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Reviewed Article:

Experimental Study of Byzantine Chafing Dishes

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This article sets out to examine the production, function, and use of Byzantine chafing dishes, which have been largely neglected by academic literature. As no practical engagement with chafing dishes has been previously attempted, experimental archaeology was chosen as a methodological tool capable of testing hypotheses associated with these wares and generating new research questions. Three chafing dishes were crafted by ceramist Alexandra Theodosiou, modelled on chafing dish 6260a and its lid 6260β from Thebes, to understand the assembly stages of the different compartments of this multi-featured form. The models

were then employed to debate questions related to function. Three prominent hypotheses regarding the heating means used to warm a chafing dish (lamp, candle, charcoal) were put into trial, so as to match use wear traces resulting from thermal stress (soot deposits) against corresponding combustible material. This could, consequently, enable reflection on the archaeological comparanda and conclude, which of the above methods would have been applied. Temperature was recorded as well as an overall reporting on the performance of each specimen. The results, though inconclusive, were taken into consideration, when discussing the use of chafing dishes, and, in particular, their association with garum.

> Though this article constitutes an introduction to a discussion about chafing dishes, it is hoped it can prompt further academic interest in this much-misunderstood Byzantine ware and encourage methodological experimental archaeological approaches in their study, which can, by extension, feed into studies of Byzantine cuisine, cookery, and dietary traditions.

Introduction

Byzantine chafing dishes constitute one of the least studied utensils of the Byzantine household. Though a series of publications discuss them in a more detailed manner (Morgan, 1942; Bakirtzis, 1989; Sanders, 1995; François, 2010; Poulou-Papadimitriou, 2008; Vassiliou, 2016), most of our knowledge about chafing dishes derives from their fleeting mention in excavation reports, where they are listed among other finds and only briefly described. It is speculated, here, that many additional fragments remain, as yet, unpublished or unidentified, especially in cases where the form is represented by non-diagnostic body sherds, rendering identification impossible. Their fragmentary archaeological presence notwithstanding, it is academically acknowledged that chafing dishes comprise a cultural and time-specific phenomenon[1] , as they appear in the wider Byzantine dominion and in spheres of Byzantine influence within a limited chronological framework (i.e. Early and Middle Byzantine period)[2] .

Morphologically, chafing dishes typically consist of two compartments; an upper bowl-shaped part attached to a lower hollow stand, the latter being perforated with ventilation holes and a larger opening, through which combustible material can be fed into the stand. The bowl is typically lead glazed on its interior, though there are examples of chafing dishes with lead glaze applied to the exterior surface of their stand, for example, chafing dish BK 4493/173 from the repository of the Museum of Byzantine Culture in Thessaloniki or chafing dish P3075 from the collection of the Museum of the Ancient Agora in Athens. The presence of a glaze suggests a need for impermeability, whereas the preference of a lead glaze, over an alkaline one, might be explained by the lower temperatures needed for firing and the fewer chances of glaze cracks during the cooling period (Greene 2007, p. 660).

The non-representative treatment of chafing dishes in the academic literature, combined with the limited petrographic and chemical analyses conducted on archaeological assemblages containing these specific ceramic wares (Poulou-Papadimitriou and Nodarou, 2007; White, 2009; Palamara et al., 2016), limits any possible discussion surrounding issues of provenance, production, function, use, and the ensuing social implications. Faced with these limitations, experimental archaeology can be employed to complement the archaeological record by outlining the *chaîne opératoire* of inter-site comparanda. This can be conducted in line with a more systematic recording and an expansion of archaeometric analyses[3] . Two small experiments will be presented here addressing the three life stages of a chafing dish: its manufacture, function, and use.

With regard to the manufacture of the wares, scanty data on the selection of raw material (clays and tempering agents), glaze recipes, and firing temperatures have impeded the drafting of a sequence of production, outlining a concatenation of manufacturing steps from the raw material to the end-product. Moreover, the academic literature has disregarded the structuring process of the ceramic vessel.

Instead, scholarly work has focused on questions regarding the function and the use of chafing dishes. Specifically, in relation to function, three fuelling methods have been proposed as heating methods for the wares: charcoal, a small candle, or a small lamp (Vroom, 2008; Böhlendorf-Arslan, 2010 p. 2; Vassiliou, 2016, p. 254), though it has also been suggested that they could be heated occasionally next to an open fire. This supposition is supported by a finding from the Western Defenses in Butrint, which displays a soot pattern on one of its exterior sides that cannot be correlated with a ventilation hole (Vroom, 2008; pp. 294 – 295; Vroom, 2012, p. 294). Apropos the use of chafing dishes, scholars primarily debated whether the ceramic vessels would have been employed to cook foodstuff or to keep already-cooked food warm, though in the literature the wares are most frequently associated with the serving of hot sauces, particularly garum (Bakirtzis, 1989, p. 55). Other propositions correlate the ware with the cooking of diverse substances, from soups, vegetables (Böhlendorf-Arslan, 2010, p. 2), and aromatised hot wine (Mark Whittow cited in Arthur, 1997, p. 538) to small morsels of solid food (such as eggs, fishes, meat, or bread buns) (Vroom 2008, p. 295). The burning of incense has also been speculated (*ibid*), and Böhlendorf-Arslan even propounded the idea of a specialisation of use according to the size of the rim diameter. (Böhlendorf – Arslan, 2010, p. 2).

To address these matters, three specific research questions are presented, each pertinent to one of the points of discussion respectively:

1. Production: Given the peculiarity of the form of the chafing dish, how and in what order would the different compartments of the ware be assembled?

2. Function: What is the method of heating chafing dishes and is it possible to deduce its nature from the soot patterning on the stand of the ware?
3. Use: Can the scholarly association of the chafing dishes with the production of garum be corroborated with a preliminary investigation of the wares' function?

Methodology

Two individual experiments were conducted to address these three objectives. The first experiment aimed at addressing research question A. As a microscopic analysis of chafing dishes was not feasible given the fact that this type of analysis requires specific authorisation from museums and ephorates of archaeology in Greece, along with the necessary equipment and technical knowledge, a macroscopic analysis was conducted on a library-based level instead. Images and drawings of different chafing dishes were examined to detect morphological features that could suggest stages in the forming of the ware. A mode of assembling the chafing dish was proposed from identifying the number and shape of different compartments and their in-between structural connections. In line with this, three models were produced in collaboration with a craftsperson, Alexandra Theodosiou (a ceramist specialising in Byzantine pottery) to assess the proposed sequence (See Figure 1). The models were crafted based on a chafing dish from the excavations at the Karamagkioli-Dettoraki plot in Thebes, Boetia (record number 6260a, 6260β) as it was found archaeologically intact with its lid (Koilakou, 1999; Koilakou, 2012). In addition, chafing dishes C36-501, C34-1459, C1999 24 from Corinth (Morgan, 1942, p. 37; ASCA Digital Collection of the Corinth Excavations) and chafing dishes no. 25, 26 and 29 from Argos (Vassiliou, 2016) were additionally considered to gain further understanding of the relationship of the bowl to its stand. All different compartments of the models were wheel-thrown to match examples of the archaeological record such as the chafing dishes no. 26 and 27 from Argos (Vassiliou, 2016) and BK 4493/173 from Thessaloniki. Lastly, regarding the perforation of the ventilation holes, the archaeological evidence suggests a degree of variance, as chafing dish P3075 from Athens indicates that ventilation holes could be pierced inwards when the ware was still leather hard, whereas a chafing dish from Mallorca (Bordoy, 1982) denotes a piercing after firing. For the sake of simplicity and time efficiency, in our experiment, it was decided to perforate the ventilation holes before the firing.

For the fabrication of the models, it was decided that Theodosiou would work with the raw materials she was already familiar with given the absence of archaeometric data on chafing dish 6260a and the unpredictability of experimenting with new resources. Thus, for the making of the ceramic bodies, she used a specific blend of clays, regular for her artwork, which is an amalgam of clays from various places in Greece supplied in sacks of 25 kilos from Athens. For the slip, which is a mixture of water and clay, Theodosiou used tap water stored in a box that was intended to wet tools and sponges during the manufacturing process. The clay came from the excavations of the METRO of Thessaloniki, in Aya Sofia Station, at about

2m below the ground level of the modern city. For the interior of the bowls a commercially available white engobe (Colorobbia S.p.A. 007059, Engobbio Bianco) in a powder form with a maximum 60 micron particle size was used. The firing temperature of the engobe was 970^{o}C, while its chemical composition consisted of SiO_2, Al_2O_3, K_2O, B_2O^3, ZrO_2. For the glazing, a lead-free powder with a maximum 60 micron particle size (Colorobbia S.p.A., CLA 000033, Cristalina Neutra Lucida) and chemical composition of SiO_2, Al_2O_3, K_2O, B_2O_3, CaO, BaO, Na_2O was used[4] . The firing temperature of the glaze was 970^{o}C as well.

To examine research questions B and C, two series of experiments were run over the course of two consecutive days, so that each of the three modelled chafing dishes would be heated using a different heating method (charcoal, lamp, and candle respectively) four times in total (See Figure 2). In the first series, the models were tested twice (with and without their lids) with an interlude of one hour, a practice repeated on the following day for the second series of experiments. The interlude was essential for the wares to cool off. The experiments lasted for a duration of 30 minutes, during which the bowls of the chafing dishes were filled with water to their maximum capacity (500ml of water/each). Measurements of the temperature of the models were taken every 5 min from two different spots on the ceramic surface (stand and interior of the bowl) with an infrared thermometer[5] . The temperature records alongside qualitative data accumulated from literary sources, were deployed to assess the suppositions about the use of chafing dishes in the modern literature and the association of the ceramic vessels with garum in particular. The use wear resulting from thermal stress (soot deposits) on all three ceramic vessels was studied and compared to three examples from the archaeological record (chafing dishes BK 4493/173 from the Museum of Byzantine Culture in Thessaloniki and 10, 147 and P3075 from the Museum of the Ancient Agora in Athens) to answer the research question pertaining to their function. Post – depositional effects were also considered in washing all three chafing dishes with tap water and rubbing their soot off by hand.

Regarding the heating means employed, the candle was made out of beeswax with a cotton wick (See Figure 3). In the first series of experiments, the metal holder of the tealight used to cast the candle was kept on, while in the second series it was removed leaving only the metallic wick holder on. With regards to the lamp, it was a ceramic wheel-thrown oil lamp, glazed on both its exterior and interior surfaces and crafted by Theodosiou. Its shape was inspired by post-Byzantine oil lamps exhibited in the Museum of Byzantine Culture in Thessaloniki, though this form is not entirely absent from the Middle Byzantine Strata, see, for example, the oil-lamp from the Pavle Cave in Kremmydi Bay at Epidauros Limera (Efstathiou-Manolakou 2009, pp. 13 – 14).

Results

The outcome of the first experiment was the provisional delineation of the models' manufacture sequence regarding their form shaping, surface treatments, and firing which is

summarised in diagram 1. The production of the modelled chafing dishes took place over three days in July 2018 at Theodosiou's pottery workshop in Thessaloniki. All the steps are outlined in detail.

During the first day:

1. The bowls of the models were wheel-thrown out of three balls of 700gr each with a flat base and with inward facing rim flange for the lid. Theodosiou used a wooden scraper to make the walls of the clay bowls thinner, and a steel scraper to make the bowls firmer – a technique employed similarly for the manufacture of the pedestal stands and the lids. To shape the inwards facing rim flange for the lid, she first flattened the rim with her thumb and then pressed a carving tool gently in the middle of the flat rim.
2. The pedestal stands were shaped on the wheel, out of three balls of 400gr each with the flaring foot being fabricated, followed by the raising of the walls for a cone.
3. Three lids (without knobs) were formed on the wheel, out of 400gr each. This step, and the two following steps, were essential intervening stages that allowed the bowls and the pedestal stands to dry to the leather hard stage, before being joined to each other.
4. The bowls being flat-bottomed had to be worked further to match the archaeological original, as the section profile of the chafing dish 6260a has a bowl with round base. Thus, the periphery of the base was carved out with a toothpick and concave bowls were shaped out of flat ones.
5. Three knobs were fabricated and attached to the lids correspondingly. This was achieved by creating a rough surface on the lids, where the knobs would be attached, with small, irregular, crisscrossed cuts and using a small amount of clay for the knobs for easy adhesion.
6. The individual compartments (bowls & pedestal stands) were assembled by, first, inverting the bowl and placing in on the wheel, then, dampening its outer wall surface and placing the inverted pedestal stand on top of it. The meeting line was smoothed, the bottom of the flaring foot made concave, and a small hole was perforated in the stand to let the trapped air escape throughout the drying stage.
7. The handles were made out of a clay ring of 150 gr each, the walls of which were raised flat on the wheel. The ring was cut in two and its halves were later adhered to the walls of the models in a manner similar to the one described in step 5.
8. Two circular ventilation holes and one semicircular feed hole were perforated on the stand, and the small hole created above to prevent cracking was closed.
9. The surface of the models was polished with a sponge.
10. The chafing dishes were put into a plastic wrap so that they could dry gradually and evenly.

During the second day:

1. The chafing dishes were polished with a dampened sponge and some sandpaper, so that all traces of manufacture (e.g. finger prints) would be removed.
2. The lids were modified, as their diameter was significantly smaller than anticipated; the diameter of each lid was first widened by pulling the clay from the top towards the bottom of the lid with the use of fingers, and by then adding a clay ring of 150gr to each one of the lids respectively on the wheel.
3. Slip was applied to the exterior surface of the polished models, while the commercially available engobe was applied to the interior of the bowls.
4. The models were covered with a plastic wrap and left to dry, only this time Theodosiou applied her own method and wrapped tape around the clay bodies, so that the handles would not dry quicker than the rest of the vessel and to avoid detachment.

On the third day:

1. The non-lead glaze was applied to every surface of the chafing dish but the interior of the stand, whereas the lids were only glazed on their exterior to match the archaeological artefact 6260β (Koilakou, 2012, p. 310).
2. The chafing dishes were stacked into a kiln with the aid of heat-resistant wires, where they were pre-fired for three hours, as the kiln gradually reached 71^{o}C.
3. The kiln was adjusted to cool down and then slowly heat to 980^{o}C and kept at this temperature for 8 hours for a complete firing stage.
4. The models were left inside the kiln, until it cooled down to 25^{o}C and then they could be safely removed without cracking.

The second series of experiments addressing the function and use of chafing dishes yielded inconclusive results, as the different means of heating the ceramic wares could not eventually be associated with a distinctive soot patterning or temperature range respectively. Namely, in regards to the soot deposition, soot patches accumulated in the ceramic walls of models A and B were almost identical, with only small differences (See Figure 4a/b/c; Figure 5a/b/c): Model A had a wider band of soot patch encircled on the interior surface of its stand than Model B (See Figure 4c; Figure 5c). Model B had a spiral mass of soot, large enough to chip off at the point, where the flame of the lamp came in direct contact with the bowl's underside. The soot deposit above the feed hole in both wares was matt, not attached and easily transferred or removed. Model Γ had a minimal soot deposit, which concentrated on the bowl's underside and on the upper edge of the feed hole (See Figure 6a/b/c). When cleaning the models with water to understand the post-depositional effects, the soot deposit above the feed-hole in both models A and B came off almost completely (See Figure 4d; Figure 5d), whereas the soot deposited on the stand persisted, though lesser in volume. Model Γ was left

with very subtle use-wear traces on the bowl's underside, the stand's interior sidewall and on the edge of the feed hole (See Figure 6d/e/f).

With regards to the temperature recordings, it is erroneous to conclusively associate any of the heating methods with a pertinent temperature range. Further experimentation is needed to corroborate the preliminary results (See Table 2; Table 3; Table 4; Table 5). Nonetheless, some initial observations are recorded here. For the data presented, the measurements taken from the bowl's inner surface were used, as the measurements from the stand presented irregularities due to the difficulty of recording accurately the temperature within the stand. The highest temperature capable of being recorded by the thermometer (380^{o}C) was achieved with all heating methods. In the case of charcoal, it did not necessarily correlate with a high temperature of water (See Table 2) –possibly due to the inconstancy of charcoal as a heating source. On average, the candle as a heating method rendered the highest temperature recorded, followed by the lamp, while both means provided a steady increase of water temperature. In the case of charcoal, the temperature of the water rose constantly during the first series of experiments, whereas in the second series of experiments, though starting from a high initial point, it eventually decreased until the fire died out. The curves of recovery in diagrams 2 and 3 should be directly associated with attempts at reviving the dying embers, which were not successful.

	CHAFING DISH A		CHAFING DISH B		CHAFING DISH Γ	
	Candle		Lamp		Charcoal	
	Stand	Bowl	Stand	Bowl	Stand	Bowl
5min	260^{o}C	36^{o}C	257^{o}C	32.1^{o}C	287.2^{o}C	29.4^{o}C
10min	250.3^{o}C	40.6^{o}C	247^{o}C	32.7^{o}C	258^{o}C	33^{o}C
15min	286.9^{o}C	44.3^{o}C	269.7^{o}C	34.7^{o}C	229.2^{o}C	38^{o}C
20min	298.5^{o}C	49.3^{o}C	264.8^{o}C	35.5^{o}C	258^{o}C	38^{o}C
25min	Hi	54.7^{o}C	260.8^{o}C	36.3^{o}C	248^{o}C	40.1^{o}C
30min	220^{o}C	56^{o}C	Hi	37.4^{o}C	243.3^{o}C	42.3^{o}C

TABLE 1. FIRST SERIES OF EXPERIMENTS. TEMPERATURE MEASUREMENTS OF THE STAND AND THE NOT LIDDED BOWL OF THE CHAFING DISHES. HI STANDS FOR THE HIGHEST TEMPERATURE CAPABLE TO BE RECORDED BY THE THERMOMETER (380^{o}C).

	CHAFING DISH A		CHAFING DISH B		CHAFING DISH Γ	
	Candle		Lamp		Charcoal	
	Stand	Bowl	Stand	Bowl	Stand	Bowl
5min	151.3^{o}C	27.3^{o}C	141.3^{o}C	23.4^{o}C	296.9^{o}C	22.4^{o}C
10min	152.2^{o}C	31.8^{o}C	155.5^{o}C	26.2^{o}C	315.7^{o}C	25^{o}C
15min	185.5^{o}C	37.7^{o}C	160.7^{o}C	28.6^{o}C	Hi	27.2^{o}C

20min	190.9°C	42.2°C	186.9°C	31.1°C	Hi	28.6°C
25min	166°C	46.6°C	160.8°C	31.7°C	Hi	29.2°C
30min	168.8°C	47.9°C	156.7°C	33.3°C	Hi	31.3°C

TABLE 2. FIRST SERIES OF EXPERIMENTS. TEMPERATURE MEASUREMENTS OF THE STAND AND THE LIDDED BOWL OF THE CHAFING DISHES.

	CHAFING DISH A		CHAFING DISH B		CHAFING DISH Γ	
	Candle		Lamp		Charcoal	
	Stand	Bowl	Stand	Bowl	Stand	Bowl
5min	149.8°C	24°C	182.9°C	25.5°C	Hi	32.6°C
10min	197.1°C	26.1°C	236.6°C	31°C	262.3°C	32.7°C
15min	232.6°C	28.4°C	252°C	34.2°C	173.6°C	32.1°C
20min	240.6°C	31.2°C	299.1°C	37.4°C	113°C	29.5°C
25min	234°C	34.3°C	284.4°C	38.8°C	81.2°C	32°C
30min	241°C	37.2°C	302.6°C	40.6°C	60°C	31.5°C

TABLE 3. SECOND SERIES OF EXPERIMENTS. TEMPERATURE MEASUREMENTS OF THE STAND AND THE NOT LIDDED BOWL OF THE CHAFING DISHES.

	CHAFING DISH A		CHAFING DISH B		CHAFING DISH Γ	
	Candle		Lamp		Charcoal	
	Stand	Bowl	Stand	Bowl	Stand	Bowl
5min	236.8°C	31.5°C	208.1°C	27°C	82.6°C	30°C
10min	284.9°C	34°C	215.3°C	28.6°C	93.6°C	30.1°C
15min	220.4°C	36.3°C	170.1°C	31.5°C	45.3°C	21.4°C
20min	243.5°C	39.8°C	193.3°C	33.6°C	56°C	26.5°C
25min	252°C	42°C	200.2°C	36°C	33.6°C	28.1°C
30min	232°C	46.2°C	218.2°C	38°C	26.4°C	27.3°C

TABLE 4. SECOND SERIES OF EXPERIMENTS. TEMPERATURE MEASUREMENTS OF THE STAND AND THE LIDDED BOWL OF THE CHAFING DISHES.

Discussion

The conclusions presented here are admittedly affected by a series of anachronistic conventions adopted during the experiments (for example, the use of modern materials, such as the commercial glazing powder, the engobe, the plastic wraps, etc., and modern tools for the manufacture of the models) and, therefore, should only be treated as a launch-pad for discussion[6] ; further experiments that incorporate different controlled variables (e.g. clays, tempered material and glaze recipes as identified in the archaeological artefacts) and

eventuating data should be considered to complement the archaeological understanding of chafing dishes.

Regarding the assemblage of chafing dishes, the first practical engagement demonstrated that the different compartments (bowl, footed stand, handles, lid) could be separately produced on the wheel (i.e. using rotating kinetic energy). The rough-out would be created from a homogenous clay mass and both the rough-out and the preform would be made with continuous inward pressure[7] . The compartments would be assembled together, after being smoothed and in a state between wet and leather hard, so that the bowl and the stand could be worked as a united piece on the wheel. For chafing dishes, such as 6260a, where the stand meets the bowl on the lower part of the body, the bowl would have been first placed upturned on the wheel, over which the upturned stand would be attached. It is possible that for chafing dishes with a different relationship between the bowl and the stand (see for example chafing dishes like C36-501 and C34-1459, where the body of the stand meets the bowl on the rim (Morgan, 1942, p. 37)) a similar assembly approach would be employed, a supposition, which can only be corroborated with further macroscopic study of the wares and experimental engagement.

To discuss the soot deposition on the ceramic walls, it should be first acknowledged that a series of factors can influence the formation of use wear traces resulting from thermal stress, for instance the temperature of the ceramic's surface, the distance of the vessel's wall from the source of heat, the type of the heating method and the presence of water in the bowl of the ware (Skibo, 2015, p. 191). It is proposed that the similar pattern in models A and B could be attributed to the wick type, the positioning of the wick and the holder of the wick. The cotton wick, having a similar length in both cases, had almost the same distance from the underside of the bowl and was set upright (even in the case of the lamp, rather than resting on the nozzle). Moreover, in the first series of experiments, the thin aluminium tealight container was kept on resulting in the candle functioning in a similar manner to the lamp, as the wick 'swam' in the molten wax held by the tealight case. Notably, during this first experiment, the wick's flame was the strongest and the temperatures recorded the highest among all series of experiments run with the candle as a heating method, a behaviour which could be associated with the presence of the tealight container. Apropos Model Γ, assuming that the soot will not deposit on the vessel's surface, if the walls' temperature approaches 400 o C (Skibo, 2015, p. 191), it is suggested that the minimal presence of soot deposit could be ascribed to the high temperature of the ceramic walls during the first experiment run. Nonetheless, the soot deposition did not alter during the subsequent experiments, when the temperature of the ceramic walls was significantly lower, as all efforts to revive the fire within the stand (blowing, adding pieces of charcoal) failed[8] . To refer back to the archaeological record, the post-depositional effects were taken into consideration: Model A and B's soot patches on the exterior of the stands were classified as the first type of soot (Skibo, 2015, p. 190), as it was cleaned, when rinsed with water, whereas the patches that stayed affixed on

the interior were classified as the second type of soot (Skibo, 2015, p. 190). In the case of Model Γ, the absence of soot was equated to the third type of soot (Skibo, 2015, p. 191). The post-depositional soot patterns on the models were juxtaposed with those of three chafing dishes that could be studied in-person (BK 4493/173 from the Museum of Byzantine Culture in Thessaloniki and 10, 147 and P3075 from the Museum of the Ancient Agora in Athens). As the soot patch in the first two chafing dishes is faint, almost untraceable on the interior of the stand (a spot on the right inner low sidewall in the first case and a spot on the bowl's underside in the latter) an association with the third type of soot, and by extension, charcoal can be drawn. On the contrary, the large soot deposit on the underside of the bowl of chafing dish P3075 suggests a different heating method, though the pattern may be directly associated with the ware's different ventilation system that was compounded by ventilation holes being placed along the circumference of the stand allowing for a different circulation of oxygen. Further experiments that factor in the distance of the wick to the bowl's underside, its positioning, the surface treatment of the exterior of the stand, the number of the ware's uses along with the duration of each cycle of use could result in the creation of a reference collection, which archaeologists could consult when studying chafing dishes. Moreover, it is hypothesized that a comparative analysis of the structure and the morphology of the soot nanoparticles deposited on the ceramic walls could establish differences contributing to the reference collection.

Lastly, concerning the use of chafing dishes, the results of the experiments highlighted that among the different hypotheses, two are primarily plausible. During the thirty minutes of each individual experiment, no cooking temperatures were achieved, though a steady increase of the water's temperature took place in the cases of lamp or candle as heating methods. Though the possibility of cooking temperatures being eventually achieved cannot be eliminated without further experimentation, it can be provisionally assumed that a chafing dish does not need to reach high temperatures, and that it can be used as a Turkish mangal to serve warm already prepared food, as Arthur has suggested (Arthur, 1997, p. 538). A second probable hypothesis is that chafing dishes could have been used for 'delicate dishes' that required a 'steady, gentle heat' as Vroom has proposed (Vroom, 2008, p. 295).

When it comes to the association of the chafing dishes with the preparation or serving warm of garum in particular (Bakirtzis, 1989, p. 55), few remarks can be drawn. In addressing the argument, which correlates the chafing dishes with the preparation of garum, two morphological features should be taken into consideration. The size of chafing dishes can only indicate a small – scale, domestic production, whereas the existence of a stand for heating insinuates a recipe other than the 'maceration and liquefaction of whole fish with salt' under the sun (Grainger, 2014, p. 14). Indeed, there is a recipe in Geoponica, a Byzantine manuscript of the 10th century with material that is dated to the 6th century (Grainger, 2013) suggesting cooking as method for the preparation of garum. However, the instructions demand the reader to 'boil' the sauce in a 'newly-made earthenware pot' (Geoponica, as cited

in Curtis, 1991, pp. 12-13; Comis and Re, 2009, p. 38). As the experiments have demonstrated, no boiling temperature was achieved with the heating methods employed and, more importantly, the material investment, skill and time needed to fabricate a chafing dish indicate that it would not be practical to manufacture these wares every time garum was cooked for the household. On the contrary, one should imagine the earthenware pots like the one produced by Comis and Re for their experimentation with the production of garum (Comis et Re, 2009) or the ones that are used for domestic production of garum today in Campania (Carannante et al., 2011, p. 69). Concerning the correlation of chafing dishes with the serving of garum, it is argued that a chafing dish could satisfy the functional need of serving garum hot. However, it is also worth pointing out, that since garum is a watery sauce, it would make sense to serve it in a non-porous ware that is made impermeable with a sealant. Interestingly enough, not all chafing dishes have internal glaze in their bowls, as examples from Amorium (Böhlendorf-Arslan, 2010, pp. 16 – 17, Böhlendorf-Arslan, 2012, pp. 156-157/158/175-176), Argolis (Vassiliou, 2016, pp. 266/275) Corinth (LOT 629:01)16 and Laconia (Armstrong, 1996, p. 132) have shown. It is debatable whether both glazed and unglazed chafing dishes can be associated with the serving of garum, or, in fact, any other sauce, or if there is a difference in surface treatment because of a distinction in the application of the wares.

On a last note, of the three heating methods, it appears that charcoal is the least practical one as it is interwoven with the continuous effort of keeping a mass of embers alive, and therefore requires a person being constantly occupied with the task, as well as a ready source of live embers. It is suggested that the candle and the lamp are more efficient heating methods, as they do not require active or attentive supervision, and of them both, the lamp would ensure a longer performance.

Future experiments should ensure that the body temperature of the ceramic ware is taken before the start of every experiment to confirm that the temperature is the same. Moreover, the fabric should be ideally deliberated after the original ware, so that any discussion about heat conductivity and temperatures is reached through a more scientific channel.

Though this article constitutes an introduction to a discussion about chafing dishes, it is hoped it can prompt further academic interest in this much-misunderstood Byzantine ware and encourage methodological experimental archaeological approaches in their study, which can, by extension, feed into studies of Byzantine cuisine, cookery, and dietary traditions.

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of the project, Anastasia Koupani for the creation of the diagram presenting the manufacturing stages of the chafing dishes and for editing all pictures, and Effie Akrivopoulou for proofreading the text and sharing insights. Moreover, I am grateful to the Museum of Byzantine Culture in Thessaloniki and the Museum of Ancient Agora in Athens for granting me access to study chafing dishes in person and to the UCD School of Archaeology for providing me with the facilities and the equipment to carry out the experiments.

1 Chafing dishes constitute a part of a Byzantine cultural or culinary koiné (Arthur, 2007, p. 15).

2 See Vassiliou for a recent and extensive account of excavated chafing dishes (Vassiliou, 2016).

3 See, for example, lipid analysis, which can be conducted on glazed ceramics, if the glaze has imperfections, as recent studies have demonstrated (Pecci et al., 2015; Pecci et al., 2016).

4 A lead-free glaze was preferred to comply with the Health and Safety Guidelines set by University College Dublin, in the setting of which all experiments were carried out.

5 The infrared thermometer employed was a Non-Contact IR Laser Infrared Digital Temperature Thermometer Gun with a temperature range of -50℃ to 380℃, an accuracy of ±1.5% (or ±1.5℃), a distance to spot ratio of 12:1, and a fixed emissivity of 0.95.

6 Investigating the archaeological original resources and drawing analogies to contemporary uses of materials and tools should consist of individual undertakings that were not considered for this project as it had different research questions in scope. For example, the convention of the plastic wrap was adopted for the production of the models, though secondary sources mention the use of strips of cloth or rope during Byzantine times (Rautman, 2006, p. 188) and ethnographic examples of late 20th C. Cyprus support the latter practice (London, 1989, p. 222).

7 The roughout and the preform are used here as defined by Roux (Roux, 2016) same as the techniques to describe the way clay was fashioned.

8 The dying out of the fire can be associated with either the lack of enough oxygen within the stand or the time requisite to walk the distance of 190m from the industrial hearth's fire to the laboratory, where the chafing dish was placed; this time might have resulted in the dropping of the temperature of the charcoal. The success of the first experiment, and the failure of the following ones could be possibly correlated with the temperature of the fire inside the industrial hearth, which was different; for the first experiment, the charcoal was taken out of the hearth, while a metal working experiment was taking place, thus constant bellowing had increased the temperature of the hearth's fire for the bronze to be melted and consequently, casted. In the following run, the charcoal was taken out of the industrial hearth before the metal working experiment had started, while in the next two runs, the charcoal was taken after it was completed.

Keywords use wear analysis
ceramics

Country Greece

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FIG 1. THE THREE MODELLED CHAFING DISHES AND THE LAMPS COATED WITH THE LEAD FREE POWDER AND WAITING TO BE FIRED. PHOTO BY GEORGIA VAKASIRA

FIG 2. THE THREE CHAFING DISHES (A, B, Γ) WITH THE THREE RESPECTIVE HEATING METHODS (CANDLE, LAMP AND CHARCOAL).

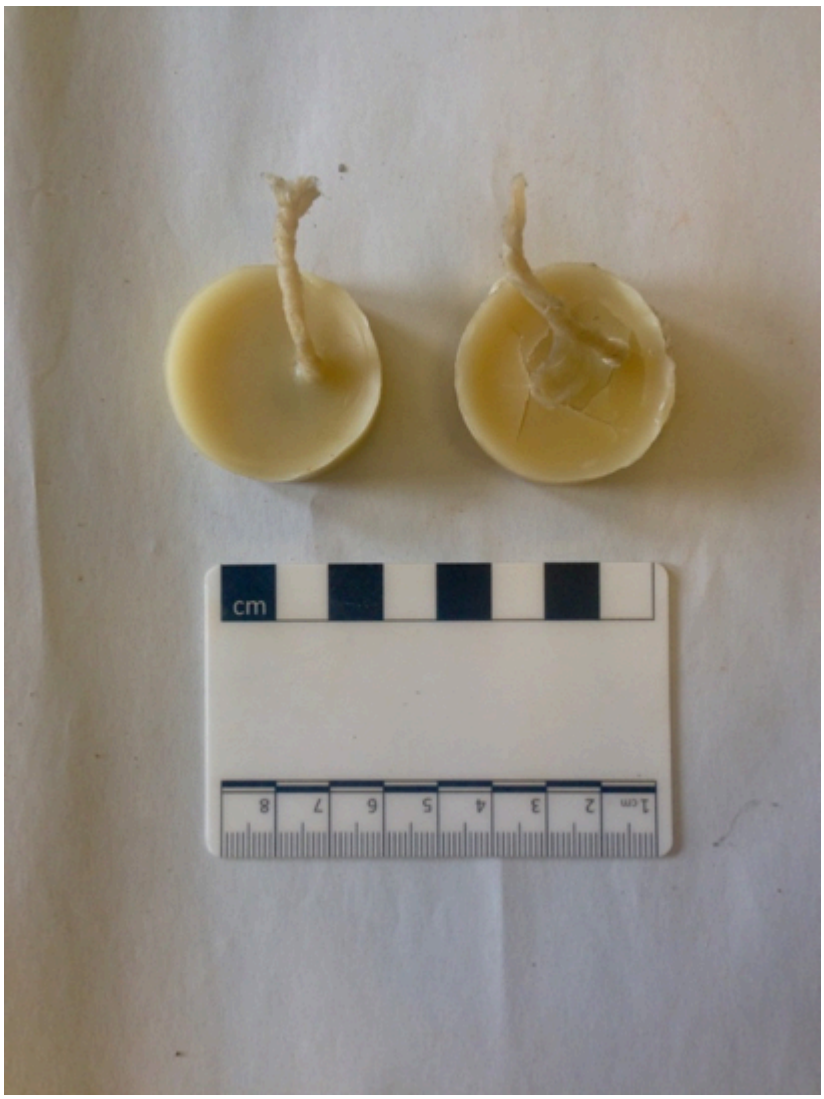


FIG 3. THE TWO CANDLES MADE OUT OF BEESWAX CASTED IN AN ALUMINIUM TEALIGHT CASE. PHOTO BY GEORGIA VAKASIRA

FIG 4A. THE SOOT DEPOSIT ON CHAFING DISH A HEATED WITH THE CANDLE. PHOTOS 4A, 4B, 4C ARE BEFORE WASHING THE CERAMIC WARE WITH WATER. PHOTO BY GEORGIA VAKASIRA

FIG 4B. THE SOOT DEPOSIT ON THE INTERNAL SIDES OF THE STAND OF CHAFING DISH A. PHOTO TAKEN BEFORE WASHING THE CERAMIC WARE WITH WATER. PHOTO BY GEORGIA VAKASIRA

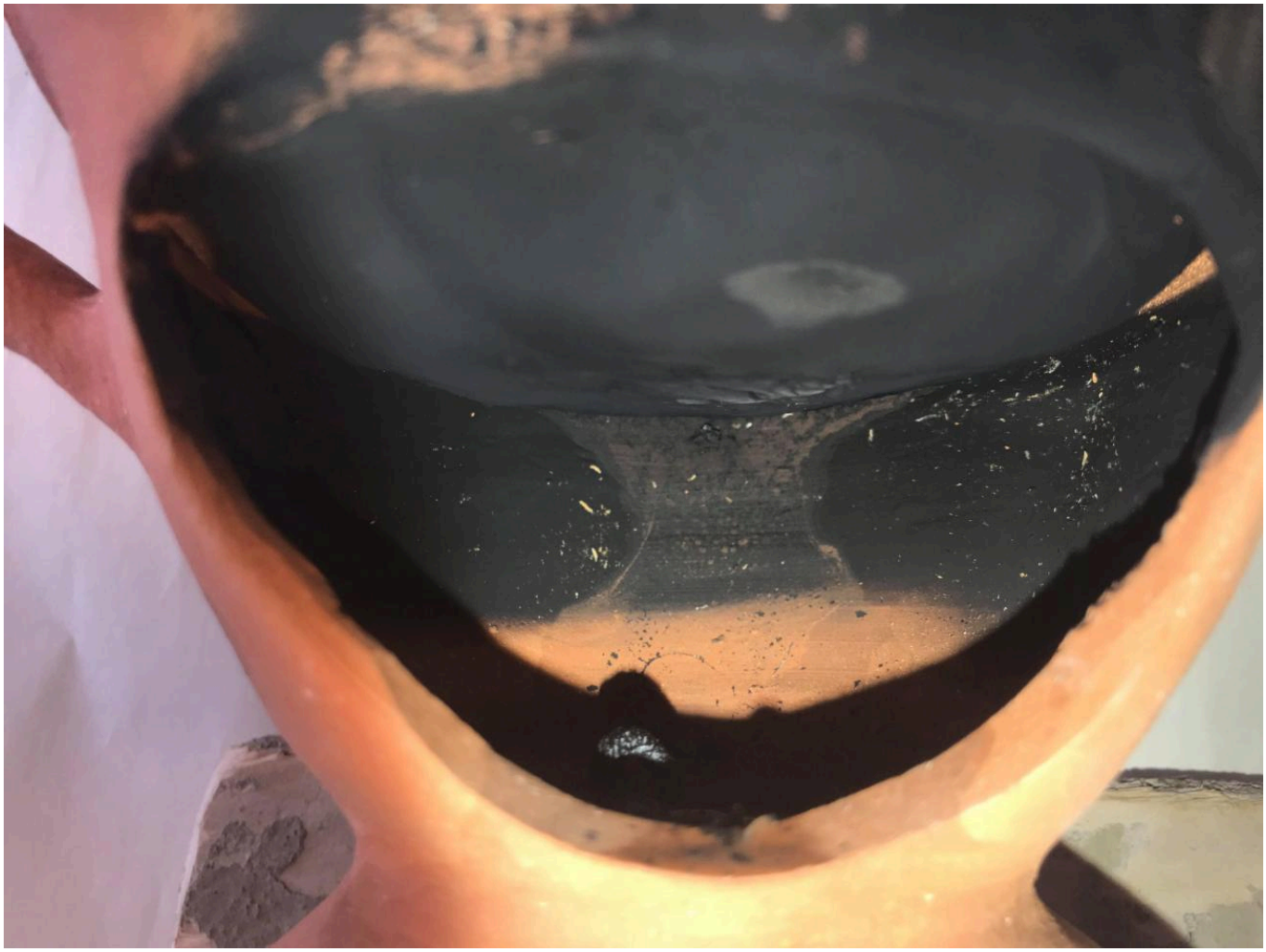


FIG 4C. THE SOOT DEPOSIT ON THE UNDERSIDE OF THE BOWL OF CHAFING DISH A . PHOTO TAKEN BEFORE WASHING THE CERAMIC WARE WITH WATER. PHOTO BY GEORGIA VAKASIRA

FIG 4D. THE SOOT DEPOSIT ON CHAFING DISH A AFTER WASHING THE CERAMIC WARE WITH WATER. PHOTOS 4D, 4E, 4F ARE WITH THE POST-DEPOSITIONAL EFFECTS BEING TAKEN INTO CONSIDERATION. PHOTO BY GEORGIA VAKASIRA

FIG 4E. THE SOOT DEPOSIT ON THE INTERNAL SIDES OF THE STAND OF CHAFING DISH A. PHOTO TAKEN AFTER WASHING THE CERAMIC WARE WITH WATER. PHOTO BY GEORGIA VAKASIRA

FIG 4F. THE SOOT DEPOSIT ON THE UNDERSIDE OF THE BOWL OF CHAFING DISH A. PHOTO TAKEN AFTER WASHING THE CERAMIC WARE WITH WATER. PHOTO BY GEORGIA VAKASIRA

FIG 5A. THE SOOT DEPOSIT ON CHAFING DISH B HEATED WITH THE LAMP. PHOTOS 5A, 5B, 5C ARE BEFORE WASHING THE CERAMIC WARE WITH WATER. PHOTO BY GEORGIA VAKASIRA

FIG 5B. THE SOOT DEPOSIT ON THE INNER SURFACES OF THE STAND OF CHAFING DISH B. PHOTO TAKEN BEFORE WASHING THE CERAMIC WARE WITH WATER. PHOTO BY GEORGIA VAKASIRA

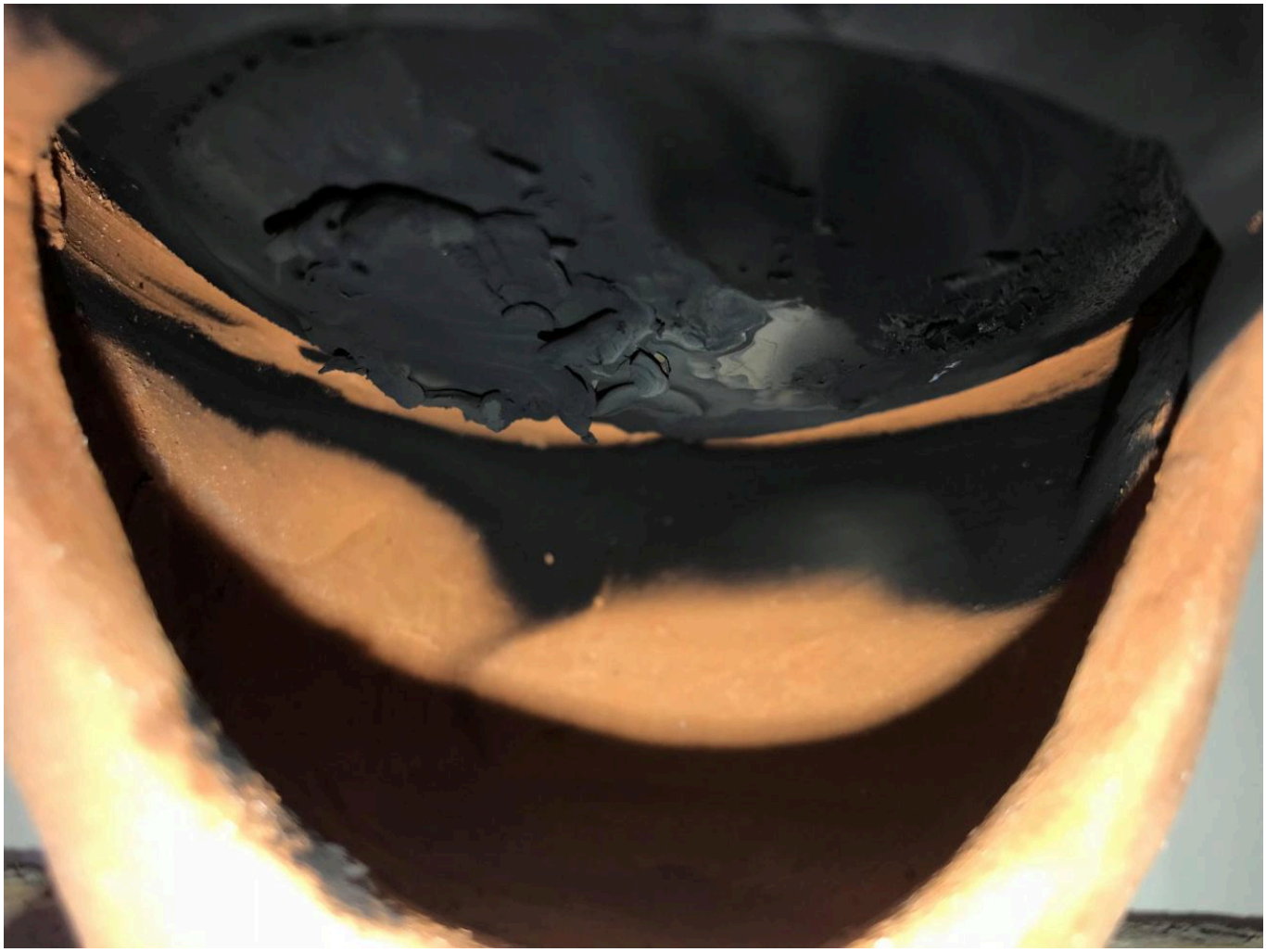


FIG 5C. THE SOOT DEPOSIT ON THE UNDERSIDE OF THE BOWL OF CHAFING DISH B. PHOTO TAKEN BEFORE WASHING THE CERAMIC WARE WITH WATER. PHOTO BY GEORGIA VAKASIRA

FIG 5D. THE SOOT DEPOSIT ON CHAFING DISH B AFTER WASHING THE CERAMIC WARE WITH WATER. PHOTOS 5D, 5E, 5F ARE WITH THE POST-DEPOSITIONAL EFFECTS BEING TAKEN INTO CONSIDERATION. PHOTO BY GEORGIA VAKASIRA

FIG 5E. THE SOOT DEPOSIT ON THE INTERNAL SIDES OF THE STAND OF CHAFING DISH B. PHOTO TAKEN AFTER WASHING THE CERAMIC WARE WITH WATER. PHOTO BY GEORGIA VAKASIRA

FIG 5F. THE SOOT DEPOSIT ON THE UNDERSIDE OF THE BOWL OF CHAFING DISH B. PHOTO TAKEN AFTER WASHING THE CERAMIC WARE WITH WATER PHOTO BY GEORGIA VAKASIRA

FIG 6A. THE SOOT DEPOSIT ON CHAFING DISH Γ HEATED WITH THE CHARCOAL. PHOTOS 6A, 6B, 6C ARE BEFORE WASHING THE CERAMIC WARE WITH WATER. PHOTO BY GEORGIA VAKASIRA

FIG 6B. THE SOOT DEPOSIT ON THE INTERNAL SIDES OF THE STAND OF CHAFING DISH Γ. PHOTO TAKEN BEFORE WASHING THE CERAMIC WARE WITH WATER. PHOTO BY GEORGIA VAKASIRA

FIG 6C. THE SOOT DEPOSIT ON THE UNDERSIDE OF THE BOWL OF CHAFING DISH Γ . PHOTO TAKEN BEFORE WASHING THE CERAMIC WARE WITH WATER. PHOTO BY GEORGIA VAKASIRA

FIG 6D. THE SOOT DEPOSIT ON CHAFING DISH Γ AFTER WASHING THE CERAMIC WARE WITH WATER. PHOTOS 6D, 6E, 6F ARE WITH THE POST-DEPOSITIONAL EFFECTS BEING TAKEN INTO CONSIDERATION. PHOTO BY GEORGIA VAKASIRA

FIG 6E. THE SOOT DEPOSIT ON THE INTERNAL SIDES OF THE STAND OF CHAFING DISH Γ. PHOTO TAKEN AFTER WASHING THE CERAMIC WARE WITH WATER. PHOTO BY GEORGIA VAKASIRA

FIG 6F. THE SOOT DEPOSIT ON THE UNDERSIDE OF THE BOWL OF CHAFING DISH Γ. PHOTO TAKEN AFTER WASHING THE CERAMIC WARE WITH WATER. PHOTO BY GEORGIA VAKASIRA

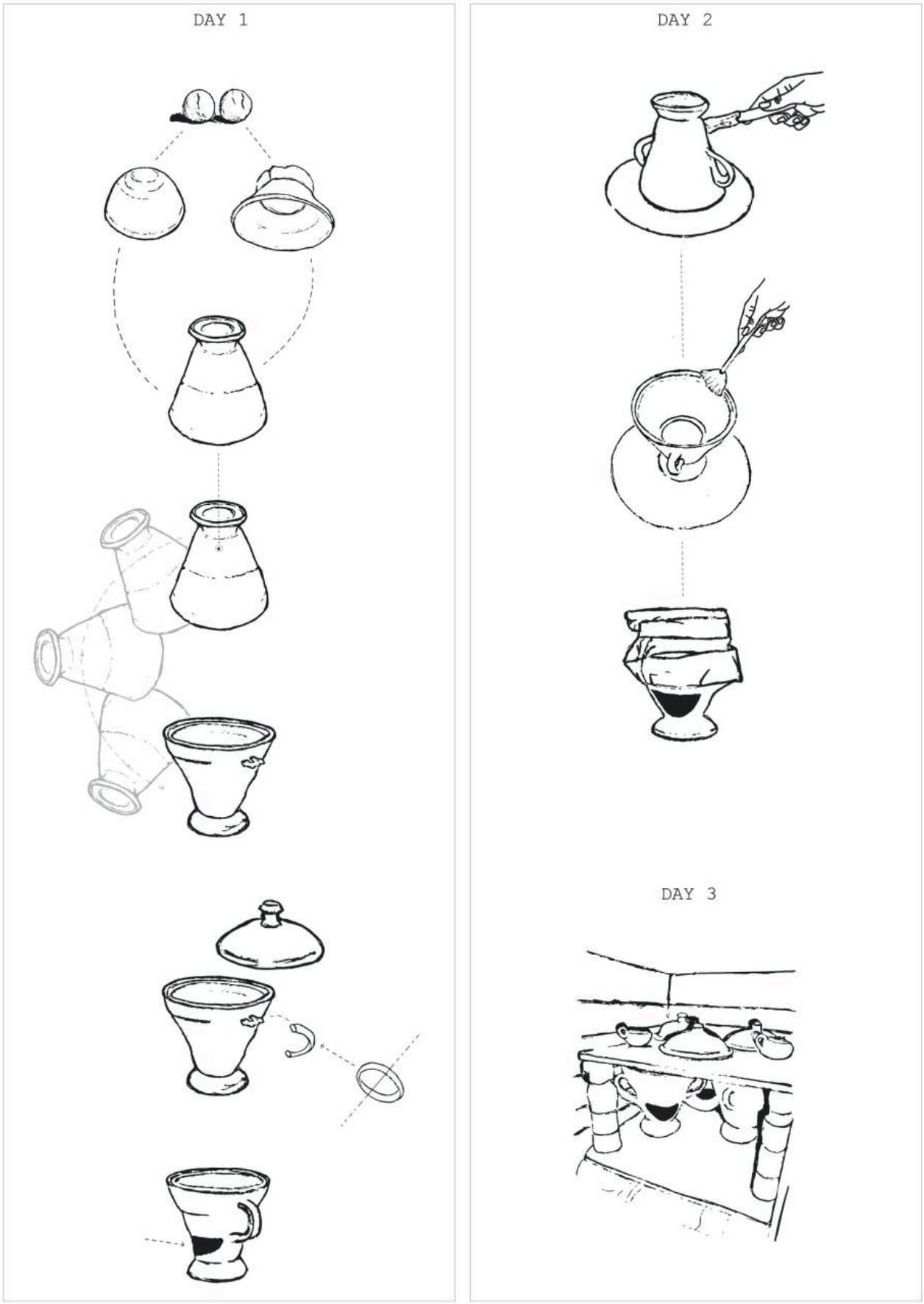
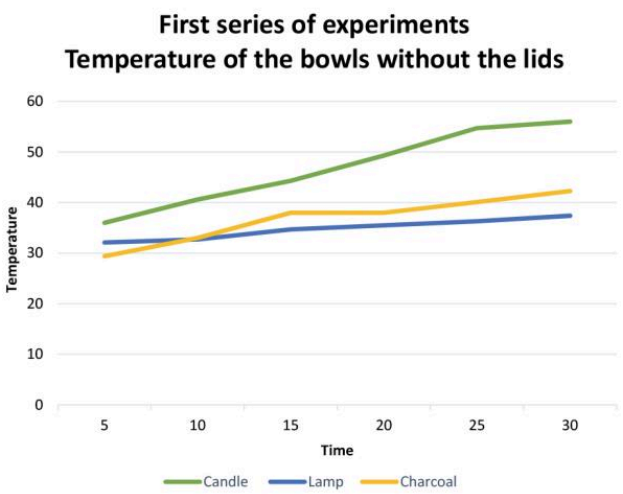
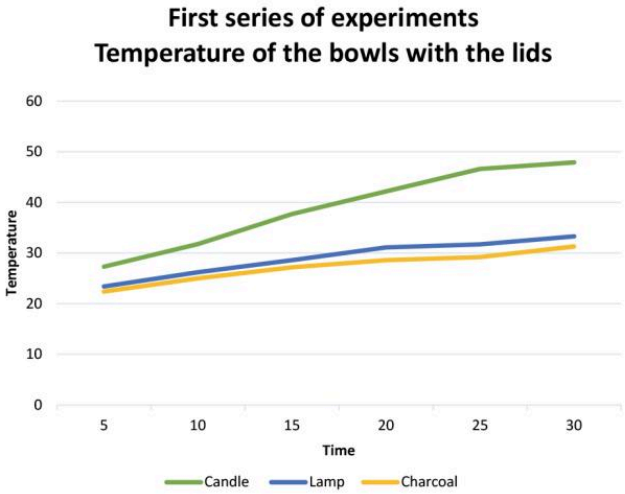
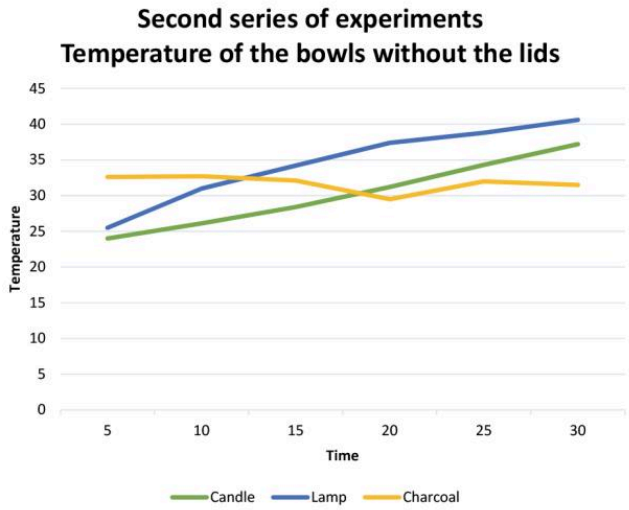


DIAGRAM 1. THE PRODUCTION STAGES OF THE THREE MODELLED CHAFING DISHES DURING THE THREE DAYS OF THE FIRST EXPERIMENT.







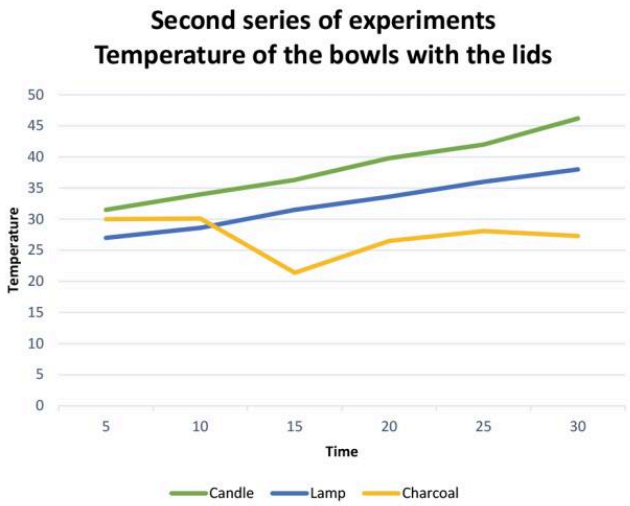
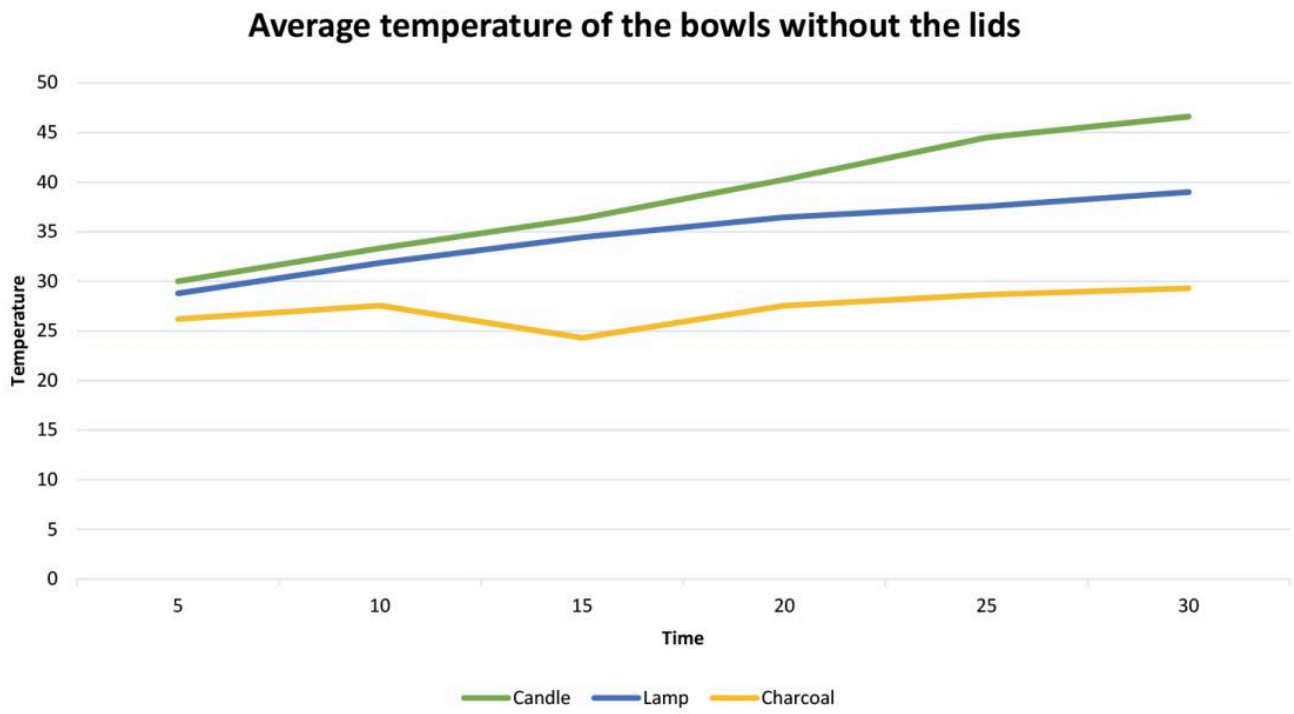


DIAGRAM 2. TEMPERATURES ACHIEVED OVER THE TWO SERIES OF EXPERIMENTS.



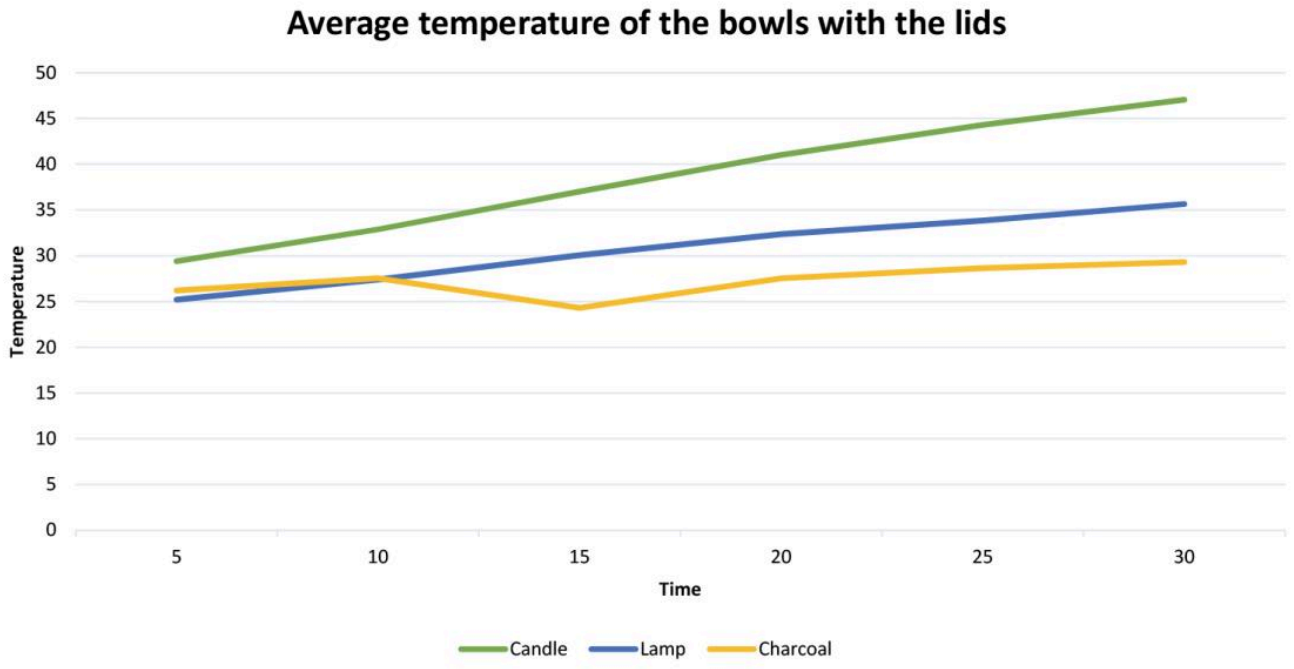


DIAGRAM 3. AVERAGE OF THE TEMPERATURE OF THE BOWLS FOR EACH HEATING METHOD WITHOUT AND WITH THE LIDS.