



An Account of Muslim Intellectual Feats and Contributions in the Fields of Sciences

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ABSTRACT

The acquisition of knowledge encouraged by Islam is not only meant for mundane benefits but the discovery of truth about the doctrine of belief in God. The primary sources of Islam motivated the classical Muslims to acquire and master various branches sciences. Thus, the spread of Islam beyond Arabia brought the Muslims into direct contacts with the cultures and traditions of Persians, Greek, Byzantine, Syrians, Egyptians and Indians. These contacts resulted in the acquisition of new ideas, knowledge, and more awareness about the practices of those communities. Muslims acquired the scientific ideas of those communities and synthesized them with what they had in the tradition of Islam. They refined the scientific ideas and developed new principles in various fields of sciences. This paper applies theoretical method in presenting a brief account of the contributions of Muslims scientists in the fields of astrology, astronomy, medicine, mathematics physics and chemistry. The aim is find out how the Muslims in the classical period learned the works of past scientists, clarified them and developed new scientific principles. However, Muslims did not only acquire knowledge from the Persians, Greek, Byzantine, Syrians, Egyptians and Indians, they combined such knowledge with what obtained in the tradition of Islam. They improved the existing scientific principles, developed new ones, and wrote original works. Such works became leading materials in sciences in the institutions of learning throughout the world. The translation of the work into Latin helped modern Europe to become acquainted with scientific principles developed by early scientists. Thus, the advancement recorded in modern sciences owes a lot to the efforts of Muslims in the preservation past works, systematizing of scientific principles and invention of new methods of tests and experiments.

INTRODUCTION

The teachings of Islam are not antithetical to knowledge, but strongly emphasize the values of knowledge and benefits of its acquisition. The encouragement to acquire and disseminate knowledge for the betterment of humanity makes knowledge an inseparable part of the religion of Islam. As an embodiment of intellectualism, Islam does not restrict the form of knowledge its adherents can acquire. It only sets requirements that the right knowledge to pursue should be beneficial to mankind and must not

negate the existence and unity of God. Such knowledge should not be harmful to mankind or benefit some at the expense of others. In the view of Islam, knowledge such as sorcery and magic do not bring any benefits to mankind, but instead cause harm and lead to disbelief (Q3:102, 20:69). The primary sources of Islam prioritize acquisition of knowledge not only for the development of human intellectual capacity, but for discovery of the truth about God. In the postulation of Nadwi (61), the pursuit of knowledge was strongly encouraged and given prominence in the scheme of life of the Muslim community, right from inception. In the *Qur'an* the status of people of knowledge is acknowledged as those with special ranks (Q58:11) and being most conscious of God (Q25:28). The traditions of the Prophet of Islam emphasize the acquisition and dissemination of knowledge. They warn against the attitudes of hiding and or blocking others from gaining and benefitting from any useful forms of knowledge (Abu Dawud vol.3, 73). However, the open instructions on acquisition of knowledge inspired the early Muslims to search for both religious and other forms of knowledge. In their quest for answers to religious and existential problems they acquired all forms of knowledge with the sole aim of generating benefits for mankind and removing harm in human society (Nadwi 62, Afridi 48).

The spread of Islam beyond the frontiers of Arabia, expanded the horizon of the Muslims. It brought them into direct contacts with the cultures and traditions of the Persians, Byzantines, Romans, Indians, the Egyptians, and even Africans. The contacts brought some communities into the fold of Islam, and created in others a new awareness about Islam as a way of life and a distinct religion. The unintended results of the contacts were the serious challenges posed to the Muslim minds by the religious and cultural practices, social and financial transactions of the communities. This stimulated the Muslim thought and flared up their desire for study and researches. Firstly, they tried to understand the practices and situate them within the contexts of the teachings of Islam in order to determine their religious statuses. Secondly, they learned and benefitted from the different branches of knowledge appropriated by the communities. The Muslims in turn, acquired new ideas, translation works on different subjects, and synthesized them with what they had in the tradition of Islam (al-Khalili 120, Faruqi 7, Essa and Ali 11). This

exercise greatly shaped the Muslim intellect, thereby raising a new breed of Muslim intellectuals who combined divergent knowledge and contributed to various disciplines, of philosophy, logic, law and sciences (Core Knowledge 28, Bennison 194).

Muslim ideas on the acquisition of knowledge were rooted in the foundation established in the time of the Prophet (SAW). The idea bore fruits in the time of the Umayyad, which saw remarkable development of knowledge. This manifested in the large number of learning centers that developed at the time. This development was achieved due to the interests shown by some Umayyad Caliphs in the pursuit of not only the religious sciences but the applied and basic sciences as well. In the time of Abbasid, Muslims have distinguished themselves as great philosophers and scientists who have mastered different branches of sciences and become authorities in their own rights (Zakariya 174, Afridi 48). They made new discoveries, interpreted, clarified and expanded what have been developed by the Greeks, Persians, Egyptians, Indians and Syrians. They contributed to all branches of science and became acknowledged experts in their respective areas of specializations. Thus, Muslim contributions have gone beyond the translation and assimilation of what they learned from other communities. They have fundamentally changed the cause of scientific research and introduced new methods of scientific experiment, measurement, and testing. Their achievements were later enhanced following the establishment of *Biat al-Hikma* in Baghdad and translation exercise initiated and supported by the Abbasid Caliphs (al-Khalili 120-21, Essa and Ali 3, Virk 5). In view of the historic achievements of the Muslims in the sciences, this paper presents a brief but concise account of the Muslim contributions to the development of modern science. It applied theoretical method and collected data from primary and secondary materials including verses of the *Qur'an* and *Hadith*. Muslim intellectual feats in sciences spanned for centuries where they excelled in fields of philosophy, metaphysics and sciences. Very few among them who rose to prominence in sciences were mentioned in this paper. Thus, their biographies, education, and details of their scientific findings and experiments were not discussed.

Muslim Contributions in Astrology and Astronomy

Astrology is one of the sciences of antiquity that had been appropriated by past communities and still survives to modern times. Like philosophy and metaphysics, astrology was one of the leading sciences that played significant roles in the development of human intellect. In almost every community in the past centuries there were individuals who specialized in observing the functions of the heavenly bodies to predict natural events like rainfall, changes in seasons and weather conditions. Though considered less systematic than astronomy, astrology remains the precursor to science of astronomy (al-Khalil 88). Thus, astrology deals with the appearance of the moon and its position, the stars and their movements. Understanding these heavenly bodies and their phenomena helped in predicting natural events in the past. Muslim interest in astrology was occasioned, as it were, by the desire to understand the movement of sun the appearance of the moon and its location, direction of the Ka'bah and using the stars in navigating trackless routes. The connection between some religious practices in Islam and the movements of the sun and the moon had flared up the desire of the Muslims in understanding the nature of these bodies. In any event, Muslim scientists have had ideas of astrology before coming across the astrological and astronomical findings of the ancient scientists of the Persian, Indian, Egyptian and Greek extractions. After acquiring the astronomical ideas of those communities, Muslim made their contributions in the area. They improved on the planetary system developed by Ptolemy and other Greek scientists, and added their discoveries and further systematized astronomy from traditional knowledge to a sophisticated science (al-Khalili 120, Bennison 163, Baloch 49).

Notable personalities in the field of astronomy include Abu Ja'far Muhammad bn Musa al-Khawarazmi (d.850 CE) who is credited with the production of the first astronomical table. The table developed by al-Khawarazmi and improved upon in course of time by other Muslim scientists provided the accurate method of calculating the positions of stars and planets. Another notable scientist in the field of astronomy was Abu al-Abbas al-Farghani (d.870 CE). He wrote many works in astronomy, including *Ikhtiyar al-Majisti*, which was a detailed account of Claudius Ptolemy's *Almajest*. Al-Farghani also wrote other works like

Jawami'Ilm al-Nujum and *Kitab amal Astrulab*. His work *Ikhtiyar al-Majisti* remained one of the most important materials in empirical verification of scientific knowledge (al-Khalili 120, Virk 17). Scholars like Nasiruddeen al-Tusi (d.1274), Qutubudin al-Shirazi (d.1311) and Ibn. al-Shatir (d.1375) have made significant contributions to the development and refining of astronomical science (Virk 26). The innovative contributions of Muslim scientists in astronomical theory and the expansion of its frontiers perfected the development of scientific method of inquiry. Their improvement of Greek astrolabe, added more features to it. They applied astronomy in calculating prayer times, determining the direction of Makkah, developing calendar system, and establishing the correct circumference of the earth. Muslim astronomers built observatories in places like Smarkand, Delhi, Turkey and several other provinces in the Muslim world. Their expertise in all areas of astronomy covered both theoretical astronomy and spherical astronomy. Their findings and discoveries reached Europe in the middle Ages and formed the significant part of the many texts of astronomy textbooks in Europe in subsequent centuries (Baloch 49, Faruqi 396-97).

Discoveries in Mathematics and Physics

The idea of calculation, or in the least, the knowledge of adding some items with others to have a higher amount is naturally imbued in human intellect. Ordinarily, an individual does not need any formal training to understand that adding one orange with another will result in having two oranges. But the understanding of complex calculations that involve the use of symbols and signs, as well as fractions will require some training. Muslim ideas of basic mathematical calculations were strengthened by the *Qur'an*. Thus, matters of *Salat* (Q73:20), inheritance (Q4:11-12), and *Zakah* (Q2:261) are explained using some mathematical calculations. The background knowledge of Muslims in mathematics was enhanced after the translation of Greek, Persian, and Hindu materials into Arabic (Virk 11, Faruqi 394). Their inventions and contributions in all fields of sciences including mathematics have eased the understanding of science not only in the middle-ages but in modern times. The works they prepared connected modern scientists with scientific ideas of antiquity. Such works preserved and disseminated the scientific findings and ideas of past Greek, Persian, Roman, Egyptian and Indian scientists.

At the initial stage, mathematics in the Muslim world was a combination of arithmetic, astronomy, geography and navigation. Muslim scientists have revolutionized mathematics after the adoption of Hindu numerals, and employment of zero in mathematical calculations. Authors like Muhammad bn. Ahmad believe that zero was an invention of the Muslim scientists (Afridi 50). But Jim al-Khalili (149) maintains that zero was part of numerals learned by the Muslims from the Hindus mathematics. Muslim mathematicians replaced the Roman numeral and Greek number systems with Hindu numerals, which were easy to handle and normally occupied less space in writing. They improved the numerical techniques in mathematics by introducing some innovation in the use of Hindu decimal and Babylonian number system. Muslims mastery of mathematics was evident in introduction of the use of fraction and development of the creative methods of calculation such as multiplication and expression of numbers in symbols. Classical Muslims were no strangers to mathematical calculations in forms of fractions and multiplication. Calculation of wealth and deduction of fate of *Zakah* as well as distribution of estate to hires after the deceased of a relation were all explained in fraction. Muslim interest in acquisition and adoption of numerals and number systems of other communities might not be unconnected with the need to better understand matters connected with calculations in the religion of Islam (al-Khalili 143-144, Afridi 49, Faruqi 395).

Some outstanding Muslim mathematicians in the classical period were Abu Musa al-Khawarazmi (d.850), Umar bn. Ibrahim al-Kayyan (d.1122), Yaqub bn. Ishaq al-Kindi (d.873), Abu Ali al-Hasan Ibn al-Haytham (d.1039) and Abu Raihan Muhammad bn. Ahmad al-Burini (d.1048). Al-Khawarazmi was the most outstanding Muslim mathematician, credited with the invention of principles of algebra and algorithm. He built on the works of Greeks and developed innovative methods of mathematical calculations (Core Knowledge 29). His work *Kitab al-Jabr wa al-Muqabalah*, treated equations and geometric methods for completing a square. Al-Khawarazmi did not use symbols in his works, but made theoretical expression of algebraic calculations in words. He used the principles of Islamic law of inheritance to make mathematical analysis, and demonstrated how issues of inheritance were resolved by means of

algebra (Khalili 166, Afridi 49). His work *Kitab al-Jabr* remained the major foundation material for algebraic calculus and decimal arithmetic (Virk 11). Umar al-Kayyan (d.1122) was another Muslim mathematician that rose to fame in the classical period. He was credited with developing a geometrical method that was applied in solving cubic equation. He studied the work of al-Khawarazmi on algebra and made significant contribution not only to the work but in mathematical science especially in geometry. The methods he invented in solving cubic and quadratic equations featured in the works of European mathematicians in the middle ages (Faruqi 395).

Al-Kindi (d.873) was credited with the advancement of Arabic number system, and improvement of spherical geometry. He is considered as the scientist that set the foundation of modern arithmetic (Virk 19). Ibn al-Haytham (d.1039) made contributions in mathematics, and his work *Kitab al-Manazir* was utilized in Europe in the thirteen century. His major contribution was in geometry and number theory, where he developed analytical geometry and forged a link between algebra and geometry thereby establishing the foundation of pure mathematics (Virk 21, Afridi 50 Faruqi 396). Al-Burini (d.1048) was a distinguished expert in mathematics, physics and pharmacology. He was one of the greatest minds that connected the sciences of antiquity with modernity (Starr 2). He developed a method for trisection of an angle, and solved a problem known as al-Birunic trisection of angle which cannot be solved with ruler and compass alone. Al-Burini made accurate measurement of specific weight, and is said to be the first to discover that the earth revolves round the sun. His works on geometry, titled *Istikhraj al-Autar Fee al-Da'irah* dealt with theorem of chord in the circle, and was significantly utilized by Europeans (Virk 22, Halilovic 70).

In physics, Muslim scientists have made significant improvement on the works of the Greek scientists and invented new principles through experimentation. Scientific understanding of the natural world played crucial role in responding to the fallacies of religious movements that adopted Manichaeism in Iran and Khurasan in the time of the Abbasid. This further strengthened the desire of the Muslim scholars to pursue scientific knowledge in physics (Bennison 185). Their study of the book of

Aristotle on kinetics and that of Archimedes on floating bodies and gravity, had sharpened their understanding of the universe (Afridi 52). Muslim scientists explained the laws of motion, and were the first to discover the effect of sound and its movement in the air in form wave (Afridi 50). Al-Biruni (d.1048) and Abu al-Fath Abdurrahman al-Khazini (d.1130 CE) were among the prominent Muslim physicists. Al-Khazini was credited with the development of theories of inclination and impulse. He invented a device that helped determine gravity of liquid, and clarified that air had power to boost moving objects. His works led to the invention of barometer, air vacuum and pumps. Abu Ali Husain bn Abdullahi famously known as Ibn Sina (d.1037 CE), treated the law of motion in his work *Isharat wa Tanbihat*. His thought on the law of motion was that an object remained unmoved or moved in a straight line if it was not influenced by anything. Hibatullah bn Malaka al-Baghdadi (d.1164 CE), explained another law of motion in his book *al-Mo'tabar fil Hikmah*. He made an analysis and demonstrated that the stronger the power that pushed an object the faster the speed of the object, and the shorter the time the object spent in covering distances (Afridi 51-52).

Muslim Expertise in Medicine, Pharmacy and Chemistry

The practice of seeking treatment for an ailment is a continuous process that never ceases throughout the human history. Sickness is a natural part of life, and treatments are always sought for different ailments that happen to both humans and animals. Thus, issues of sickness and healing featured prominently in the primary sources of Islam. The *Qur'an* contains references on sickness and treatment (Q38:41-42), and mentions the benefits and healing power of honey (Q16:69). The tradition of the Prophet of Islam also makes references to illness and presents some practical methods of healing by means of prayer and of medicinal values of certain materials (Abu Dawud vol.3, 342). These references, among others, inspired the Muslims to embark on search for cure for different forms of illness. They carried out experiments and discovered medicinal properties in plants and other materials. This endeavour never stopped throughout the history of Islam, thus, Muslim physicians and nurses flourished in the time of the Prophet. However, the advancement of medical science to its present condition has been gradual, and the contributions of Muslim physicians remained significant to this day.

Drawing from the works translated into Arabic from Greek, India and Persia, Muslim scientists have made inroads in medicine, pharmacy and chemistry. Muslim physicians excelled in their profession and became the leading figures in medical sciences throughout the world. Their works became masterpieces in the field and remained the primary materials in medical science for centuries (Essa and Ali 12, Baloch 47).

Notable Muslim physicians of the past were Abu Ali Husain bn Abdullahi, bn Sina (d.1037 CE), Abubakar Muhammad bn Zakariyyah al-Razi (d.935 CE), Abu Qasim al-Zahrawi (d.1013), and Abu al-Walid Muhammad bn Ahmad bn Rushd (d.1198 CE). Al-Razi wrote a compendium of medicine titled *Kitab al-Hawi*, in which he synthesized and categorized all areas of medicine. In this work al-Razi explained eye disease, gastrointestinal issues, and dietary matters. The book was the major medical text book in Europe for several centuries, and is believed to have laid the foundation of other disciplines like gyneacology, obstetric and ophthalmic surgery. Al-Razi also wrote another book *Kitab al-Judari wal Hasbah*, where he explained smallpox and measles. He was credited with the introduction of clinical trials involving controlled groups in medicine (al-Khalili 199). Like al-Razi, Ibn Sina (d.1037 CE) was another strong pillar in medicine whose contributions remained indelible in history. His encyclopedic work in medicine *al-Qanun fi al-Tibb*, remained an important source for medical scholars throughout the world. In this book he explained hundreds of diseases and clarified how they can be transmitted through water and soil. He had contributed in gynaecology, and scientifically established the connection between health and psychology (Afridi 53).

Ibn Rshd (d.1198 CE), was one of the finest philosophers of all time, who was considered to be the gateway between the Muslim and European scientists. He studied the works of previous scientists like Ibn Sina, al-Razi, al-Farabi and al-Kindi, and through him the works became accessible to Europeans. He had a seven volume work in medicine and related fields titled *Kitab al-Kulliyat fi al-Tibb*. Two volumes of the works were devoted to general medicine and therapy (al-Khalili 264, Virk 8). Another prominent expert in field of medicine was Al-Zahrawi (d.1013). He was a re-known surgeon with expertise in the field of

medicine. One of his works *al-Tasrif fi man Ajaz an al-Ta'lif*, treated, among other things, medical matters related to surgery and surgical equipments some of which were his original designed. He carried out caesarean operations and was the first to apply silk in stitching injury as a means of treatment (al-Khalili 261, Afridi 53).

The exploitation of materials and substances, in the natural environment was practiced by the ancient communities of Greek, Persians, and Chinese. By means of rudimental methods they developed some ways of production salt, dye, paints and fermenting beverages. The methods they applied in combining materials and other substances in the production of dye and other useful properties could be regarded as foundation ideas of chemistry. Though al-Khalili argued that such rudimental methods of combination and production should better be named protochemistry, because, as far he was concerned they did not meet the rigor of scientific methods. However, chemistry as a real scientific discipline began in Baghdad during the Abbasid period. As a science chemistry owes its origin to the great work of Jabir bn Hayyan (d.721-815 CE) who is regarded as the father of modern chemistry. He is said to be the scientist that freed up chemistry from superstition, and systematically established the norms of performing practical experiments (al-Khalili 89). Other prominent Muslims that excelled in chemistry, were Khalid bn Yazid (d 704 CE) the grandson of Caliph Mu'awiyya bn Abi Sufyan, and the great philosopher and exegete Muhammad bn Zakriyyah al-Razi (d.935 CE). Khalid's interest in chemistry led him to developing method of liquefying metals by means of practical experiments. During his time as a Caliph, he ordered the translation of works in chemistry from Greek. to Arabic language. Jabir Ibn Hayyan and al-Razi described the preparation of chemicals processes and procedure of converting baser metals into gold. However, Muslim scientists were credited with the discovery of the formula of creating three mineral acids, namely nitric acid, sulphuric acid and hydrochloric acid. They were also credited with development of the method of water distillation, technique of oxidation and crystallization (Hill 83).

Muslims in the past centuries have made great contributions in pharmacology, by inventing methods and formula of producing drugs and

their usages. Like medicine and chemistry, pharmacy started in a rudimentary way where people would collect plants and herbs or merge certain substances for purposes of treatment. Muslims have had ideas of toxic substances before coming into contact with the works of Greek Persians and Syrians etc. The translation of works originally prepared by Greeks and other communities further stimulated Muslim minds in pharmacy. The expertise of Muslim pharmacists and their contribution in the area remained indisputable (Virk 20). Muslim scientists have made significant contributions in pharmacy by establishing the composition, dosages and therapeutic effects of drugs, and the in development of the methods of manufacturing syrups (Baloch 48, Faruqi 394). In 754 CE drug stores began to be established in Baghdad and licensed by the government. The stores were placed under serious surveillance to ascertain their hygienic statuses and to make sure they met all necessary requirements to operate. Muslim pharmacists invented new substances, pills, elixirs, and syrups and investigated the dosage, composition, uses and effect of drugs (Virk 21). Thus, Muslim achievements in the fields of medicine, pharmacy and chemistry in the classical period were partly the results of the encouragements of the primary sources of Islam on knowledge and its values. Muslim scientists almost always doubled as specialists in religious sciences as well as applied and pure sciences. Their acquisition of pure and applied sciences did not carry them away from the pursuit of scholarship in the sciences of *Qur'an* or *Hadith*. This explains why names like Ibn Rush, al-Razi, al-Kindi, al-Zahrawi, and al-Khawarazmi featured as experts in language, philosophy, religion as well as in mathematics, medicine and pharmacy.

Muslim Legacy in Science

Contacts between Arabia and other parts of the world did not begin at the time of the advent of Islam. Before Islam, some parts of southern Arabia were under the rule of Byzantine Empire while some other parts were under the control of the Persian Empire. The contacts were not restricted to southern part of Arabia, the northern part has had contacts with outside world through trade, religious and cultural activities. The advent of Islam and its subsequent spread to neighbouring areas in Africa, Asia and Europe, enhanced the contacts and brought the communities in those areas into direct contacts with Islamic culture and

civilization. The translation of works on philosophy and other sciences prepared by the Greek, Persians, Syrians, Egyptians and Indians, into Arabic language exposed the Muslims to the knowledge and culture of those communities. The translation exercise got the support of the government particularly during the time of Abbasid. Muslim scholars did not just assimilate the contents of the works that had been translated, they synthesized the ideas, improved them and developed new principles. Thus, the translation movement was a quest for knowledge that turned into a new tradition of original scholarship fuelling the demand for knowledge. It aided the Muslim in understanding Greek logic and philosophy, Hindu arithmetic Persian and Egyptian sciences. It also functioned as the most important medium for preserving the scientific knowledge of the Greek, Persians, Indians, Egyptians and Syrians (al-Khalili 71).

The spread of Islamic influence to Spain and subsequent establishment of a Dynasty by the Umayyad Abdurrahman al-Dakil, was the beginning of serious Islamic influence in Europe. Qurtuba (Cordoba) in Spain became the center of knowledge and Islamic civilization in Europe (Bobrick 93). The city was the center of excellence in the study of medicine, philosophy, pharmacy, chemistry, and engineering etc. Institutions of higher learning were established including the famous University of Cordoba, which was the torch bearer of Islamic civilization in Europe. Toledo and Grenada were parts of the learning centers that rose to prominence in Muslim world and Europe. People from different parts of the world travelled to Spain to acquire knowledge in sciences and related fields including religious sciences. France and Italy in Europe were the areas that had early benefits from the scientific discoveries of Muslim scientists. From Spain works prepared by Muslim scientists in philosophy, mathematics, physics, chemistry, as well social sciences were translated into Latin and transmitted to other parts of Europe. In the process Europe became acquainted with the philosophy of Plato, and the works of personalities like Ibn Sina, al-Razi, Ibn Rushd, al-Khawarazmi, al-Zahrawi, al-Kindi and other Muslim scientists. Scientific works written by Muslims remained the leading text books in European universities for many centuries. The works played significant roles in

renaissance and in the cultural reawakening of Western Europe (Halilovic 69).

The scientific advancements recorded in contemporary times, owes a lot to the efforts of the Muslim scientists. They were inspired by the unrestricted order in primary sources of Islam on the acquisition of knowledge. One of the key principles prescribed in the *Qur'an* is that anything good is strongly encouraged and anything bad or evil is discouraged and strictly prevented (Q7:157). This principle allowed the Muslims to engage in all activities including acquisition knowledge with the aim of generating benefits and removing evil in the world. It permitted them to diversify their sources of knowledge thereby acquiring new ideas and knowledge, and domesticating them a situation that resulted in new inventions in all areas of knowledge. They sought any forms of knowledge from any communities provided that they did not negate the doctrines of Islam, destroy spirituality and cause the collapse of morality. Historical accounts showed that Muslims have made inventions and discoveries that improved the arts of paper making, irrigation, building of observatories and establishing windmill (Baloch 53-55). If Islam had placed restrictions on the form of knowledge the Muslims could acquire, the scientific development they achieved in the past would not have been possible. The past Muslim communities utilized the permission provided by, Islam on acquisition and dissemination of knowledge, acquire knowledge and used it for the benefit of human societies. The established rule in Islam that individuals and communities should not be denied the right to knowledge because of their faith race, or tribe was observed. They had it in mind that hiding knowledge and keeping it beyond the reach of any individuals and communities, was contrary to the spirit of Islam.

CONCLUSION

Muslims were inspired by the unrestricted Islamic encouragement on the acquisition and dissemination of knowledge. This provided them with the idea that that knowledge was not restricted to religious principles, but included any form of knowledge that benefits the world. The contacts of Muslims with other communities exposed to the knowledge and philosophies of Greek, Persia, Hindu, Egypt, and Syria etc. Armed with the instruction to acquire knowledge and desire to understand the natural world, Muslims studied and translated works written in other languages

into Arabic. This translation movement resulted not only in the re-writing of sciences of antiquity but in the development of new ideas and new inventions as well. It also helped in the preservation of knowledge, scientific principles and ideas developed by learned personalities of the past communities. The original works prepared by Muslim scientists in mathematics, physics, chemistry, medicine, astronomy, pharmacy, geography, and philosophy, helped in preserving the scientific findings of the past communities. The improvement made by the Muslim scientists on the works of the previous personalities eased the understanding of the works of the ancient scientists. The invention of new scientific principles by Muslims paved the way for rapid scientific development in modern world.

The diversification of the sources of knowledge and the domestication of ideas allowed the Muslims to come up with new inventions. Thus, within few centuries Muslim became leading figures in science and invention and names like al-Khawarazmi, Ibn. Sina', Ibn. Rushd, al-Razi, al-Zahrawi, al-Kindi, and Ibn Haytham etc. featured prominently in different fields of sciences. The contributions of leading Muslim scientists inspired through Spain, with the tradition of learning that had been established in the Muslim world for many centuries. The works of Muslim scientists had refined and improved the rudimentary findings of ancient scientists, tested and verified scientific principles, and developed new ones. Thus, the academic freedom enjoyed in Muslim world in the past strongly encouraged scholarship and facilitated the spread of knowledge. Muslim rulers did not shut their doors from anybody who would want to learn, bring new ideas or contribute in advancing knowledge. This was the reason why cities like Baghdad, Qurtuba, Toledo became centers of excellence in scientific knowledge. People from different parts of the world went in search of knowledge and as contributors to its development.

REFERENCES

Abu Dawud, Sulaiman bn. Al-Ash'ath al-Sajastani, *Sunan Abu Dawud*, Beirut: al- Maktabah al-'Asriyyah, ND.

- Al-Faruqi, Isma'il Raji, *the Essence of Islamic Civilization*, London, International Institute of Islamic Thought, (IIIT), 2013.
- Afridi, Muhammad Adil, "Contribution of Muslims Scientists to the World: An Overview of Some Selected Fields," *Revelation and Science*, vol.03, no 01, 2013, pp, 47-56, www.core.ac.uk, accessed on 14th/12/2022.
- Al-Khalili, Jim, *Pathfinders: The Golden Age of Arabic Science*, London and New York, Penguin Books, 2010.
- Baloch, Qadar Bakhsh, "The Islamic Civilization," *The Dialogue*, Pakistan, Qurtuba University, ND, pp, 37-56, www.qurtubauniversity.edu.pk, accessed on 14th/12/2022.
- Bennison, K. Amira, *The Great Caliphs The Golden Age of the Abbasid Empire*, United States, Yale University Press, 2009.
- Bobrick, Benson, *The Caliph's Splendor Islam and the West in Golden Age of Baghdad*, New York, Simon and Schuster, ND.
- Core Knowledge Foundation, *Early Islamic Civilization and African Kingdoms*, 2017, www.coreknowledge.org, accessed on 05th/12/2022.
- Essa, Ahmad and Ali Othman, *Studies in Islamic Civilization: The Islamic Contribution to Renaissance*, London, International Institute of Islamic Thought (IIIT), 2012.
- Faruqi, Yasmeen Mahnaz, "Contributions of Islamic Scholars to Scientific Enterprise" *International Education Journal*, 7(4), 2006, pp., 391-399, <http://www.iej.cjb.net>, accessed on 05th/12/2022.
- Halilovic, Safvet, "Islamic Civilization in Spain-A Magnificent Example of Interaction and Unity of Religion and Science," *Psychiatiria Danubina*, vol.29, suppl.1, 2017, pp., 64-72, www.psychaitria_danubina.com, accessed on 13th/12/2022.
- Hill, D.R., *Islamic Sciences and Engineering*, Edinburgh, Edinburgh University Press 1993
- Nadwi, Syed Abul Hasan Ali, *Islam and Civilization*, Translated into English by Mohiuddin Ahmad, Lucknow, Academy of Islamic Research and Publication, 1986.
- Starr, S. Frederick, *Lost Enlightenment: Central Asian Golden Age From the Arab Conquest to the Tamerlen*, New Jersey, Princeton University Press, 2013.

- Virk, Zakaria, "Muslim Contributions to Sciences," USA, Safir Rammah, 2017, www.apnaorg.com, accessed on 17th/12/2022.
- Zakariya, Muhammad, "Development of Islamic Thought and Civilization in History Perspective," *Studia Religia: Journal Pemikiran Pendidikan Islam*, vol4, no. 1, 2020, pp. 167-177.