

Investigating Mummification Salts on Segments of an Orange.

Abstract

An experiment into the effectiveness of three salts in mummification using orange segments as the fabric. This is based on the mummification salts seen in Ancient Egyptian artificial mummification. The three salts: Epsom Salt, Sodium Chloride and Sodium Bicarbonate were observed over a period of two weeks, individually and in a mixture (50% Epsom Salt, 25% Sodium Chloride and 25% Sodium Bicarbonate). The mixture performed best losing the most amount of weight followed by the Epsom Salt, Sodium Chloride and lastly the Sodium Bicarbonate. Sodium Bicarbonate was the worst of the individual salts removing colour and showing no signs of desiccation, Epsom Salt despite losing weight lost its shape. Sodium Chloride performed the best out of the individual salts, losing weight and keeping its shape. The experiment showed, despite its short time span, that a mixture of salts was likely used for mummification with Sodium Chloride as a key component.

Key words – Mummification, Desiccation, Salts

Introduction

This experiment focused on three different materials' abilities to remove moisture from orange segments based on the process of mummification. Mummification in Egypt was first observed naturally as burials in the arid desert had caused dehydration or desiccation (Öhrström, *et al.* 2020). The state of preservation of mummified remains depends on the level of dehydration. Artificial mummification from the New Kingdom to the Ptolemaic period pre-treated bodies with resins (Kaup *et al.* 2003). Most information on the process of mummification is based on secondary literature; this means that experimental archaeology is important to aid understanding. Three stages have been identified: evisceration and excerebration, desiccation in natron, and anointment with preservatives (Öhrström, *et al.* 2020). The area of interest for this experiment is desiccation with mummification salts. Mummification salt was often comprised of sodium ions, carbonate, hydrogen carbonate, chloride and sulphates (Kaup *et al.* 2003). Natron, an impure sodium carbonate and bicarbonate (found in dried up lakes of Egypt) along with sodium chloride and sodium sulphate, is thought to have been used in the desiccation stage (Kaup *et al.* 2003 and Panzer *et al.* 2013). The process is said to have taken seventy days with forty days spent in Natron (Öhrström, *et al.* 2020). Natron is not available to use, so Epsom Salt (magnesium sulphate), Sodium Chloride and Sodium Bicarbonate were used to mimic the components of mummification salts. The salt's ability to desiccate an orange segment were viewed individually alongside a mixture and control.

Aims and Hypothesis

The aim of this experiment is to observe how Epsom Salt, Sodium Chloride and Sodium Bicarbonate interact with orange segments, specifically their ability to remove moisture. The removal of moisture may potentially result in a change in weight or size; these will be measured over the course of two weeks. It is expected that the mixture of salts will perform better than the individual salts as it is closest to the mix seen in mummification salts. However, it is uncertain which of the three individual salts will remove the most moisture.

Method

Materials

For the experiment, four salt bags were created; the materials used were: Epsom Salt, Sodium Chloride, Sodium Bicarbonate, four orange segments and sealable food bags. Bag A had 100% Epsom Salt, bag B had 100% Sodium Chloride, bag C had 100% Sodium Bicarbonate and bag D had 50% Epsom Salt, 25% Sodium Chloride and 25% Sodium Bicarbonate. The control was an orange segment in a sealable bag. For measuring weight, an electronic scale was used and to measure size electronic callipers were used. To remove the salt from the segment a rounded knife, wooden spoon and dental pick were used.

Procedure

An orange was used for this experiment; it was decided that the peel would be removed to clearly observe the changes to the segments. Each segment consists of the membrane 'skin' and juice vesicles where most of the moisture is. The salt concentrations were decided to observe the effectiveness of the salts individually and then in a mixture, which was decided based on the consistency of the salts (50% coarse (Epsom) and 50% fine (Sodium Chloride and Sodium Bicarbonate)). The five largest segments were chosen, and any loose pith was removed. The weight of each segment was recorded in grams then the length and width at the largest points were recorded with electronic callipers in millimetres (see Image 1 and 2), these measurements can be seen in Table 1. On each of the sealable bags, the names of those carrying out the experiment, the date and control or experiment letter was written on the label. Next 100g of Epsom salt for A, 100g Sodium Chloride for B, 100g Sodium Bicarbonate for C and 50g Epsom salt, 25g Sodium Chloride and 25g Sodium Bicarbonate for D were measured using the electronic scales and placed in the bags. The orange segments were placed in the salt bags ensuring they were fully covered; the bag was folded to remove excess air taped up. The salt bags were then left for a week. Observations were made before the segments were removed, the colour of the salt and the firmness of the salt tested by pressing on it. The orange segments were removed from the salt bags, the salt was then removed using a rounded knife, dental picks and spoons. Observations were made about ease of salt removal and the weight, length and width were measured again. The segments were then placed back in the same salt bags and left for another week, when the same observations were made, the results and observations are recorded in the section below titled results.



Image 1: Length measurement taken with electronic callipers (Dabell, 2026a)



Image 2: Width measurement taken with electronic callipers (Dabell, 2026b)

Results

Table 1															
Week	Weight (g)					Length (mm)					Depth (mm)				
	Control	A	B	C	D	Control	A	B	C	D	Control	A	B	C	D
Initial	5.9	6.2	6.2	8.1	7.9	30.44	32.75	33.85	32.28	35.33	13.90	15.35	15.77	17.87	15.98
1	5.8	4.1	3.4	6.3	4.8	33.52	30.47	31.72	33.39	35.56	14.42	13.01	11.11	15.95	13.61
2	5.5	2.7	3.4	5.4	4.1	33.26	31.00	33.39	32.30	36.11	13.16	8.68	10.63	15.03	12.44

Observations

The five segments chosen were similar in shape size and colour and had no notable differences, see Image 3.



Image 3: Initial Orange Segments (Stewart, 2026a)

After the first week, the control segment that had no salt covering, had a few visible spots of mould on one end of the segment. The control bag also had condensation showing the moisture within the bag, the colour was not noticeably different. Image 4 shows these changes. When removed from the bag, the segment was sticky and softer but not yet rotten. By the second week, there was white liquid around the segment (Image 5), the segment was also stickier and softer than the first week.



Image 4: Control Segment Week 1 (Stewart, 2026b)



Image 5: Control Segment Week 2 (Stewart, 2026c)

Before removing the segment from Bag A after the first week, the orange colour was showing through the salt this is likely due to the coarseness of the Epsom Salt. The salt was unfirm when pressed. When removed from the bag, most of the Epsom Salt came off easily apart from pieces that were indented into the segment, a dental pick was used to remove the rest. The segment was wrinkled from the salt and was still soft. By week two, the salt looked damp, the orange colour was slightly visible through the salt, and the salt was unfirm. The Epsom Salt came off easily; the segment was visibly smaller and was harder than the control. Images 6, 7, 8 and 9 show the progression of Bag A.

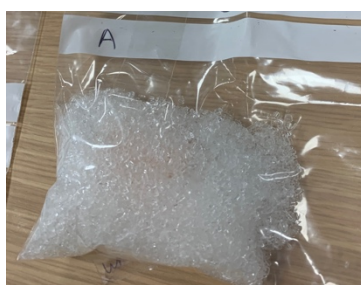


Image 6: Salt Bag A Week 1 (Stewart, 2026d)



Image 7: Orange Segment A Week 1 (Dabell, 2026c)



Image 8: Salt Bag A Week 2 (Stewart, 2026e)



Image 9: Orange Segment A Week 2 (Dabell, 2026d)

Salt Bag B after the first week had no visible change, and the salt was unfirm when pressed. When removed from the bag, it was more difficult to clean the salt off due to the fineness of the Sodium Chloride. The segment was visibly smaller but was still soft and maintained its colour. At the two-week mark, there was still no visible change to the salt, the firmness also did not change. The salt was easier to remove from the segment than the first week, the segment was also softer but kept its colour well. Images 10, 11, 12 and 13 show the progression of Bag B.



Image 10: Salt Bag B Week 1
(Stewart, 2026f)



Image 11: Orange Segment B Week 1
(Stewart, 2026g)

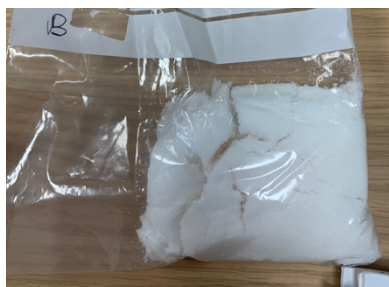


Image 12: Salt Bag B Week 2
(Stewart, 2026h)



Image 13: Orange Segment B Week 2
(Stewart, 2026i)

Salt Bag C after the first week had a ring of orange in the Sodium Bicarbonate on both sides of the bag, the salt was unfirm when touched. When removed from the bag, the salt was difficult to remove due to fineness and the segment was brown but similar in size. By week two, the salt was entirely orange and unfirm. When removing the segment from the bag there was a green/black spot of mould, it was still brown but had hardened mostly in the centre. Images 14, 15, 16 and 17 show the progression of Bag C



Image 14: Salt Bag C Week 1
(Stewart, 2026j)



Image 15: Orange Segment C Week 1
(Stewart, 2026k)



Image 16: Salt Bag C Week 2
(Stewart, 2026l)



Image 17: Orange Segment C Week 2
(Dabell, 2026e)

Salt Bag D after the first week had orange colour slightly showing through but was quite firm. When the segment was removed, a section of salt was stuck to it which was difficult to remove. The segment kept its colour but had dipped on one side and it felt as though there was space between the juice vesicles and the skin. By week two, the salt mixture had solidified further, and no orange colour was visible through it. The block of salt had to be slowly scraped away to uncover the segment using dental picks and the round edge of a spoon. The segment had lost some of its colour and was still sunken in the middle with a gap between the juice vesicles and the skin. Images 18,19, 20 and 21 show the progression of Bag D



Image 18: Salt Bag D Week 1
(Stewart, 2026m)



Image 19: Orange Segment D Week 1
(Stewart, 2026n)

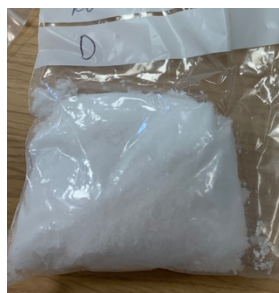


Image 20: Salt Bag D Week 2
(Stewart, 2026o)



Image 20: Orange Segment D Week 2
(Dabell, 2026f)

Discussion of Results

Interpretation

All segments changed over the course of the two weeks. The control changed little in weight, length and depth. There is also a margin of human error in the measurement of the length and depth. The length seemed to change little however the depth did change particularly for segment A. Segment A lost weight relatively consistently losing 2.1g in the first week and 1.4g in the second week. Unfortunately, the segment lost its shape a bit, it is unclear if Epsom Salt can remove all moisture. Of the individual salts, Sodium Chloride visually performed the best, it lost the most in the first week compared to A and C. It did not lose weight in the second week; it is unclear why as it had visibly changed. Nevertheless, it seemed the most dried out of the three suggesting that Sodium Chloride may have been a key ingredient in mummification salts. Sodium Bicarbonate alone was the worst of the individual salts as it removed the colour, lost the least amount of weight and had signs of decay such as mould. This implies that Sodium Bicarbonate may have been in a smaller concentration in the mixture, rather than making up the bulk of it. The mixture was unsurprisingly the most successful as it lost the most amount of weight whilst keeping its shape and colour, this matches with current understanding that mummification salts were a mixture of different types of salt and natron.

Limitations

This experiment had many limitations with the most obvious being the length, two weeks is not long enough to fully understand the impact of the salts. Another issue comes with the salt bags themselves as they were reused, changing the salt once the segment had been removed may have had an impact on its ability to remove moisture. The bags were also not kept at temperatures resembling the climate of Egypt, this may have impacted the outcomes. If the experiment was to be repeated, using different concentrations of salts in mixtures over a longer period would provide more insight into the composition of mummification salts.

Conclusion

The experiment was successful in showing that a mixture of salts is more effective than any of the singular salts, Epsom Salt, Sodium Chloride and Sodium Bicarbonate. Despite the limitations mentioned above, the experiment was able to show the importance of a high concentration of Sodium Chloride and a lower concentration of Sodium Bicarbonate in mummification salt. Whilst this experiment alone does not further the understanding of the composition of Ancient Egyptian mummification salts, it does show that submerging a fabric (in this case an orange segment) in a mixture of salts can remove moisture. As stated previously, this experiment is a starting point that could be improved upon to advance understanding of mummification salts.

Reference List

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- Stewart, R. (2026e) *Salt Bag A Week 2*. [Photograph]
- Stewart, R. (2026f) *Salt Bag B Week 1*. [Photograph]
- Stewart, R. (2026g) *Orange Segment B Week 1*. [Photograph]
- Stewart, R. (2026h) *Salt Bag B Week 2*. [Photograph]
- Stewart, R. (2026i) *Orange Segment B Week 2*. [Photograph]
- Stewart, R. (2026j) *Salt Bag C Week 1*. [Photograph]
- Stewart, R. (2026k) *Orange Segment B Week 1*. [Photograph]
- Stewart, R. (2026l) *Salt Bag B Week 2*. [Photograph]
- Stewart, R. (2026m) *Salt Bag D Week 1*. [Photograph]
- Stewart, R. (2026n) *Orange Segment D Week 1*. [Photograph]
- Stewart, R. (2026o) *Salt Bag D Week 2*. [Photograph]