

Razi's innovations in medical sciences†

Modjtaba Raoufi¹, Hamed Abedtash^{1,2}, Abdolali Mohagheghzadeh^{1,3*}

¹Department of Phytopharmaceuticals (Traditional Pharmacy), Faculty of Pharmacy, Shiraz University of Medical Science, Shiraz, Iran.

²Department of BioHealth Informatics, Indiana University-Purdue University Indianapolis, Indiana, USA.

³Pharmaceutical Sciences Research Center, Shiraz University of Medical Sciences, Shiraz, Iran.

†Festschrift in honor of late Prof. Dr. Mahmoud Najmabadi, Tehran University of Medical Sciences who was a prominent Razi Researcher.

Abstract

Abu Bakr Muhammad ibn Zakariyya Ar-Razi (Rhazes), one of the greatest Persian Physician, Philosopher, polymath, alchemist, and encyclopedist, has significant contributions to medical sciences. His ingenious innovations in medical sciences, from differential diagnosis of measles and smallpox to applying anesthesia sponge and discovery of Ethanol and pioneering for medicinal chemistry and pharmacy, have held his name in high esteem as an unforgettable icon in medical history. His relentless tendency toward criticism of other scholars—regardless to the reputation of them—might have helped medieval practitioner to unshackle them from zeitgeist of fundamentalism. Available literature was extracted from Scopus, Google scholar, Pubmed and Science Direct databases and Persian publications. Four characteristics have been extracted as distinguishing factors which have made Razi a prominent figure in his working fields. Briefly they can be defined as meticulousness in his medical practice, relentless endurance in pursuing scientific problems, believing in scientific criticism and his irrevocable commitment to medical ethics.

Keywords: Razi, Medical Innovations, Criticism

1. Introduction

Whenever we hear from Abu Bakr Muhammad Ibn Zakariyya Ar-Razi (Rhazes or Razi) (Figure 1), instantaneously, we will think of a prominent practitioner who scrupulously differentiates measles from smallpox, and, some of us might refer him as a notable alchemist or pharmacist who extracted ethanol and applied it for medical purposes (1). Although all of aforementioned activities are truly assigned to him, yet we might have never heard that Razi was beyond an obedient practitioner who strictly followed the footsteps of Galen in medicine. We, personally, saw Razi an

iconoclastic revolter who contradicted infallibility of ancients. He blatantly encourage criticizing ancient works, since he believed that human beings inevitably committing errors in their scientific works. He mentioned in his famous *Continens* (Figure 2) that "...as sciences refining over time, modern scholars should criticize them and make them more perfect..." However, he, humbly, refers ancient scholars' works as foundation which modern sciences stand upon them. To know more about his pivotal role in uprising against dogmatism and fundamentalism in medical sciences, his influence on Andreas Vesalius Renaissance against prevailing authoritarian Galenism is of great importance. Surprisingly, Andres Vesalius commenced his academic by paraphrasing ninth book of the *al-Mansor* (Figure 3) written by Razi in which he be-

Corresponding Author: Abdolali Mohagheghzadeh, Department of Phytopharmaceuticals (Traditional pharmacy), School of Pharmacy, Shiraz University of Medical Science, Shiraz, Iran.
Email: mohaghegh@sums.ac.ir

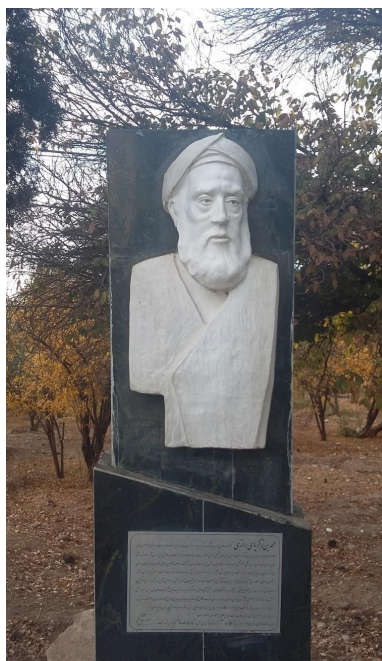


Figure 1. The statue of Razi places at the Entrance of Shiraz Faculty of Pharmacy, Shiraz, Iran (Photo by authors).

came acquainted with unbelievable Razi critiques on Galen which at that time was unacceptable for him. Thus, whenever he faced with Galen name in the book, he converted it into capital letters and

tried to refine Razi when he thought he deviated from Galen's path. However, as his scientific conception matured over time, his unshakable beliefs in Galen flawed and his celebrated Renaissance

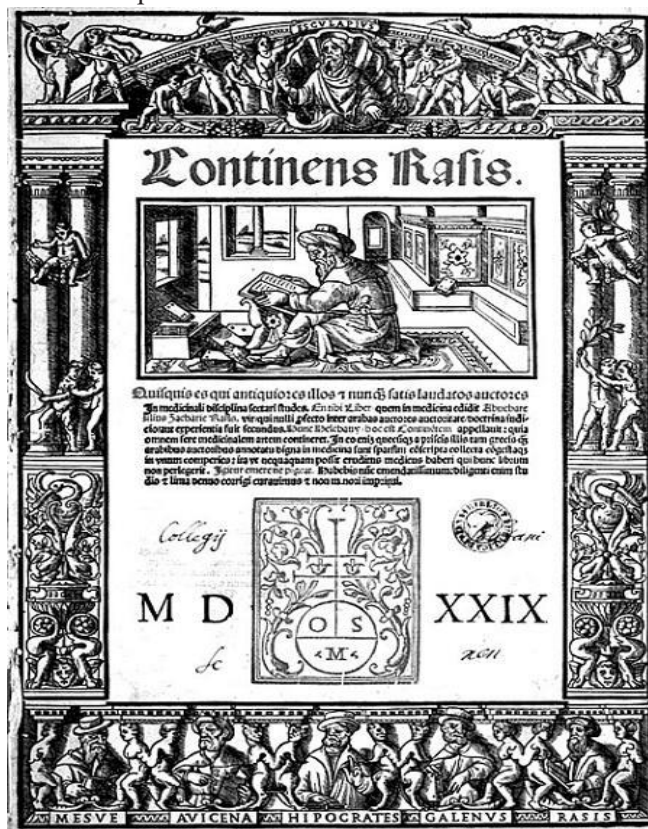


Figure 2. Title page of a Latin translation of Razi's famous Continens (Al-Havi)

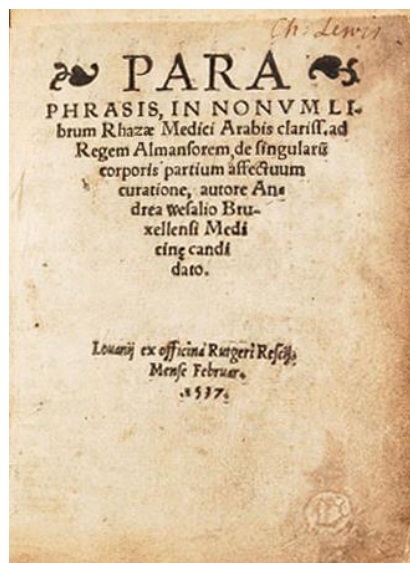


Figure 3. Title page of Andres Vesalius paraphrasing on ninth book of the Almansor written by Razi.

triggered. In his Letter on the China Root, Vesalius confessed his dogmatic standpoint on Galen authority and paid tribute to Razi (2). Razi criticism was not confined to medicine, and he has significant contributions in alchemy and philosophy. He was not only a dauntless critic that no one could feel safe from his keen intellectual criticism, but he is also famous for his lucubration. As he wrote himself, he was a pertinacious devotee of science and research. He has spent more than fifteen years to compile his great *Continens* and during this time

his hands paralyzed and his eyesight weakened; however, he assisted other people to continue his scientific works (3). Although Razi's innovations in medicine have not yet fully appreciated, few of them have published before. In this paper we aim to mention few of Razi contribution to medical sciences and to honor his colossal impact in this field of science.

2. Material and methods

Available literature was extracted from

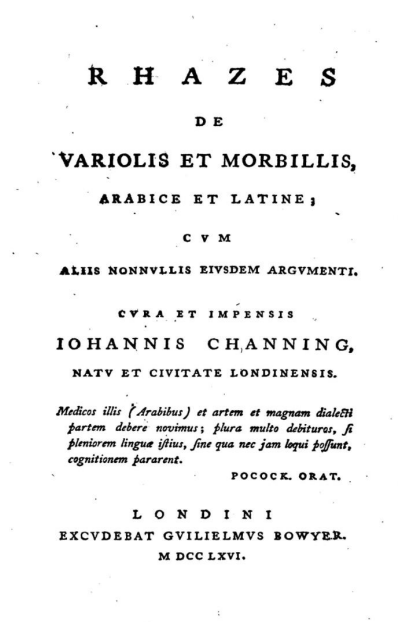


Figure 4. Title page of a translation of Razi's Measles and smallpox.

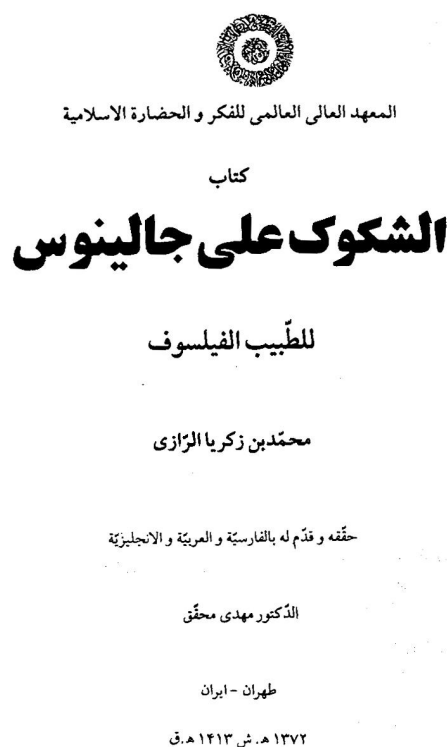


Figure 5. Title page of a Razi's Kitāb al-shukūk 'alājālīnūs.

Scopus, Google scholar, Pubmed and Science Direct databases as well as Persian publications with terms of “Rhazes”, “al-Razi”, “Razi”, “Innovation”, “Criticism” and related keywords up to 2020.

3. Result

Razi seems to be the first physician who perspicaciously and efficiently has implemented **silk sutures** and alcohol to curb bleedings. And, he for the first time used **catgut** for suturing abdomen wounds personally (4, 5).

Cotton has an inveterate story in human history of civilization; however, Razi was first who applied **cotton for medical purposes**. For instance, he has suggested camphor and/or rose water-smearred cotton to be inserted in nose to alleviate and/or avert vexing respiratory symptoms of smallpox. He accentuated the purity of cotton which is suitable for medical purposes (6).

Seton stitch is a surgical technique in which surgeon applies to promoting the healing process of fistulae. In this procedure the fistulae would not close completely thus wound drainage

would have place to outflow. Razi was the first physician who applied this procedure in treatment of carbuncles repetitively-he usually used horse-tail as surgical grade cord in this procedure (5-7).

Razi admirably used fresh liquid of bile as a substance to **disinfect surgical instruments**. Bile has two major characteristics which makes it appropriate as cleansing and/or disinfectant substance: emulsifying, and antibacterial trait with which Razi was thoroughly acquainted (1).

Fever is a torrid trench which our body apply it to protect itself from exogenous substances and/or infections. Whenever our body face aforementioned threats, it produces mediatory chemicals which their effects on hypothalamus elicit increase in body temperature. Razi was the first scientist who ferrets out this miraculous mechanism and mentioned it in his famous *Continens* (8).

Seasonal allergic rhinitis is an inflammation of nasal cavity usher in nasal congestion, rhinorrhea, and sneezing. Razi, almost nine centuries before Bostock, had described allergic rhinitis practically in his *Alfosus al-Mohemma fi al-Teb*

ol-Aemma, and provided us with ample treatments and/or managements which are summarized below.

“Refraining from high-calories’ food which might make you sleepy is highly recommended. Do not drink very cold water and/or sleep immediately after dinner. Restrain from living in cold and damp places. And do not soak your head through cold water or washing yourself with cold water. Do not apply strong perfume and never smell sources of aromatic substances, such as redolent flowers.” Moreover, for treatment he reported, “Frequently clean nasal cavity. Inhale Chamomile, Mint, common Madder, and common Wormwood suspension in hot water. For sever situations combination of Fenugreek, Marrubium, common Fig and special type of ate could be alleviating. If patient is suffering from pertinacious rhinorrhea, pruritus, and sneezing, aforementioned formulation could be practical. In addition, walking and taking sweating bath will be effective. Bloodletting by making tiny holes on the back of the patient via silvery blade is recommended. More than one patient consummately recovered by bloodletting forehead delicate vessels, which are not directly connected to the bone and do not carry very much blood. Patients with flushed faces should be bloodletted via ears. And should eat cold-tempered fruits, such as unripe Grape, Rhubarb, and so forth" (9).

Inarguably, ground breaking discovery of Ethanol (ethyl alcohol) is Razi most profound contribution to the medical science. He applied alcohol as disinfectant and/or antiseptic agent frequently (10, 11).

Razi, besides his invaluable contribution as a physician, was a prominent alchemist. As Cawbell in his *Arabian Medicine and Its Influence on the Middle Ages* postulated, Razi was first who “introduced chemical substances into the medicine.” He was an adroit chemist who contrived variety of formulations and/or dosage forms and prescribed them for his patients reportedly. For instance, he formulated special kind of syrup comprised of whole Lemon jam and/or currant jam, Sandal wood, and camphor. Another syrup contrived by combination of vinegar or Pomegranate syrup, Lemon juice, unripe Grape juice, currant juice, Lettuce, Toot Shami (special kind of berry),

Tarakhone, Jujube, Lentil, and camphor which was efficient in chronic fever. He also was first one who discovered antiseptic property of Mercury and applied it as an ointment for cutaneous wounds (5, 10-12). So we may consider Razi as the **pioneer for medicinal chemistry and pharmacy**.

Razi, for the first time in medical history, has introduced and applied general anesthetic agents as ‘**anesthetic sponges**’. He amazingly soaked piece of sponge through extracts of Cannabis, Wicken, and Bilsenkraus and desiccate it under the sun light. Then before any procedure in which general anesthesia was necessary, he dampened the sponge through water and tamped it into the patient nose. The extract would be absorbed via nasal epithelium directly to the brain elicits general anesthesia (1, 13).

Razi successfully diagnosed **Tuberculosis dactylis**, which is special type of tuberculosis infecting small tubular bones, and very rare disease. As, manifestation of it is so similar to osteomyelitis, sarcoidosis or malignancies, Razi diagnosis for the first time in medical history is consequential (5, 14).

Another astonishing contribution to the medicine is pertain to ‘**pupillary reflex**’, in which Razi clearly described it as dilation and constriction of pupil, by the means of delicate muscles circumvented it, in response to intensity of light (10). He also contradicted Euclidean theory on the mechanism of observation. He posited that light beam, on the contrary to contemporary belief, reflects from surrounding environment and goes into the eyes makes environment visible for us. However, medical aspect of this new theory developed by Avicenna in which he contradicted Galen’s opinion. And, ibn al-Haytham (Alhazen) expatiated upon physical aspects of this groundbreaking idea eventually (15).

Measles and smallpox (Figure 4) is one the most accurate and reputable treatise of Razi in which he clearly differentiates smallpox from measles through meticulous and multifarious case-by-case observations and documentation. His method could be adduced as predecessor of contemporary differential diagnosis method which is the foundation of modern medicine. At the end of its first chapter Razi determined the etiology of

smallpox and postulated that it should transmit by yeast via infected blood. Charles Greene Cumston, an expert in medical history, asserts that "...if we compare Razi opinion with contemporary opinion and replace yeast with bacteria and/or virus, we will result in the same thousand years ago opinion which is astoundingly correct." Exploring the whole book is a consummate course of smallpox and measles; however, the fourteenth chapter which is on *mild and fatal measles and smallpox* is germane to be mentioned below.

"Measles and smallpox are acute diseases which can be categorized into fatal and mild regarding to patients' signs and symptoms. Regular respiration, heart rate, and sleep, sobriety, normal appetite, serenity, agility in his/her movements, and to ignoring and/or belittling his/her disease adduce as benignity of the disease. However, if the patient experienced vice versa, it portends fatality of the disease. And we have explained this in book of the *al-Mansor* in more details.

The most innocuous type of smallpox are those with scattered white macular rash in which patients immediately exposed them without any fever, distress, and the patient is not ill-humored. And, the ones in which patient's fever and ill-humored condition alleviate immediately after exposal of rashes. Moreover, the other innocuous type of smallpox related to large macules. The more macules that are tightly close to each other, portending more innocuous they are. And, if the demonstration of the disease was slightly and/or patient relieve immediately as mentioned above. Patients who do not relive after the demonstration are related to virulent ones; however, they are not fatal unless patient bad condition continues and worsened. Large white macules could be fatal if the macules merging and forming colossal, consistent abscess which are similar to large adipose circles on patients' skin. Merged white rigid little and wart-like macules are related to virulent ones, and the fatality correlates to severity of patents' condition after rash demonstration. Greenish, yellowish, and purplish macules are related to fatal smallpox altogether. Patients with tightness of breath and/or syncope pertain to fatal smallpox. Patients with high fever could be virulent ones unless the fever relieves. Recrudescence smallpox is considered

fatal if it belonged to virulent one and will be less fatal if belonged to mild ones. The most harmless measles are those with fainter redness, and the darker ones are more pernicious ones. Greenish and purplish measles are pernicious types. Patients with measles and smallpox in which the rashes diminish immediately would lead to syncope and death unless rashes reappear respectively. In cases of smallpox, if fever (prodromal phase) and rashes manifested simultaneously, categorizing as severe (fast movement), and if rashes manifested from third day of fever, categorizing as moderate (moderate movement), and if rashes delayed for more than four days from onset of fever, categorizing as mild one. In cases of smallpox, if rashes turned adhesive and wildly propagated throughout the body, and the abdomen became flatulent, his/her death is imminent. Whenever, rigid little and wart-like rashes ruptured and patient became hallucinated, his/her death is imminent. Another fatal type of smallpox is related to the condition in which patient shows manic behavior and feels severe pain in his/her extremities respectively. Usually in these condition rashes turn to yellow or become darker. And patients' situation worsens and become exhausted. However, patients will survive only if they revitalize again. However, they will lose their extremities. In order to save extremities, for the patients who seem to be revitalized, making incision on the organ is recommended..." (5).

Razi is also respected as an expert in applying neuroanatomical knowledge to localize nervous system lesions (16). He compiled wonderful "*Upon the circumstances which turn the head of most men from the reputable physicians,*" (*Man La Yahzarol-Tabib or Teb al-Foghara val-Masakin*) which could be accounted as a practical source of medical ethics, since in this book Razi provide simple and available medical instructions for deprived people. In addition, Razi practices as director of Baghdad hospital in psychiatric after-care and psychiatric consultation services were unprecedented and pioneering in medical history (17).

Ibn Abi Usaibae, who has written the most all-inclusive biography and bibliography of Razi, has attributed 320 works, from medicine to religion and philosophy, to Razi. During a sixty-year

of life time, Razi doubtlessly is a prolific author which his enormous *Continens*—that is enough solely to hold his name in high esteem—is just the tip of the iceberg (18). As we mentioned, Razi should never be assumed as a laborious compiler who strictly follow ancients' rulers, such as Galen. However, he was a stringent thinker who never been intimidated by giant scholar names, and stubbornly try to revise and rectify their possible mistakes, and, as he posited, errors are the inevitable by-products of science and human beings' works. Razi can be assumed as an icon of empiricism, as his irrefutable impact on Vesalius which promoted him to emancipate himself from contemporary fundamentalism and Galensim and moving toward empiricism (2).

4. Discussion

By exploring in Razi's available works and his ideas, we can determine four characteristics as his key to success. The first one is his meticulous observation in the field of medicine. In his treatise *Ghesas ol-Hekayat ol-Marza*, Razi has taught us how consummately report medical cases in its best form. His method to document medical history and medical record of patients, in a case-by-case manner, is exemplar. The second characteristic is his endurance and stubbornness in pursuing scientific problems and/or scientific works. his enormous *Continens* and his laborious endeavor in chemical experiences—few has claimed that he kept a wary eye on crucible to monitoring chemical reactions, and this is the underlying reason for permanent damage to his eyes—can be adduced as evidence of his endurance in scientific works. The third trait

is his deep believes in criticism. As we know, Razi profoundly believed in criticism and repeatedly has scrutinized and revised his contemporary and/or non-contemporary scholars as he even has allocated a book to critique of Galen, the *Kitab al-Shukuk 'ala Jalinus* (Figure 5). And, Razi's last characteristic is his irrevocable fidelity to medical ethics. He advocated his time and expertise to the patients regardless of their social classes. He has devoted *Teb al-Foghara val-Masakin* to indigent and lower-class population in which he provided obtainable medical instructions. And, also, he has allocated a book *Teb al-Moloki* to royal families and/or rich people. It seems that all of aforementioned characteristics make Razi a perfect role-model for young scientists and/or practitioners who want to be distinguished in their clinical and/or scientific works.

5. Conclusion

To draw a conclusion, although some of Razi meaningful contributions to medical and other branch of sciences have been elucidated, yet to sketch a more comprehensive portray of his far-reaching position in science and philosophy we need to devote more studies to scrutinize his colossal works.

Acknowledgements

This work was made possible by financial support from The Iranian Academy of Medical Sciences, Tehran, Iran.

Conflict of Interest

None declared.

References

1. Shehata M. The ear, nose and throat in Islamic medicine. *J Int Soc History Islamic Med.* 2003;1:2-5.
2. Compier AH. Rhazes in the renaissance of Andreas Vesalius. *Med Hist.* 2012;56(1):3-25. doi:10.1017/S0025727300000259
3. Nadjm-Abadi M: Mohammad Zakariya Razi: Iranian Physician, Chemist and Philosopher. Kermanshah, Razi University Publications. 1993:173.
4. Siddiqui M: Studies in Arabic and Persian

medical literature. Calcutta: Calcutta University; 1959:20.

5. Najmabadi M: History of Medicine in Iran after Islam. Vol. 2, 2nd ed. Tehran: University of Tehran Press, 1987.
6. Najmabadi M: Muhammad Zakariyya Rāzī. 2nd ed. Tehran, University of Tehran Press, 1992.
7. Hitti PK: The Arabs: A Short History. Chicago, Princeton University Press. 1943:143.
8. Doherty M, Robertson MJ. Some early Trends in Immunology. *Trends Immunol.* 2004

Dec;25(12):623-31. doi: 10.1016/j.it.2004.10.008. PMID: 15530829.

9. Bungy GA, Mossawi J, Nojoumi SA, Brostoff J. Razi's report about seasonal allergic rhinitis (hay fever) from the 10th century AD. *Int Arch Allergy Immunol.* 1996 Jul;110(3):219-24. doi: 10.1159/000237290. PMID: 8688667.

10. Lee Ligon B. Biography: Rhazes: his career and his writings. *Seminars in Pediatric Infectious Diseases.* 2001;12: 266-272.

11. Nasr SH. Science and Civilization in Islam. New York, New American Library, 1968,184-229.

12. Cawbell D. Arabian Medicine and its Influence on the Middle Ages. Vol. 1. London: Kegan Paul, Trench, Trubner & Co., 1926;69-77.

13. Hunke S. Allah's Sun Over the Occident. Translated by Rahbani M. 4th ed. Tehran: Daftar-

enashr-e Farhang-e Islami, 1994.

14. Erer M, Aydın A, Nazik H, Kuvat N, Kuvat S. Tuberculous dactylitis with severe deformation in the phalanx of the index finger: a case report. *Eur Orthop Traumatol.* 2011;2:97-9.

15. Sezgin F: Discourses on the History of Arabic and Islamic Sciences. Translated by Rahbani M, Attai R. Mashhad: Foundation of Islamic Researches, 1992.

16. Souayah N, Greenstein JI. Insights into neurologic localization by Rhazes, a medieval Islamic physician. *Neurology.* 2005 Jul 12;65(1):125-8. doi: 10.1212/01.wnl.0000167603.94026.ee. PMID: 16009898.

17. Daghestani AN: al-Razi (Rhazes), 865-925. *Am J Psychiatry.* 1997;154:1602.

18. Meyerhof M. Thirty-three clinical observations by Rhazes. *ISIS.* 1935;23:321-372.