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THE CONTRIBUTION OF MUSLIM SCIENTISTS TO THE DEVELOPMENT OF MODERN SCIENCE

Muhammad Komaruddin
Raden Fatah State Islamic University, Palembang, South Sumatra, Indonesia
E-mail; muhammadkomarudin703@gmail.com

Abstract
This paper presents a discussion of the contribution of Muslim scientists to the development of modern science. It is commonly known that during the golden age of Islam, scientists emerged who were very competent in their respective fields. They succeeded in appearing as philosophers and scientists who filled various scientific fields, such as medicine, mathematics, chemistry, physics and so on. Their knowledge is very valuable, especially for the development of science in the following times. So valuable is science and what it offers, that it is not uncommon for scientists who came later to call them the fathers of science in their respective fields. However, not all of them will be discussed in this paper, but only the triumvirate of Muslim scientists, namely Ibn Rushd, Ibn al-Haytham, and Jabir ibn Hayyan. The contributions of the three were enormous to the development of modern science and are recognized by scientists, both in the East and especially in the West.

Keywords: Islam, science, modern, contribution

Abstrak
Tulisan ini menyuguhkan pembahasan mengenai kontribusi ilmuwanilmuwan muslim bagi perkembangan sains modern. Sudah jamak diketahui bahwa pada zaman keemasan Islam banyak bermunculan ilmuwan yang sangat kompeten di bidangnya masing-masing. Mereka berhasil tampil sebagai filosof dan saintis yang mengisi berbagai bidang keilmuwan, seperti kedokteran, matematika, kimia, fisika dan sebagainya. Keilmuwan mereka sangat berharga terutama bagi perkembangan sains pada masa-masa berikutnya. Begitu berharganya keilmuwan dan apa yang dipersembahkan oleh mereka, sehingga tidak jarang para ilmuwan yang datang belakangan menjuluki mereka sebagai bapak sains di bidangnya masing-masing. Namun, tidak semua dari mereka akan dibahas dalam tulisan ini, melainkan hanya triumvirat ilmuwan muslim, yakni Ibn Rushd, Ibn al-Haytham, dan Jabir ibn Hayyan. Kontribusi ketiganya begitu besar bagi perkembangan sains modern dan diakui kalangan saintis, baik di Timur dan khususnya di Barat.

Kata Kunci: *Islam, ilmu pengetahuan, moderen, kontribusi*

INTRODUCTION

Islam gives a very high appreciation of reason. So high that reason occupies an urgent and vital position in the struggle for Islamic discourse. Therefore, reason is often juxtaposed with revelation in many occasions and discussions. Thus it is natural to say that Islam highly values science. Of course the product of the utilization of reason is

science. From the reason and intellect that God has bestowed, humans can explore various knowledge that exists in the universe, both macro and micro. Thus, various disciplines emerged (Abdullah, 2016).

According Fabriar, (2019)This is evidenced in the history of Islam by the widespread development of knowledge from various fields and the emergence of hundreds or even thousands of Muslim scholars. Islam's respect for reason and knowledge is not just a lip service, because it has been carried out and practiced by an extraordinary number of Islamic scholars or scholars. Such conducive conditions have succeeded in presenting several prominent Muslim philosophers, such as al-Kindī (801-873 AD), al-Farabī (870-950 AD), al-Rāzī (864-930 AD or 251-313 H), Ibn Tufail (1105-1185 AD), Ibn Bajjah (1085-1138 AD), and a number of experts in their respective fields, such as Ibn Rushd (1126-1198 AD), Ibn al-Haytham (965-1040 AD or 354-430 H), and Jabir ibn Hayyan (721-815 AD) as well as the Muslim ethicist, Ibn Maskawaih (932-1030 AD or 330 - 421 H).

In fact, there are many Muslim scholars who appear on the stage of history. In the book Uyūn al-Anbā' fi Ṭabaqat al-Aṭibba' written by Ibn Abi Ushaybi'ah, a thirteenth-century medical expert, contains information and biographies of more than three hundred and fifty Muslim scientists (Djalaluddin, 2015). There are medical experts, chemists, geometry, geology, geography, mathematics, astronomy and so on. However, only a few are known. Unfortunately, because our education system still reflects and is oriented to the West, while the West hides the merits of Islam in the scientific arena, the public basically does not know Islamic figures who are actually very big and well-known. Even though the development and progress of science in the West was the impact of and influenced by progress in the Islamic world, especially after the Averroism movement took root in Europe. The West has had a positive influence on science from the Islamic world.

METHOD

This research uses a qualitative method which is a qualitative research as a research used to reveal and understand a phenomenon in the field (Yusanto, 2020). Meanwhile Robert K Yin describes qualitative methods as instruments for studying human activity, both in terms of seeing, hearing, reading and the like. The type of this research is literature study research. While the primary data is collected from books, manuscripts and other articles that are in accordance with the title of this study which the researcher then analyzes and draws common threads to make conclusions (Iswadi dkk., 2023).

RESULTS AND DISCUSSION

A. The Thoughts of Ibn Rusdh (The Influence of Averroism on the Enlightenment of Islamic Education)

Ibn Rushd's thoughts have succeeded in opening new horizons for the world of science. Ibn Rushd's exploration of this world has invited massive interest among students and scholars, both in the Islamic and Western worlds, to transfer his thoughts. The

transformation of Ibn Rushd's views can be accessed through his works and lectures at various universities, including the Universities of Cordoba, Seville, Malaga, Granada and Samalanca, in Andalusia. Students from Europe flock to study at these institutions. Then they brought Ibn Rushd's mindset to the European plains, such as at the Universities of Padua, Bologna, Ferrara and Venice in Italy. Even according to Ernest Renan (1823-1892 AD), his works were translated and printed repeatedly in Europe and Latin. The University of Paris, France, is no less extraordinary, namely bringing in educational staff specifically from Andalusia to teach Averroes' mindset. At the university there was a professor in charge of Ibn Rushd's comments, namely Siger de Brabant (1240-1280 AD) (Dalimunthe, 2016).

European historians remember him as a 'bridge of knowledge' between East and West, a link between Islam and Christianity. He is Ibn Rushd or Averroes, a figure touted as the epitome of the enlightenment movement in the West, the new idol of liberalists in Europe. After several centuries of his work being buried in historical limbo, the figure of Ibn Rushd seems to have come back to life. Is Ernest Renan according to Dr. Syamsuddin Arif (INSISTS researcher) who first brought up his character through his work “Averroesetl' Averroism”. According to this French intellectual of Jewish descent, Ibn Rushd was the cornerstone of European rationalism. He eloquently recounts the life history of Ibn Rushd and the ultimate fate of his legacy in the Islamic world and Europe. Renan's work has become an antidote to grief. By reading it, the readers seem to find a lost heirloom.

The first scholar who allegedly brought Ibn Rushd's thoughts to the Latin world was Michael Scott, who in AD 1230 translated his Commentary of the Sky and the Nature and Commentary of the Soul. Then Hermann from Germany translated Kulliyat's book Colliget. The Averroism movement had a very strong influence in the West so that it was able to overturn the doctrines of Orthodox Christian Theology and Augustinism in the Scholastic Age, which eventually gave birth to the Renaissance movement. Renaissance means rebirth, which is an attempt to revive the classical culture of Greece and Rome.

The Renaissance is often called the Age of Humanism, namely the era in which humans were raised from the Middle Ages. The characteristics inherent in this era are humanism, individualism, apart from religion, empiricism, and rationalism. In this era, Ibn Rushd's views are very much loved, both those that are informed through his works and through the comments of his students.

On the subject of truth, Ibn Rushd believes in what is called the "unity of all truths," which is the only way in which Muslim philosophers have justified their philosophical pursuits, appeased the theologians, and satisfied the desires of thought by internal coherence." As a result, philosophical truths that are reached through rational inquiry are essentially the same as religious truths that are based on Divine revelation. “Ibn Rushd,” said the Mahdi, “interpreted the identity of Divine law and human philosophy

for the purposes of the identity of Divine law and human philosophy through their aims," namely, "striving for happiness and truth." In his book Fashl al-Maqal, Ibn Rushd says: "If sharia is a truth and advice to investigate (everything that exists) leads to knowledge of that truth, then Muslims will know for sure that demostrative investigation will not create any contradiction with what sharia states, because the truth will never contradict the truth, but each other is a witness to each other.

Apart from Ibn Rushd, there are still many Muslim scientists who are active in the field of science with their respective expertise and have a very big influence on the growth and development of science itself. Among them were Ibn al-Haytham and Jabir ibn Hayyan. In the following, the thoughts of the two of them and their influence on the development of modern science, especially in their respective fields of expertise, will be presented.

B. Ibn al-Haytham's thoughts

Ibn al-Haytham was born in Basrah in 354 AH to coincide with 965 AD. He started his early education in Basra. After that he served as a government employee in the area of his birth. After serving the government there for some time, he decided to migrate to Ahwaz and Baghdad. In overseas he continued his education and devoted attention to writing. His love for knowledge has brought him to emigrate to Egypt. While there he took the opportunity to do some research work on the flow of the Nile as well as copying books on mathematics and astronomy. The goal is to earn extra money on the way to al-Azhar University. This effort paid off, he became a very proficient in the fields of science, astronomy, mathematics, geometry, medicine, and philosophy. His writings on the eye, became one of the important references in the field of scientific development in the West.

Ibn al-Haytham is a scientist who likes to conduct investigations. His investigations of light have inspired Western scientists such as Boger Bacon and Kepler, creator of the microscope and telescope. He was the first to write and find important data about light. Several books about light that he wrote have been translated into English, including Light on Twilight Phenomena. His studies are devoted to twilight and the many halos around the moon and sun as well as shadows and eclipses. Several experiments were carried out by Ibn al-Haytham, including an experiment on glass that was burned, and the theory of a magnifying lens was discovered. The theory has been used by scientists in Italy to produce the world's first magnifying glass and the principle has been adopted by scientists since. Similarly, the even more amazing principle of air integration, Ibn al-Haytham had discovered and introduced it long before a scientist named Tricella who knew about the matter 500 years later (Alimuddin, 2007).

Ibn al-Haytham is also alleged to have conveyed the existence of gravity or gravity before Isaac Newton knew about it. In addition, Ibn al-Haytham's theory of the human soul as a sequence of feelings that continues on a regular basis has inspired Western

scientists to produce wayang images. His theory has led to the invention of films which are then spliced and played to the audience as we can see today.

Ibn al-Haytham died in Cairo, Egypt, around 1040 AD Because of his in-depth observations in the field of optics, his concepts became the basis of optical science. Moreover, he ushered in optics to today's rapid advances. Thus, Ibn al-Haytham earned the nickname "Father of Modern Optics."

C. Jabir ibn Hayyan's thoughts

He is a prominent scientist and philosopher who has the full name Abu Musa Jabir ibn Hayyan al-Azdi. Westerners know him by the name Geber. He was born in Thus Khurasan, Iran (Persia), in 721 AD or around the 8th century. Jabir is a person of Arab descent, but some say that he is Persian. His father, Hayyan al-Azdi, came from the Azd Arab tribe, who was an expert in the pharmaceutical field from the large Yemeni tribe, the Azad tribe, and most of them emigrated to Kufah after the collapse of the Ma'rib Dam. Besides being an expert in the pharmaceutical field, his father was also a supporter of the Abbasid dynasty and participated in helping to overthrow the Umayyad dynasty. During the reign of the Umayyads, he migrated from Yemen to Kufah which was one of the cities center of the Shia movement in Iraq. When his father was carrying out a rebellion, he was caught by Umayyad troops in Khurasan, then he was executed and sentenced to death. After his father died, Jabir and his family returned to Yemen and he began to study the Koran and various other sciences from a scientist named Harbi al-Himyari. Jabir returned to Kufa after the Abbasids succeeded in overthrowing the Umayyads and began his career in chemistry (Ahmad dkk., 2021).

His interest in this field made him continue to explore it so that he became an expert in chemistry. Some say, his interest in chemistry was due to his father's profession as a druggist. Jabir ibn Hayyan lived during two dynasties, namely the end of the Umayyad Caliphate and the beginning of the Abbasid Caliphate. Jabir then studied medicine during the Abbasid Caliphate under the leadership of Harun al-Rashid from a teacher named Barmaki Vizier. Jabir continued to work and experiment in chemistry diligently in a laboratory near Bawaddah in Damascus with the characteristic of his experiments being carried out quantitatively, even the instruments used for his experiments were self-made from metals, plants and animals.

It was in his laboratory that Jabir managed to find major discoveries that are very useful to this day, even in that laboratory various of his chemical equipment have been found, and after having a career in Damascus, Jabir is said to have returned to Kufah after the Baramikah tragedy. When he returned to Kufa, not much was known about his whereabouts, but two centuries after his death, his laboratory was discovered, as mentioned above. Inside were his chemical equipment, which is still dazzling, and a fairly heavy bar of gold.

Jabir's greatest contribution was in the field of chemistry. He got this expertise by studying with Barmaki Vizier, during the reign of Harun al-Rashid in Baghdad. He

developed a systematic experimentation technique in chemical research, so that every experiment can be reproduced. Jabir emphasized that the quantity of a substance is related to the chemical reaction that occurs, so that it can be considered that Jabir has pioneered the discovery of the law of fixed proportions. Other contributions include improving the processes of crystallization, distillation, calcination, sublimation and evaporation as well as developing instruments to carry out these processes.

Like medieval Muslim scientists, Jabir ibn Hayyan was not only able to study one particular field of knowledge, but they were also able to master other scientific fields and were very diverse. Besides being an expert in chemistry, he is also an expert in other sciences such as medicine, philosophy and physics. It's just that of the many sciences he has worked on, it seems that chemistry is more attached and prominent to him.

Many of his works were translated into various languages, and then absorbed by modern chemistry. Europe then began to recognize technical terms such as realiger (red sulphite from arsenic), tutia (zinc oxide), alkali, antimonia, alembic, and aludel. Likewise salamoniac (a new type of chemical substance) was introduced by Jabir ibn Hayyan which had never been known to the Greeks.

Some of Jabir Ibn Hayyan's discoveries include: hydrochloric acid, nitric acid, citric acid, acetic acid, distillation techniques and crystallization techniques. He also invented the aqua regia solution (by combining hydrochloric acid and nitric acid) to dissolve gold. Jabir Ibn Hayyan was able to apply his knowledge in chemistry to the process of making iron and other metals, as well as preventing rust. He was also the first to apply the use of manganese dioxide in the manufacture of glass cups (Cahyati & Rizal, 2022).

Jabir Ibn Hayyan was also the first to note that heating wine would produce flammable gases. This then paved the way for Al-Razi to find ethanol. If we know the metal and non-metal groups in the compound group classification, then Jabir was the first to do it. He proposed three groups of compounds, namely: 1) "Spirits" which evaporate when heated, such as camphor, arsenic and ammonium chloride. 2) "Metals" such as gold, silver, lead, copper and iron. 3) “Stones” which can be converted into powder form. Jabir continuously developed his research in the field of chemistry until he was able to have works in the field of chemistry reaching 500 chemical studies, but only a few of them were discovered until the Renaissance era. Among his famous books are: 1) al-Ḥikmah al-Falsafiyah which was translated into Latin and entitled Summa Perfecdonis, and in 1678, another English scientist, Richard Russel, translated Jabir's work with the title Summa of Perfection, 2) Kitāb al-Raḥmah, 3) Kitab al-Tajmi, 4) al-Zilaq al-Sharqi, 5) Book of The Kingdom, 6) Book of Eastern Mercury,, 7) Book of Balance (all three were translated by Berthelot), 8) al- Khawash, 9) Ṣifat al-Kaun (cosmology), 10) al-Ḥikmah al-Mashunah, 11) al-Ṭabi'ah, 12) Shunduq al-hikmah (The Chest Cavity of Wisdom), a manuscript, 13) al-Lahut , 14) al-Ṭabi'ah al-Fa'ilah al-ulā al-Mutaḥarrikah, 15) Kitāb al-Sumūm, 16) Asrār al-Ḥikmah, 17) Al-Sir al-Maknun, 18) Al-Takhlish, 19) Al-Ihraq, 20) AlIbdah, 21) Shubh al-Nufus, 22) al-Sir al-Maktum, 23) al-Ijaz, 24) al-Juf al-Aswār,

25) Nihāyat al-Itqān, 26) Istiqṣa 'at al-Mu'allim, 27) al-Kimia al-Jabiriyyah, 28) Kitāb al-Sab'in, 29) al-Zuhrā, translated into Book of Venus, 30) Kitab alAhjār which is translated into Book of Stones, 31) al-Kimya, translated and published by the English scientist, Robert Chester in 1444, under the title The Book of the Composition of Alchemy, and 32) Mukhtār Rasā`il. 1. Islamic Chemistry as the Embryo of Modern Chemistry Empirical findings form the basis of modern science , including chemistry. Centuries before the emergence of Islamic civilization, the basic premises of chemistry had stood firmly along with the development of the scholastic natural philosophy that shaped it (Cahyati & Rizal, 2022).

Entering the world of Islamic chemistry, these basic assumptions experience adjustments and there is a connection between chemical, spiritual and mystical themes. Muslim chemists try to turn natural phenomena that are sometimes mysterious and difficult to understand for some people into something that can be studied. Not infrequently, Muslim chemists are often regarded as pseudo-science experts. Furthermore, the attention of Muslim chemists was directed to the ability surrounding the conversion of ordinary metals into precious metals (gold) or what is called a transmutation event.

This event became a common work in chemistry until the cosmological tables and diagrams were compiled by the great scientist Jabir ibn Hayyan. This diagram is popular because it reflects the location of the elements and all inanimate and animate objects into a dynamic constellation framework. The transmutation of an ordinary metal into gold symbolizes the striving towards perfection or the heights of existence. Classical chemists including Muslim chemists believed that the whole universe was moving towards a state of perfection; and gold, because it never decays, is considered the most perfect substance. By turning ordinary metals into gold, chemists are actually trying to help the universe maintain its balance. So, it is logical that by understanding the secret of the immutability of gold, the key to maintaining the existence and preservation of matter in the universe will be found. Francis Bacon (1561-1626 AD). 2. The Role and Contribution of Islamic Chemistry to Civilization The figures who gave the characteristics of Islamic chemistry were Jabir ibn Hayyan, ar-Razi and Izz al-Din al-Jaldaki.28 G. Le Bon mentioned that many chemicals before Geber (Jabir) unknown, thanks to his services to be known. Some of the substances discovered by Muslim chemists are still being used today and have even been developed into important compounds.

CONCLUSION

The method of thinking concocted by Muslim thinkers such as Ibn Rushd, Ibn al-Haytham, Jabir ibn Hayyan and others which is packaged in a more elegant perspective by dismantling textual and doctrinal thinking methods, which then presents a contextualist way of thinking is the power special attraction for their method of thinking that has won a place in the hearts of later thinkers to follow his mindset. The point of view

offered has been able to shift the mindset of exclusivism towards the mindset of inclusivism which is packaged rationally and experimentally. With this perspective, the perspectives and methods of thinking that were developed in the future were more rational and systematic than the models of thinking that were developed before. What they developed had a huge impact on the development of modern science and was a breath of fresh air for the development of science and technology in the contemporary era like today. Many Western thinkers have adopted their mindset, so that not a few of them are oriented towards Muslim scientists. What was presented and offered by Muslim thinkers has been able to conjure up modern science as it is developing in today's world, both in the West and in the East.

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