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# The Transmission of Arabic Science in the Middle Ages: Translation, Expansion, and Legacy

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***Abstract—*** *The Arabs have written one of the most golden pages of the history of science, for being the transmitters and preservers of the thought and knowledge of Antiquity, especially of the Greeks, to the Europe of the Renaissance across three phases. This article approaches these stages and provides an overview of the key authors in each of them. It argues that the standard tripartite periodization—translation, expansion, transmission—while heuristically useful, obscures the extent to which original contributions and translation activities were intertwined from the outset, and underestimates the distinctive role of Andalusian scholars in shaping the pharmacological tradition that reached Christian Europe*.

***Keywords— Medieval Arabic Science, Medieval Islamic Pharmacy, Scientific Heritage by Arabs.***

## I. INTRODUCTION

The Arabs have written one of the most golden pages of the history of science, for being the transmitters and preservers of the thought and knowledge of Antiquity, especially of the Greeks, to the Europe of the Renaissance across three phases or stages.

With the patronage of the Abbasid caliphs, the labour of translation of the principal works of the ancient cultures in the fields of philosophy, astronomy, mathematics, medicine, pharmacopoeia, botany, and so on, begins around the middle of the 8th century of the Christian era, under the patronage of the famous House of Wisdom (*Bayt al-Hikma*) of Baghdad, a mixture of library, academy, and translation centre. The translation movement was not a spontaneous affair but a state-sponsored enterprise, and its scale was unprecedented: Greek, Persian, and Indian works were rendered into Arabic on a scale that had no parallel in the ancient world. In the middle of the 9th century, approximately, the Arabs—who had already assimilated and adapted the ancient knowledge from India and Persia as well as the classical inheritance from Greece—began extending this legacy with their important findings and contributions, in a period of creative activity without precedent that would last approximately until the end of the 12th century, though there are later exceptions. Finally, all this scientific knowledge was transmitted to Christian Europe through the translations made from Arabic to Latin in Spain, at the famous Translators' School of Toledo, and in Sicily, at the School of Salerno, during the 12th and 13th centuries.

Arab-Islamic medieval medicine is highly influenced by Galen and closely linked with pharmacopoeia. All the relevant works of medicine written in the Arabic language in the Middle Ages contain pharmacological treatises on simple and compound remedies and on the preparation of these remedies, with allusion to the diseases that they treat and cure. Medicine and pharmacy became independent disciplines from the 12th century; and, even then, books continued to emphasize the importance of remedies and drugs in the treatment of diseases and contained chapters on pharmacopoeia. In addition, the Arabs practised Hippocratic medicine and considered pharmacopoeia to be a basis of therapeutics together with dietetics and, later, surgery. Under their influence, pharmacy reached a high level of mathematical precision, calculating the degrees of action of medicines and the relation between the degrees of the qualities of medicines and the degrees of their therapeutic action. The Arabs were responsible for establishing the pharmaceutical profession in their domains, independent from medicine. They also introduced apothecary shops and the places for dispensing drugs.

In this paper, I use the term "Arabic science" to refer to scientific work written in Arabic, regardless of the religious affiliation of the author, while recognizing that this tradition is often described as "Islamic science" in the scholarly literature. This survey, while wide-ranging, has necessarily been selective. It has concentrated on medicine and pharmacology, to the neglect of other fields such as astronomy, mathematics, and optics, in which Arabic scholars also made significant contributions. It has also focused on the transmission of Greek knowledge, without giving adequate attention to the contributions of Indian and Persian traditions to Arabic science. These limitations should be addressed in future research.

## II. RESULTS

### 2.1 The Three Stages of Arabic Science

#### 2.1.1 The First Stage

In relation to the first stage of the three indicated, in the field of pharmacology it is necessary to emphasize the figure of Hunayn b. Ishaq, known as Johannitius (808–873), who, besides his translations of Hippocrates, Galen, Oribasius, Paul of Aegina, Plato, and Aristotle's works, among others, as well as his own writings, carried out the revision of the Arabic translations of the five treatises of Dioscorides's *De materia medica*, which had been made by Istifan b. Basil. This book was studied by students of medicine and pharmacy at this time and was of obligatory consultation for later Arabic authors, being the foundation of the Arabic medieval pharmacopoeia. The Arabic physicians and pharmacists built on this solid base and added personal observations on drugs and remedies. His work entitled *Masa'il fi-l-tibb* (Questions on Medicine) contains diverse passages of interest for the history of pharmacy, which were incorporated into the plan of education of this science. The author gives recommendations on simple and compound remedies, techniques and ways of preparing drugs, and rules and manners of experimentation of these drugs as a result of determining their physical properties and the pharmacological effects that they exercise on man. The original writings of Hunayn and his translations constitute the foundation of medical education in the Islamic world [1].

It is worth noting that Hunayn's activity exemplifies the point made above about the permeability of the boundary between translation and original contribution. His work was not merely linguistic: in revising existing translations, he was also correcting pharmacological knowledge, adjudicating between competing versions, and thereby producing new knowledge in the act of transmitting it. The distinction between "translator" and "contributor," in other words, is one that the historical record itself resists.

In relation to alchemy, so closely linked with the history of pharmacy, we must mention Jabir ibn Hayyan, known as Geber, who lived in Iraq in the 8th century. His name, after that of Al-Razi, is the greatest in the field of medieval chemical science and had a very important influence on later Muslim and Christian authors as well as on the development and evolution of medieval chemical, medical, and pharmaceutical science [2]. Jabir's work on substances, apparatus, and processes—though much of the corpus attributed to him is of contested authorship—provided a vocabulary and a set of techniques that later pharmacological writers would draw upon.

The line of demarcation between the first period and the second is not always clearly drawn because many of the translators were also contributors. Such was the case with Yuhanna Ibn Masawayh and the aforementioned Hunayn b. Ishaq.

#### 2.1.2 The Second Stage

In relation to the second stage, in the field of pharmacology, in the East we must highlight three Persian authors who wrote in Arabic: Al-Razi, Al-Majusi, and Ibn Sina.

Al-Razi (865–925) wrote, among other works, a treatise of medicine entitled *Kitab al-tibb al-mansuri*, translated into Latin as *Liber Almansoris*, which was first published in Milan at the end of the 15th century and some of whose parts were translated into French and German at the same time. Likewise, he wrote an encyclopedic book called *al-Hawi*, his most important work, which was translated into Latin under the name *Continens* by Faraj b. Salim in 1279. Both are also heavily influenced by Galen and treat the preparation of remedies and medicines, and contain recipes and descriptions of drugs and chemical compounds used in pharmacy, such as saltpetre, iron and copper sulfates, and mercury chloride. He was the first great figure of Islamic medicine and undoubtedly its finest clinician. He took a particular interest in pharmaceutical methods, recommending pills as an agreeable and effective way of administering medicines.

Al-Majusi (d. 994) wrote, among other works, a book entitled *Kamil al-sina'a al-tibbiyya* (Compendium of Medicine), which is a wide treatise on the science and practice of medicine. In this work, the author includes several chapters emphasizing

dietetics and *materia medica*. Al-Majusi's systematic arrangement of medical knowledge in this work would influence the encyclopedic format adopted by later compilers.

Ibn Sina (980–1037), philosopher, physician, and poet, is one of the most relevant figures of medieval times. Among his scientific writings, *al-Qanun fi-l-tibb* (Canon on Medicine) stands out, which was translated into Latin in the 12th century by Gerard of Cremona under the name *Canon*. In this work, the influence of Dioscorides and especially of Galen is observed, as well as that of Indian medicine. Two of the Canon's five volumes are devoted to the work of the pharmacist: the second, to simple medicines; and the fourth, to compounds, and both contain a wide relation of remedies, procedures for preparing these remedies, and a treatise on poisons. The *materia medica* of the Canon contains 760 drugs. Ibn Sina names medicines of Persian, Indian, and Greek origin and introduces, for example, the gilding and silvering of pills. Among the simples, he names kamala and coffee. The Latin version of Ibn Sina's Canon became a fundamental text for pharmacists up to the 18th century [3]. Its systematic structure—organizing simples alphabetically and compounds by therapeutic category—provided a model for European pharmacopoeias for centuries.

In the Western Islamic world, among others, it is necessary to highlight, in chronological order, Ibn Juljul (943–982) from Cordova, physician, botanist, and historian, who wrote a commentary on Dioscorides's *De materia medica*, whose Arabic translation was introduced to Al-Andalus in the time of Abd al-Rahman III, and which was revised by the Monk Nicholas in 951, with the collaboration of the Jewish physician Hasday ben Shaprut and others. In addition, he authored a treatise on Andalusian medicinal plants, which were not included in the work of Dioscorides. This treatise is significant because it represents an explicit attempt to add to the classical pharmacological corpus on the basis of local observation—a gesture that would become characteristic of Andalusian pharmacological writing.

In the 10th century we have the famous physician and surgeon from Cordova, Al-Zahrawi (circa 936–circa 1013), whose *Kitab al-tasrif* (Book of the Medical Disposition) contains several treatises of important pharmacological value. In the 11th century we have Ibn Wafid (1008–1074) from Toledo, expert in the works of Dioscorides and Galen. He wrote, among other works, a treatise on simple remedies (*Kitab al-adwiya al-mufrada*). In Toledo, at the order of al-Ma'mun, he planted a botanical garden, the Garden of the King, where he experimented on acclimatization and artificial fertilization. This garden is often cited as one of the earliest experimental botanical gardens of the medieval world, and it reflects a shift from the compilation of inherited pharmacological knowledge toward its empirical extension through cultivation and observation.

Later, we must mention Ibn Zuhr (1073–1161/1162) from Seville, who treated in his book *Taysir fi-l-mudawa wa-l-tadbir* (Facilitation on Therapeutics and Diet) very important therapeutic and dietetic questions, very important from a pharmaceutical point of view. We must also mention the Andalusian physician and botanist Abu Ja'far Al-Ghafiqi (d. 1166), who wrote the encyclopedic book entitled *Kitab al-adwiya al-mufrada* (Book of the Simple Remedies), one of the most important medieval manuals on Arabic pharmacology, which had a great influence later. Islamic pharmacology is summarized in Al-Ghafiqi's work, which, starting from Dioscorides and Galen through Hunayn ibn Ishaq, comes to Al-Andalus with the writings of the Jews Hasdai ibn Shaprut and Ibn Buqlaris. According to Meyerhof, he is the greatest of the scholars of pharmacology and botany of the Islamic Middle Ages. Al-Ghafiqi's work is particularly valuable because it combines inherited Greek material with Andalusian and North African plant knowledge, producing a synthesis that reflects the distinctively composite character of Andalusian pharmacology.

Above all, we must mention Ibn Al-Baytar (d. 1248) from Malaga, known as the "Arabian Dioscorides," who is the most famous and relevant botanist and pharmacologist of medieval Islam. Among his works, we have *al-Mughni fi-l-adwiya al-mufrada* (Compendium on Simple Remedies), about *materia medica*; and *Kitab al-Jami' li-mufradat al-adwiya wa-l-aghdhiya* (Compendium of Simple Remedies and Foods), a collection of simple remedies of the mineral, vegetable, and animal world that incorporates Greek and Arabic information and is complemented with the fruits of his own experiments and research. It is the largest compendium of pharmaceutical materials in the Arabic world and the best medieval treatise of its kind. It describes 1500 drugs of vegetable origin and 150 of animal origin with their therapeutic application. The number of authors mentioned is about 150, and 50 of them are Greek [4]. By this time, the first botanical gardens dedicated to the study of medicinal plants had already been established. The Arabs introduced to Spain the cultivation of rice, alfalfa, and the carob tree. They also used precious stones and, as relevant alchemists, sought the philosopher's stone capable of turning metals into gold, and the elixir of eternal youth. Part of the Latin version of the *Simplicia* of Ibn Al-Baytar was published in Cremona in 1758 [5].

For the 13th century, the Arabic manuals on *materia medica*—I refer to the herbals based on Dioscorides's *De materia medica*—as well as the therapeutic and pharmacological effects of the drugs and remedies contained in the work of these authors and others, such as Al-Sharif Al-Idrisi and Ibn Al-Suri, reached their fullest expression and greatest influence.

### 2.1.3 The Third Stage

In the Christian West, the seeds of Arab-Islamic culture germinated in an intellectual effort that culminated in the high development of the schools of Salerno and Montpellier. In fact, all that scientific knowledge came to Europe, as already indicated, thanks to the translations into Latin of these works written in Arabic in Salerno and Toledo during the 12th and 13th centuries, influencing European higher scientific knowledge—for example, the famous School of Montpellier—and imposed in the Christian West until the 16th and 17th centuries and part of the 18th. In this third stage, it is necessary to highlight Constantine the African (d. 1087), Gerard of Cremona (d. 1187), and Fararius (Faragut) (d. 1279). Constantine the African's translations, produced at Monte Cassino, were among the first to make Arabic medical learning available in Latin, and they shaped the curriculum of the Salernitan school. Gerard of Cremona's vast output at Toledo, meanwhile, made available in Latin not only Ibn Sina's Canon but also works of Al-Razi and a wide range of astronomical and mathematical texts. And as testimony of this influence of the Islamic legacy over Europe, many European scientific terms are of Arabic origin; examples in the field of pharmacy are alcohol, julep, syrup, and so on.

Meanwhile, Christian Europe was surviving as best it could and, impoverished by wars and epidemics, it had no other remedy than to recognize the supremacy of Islamic science and to draw from it. In the early Middle Ages, in Christian Europe, science was exercised in the monasteries by the monks [6]. Medicine and pharmacy developed through the transmission and interpretation of the works of Galen, known through the commentators—because Greek was no longer known at that time—and through the Arabic writings [7]. The texts of monastic medicine, written in Latin, were mainly simplified fragments or summaries of the most important Greek works, primarily from Galen, Dioscorides, Hippocrates, Oribasius, and Alexander of Tralles, and had a practical character. And in the late Middle Ages and early Renaissance, the influence of Arab-Islamic science and the teachings of Muslim academics over the most outstanding Christian European authors of the field of pharmacy, alchemy, and botany is evident, such as Albertus Magnus (1193–1280), Roger Bacon (1214–1294), Arnaldus de Villa Nova (d. 1235), Ramon Llull (d. 1232), Pietro d'Abano (1250–1316), Nicholas Flamel (1330–1418), Saladino de Ascoli (15th century), Pedro Benedicto Mateo (15th century), and Paracelsus (1493–1541), among others. The Islamic legacy remained in the most prestigious universities in Europe, influencing the teaching of science even until the beginning of the 18th century [8].

## III. CONCLUSION

This article has surveyed the three principal phases of Arabic scientific activity in the Middle Ages, with particular attention to medicine and pharmacology. Several conclusions emerge from this survey.

First, the tripartite periodization—translation, expansion, transmission—while heuristically useful, should not be applied too rigidly: many of the translators were also original contributors, and translation activities continued well into the period of creative expansion. Hunayn b. Ishaq, as noted above, was at once a translator and a producer of new pharmacological knowledge, and his case is emblematic rather than exceptional.

Second, the contributions of Andalusian scholars, particularly in pharmacology and botany, deserve greater recognition than they have sometimes received in surveys focused on the Eastern Islamic world. The work of Ibn Wafid, Al-Ghafiqi, and Ibn Al-Baytar represents a significant and distinctive tradition of pharmacological scholarship that shaped both Arabic and European medicine. The Andalusian tradition is distinctive for its empirical orientation—its botanical gardens, its attention to local flora, and its willingness to add to the inherited classical corpus on the basis of observation.

Third, the transmission of Arabic science to Christian Europe was not a simple one-way process but a complex mediation that shaped European science for centuries. The legacy of this transmission is visible not only in the content of European medicine and pharmacology but also in the vocabulary of European science, where terms such as alcohol, julep, and syrup remain as linguistic traces of this debt.

The Arabs were the heirs of the Greeks and, with their contributions, scientific knowledge reached the highest levels of quality thanks to the important work made by distinguished thinkers, scholars, and doctors. The legacy of Islam to the history of both pharmacy and medicine is very rich. Future research might productively examine the specific mechanisms of this transmission and the ways in which Arabic scientific texts were adapted and transformed in their European contexts.

## CONFLICT OF INTEREST

The author declares no conflict of interest.

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