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Between al-Rāzī and the Pseudo-Rāzī: Classifying Matter and Composing an Alchemical Handbook

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Abstract. This contribution focuses on two Arabic alchemical treatises that circulated under the name of the 10th century philosopher, physician, and alchemist Muḥammad ibn Zakarīya al-Rāzī: the genuine *Book of Secrets* (*Kitāb al-Asrār*) and the spurious *Book on Alums and Salts*. The two treatises are discussed in the context of al-Rāzī's genuine and spurious production and of their reception among Western scholars. By examining the contents and structural features of these two treatises, this work seeks to shed light on the relationship between perceived authority, structure, and laboratory practice in medieval alchemy.

Keywords: Alchemy; Medieval Science; Early Chemistry; Transmission of Knowledge; Muḥammad ibn Zakarīya al-Rāzī

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INTRODUCTION

When, in 1144 CE, the Latin translation of an alchemical epistle attributed to the Umayyad Prince Khālid ibn Yazīd (fl. early 8th c.) started circulating under the title *Liber de compositione alchimiae*, the Latin world had its first exposure to alchemical doctrines that were considered a complete novelty.[1] The innovative character of the materials expounded in this translation is made explicit in a brief text known as *Prefatio Castrensis,* a work that is often connected to the text of the *De compositione alchemiae* and whose authorship is still debated.[2] What appears to be beyond doubt is the fascination that this new translation exerted on its Latin readers. The interest that it sparked is mirrored by the proliferation of Arabic-Latin translations of alchemical works in the 12th and 13th centuries. As highlighted by Moureau, the phenomenon of reception, acquisition, and assimilation of the Graeco-Arabic alchemical heritage into Latin can be roughly described as a sequence of waves, that included: a) translation of Arabic treatises into Latin; b) composition of Latin compendia and works under the strong influence of Arabic models; c) composition of original and autonomous Latin alchemical treatises.[3] It is through this process that the 'canon' of medieval Latin alchemy was formed, a canon that kept influencing alchemists and early chemists up

to at least the 18th century.[4] The alchemical material that entered the Latin world reflected the different ways in which alchemists had written about their subject matters in Arabic and in Greek even before: while some authors had kept loyal to the esoteric nature of alchemy and had made sure their alchemical teachings were sheltered from the greedy approach of the uninitiated by employing an allegorical style and a coded lexicon (*Decknamen* and alchemical symbols),[5] others–few and far between–had laid down their teachings on alchemy in plain language and simple prose.

This contribution will focus on two Arabic alchemical works of the latter kind that circulated (genuinely or pseudo-epigraphically) under the authoritative name of the 10th century philosopher, physician, and alchemist Muḥammad ibn Zakarīya al-Rāzī: the *Book of Secrets* (*Kitāb al-Asrār*) and the *Book on Alums and Salts*.[6] After setting the two works in the context of al-Rāzī's genuine and spurious production, and of their reception among Western scholars, I analyse in this article their similarities and differences in contents and structure, and provide materials for problematising the relationship between perceived authority, structure, and practice in alchemy.

THE *BOOK OF SECRETS* AND THE *ON ALUMS AND SALTS*: TWO PRACTICE-ORIENTED ALCHEMICAL HANDBOOKS

The tenth-century polymath Muḥammad ibn Zakarīya al-Rāzī is considered one of the towering figures of medieval Islamic thought. Born in Rayy (now in Iran), his vast production covered medicine, pharmacology, toxicology, alchemy, philosophy, and religion.[7] Al-Rāzī's extant philosophical production represents only a small part of his writings, since the tradition of the works that gained him the fame of 'free-thinker of Medieval Islam' was weakened by a form of *damnatio memoriae:* his most controversial ideas, that included a harsh criticism of prophecy, are now only preserved in treatises by al-Rāzī's opponents who report his opinions in order to criticize them.[8] The lasting fame of al-Rāzī was assured by his career as a physician and director of the hospital of Baghdad and by his medical works, that circulated widely in the Arabo-Islamic world, and became extremely popular in Europe in their Latin translations. Apart from a number of shorter monographs on specific medical topics (and these include, for instance, an innovative treatise *On Smallpox*), al-Rāzī dedicated a major compendium of medicine, the *Kitāb al-Manṣūrī fī al-Ṭibb* ("The Book on Medicine for Al-Manṣūr"), to his patron Manṣūr b. Isḥāq, the Sāmānid governor of Rayy. His students collected also the medical notes and observations of their teacher in the extensive *Kitāb al-Ḥāwī fī al-Ṭibb* ("The Comprehensive Book on Medicine"), which is considered a *unicum* for its time of production, since it contains and reports on several medical cases derived from the physician's daily medical practice and presents an unstructured, yet thorough, approach to medicine.[9]

In the field of alchemy, the works composed by al-Rāzī are listed by the 10th century bibliographer Ibn al-Nadīm in the tenth and final chapter of his *Kitāb al-Fihrist* ("Book of the Index"):[10] a volume composed in twelve sections known as the *Twelve Books*, the first part of which had an autonomous circulation under the title *Al-Madkhal al-Taʿlīmī* ("The instructive introduction"),[11] a *Sirr al-Asrār* ("Secret of Secrets"),[12] a small group of titles that do not appear to have reached us, and the *Book of Secrets,* which will be the focus of this article.

In the introduction of the *Book of Secrets,* al-Rāzī explains his motivation for writing the treatise:

> What led me to write this book was the request of a young student of mine from Balkh called Muḥammad ibn Yūnus, knowledgeable in mathematics (*al-riyāḍiyyāt*), natural philosophy (*al-ʿulūm al-ṭabīʿiyya*) and rhetoric (*al-manṭiqiyya*) […] He asked me […] to put together for him something on the secrets of the works of the Art (*asrār afʿāl al-ṣanʿa*) that could be a guide (*imām*) and an example (*dustūr*) to which he could return.

He then praised the accomplishment of this work:

> I composed this book of mine, and with it I have presented him with what I have never presented to any king nor prince. I have explained to him what is needed for the science of the art (*ʿilm al-ṣanʿa*, i.e. alchemy) [deriving it] from all my books on this topic; I presented him with a concise book […] From the procedure (*tadbīr*) that I have explained, the bodies (i.e. metals, *ajsād*) are elevated gradually to the top of the furnace, his aim is reached with an easy procedure (*tadbīr*), [the bodies] are deconstructed and [then] returned to their first condition (*ḥālatahu al-ūlā*) […]

And underlines the exceptionality of such a plain and explicit exposition of the alchemical art:

> […] If I did not know about the elapsing of my days (*inṣirāf ayyāmī*), […] I would have never collected all that I have collected in one single book through thorough examination.

Finally, al-Rāzī provides a brief outline of the structure of the treatise:

> […] This book of mine includes the knowledge (*maʿrifa*) of three topics: the knowledge of the ingredients (*maʿrifat al-ʿaqāqīr*), the knowledge of the instruments (*maʿrifat al-ālāt*), and the knowledge of the operations (*maʿrifat al-tadābīr*).[13]

Al-Rāzī's claim to have presented his student with a unique compendium of all one needs to know for practicing alchemy is reflected by the exquisitely operational nature of this treatise and its comprehensive table of contents: the *Book of Secrets* appears to truly encompass all one needs to master in order to perform alchemical operations in the laboratory. The fame of its author as an accomplished physician and alchemist together–as will be argued below–with the usability of the contents of the treatise itself cooperated to assure a certain diffusion of the work in Arabic, as shown by the existence of several Arabic manuscript copies of the work in European and Indian libraries.[14] An edition of the Arabic *Book of Secrets* was published in 1964 in Tehran under the sponsorship of the UNESCO; this edition has the merit of allowing access to al-Rāzī's work, but cannot be considered a reliable critical restitution of the text. [15] The production of a critical edition of the *Book of Secrets* remains a scholarly desideratum. The *Book of Secrets* attracted the attention of the 12th century Arabic-into-Latin translators in Toledo and in particular of Gerard of Cremona, whose translation of the first two sections of the treatise is preserved in MS Paris 6514 of the Bibliothèque Nationale. The fame that the *Book of Secrets* enjoyed in the Latin world is testified by the existence of several Latin copies which were studied and partially edited and translated into German by Ruska.[16]

As anticipated, the truly exceptional character of this alchemical treatise in the context of the contemporary Arabic alchemical production lies in its clear structure, its thoroughness, and the plain language and style in which ingredients, apparatus, and operations are dealt with. In consideration of these features, the *Book of Secrets* attracted praise among early 20th century historians of chemistry, and al-Rāzī became an *ante litteram* hero of the scientific approach to the natural world. Few quotations from secondary literature devoted to the *Book of Secrets* clearly convey the kind of positivistic enthusiasm and–one may point out– "precursorism" with which the alchemical contents of the *Book of Secrets* were received. In their 1927 contribution on the alchemy of the *Book of Secrets,* Stapleton, Azo and Hidayāt Hussain write:

> For the first time in the history of the world we find a systematic classification of carefully observed and verified facts regarding chemical substances, reactions, and apparatus, described in language which is almost entirely free from mysticism and ambiguity.[17]

and on al-Rāzī they write:

> [he] was the most noteworthy intellectual follower of the Greek philosophers of the seventh to the fourth centuries B.C. that mankind produced for 1900 years after the death of Aristotle.[18]

This re-assessment of the chronology of the insurgence of a 'modern' approach to chemistry was a great preoccupation for these historians of alchemy, as stated in the opening of their work:

> Our aims are confined, in the first place, to supporting the thesis that in 900 A.D. such a degree of exact knowledge of chemical substances and apparatus was displayed that historians may henceforward be justified in antedating the birth of scientific Chemistry by – in all probability – at least 900 years.[19]

Gerard Heym, some ten years later, expressed a similar judgement in an article that considered the alchemical ideas conveyed in al-Rāzī's works in the context of the intellectual and religious currents running through the Islamic world in the 10th century:

> al-Rāzī transformed alchemy for the first time into a science based on experiment. That accounts for the great vogue of his alchemical works, especially in the West: it was his scientific approach to the problems of nature that attracted the best minds for 700 years. [20]

Julius Ruska, who partially translated the Arabic original and edited and studied the Latin translations of the work, in consideration of the contents and style of the *Book of Secrets*, defines al-Rāzī as the founder of a new alchemy ("Begründer einer neuer Alchemie") and as the person who "rendered alchemy in a strictly scientific form."[21] In the almost one hundred years that separate us from the research of these pioneers of the history of alchemy in the Islamic world, more evidence has been unearthed and more authors and treatises have been studied. In addition, historians of science have moved away from presentism or teleological narratives that look for a direct line of transmission from an ancient origin. In the field of alchemy, it has been proved that highly allegorical and encoded texts can also convey effective and reproducible alchemical operations while, at time, even the plainest of recipes derived from one of the 'chemical' works of al-Rāzī can present interpretational and technical challenges to the modern reader and the modern chemist.[22]

The treatise that will be analysed and compared with the *Book of Secrets* is the *Book on Alums and Salts*, at times attributed to the same Al-Rāzī, but very likely a spurious work composed in Islamic Spain during the 12th century, and almost immediately translated into Latin. The Arabic original of the *On Alums and Salts* is only represented by a fragmentary copy preserved in a multiple-text manuscript in Berlin's Staatsblibliothek (MS Sprenger 1908, ff. 19r-30 v), which contains neither a specific title page for the treatise nor colophon, and no indications of authorship, copying circumstances and dating are found. The heading for the whole manuscript reads *Kitāb al-jawhar al-naḍīr fī ṣināʿat al-iksīr li Abī ʿAbdallāh al-Ṭuġrā'ī* ("*The Book of the Blooming Gem in the Preparation of the Elixir* by Abū ʿAbdallāh al-Ṭuġrā'ī") which appears to misrepresent the contents and authorship of the manuscript.[23] In the 12th century, the Arabic *On Alums and Salts* attracted the attention of one of the most influential Arabic-Latin translators of the Middle Ages, Gerard of Cremona, who was active in Toledo, Spain, and had already worked on the *Book of Secrets*. Not only did Gerard translate the treatise, he also contributed something else that proved crucial for the future fame of this work: he attributed it to a certain Bubacher Magumet filius Ceceri Arrasi, which is a crude Latin rendition of the name of Muḥammad ibn Zakarīyā al-Rāzī, the author of the aforementioned *Book of Secrets*. The *On Alums and Salts* appears–together with a *Liber divinitatis de LXX,* the first treatise from the *Book of the Seventy* by Jābir ibn Ḥayyān, and an anonymous *Luminis luminum*–among the alchemical works listed in the *Commemoratio librorum*, a catalogue of Gerard's translations compiled by members of his circle, which circulated together with Gerard's *Vita* and *Eulogium*.[24]

We currently know of seven manuscripts of the Latin translation of this work, dating from the 14th and the 15th century,[25] and of a 16th-century printed edition, which appeared as part of the *Compendium Alchemiae* attributed to John of Garland and published in Amsterdam in 1560 by Basilius Johannes Herold.[26] The similarity of style and contents between the *On Alums and Salts* and the *Book of Secrets* must certainly be taken into account as one of the reasons for the misattribution of the former. Moreover, the same two treatises are found together in one of the oldest manuscripts preserving Latin alchemical texts, the so-called 'Codex Speciale' (Biblioteca Comunale di Palermo, MS 4 Qq A 10). Both treatises were described by Isidoro Carini towards the end of the 19th century in an account of the history of occult sciences that is chiefly based on a survey of the contents of the aforementioned Sicilian manuscript.[27]

While the first editor of a Latin version of the *On Alums and Salts,* Robert Steele, considered the treatise as an original work by al-Rāzī, Julius Ruska advanced a series of very sensible objections to the traditional attribution.[28] At the current state of knowledge, Ruska's opinion that the Arabic *On Alums and Salts* is a product of an anonymous Arabic alchemist active in al-Andalus during the 11th-12th century appears as the most plausible. In order to grasp the whole picture of the contents of the *On Alums and Salts* one cannot rely exclusively on the extant Arabic manuscript, from which entire sections of the work are missing. For the aim of this article, I have relied on the contents of the Latin translations, when the Arabic text is not available, and supplemented them with the contents of a peculiar early-modern Hebrew version of the same treatise.[29] This Hebrew version was probably produced in Northern Italy by an alchemist who not only translated from a more complete Arabic *Vorlage* than the one now extant, but also actively intervened in the text and its margin, adding notes, comments, opinions and quotations of other works. In particular, the Hebrew translator appeared to keenly intervene in the content of the alchemical recipes of the *On Alums and Salts* by adding in the text itself; in the margins this same translator inserted a large number of comments and notes that clearly derive from an active practical engagement with the text and are the result of a process of 'practical exegesis'.[30] Alternative quantities, substitute ingredients, and different operations were also introduced in the Hebrew version of the *On Alums and Salts,* giving the clear impression that the Hebrew copyist sought practical, operative applications to the text he was reading.

In all accounts, the *On Alums and Salts* shares with the original *Book of Secrets* a similar approach to alchemical doctrines that points at the laboratory rather than the library and at an alchemical production that, being devoid of allegorical images and complex *Decknamen*, aims at recording laboratory recipes and techniques in the most straightforward (and reproducible) way possible.

It should not surprise us that also the *On Alums and Salts* was considered by the 20th-century historians of chemistry as a precursor of modern positive chemistry. Robert Steele titles his edition of a Latin version of the work "Practical Chemistry in the 12th century" and opens his contribution by stating: "This work, the first known to Western Europe dealing with the preparation of chemical substances for use in subsequent operations, must rank as one of the classics of chemistry and pharmacy".[31] Julius Ruska, who edited the Arabic text and edited and translated the Latin version of the work on the basis of the text found in the aforementioned *Compendium Alchemiae* and a selection of Latin manuscripts, titled his monograph *Das Buch der Alaune und*

Saltze. Ein Grundwerk der spätlateinischen Alchemie, "a basic work of late Latin alchemy", somehow by-passing the Arabic origin of the treatise. In the conclusion of the introduction to his edition, Ruska writes that "the unity and internal uniformity of the work becomes apparent" ("so ist zunächst di Geschlossenheit und innere Einheitlichkeit der Schrift sichtbar geworden") and that "the descriptions of the most important substances are carried out according to a uniform plan and from a uniform understanding" ("die Beschreibungen der wichtigsten Stoffe sind nach einem einheitlichen Plan und aus einer einheitlichen Auffassung heraus durchgeführt"). Ruska stresses the practical interests of the anonymous author and his claims to present truthful recipes and procedures ("Er betont an zahlreichen Stellen die eigene Erfahrung und ermahnt den Leser, sich durch Versuche von der Richtigkeit seiner Angaben zu überzeugen").[32] Based on the present analysis of this section of text, we may conclude that both the *Book of Secrets* and the *On Alums and Salts* were composed and are intended to be read as practical alchemical handbooks, operative guides for the alchemists where substances are organised according to their physical and chemical properties, and recipes are described step-by-step in clear language and plain style, at least if we compare these two works with most of the contemporary alchemical materials in circulation.

CLASSIFYING ALCHEMICAL MATTER

The alchemical operations described in both the *Book of Secrets* and the *On Alums and Salts* rely on a precise classification of the ingredients that enter the alchemical work. These classifications, which are based on the analysis of a specific ingredient's behaviour when exposed to external agents (heating, cooling, compressing, etc.) or combined with other ingredients, are mutually consistent in almost all respects.

In the first section of the *Book of Secrets*, alchemical ingredients *(ʿaqāqīr)* are distinguished as earthy (*barrāniyya*), vegetable (*nabātiyya*) and animal (*ḥayawāniyya*). Earthy substances, that are central in the alchemical work according to Al-Rāzī are of six different kinds: spirits (*arwāḥ*), bodies (*ajsād*), stones (*aḥjār*), vitriols (*zājāt*), boraxes (*bawāriq*), and salts (*amlāḥ*). These six kinds represent the smallest groupings of earthy substances, below which al-Rāzī mentions individual substances. Spirits are mercury (*zi'baq*), sal ammoniac (*nushādir*), sulphur (*kibrīt*) and arsenic (*zarnīkh*); bodies are the seven metals: gold (*dhahab*), silver (*fiḍḍa*), iron (*ḥadīd*), copper (*nuḥās*), tin (*qalāʿī*),[33] lead (*usrub*) and *khārṣīnī*; stones are marcasite (*marqashīshā*), magnesia (*maġnīsiyā*), iron oxide (*daws*), tutty (*tūṭiyā*), lapis lazuli (*lazawārd*), malachite (*dahnaj*), turquoise (*fayrūzaj*), hematite (*shādanj*), arsenic oxide (*shakk*), antimony (*kuḥl*), mica (*ṭalq*), gypsum (*jabsīn*) and glass (*zujāj*); vitriols are black vitriol (*al-aswad*), yellow vitriol (*al-aṣfar*), alum (*shabb*), *qalqand, qalqadīs, qalqaṭār* and *sūrī*; boraxes are bread borax (*bawraq khubzī*), natron (*naṭrūn*), borax of the art (*bawraq al-ṣināʿa*), *tinkār*, borax of *zarāwand*, borax of the West (*bawraq al-ġarb*); salts are good sweet salt (*al-milḥ al-ṭayyib al-ḥulw*), bitter salt (*al-milḥ al-marr*), salt of Andara (*al-milḥ al-andarānī*), salt of *ṭabarzad* , salt of naphtha (*milḥ nafṭī*), Indian salt (*milḥ hindī*), salt of the egg (*milḥ bayḍī*), alkali salt (*milḥ al-qalī*), salt of urine (*milḥ al-bawl*), salt of borax (*milḥ al-nūra*), salt of ashes (*milḥ al-ramād*).[34]

In the *Book of Secrets*, al-Rāzī does not devote much space to vegetable substances, which are discussed in a chapter of the third and final section of the treatise. Al-Rāzī argues that these are of not much interest to the alchemist, apart from the ashes of a plant found in the proximity of swamps called *ushnān*. Substances derived from the animal realm and employed in alchemy are more numerous and relevant: hair, skull, brain, egg, gall, blood, milk, urine, mother of pearl, and horn.[35] Al-Rāzī's account is arguably the most precise description of the contents of the cabinet of a medieval alchemist that has reached us, and shows the clear traces of a tendency towards simplification, organisation, and systematisation that characterises the *Book of Secrets*. Some of the substances mentioned in this classification may require few words of explanation. The list of the seven metals is concluded by the mention the *khārṣīnī*, which is often translated as 'Chinese iron' or as 'Chinese arrowhead' (*al-Ṣīn* is the Arabic for China). Stapleton, Azo and Ḥidāyat Husain devoted some remarks to the identification of *khārṣīnī*, which they considered significant also as a hint to the sources of al-Rāzī's alchemical ideas.[36] In their opinion, the presence of *khārṣīnī* places the origin of al-Rāzī's ideas on metals in Ḥarrān (in modern Turkey), and in particular among its Sabian inhabitants who were heirs of Greek as well as Babylonian technical traditions. They also go as far as hypothesizing possible traces of a connection between the tradition of Chinese alchemy and Islamic alchemy for which, even after almost a century of research, no substantial evidence has been found. Among the different kinds of vitriol, four names are employed for distinguishing the vitriol's colour: *qalqand*–at times also called *qalqant*–indicates green vitriol, *qalqadīs* white vitriol, *qalqaṭār* yellow vitriol and *sūrī* red vitriol, being possibly the Arabic rendition of four Greek terms: *chalcathon*, *chalchitis*, *colocothar* and *sory*.[37] *Tinkār* is a term commonly

used for describing either a kind of borax or a kind of salt and is associated with the name *liḥām al-dhahab* in the literature, a phrase sometimes interpreted as referencing chrysocolla.[38] Borax of *zarāwand* refers probably to the plant called in Persian *zarâvand*, the *aristolochia* or birthworth. Salt of Andara refers to the geographical area form where it was customarily obtained: Andara is a village in the province of Kerman (modern Iran); the phrase 'salt of *ṭabarzad*' (Persian: *ṭabar-zad*, 'axe-splitting') possibly refers to coarsely crystalline rock salt.[39]

The *On Alums and Salts* does not offer a classification of alchemical substances in the form of a list, as it is the case with the *Book of Secrets*. Instead, it is possible to retrieve such classification from the structure of the treatise itself, as will be discussed below. For the sake of returning the most complete image possible of the system of understanding of matter in the *On Alums and Salt*, I am going to follow closely the Hebrew translation of the work for the passages where it preserves a more complete version of the treatise, in particular for the large sections that are not found in the only extant Arabic manuscript.[40] In the pseudo-Rāzian treatise, the order in which the different kinds of alchemical ingredients are presented is virtually reversed in comparison to the one found in the *Book of Secrets*: in the extant Arabic and Hebrew versions, the treatise opens with a discourse on vitriol, whose varieties are listed in the Hebrew version as *qolqodor*, *sūrīn, qalqadīm* and *qalqant* and correspond to the kinds of vitriol mentioned by the genuine al-Rāzī. The section on alum, regardless of the title of the treatise, is very brief, while an extensive treatment is devoted to salts. Among salts, rock salt, bread salt, Indian salt, salt of lime, bitter salt, sal ammoniac and alkali salt are mentioned. It is particularly significant to highlight the different position of sal ammoniac (*nushādir*), which is classified as a 'spirit' in the *Book of Secrets* and here, instead, as a salt. The discrepancy between the two treatises on the classification of sal ammoniac was considered by Ruska as one of the hints pointing at a pseudo-epigraphical origin of the *On Alums and Salts*. It must anyway be noticed that sal ammoniac is similarly mentioned among salts in another undoubtedly original work by al-Rāzī, the aforementioned *Al-Madkhal al-Taʿlīmī* ('The instructive introduction'), one of the *Twelve Books*.[41] Given the different contexts in which sal ammoniac is mentioned, the *On Alums and Salts* lists only three kinds of spirits: arsenic (of which only the yellow kind is considered), sulphur and mercury. In accordance with the contemporary theory of metallogenesis, mercury is praised as the basic constituent of all minerals and as their 'ferment', i.e. the agent that activates the alchemical transmutation and that is generally able to perform marvelous actions when combined with metals:

> God created all the minerals from it, and for this [reason] it is their birth […] it makes great, marvellous and praiseworthy actions. It alone is the living spirit. In the world, there is nothing like it that can perform what it can perform. It penetrates all the bodies […] For this reason, when it is mixed with any of all the bodies, it vivifies it, enlightens it, and makes it change from one state to another and from one shape to another. When it is mixed with it, it is the ferment of that body […] Then it is the complete elixir for the white and for the red. It is the eternal water, the water of life, the milk of the virgin, the herb that purifies and washes, the source of life, because he who drinks from it will live and will never die.[42]

Among the 'bodies' (i.e. metals, Hebr. *gufot*), the Pseudo-Rāzī mentions gold, silver, iron, copper, tin (in its two varieties *al-ūqī* and *al-qalaʿī*) and lead.[43] The positioning of mercury among spirits and the absence of *khārṣīnī* from this list brings the number of metals discussed in the *On Alums and Salts* down to only six, in a rather non-traditional fashion. The treatise is concluded by few chapters on glass and on the production of artificially coloured gemstones (red, azure and green).

Both the *Book of Secrets* and the *On Alums and Salts* are organised around a clear classification of matter in which alchemical ingredients are distinguished according to their physical features. These features, derived from the material composition of their substance, are instrumental for the definition of the alchemical operations that need to be performed on the various ingredients mentioned in order to purify them and make them suitable to enter the final steps of the alchemical transmutation, the production of silver and/or gold. In this respect, both treatises stem from these classificatory schemes and appear to derive the sequence of recipes that they encompass as a direct consequence of such considerations and distinctions.

COMPOSING AN ALCHEMICAL BOOK

While the range of ingredients mentioned and classified in the *Book of Secrets* and in the *On Alums and Salts* overlaps almost completely, the structure of the two treatises differs in a significant manner. While both treatises show a remarkable operative aim and tone, and consistently share a similar plainness of language and stylistic restraint – a feature that was highlighted and appreciated by 20th century historians of chemistry – the ways in which they expound alchemical recipes and trace the *cursus* of the alchemical work diverge.

The *Book of Secrets* opens with the aforementioned classification of substances that enter the alchemical work. The following section encompasses the description

of derivative substances (*al-ʿaqāqīr al-muwallada*), which are artificial substances derived from the basic ingredients listed in the first section. Here we find mention, for instance, of white lead (*isfīdāj*), verdigris (*zinjār*), and of various metallic oxides. The *Book of Secrets* devotes a short section to alchemical instruments: apparatus for melting metals include bellows (*minfakh*), crucibles (*būṭaqa*), the double-crucible (*būṭ bar būṭ*, from which the Latin *botum barbatum*) and ladle (*miġrafa*); apparatus for the manipulation of substances more in general include cucurbit (*qarʿ*), alembic (*inbīq*), blind alembic (*al-inbīq dhāt al-khatm*), receiving vessel (*qābila*), tongs (*māsik*), hammer (*mukassir*), etc. The treatise here reveals its organising structure: the section on alchemical operations employs single operations as headings and describes how each operation must be adapted and planned in order to be applied fruitfully to a specific ingredient.[44] The organisational unit in this section is the single operation, which is adapted to the substance that constitutes its main ingredient, and not a particular ingredient or goal. A clear aim of systematisation can be detected in the lines of the *Book of Secrets*: it appears that al-Rāzī worked at organising in a logical and operative structure the shapeless materials he derived from the reading of previous alchemical works and from laboratory observation. The operations described in the *Book of Secrets* are distillation (*taqṭīr*), sublimation (*taṣʿīd*), descension (*istinzāl*), assation or roasting (*tashwiya*), cooking (*ṭabkh*), amalgamation (*talġīm*), lavation (*ġasl*), calcination (*taklīs*), and ceration (*tashmīʿ*). For instance, details of the operation of distillation differ depending on the main ingredients the alchemist wants to distil. The *Book of Secrets* thoroughly describes several operations of distillation for the following starting ingredients: mercury (twelve recipes), sal ammoniac (five recipes), and sulphur (eleven recipes). The operation of calcination can be performed in three ways, through burning (*taklīs bi-al-ḥaraq*), through the action of rust (*taṣdiya*) or through amalgamation (*talġīm*). The treatise details how to perform the three kinds of calcination on gold, silver, copper, iron, lead and tin; al-Rāzī provides further operative notes on the calcination of marcasite, magnesia, tutia, lapis lazuli, malachite, turquoise, hematite, antimony, and talc. Overall, the *Book of Secrets* places at its centre of interest alchemical operations, and appears to emphasize the ways in which each alchemical operation is adapted according to the ingredients involved in it.

*On Alums and Salt*s, on the other hand, employs a different organisational principle: here, the work focuses on single ingredients. Lacking the list of alchemical materials that features in the *Book of Secrets,* the *On Alums and Salts* deals with each substance within dedicated sections, each of which constitutes an individual treatise that can be read as an independent textual unit providing all the information needed on a specific substance. Therefore, for every ingredient under discussion, the Pseudo-Rāzī offers a description of its qualities, physical features, connection with celestial bodies (in the case of metals) and relevance to alchemists who intend to use it. Very frequently, the procedures described are the preliminary steps to prepare ingredients that may be used in other successive operations, thus creating a logical sequence whereby the final product of one prescription often becomes the starting material for the next.

Similar in their contents, but different in their structure, the authentic and the spurious Razian treatises discussed above present two equally effective strategies of transmitting the practicalities of the alchemical work in plain language, consequential steps, and in a firmly structured discourse. While the *Book of Secrets* focusses on the operations and how they apply to the different ingredients, the *On Alums and Salts* is centred around the ingredients, which are dealt with exhaustively in separate and self-conclusive sections. What appears to be clear from the extant manuscript evidence is that both treatises managed to attract the attention of readers, translators and copyists, be it for the fame of their author or for the intrinsic perceived usefulness of their contents.

CONCLUSIONS: AUTHORITY, STRUCTURE, AND PRACTICE IN MEDIEVAL ALCHEMY

The circulation of the *Book of Secrets* and of the *On Alums and Salts* was surely fostered by their genuine or spurious association with the name of Muḥammad ibn Zakarīya al-Rāzī, an authoritative figure connected to medical "best-sellers," that circulated widely in Arabic language and Latin translation. It appears, in any case, that at least for the *On Alums and Salts* the connection with the Persian polymath was not the main incentive for its fame. If we examine the extant manuscripts of the *On Alums and Salts* in Arabic, Latin and Hebrew, the evidence may reveal the shortcomings of the argument for authority or, at least, may hint at the need for further analysis. Among the nine manuscripts (the two Arabic and Hebrew *codices unici* and the seven Latin manuscripts), only the Latin Parisian manuscript (MS 6514, Paris, Bibliothèque Nationale), the one that possibly derives from the translation by Gerard of Cremona, transmits the name of al-Rāzī as the author of the treatise. The Arabic, the Hebrew and the other Latin versions are silent on the authorship of the work or, at times, offer indication of different names. For example, the Latin

manuscript in the Biblioteca Comunale of Palermo on the side of the traditional title *Sermo de aluminibus et salibus, quae in haec arte necessaria existunt* ("The *Book on Alums and Salts* that are needed in this art") records another title and attribution: *alii intitulant hunc ita Incipit Liber Ypocratis et Galieni* ("others call it «Here begins *The Book of Hippocrates and Galen*»").[45] Since the largest part of the tradition of this treatise is anonymous, the reason of the fame of this work must be found outside the influence of its pseudo-epigraphic attribution.

Scholarship on the production and transmission of European medical treatises between the XIII and the XIV century has shown that early collections of medical recipes and remedies derived their authoritativeness not only from the names of their compilers–which, in the case of single recipes was often unknown or not explicit –but also from their organising criteria and structure. These treatises offered a sound structure that also enhanced the didactic value of a work; this was the discriminant between a random accumulation of medical (or alchemical) recipes and a medical *Summa*, like the one composed by Guglielmo da Saliceto (XIII c.) or, alternatively, a medical *Thesaurus,* like the one compiled by Petrus Hispanus (XIII c.) as a medical handbook for the poor.[46] When we consider the way in which alchemical recipes are organised as a logical progression and as a direct application of the theoretical points that are made explicit at the beginning of each section of the *On Alums and Salts*, we may see a similar phenomenon: the *On Alums and Salts* may derive its *auctoritas* and its fame as an alchemical treatise from the strength of its internal structure, a structure that, together with the plainness of exposition and language, made this treatise readable in the library and useful in the laboratory. The fact that the *On Alums and Salts* was employed as an operative handbook is clearly shown by the only extant Hebrew version of the treatise. Its translator or copyist did not limit himself to rendering the treatise in Hebrew language, but intervened heavily on the work, adding comments, variants, and notes both in the main text and on the margins of the manuscript. These additions – often placed between brackets and frequently introduced by the Hebrew abbreviations *n´´l* (for *nireh li*, "it seems to me") and *s´´* (for *sevarah aḥeret*, "another explanation") – tend to suggest modifications of the recipes of the *On Alums and Salts*, proposing the substitution of ingredients, variations in their quantities and different operative steps.[47]

The practical character of these additions and notes (in italics in the excerpts) can be appreciated, for instance, in the passage describing the operation for the congealment of mercury, where the Jewish copyist intervenes a first time describing the colour of a partial product of the operation and a second time correcting the main text:

> The congealment with sulphur is that you take three ounces of sesame oil, if you find [it] or, if not, olive oil. Boil it on fire in a glass vessel and, after this, put with it slowly half an ounce of pulverised yellow sulphur, and grind it with the oil until it dissolves. I tried it and I dissolved it all. Then take it out on top of the fire and let it rest to cool in [it] – *in my opinion: you should do it like this and it will be as white as lead*. Then put with it one ounce of mercury, place the pot on a gentle fire, and increase it slowly and little by little. Let it rest until it congeals, since mercury will congeal to a red stone – *in my opinion: white*. If not, put in it the element of fire. Then conceal it, save it, rejoice and put [some] of it in all your operations.[48]

Another example can be seen in a passage describing alchemical operations on lead, where the additions of the Jewish copyist are aimed at specifying the chromatic consequences of the use of different ingredients and at clarifying the quantity of salt to be used in this recipe:

> Take the one you prefer between lead or tin and melt it in an iron ladle. Feed every pound of it with one ounce of sulphur – *in my opinion: for red* – or one ounce of arsenic – *in my opinion: for white*. Stir it with a stick until in one hour it looks suddenly like dark ash. After that, grind it in – *in my opinion: the same amount of* – roasted salt dissolved in sharp vinegar and, when it has absorbed it all, put it in a glass pan that withstands fire and light a fire under it for ten hours until white calx comes out.[49]

There is no doubt that the *On Alums and Salts* was read, at least by this early modern Jewish reader, as a practical handbook for the chemical laboratory.

The *Kitāb al-Asrār* and the *On Alums and Salts* represent two accomplished examples of alchemical works that travelled between different geographical, cultural, religious, and linguistic contexts thanks to the appeal of their contents and structure. Contemporary alchemical works of Arabic origin and those produced in medieval Europe engaged readers in an exegetical exercise, in particular when their alchemical contents were concealed under imaginative and allegorical descriptions and obfuscated by the use of *Decknamen*. In the case of the *Book of Secrets* and of the *On Alums and salts,* which are devoid of such intricacies, the exegesis required was of a practical kind, an exegesis that was arguably conducted between library and laboratory.[50]

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