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# A Comprehensive Exploration of Scientific Development under Akbar the Great (1556-1605)

**Saqib Tariq[1], Madeeha Khan[2], Hassan Shamraez[3]**

## ABSTRACT

*The Akbar's era marks a shift in Indian society with scientific progress and cultural advancement. The study aims to present the scientific and scholarly contributions made by Akbar's patrons, including Fatah ul Ullah Shirazi, Hakim Ali Gilani, Todar Mal, and others, as well as to discuss some significant scientific discoveries and advancements. This study utilize a combination of historical analysis and critical examination of primary and secondary sources to investigate the scientific contributions during Akbar's era. The key findings of this study are as follows: Shirazi introduced essential mechanical devices like the volley gun, wagon mill hand cannon, traveling bath, and the Tarikh-i-Ilahi solar calendar, exemplifying the era's spirit of innovation. Alongside Shirazi, Hakim Abul Fateh Gilani, a royal physician and medical writer, translated significant works and developed important medicines like Roghan-e-Deodar, and Hakim Ali Gilani invented Hookah. Furthermore, Raja Todar Mal established a systematic land revenue system known as "Zabt," which was based on accurate land measurement and fixed taxation rates, to improve revenue collection efficiency and fairness across the empire. The study also revealed that Akbar encouraged the translation of scientific texts into Persian. Some important translations were Sharh al Qanoon, (Commentary on Avicenna's book of canon of Medicine), Brahmaputra Sindhanta (astronomical text) and Mathematical works like Tahrir al Majisti and Khulastul Hisab etc fostering the exchange of knowledge. Examining the rich cultural heritage, architectural marvels, advancements in trade and commerce, and the flourishing of arts and sciences, the growth of the economy under Mughal patronage, this work undoubtedly dispels the myth that there were no scientific or technological advances during the Mughal era. This research also gives a way to conduct future research on different scientific developments Such as astronomy, medicine, physics mathematics paintings architectural heritage and advancement in technology under the Mughal dynasties.*

***Key Words:*** *Mughal Era, Akbar the Great, Science, Technology, Invention, Institutional development, Astronomy, Mathematical advancement, Medical*

[1] *Department of History, Government Post Graduate College No.1 Abbottabad, Khyber Pakhtunkhwa, Pakistan.* ***Corresponding Author's Email****:* saqibabb888@gmail.com
[2] *M.Phil Research Scholar, Department of History, University of Peshawar, Khyber Pakhtunkhwa, Pakistan*
[3] 8th Semester Student, Department of History, Government Post Graduate College No.1 Abbottabad. Khyber Pakhtunkhwa, Pakistan

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*Innovations, Architectural Fusion, Cross-cultural Synthesis, Scientific Manuscripts, Technological Patronage, Mughal women.*

## INTRODUCTION

Akbar's rule was characterized by a strong emphasis on promoting learning, patronizing scholars, and encouraging cross-cultural exchange, all of which contributed to the flourishing of various scientific and technological fields. The Mughal era built upon the legacy of earlier Islamic civilizations, which had made significant contributions to the advancement of knowledge in areas such as mathematics, astronomy, optics, and medicine. The Quran was revealed in the 7th century AD, which brought justice to the entire Arab peninsula and beyond Justice, peace, and prosperity during Muslim rule, encouraged intellectual progress in medieval Islam. A renowned Islamic scholar Jalal ad-Din Sayuti stated that the Quran has a source of 3000 sciences (Ibn Khaldun, 2001). During the Middle Ages, Muslims were a prominent and remarkable nation regarding services to science and technology. The Muslims made great achievements in several fields such as Physics, Philosophy, Chemistry, Mathematics, Astronomy, Geography, and social sciences.

Muslims introduced unique architectural styles such as geometric patterns, arches, and domes, as seen in the Alhambra in Spain and the Blue Mosque in Turkey. The walls of buildings are decorated with Quranic verses and calligraphy. Ibn Sina wrote a Book 'The Medicine of Cannon' an encyclopedia of medicine that became a standard text in Europe. Ibn e Haytham contributed to the field of optics. His works in optics greatly influenced later scientists such as Galileo, Kepler, and Descartes, his work contributed significantly to the development of the scientific method as we know it today. Al Khawarizmi, a mathematician, introduced algebra and the decimal system, which are still the foundations of modern mathematics. He also invented an "algorithm," which is used in modern computer programming. Furthermore, A famous astronomer, Al Battani, made accurate observations of the solar year. They built vast libraries, laboratories, and observatories in the entire Islamic world. The Scholars developed Greek theoretical knowledge and transformed it first into the practical form. Modern sciences are based upon the principles and methods which are given by Muslim scholars. The Western scholars agreed upon the Muslim legacy and contributions toward intellectual works. Hulegu Khan destroyed Baghdad in 1258 bringing the golden era of Muslims to an end, burning and wasting a lot of intellectual works. However, non-Arab Muslim dynasties emerged, and intellectual advancement continued after that, with Ottomans, Safavids, and Mughals.

Under Akbar's patronage, the Mughal Empire continued to be a center of intellectual activity, attracting scholars and scientists from diverse backgrounds. The emperor himself was known for his keen interest in various branches of knowledge, including astronomy, mathematics, and medicine. Akbar's court was home to renowned experts in these fields, who were given the resources and support to pursue their research and make groundbreaking discoveries.

### Research Objectives

i. To study the important scientific work done during Akbar’s rule, and how it affected different areas of knowledge and progress.

ii. To examine the role of major personalities, institutions, and inventions in promoting scientific innovation in the Akbar court.

## RESEARCH METHODOLOGY

The research is based on secondary data; however, a little bit of primary data has been used. The approach of the study is qualitative. The secondary data have been collected from books, journals, working papers, and websites. Additionally, many primary data sources are available in Persian, some of which have been translated into English or Urdu, but more work is needed to gain a clear understanding of Mughal science. The source of primary data includes Ain e Akbari, a comprehensive chronicle of the Akbar era penned by Abul Fazl during Akbar's reign. Most of the secondary data collected from articles of Zakaria Virk, a science historian, has been used as well. By adopting this multi-faceted methodologies approach, the study aims to provide a comprehensive understanding of the scientific contributions that flourished during the reign of Akbar.

## LITERATURE REVIEW

Most of the primary work of the Akbar era consists of details of wars and administrations such as “Ain Akbari” compiled upon four volumes of the book provides valuable information on science, social norms, culture, and philosophy but various scientific details are not discussed especially some important inventions. ‘Science in India during the Muslim’ is a research article that provides a wide overview of Muslim contribution in India but some important works of scientists have been missed (Virk 2019). ‘Contribution of Mughal Emperors in Education’ This article deeply discussed the language, culture art, and religion of the Mughal empire but did not touch development in the science and technology of the empire. (Jahan, Obaydullah 2019).

S.A. Khan Ghori's work on the "Development of Zij Literature in India" provides a thorough examination of the evaluation of Graeco-Arabic Astronomy in India. Ghori's research elaborate nature, origin and development of this system, the contributions of Indian Muslim scholars to Zij literature and their impact on the region. Anuj Misra, Clemency Montelle, and Kim Plofker's collaborative work on "Indian Mathematics in the Early Modern Age" provides comprehensive examination of India's mathematical advancements during Mughal period. Their research listed mathematical texts composed during 1500 to 1800 CE and examine contributions of Indian mathematicians to algebra, geometry, trigonometry, and calculus, highlighting the continuity and innovation within India's mathematical traditions (Misra, Montelle,Polfker, 2023).

Soma Mukherjee's "Royal Mughal Ladies and their Contribution" provides a comprehensive and insightful exploration of the impactful roles played by women such as Empress Nur Jahan and Empress Mumtaz Mahal in the Mughal Empire, shedding light on their political, economic, cultural, and social contributions (Mukarjee, 2001).

### Mughal patronize knowledge

The Mughal rule in India began in 1526 and ended when the British seized control in 1857. The Mughal rulers recognized the importance of education. Many philosophers and scholars were affiliated with the Mughal court. The Mughal emperors were the supporter of art and literature. Babur established the *Shurhrat-am* department, which was tasked with publishing a gazette as well as building and establishing colleges, demonstrating his commitment to expanding education in his Indian empire (Jahan & Obaydullah, 2019), which saw the establishment of numerous madrasas across the subcontinent. These institutions offered both modern and religious studies. American unitarian minister J. T Sunderland described India as:

> "Almost every type of human creation, including the brain and hand, had long been produced in India and valued for its utility or beauty. India had a far greater industrial and manufacturing base than any other country in Europe or Asia. Her textile goods, the fine products of her looms, in cotton, wool, linen, and silk, were famous throughout the civilized world; so were exquisite jewelry and precious stones cut in every lovely form; so are pottery, porcelains, and ceramics of every kind, quality color, and beautiful shape; and so are her fine works in metal, iron, steel, silver, and gold."

She had a stunning architecture that rivaled any in the world. She had done excellent engineering work. Excellent bankers and financiers. She was not only a shipbuilding nation, but she also had extensive commerce and trade with all known civilized countries, both on land and at sea. When the British arrived in India, they discovered it like this (Tharoor, 2018)."

**Akbar the Great**

Akbar the Great was the supreme Mughal ruler, reigning from 1556 to 1605 AD. It was the golden age of the Mughal dynasty, and he supported scholars and successfully united India. During his reign, he maintained peace and promoted prosperity. Despite being illiterate, Akbar invited and hired scholars from various regions; the majority of these scholars were Persian and Central Asian, and he did not discriminate against them in his court. They discussed a variety of subjects, including science, philosophy, religion, and history. Akbar was a visionary ruler surrounded with the brightest minds called the Nine Jewels, a group of intellectuals including advisors, scientists, artists, etc.

Early Muslims in India founded *madrasas* to uphold their religious identity, but after a while, a purely religious system disappeared, and modern subjects gradually but steadily made their way onto the syllabus alongside religious ones (Parvaiz, 2020).

Akbar wants to be considered as the pioneer of education reform in the subcontinent. He established a state department to provide state patronage for both Muslim and Hindu educational institutions (Parvaiz, 2020). Akbar was the first Muslim ruler of the subcontinent to declare education a fundamental right of all citizens (Parvaiz, 2020). His policy was to educate the state subjects, regardless of religion and creed. Additionally, he established *Madrasas*, wherein Muslims and Hindus were taught modern subjects in the same classroom; these Madrasas had

separate classes for their respective religious curricula (Parvaiz, 2020). Hindus studied the Nayaya Vandena and the Patanjali (Muhammad Basheer, 2014).

Mir Fatah Ullah Shirazi, a well-known philosopher and logician of his era, was tasked by Akbar with updating the Madrasa curriculum. He added courses of mathematics, ethics, government affairs, astronomy, logic, agriculture, Sanskrit, grammar, and philosophy (Virk, 2019). Akbar owned a massive library comprised entirely of manuscripts written and engraved by skilled penmen. His library contained only 24,000 volumes, but they were valued at $3,500.00. The library was staffed by members of the translation bureau *Maktab Khana*, which was founded in Fatehpur Sikri's *diwan khana*. These included Faizi, Abdul Fazal, Abdul Qadir Badauni, and Fathullah Shirazi. Persian scholars made translations into literary languages after Sanskrit scholars explained the original text. Akbar's court painters illustrated every Sanskrit literature translation prepared during his reign (Virk, 2019).

Some Muslim nobles, such as Abdul Rahim Khan-i-Khana and Abul Fazal, were familiar with Sanskrit they and could translate it. In 1584, Akbar assigned Mulla Abdul Qadir Badauni the task of translating *Singhasan Battisi* (stories of King Vikram Aditya) (Virk, 2019). A learned Brahmin was appointed to assist Badauni in interpreting the Sanskrit texts (Virk, 2019). The Persian work was known as *Naama-i-Khirad* (The Wisdom Augmenting Book). Similarly, Akbar ordered Abul Fazl to translate *Hayat ul Haiwan* Arabic into Persian, besides the zoological dictionary and Musa al Damari's book on medicine (Virk, 2019). Mughal emperors used the imperial hunt not only for entertainment, but also to learn about and carry out scientific experiments, investigations, and analyses of natural phenomena. According to Abdul Fazal, some people believe that Akbars' only goal was to hunt, but this is not the case. Akbar's hunting was a means of locating better agricultural lands as well as a secret location where he could monitor his military troops (Parpia, 2016). Father Monserrete wrote in his travelogue about seeing Akbar working on a machine and giving instructions on how to build new machines. He went into great detail about Akbar's intellectual curiosity:

"He is a great patron of learning, and always keeps around him erudite men, who are directed to discuss before him philosophy, theology, and religion and to recount to him the history of great kings and glorious deeds of the past. He has excellent judgment and good memory and has attained a considerable knowledge of many subjects, using constant and patient listening to such discussions. Thus, he not only makes up for his ignorance of letters (for he is entirely unable either to read or write), but he has also become able clearly and lucidly to expound difficult matters. He can give his opinion on any question so shrewdly and keenly, that no one who did not know that he is illiterate would suppose him to be anything but very learned and erudite" (Virk, 2019).

**Development in Paintings**

The Mughal painting started during Humayun's reign when he was in exile in Persia, He was impressed by the Behzad School of Painting in Persia. When he returned to India and reestablished Mughal rule, he invited the famous artists Khawaja Abdul Samad and Mir Sayyid Ali to visit India. Humayun was the first documented patron of Mughal painting, and Akbar was

the first Mughal king to take an active role in promoting painting, he founded a *karkhana* to create a new style of painting (Hajianfard, & Zekrgoo, 2023). The style that developed was the best of Behzad school besides pre–Mughal Indian art amalgamated with European and Chinese influence. The Akbar court had 17 artists, among whom Mir Sayyed Ali, Khawaja Abdul Samad, Jaswant, and Basawan were prominent. Akbar was particularly interested in the stories of Amir Hamza, the prophet Muhammad's uncle PBUH. The first work was an illustration of these stories called Hamza Nama (Hasan, 2021). Mir Sayyid Ali, a Persian master was entrusted with 1400 pictures in volumes which he completed in 15 years. The paintings were in the Persian Safavid style. This painting depicts Amir Hamza's victory over his enemy on the battlefield. Aside from that, there was a painting depicting Laila Majnu's story as well as his ancestors' portraits (Welch, 1976). The painting was drawn using paper and other related materials. Colors and pigments were extracted from natural sources. Painting tools were made from animal hair, gills, and other materials. The artists used to present their paintings to Akbar and received heavy rewards from him.

**Architecture**

Mughal architecture is a combination of Persian, Turkish, and Indian styles all the Mughal rulers were excellent patrons of architecture. They developed Indo-Islamic architecture in India. The Mughal architecture was notable for its extensive use of red sandstone as a construction material.

The Mughals also developed and improved the architectural style of earlier Muslim dynasties. The first Mughal emperor, Babar built mosques in Panipat and *Rohilkind* in 1526. Babur's reign was brief, there was little architectural development. Humayun's era was also characterized by a power struggle between the Mughal and Sur family, so no special attention was paid to architecture and no major development occurred. Humayun led the construction of a new city called *Dinpanah* but did not complete it. During Akbar's reign, architecture underwent significant development, and Mughal architecture truly began and reached its zenith during this time. The most common building materials at the time were limestone, clay, red sandstone, white marble, bricks, and wood. Similarly, Ain-i- Akbari also discusses building construction methods and material estimates (Abul Fazl, 1988).

**Akbar the Great's Architecture**

**Humayun's tomb**

The first great monuments of Mughal architecture were the mausoleum of Humayun. It was built during Akbar's reign at the suggestion of his widow wife, Hamida Banu Begum. The tomb, designed by Persian architect Mirak Mirza Ghiyas, was built in Delhi's garden in the 1560s. The Humayun tomb was built with red stone and white marble, and the Persian style was popular at the time, as was the Charbagh style. (Square Garden) The tomb was designated as a UNESCO World Heritage Site in 1993 (Mehta, 2022).

**The Agra Fort**

Akbar built the Agra Fort during 1565 to 1575. It is a magnificent example of the Mughal architecture. The Moti Masjid, Meena Bazar, and Jahangiri Mahal, which was built for Jahangir and his family, are among the fort's notable structures.

**The City of Fatehpur Sikri**

Another significant architectural development was the construction of Fatehpur Sikri near Agra. The construction of the new walled city took six years and it has the most beautiful buildings. Both religious and secular buildings were built, with the main religious structure being the Jamia Masjid and the tomb of Salim Chisti. *Haramsra*, the royal seraglio, was also established for royal women. Jodha Bai's Palace was the largest structure in the Fatehpur Sikri seraglio (Giridhar, 2019).

An important feature of Mughal architecture under Akbar was the introduction of Tudor (four-centered arches), bulbous domes, and minarets. Red sandstone and marble are used as construction materials. Every building from the Mughal period has a garden layout, a charbagh style (Square Garden), and a large gateway. The pillars and walls were built using a geometric pattern.

Salim Chisti's Tomb

Jodha Bai's Palace

**Mathematics and astronomy:**

Some Indian Muslim mathematicians and astronomers who settled in India translated Arabic books on mathematics and astronomy into Persian. These translations are several commentaries mostly in Persian on the works of Euclid, Archimedes, Theodosius, Apollonius, and Ptolemy are available manuscripts in the different libraries of India and abroad. Thus, Greco-Arab astronomy and mathematics were introduced into India and studied. Some of them were taught as textbooks in educational institutions in late medieval India from the time of Akbar who made astronomy and mathematics compulsory subjects to be studied. It would be correct to claim that some mathematical concepts originated

in India. Because there is evidence that the people of the Indus Valley civilization were aware of the weight system, artistic design, Indus scale brick technology, and so on. Another notable work in mathematics was Bhaskaracharachrya's Sanskrit work Lilavati, which was translated by the Faizi at Akbar's suggestion (Azad, 1898). Prominent figures such as Raja Todarmal, Fathallah Shirazi, Abul Fazal, and Fazi contributed towards mathematics and astronomy

The foundation of Islamic astronomy started during the Abbasid Abu Jaffar (754-765). The first time copy of the Indian astronomical text Brahmaputra Sindhanta was brought from Sindh to Baghdad and translated from Sanskrit to Arabic (Virk, 2019). Later on, Al Biruni was a very important person who came to India in 1017 AD. He spent 17 years in India and wrote many books on different aspects of astronomy. With the advent of Muslims in India Zij astronomy took root in Indian soil, Muslim astronomers prepared astronomical tables called Zij these were tables of data containing useful information about heaven, which can be divided into three groups (I)Zij e Rashidi; it is a data calculation taking care of various types of corrections and effects in the observed data but not observed directly. (II)Zij e Hisabi; these are tables of calculated raw data obtained from direct data. (II) Zij e Tashil: simplified tables for easy application to specific tasks like studying the motions of the moon alone, not the whole of astronomy.

Iltutmish first time formally introduced Zij astronomy in India. Mughal dynasty's work on astronomy and astrology started with fresh enthusiasm.During Akbar times there were around 86 zijis (Ghori, 1985).

Many scientific works were brought from outside India like Bahauddin Amuli,s *Khulastul Hisab*, and Tusi's *Tahrir al Majisti*. Attempts were made to write commentaries and translate these works, as a result, the intermingling of Indian mathematical tradition with Arabic and Persian did take place enriching the country (Samuel, 2015).

**Land Reforms**

According to Abdul Qadir Badyuni, Raja Todarmal joined the revenue department of the Mughal court in 1562. Raja Todarmal established the three-system *gulla bkhshi* (crop division). On zabt measurement Muqta (it was a system in which amount of lived every year) Muzaffar Khan Turbati and Todar Mal obtained from the local qanungos the schedules of produce and assessed revenue prepared on their knowledge of actual yield (*taqsimat-i-mulk*), and having completed the Rahul (revenue) by estimate and computation brought into force a new system. Raja Todarmal also established India's Patwari system. Raja Tudor Mall established the standard weight land survey and settlement system, as well as the patwari maintenance system, which is still used in India and Pakistan, albeit with some modifications by the British government. The Mughal Empire was divided into 15 provinces, which were further divided into 187 *sarkars* and 3367 Parganas. Land measurements were made using the ہی الہ ز گ unit of measurement. This ہی الہ ز گ was equal to about 41 fingers which is 29 to 31 inches Land was measured with *Tanab* which was a rope used to measure the land just as in modern times, an inch of tape is used to measure the things (Das,1979).

**Fathallah Shirazi's inventions**

The Persian- Indian polymath Fathallah Shirazi was born and spent his early life in Shiraz. He was highly influential astronomer and inventor of outstanding inventions, Abul Fazl said that if the old books of wisdom disappeared Shirazi could lay down a new foundation of knowledge and he would not wish for what had gone unfortunately, there is no original writing of Shirazi found in science and technology beside zij I Fadi (astronomical tables of Uleg beg) had been translated under his guidance by Faizi and other scholars but this work could not be completed due to some reasons. Some of his outstanding inventions is a military weapon that was designed to target infantry and an early volley gun with multiple gun barrels similar to a hand cannon. Another canon-related machine that could clean sixteen-gun barrels simultaneously was operated through a cow. Similarly, he invented a 17-barreled canon fired with a matchlock.

**Traveling Bath**

These baths were made for a king and his family, it was luxurious baths containing dressing rooms, bathing rooms water containers, heating, and other equipment, the structure was made from a wood number of apartments were used for various purposes (Alvi & Rahman, 1968).

**Light Carriage**

Abul Fazl referred to it as Bahl, a wheeled device. It can carry a few people on smooth roads, it can carry a few people on smooth roads, which means it can travel faster than other carriages (Alvi & Rahman, 1968).

**Mirrors**

According to *Tabaqat Akbari* Shirazi had also invented a unique type of mirror that showed strange figures from a distance. However insufficient detail has been found about the mirror (Alvi & Rahman, 1968).

**Wagan Mill**

It was a very interesting device among Shirazi's inventions used for grinding the grain. it was a combination of two distinct sets of mechanisms: the carriage, and the gear operated by animals (Alvi & Rahman, 1968).

In 1584, Akbar the Great implemented the "Tarikh-I-Ilahi," or "Ilahi calendar." This calendar was based on the sun, and the year began with his ascension to the throne in 1556. Twelve months were comprised of its 365 days this was also an astonishing achievement of Shirazi. Names of the month mentioned under:

1. Farwardin Mah-i Ilahi
2. Urdibihisht
3. Khurdad
4. Tir
5. Amurdad

6. Shahrivar
7. Mihr
8. Aban
9. Azar
10. Bihman
11. Dai
12. Isfandarmuz (Alvi & Rahman, 1968).

**Medicine**

India comes into contact with this Greco-Arab medical system after the Arab conquest of Sindh. This system progressively evolved into the hybrid Muslim-Hindu system known as the *Tibbs* in India. With arrival of the Mughals in India, This system began to flourish on its own. Many hospitals and training centers had been established in India. Akbar established hospitals in Fatehpur Sikri, in 1597 he built *Ilajkhana* in Hyderabad and *Dawakhana* in Akbarabad. A doctor or surgeon had to pass specific exams to be admitted to the Medical Service. Urine therapy was highly valued in the Indian medical system. Thus, when Ali Gilani was being considered for an appointment, he had to pass a test devised by Akbar. The emperor ordered that several bottles containing sick and healthy people's urine, beside urine be brought to the Hakim for detection. He was only admitted to imperial service after the hakim detected each sample (Rezavi, 2012).

**Hakim Ali Gilani**

Hakim Ali Gilani was a sixteen-century royal physician and medical writer. Gilani served two Mughal emperor's courts such as Akbar and Jahangir. Akbar give him the title of Galen of the time. He used to travel with Akbar. He invented a type of sweet wine that relives the weariness that comes with traveling. During these trips, he used to travel with his pharmacy, some important works of Gilani are mentioned below:

**a) Sharh Al Qanoon**: A commentary on Avicenna's book "Canon" written in Arabic.

**b) Bayaz e Gilani:** The book contains a compilation of Hakim Ali Gilani's tested prescriptions and practices. The book holds Roghan I Deodar's (oil of cadrus deodara) well-tested and popular formula which he invented. This oil was used for the treatment of muscle pains and joints.

**c) Mujarrabat Ali Gilani:** This book also includes a compilation of Hakim Ali Gilani's tested and true remedies and methods. The book serves as a medical source.

Besides Ali Gilani, some other physicians also worked in the Akbar court like Sheikh Bina Mulla Qutbuddin Kuhhal, Hakim Biarjiu, Hakim Bhairon, and Chandrasen were all experts in surgery. Hakim Muhammad Gilani had expertise in sexology. Hakim 'Ainul Mulk 'Dawwani' Shirazi excelled in both ophthalmology and pharmacology he authored Fawuid-ul-Insun, a pharmacological treatise. Hakim Sheikh Bina compiled medical prescriptions named Muhajjrat-e Sheikh Bina (Rezavi, 2012).

**Invention of Hookah**

Hookah or water pipe invented by Hakim Abul-Fateh Gilani who served as a physician in the Akbar court. During these days smoking was popular among Indian nobility. Emperor Akbar was encouraged to smoke tobacco by the Bijapur ambassador, Asad Beg. Gilani was concerned about this and designed a system in which the smoke had to pass through water before being inhaled. He believed that by doing so, the smoke would be purified and it would not have adverse impacts on the emperor's health (Reed, 2022).

**Women's Contributions to Science and Technology During Akbar Era**

During Akbar era, women made significant contributions to science and technology. Despite the societal norms of the time, which limited women's participation in intellectual pursuits, several remarkable women emerged as pioneers in various fields. Some ladies devoted themselves to religious and literary activities, and some made contributions to science and technology some others passed their time in music, dancing and fine arts which were considered the best sources of their entertainment. Many of them went on excursions and pleasure trips. Most of the ladies were interested in dresses and ornaments. But all their cultural activities were restricted behind the purdah (Iftikhar, 2010). Some of their contributions are:

**Role in Observatories**

Akbar is known for his interest in astronomy and established observatories (Mercier, 2023). His well-known interest in Astronomy led to the establishment of observatories equipped with advanced instruments for celestial observations and calculations. While historical accounts likely would not credit them directly, women might have participated in these endeavors in a supporting role. This could have involved tasks like recording data, assisting with instruments, or performing mathematical calculations necessary for astronomical studies.

**Indigenous Knowledge of Medicine**

Women often played a vital role in traditional healing practices and Herbal remedies. Ladies often played a vital role as healers and midwives. Traditional medical practices had been mainly learned via apprenticeships, and women were able to benefit from this knowledge via their own family connections and networks (Zaidi, 2023). This knowledge base could have indirectly contributed to the overall understanding of medicine during the Akbari Era, potentially influencing the development of new treatments or the cultivation of medicinal plants.

**Insights into Architecture**

The Mughal Empire was celebrated for its magnificent architectural achievements. While women likely were not directly involved in construction, their lived experiences within the domestic sphere could have offered valuable insights on design or functionality. Their suggestions regarding aspects like ventilation, layout, or even aesthetics might have been incorporated into the palace or household design.

The first lady who seems to pay higher attention to construction was Haji Begum (the wife of Humayun). She built the tomb of her husband Humayun under her Supervision (Jangir, 2019). She also built. an Arab Sarai for the accommodation of Arab travelers and merchants (Iftikhar, 2010). A royal house and garden was built on the road from Agra to Bayana under the supervision of Haji Begum. Thevenot writes, "Upon the road from Agra to Bayana there is a royal house built by the queen mother (step) of Eebar (Akbar) with gardens kept in very good order" (Iftikhar, 2010).

**Literary Accomplishments**

The ladies of Mughal royalty were quite educated. They occupied themselves with reading, writing, and composing verses. Mughal Emperors always hired some experienced old people, especially for the education of their women; she was known as *At-un-Mama* (Lady Teacher) (Iftikhar, 2010). During Akbar's time, regular training was given to the ladies of the royal household. Akbar set apart certain chambers as a school for girls in his palace at Fatehpur Sikri. Monserrate, who came to Akbar's court says: "He (Akbar) gives very great care to the education of the Princesses... (who) are taught to read and write and are trained in other ways by matrons" (Mukarjee, 2001, *p*.70).

Hamida Banu Begum, Emperor Akbar's mother, whose patronage of scholars and scientists fostered an environment conducive to scientific inquiry. Under her influence, several advancements were made in fields such as medicine, agriculture, and architecture. Her support of scholars like Abu'l-Fazl ibn Mubarak, the author of the "Akbarnama," facilitated the exchange of ideas and the development of innovative technologies.

**Women's Involvement in Perfumery and Aromatics**

During Akbar's era, women played a significant role in the realm of perfumery and aromatics, contributing to the flourishing fragrance industry of the time. Abul Fazl, in his comprehensive work Ain-i-Akhari, provides valuable insights into the use and production of perfumes during this period.

Perfumes of Akbar's reign such as Kiura and Musk were very popular (Jangir, 2019, *p.*168). Abul Fazl says that oils extracted from certain sweet-smelling flowers were used for the skin and hair, (Mukarjee, 2001, *p*.74) showcasing the involvement of women in the application and appreciation of fragrances. Akbar actively patronized the perfumery industry, fostering its growth and innovation within the Mughal Empire. Akbar's interest in perfumery extended to the establishment of specialized departments and institutions dedicated to the art of fragrance-making. *The Khushbu Khana* (Mukarjee, 2001, *p*.74), or the Perfumery Department, was one such institution under Akbar's administration. This department was responsible for the production, refinement, and distribution of perfumes, ensuring the availability of high-quality fragrances within the empire. This department likely provided opportunities for women to participate in activities related to the production, refinement, and distribution of perfumes.

## CONCLUSION

Akbar's enthusiastic approach towards the development of science was remarkable it brought a new change in India and spread social religious cultural harmony, Scholars came to India from different territories met together, and exchanged their knowledge. Some notable inventions and discoveries like Wagon mill, traveling bath, light carriage, Hand cannon, Hukkah etc. mentioned above were made by scholars and scientists considered highly appreciated work. The valuable ancient works of mathematics astronomy medicine were translated from Arabic, Greek, and Sanskrit to Persian. Akbar appoints a highly qualified team for the preparation and revision of the curriculum. Akbar's scholarly patronage refutes Western intellectuals' claims that there was no scientific development during the Mughal period. Akbar directed everyone equally in his court without discriminating against cast creed and gender. This intellectual progress made India the biggest economy of time but unfortunately, colonial powers disturbed the peace and progress of the subcontinent which led the region towards instability and poverty. Shashi Tharoor's book, "Inglorious Empire: What the British Did to India," mentioned the demonstration of British economic historian Angus Madison. He stated that India's share of the global economy was 23 percent, but when the British left, it dropped to just over 3 percent.

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