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The Salafia embalming formula: do it well or don't do it at all

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Abstract. Medical imaging allows non-invasive investigation of human remains. While paleoimaging is undoubtedly necessary in mummy studies, it is intrinsically limited in the sense that it cannot provide mummy experts with information on the chemical composition of the embalming substances. This holds particularly true for modern embalmed mummies (19th-20th centuries). Since the end of the 19th century, cadavers were arterially injected with chemicals which varied depending on different methods. One of those embalming methods was Salafia's, which was much advertised in the USA. Since attempts at experimental reproduction of the Salafia method are planned by our team, a re-examination of the published literature on the formula was made. Here we provide evidence that an error in unit conversion from gallons to litres occurred and that the same mistake was repeated in the majority of the published English literature with a single exception which went unnoticed. Furthermore, we provide English speaking embalmers and mummy scholars with the complete and correct translation of the original version of Salafia's formula.

Keywords: medical imaging vs toxicology, embalming formula, Alfredo Salafia, perfection fluid, United States, historical sources

Paleoimaging allows the non-invasive investigation of human remains and is almost routinely applied in mummy studies (Loynes & Bianucci, 2021). This in order to gain both anthropological and paleopathological data and to understand whether a corpse underwent embalming and which type of cavity treatment (if any) was performed.

In modern mummies (19th-20th centuries), medical imaging has allowed scholars to suppose that chemical compounds such as arsenic or mercury were used to embalm corpses (Panzer et al. 2014). However, the information retrieved is intrinsically limited by absence of grounded chemical evidence, which can be reached exclusively via toxicological analysis. Resorting to modern techniques, it is currently possible to perform paleoproteomics and paleometabolomics on mummified and embalmed bodies with no damage to the analysed specimen (Barberis et al., 2022). The chemical data are, then, compared with the available historical sources (if any) and with the radiological ones (Loynes et al., 2017).

In the field of mummy studies, the Human Embalming Project@ team is devoted to the study of modern embalming techniques. When feasible, attempts at experimental reproduction are made (Bianucci & Nerlich, 2022). Since 2021, we have focused on the figure of Alfredo Salafia (1869-1933), a renowned Sicilian embalmer who invented the "Perfection Fluid" (Galassi et al., 2021; Bianucci et al., 2022a-c; Bianucci et al., in press 2023). This embalming fluid is claimed to allow a cadaver to preserve in a permanent fresh state (Nerlich & Bianucci, 2021). Salafia embalmed the bodies of several important Italian personages, politicians, clergymen and notables (Johnson et al., 1993). One of these, the cadaver of the Deputy and Vice-Consul of the United States, Giovanni Paterniti (died on the 1st of May 1911) is still on display at the Capuchin Catacombs of Palermo (Bianucci et al., 2022c) (Figure 1).

In 1910 to gain a reputation in the American embalmers market, Alfredo Salafia, and his nephew, Achille Salomone (1879-1947) [a licensed funeral director who had studied at The Renouard Training School for Embalmers – Founded in New York in 1895 by Auguste Renouard (https://funeraleducation.org/home/about-aami/)] performed successful demonstrations of their embalming method in New York (Johnson et al., 1993).

In order to sell the Perfection Fluid to the American embalmers, Salafia and Salomone also formed the Salafia Permanent Embalming Method Company (20th of June 1910). The company was registered as the Salafia Permanent Embalming Method Company-Achille Salomone 338 East 63Rd St. New York 10021 under Department of State Id 985, as Foreign Business Corporation entity type. The trademark of the Salafia Permanent Embalming Method Co. was filed on the 16th November 1911 [Ser. Number 59, 748 (Class 6. Chemicals, Medicines and Pharmaceutical Preparations); claims use since the 27th of October 1911] (Official Gazette of the United States Patent Office,1912; Galassi et al., 2021). While the trademark was patented, the formula was not disclosed at the time.

In May 1993, the American embalmers Johnson et al. described one of Salafia's demonstrations performed on the 23rd of April 1910 on the unclaimed body of John Flinch [quoted as Robert Flinch by Quigley (Quigley, 1998)]. He was embalmed at the Eclectic Medical College in New York using the *Salafia chemicals and procedures* (Johnson et al.,1993). Flinch *had died about ten days* and had clear signs of putrefaction (*black and green areas on the trunk, face and neck, arms, and legs).* Johnson et al. (1993) wrote that *the embalming procedure was absurdly simple, consisting solely of the injection (distally) of the right common artery with a total of 15 gallons of Salafia embalming fluid (*Johnson et al., 1993). *No blood drainage, cavity treatment, or secondary injections were resorted to. The body, unrefrigerated, was dissected in early November (1910), six months after embalming.* At dissection "*…all discolorations… had virtually disappeared…The body was well preserved, with the skin firm and moderately hard and dry. All tissue, including fat, was firm and dry. No odor of decomposition, or fecal odor, was present, only the chemical odor of the embalming fluid* (Johnson et al., 1993). The same description was reported by Quigley (1998, p. 52): *On April 23,1910, Prof. Salafia embalmed the unclaimed body of John Flinch to demonstrate the efficiency and simplicity of his process… Fifteen gallons of Salafia's embalming fluid were injected (distally) into the right common artery without draining the blood, treating the cavities, or carrying out secondary injections. The body was stored but not refrigerated.*

On the 22nd of September 1910, a second embalming demonstration on the body of David Jenkins took place *using the same procedure as in the Flinch case* (Johnson et al., 1993). Following the content of an advertisement by the American Embalmers' Association dated to 1910, originally published in Johnson et al. (1993), Quigley described the embalming procedure of David Jenkins: *A committee appointed by the New York State Embalmers' Association witnessed the embalming of the body of David Jenkins at their annual meeting in Syracuse, New York. The embalming was done by Professor Achille Salomone by his uncle's method. Jenkins' decomposing body weighed approximately 130 pounds* (58.9 Kg) *and the surface of the abdomen was green. The carotid artery was raised and six quarts of embalming fluid were injected, a difficult task because of arteriosclerosis* (Quigley, 1998, p. 52).

In March 2009, Piombino-Mascali and Johnson-Williams re-enacted the above demonstrations without noticing any difference: *His much-advertised method was characterized by simplicity: one single injection into*

Figure 1. The embalmed body of the Deputy and Vice-consul of the United States Giovanni Paterniti (died May 1st 1911) in a picture dated to the 23rd of February 2008 (Credits: Prof. Luca Sineo).

the carotid artery of 15 gallons of "Salafia Perfection Fluid" – a chemical compound said to contain nonpoisonous ingredients. No other procedure generally adopted in modern embalming, such as blood drainage, cavity treatment, or further injections appeared to be necessary.

In a second paper dated March 2009, Piombino-Mascali et al. further revealed the rest of the Salafia's secret chemical preparation which *included the use of zinc, glycerin, alcohol and salicylic acid-many of the same chemicals we use today in modern embalming preparations, with the exception of zinc* (Piombino-Mascali et al., 2009). This chemical preparation was contained in Salafia's handwritten memoires whose discovery is now attributed to Di Cristina et al. (Di Cristina et al., 2007; Galassi et al., 2021).

Following the English version of the formula published in 2009 by the Sicily Mummy Project team the Perfection Fluid was composed of *one part glycerin, one part formalin saturated with both zinc sulphate and chloride, and one part of an alcohol solution saturated with salicylic acid* (Piombino-Mascali et al., 2009).

If the scientific data provided by Johnson et al. (1993), Quigley (on the embalming of John/Robert Flinch, 1998) and Piombino-Mascali & Johnson-Williams (2009) were correct, the Salafia Perfection Fluid would have consisted of a solution of 15 gallons (1US gallon= 3.8 litres; 15 US gallons= 57 litres) made of 19 litres of glycerin, 19 litres of formalin saturated with both zinc sulphate and chloride and 19 litres of an alcohol solution saturated with salicylic acid.

It is worth noting that, while describing the embalming procedure of David Jenkins, Quigley wrote that the man, whose weight was 130 pounds (58.9 Kg), was embalmed using six quarts (1.5 US gallons) of the Salafia Perfection Fluid.

Although a discrepancy between the number of gallons used in the two demonstrations could be easily identified by reading the original 1910 advertisement, Piombino-Mascali & Johnson-Williams (2009) still reported the use of 15 US gallons while referring to Salafia's demonstrations in the USA.

It is improbable that John/Robert Flinch was really embalmed with 15 US gallons of Salafia's Perfection Fluid (57 litres per 58.9 kg) (Johnson et al., 1993; Quigley, 1998; Piombino-Mascali & Johnson-Williams, 2009) compared to David Jenkins with 1.5 US gallons (5.7 litres pr 58.9 Kg) (Quigley, 1998).

Bryant and Peck (2009) state that *modern arterial embalming involves injecting chemicals (including preservatives and tint) into the circulation system usually via the right carotid artery. The 3 to 4 gallons (1 gallon per 50 pounds of body= 3.8 litres per 22 kg) of embalming solution is injected while the embalmer massages (and perhaps washes) the corpse to ensure proper distribution of the embalming fluid*. This implies that, depending on the weight of the corpse, 11.36 to 15.142 litres are routinely injected. Furthermore, modern embalmers often resort to *a periodic opening of the jugular drain tube to allow blood to escape and prevent too much pressure from building in the vascular system*. However, it has been repeatedly stated that Salafia never resorted to blood drainage although, in case of need, he himself wrote that abdominal cavity treatment had to be performed by two operators (Piombino-Mascali, 2009, third edition 2012, p. 54).

Apparently, Salafia did not resort to multiple washes, a situation which may have justified the use of 15 gallons/57 litres of embalming fluid. It should be noted that the injection of 57 litres of embalming fluid in a corpse without draining any blood would have caused bloating of the cadaver and disruption of the vascular system.

It is evident that Salafia's experimental embalming cannot be reproduced based on the published data in the English language by Johnson et al. (1993), Quigley

(1998 describing the embalming of John/Robert Flinch) and Piombino-Mascali & Johnson-Williams (2009). Therefore, the embalmers and mummy experts cited here must have made a unit conversion error which was repeated in all published English literature with the sole exception of Quigley's description of the embalming of David Jenkins (1998).

The "15 gallons mystery" can be easily solved if the scattered Italian excerpts of Salafia's memoirs published by Piombino-Mascali (2009; third edition, 2012, p. 53) are carefully translated into English: *the operator will check the glass container and will fill it continuously before it empties in order to impede the ingress of air into the liquid and this (has to be done) until at least seven litres of embalming fluid has been introduced; and sometimes a higher quantity is needed: in this rare case, alcohol needs to be added to the glass container until the injection is completed* [Italian translation: *L'operatore avrà cura di sorvegliare la vaschetta di vetro, e riempirla sempre, prima che si svuoti, in modo di non lasciare penetrare dell'aria con il liquido e ciò sino alla introduzione di almeno sette litri di liquido conservativo, e qualche volta occorrendo una quantità maggiore: caso molto raro, si aggiunge dell'alcool nella vaschetta e ciò fino ad iniezione completa*] (Piombino-Mascali, 2009; third edition, 2012, p. 53).

The above paragraph indicates that Salafia used (at least) seven litres of embalming fluid which corresponds to 1.85 US gallons, not to 15 gallons.

Furthermore, the original Italian excerpt regarding the chemical composition of the formula was never correctly translated. Here we provide English speaking embalmers and mummy scholars with the original version of Salafia's formula (Piombino-Mascali, 2009; third edition, 2012, p. 55).

A mixture of at least 1.85 US gallons (1US gallon= 3.8 litres; 1.85 US gallons= 7 litres) made of:
1- ca. 2.33 litres of glycerin
2- ca. 2.33 litres solution of 40% formalin saturated with zinc sulphate and 10% dry chloride
3- an alcohol solution of 2.33 litres saturated with salicylic acid.
First glycerin has to be added to the formalin solution and then the alcohol solution has to be added. The whole solution has to be carefully mixed, filtered and the injection of seven liters (of the embalming solution) guarantees the perfect sterilization of the body.

We strongly encourage the Sicily Mummy Project team, which is composed of both Italian and English native speakers, to double-check the sources so as to confirm this interpretation for the scientific community. Furthermore, we encourage, for the fifth time from 2021 (Galassi et al., 2021; Bianucci et al., 2022a-c; Bianucci et al., 2023), the Sicily Mummy Project team to publish a complete open access version of the Salafia handwritten memoirs.

In case personal details are contained in the unpublished document and the legal owner does not want them to be shared with the scientific community (Piombino-Mascali & Zink, 2023), it would be sufficient to introduce the term *OMISSIS*. Lastly, we express our concerns to the scientific board of the Paleopathology Association (PPA) and to the World Committee on Mummy Studies and kindly invite them to re-analyse the "Salafia case" in the light of this new information. Free accessibility of the scientific sources to all scholars should be customarily provided.

DISCLOSURE

The authors confirm that they are entertaining a scientific debate on the case of Rosalia Lombardo with another team of authors. The references to these exchanges are offered in this article's comprehensive bibliography. The authors also confirm that the information contained in their article is true and can be verified through the references and links provided. They also specify that their study is merely aimed at assessing a scientific issue and no other third-party objectives are involved.

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