Inorganic substances and their uses in Nikolaos Myrepsos’ *Dynameron*. Recent applications in modern therapy

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**ARTICLE INFO**

Handling Editor: Dr. Aristidis Tsatsakis

**Keywords:** Inorganic drugs, Mineral salts, Stones, Earths, Nikolaos Myrepsos, Dynameron, Byzantine medicine

**ABSTRACT**

Inorganic compounds have been known and used since antiquity. *Dynameron* is the largest Byzantine medical manuscript divided into 24 sections, in accordance with the letters of the Hellenic alphabet, which contains 2667 recipes. The majority of them contain ingredients of plant origin, followed by animal origin, while fewer inorganic substances are quoted. In the present study, the latter ones are listed. Moreover, the information on the uses of inorganic ingredients in the treatment of many diseases in the late Byzantine era is presented and their evaluation in light of the modern Pharmacology and Toxicology.

1. Introduction

Since archaic period, several minerals, metals, clays, and rocks were among the natural products used by the healers in different civilizations. Later on, inorganic medicinal substances can be found in the writings of Hippocrates, Dioscorides, Galen and many other physicians of classic Hellenic, Hellenistic and Byzantine eras.

In continuation to our previous reports [18, 19, 22], the present study aims to the documentation and assessment of the information concerning the inorganic ingredients quoted in Nikolaos Myrepsos’ *Dynameron*, which remains largely understudied. Our main source material is its recent digital edition [20]. This treatise was written in Greek on the late Byzantine period (13th century) and includes 2667 recipes, where more than 300 plants are quoted, as well as 93 animals, 16 anatomical parts of different animals and 34 animal by-products. The influence of previous medical Hellenic, Roman and Byzantine treatises is obvious. Also, some Arabic drugs are incorporated.

The present study focuses on the use of inorganic substances, such as chemical elements, mineral salts, some semi-precious and precious stones and earths present in the formulations described in *Dynameron*, one of the most extensive medical treatises ever been. In ancient times, mineralogy existed as a Chaldean custom. Magicians used gemstones and as they believed in their beneficial effect, they used to place them on the body for protection against various diseases. This belief, as a remnant of much older times, has been maintained for centuries and it was especially favored in middle age and later on by a lot of physicians and alchemists.

2. Material and methods

In our study, we used the critical editions, published in two volumes with a German [20] or with an English introduction [21], which are also available in a digitalized form.

Only a few Hellenic codices of *Dynameron* rescued to our days [20] and a printed Latin translation [8]. The book contains 2667 recipes and it is divided into 24 sections, named “Elements” from “Alpha to Omega”, according to the letters of the Greek alphabet. Each recipe contains information on the indication(s), the ingredients and also instructions for their mixing in order to be used by the patient or the physician.

Most of the ingredients are plants [18, 19], but there are several recipes containing also ingredients of animal origin [22] and proportionally a few minerals.
| Name in the book | Common name/ Symbol | Indications as in the book | Indications translated |
|------------------|----------------------|----------------------------|------------------------|
| 1. ἀργυρος [argyros] | silver Ag | a ψήθεσις | a Tuberculosis |
|                  |         | b βής | b cough |
|                  |         | c στομαχίανος | c stomach pain |
|                  |         | d άθαναμία μάτης | d body weakness |
|                  |         | e έταιροι καὶ άθαναμία νεφρῶν | e kidneys' atony and weakness |
|                  |         | f φρασίον | f vesicular diseases |
| 2a. ἀρσενικὸν [arsenikon] | arsenic As | a ὄξωσις | a Applied to puncture wounds caused by nails |
|                  |         | b χορδαί | b scrofula |
|                  |         | c χαλαζία | c chalazion |
|                  |         | d έσοπτηματα | d abscesses |
|                  |         | e ψυχετίμα | e swelling of the glands, esp. of the groin or armpit; blister |
|                  |         | f ἄγγεια, θήμα αληθή | f beast bites |
|                  |         | g στειτίματα | g steatoma |
|                  |         | h ομορρίαδες | h hemorrhoids |
|                  |         | i ξεοχύτες | i external piles |
|                  |         | j έπιγυμνοσία | j cataract |
|                  |         | k ἀμφιλίκευσις | k amblyopia |
|                  |         | l τύμιο | l callus |
|                  |         | m πέρας | m digestion |
|                  |         | n νύχια | n fresh and healthy look |
|                  |         | o νάρ | o noma (cancerum oris) |
|                  |         | p σηκεύδα | p decay, putrefaction |
|                  |         | q θνοίας | q hence, carbuncle, malignant pustule (acc. to some, small-pox) |
|                  |         | r πετρόνα | r disease of the eye (when a membrane grows over it from the inner corner) |
|                  |         | s ὑπεροστάσεως | s purulent ears |
|                  |         | t οπορφυγία | t overgrown flesh |
| 2b. σανδραχή, σανδραχήγον [sandrace; sandracche] | arsenic As | ld. | |
| 3. χρυσός [chrysson] | Gold Au | a φήθεσις | a Tuberculosis |
|                  |         | b βής | b Cough |
|                  |         | c στομαχίας | c Digestive |
|                  |         | d άθαναμία μάτης | d asthenia |
|                  |         | e έταιροι καὶ άθαναμία νεφρῶν | e renal failure |
|                  |         | f φρασίον | f sexually transmitted infections |
|                  |         | g ψάρια μάτης | g body cold |
|                  |         | h λισθημα εἰς ἐγκεφαλοκοσμία | h collapse |
|                  |         | i κυρίας συγκοιλία | i to pregnant woman |
|                  |         | j κυρίας συγκοιλία | j heart attack |
|                  |         | k μελαγχολία | k melancholy |
|                  |         | l κεραία | l mania |
|                  |         | m μέλαρες | m beast bites |
|                  |         | n θηρόδοσίμα | n every disease |
|                  |         | o φυλακτής | o fracture |
|                  |         | p νεφρὸς κέρας | p nerve pains |
|                  |         | q δυσμένειας | q eye disturbances |
|                  |         | r κεφαλαία | r headache |
|                  |         | s ψυχαρτημέας | s nerve suffering |
|                  |         | t κεραίσμα | t carcinomas |
|                  |         | u στειτίμα | u steatoma |
|                  |         | v στειτίμα | v scrofula |
|                  |         | w χειρόκτονος | w scrofula |
| 4. χαλάς | Copper Cu | a πάροια | a Cirrhosis |
|                  |         | b καταγχηματη | b fractures |
|                  |         | c τρίημα | c wounds healing |
|                  |         | d έμφθεις ἐν τῷ στομάχῳ | d worms in the stomach |
|                  |         | e τοῦ φάραγγος καὶ τῶν νουτῶν | e pharynx and nose inflammations |
|                  |         | f κεραία | f emetic |
|                  |         | g συρίχας | g angina |
|                  |         | h κολλίων νεφρῶν | h nerve adhesive |
|                  |         | i κολλίων νεφρῶν | i muscle collapse |
|                  |         | j μαὼν διακοπή | j sinus adhesive |
|                  |         | k κολλίων κώλιος | k ulcers |
|                  |         | l κέλμα | l cysts |
|                  |         | m μελακρύσις | m beast bites |
|                  |         | n θηρόδοσίμα | n every disease |
|                  |         | o πυό σάτος | o fracture |
|                  |         | p θυλάσμα | p nerve pains |
|                  |         | q νεφρῶν πάσος | q eye disturbances |
|                  |         | r άθαναμίας | r headache |
|                  |         | s κεφαλαία | s nerve suffering |
|                  |         | t κεραίσμα | t carcinomas |
|                  |         | u κεραίσμα | u steatoma |
|                  |         | v στειτίμα | v scrofula |
|                  |         | w χειρόκτονος | w scrofula |
| Nonmetal | | | |
| 5. θῖος (İπιρος) | Sulfur S | a άλοιπτικία | a alopecia |
|                  |         | b Ψηράς | b scale |
|                  |         | c έλαιονία | c antheminish |
|                  |         | d άρεπίτια | d erysipelas |
|                  |         | e έλαιόμης | e pleurisy |
|                  |         | f ἄξεια | f a festid polypus |
|                  |         | g δερχημίας | g corrosion |
|                  |         | h ιόης | h nomas |
|                  |         | i πήγαρος | i thickening |
|                  |         | j θρώμοντος προσώπου | j redness of the face |
|                  |         | k ὑδατίκτον | k dropy |
| Name in the book | Common name/Symbol | Indications as in the book | Indications translated |
|------------------|--------------------|---------------------------|------------------------|
| 1. διαβροντινον [alavantinon] | almadine Fe₃Al₂Si₃O₈₃ | ἐμμεναγού | emmenagogue |
| 2. διαβροντισ [alavastros] | alabaster probably onyx marble; type of carbonate mineral | ἄμμος ὑπωπυρικαὶ καὶ ἑμμεναγού πάθῃ | hysteria and renal ailments |
| 3a. δίας γάγριμον [alas gaggrinon] | | | |
| 3b. σάλτζεμα [saltzema] | halite (rock salt) NaCl | | |
| 4. δίας ὀμονικουν [alas ammoniakon] [ammoniakon] | Sal ammoniac (NH₄Cl)? or soda | | |
| 5a. ύτερον [nitron] | soda ash (natron) In antiquity: sodium carbonate; modern nitron: nitric salts mainly potassium nitrate & sodium nitrate | | |
| 5b. ἵσθην ύτερον [erythron nitron] | υτροπηνικὰ φιλατι = ντροπῆς | | |
| 6. μᾶσως ὀξυς [misys opinis; misy] | iron pyrite FeS₂ or Chalcopyrite CuFeS₃ or copper sulphates with ferrous sulphate and zinc impurities | | |

(continued on next page)
Salts and/or oxides of copper produced during clearing.

Table 2

| Name in the book | Common name/Symbol | Indications as in the book | Indications translated |
|------------------|--------------------|---------------------------|-----------------------|
| 7. στεφτηρία σχιστή [stephtyria schistil] | Potassium alum commonly encountered as KAl(SO₄)₂·12H₂O | a) άλυση | a) polyps |
|                  |                    | b) οὐδέν πλασιάθρια | b) shrinking gums |
|                  |                    | c) οὐδέν τά ἐν τοῖς στόματα καὶ | c) gums and mouth rashes |
|                  |                    | ξυμάθητα | d) painless tooth extraction |
|                  |                    | d) οὕτως οὖν ἄλυσις ἕλοσυ | e) black eyebrow tint |
|                  |                    | e) οὐδέν τάς μείζονες πωθήσεως | f) encanthus |
|                  |                    | f) ἡγείσθη | g) dysentery |
|                  |                    | g) δισσυσιτερία | h) abdomen disorders |
|                  |                    | h) κυλωκάκις πώς | i) erysipelas |
|                  |                    | i) ἑκποτελέσει | j) malignant ulcers |
|                  |                    | j) ῥοζομόνιος ἐλέγχ | k) ear tumors |
|                  |                    | k) συμμάχοιντα ἐν ὕτε | l) any tumor |
|                  |                    | l) ὑπηρίκαίσις | |

Table 3

Salts and/or oxides of copper produced during clearing.

| Indications | Heating; wound healing; against erysipelas, herpes, mororrhagia; as collyrium to treat swollen and hard eyelids |
|-------------|-----------------------------------------------------------------------------------------------------------|
| ὑ χαλακάθης | chalkanthe; fem. |
| τὸ χαλάκαθον | chalkanthe; neutr. |
| τὸ χαλάκων | chaleeon; neutr. |
| ὕ χαλάκης | chalkit; fem. |
| ὃ χαλάκης | chalkit; masc. |
| ἥ χαλάκη | chalk; fem. |
| τὸ χαλάκων | chaleeon; neutr. |
| χαλάκιτια | chalkitida |
| σπόδιον | spodion |
| σποδή | spodi |
| σπόδιου, -ος, -ου | spodios, spodia, spodion |
| σποδός, ὑ | spodos; fem. |

For the interpretation of the inorganic material, we used Dioscorides’ Materia Medica [23], Stephanides’ The Theophrastus Mineralogy (1897) [16] and Caley & Richards’ Theophrastus On Stones (1956) [5], as well as the NIST database [12]. Actually, the first three books were useful, while by the database, we confirmed that most of the encountered names used in the past do not exist anymore.

We have also quoted in the Tables the pathological conditions for which these materials were proposed in Dynameron trying to determine the nosological conditions according to the modern medical terminology. In the manuscript, there are several pathological conditions with terms originating from antiquity, which can be found in texts of earlier authors [1]. It is noteworthy that these terms are not always clear and are not used by all authors in the same way. However, earlier descriptions facilitated the work of scientists during the 18th and the 19th centuries, who studied and classified the diseases [3]. Additionally, it should be noticed that the ancient name of a specific illness or ailment does not necessarily correspond to the one used by modern medicine, despite apparent similarities.

3. Results and discussion

The research presented in this article focuses on the inorganic substances applied as remedies in Dynameron, which are presented in Tables 1–5. Of the 2667 recipes of Dynameron, 822 includes inorganic ingredients, at least 54 different ingredients in total.

Most of the inorganic substances do not concern minerals properly, but stones and earths; actually, they do not belong to minerology, but to petrology, being igneous materials or sedimentary. The separation of petrology to minerology took place at the end of the 19th century. Aristotle (4th c. B.C.) in his manuscript Meteorologica, as well as his discipline Theophrastus (4th c. B.C.) in his work on Stones [5,16] placed together the inorganic products of human industry with the minerals and stones [10].

In Dynameron, 5 metals, i.e. arsenic, silver, gold, iron and copper; and one nonmetal element, sulphur, are quoted (Table 1). Silver was mentioned in the Hippocratic Corpus, under the name flos of silver (ἀετός χρυσός) and dust of silver (σκωρία χρυσός) [16]. In addition, several mineral salts (Table 2) are found under different names, as progressively the Greek language incorporated latinized and nitzo-barbarian words. Special portion of the inorganic materials constitute the salts and oxides of copper (Table 3). Stones and earths (Table 4) from different areas around the East Mediterranean basin, mainly from the Aegean islands and the Hellenic colonies in Asia Minor, are mentioned. In most cases, the names of the stones are derived either from their physical properties, either from the name of the place of their origin, e.g. achate stone from Ace of Sicily. Similarly, the names of the earths coincide with the name of the areas where the certain earth is abundant, e.g. Samiou asteroes, earth from the island of Samos [16]. The differentiation in their inorganic content resulted a plethora of indications, which allowed the physicians to treat several skin and eyes lesions and other ailments (Tables 1–5).

Finally, in Table 5, amber and pearl are categorized as miscellaneous inorganic products. Amber is fossilized tree resin with inorganic elements, while pearl, although composed of inorganic compounds, such as calcium carbonate (mainly aragonite or a mixture of aragonite and calcite), is produced within the soft tissue of a living shellled mollusk or another animal.

In all Tables, information is given on each quoted inorganic substance, including the name, the potential interpretation and the therapeutical indications.

The most cited elements were arsenic/sandarach, sulphur and copper, followed by gold, while silver was mentioned few times. Ammonia salt and sandarach were ingredients used in the preparation of trochisci, drying powders applied to wounds, soaps, poultries and liniments. Copper, gold and silver were similarly used excluding soaps, but also in collyria and antitodes. Sulphur was mostly incorporated in patches, trochisci, pessaries, in recipes used for the treatment of alopecia, in drinking powders applied to wounds, in lichen smears, in sprinklings, collyria, patches, against sebum and as antitodes.

Ammonia sal, nitron and misy were widely used, while fewer refers are found for halite (sal gagnarum) and alum. Among medicinal salts, ammonia sal was always used in every recipe; these salts were used mainly as laxatives. The dominant ingredients in ointments against inflammations were ammonium sal, nitron (salpetre) and nitric components. Misy was the ingredient used in ear patches and medicines, trochisci, powders, lichen smears, poultries and in sprinklings. Alum was ingredient in suppositories, sprinklings, poultries, against hemorrhoids, sebum, as well as in powders, dental medicines, pessaries, soaps, trochisci and ear patches.

Copper oxides run through all Dynameron, as recipes ingredients reported for the treatment of specific diseases such as healing, wound healing, erysipelas, herpes, mororrhagia. Moreover, they were included in collyria to treat swollen and hard eyelids. Among the stones and
| Name in the book/Mentioned in the text (Page/Line) | Common name/Symbol | Indications as in the book | Indications translated |
|------------------------------------------------|------------------|-----------------------------|------------------------|
| 1 ἱδρυς & ἱδρυς λίθος [indikon & indikos lithos] | Indian agate | a φλεγμόνη | a against inflammations |
| 2a ἁμαρτίας [haematitisis] | | b ἀπόθεμα | b abscesses |
| | | c Ἠλις | c ulcers |
| | | d σμηνυτικό διηγήμα | a astringent, |
| | | e ἡμερινοίς | b in poultries |
| | | f ἀσωματικά | c against skin rashes |
| | | g έξεκασμάτων | | |
| | | h ἐξοπέλατα | | |
| | | i Ἐλευσία | | |
| | | j κύρτης | | |
| | | k μνεμοσυνών | l noma |
| | | l μνεμοσύνης | m rheumations pustules |
| | | m ἡμερινοίς | | |
| 2b μύλος Σίμισσης (–αμαρτίας) [milto siinopitias (– haematitisis)] | haematite [Fe₂O₃] | | |
| 3a Ἀρμενιός [armenios] | | a δοσετήμα | a dyssenter, apoppy (defective |
| | | b λεντερία | digestion) |
| 3b Ἀρμενικός [armeniakos] | Bright red mineral colorant | b δηλήτρις | b arthritis |
| | | c στομαχάτος | c disordered in the stomach |
| | | d σπέρματος | d splenic ailments |
| | | e μελαργία | e melancholy |
| | | f κοιμιάλγα | f headache |
| | | g δηλημάσεας | g eye ailments |
| | | h τεταρτικός (στενοχόν) | h tertiary fever |
| 4a Ἁπιος [asios] | | a σάμιρας | a scharius (hard dense cancerous |
| | | b περιδόθεν | growth) |
| | | c δηληταίας | b eye excessive pain |
| | | d διαφοράς | c desiscant |
| | | e κολλούσες κόλλας | d diaphoretic |
| | | f μεταμικρεσίων | e scrofula, gout, sinus and joints |
| | | g στραγγάλαις | adhesives, |
| | | h τοις δηλήμασας | f rheumations |
| | | i τοις δηληματοι | g against head |
| | | j λέγης | h joints |
| | | k προς λεικώματα | i eye ailments |
| | | l στερικαλις | j lichens |
| | | m δηληταίας | k amylobeia |
| | | n δηληταίας | l splenic ailments |
| | | o δηληταίας | m dropsy |
| | | p τοις καταστάσεις | n scrofula and |
| | | q προς διακρατικός τε & πέτρυρα | p noma and sepsis |
| | | | q anthrax |
| 5 ἄγαθος [achatis] | Agate SiO₂ (Chalcedony variety) | | |
| 6 ὑφάσκον [borahios]: | Borax [Na₂B₄O₇(OH)₄ 8H₂O] | | |

(continued on next page)
| Name in the book/Mentioned in the text (Page/Line): | Common name/Symbol | Indications as in the book | Indications translated |
|---------------------------------------------------|--------------------|-----------------------------|------------------------|
| 7 Γαγάτης [gagatis] | Gagate stone; the name derives from the ancient city Gagai of Lycia | a ἐλέχθαις ἐν τῷ σῶματι καὶ ψυγίζει | f dandruff |
| | | b ἀπὸ ἐπιστροφής καὶ δημηκάσιον πῦνος καὶ ἐπὶ διψῆς υγρῶν | a epilepsy |
| | | c ἐς αὐθεντίας ἑρωδοῦν καὶ ιόμων | b headache, migraine, insomnia |
| | | d Υψητάτῳ θημίσει | c valva scars and noma |
| | | a μὴ μελημαχεῖσθαι | d incense for insomnia |
| 8 Γράφανος [geranos] = Ἰάσπις Ἰάζολον | | a μὴ μελημαχεῖσθαι | |
| | | b μὴ συγκαταμένος | |
| | | c μὴ ἔριθαμαν | |
| | | d μὴ ἐπαινοῦν | |
| 9α Ζάμφυρος [zephyros] | | a πρὸς ἐλεφατούμασις | |
| 9b Ζέφυρος [zephyros] | | b βρεχοῦς | |
| | | c δρυμωδοῖς | |
| | | d μὴ ἕτοιμος καὶ λιπωδήματα καὶ συγκατήρ | |
| | | e καρδικαίς | a elephantiasis (filariasis) |
| | | f διαφορτικοῖς | b cough |
| | | g ὑπὸν ἔπειε | c high blood pressure |
| | | h ὄξινον στέλλει | d asthma, fainting |
| | | i βῆξι νάει | e heart attack |
| | | j ἐμένον ἀμορτός δυστέλλει | f diaphoretic |
| | | k πάθει στίγμων καὶ πνευμάτων καὶ σταλάξιοὺς | g sleep-inducing |
| | | l τῶν νεφρῶν σύνοι τα καικολοικοῖ δομήτι | h reduces lacrimation |
| | | m στραγγοτρισμόν καὶ δυσπυρέ μάρτι | i antiviscous |
| | | n καπνοῦ ἐν νεφρῶι καὶ ἐστότοις λάει καὶ ὄρηται | j hemoptysis |
| | | o βοην ἀμορτός σφέγγει | k chest, lung, viscera |
| | | p δέμοις ψύχεις παραμετρι | l kidneys pains |
| | | q ἀδέοτας φέρει | m stragaria (droplet urination), dysuria |
| | | r καπνοὺς ῥειμάει | n kidney and bladder stones |
| | | s καπνοὺς ἐν νεφρῶι καὶ ἐστότοις λάει καὶ ὄρηται | o hemostatic |
| | | t καπνοὺς σφεγγαί | p carminative |
| | | u καπνοὺς σφεγγαί | q sudorific |
| 9c Ζάμφυρος [zephyros] | Sapphire | | |
| 10 Ἰάσπις [jaspis] | Jasper | | |
| 11 Ιουδαίος [ioudaikon] | Judaic/ Jerusalem stone | | |
| 12 Λαζόρου [lazourion] = Δ̄πης λάζουλος | Lapis lazuli [mixture of minerals mainly of lazurite: tectosilicate mineral with sulfate, sulfur and chloride] | | |

(continued on next page)
Table 4 (continued)

| Name in the book/Mentioned in the text (Page/Line): | Common name/Symbol | Indications as in the book | Indications translated |
|------------------------------------------------------|-------------------|---------------------------|-----------------------|
| **13 Λίτζι [litzi]—, λίθος λαζορόδος** | Sapropílos | g. turgididios | h. stomach and splenic ailments |
| | | a. melagynèia | a. melancholy |
| | | b. μυκητία | b. heart attack |
| | | c. λυπιδόμα | c. fainting |
| | | d. καρδική δίπτη | d. sanguine temperament |
| | | e. μανία | e. mania |
| | | f. κατάληψη σφην | f. necrosis |
| | | g. κακόχρους εκ μεταλλικού χρώματος | g. bad skin color due to excess of black bile |
| | | h. στυμεθένιος σκέλος | h. bone porosis and scirrhosis |
| | | i. στ στυμεθένιος σκέλος | i. bone porosis and scirrhosis |
| | | j. στυμεθένιος σκέλος | j. bone porosis and scirrhosis |
| | | k. στυμεθένιος σκέλος | k. bone porosis and scirrhosis |
| | | l. στυμεθένιος σκέλος | l. bone porosis and scirrhosis |
| | | m. στυμεθένιος σκέλος | m. bone porosis and scirrhosis |
| | | n. στυμεθένιος σκέλος | n. bone porosis and scirrhosis |
| | | o. στυμεθένιος σκέλος | o. bone porosis and scirrhosis |
| | | p. στυμεθένιος σκέλος | p. bone porosis and scirrhosis |
| | | q. στυμεθένιος σκέλος | q. bone porosis and scirrhosis |
| | | r. στυμεθένιος σκέλος | r. bone porosis and scirrhosis |
| | | s. στυμεθένιος σκέλος | s. bone porosis and scirrhosis |
| | | t. στυμεθένιος σκέλος | t. bone porosis and scirrhosis |
| | | u. στυμεθένιος σκέλος | u. bone porosis and scirrhosis |
| | | v. στυμεθένιος σκέλος | v. bone porosis and scirrhosis |
| | | w. στυμεθένιος σκέλος | w. bone porosis and scirrhosis |
| | | x. στυμεθένιος σκέλος | x. bone porosis and scirrhosis |
| | | y. στυμεθένιος σκέλος | y. bone porosis and scirrhosis |
| | | z. στυμεθένιος σκέλος | z. bone porosis and scirrhosis |
| | | | a. arthritis |
| | | | b. reducing the excess phlegm |
| | | | c. melancholy |
| | | | d. gout |
| | | | e. kidney and urinary bladder |
| | | | f. disorders produced by cold temperament |
| | | | g. whole body coldness |
| | | | h. cardiac failure |
| | | | i. fainting |
| | | | j. of pregnant women |
| | | | k. hystery |
| | | | l. heart attack |
| | | | m. asthenia |
| | | | n. bone porosis |
| | | | o. bone porosis |
| | | | p. bone porosis |
| | | | q. bone porosis |
| | | | r. bone porosis |
| | | | s. bone porosis |
| | | | t. bone porosis |
| | | | u. bone porosis |
| | | | v. bone porosis |
| | | | w. bone porosis |
| | | | x. bone porosis |
| | | | y. bone porosis |
| | | | z. bone porosis |
| | | | a. stomach |
| | | | b. spleen |
| | | | c. kidney |
| | | | d. liver disorders |
| | | | e. headache |
| | | | f. any illness of hypochondriasis |
| | | | g. arthritis |
| | | | h. favus |
| | | | i. necrosis |
| | | | j. for good temperament |
| | | | k. diaphoretic, scrofula and gout |
| | | | l. scirrhosis |
| | | | a. porosis |
| | | | b. any carcinoma |
| | | | a. chronic ophthalimia |
| | | | a. cardiac disorders |
| | | | b. myocardial infraction, fainting |
| | | | c. elephantiasis |
| | | | a. effective in difficult disorders |
| | | | b. trachoma |
| | | | (continued on next page)
| Name in the book/Mentioned in the text (Page/Line): | Common name/Symbol | Indications as in the book | Indications translated |
|--------------------------------------------------|--------------------|-----------------------------|------------------------|
| Συριακός [syriakos] | Syrian stone | a ὑπόστις σώματος | a ashenia (weakness), |
|  |  | b λυσποδία | b fainting, |
|  |  | c συγκοπή καρδίας | c myocardial infarction, |
|  |  | d καρδία | d cardiac disorders, |
|  |  | e διαφθοράς | e diaphoretic, |
|  |  | f υρίας σώματος | f for good temperament, |
|  |  | g περιέχει εὐσφακίαν | g corpulence, beautiful color, |
|  |  | h χύμων καρδίας | h valva ulcers |
|  |  | i ἐπικρύστη τοὺς ἐν τῇ κόστε ἱλίσκος | a kidney stones removal, |
|  |  | b στραγγισμὸς, δοσολογία καὶ λειτυς | b droplet urination, dysuria |
|  |  | c πρὸς τὰ βερυματικὰ πάθη | a rheumatism, |
|  |  | d πρὸς ἅπασταμάτα | b abscesses |
|  |  | e πρὸς χαλανόματα | e carcinomas |
|  |  | f φύτεμα | d favus, |
|  |  | g νικρὼπες σώματος | e body necrosis, |
|  |  | h παυκεῖ συρακίων | f for good temperament, |
|  |  | i πρὸς πάνως καὶ ἄλλους παντοίους σκυρίας ἐγκόπος | g cirrhosis, |
|  |  | j πρὸς ἄκος, ἱμισιδον | h removes ear tumors |
|  |  | k ἐκμυκένος | l tumors |
|  |  | λ ὑπόστις σώματος | a dysentery, abdominal ailments |
|  |  | b λευστερικός | b lientery |
|  |  | c κολασικός καὶ εἰς πάνω κοιλικὴ ἱάτος | c apepsy (defective digestion), |
|  |  | d Ἡμιλαντοῦ πρὸς κολασικός, σπερμακός καὶ στομαχοκός | d plasters for abdominal, splenic, stomachic |
|  |  | e πρὸς αὐτοχρώτικας | e ailments, nerve related diseases, |
|  |  | f εἶ ὁμοτιτοῖκον | f against hemoptysis, |
|  |  | g πρὸς κεφαλοκλίαν καὶ ἕμμερφων πάνω | g headache, migraine, as incense for insomnia, |
|  |  | h πυρόμακτον ἐμπλοτες | h removes any dirty spirit, |
|  |  | i ἐκκακτίστην πνεύμα | i against evil eye and envy |
|  |  | j πρὸς βασικόν καὶ πρὸς πάντα φόθου | j menstruation, metrorrhagia, |
|  |  | k πρὸς μοί γυναίκη καὶ σφυραγίων ὑπέρτας | k removes ear tumors |
|  |  | l καταστέλλει τὰ ἐν ω ὑπάρκτορα | l tumors |
|  |  | m ἐκποτάτον | m hemostatic, antihemorrhagic, |
|  |  | n ὑποστηρικός | n nerve related ailments |
|  |  | o κολλητική κατά τῆς ἀφίμανος | c applied in chest |
|  |  | p πλαγογράμμιτος | f vagina adhesive |
|  |  | q ἐκτίθεται κατὰ τῶν ὀμίσχους | g inflammations and ulcers |
|  |  | r κολλητική κατά τῶν ὀμίσχους | h starting ophthalmia |
|  |  | s πυρετικά κάλυμα | i purulent ulcers |
|  |  | t ἐπικρύστη τοὺς ἐν τῇ κόστε ἱλίσκος | j pustules |
|  |  | u ἔκφρας κατὰ τῶν ὀμίσχους | k bruises |
|  |  | v ἔντεινες κατὰ τῶν ὀμίσχους | l bites |
|  |  | w ὑποστηρικός | m dropy |
|  |  | x ἐκκακτίστην πνεύμα | n colic |
|  |  | y πυρετικάς | o womb ailments |

(continued on next page)
Table 5
Miscellaneous inorganic products.

| Name in the book/Mentioned in the text (Page/Line): | Common name/Symbol | Indications as in the book | Indications translated |
|-----------------------------------------------------|---------------------|-----------------------------|------------------------|
| 1a ἐλεκτρον [elektron]                               | amber fossilized tree resin with inorganic elements |
| 1b ἐρυθρὸν ἐλεκτρον [erythron elektron]               | pearl               |
| 2a Μαργαρίτηρον (neutr.) [margaritarion] Μαργαρίτιρ (neut.) [margaritari] |                       | a kidney ailments, b headache, c stomachache, d dysentery, e dysmenorrhea |
| 2b ὁ μαργαρίτης (masc.) [o margaritias]              |                       | a kidney ailments, b headache, c stomachache, d dysentery, e dysmenorrhea |

Table 4 (continued)

| Name in the book/Mentioned in the text (Page/Line): | Common name/Symbol | Indications as in the book | Indications translated |
|-----------------------------------------------------|---------------------|-----------------------------|------------------------|
|                                                      |                     | k πράξει τούς μή ὑποφέρουσας δήλῳ |                       |
|                                                      |                     | l ὑδροσακούς                    |                       |
|                                                      |                     | m κολλακίου                    |                       |
|                                                      |                     | n πράξει ὃστεραν               |                       |

In antiquity, three well-known scientists, whose manuscripts survived, used inorganic substances as healing agents, Nicander of Colophon (2nd c. B.C.), Dioscorides (1st c. A.D.) and Galen (2nd c. A.D.), being all of them Greek. Also, Pliny the Elder’s (1st c. A.D.) encyclopedia De Historia Naturalis refers to minerals and other inorganic compounds, but the section on these materials derives from a lost treatise of Xenocrater of Ephesos (1st c. A.D.) [10].

Comparing the inorganic substances of Tables 1–5 with those described in Dioscorides’ Materia Medica [23], the matching is remarkable, although there is a time distance of more than thousand years. Moreover, many references to minerals and chemicals are also found in the Muslim medical literature of the Eastern and Western Caliphates [9]. It is also noticeable the similarity in number and nature of the inorganic ingredients used for medicinal purposes in the Levant Medieval and early Ottoman periods [9]. Most of the mentioned fifteen inorganic substances, namely alum, arsenic, sulfides, asphalt, jew’s stone, earth sp., galena, haematite, iron, lead, pyrite, salt, sulphur, thermal water, green vitriol, and zinc, can be also found in Tables 1–5. A notable tendency to use these substances for treating diseases of the skin, the eyes, the sexual organs, and haemorrhoids was detected in the Muslim medical literature [9], as well as in Nikolaos Myrepos’ Dynameron. In the latter byzantine manuscript, most of them were used as ingredients of poultices for treating diseases of the skin and the eyes. Moreover, sulphur (Table 1), halite (Table 2), sapphire (Table 3), earth from Samos (Table 4) were part of antidotes against snakes, scorpions and other venomous bites (Tables 1–5). Only in few cases, they were added in preparations for internal use. Although, in archaic Antiquity, stones were used according to their so-believed “magic” properties, there is only two such cases, namely of iaspis, used as exorcism against rhinorrhea and of terra sigillata used against evil eye and envy. The name iaspis is not clear that refers to jasper or according Plinius to a form of pills (1st c. A.D.) encyclopedia.

Taking into consideration that the traditional Hellenic medicine is very well documented in a considerable number of texts since the 8th century BC, the Byzantine physicians had a well-established arsenal of inorganic elements quoted in inorganic products.

It is obvious that the medieval physicians knew their dose-dependent intoxication. The significance of the right dose has been recognized for centuries [17]. Moreover, most remedies including inorganic ingredients were administered externally for the short period.
that lasted the disease, thus reducing the possibility of toxic effects.

Metal has obvious importance in our modern way of life. Inorganic substances are still in the arsenal of therapeutic agents. Nowadays, ferric Spiritus other effective drugs. Electuaries composed of gold, pearls and precious element into the others and finally to gold [11]. Before the alchemical age. The main interest of the alchemists in this element was related to their efforts to induce material transformations of one less precious ancients; they were also produced by many alchemists of Middle Ages, from China of its intravenous administration to achieve remission in patients with acute promyelocytic leukemia [24,2]. In the beginning of 2000s, FDA and EMA approved an injectable solution of arsenic trioxide for all stages of acute promyelocytic leukemia, relapsed cases, or as first-line treatment. It is very potent against this rare form of leukemia caused by a genetic ‘translocation’ (when there is a swap of genes between two chromosomes). Another medicine based to arsenic discovered in 1910 by Dr. Paul Ehrlich, salvarsan (also known as arsenicalis Fowleri, an arseneou solution was prescribed as a tonic to treat malignant anaemia, probably due to the increased pigmentation of the cheeks, as chronic arsenic poisoning induces increased capillary fragility [15]. In the 1990s, there were reports from China of its intravenous administration to achieve remission in patients with acute promyelocytic leukemia [24,2]. In the beginning of 2000s, FDA and EMA approved an injectable solution of arsenic trioxide for all stages of acute promyelocytic leukemia, relapsed cases, or as first-line treatment. It is very potent against this rare form of leukemia caused by a genetic ‘translocation’ (when there is a swap of genes between two chromosomes). Another medicine based to arsenic discovered in 1910 by Dr. Paul Ehrlich, salvarsan (also known as arsphenamine), was used to treat syphilis until the launch in market of penicillin after the World War II. In 1949, melarsoprol was introduced for the treatment of human African trypanosomiasis (sleeping sickness) and still the World Health Organization (WHO) is recommending it in combination with other drugs [15]. Actually, melarsoprol is donated by WHO to the countries where the disease is common. Today, both inorganic and organic arsenic preparations are still manufactured for medical and veterinary uses.

Gold-based remedies have been used against several diseases since ancient times; they were also produced by many alchemists of Middle Age. The main interest of the alchemists in this element was related to their efforts to induce material transformations of one less precious element into the others and finally to gold [11]. Before the alchemical era, gold was administered as solid gold leaves suspended in wine, “Spiritus” (distilled alcohol) and this preparation was appeared in official Pharmacopoeias. However, the alchemists came to the conclusion that a liquid gold preparation could be more active and safer [15, 14]. Gold therapy in the 17th century was systematically advertised and all forms of gold were used. Gold dominated for some time and displaced others extraction drugs effectuates; preparations of gold, pearls, and animal grains were remedies for restoring and maintaining health and preventing disease. Moreover, gold medications were thought to have rejuvenating properties because of their shine. It is reported that Louis XI, who was epileptic, used gold in drinks, enemas, liniments to treat epileptic seizures. Louis XIV tried with gemstones to regain his youthful vigor and in his old age paid exorbitant sums for gold preparations [7]. Some gold thiolate drugs, first introduced in the 1920s, are still clinically used today and are included in the class of disease-modifying antiinflammatory drugs (DMARDS), that primarily slow the progression of the disease [4]. Auranofin, an oral gold salt was approved for clinical use in 1985. Although, it may no longer be the drug of choice for rheumatoid arthritis, it has the potential to be repurposed for some cancers, parasitic infections, bacterial infections, HIV and even neurodegenerative disorders, such as Parkinson’s disease and Alzheimer’s [13].

Moreover, a considerable number of new metallooid candidates have been developed as new anticaner drugs and anti-infectives. In addition, inorganic substances at concentrations below the threshold of toxicity are used for drug delivery systems and diagnosis [25]. Furthermore, by offering historical context and discussion about the ingredients of ancient and medieval medical manuscripts, we bring in light their perpetual presence hitherto in some modern medicines. 4. Conclusion

Inorganic compounds have been known and used for medical purposes since antiquity. The present study focuses on the inorganic ingredients quoted in Dynamic, an enormous Byzantine medical manuscript, which contains 2667 recipes of which 822 include inorganic substances. In total, at least 54 different inorganic ingredients are referred. In comparison with herbal and animal products their number is considerably lower. The most cited elements were arsenic/sandarach, sulphur and copper, followed by gold, while silver was mentioned few times. Most encountered disorders were mainly ophthalmic and ear diseases and skin lesions. It is also important that the concentration of these inorganic substances was at sub-toxic levels for a short period avoiding both chronic and acute intoxication.

Conflict of Interest

The authors declare no conflict of interest.

Declaration of Competing Interest

The authors report no declarations of interest.

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