100 g of patchouli, divided into four batches of 25 g each, where each batch corresponds to an *enfleurage* cycle. After four complete cycles, a total of 100 g will be reached. The time span of an *enfleurage* cycle can vary depending on the level of saturation desired for the oil – in our specific case, the timing was determined by the amount of dry material used. The oil, as mentioned earlier, was used at room temperature and was structurally free, meaning it underwent no preliminary treatment. This approach was employed to thoroughly investigate its behavior when it encounters the dried leaves of *Pogostemon cablin* Benth., which will be placed inside the oil, without any preliminary treatment as well. A not-too-thick linen cloth (at least for this first part of the experiment) was placed between the two substances, serving a filtering function. The material used for this purpose needed to be easily accessible and low-cost, characterized by a certain lightness and elasticity, good resistance under heavy pressure, and excellent filtering capabilities – all characteristics perfectly attributable to linen.
The experiment will focus on attempting to reproduce the essential oil, with only Phase I involving the use of bitumen. This decision is based on the hypothesis that the presence of bitumen in the ointment container was not merely due to contamination, where the bitumen used for sealing would have simply dripped into the contents, but that it may have played an active role in the perfume production process itself. This is suggested by some Egyptian evidence[6], possibly replacing those stabilizing elements (such as salt or resins) passed down by classical authors, which seem to be absent in our ointment.
With this premise in mind, phase the experiment will strive to answer the following questions:

- Could the oil have been conceived in a 1:1 ratio with patchouli?
- Which of the oils used (*Balanites aegyptiaca* (L.), Delile, 1812, olive, *M. oleifera* Lam.) demonstrated a greater receptive capacity?
- Could bitumen have played a decisive role in the production process, or was its function limited to simply sealing the ointment container?

Each product from this first phase has been labeled with the designation 'experiment', numbered progressively according to the type of oil used:

- *Balanites aegyptiaca* L. oil: Experiment no. 1.
- Olive oil: Experiment no. 2.
- *Moringa oleifera* Lam. oil: Experiment no. 3.

1. The first step involved a visual and olfactory comparison of the three oils used (each in a quantity of 100 g), which turned out to be very different from one another in texture, appearance, and scent. This need arose from a purely logical consideration: while olive oil is an element with which we have a certain olfactory familiarity in our daily lives, *M. oleifera* and *Balanites aegyptiaca* oils represent something generally unfamiliar in our

Figure 2: Aspect and texture of moringa *oil (photo taken by the author).*

[6] Modern literary sources testify the use of bitumen in the production of the so called 'Saven Sacred Oils' under the Ptolemies (Dümichen 1879, pp. 197-128; Chassinat 1922, pp. 463-464; 1955, p. 66; 1990, pp. 209-210; Aufrère 1991, p. 640).

Figure 3: Aspect and texture of Balanites aegyptiaca *oil (photo taken by the author).*

Figure 4: Aspect and texture of olive *oil (photo taken by the author).*

common imagination, or at least in my personal imagination. Why were these three oils chosen?

- *M. oleifera* oil (*fig*. 2) was selected for its eastern origin, aligning with the idea of particularly long and complex production process, where specialized craftsmanship was combined with the refinement of the ingredients used, which could have contributed to increasing the price of the perfume.
- *Balanos* oil (*fig*. 3) because Theophrastus identified it as the most used in perfume production (Theophr. *Od*. 15).
- Olive oil (*fig*. 4) because it was widely employed in this field due to its great availability and its qualities.

The characteristics of the three oils can be summarized as follows: *Balanites aegyptiaca* oil has an intense yellow color, a sour smell, and a very liquid consistency; olive oil has an almost orange color, a very strong fragrance, and is of medium density; *M. oleifera* oil has a very thick consistency, comparable to wax, with an almost sweet smell, though it seems to be the least fragrant of the three oils.

2. Three small ceramic bowls were then used, each associated with one of the three oils.
3. As a filtering element for the *enfleurage* process, three linen cloths (approximately 37.5 cm x 33 cm), one for each container, were used.
4. The linen cloths were placed over each container, already filled with oil, and were then covered with 25 g of patchouli.

Now, a plausible objection might concern the choice of immersing the linen directly in the oil, which results in an exponential increase in its absorbent capacity, already sufficiently high due to the presence of the dried (untreated, moreover) leaves. So, why was this method chosen? Linen is known to be a material with a high absorbent capacity, but its direct immersion in the oil, not

Figure 5: Dried patchouli (Pogostemon cablin Benth.) leaves (photo taken by the author).

Figure 6: New leaves are placed upon the linen cloth (photo taken by the author).

Figure 7: Pressure and clockwise movements (photo taken by the author).

limited exclusively to the filtering stage, concerns both the need to make the oil as concentrated as possible and a matter of mere practicality. The limited use would have required the involvement of other tools (such as a strainer, for example), making the filtering process longer and less practical.

5. Following the hypothesis of a 1:1 ratio between the dry component and the thick component, the *enfleurage* stage was divided into four parts, each characterized by 25 g (*fig*. 5) of patchouli, placed on the linen cloth (*fig*. 6).

6. The pressure applied, combined with a series of clockwise circular movements (*fig*. 7), allows the dried patchouli leaves to become saturated with oil.

7. The containers are covered with another linen cloth, of the same type used for filtering, and sealed with a jute string (*fig*. 8), wrapped around the widest point of each container, to avoid external contamination. The containers are then stored in a cool, dry place, where they are left to rest until the following day.

8. The following day, after allowing the mixture to rest for 24 hours, the containers were stripped of the linen cloth covering the surface, and the contents were freed by twisting and squeezing: this technique was employed using two wooden tools, each inserted into the two holes made near the four corners of the linen cloth on which the patchouli had been placed. The four holes were created using a knife.

9. The two wooden sticks were rotated in opposite directions to ensure that the cloth, subjected to significant pressure, would squeeze out the liquid (*fig*. 9). The linen cloth and the large quantity of dried patchouli leaves absorbed much more oil than expected, to the extent that the remaining content, the result of the squeezing, was deemed insufficient to proceed with another cycle of *enfleurage*.

The oil from *Balanites aegyptiaca* and that from *M. oleifera* underwent the same steps, and the resulting outcome led to the same conclusions.

10. In the absence of phials to store the liquids, another twenty-four hours passed before being able to proceed.

Figure 8: Closure of containers (photo taken by the author).

Figure 9: Twisting and squeezing phase (photo taken by the author).

11. The next day, the content of each container was decanted into a glass phial (*fig*. 10) with a cork stopper.

The oil that presented the most difficulties was undoubtedly the *M. oleifera* oil, which showed an even denser consistency compared to the previous days, a situation likely caused by a drop in temperature that occurred during the days when this first phase of the experiment took place. The *M. oleifera* oil had thickened to the point where it could not flow spontaneously into the glass phial. Unlike the other oils, it was necessary to retrieve the oil from the linen cloth and scrape the bottom of the container with bare hands to save as much product as possible (*fig*. 11).

12. The rim of each container was coated, by hand, with bitumen (*fig*. 12), just as documented in the chemical analyses referenced. This served the dual purpose of testing its preservative properties and investigating whether it might have played a more active role in the production process itself.

13. Each vial was sealed with a cork stopper and labeled.

14. The labeling consisted of the term 'experiment' and an identification number from 1 to 3, where number 1 was associated with the *M. oleifera* oil, number 2 with the *Balanites aegyptiaca* (L.) Delile, 1812, and number 3 with the olive oil (*figg*. 13 a, b, c). The contents of the phials, that is, the essential oils, were stored in a cool, dry, and dark place,

Figure 10: Pouring scented oils into the phials (photo taken by the author).

where the temperature is kept as constant as possible.

Figure 11: Aspect and texture of moringa *oil the following day (photo taken by the author).*

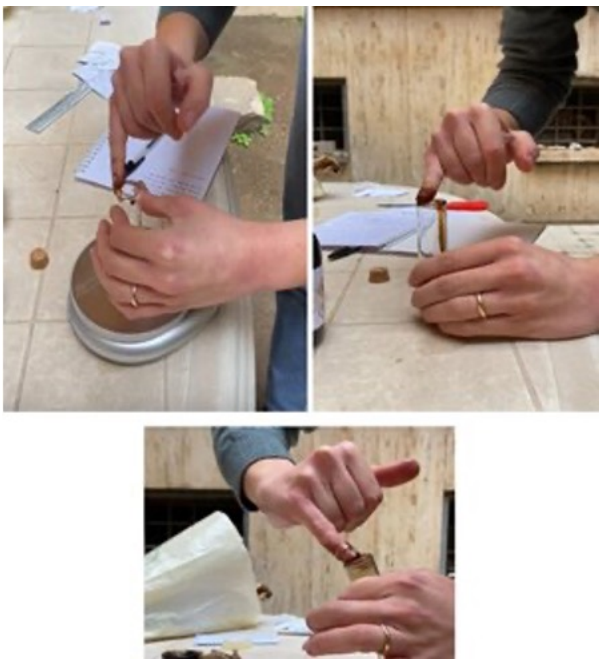


Figure 12: Coating each rim with bitumen *(photo taken by the author).*

Figure 13 a, b, c: Labeling phase (photo taken by the author).

4. Towards phase II[7].

Following the end of this first phase, several purely personal observations are necessary, relevant to the second phase of the experiment, which took place 27 days after the end of the first cycle. The considerations made below are connected to the hypotheses outlined at the beginning of this first phase of the experiment:

- It is concluded that the perfectly balanced ratio between the dry component and the thick

[7] The following description refers to two distinct moments: the day during which scented oil were bottled (13-12-2023) and the day they were reopened (09-01-2024). The label 'twenty-seven days later' refers to the second moment.

component (1:1) should be adjusted, considering a reduction in the amount of dried patchouli leaves, always taking on mind that the excessive absorption of oil may have also been influenced by the nature of the linen cloth. The oil that seems to have responded best to the stress of this first phase is olive oil (from 100 ml to 8 ml), followed by *Balanites aegyptiaca* oil (from 100 ml to 7 ml), and *Moringa oleifera* oil (from 100 ml to 5 ml).

- The content of experiment no. 1 (*M. oleifera* oil), where the oil initially appeared to be the most odorless of those selected, has released a particularly acidulous note, which continues to prevail even now, during the preservation phase; it has a yellowish color and a particularly pasty consistency. After twenty-seven days, the content has the same cream color and almost solid consistency (*fig*. 14). It seems that the bitumen did not excessively alter the color, unlike what happened with the olfactory structure, which has been completely modified, although the characteristic sour note of the base oil remains present.

Figure 14: Experiment no. 1 twenty-seven days later (photo taken by the author).

Figure 15: Experiment no. 2 twenty-seven days later (photo taken by the author).

- In the content of experiment no. 2 (*Balanites aegyptiaca* oil), the aromatic note from the patchouli is barely noticeable; the color and consistency of the final compound are the same as the oil presented at the beginning. After twenty-seven days, the oil has a bipartite structure, with the denser part settling at the bottom and the more liquid part floating on the surface (*fig*. 15); the bitumen has completely contaminated its color and smell, making it the only perceptible element.
- The content of experiment no. 3 (olive oil) presents a color and consistency very similar to that of *balanos* oil, and although the smell of the base oil still prevails, the patchouli fragrance is noticeable, albeit faintly, resulting in a blend that most closely resembles a perfume (or ointment). After twenty-seven days, the crystallization of the oil is almost complete (about 90% of the content): it appears as a compact mass, with a small amount of liquid remaining near the surface. Here too, as with *Balanites aegyptiaca*, the bitumen has affected the color of the liquid part, while the dense part has a whitish-green color near the bottom and is white on the surface (*fig*. 16). It seems that olive oil was the only one able

to neutralize the smell of the bitumen, while still retaining its own fragrance and allowing a patchouli note to be perceived.

Figure 16: Experiment no. 3 twenty-seven days later (photo taken by the author).

PHASE II[8]. This second phase of the experiment begins with the observations that concluded the previous one, which allowed us to pursue a new line of inquiry, albeit through a different path. This time, it involves the use of the four oils most frequently mentioned in classical sources for perfume production (*balanos*, almond, olive, and sesame), a reduction in the ratio between oils and the dry component, and the elimination of bitumen.
The process of this second phase follows the same path outlined in the first phase, repeating the same techniques, materials, and methods, with some minor variations dictated by specific needs, as in the case of the linen. Four containers were obtained, each associated with a specific oil. This phase also includes the use of linen cloths, this time of two different qualities: the first identical to that of the previous phase and the other thicker, which

Figure 17: Linen A (left) and linen B (right) (photo taken by the author).

for practical reasons are respectively called linen A and linen B (*fig*. 17).

While linen A was used for filtering the contents of the containers with *balanos* oil, almond oil, and sesame oil, linen B was reserved solely for covering the containers. Regarding olive oil, linen B was used for both filtering and covering activities.
The amount of patchouli used was drastically reduced: from the 25 gr per *enfleurage* cycle used in the previous phase to 3 gr, still involving four *enfleurage* cycles, for a total of 12 gr.

1. After filling each container with the corresponding oil, the linen cloth (linen A for sesame oil, almond oil, and *balanos* oil, linen B for olive oil) is placed on the surface, applying slight pressure toward the bottom to ensure it adheres as closely as possible to the container, and is then covered with patchouli leaves. These leaves were also lightly pressed and subjected to a clockwise circular motion to saturate them with oil (*fig*. 18).

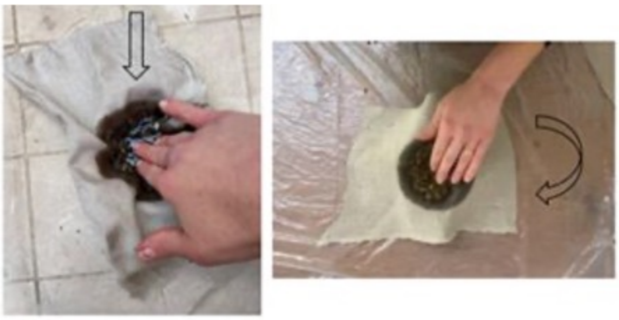


Figure 18: Pressure and clockwise movements (photo taken by the author).

[8] Phase II took place from 09-01-2024 to 16-01-2024.

2. Each container was covered with another linen cloth, secured with a jute string to prevent any contamination (*fig*. 19). The containers were stored in a cool, dry place until the next day.

Figure 19: Closure of containers (photo taken by the author).

3. After twenty-four hours, the containers were uncovered, and the contents of each cloth were wrung out using the twist-pressing technique (*fig*. 20), utilizing the same equipment as in phase I.

Figure 20: Twisting and squeezing phase (photo taken by the author).

Now that the containers were exposed to light, a significant reduction in the contents (about 10 ml) was observed, a factor resulting from the drastic reduction in the amount of dry component used. This seemingly minor observation allows us to notice that the dried patchouli leaves play a key role in the reduction of the oil, and their association with a coarse fabric like linen only further amplifies this effect.
Regarding the oil's receptivity, it seems that – at least for now – the most effective is *balanos* oil, followed by sesame oil, almond oil (which still seems to be very resistant), and finally olive oil, where the scent of the oil is still very strong.

4.The squeezed cloth is placed back on the container and covered with another 3 gr of patchouli (*fig*. 21), which is lightly pressed and subjected to a circular motion to ensure the dry leaves absorb the oil in the container.
Once this *enfleurage* cycle is complete, the containers are covered with the same cloths, secured with the same jute string, and stored again in the cool, dry place mentioned earlier.

Figure 21: Replacing old leaves with 'fresh' ones (photo taken by the author).

5. During the following day, the containers underwent the same process. Initially, after the containers were uncovered and the linen cloth removed from the surface, the fabric immersed in the oil was squeezed again.

6. After squeezing, the oil-soaked leaves were replaced with fresh leaves, which were subjected to the customary pressing and clockwise circular motion.

7. Once this phase was completed, the container was again covered with the linen cloth and placed back in the usual cool, dry place to rest. By the evening of this third day, in addition to the usual reduction in the amount of oil, a change in the receptivity of the oils was also noticed: at this point, the most effective oil seems to be almond oil, followed by *balanos* oil, sesame oil, and olive oil, where the scent of the oil still dominates, almost reversing the situation from the previous day. After another 24 hours, the activities were repeated exactly as the previous day: after uncovering the containers, the cloths immersed in the oil were squeezed again; as with every day, this action was

followed by a close examination of the oil, which once again showed a drastic reduction in quantity. The *balanos* and olive oils have an almost mucilaginous consistency (*fig*. 22), due to the crystallization process caused by the temperatures recorded in recent days.

Figure 22: Consistency of balanos *oil (left) and olive oil (right) after a drop in temperature (photo taken by the author).*

The last cycle of *enfleurage* began, given the remaining quantity of oil.. Once again, the squeezed linen cloth was retrieved and covered with 3 gr of dried patchouli leaves, which were subjected to the usual pressing and circular motion. Once the dry leaves had absorbed the oil, the containers were covered again and placed in a cool, dry place.
As we near the end of this cycle, we observe a different olfactory situation from the previous day: in the sesame oil-based essential oil, the patchouli scent is extremely weak; in the *balanos* oil-based one, the situation is difficult to describe – it's almost as if the ingredients are struggling to blend together; in the almond oil-based one, a very sweet note is still present; and in the olive oil-based one, the strong base scent continues to persist.
The experiment is about to conclude: the few milliliters of oil remaining at the bottom of the containers precluded any other for another cycle of *enfleurage*, so the final squeezing of the linen cloths used for filtering was carried out, and the essential oils were poured (*fig*. 23) into four glass phials, each shut with a cork stopper.

Once filled – or rather, partially filled – the phials were labeled using a composite system, consisting of the general designation 'experiment' and progressive numbering based on the oil used, continuing from where the numbering in phase I left off, thus starting with number 4[9].
Considering this intent, the following labels were adopted:

- Experiment 4: essential oil based on sesame oil.
- Experiment 5: essential oil based on *balanos* oil.
- Experiment 6: essential oil based on almond oil.
- Experiment 7: essential oil based on olive oil.

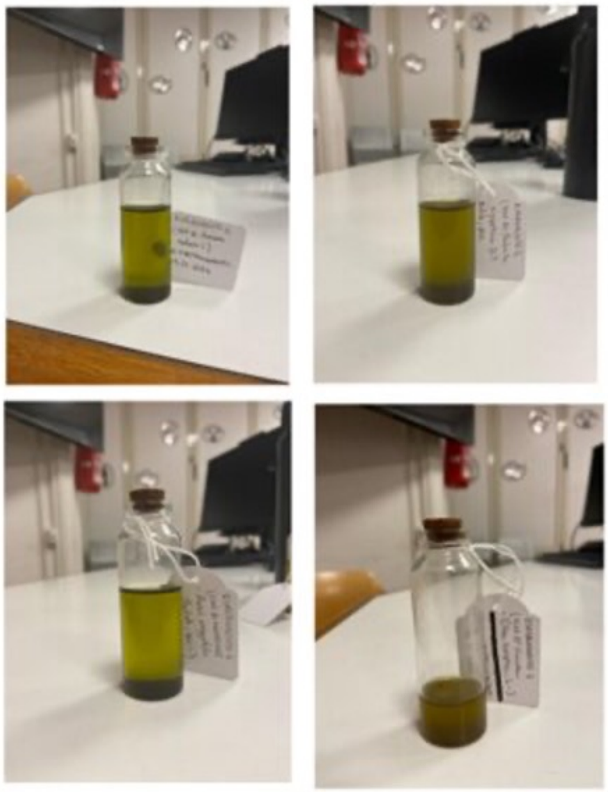
Figure 23: Pouring phase (photo taken by the author).

At the conclusion of this cycle, a further drastic reduction in the quantity of oils used was once again noticed (*figg*. 24 a, b), especially in the case of olive oil, likely due to the thickness of the linen cloth used (linen B), which contributed to an increased level of absorption. For this reason, it also had a different outcome: the olive oil *enfleurage* cycles were three, rather than four (as in the other cases), so the total amount of patchouli used was 9 gr instead of 12 gr.

5. Conclusions

The hypothesis from which everything began, as previously mentioned, stems from the inability (mainly due to the short timeframe in which the process was conducted) to consider certain variables that would have played a crucial role in this process. First of all, the impossibility of heating the oil: without suitable. Without suitable ceramic containers for this purpose and without access to an actual fire, a path diametrically opposed to the one suggested by literature was chosen – one that focuses on the role of oil in the production of ointments. This leads to the question of why the oil

[9] The decision not to restart the numbering was made primarily for practical reasons and to create continuity with the previous phase, from whose conclusions this new cycle was derived.



Figures 24 a, b: Results of phase II (photo taken by the author).

could not be used without any preliminary treatment, and why its scent had to be necessarily neutralized. In short, how much does the smell of the oil influence the structure of the ointment?
The answer to this question may seem obvious, but my curiosity arose from the observation that in all fragrant concoctions, whether modern or ancient, each element is used for a specific purpose and occupies a precise place within the whole. This led me to wonder why they would have gone so far as to alter a fundamental component, which could have played a decisive role in the overall fragrance structure. While the answer to these concerns may seem obvious, a much more controversial aspect concerns the degree of receptivity of each oil, even when the oil has not undergone any process that could somehow facilitate this situation. So, which oil performed best in this regard?
This stream of consciousness served as the prime mover of both the first and second phases of the experiment, from which the following results were derived:

In Phase I, before the content of each phial was contaminated by bitumen, the most effective oil was olive oil, which was able to create a very balanced harmony with patchouli, despite its extremely rich structure. Meanwhile, *Moringa oleifera* oil continued to maintain the acidic note that characterizes it, just as *balanos* oil did not alter its scent at all. It is important to note other elements, such as the fact that only one *enfleurage* cycle was conducted. While this is perfectly plausible, it does not allow the oil to become sufficiently saturated with the fragrance. What can we infer from this? Olive oil, despite being structurally rich and full-bodied, can preserve and retain the final fragrance of the perfume (patchouli, in our specific case), proving to be extremely effective in short cycle *enfleurage*. This hypothesis is supported by the results of phase II of the experiment, where the use of the same extraction technique, this time with more extended periods, caused the opposite effect: the characteristic scent of the oil continued to dominate the overall fragrance structure.

In Phase II, on the contrary, the oils that showed the best results were *balanos* oil and sweet almond oil. This is not surprising, given that literature cites *balanos* oil as the most used in ancient perfumery (Theophr. *Od*. 15.), just as the results shown by almond oil are not surprising, as Theophrastus lists it among the most used to produce high-quality ointments (Theophr. *Od*. 15). A very curious thought on this matter comes directly from *De Odoribus*, where it is stated that almond oil and *balanos* oil are those most characterized by a distinctive smell (Theophr. *Od*. 15). Given the results obtained during this phase, we might be led to think that it is out of this characteristic that makes them somehow more suitable for perfume production, perhaps allowing the oil to be more receptive to long-cycle *enfleurage*, as in our specific case, and to retain the absorbed scent for a longer time. But what does it mean, concretely, to be characterized by a distinctive smell? If the scent characterizes the fatty part of each oil, it means that the stronger the scent, the denser the fatty component in its structure. However, this clashes with the tendency in perfumery to choose oils that are less greasy and dense. The issue here is too complex to be easily resolved, which is why the question is intentionally left open.
The choices made regarding the oil variable are many, but they all share a common denominator: curiosity about why certain types were selected over others, such as oil pressed from ripe olives

and sweet almonds, especially when these are known for their beneficial properties, even more so when they yield excellent practical results, as in our case. Even Theophrastus, in a passage from *De Odoribus* (Theophr. *Od*. 16), questions how reasonable it is to use both the more odorless oils and those with a more typical scent indiscriminately in this production process. Meanwhile, the underlying question of the procedure described so far is based on the opposite concept: why strip them of the characteristic that makes them different? Why reduce the oil to a mere absorption base, a tool completely devoid of distinctive elements, when the unique qualities of each oil could only enrich the overall structure of the finished product? The intention here is not to judge whether the production techniques used are right or wrong, nor to question why certain methods were chosen over others. First, because this would impose our perspective on a reality that does not belong to us, and second, because each individual ointment, unlike our modern perfumes[10], constituted a world of its own, characterized by a range of variables that were extremely difficult to control.

It should also be noted that the oils selected for this experimental process represent only a tiny portion of the varieties of oils available. The choice could have fallen on many other types, each with its own peculiarities and qualities, which would have contributed to creating an even more varied scenario – and which, in turn, would have produced a unique finished product.

Another clarification concerns a concept that has so far been taken for granted: whether the Romans, or ancient populations in general, conceived essential oils as something distinct from actual perfumes. This may seem like a weird observation, but the methods by which the latter were produced are identical to those used in the final stages of the perfume production cycle, where plant-derived components come into play. So, were perfumes and essential oils considered the same thing?

The answer is not known; what can be said is that the hypothesis on which the experimentation is built identifies the production of the essential oil as something distinct and separate from the main process, a reason that justifies an autonomous production. As far as we know, the essential oil could also be produced through a much simpler process, through which the dry element was simply immersed in some vegetable oil. However, this would undermine the hypotheses related to the complexity of the process, and consequently the rarity and presumably high cost of the final product.

To conclude the discussion on the substantial component, the results of the two experimental phases allow us to affirm that olive oil is undoubtedly the one with the best yield in short-cycle *enfleurage*, followed by *balanos* oil and *Moringa oleifera* oil, while in longer-cycle production, *balanos* oil and almond oil are the most effective, followed by sesame oil and olive oil.

A second particularly decisive element during these two phases has undoubtedly been the definition (and redefinition) of quantities: as previously mentioned, the quantities considered are completely arbitrary, since there is almost no reference to them in the relevant literary sources[11]. Therefore, I thought that the two components, having the same weight in terms of internal structure, could be used in a 1:1 ratio, without considering the fact that we are dealing with dried leaves, not fresh ones, which tend to absorb much more oil than we might imagine. Since just one *enfleurage* cycle was enough to discard this possibility, and without knowing how to recalibrate the ratios, it was decided to keep the same amount of oil used for phase I (100 ml) for phase II, drastically reducing the amount of patchouli to be used for each enfleurage cycle (3 gr)[12]. Now, I believe that making such a drastic change was excessively hasty and overly influential (a more moderate quantity could have been used, perhaps around 5/10 gr, for a total of 20/40 gr), given that the scent of patchouli is very, perhaps too, faint in each of the four phials.

In addition to the dry component, the equipment used also plays a significant role in oil reduction. A

[10] Modern production techniques allow for much more direct control over the creation of perfumes, something that would never have been possible (except in a very limited way) in the historical context we are referring to.

[11] Dioscorides is the first author to provide the dosages to produce certain medications, but not for our perfume in particular, which is why we cannot rely on this source.

[12] This quantity was recalibrated during the process, as the patchouli was gradually placed on the linen cloths ready to be immersed in oil. Fearing that a larger amount could produce the same effect as in the previous phase, it was decided to minimize the dry component as much as possible.

case in point is the olive oil-based essential oil from phase II, where the use of a much thicker and coarser linen cloth (linen B) contributed to shortening the *enfleurage* time, which is why the leaves were replaced only three times instead of four, as was done with the other oils (for a total of 9 gr instead of 12 gr). Again, as with all the other components of this experiment, it is possible that a different type of fabric was used for this process, even if the range of choices is not particularly wide (Croom 2010). Still, in my personal opinion, linen is the only fabric capable of satisfying all the parameters required by this process: low cost, non-contaminating, light, malleable, durable, and with high filtering capacity. Since these are perishable materials, never found in archaeological contexts related to these specific production processes, the question must necessarily remain open.
Now we come to the issue of bitumen, whose involvement in phase I was not limited to investigating its sealing qualities but also aimed to understand whether it may have played a determining role in the production process, perhaps as a stabilizer, in the absence of elements that usually perform this function, such as salt (Theophr. *Od*. 31; Plin. XIII, 2, 7; Diosc., *passim*). The final results of phase I seem to disprove this hypothesis, as the color and smell of the bitumen contaminated the final result in two out of three cases (*Balanites aegyptiaca* and *M. oleifera*), but they also supported its actual preservative effectiveness. More than an actual disproof, I would define it as an unresolved issue, since perfume production involved using oils and spices in much larger quantities than those used in this experiment, which was structured to reproduce a miniature cycle. Considering this, a certain amount of bitumen, even more substantial than that used in our specific case, could have perfectly blended with the other components used, without altering the color or smell of the final product.
Regarding the choice of technique, pressing is only one of the plausible methods through which patchouli may have been processed and filtered. The decision to use wooden sticks and linen cloths depended on the rich documentation available (Klebs 1922, *fig*. 59; Tallet 1995, p. 490, *figg*. 1-2; Tallet 1995, p. 492, fig. 5; Brun 2000, p. 279, *fig*. 1; Serpico 2000, p. 461-462, *fig*. 18.22; Fritschy 2021, p. 221, *fig*. 10), the longevity that this technique may have enjoyed, and the total lack of archaeological references to it in Roman-era contexts.

Since it was not possible to closely observe the content, we do not know how similar the results obtained are to the original ointment.. To conclude, the phials that constitute the result of this experimentation likely embody what the ointments should not have been, precisely because their structure was deliberately altered, and because, due to this manipulation, the final note of patchouli is much more subtle than it should have been. The reasons for pursuing this path, though they may seem senseless, are fundamental to better understanding the logic behind some production cycles.
While we wait to expand the information we have regarding the production process, the components used and many other elements about which we still have many gaps, this experimentation seeks to give dignity to something intangible and without substance, which is at once both the bane and the boon of this situation: on one hand, it can be a true turning point in experimental activities and an exciting investigative element, while on the other, it is precisely the intangible nature that leads to a sense of scientific dissatisfaction.

Bibliography

ABD RANI N. Z., HUSAIN K., KUMOLOSASI E. 2018, *Moringa genus: a review of phytochemistry and pharmacology*, in "Frontiers in Pharmacology", 9, 108, pp. 1-26.

AGOZZINO P., AVELLONE G., DONATO I. D., FILIZZOLA F. 2007, I*dentification of Organic Compounds in Fictile Unguentaria from Two Sicilian Necropolis of Greek Age (5th Century, BC) by GC-MS Analysis,* in "Annali di Chimica", 97, pp. 859-865.

AUFRÈRE S. 1991, *L'univers minéral dans la penseé égyptienne* I-II, Cairo.

BELGIORNO M.R. (ed.) 2007, *I Profumi Di Afrodite e Il Segreto Dell'olio: Scoperte Archeologiche a Cipro*, Catalogo della Mostra di Roma (Musei Capitolini, 14 marzo - 2 settembre 2007), Roma.

BRUN J. P. 2000, *The Production of Perfumes in Antiquity: The Cases of Delos and Paestum*, in "American Journal of Archaeology", 104, 2, pp. 277–308.

CAMPOS M. R. S. (ed.) 2019, *Bioactive Compounds Health Benefits and Potential Applications*, Cambridge.

CHASSINAT É. 1922, *Le mot [mrH.t] dans les textes médicaux*, in *Recueil d'études égyptologiques dédiées à la mémoire de Jean-François Champollion à l'occasion du centenaire de la lettre à M. Dacier*, Paris, pp. 447-465.

CHASSINAT É. 1955, *Le manuscipt magique copte: no. 42573 du Muséé égyptien du Caire,* Cairo.

CHASSINAT É. 1990, *Le temple d'Edfou* II, (rev. S. Cauville, D. Devauchelle), Cairo.

COLOMBINI M. P., GIACHI G., IOZZO M., RIBECHINI E. 2009, *An Etruscan ointment from Chiusi (Tuscany, Italy): its chemical characterization*, in "Journal of Archaeological Science", 36, pp. 1488-1495.

COSANO D., ROMÁN J. M., LAFONT. F., RUIZ ARREBOLA J. R. 2023, *Archaeometric Identification of a Perfume from Roman Times,* in "Heritage", 6, pp. 4472-4491.

CROOM A. 2010, *Roman Clothing and Fashion*, Stroud.

DEVOTO G., MOLAYEM A. 1990, A*rcheogemmologia. Pietre antiche - glittica, magia e litoterapia*, Roma.

DÜMICHEN J. 1879, *Ein Salbolrecept aus dem Laboratorium des Edfutempels*, "Zeitschrift für Agyptische Sprache und Altertumskunde", 17, pp. 97-128.

FRITSCHY W. 2021, A *New Interpretation of the Early Dynastic so-called 'Year' Labels. 'Balm Labels' and the Preservation of the Memory of the King,* in "The Journal of Egyptian Archaeology", 107, 1-2, pp. 207-224.

KLEBS L. 1922, D*ie Reliefs und Malereien des mittleren Reiches (VII.-XVII. Dynastie ca 2475 1580 v. Chr.). Material zur ägyptischen Kulturgeschichte*, Heidelberg.

KOU X., LI B., OLAYANJU J. B., DRAKE J. M., CHEN N. 2018, *Nutraceutical or Pharmacological Potential of Moringa oleifera Lam*, in "Nutrients", 10, 343, pp. 1-12.

KOUPADI K., BOYATZIS S. C., ROUMPOU M., KALOGEROPOULOS N., KOTZAMANI D. 2021, *Organic Remains in Early Christian Egyptian Metal Vessels: Investigation with Fourier Transform Infrared Spectroscopy and Gas Chromatography–Mass Spectrometry*, in "Heritage", 4, pp. 3611-3629.

LUCAS A. 1962, *Ancient Egyptian Materials and Industries* (rev. J. R. Harris), London.

MAHMOOD K. T., MUGAL T., HAQ I. U. 2010, *Moringa oleifera: A natural gift-a review*, in "Journal of Pharmaceutical Sciences and Research", 2,11, pp. 775-781.

NICHOLSON P. T., SHAW I. (eds.) 2000, *Ancient Materials and Technology*, Cambridge.

ORTEGA A. M. M., CAMPOS M.R.S. 2019, *Medicinal Plants and Their Bioactive Metabolites in Cancer Prevention and Treatment*, in CAMPOS M. R. S. (ed.) 2019, pp. 85-109.

RAMACHANDRAN C., PETER K.V., GOPALAKRISHNAN P.K. 1980, *Drumstick (Moringa oleifera) a Multipurpose Indian Vegetable*, in "Economic Botany", 34, pp. 276-283.

RIBECHINI E., MODUGNO F., COLOMBINI M. P., EVERSHED P. 2008, *Gas Chromatographic and Mass Spectrometric Investigations of Organic Residues from Roman Glass Unguentaria*, in "Journal of Chromatography A", 1183, pp. 158–169.

ROMÁN RODRÍGUEZ J. M., SANTOS ALLELY A., VÁZQUEZ PAZ J. 2019, *Una nueva tomba hipogea de época romana en Carmona (Sevilla)*, in "ROMVLA", 18, pp. 203-209.

SERPICO M. 2000, *Resins, amber and bitumen*, in NICHOLSON P. T., SHAW I. 2000, pp. 430-474.

TALLET P. 1995, *Le shedeh: étude d'un procédé de vinification en Égypte ancienne,* in "Bulletin de l'Institut français d'Archéologie Orientale ", 95, pp. 459-492.

ZOHARY M. 1966, *Flora Palestina, Part One, Text,* Jerusalem. 52.