

EXPERIMENTAL TECHNIQUES AND
LABORATORY APPARATUS IN ANCIENT GREECE:
DRUG AND PERFUME PREPARATION

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SUMMARY

Ancient greek laboratory experts - physicians, druggists or perfumers - may be accredited with the evolution of rather sophisticated techniques for the isolation of plant ingredients and the preparation of medicines and fragrances. Mainly based on literary sources, from linear B tablets to Galen or the alchemic corpus, the present paper presents these procedures and describes the apparatus use.

Studies on ancient chemical technology are usually interested in metallurgy, a branch of outstanding financial importance endowed with a rich archeological inheritance. Significant experimental processes, however, owe their evolution to antique physicians and perfumers, who could promote rather sophisticated laboratory techniques, opening thus new horizons in the isolation and manipulation of plant ingredients^{1,2}.

The oldest testimonies on the subject, to be found in the hippocratic writings, are rather accidental, since most recipes are primarily occupied with drugs and therapeutic schemes, considering the preparative details as an evident knowledge³. Nevertheless, even a non exhaustive approach permits to draw a rough sketch of methodology and apparatus, both deriving in fact from housekeeping devices. At a first level the plants are desiccated and sometimes roasted in a *σείσων*, furthermore cut into pieces, bruised in a mortar and sieved: *λίνου σπέρμα φῶσαι, κόψαι καὶ σῆσαι* - *roast, cut and sieve the seed of flax* (Hipp., *Mul. II 126, 276*), *ἔπειτα ἔψειν*

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ἀνακινέων ὡς μὴ φρυγῆ, μαλθακῶ πυρὶ - then boil, stirring it so that it may not be burnt, at a gentle fire (Hipp., *Ulc.* 12, 414), τὴν τρύγα κατακαύσας - burn out the sediment (Hipp., *Nat. mul.* 97, 414), κόψον λεῖα ἐν ὄλμῳ - cut finely in a mortar (Hipp., *Mul.* I 109, 424), ἔμβαλε τὰ κεκομμένα ἐν τῷ ὄλμῳ - cut them in pieces and put them in the mortar (Hipp., *Nat. mul.* 109, 424), τρίψας λεῖον - bruise finely (Hipp., *Mul.* II 78, 184), τρίβειν ὡς φάρμακον τρίβεται - bruise it as you would bruise a medicine (Hipp., *Mul.* I 74, 156). Juices are obtained by squeezing off (ἐκθλίψις, ἐκπίεσις, ἐκχύλισις) the plant through a cloth filter: χύλωσον - squeeze off (Hipp., *Mul.* II 209, 404), ἐκθλίψας τὸν χυλὸν - strain off the juice (Hipp., *Mul.* I 75, 166), ἐκπίεσαι τὸν χυλὸν δι' ὄθονίου - press the juice through a filter (Hipp., *Mul.* I 104, 226), δι' ὄθονίου ἐκχύλισας - squeeze off through a cloth (Hipp., *Mul.* I 44, 104), δι' ὄθονίου διηθῆσαι - filter through a cloth (Hipp., *Mul.* I 75, 168). More details on the pressing devices in next paragraphs.

Further on, the preparation of common galenic forms demands quite often the addition of a large amount of liquids: χρῆ οἶνω καὶ ὕδατι διέναι καὶ πίνειν - it has to be dissolved in wine and water and then drunk up (Hipp., *Mul.* II 192, 374) and τρίψας ἐπίχεε . . . ἔλαιον - bruise it and pour . . . oil over it (Hipp., *Mul.* II 78, 176), or even mere humidation: ῥοδίνῳ μύρῳ δεύσας - dilute it with rose perfume (Hipp., *Nat. mul.* 32, 352), ἐλαίῳ ὀλίγῳ φυρίσας - being mixed with a little oil (Hipp., *Ulc.* 11, 410). Similarly, broadly used are macerations: τρίβειν καὶ ἐπιχέειν ὕδωρ, βρέξον δὲ ὄλην ἡμέρη - bruise and pour water over it, then let it macerate a day long (Hipp., *Mul.* I 78, 192), as well as decoctions and infusions: τὰ φύλλα ἐψῆσας ἐν ὕδατι, ἀποχέαι καὶ πίνειν - boil the leaves in water, then decant and drink (Hipp., *Mul.* I 78, 174) or τὰ φύλλα ἐμβάλειν εἰς ὕδωρ, ἀφέψειν - put the leaves into water, boil (Hipp., *Mul.* II 203, 392), furthermore various extracts: τρίψας δὲ καὶ συμμίξας πάντα λεῖα, διέναι ἐν οἶνω λευκῷ γλυκεῖ. ἔπειτα ἐψεῖν ἔστ' ἂν παχὺ γένηται οἶόν περ μέλι - bruise finely and mix everything, dissolve it in sweet white wine and then boil till it takes the consistence of honey (Hipp., *Mul.* I 63, 130). Finally, the essential oils of many plants are gained by infusion according to traditional perfumery procedures to be discussed later on.

Still at classical times, Theophrast permits himself some

hints regarding the techniques under investigation, so bruising: ἐάν τις τρίψας ἐμβάλη - if one shreds it and puts it in (Th., *Hist. plant.* IX, 18, 3) or maceration: ἐνίων δὲ χυλισμός ἐστίν, ὡσπερ ὅσα κόψαντες καὶ τρίψαντες καὶ ὕδωρ ἐπιχέαντες ἀπηθοῦσι καὶ λαμβάνουσι τὴν ὑπόστασιν - in some cases there can be no collection of juice, but there is a sort of extraction of it, for instance in the case of plants which are cut down or bruised; they then pour water over them and strain off the fluid, keeping the sediment (Th., *Hist. plant.* IX, 8, 3).

Leading figure of the first centuries a.D., Dioscorides from Anazarba will take over hippocratic methodology, from simplest processes to most complicated ones: κόψας καὶ σείσας - cut and sieve (Diosc., *Mat. med.* I 53), ῥόδα τρίβειν ἐν θυεῖα - bruise roses in a mortar (Diosc., *Mat. med.* I 99), ἐξίπου βιαίως - strain off vividly (Diosc., *Mat. med.* I 56) or ἐξίπωσον διὰ σφυρίδος - strain off through a woven basket (Diosc., *Mat. med.* I 54), and will shortly speak of macerations: τὰ φύλλα ἀποβρέχειν - macerate the leaves (Diosc., *Mat. med.* I 39), ἀποβρέχουσι ἐν ἐλαίῳ - they let it macerate in oil (Diosc., *Mat. med.* I 45), and ἀποζέματα, e.g. decoctions, infusions or extracts: ῥίζα ἐν οἶνω ἀφεψηθεῖσα - root boiled in wine (Diosc., *Mat. med.* III 11), βρεχομένου ὕδατι θερμῷ - let it infuse in hot water (Diosc., *Mat. med.* I 38).

Galen will later on contribute to the preparative knowledge using similar prescriptions: εἰς θυεῖαν καταράσας καὶ τρίψας - put in a mortar and bruise (Gal., *Comp. loc.* IV 734), λεῖα ποιῶν ἐν θυεῖα μείζονι - pulverize in a large mortar (Gal., *Comp. gen.* VII 989), furthermore: σῆθι λεπτῷ κοσκίνῳ - use a fine sieve (Gal., *Comp. loc.* I 438), τὰ ξηρὰ παχυτέρῳ κοσκίνῳ σῆθεται - a broader sieve is needed for dry substances (Gal., *Comp. loc.* IX 283), λεπτότατον κόσκινον - extremely fine sieve (Gal., *Comp. gen.* V 819), or concerning straining off: χυλῷ δι' ὄθονίου ἐκτεθλιμμένῳ - juice squeezed off through a cloth (Gal., *Comp. loc.* II 502), ἐκθλίψας διὰ ῥάκου - strain off through a cloth (Gal., *Comp. loc.* IV 740), ἐκθλίβειν τὸ μὲν πρῶτον διὰ χειρῶν εἶτα διὰ πιεστῆρος - squeeze by hand and then in a pressing machine (Gal., *Comp. gen.* VII 1044). Moreover, he will mention maceration: λειάνας μετὰ καλαμίνθης ἀποβρέγματος - bruise with macerated calaminthe (Gal., *Comp. loc.* IX 264), ἐμβρέξας ἔψε - macerate and then boil (Gal., *Comp. loc.* I 486) or τὴν τρύγα καὶ τὸ ὕδωρ βαλὼν εἰς πίθον

κεραμεῶν ἀκόνιτον ἕα βρέχεσθαι ἐπὶ ἡμέρας ζ' - put the sediment and water in a porous earthenware jar and let it macerate for seven days (Gal., *Comp. loc.* I 490), ἐπιβαλόντες οἶνον ἔωμεν βρέχεσθαι - pour wine over it and let it macerate (Gal., *Comp. gen.* VII 1028), κοσκινέειν κοσκίνῳ οἶνον βρέχε - sieve it through a sieve and let it macerate in wine (Gal., *Ther.* 267), and will promote the preparation of decoctions and infusions : ἀψίνθιον ἐν ὕδατι ἀπεξεσμένον - absinthe boiled in water (Gal., *Comp. loc.* III 654) or βαλὼν εἰς θερμὸν ὕδωρ ἕα βρέχεσθαι τὸ ψύλλιον - let plantain infuse in hot water (Gal., *Comp. loc.* VII 86), as well as extracts : ἀφέψημα εἰς πάχος ἠγμένον ἀπτικῶς μέλιτος ὑγροῦ - boil till it takes the consistency of fluid honey from Attica (Gal., *Comp. loc.* VII 11).

It is noteworthy that the *papyri* of Leiden and Stockholm, compendia dating from the years of Constantine the great but echoing the knowledge of the remote past, propose as well: ἐπέβαλε εἰς ἀγγεῖον ὑπὸ χεῖρα τρίβων - pulverize it by hand and put it in a vase (Leid. 551) and speak of filtration - ἐξέρασις (Leid. 485), ἀποσείρωσις (Holm. 1054), humidation - νότισις (Holm. 999), maceration - ἔμβρεξις (Holm. 424), ταρίχουσις (Holm. 1009), as well as of decoctions - ἀποζέσματα (Holm. 650 and 1049). Finally, the alchemic *corpus* of the ptolemaic and roman period is mentioning filtration - ἀποσείρωσις (CAG 55), sedimentation - ὕλισις (CAG 41) and squeezing: βαλὼν εἰς ῥάκος ἐκπίασον - strain off through a cloth (CAG 222), λαβὼν ῥάκος ἐρίου ἐκθλίβε - squeeze through a woolen cloth (CAG 447) or φάρμακα διὰ ῥάκου ἐκθλιβόμενα - drugs squeezed off through a cloth (CAG 439).

The plants are usually pressed by hand: ἀνακινήσας ταῖς χερσὶ ἐκπίεζε - stir and squeeze by hand (Diosc., *Mat. med.* I 43), and references to concret mashinery are spare and rather vague: τὴν δ' ὑπόστασιν ἀποθλίβειν ὀργάνοις - squeeze the sediment in a press (Th., *Odor.* 29), ἀποτεθλιμμένης τε δι' ὀργάνου - squeeze in a press (Diosc., *Mat. med.* I 60) or ἐκθλίβειν τὸ μὲν πρῶτον διὰ χειρῶν, εἶτα διὰ πιεστήρου - squeeze them first by hand and then in a pressing mashine (Gal., *Comp. gen.* VII 1044). The speech goes most probably about small devices resembling oil or wine presses, or even analogous to the portable single-screw frame press invented by Hero from Alexandria⁴.

Seen from an experimental point of view, even greater seems the importance of another field, closely linked with pharmaceutical technology and often served by the same experts^{5,6}. Indeed, Perfumery is efficiently working on the isolation of essential oils and is practising extraction from liquids. The first hints on perfumed oil preparation are found on late bronze age linear B tablets, attesting that the experimental procedure includes boiling in olive oil. An example from Pylos should elucidate the technique: o-do-ke a-ko-so-ta/ tu-we-ta a-re-pa-zo-o/ tu-we-a a-re-pa-te/ ze-so-me-no - ὡς δῶκε Ἀρξώτας (?) θνέστα ἀλειφαζῶ θύεα ἀλειφάτι ζεσομένῳ - thus Arxotas gave the perfumer drugs for the aromatic oil to be boiled (tablet Un 267)^{7,8}.

About five centuries later, Homer notes: ῥοδόεντι δὲ χρίειν ἔλαιῳ ἀμβροσίῳ - and with oil anointed she him, rose sweet, ambrosial (Homer, *Ilias* Ψ 186). Real technical information dates, however, from classical times. Should the odoriferous parts of some plants, as those of citrous fruits, be gained by simple squeezing, the usual methodology is by far more complicated. According to the standard procedure, an ancestor of contemporary *enfleurage*⁹ well known to Theophrast, the drug is added portionwise to a liquid fatty substance - preferably olive oil - until the latter is fully saturated: ῥοδίνου σκευασία. τὰ ἐξιποθέντα ῥόδα βαλὼν εἰς λουτηρίδιον ἐπίχει λίτρας ὀκτώ... τοῦ ἐστνυμμένου ἐλαίου καὶ πάλιν ἐξίπου. . . ἄχρι δὲ ἐβδόμης ἐμβροχῆς ἐπιδέχεται τὸ ἔλαιον τὴν ἐμβολὴν τῶν ῥόδων - rose perfume preparation: put squeezed roses in a small bassin and pour over them eight liters . . . of an oil bearing adstringent properties, and squeeze them off anew . . . you can go on adding new roses up to seven times (Diosc., *Mat. med.* I 43). This absorption of essential oils by the fatty phase is sometimes possible at normal temperatures and can then be considered as a maceration: ὥσπερ τῶν ἀνθῶν τὰ μὲν ψυχροβαφῆ, τὰ δὲ θερμοβαφῆ, παραπλησίως ἔχειν καὶ ἐπὶ τῶν ὁσμῶν - some floral dyes have to be heated and some not, and the same applies to odours (Th., *Odor.* 22), usually however it requires smooth heating, to be achieved by means of the so-called ἀγγεῖον διπλοῦν μυρψικόν - the perfumer's double vessel (Gal., *Comp. loc.* I 429, VII 55), e.g. a classical water bath : πάντων δὲ ἢ ἔψησις καὶ εἰς τὴν ὑπόστῳψιν καὶ εἰς τὰς κυρίας ὁσμὰς ἐνισταμένων τῶν ἀγγείων ἐν ὕδατι γίνεται καὶ οὐκ αὐτῷ τῷ πυρὶ χρωμένων. τοῦτο δὲ ὅτι μαλακὴν εἶναι δεῖ τὴν

θερμότητα - but in all cases (whether to produce the adstringent quality or to impart the proper odour) they should boil in vessels standing in water and thus avoid actual contact with the fire; the reason being that the heating must be gentle (Th., Odor. 22), or διπλοῦν σκευῶς. ὀνομάζομεν οὕτω ὅταν ἐν κακκάβῃ θερμὸν ὕδωρ ἔχουση σκευὸς ἕτερον ἐνίσταται . . . ὑποκαιομένης τῆς κακκάβης we speak of a double vessel whenever a pot is standing into a large bassin of hot water and the bassin is heated from underneath (Gal., Comp. gen. II 629), furthermore: λ' δὲ ἡμέρας ἐν διπλῷ ἀγγεῖῳ ἐπ' ἀνθράκων δύο ἢ τρία ζέματα δεῖ ἐνδιδόναι τὸ μύρον ἀποδίδοντας . . . καθελόντες δὲ τὸ ἀγγεῖον καὶ ψύξαντες ἐπὶ ποσὸν ἀποχεῖν τὸ μύρον - you should boil over charcoal in a double vessel two or three portions for thirty days in order to get the fragrance . . . then you remove the pot, cool shortly and pour off the perfume (Gal., Comp. gen. VII 1044), and διὰ διπλώματος ἔψε, ὅπερ ἐστὶν ἐπ' ἀγγείου διπλοῦ, καθάπερ οἱ μυρεψοὶ τὰ μύρα σκευάζουσιν εἰς μέγαν τινα λέβητα θερμὸν ὕδωρ ἐγχέοντες, δεύτερον ἐνιστάντες ἔχοντα ἐν αὐτῷ τὸ ἐψόμενον φάρμακον, εἶτα προδιακεκαυμένους ἀνθραξίν ἢ ξύλοις ἀκάπνοις ὑποκαίοντες - boil by means of a dipl-oma, that is a double vessel like those used in perfumery, consisting of a large cauldron of hot water and a second vessel standing in it and containing the drug to be boiled; heat the device using charcoal or smokeless wood (Gal., Comp. loc. VII 37).

Sometimes, extraction under heating in presence of both water and oil is applied as well: τὴν ἐργασίαν τῆς στακτῆς εἶναι τοιάνδε. τὴν σμύρναν ὅταν κόψωσι καὶ διατήξωσι ἐν ἐλαίῳ βαλανίνῳ πυρὶ μαλακῷ ὕδωρ ἐπιχεῖν θερμὸν. συνιζάνειν εἰς βυθὸν τὴν σμύρναν καὶ τοῦλαιον καθάπερ ἰλὺν. Ὅταν δὲ τοῦτο συμβῇ, τὸ μὲν ὕδωρ ἀπηθεῖν, τὴν δ' ὑπόστασιν ἀποθλίβειν ὄργανοις - stakte is prepared in the following way: they bruise the myrrh and dissolve it in oil of balanos over a gentle fire; then they pour hot water over it; the myrrh and oil form a sediment that sinks to the bottom; as soon as this has occurred, they strain off the water and squeeze the sediment in a press (Th., Odor. 29) and στακτῆ δὲ καλεῖται τῆς προσφάτου σμύρνης τὸ λιπαρὸν, κεκομμένης μεθ' ὕδατος ὀλίγου, ἀποτεθλιμμένης τε δι' ὄργανου - they call stakte the oil of fresh smyrna that has been cut in pieces, dissolved in a small amount of water and squeezed in a press-ing mashine (Diosc., Mat.

med. I 60), furthermore analytically: ἐλαίου κυπρίνου στύψις καὶ σκευασία. ἐλαίου ὀμφακίνου πεπλυμένου μέρος ἐν, ὕδατος ὀμβρίου μέρος ἐν ἡμισυ, τὸ μὲν ἐπίχει τῷ ἐλαίῳ, τὸ δὲ φύρα ἐν τοῖς ἐμβληθησομένοις ἀρώμασι. εἶτα λαβὼν . . . τὸν ἀσπάλαθον κόψας καὶ βρέξας ἐν ὕδατι ἐμβαλὼν ἔψε μετὰ τοῦ ἐλαίου ἕως ἂν συναναζέσῃ . . . καθελὼν ἀπήθησον τοῦ χαλκοῦ τὸ ἔλαιον καὶ κατάχει κατὰ τοῦ καρδαμώμου κεκομμένου καὶ πεφυραμένου τῷ λοιπῷ ὕδατι καὶ κίνει σπάθη ἕως ἂν ψυγῇ, μὴ διαλείπων. εἶτα ἀπήθησον τὸ ἔλαιον - preparation of Cyprus oil: one part of well washed unripe olive oil and one part of rain water; the first is to be poured over the oil, the latter acts as a solvent for the fragrances; then take . . . the aspalathos drug, cut it, macerate it in water and boil it with the oil . . . remove the copper vessel, strain off the oil and pour it over the cardamon that has already been cut in pieces and diluted with the rest of the water; stir up continuously with a spade until it cools and then filter off the oil (Diosc., Mat. med. I 55), or shortly: μύρον κεχυμένον ἐπὶ θερμοῦ ὕδατος ἀνακινεῖν - stir up myrrh poured over hot water (Gal., Comp. gen. VII 1044). In these cases, direct heirs of the minoan and mycenaean tradition, the essential oils pass into the fatty substance, taking thus the form of the ready-to-use perfume.

Appliances and vessels - ἄγγη, ἀγγεῖα - of general laboratory use bear many common features, being at the same time greatly differentiated according to the scope of the process. Though of course not excluding the use of mills, the mortar - ὄλμος, θυεῖα, ἴγδη, τριπτῆρ is of primary importance in the working out of plant products. Thus, the hippocratic writings often mention the pulverisation of desiccated plant parts: ἐμβαλὼν εἰς θυεῖαν τρίψας πάντα - put everything in a mortar and bruise (Hipp., Mul. I 44, 104) οἱ τούτων ἕκαστον ξηρὸν τρίψας ὡς λειότατον - let each of these be dried and finely levigated (Hipp., Ulc. 12, 414). In more recent years Dioscoride will make use of various analogous devices: λιθίνη θυεῖα καὶ λίθινος δοίδυξ - stone mortar and stone pestle (Diosc., Mat. med. V 81), θυεῖα θηβοαῖκη - theban stone mortar (Diosc., Mat. med. V 87), κίνει ἐν ὄλμῳ - stir in a mortar (Diosc., Mat. med. I 54), and Pliny the elder will consider granite, especially the theban one (Pl., Hist. nat. XXXIV 23), as most adequate for the fabrication of pharmaceutical mortars: auctoribus curae fuere lapides mortariorum

quoque, nec medicinalium tantum aut ad pigmenta pertinentium. Etesium lapidem iniis praetulere ceteris, mox thebaicum, quem pyrropoecilon appellavimus (alique psaranum vocant), tertium ex chalazio chrysitē, medicis autem ex basanite. Hic enim lapis nihil ex sesse remittit - our authorities have been interested also in stones used for making mortars; and I do not mean merely mortars used for pounding drugs or grinding pigments; among such stones I give the first place to the etesian and the second to that of the Thebaid which I have already cited as the pyrropoecilon or stone with the red spots, and some people call psaranon, the speckled stone; the third place they award to the touchstone of rock resembling hail, or for medical purposes to one of silicious slate; for this latter stone yields nothing from its own substance (Pl., *Hist. nat.* XXXVI 43). Moreover, Galen, experienced in laboratory work, will speak of materials and sizes : *θυεία μολυβδίνη* - lead mortar (Gal., *Comp. loc.* I 454), *θυεία ὄστρακίνη* - earthenware mortar (Gal., *Comp. loc.* IX 545), *λεῖα ποιῶν ἐν θυείᾳ μείζονι* - pulverize in a large mortar (Gal., *Comp. gen.* VII 989), while the papyri of Leiden and Stock-holm prefer mortars made of basanite stone - *βασανίτης λίθος* (Leid. 380). Finally, the alexandrine alchemists not only use stone mortars - *λιθίνη θυεία* (CAG 332), but at the same time they enrich the possibilities by speaking of a glass device - *ὑέλινον ἰγδίον* (CAG 32, 350), *υαλίνη θυεία* (CAG 359).

Made as well of stone, metal or wood, the pestle is called *ὑπερος*, *δοίδυξ*, *ἀλετριβανος*, *κόταλις*, *λάκτις*, *ναγεύς*. Should the first term usually apply to a wooden instrument : *κόψον ὑπέρω ξυλίνῳ ἐν ὄλω* - bruise with a wooden hyperos in a mortar (Diosc., *Mat. med.* I 33), the *δοίδυξ* can be made of stone - *λίθινος* (Diosc., *Mat. med.* V 81), or metal : copper - *χαλκοῦς* (Th., *Lap.* VIII, 60), even silver - *ἀργυροῦς* (CAG 366) to prevent corrosion.

Squeezing - *διήθησις*, *ἀποσείρωσις* makes common use of cloth filters. Though late bronze age hints are spare (tablet Un 249)¹⁰, more recent information is rather precise: *δι' ὀθονίου* - through a cloth (Hipp., *Mul.* I 75, 168), *λαβῶν μοτάριον ἐκ ῥάκους* - take a piece of cloth (CAG 103, 158, 192), *διηθήσας ὀθόνη* - filter through a cloth (CAG 195, 360), or in a more concrete manner: *λινῷ ῥάκει καθαρῷ* - by means of a clean linen cloth (Leid. 329), *σάκκος λινὸς καὶ λίαν πυκνότητος* - a linen bag of close texture (CAG 137), *πανὶν λινὸν* - linen cloth (CAG 332), *ῥάκος λινούν* - linen cloth

(CAG 371), *βάλλοντες εἰς λινούν στερεὸν καὶ πυκνὸν ῥάκος* - put in a firm linen cloth of close texture (CAG 99), *σεῖσον πανίῳ μεταξωτῷ* - sieve through a silken cloth (CAG 363), *πανίον λευκὸν μεταξωτῶν* - white silken cloth (CAG 365), *ῥάκος ἐρίου* - woollen cloth (CAG 114, 309). Among handy materials noteworthy are palmtree leaves : *ρεύσει καθαρὸν διὰ τοῦ σεβεννίου* - it shall be well filtered by means of palmtree leaves (Holm. 570), while great use is made of woven baskets : *ἐξίπωσον διὰ σφυρίδος* - strain off through a basket (Diosc., *Mat. med.* I 44, 54), *διὰ φορμοῦ ἐκθλίψας* - press through a basket (Diosc., *Mat. med.* I 35), *εἰς κυρτίδα ἐξίπου* - strain off through a basket (Diosc., *Mat. med.* I 52), *ἄρας τὸ γυργάθειον ἢ τὸ σφυρίδιον ἐκπίασον ἐπιμελῶς εἰς τὴν λωπάδα* - take the basket and carefully squeeze the juice into the pot (Holm. 759).

Among reaction vessels very common are pots - *χύτρα* or *κύθρα*, *λωπάς*, *γαστήρ*, and cauldrons - *λέβης*, *χαλκίον*; more seldom appear jars - *μετρηται* (*Comp. gen.* H 1041), *κρατήρες* (CAG 440), *πίθοι* (Holm. 778), *πιθάκναι* (*Mat. med.* E 79), shells - *λεκάναι* (CAG 222), *τεύχη* (CAG 54), *χῶστρα* (CAG 289), and bassins - *κακκάβαι* (Gal., *Comp. gen.* II 629), *λουτήρες* (Diosc., *Mat. med.* I 44), *κόλυμβοι* (CAG 25). Dishes and plates are called *τριβλία*, *βατάνια*, *πινάκια*, *πατέλια*, while *βίκος*, *φιάλη*, *ληκύθιον*, *βοτάριον*, *κώθων* (Diosc., *Mat. med.* IV 731), *ποτάριον* (Gal., *Comp. loc.* IX 280, Holm. 84), *βούκλα* (CAG 140), *ποτήριον* (CAG 353), *βήσσα* (CAG 311), *ἐπιβαλτάριον* (CAG 443) are flask-shaped. Finally, of high quality are supposed to be earthenware vases from Attica or Ashqalon - *ὄστρακον ἀττικὸν* (Diosc., *Mat. med.* V 88), *ἀσκαλωνίτις γάστρα* (CAG 210) or granite mortars from the Thebais - *θυεία θηβαϊκή* (Diosc., *Mat. med.* V 87).

Auxiliary utensiles are often mentioned as well: *ξύστρα* - rasp (Diosc., *Mat. med.* III 624), *κίνει σπάθη* - stir with a spade (Diosc., *Mat. med.* I 54), *ξύων σπαθομήλη* - scrap with a medical spade (Gal., *Comp. gen.* I 381), *ἔψε κινῶν σπάθη* - heat stirring with a spade (Gal., *Comp. gen.* V 823), *σπάθη μυρεψικῆ σαλευέσθω* - stir it with a perfumer's spade (Gal., *Comp. gen.* VII 1044), *ἰατρικῶς σπαθίζων* - stir up with a medical spade (CAG 56), *λαβίδιον* - small forceps (Holm. 226), *στρέφων τριχολαβίσι* - move it by means of a fine forceps (CAG 362), finally *εἰς μύκα ἀναλάμβανε* - take it with a spoon (Diosc., *Mat. med.* I 32). In the same connection, feather

offers a gentle touch - *περῶ ἄφελε* (CAG 220).

In general, vessels are *χαλκῶ καὶ . . . ὑέλινα καὶ ὀστράκινα* - made of copper and . . . glass and earthenware (CAG 438), clay being sometimes baked only during the procedure: *εἰς ὠμὴν χύτραν ἐμβαλε καὶ περιαλείψας τὸ στόμα αὐτῆς πηλῶ δὸς εἰς κάμινον. ὅταν δὲ ὀπτηθῇ ὁ κέραμος αὐτῆς, ἀνελόμενος ἀπόθου* - put it in a raw earthenware pot, tighten the lid with clay and heat it in a furnace; when the pot is baked, remove it and keep it (Diosc., *Mat. med.* V 118), *ὠμὴ κύθρα . . . πομασθεῖσα καὶ περιπλασθεῖσα πηλῶ* - a raw pot . . . sealed and smeared with clay (Diosc., *Mat. med.* II 4, V 76) *οἱ ἔστω τῆς χύτρας τὸ πῶμα ὠμὸν* - the pot's cover shall be raw (Holm. 480). The use of clean, or rather new earthenware vessels is a common practice preventing undesirable effects due to former absorptions: *τιθέασι εἰς τὰς καμίνους χύτρας καινὰς* - they put new pots in the furnace (Th., *Lap.* VIII, 54), *καινῶ ἀγγεῖω κεραμεῶ* - in a new earth-enware vase (Diosc., *Mat. med.* A72), *χύτρα καινὴ* - new pot (Gal., *Comp. loc.* I 420), *σκευὸς καινὸν ὀστράκινον* - new earthenware vessel (Gal., *Comp. loc.* I 431), *ἀγγεῖον κεραμεοῦν καινὸν* - new earthenware vase (Gal., *Comp. loc.* I 433), *λωπᾶς καινὴ κεραμεῦ πλατύστομος* - new broad-necked earthenware pot (Gal., *Comp. gen.* V 823), furthermore *ἄγγος καθάριον* - clean vessel (Leid. 218), *ὄστρακον καινὸν* - new clay vase (Leid. 226), *χυτρίδιον καινὸν* - small new pot (Holm. 298), *βατάνιον καινὸν* - new plate (CAG 222), *χύτρα ἄθικτος* - untouched pot (CAG 300), *ἄγγος νέον πυρίμαχον* - new, fire-resistant vessel (CAG 318), *τριβλίον καθαρὸν* - clean dish (CAG 366), *βικίον καθαρὸν* - clean flask (CAG 383). The material may be porous: *κεραμεοῦν δοχεῖον ἀκόνητον, τοῦτέστιν ἀπίσσωτον* - earthenware vessel not smeared with tar (Diosc., *Mat. med.* I 71, 99), *κεράμιον ἀπίσσωτον* - earthenware vessel not smeared with tar (CAG 29), *χύτρα ἀνάλειπτος* - earthenware vessel not smeared on (CAG 380), or of close texture: *ἀσύμποτον κυθρίδιον* - pot absorbing small pot (CAG 75), *ἀποτίθεσθαι ὑέλινους ἀγγεῖους ἢ ὀστρακίνοις κόμμι κεχρισμένοις* - put it in glass or clay vessels smeared on with turpentine (Gal., *Comp. gen.* VII 1044), *ὑάλινα σκευὴ τὰ γὰρ ὄστρακα ἵνα μὴ πῖη τὴν βαφὴν* - use glass apparatus, for clay may absorb the reactants (CAG 176).

Glass, an inert material *par excellence*, allows the manufacture of high quality laboratory appliances, sole important

objection to their wide use being their fragility. Thus, care about these vessels is continuous: *ἀγγεῖον ὑέλινον εὐτόνον* - a strong glass vase (CAG 490), *πατέλιον παχὺ ὑάλιον* - a thick glass plate (CAG 365), *βίκους ὑέλινους μεγάλους, παχεῖς, ἵνα μὴ ραγῶσιν ἀπὸ τῆς θερμῆς* - glass flasks, big and thick, so that they do not crack when heated (CAG 225), *βησσίων ὑάλινον κεχρισμένον πυριμάχῳ πηλῶ* - a glass flask smeared on with fire-resistant clay (CAG 350), finally: *ἀναγκαῖον τὸ ἄγγος τὸ ὑέλινον διὰ πηλοῦ κεραμικοῦ ἐπιδερματίδα ἡμιδακτυλαίαν, ἵνα μὴ τὸ ἄγγος ῥῆξιν ὑπομένη διὰ τῆς θερμῆς* - it is necessary for the glass vessel to be covered with a clay layer half an inch thick, so that it will not break when heated (CAG 250) and *περιδεύουσιν ἐξῶθεν τὰ ὄργανα ἐκ δευτέρου καὶ τρίτου, ἵνα τὴν πύρωσιν ἐκστρέψωνται* - they wrap up the apparatus two or three times to prevent overheating (CAG 135). It is noteworthy that precious metals find sometimes the same applications: *ἀγγεῖον ὑελοῦν ἢ ἀργυροῦν* - a glass or silver vessel (Gal., *Comp. loc.* VII 54) or *ἀργυρᾶ λεπτὴ φιάλη* - a thin silver flask (Gal., *Comp. gen.* VII 1057).

Copper and its alloys are a basic material for pots, jars and cauldrons: *ἄγγος ἐρυθροῦ χαλκοῦ* - red-copper vessel (Gal., *Comp. gen.* II 545), *χαλκοῦν χυτρίδιον* - small copper pot (Holm. 141), furthermore: *ἐν χαλκεῖῳ ἐψεῖν* - heat in a copper cauldron (Hipp., *Mul.* I 105, 228), *χαλκεῖον βαλανίου* - copper cauldron used in baths (CAG 361, Holm. 133), *χαλκεῖον ὕδατος* - copper water-jar (Holm. 669). Rather restrained is the presence of other metals: *κασσιτερινὸν ἀγγεῖον* - tin vessel (CAG 362), *ἀγγεῖον μικρὸν μυρρωτικὸν κασσιτερινὸν* - a small perfumery vessel made of tin (Gal., *Comp. gen.* VII 1043), *ἀγγεῖον μολυβοῦν* - lead vessel (CAG 323) or *μολυβοῦν χαλκεῖον* - lead cauldron (Holm. 939), finally *λέβης κεκασσιτερωμένος* - pewtered cauldron (Diosc., *Mat. med.* I 30), *ἀγγεῖον χαλκοῦν γεγανωμένον* - pewtered copper vase (CAG 490). Among further materials, the box tree wood finds constant use: *πύξινον χυτρίδιον* - small box tree pot (Holm. 149), and so do osiers suitable for baskets and panniers - *σπυρίδια, κυρτίδες, γυργάθεια*.

Noteworthy are, finally, several *sui generis* reaction vessels belonging to the natural world and serving various necessities, from the possibility of consuming them: *βαλῶν εἰς ῥοιᾶς κενώματα καὶ τὸ στόμιον στέατι περιπλάσας, ὅπτα ἐπ' ἀνθρώκων, ἔπειτα τὴν*

ροϊάν ἀποκαθάρας δίδου φαγεῖν - put the drug into a pomegranate and tighten it with dough, then bake it over charcoal, peel the fruit and give it to be consumed (Gal., Comp. loc. IX 302) or their handiness: ταῦτα ἐμβάλλειν εἰς ἐχίνον καινόν καὶ τὸν οἶνον ἐπιχέαντα πυριῆν - put them into a sea urchin, pour wine over it and heat it (Hipp., Mul. II 206, 400), κενώσεις εἰς κογχύλην - pour it into a sea shell (CAG 323), to the participation in the reaction: ἐγκρύψας εἰς ἰσχάδα λιπαράν - put it into a fat fig (Holm. 214) or βάλε εἰς βολβὸν ἢ εἰς κρουφίκιν καὶ περισκέπασον στέατι ἄρτου καὶ ὄπτα φούρνῳ ἢ κλιβάνῳ - put it in a bulb, tighten it with bread dough and bake it in an oven or furnace (CAG 369).

Greatest care is taken for the tightness of the appliances. Should sometimes a hole appear necessary: χύτραν ἐξ ὀστράκου καινήν . . . τρήσον τέττερσί που τρήμασιν αὐτῆς τὸ σῶμα - take a new earthenware pot . . . and pierce four holes into its body (Gal., Ther. XIV 291) or ἔχον τὸ ἄγγος πόρον διὰ τὴν ἔξοδον - the vessel bears a hole for the removal of gaseous products (CAG 26), the insistence on sealing - φίμωσις is by far more common: κεράμιον ἐπιμελῶς φίμου - seal carefully the vessel (Holm. 495), ἔστω περιμωμένον τὸ ἄγγος - the vessel should be sealed (Holm. 504), θές εἰς καινὸν ἄγγεῖον περίφιμον ὡς τὸ ἔθος - put it as usually in an new and well sealed vessel (CAG 52), φίμωσον βίκον ἀσφαλῶς - seal the flask securely (CAG 303). Thus, the properties of the cover or stopper are mentioned in detail: τὸ πῶμα ὠμὸν - the cover shall not be baked (Holm. 480, 485), φίμωσον μετὰ πυριμάχου πηλοκαρβῶνους τὸ στόμα βίκου - seal the neck of a flask with fire-resistant earthenware (CAG 38), or εἰς λωπάδα ἀγάνωτον βαλὸν πώμασον πώματι χαλκῷ - put it in a non pewtered pot and cover it with a copper cover (CAG 220), furthermore: λίθον φρύγιον εἰς χυτρίδιον καινὸν ἐμβάλλοντες, εἴτα περιπηλοῦντες ἔξωθεν, ἐπιτιθέντες δὲ πῶμα τετρημένον - put a phrygian stone in a small new pot, smear it with clay and cover it with a cover bearing holes (Gal., Comp. loc. IV 727), χύτρα πῶμα τετρημένον ἔχουσα - a pot with a cover bearing holes (CAG 654). The tightening is brought about by smearing on the system with clay before heating: τιθέασι εἰς τὰς καμίνους χύτρας καινὰς περιπλάσαντες πηλῷ - they put in the furnace new pots smeared on with clay (Th., Lap. VIII, 54), πομάσας τὸ χυτρίδιον περιπήλωσον τὸ πῶμα - cover the pot and smear on the fittings with clay (Holm. 335), ἐπιχρίσας ἀσφαλῶς τὸ

. . . πῶμα μετὰ τοῦ ὀκονομημένου πηλοῦ - smear securely the stopper . . . with the clay you have kept (CAG 363), περιπήλωσας τὰς ἀρμονίας - smear the joints with clay (CAG 362).

As substitutes to earthenware serve wax, resins, bread dough, egg white: περίπλασον τὸ ἄγγος κηρῷ - smear on the vessel with wax (Holm. 553), πεπομάσθω τὸ χυτρίδιον καὶ περιπεπλάσθω καὶ στέατι - cover the pot and tighten it with dough (Holm. 276), συμπηλώσας τὰς συμβολὰς στέατι ἄρτου - smear on the joints with bread dough (CAG 225), φιμώσας μετὰ ζύμης καὶ ὄου τὸ λευκὸν - seal with dough and egg white (CAG 332), πομάσας ἄλατι καὶ πηλῷ - seal it with salt and clay (CAG 300), more generally: περιπήλωι στέατι ἢ κηρῷ ἢ πηλῷ ἢ ὡς βούλει - smear it on with dough or wax or clay or in any manner you wish (CAG 237), περιπήλωσας . . . στέατι ἢ γύψῳ ἢ προπόλει ἢ ἐλαιοκονίᾳ ἢ ὡς βούλει δὸς ὀπτάσθαι - smear on . . . with dough or clay or propolis or plaster or in any manner you wish and heat it (CAG 141).

The references on adequate depot vessels for medicines and perfumes are extremely detailed: διὸ καὶ εἰς ἄγγεῖα μολυβδᾶ ἐγγέουσι καὶ τοὺς ἀλαβάστρους ζητοῦσι τοιοῦτου λίθου. ψυχρὸν γὰρ καὶ πυκνὸν καὶ ὁ μόλυβδος καὶ ὁ λίθος ὁ τοιοῦτος . . . ὥστε δ' ἄμφο τηροῦσι, καὶ τῷ ψυχρῷ καὶ τῷ πυκνῷ, μήτε διέντες ἔξω τὴν ὀσμὴν μηθ' ὄλωσ' ἐπιδεχόμενοι μηδὲν - that is why they put them into vessels of lead and try to secure phials of alabaster, a stone which has the required effect: for lead is cold and of close texture and stone has the same character . . . so that vessels made of these materials keep the perfume well for both reasons, their coolness and their closeness of texture: they neither let the odour pass away through them, nor do they take in anything else (Th., Odor. 41), unguenta optime servantur in alabastris - ointments are better kept in alabaster vases (Pl., Nat. hist. XIII 3, 19), or ἀποτίθεσθαι ὅσα εὐώδη τυγχάνει ἐν κιβωτίοις φιλυρίνοις ἀνοτίστοις. ἔστι δ' ὅτε ἐν χάρταις ἢ φύλλοις χρησίμως περιδεῖται . . . πρὸς δὲ τὰ ὑγρά φάρμακα ἀρμόσσει ὕλη πᾶσα ἐξ ἀργύρου ἢ ὑάλου ἢ κεράτων γεγενήμενη, καὶ ὀστρακίνη δὲ ἢ μὴ ἀραιὰ εὐθετος, ξυλίνων δὲ ὅσα ἐκ πύξου κατασκευάζεται. τὰ δὲ χαλκᾶ ἄγγεῖα ἀρμόσσει πρὸς τὰ ὀφθαλμικὰ ὑγρά καὶ ὅσα δι' ὄξους ἢ πίσης ὑγρᾶς ἢ κεδρίας σκευάζεται. στέατα δὲ καὶ μυελούς ἐν κασσιτερίνοις ἀποτίθεσθαι - odoriferous drugs should be kept in dry lime tree boxes; sometimes even paper or leaves may serve as wrapping

material . . . moreover, liquid medicines should be kept in containers made of silver, glass or horn; clay of close texture and box tree wood would also do; copper vessels are adequate for eye drops and for preparations using vinegar, turpentine or cedar resin; keep fats and marrow in tin vessels (Diosc., *Mat. med.* 19). It should be mentioned that already at minoan times perfumed oil is stored in broadnecked alabaster vessels¹¹.

Furthermore, of primary importance is the role of fire, most essential element and determinant factor of all chemical processes:¹² *πρῶτον αἴτιον καὶ μάλιστα τῆς ὅλης τέχνης τὸ πῦρ ἐστίν, ὡς καὶ τῶν δ' στοιχείων πρῶτον τυγχάνον* - for fire is by far the determinant factor in the art and at the same time the most essential of the four elements (CAG 78). As a matter of fact, of actual use are rather simple devices, e.g. bath or kitchen ovens - *βαλανεία* or *ὀπτάνια*, the recipes focusing mainly at the way of heating. Indeed. The type of wood or coal has always been the object of careful observations: *χρεία δὲ ἀνθρώπων ἄλλων ἄλλη. πρὸς ἓνια γὰρ ζητοῦσι τοὺς μαλακοὺς, οἷον ἐν τοῖς σιδηρίοις . . . πρὸς δὲ τὰς καμινίας καὶ τὰς ἄλλας τέχνας ἄλλη ἄλλοις χρήσιμοι. ἐμπυρεύεσθαι δὲ ἄριστα συκῆ καὶ ἐλάα* - but different kinds of charcoal are used for different purposes: for some uses men require it to be soft; thus in iron-mines . . . for the crafts requiring a furnace and for other crafts various woods are serviceable according to circumstances; for kindling fig and olive are best (Th., *Hist. plant.* V 9) or *ἔψει ξύλοις ἐλαῖνοις* - use olive tree wood for heating (CAG 362), *καύσατε ἐν δαφνίνοις ξύλοις* - burn it by means of bay tree wood (CAG 180), *ἢ κάμιнос καιέσθω ξύλοις καὶ λεπύροις φοινίκων* - the furnace should make use of palm-tree wood and leaves (CAG 188). The amount of heat - *ἢ τῶν φώτων ποσότης* (CAG 147), is scrupulously given: *ἔπειτα ἔψειν, ἀνακινέων ὡς μὴ φρυγῆ, μαλθακῶ πυρὶ* - then boil, stirring it so that it may not be burnt, at a gentle fire (Hipp., *Ulc.* 12, 414), *ἀνθρακιᾶ ἐγκρύψαντας ἄχρις ἐκπυρώσεως* - keep it into glowing embers until it burns out (Diosc., *Mat. med.* V 109), *ὀπτησον ἐλαφροῖς φωσὶ* - heat at a gentle fire (CAG 155), *ἐλαφρῶ πυρὶ ὑπόκαιε* - put it over a gentle fire (CAG 391), *βάλε ἐπὶ θερμοσποδιάς μὴ ἐχούσης τὸ πῦρ διάπυρον, ἀλλ' ἐπὶ θερμοσποδιᾶν πραεῖαν* - put it over the fire, not a vivid but a gentle fire (CAG 60), *ἔασον καίεσθαι ἐν ἴσῳ πυρὶ* - let it burn at a uniform fire (CAG 76), while quite common is the

warming up in dung - *πυροκόπρος* (CAG 311): *πυρώσας ἐντίθει εἰς κόπρον ὀρνίθειον* - heat it and then put it in poultry dung (Leid. 370), *δὸς ὀπτάσθαι ἐν ἰπτεία κόπρῳ ἢ ὄνεια ἢ οἶα δῆποτε συμμέτρῳ θερμοσία, εἴ τι βαστάζει ἡ χεὶρ ἀνθρώπου* - let it be heated in horse or donkey dung, or into any means that bears an analogous temperature, not exceeding what a man's hand can stand (CAG 141) or *δὸς ἐμπύρῳ κόπρῳ βοῶν* - put it in fresh beef dung (CAG 300).

Testimonies on antique laboratory techniques are rather accidental, as they are usually found in textes having broader or even different aims. Nevertheless, the importance of the procedures cited remains evident: critical inheritors of old traditions and forerunners of recent methodology, they constitute a primordial parameter in the evolution of ancient greek science and an important factor in the construction of the medieval world.

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Abbreviations

- Hipp., *Mul. I, II*: HIPPOCRATES, *De mulieribus liber primus/secundus*.
 Hipp., *Nat. mul.*: HIPPOCRATES, *De natura mulierum*.
 Hipp., *Ulc.*: HIPPOCRATES, *De ulceribus*.
 Th., *Odor.*: THEOPHRASTUS, *De odoribus*.
 Th., *Lap.*: THEOPHRASTUS, *De lapidibus*.
 Th., *Hist. plant.*: THEOPHRASTUS, *Historia plantarum*.
 Diosc., *Mat. med.*: PEDANIUS DIOSCORIDES, *De materia medica*.
 Gal., *Comp. loc.*: CLAUDIUS GALENUS, *De compositione medicamentorum secundum locos*.
 Gal., *Comp. gen.*: CLAUDIUS GALENUS, *De compositione medicamentorum per genera*.
 Gal., *Ther.*: CLAUDIUS GALENUS, *De theriaca*.
 Pl., *Hist. nat.*: PLINIUS SECUNDUS, *Historia naturalis*.
 CAG: Collection des anciens alchimistes grecs.
 Leid.: Papyrus de Leyde.
 Holm.: Papyrus de Stockholm.

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Articoli/Articles

PAGINE DI ODONTOIATRIA E DI ODONTOLOGIA
NEL MONDO ANTICO

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SUMMARY
AN OUTLINE OF ODONTOIATRY AND ODONTOLOGY IN
THE ANCIENT WORLD

Dentistry was surely practiced in ancient Egypt, Mesopotamia, Phoenicia, Etruria, Greece and Rome, but odontology arose only with the dawn of Greek science. One may find the first references to a rational odontology only in the fragments of the Pre-socratic philosophers and in the Corpus Hippocraticum.

Aristotle was the first to treat odontology under a comparative anatomophysiological point of view. Celsus and Scribonius Largus got their matter from Hippocrates, Aristotle, the Hellenistic anatomists as well as from folk-traditions, but payed attention rather to dentistry than to odontology. Finally Galen gathered all the knowledge about odontology and dentistry from Hippocrates up to the Hellenistic anatomists and organized all the matter in his monumental teleologic and theological system, that was inherited by both the so called iatrosophists and the Byzantine physicians.

Dalle origini ad Aristotele

Quando, nella seconda metà del secolo scorso, in coincidenza con la nascita dell'Odontologia e dell'Odontoiatria come branche a sé della Medicina, nacque la *Paleodontologia*, le ricerche e le scoperte paleontologiche e palenologiche avevano già raccolto e messo a disposizione della nuova scienza migliaia di denti, vuoi singoli (e, quindi, o caduti spontaneamente per cau-

Key words: Odontoiatry - Odontology - Dental mechanics - Dental surgery