Chapter – 4

CHEMICAL INDUSTRIES

(A) GUN POWDER AND ITS APPLICATIONS

(i) Composition

(ii) Recipes

(iii) Application

(B) PREPARATION OF ACIDS, AKALIS, INKS, POISONS

(C) PAPER TECHNOLOGY

(D) COSMETICS AND PERFUMES
CHEMICAL INDUSTRIES

The medieval period saw the development of chemical industries at a considerable large scale. The gunpowder industry brought about a revolutionary change in the Indian scenario during the medieval period. The Persian and Sanskrit sources of medieval period enlighten us about the ingredients such as saltpeter, sulphur and charcoal used for making of gunpowder and also discuss its various recipes and application for military purpose and making fireworks. These sources are also a rich store house for providing information on preparation of acids, both organic and mineral acids, alkalis, preparation of ink and poisons and several chemical components used for making them. A great deal of information on paper technology, cosmetics and perfumes soap manufacture has also been dealt by the medieval texts.

(A) GUN POWDER AND ITS APPLICATION

The gun powder technology brought a revolutionary change in the existing socio-political structures around the world. The Chinese are generally regarded as the harbingers of this technology by inventing gunpowder through mixing saltpeter, sulphur and carbonaceous material in as early as ninth century A.D.¹ There is a great deal of information on the subject in the Chinese military compendia. The earliest mention of gunpowder is found in Wu Ching Tsung

¹ This is given in a reference in a Taoist book which asks the alchemists not to mix these materials with arsenic as it may burn down their building and cause serious injury. Cf. Joseph Needham, Science and Civilization in China, Vol. V, Part 7, p. 1.
Yao (collection of the Most Important Military Techniques), written under the orders of the Emperor Sung (1040 to 1044 AD) by an official named Tseng Kung Liang.\(^2\)

It is only in the late thirteenth century that we get the first reference of gunpowder in the European texts.\(^3\) *Liber Ignium ad Comburendos Hostes* (Book of Fires for the Burning of Enemies), supposed to have been written by Marcus Graecus\(^4\), is often regarded as Arabic in origin.\(^5\) An Arabic text named *Kitab al Furusiya wa’l-Munasab al-Harbiya* written by Hasan al-Rammah Najm al-Din al-Ahdab in about 1280 A.D. is believed to be the source of Mark the Greek’s *Liber Ignium*. Further, Partington noticed some traces that point towards the Chinese origins of the Arabic text itself.\(^6\) Roger Bacon on the other hand is famous for texts like *Secretum Secretorum, Opus Maius, Opus Minus, Opus Tertium* and *Epistola de Secretis*.\(^7\) *Opus Maius* and *Opus Tertium* refer to experiments which hint that explosion may have been witnessed by the writer.\(^8\) It seems that he had a sample of Chinese crackers in his possession. His recipes however were not sufficient to produce any pyrotechnical reaction.\(^9\)

In the Indian context there has been a lot of doubt regarding the earliest reference of gunpowder. The issue started with Elliot’s note on the subject

\(^2\) Ibid., pp. 18-19.
\(^3\) The important names in this regard are Marcus Graecus or Mark the Greek and Roger Bacon.
\(^4\) While there have been many interpretations regarding the identity of the writer Needham thinks that he was just a name for the collection.
\(^5\) Needham, p. 39.
\(^7\) Needham, pp. 47-8. Interestingly, he wrote his formulae and recipes in a cryptic form.
\(^8\) Ibid., p. 48.
entitled, “On the Early Use of Gunpowder in India”.¹⁰ He gave an account of the arguments forwarded by Elphinstone, Halhed, Carey, Marshman, Johnson and others who tried to situate the use of fire-arms in Ancient India.¹¹ He concludes his account by saying: “Fire-arms of some kind were used in the early stages of Indian History”.¹² Most importantly he stated that, “this destructive agent [salt peter] appears to have fallen into disuse before we reach authentic history”.¹³

On the other hand, P.C. Ray seriously doubted the ancient origins of the use of gunpowder in Indian warfare. He is of the view that “the first record of the use of cannon and gunpowder in Indian warfare is in the memoirs of Baber (Babur)”.¹⁴ Later on P.K. Gode found references to fireworks in a fifteenth century Sanskrit text called Kautukacintamani by Gajapati Prataparudradeva of Orissa. The text provides details about the various ingredients of pyrotechnic mixtures.¹⁵

Recently, Vijaya Deshpande asserted that the firearms were first mentioned in ancient Sanskrit texts like *Rigveda, Atharavaveda, Arthasastra, Manusmriti* and *Dasakumaracharita*.¹⁶ She found a reference of an Indian

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¹¹ Ibid., pp. 470–474.
¹² Ibid., p. 481.
¹³ Ibid., p. 482.
¹⁶ Written by Dandin in sixth century A.D. it discusses about magic powder (*Yogachurna*).
Buddhist monk visiting China in AD 664 with ample knowledge of saltpeter. She, however, maintains that perhaps it was not used as an ingredient in the gunpowder mixture.\(^{17}\) It is a verse in the Sanskrit alchemical text *Rasopanishad* (11\(^{th}\)-12\(^{th}\) century AD) which narrated the preparation of a gunpowder mixture.\(^{18}\) But then she also acknowledges that it is rather difficult to say whether the Indians knew about gunpowder mixture as used in fire-arms before the fifteenth century.\(^{19}\)

Using the fifteenth century dictionary *Sharafnamah-i-Ahmad Muniari* M. Akram Makdooomme read the term *kushk-anjir*\(^{20}\), mentioned in *Adab al-harb wa'l shuja'ah* by Fakhr-i Mudabbir as modern day cannon. He also used an eighteenth century work, *Bahar-i Ajam* by Tek Chand Bahar which defines the same term as an instrument of war worked with gunpowder. He concluded that the use of gunpowder was known “much earlier than the fourteenth century”.\(^{21}\) I.A. Khan has criticized Makdooomme for ‘a serious flaw in the methodology’.\(^{22}\) He ascribes the earliest textural reference about pyrotechnics based on gunpowder in the Delhi Sultanate to a *qasida* composed by Amir Khusrau.\(^{23}\)

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18. Ibid., p. 141.

19. Ibid., p. 143.

20. It is mentioned in *Adab al-harb wa'l shuja'ah* by Fakhr-I Mudabbir belonging to Iltutmish’s reign.


23. The *qasida* was composed in the praise of Jalal al-Din Firoz Khalji in 1290-6. A *hawai* or rocket is mentioned in the *qasida* which could only work with the use of gun powder. L.A. Khan, op.cit., p. 18.
COMPOSITION : (A) INGREDIENTS

The basic ingredients of gunpowder are saltpeter, sulphur and charcoal. All of these components were easily available in the Indian subcontinent in Ancient India. There is ample amount of information in both Sanskrit and Persian texts of this period on this issue. We shall be dealing with all the three components one by one with special emphasis on their reference in the Sanskrit and Persian sources.

Saltpeter:

Saltpeter, the first basic component, was easily available through lixiviation and crystallization in Gangetic India. It was also obtained from soil efflorescence in Bengal during the rainy season.

Basically, the Sanskrit sources provide information about saltpeter as one of the ingredients in the transmutation of metals. Rasarnava mentions the use of saltpeter or Sauvarchala in the transmutation process. The text explains the use of saltpeter with other substances to make a vida (mixture) to kill all metals. Later in the text there is a reference to the killing of gold with the help of saltpeter along with other components.

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25. Elliot, H.M., History of India as Told by its Own Historians, Vol. VI, Appendix A, pp. 481-82.
Rasahridaya by Govinda Bhagavat and Rasa Ratna Samuccaya by Vagbhata refer to Sauvarachala or saltpeter in the category of six salts. It is in Katukacinatamani by Gajapati Prataparudradeva that we find the use of saltpeter as an ingredient in gunpowder mixture. The term used for saltpeter in the text is Yavakshara. It also mentions Panchakshara or five kinds of salt.

Verses 201-202 of Sukraniti, a sixteenth century treatise by Sukracharya, mention the use of Saltpeter in the formation of fire-powder. Further, in the same text, verse 203 and verses 206-08 provide the recipes for the use of fire powder in guns and pyrotechnics respectively.

In the Persian sources too there is a considerable amount of information on saltpeter but it is scattered. Adat ul-fuzala, written by Qazi Khan Badr Muhammad Dharwal at Jaunpur during 1419-20 A.D. and Sharaf-nama-i Ahmad Munairi compiled by Ibrahim-i Qawam Faruqi during 1457-64 AD, explain shora or saltpeter in different ways. Abul Fazl's famous work Ain-i Akbari provides interesting information about Saltpeter and its uses. There is a

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33. Ibid., p. 225.
34. Maulana Azad Library, A.M.U., MS, Univ. Farhang Lughat, No. 5.
35. This text is preserved in the Maulana Azad Library, A.M.U. and Aligarh under the title Farhang-Ibrahim, Habibganj Collection 53/22.
36. While Adat ul Fuzala calls it as “salt derived from earth which is at times used for throwing naft (naft andazi)”, the Sharafnama-i Ahmad Munairi calls it “saline earth from which salt is separated. Fire workers are known to use it and it is also used in pyrotechny (atishbazi)”, Cf. Khan, I.A., op.cit., pp. 211-12.
reference to the use of saltpeter as a coolant. Significantly enough the use of saltpeter as the base matter for gunpowder and the latter's use in wars and ceremonial fireworks. The text also mentions the subah of Berar as the area from which saltpeter was procured.

Bayaz-i Khushbui, an anonymous text of Shahjahan’s reign contains vivid details about the use of shora in gunpowder. Particularly, its thirteenth Bab is exclusively devoted to atishbazi (fireworks or pyrotechnics), wherein various recipes and the quantity of shora along with different ingredients are elucidated.

The traveler accounts also shed some light on the procurement of Saltpeter. The Remonstrantie of Francisco Pelsaert, a Dutch factor posted in India from 1620 to 1627, provides information on the procurement of Saltpeter. The author states that Saltpeter was found naturally near Agra in the periphery of 10 to 40 kos. The method of its extraction has been explained in detail. Further, the author gives the quantity of Saltpeter produced in Agra as a probable 5,000 to 6,000 maunds per annum.

Sulphur: Sulphur is the second basic ingredient of gunpowder. The Sanskrit sources possess interesting information on the origin of Sulphur. The texts like Rasarnava, Rasarnavakalpa, Rasahrdayatantram, Rasa Ratna Samuccaya,

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41. Ibid., p. 36.
Katukacintamani and Sukraniti provide detailed account of its ‘origin’\(^42\), varieties, properties, purification and method of its uses.

Out of the above mentioned sources only Rasa Ratna Samuccaya provides a comprehensive account of Sulphur and its uses. It gives a mythological origin of Sulphur by claiming that it originated from the menstrual discharge of goddess Parvati at Sveta dvipa and came out of the churning of milk ocean Ksira Sagara as gandhak along with nectar.\(^43\) Damodar Joshi interprets goddess Parvati as nature. Sveta dvipa as Sicily, churning of ocean as volcanic eruptions and menstrual discharge as the molten materials from the volcano.\(^44\) The text mentions four varieties of Sulphur based on colour viz., white, yellow, red and black. Verses 12-15 of the third chapter in the text provide this information and are being quoted below:

“On the basis of colour it [Sulphur] is of four types, i.e., white, yellow, red and black. The white variety is called khatika which is good for lepana (pasting) and loha marana (converting metals to ashes). That which is yellow in colour is called amala sara. The same is called Sukapiccha also. It is considered best for rasakarma and rasayana karma, both. The sulphur is called sukatunda and is good for dhatuvada vidhi (alchemical processes/purposes). The black variety of sulphur is rare. If available it can destroy senility/ageing process and may cause death”\(^45\).

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42. These texts trace a mythological origin of Sulphur.
44. Ibid., p 115.
45. Here dhatuvada vidhi specifically implies the use of sulphur in transmutation of metals. Ibid., p. 97.
According to the author Sulphur possessed a superior *rasayana* (rejuvenating) property and was known to have a sweet taste. The text mentions two types of impurities. The insoluble impurities from the first type while the soluble impurities form the second one. For purification the *Rasa Ratna Samuccaya* advises to melt sulphur with cow's ghee and pour it in milk or other extractives through a cloth. When repeated several times this process yielded pure sulphur. Purified sulphur was to be used both externally and internally for the treatment of skin disorders. Hot in effect it could stimulate digestive fire, remove toxins and improve vigour and strength. It could also impart potency to mercury and lessen its toxicity. Curing of skin diseases, improvement in digestion, removal of toxins, the removal of bacteria and worms, are some of the other uses of Sulphur mentioned in the text. For internal use purified sulphur or its oil form or *druti* had to be used.\(^{46}\) *Rasarnava* too mentions that any metal could be easily killed by sulphur.\(^{47}\)

Verses 336-337 of *Rasarnavakalpa* recommend the use of sulphur according to the prescribed rules as its otherwise nectar like qualities can change into poison.\(^{48}\)

The Persian sources like *Ain-i Akbari* and *Bayaz-i Khushbui* give information about the procurement and uses of sulphur. While the earlier source sheds light on its uses in metallurgy the latter highlights its importance in pyrotechnics. *Ain-i Akbari* mentions that mines of Sulphur are found in

\(^{46}\) Ibid., pp. 97-99.


\(^{48}\) *Rasarnavakalpa*, Mira Roy and B.V. Subarayappa eds., INSA, Delhi, p. 84.
Bengal. Bayaz-i Khushbui mentions the use of gugird or sulphur in the preparation of fireworks.

Charcoal: The third basic ingredient of gunpowder is Charcoal. India being immensely rich in flora, charcoal was produced from different varieties of trees each having its distinct quality. Few texts name the plants whose charcoal was used in the preparation of gunpowder. Rasa Ratna Samuccaya informs us about charcoal or kokilas. The verse 18 of the seventh chapter gives three synonyms of charcoal viz. Sikhitra, pavakocchista and angara. It defines the kokilas as the burning charcoals extinguished by itself without water. Katukacintamani of Gajapati Prataparudradeva of Orissa written in the early sixteenth century mentions two types of charcoal for pyrotechnic mixtures. The first type of charcoal is called Angar or the charcoal made of bamboo, pine, willow, etc. in the text. The second type is Arkangaar or the charcoal prepared from the wood of the Arka. It is from the verses 201-202 of Sukraniti written by Sukracharya in the sixteenth century that we come to know about the use of the plants Arka (Calotropis gigantea) and Snuhi (Euphorbia nerrifolia) for the preparation of charcoal. Thirteenth bab of the Bayaz-i Khushbui mentions the use of zughal (a live coal) as different from angisht (charcoal) an ingredient in a gunpowder recipe.

50 . Bayaz-i Khushbui, op.cit., folio b, p. 149.
51 . Rasa Ratna Samuccaya (tr.) Damodar Joshi, p. 294.
52 . Gode, P.K. maintains that the materials used in this type of charcoal are also mentioned in the Chinese text Wu Pei Chih.
55 . Bayaz-i-Khushbui, op.cit., passim.
**Gunpowder Recipes:**

Most of the sources of this period provide various recipes for the preparation of a gunpowder mixture. *Rasopanisad* narrates the preparation of *Sphotaka* or explosive mixture. The author mentions the heating of various salts with alkalies and the addition of wax and sulphur to form an explosive mixture. The *Katukacintamani* of Gajapati Prataparudradeva has a section on the manufacture of specific fireworks which was discovered by P.K. Gode. Gode asserts that the text contains formulas for the preparation of fireworks like *Kalpavrakshabana, Chamarabana, Chandrajyoti, Champabana, Pushpavarti, Chhuchhundrirasabana, Tikshanalanala* and *Pushpabana.* Gode mentions the use of the following materials in the manufacture of fireworks in the text: Sulphur (*gandhaka*), Saltpeter (*yavakshara*), Charcoal (*angara*), Steel and Iron powder (*tikshna loha churna* and *loha churna*), copper carbonate (*jangala*), yellow orpiment (*talakam* or *harital*), ochre (*garika*), wood of 'khadire' tree (*khadiram daru*), hollow bamboo piece (*nalaka*), wick (*bartika*), five salts (*pancha kshara*), lodestone (*akhupashan*), pulp of castor seeds (*aranda majja*), mercury (*sutam*), rice paste (*annapista*), tin or lead (*naga*), charcoal from the 'arka' wood (*arkangara*), cow’s urine (*gomutra*) and cinnabar (*vermilion*).

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56. Sea-salt, black-salt, saline-salt, ammonium chloride, Romaka and potassium nitrate were the mentioned salts.
59. Ibid., pp. 43-44.
Sukracharya’s *Sukraniti* or the ‘Elements of Polity’ gives enough indication about the presence of the knowledge of manufacturing gun-powder by providing recipes of the same. The verses 201-202 of the text describe the method by which it was produced. The author advises to powder and mix five *palas* of saltpeter, one *pala* of sulphur and one *pala* of charcoal. Thereafter, the mixture needed to be mashed in the juice of various plants and garlic, dried in the sun and grinded to obtain the fineness of sugar. This resulted in the production of firepowder. Further, the verse 203 suggests adding six or four *palas* of saltpeter instead of five *palas* to produce fire-powder for a gun with the proportion of other substances remaining the same.

*Bayaz-i-Khushbui* discusses in detail the method of preparing cannon balls for *tufung* and *top*. It also provides eighty seven gun-powder recipes for use in pyrotechnics. The exact measurements and quantities of various ingredients to be used are vividly explained in the text. Most of the recipes mention the use of four basic ingredients in various proportions. They are *shora* (saltpeter), *gugird* (sulphur), *zughal* (live coal) and *faulad* (powder of iron/steel). The quantities of these ingredients differ to give varied results in terms of the sound and smoke created after the explosion. While the quantity of *shora* remains more or less the same at 10-12 *misqal*, the other ingredients vary. The standards used for weight in the text are *misqal* and *dirham*. A *misqal* was equivalent to 4.23 grams. Some important recipes are *Ayar-i- Tarakak*,

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60. According to *Rasa Ratna Samuccaya* one *pala* consisted of four tolas. See *Rasaratna Samuccaya*, tr. Damodar Joshi, p. 469.

61. This kind of charcoal was prepared from the wood of *Calotropis gigantean* and *Euphorbia nerifolia* by destructive distillation.


Ayar-i Gule Sadbarg and Ayar-i Tutak Andarkafas. Unlike other recipes each of these three recipes is followed by directions to bring desired results by change in the proportion of the ingredients. To prepare the recipe of Ayar-i Tarakak, the text advises to use two dirham of gugird (sulphur), one daram of shora (saltpeter) and two darams of angisht (charcoal). The note given below the recipe states that the loudness of the result depends upon the quantity of paper in the mixture. Its range is same as of Ayar-i Hawal. The recipe of Ayar-i Gule Sadbarg includes ten darams of shora, ten darams of gugird and seven dirham of angisht. The text also gives a detailed method to prepare this mixture. The text advises to increase the quantity of anyone of the ingredients in order to produce more smoke. In case less smoke is desired the quantity of anyone of the ingredients may be decreased. The preparation of Ayar-i-Tutak Andarkafas needs ten dirham of shora, 13½ dirham of angisht, six dirham of gugird, twelve dirham of faulad, three dirham of nakhudgugird. All the ingredients are to be mixed in vinegar and dried in the sun. This process is to be repeated ten times and the mixture is to be covered and stored in a container. Gugird is to be mixed fifty times and grinded. It should be grinded five hundred times. The container or kafas is to be coiled with an iron wire and two pieces of wood are to be placed on its top to form a wheel. On ignition the wooden pieces soar in the air and the firework display is witnessed. This recipe is also called Ustad-i-Awaz Baghdadi.

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64. Bayaz-i-Khushbui, p. 141 folio (b).
65. Ibid., p. 149 folio (a)
66. Ibid., p. 151 folio (b).
Gunpowder Application

The Sanskrit and Persian sources of the period enumerate the varied applications of gunpowder. Broadly, these can be classified into two types:

(a) Military applications

(b) Fireworks

(a) Military applications

The uses of gunpowder as weapon of war was an important phenomenon in military operation during medieval time. There were many firearms were used but three weapons like ban, cannon and guns were most important.

Ban:

The term Bana to denote an arrow first appeared in the Sanskrit text during the 15th century. Irfan Habib point out that the term ban or its Sanskritized version bana was of obscure origin which came to be adopted first in Sanskrit usage and then in the Persian writings to mean a rocket during the period its use as a weapon of war became increasingly common.

The gunpowder based device, the hawai is reported being frequently used in military operations by the rulers of Malwa, Gujrat, Delhi and Jaunpur. We find many references to tir-i Hawai (rocket arrow) or Huqqa (round vessel). But from the end of 16th century onward, it came to generally referred

to India as ban. The *banfir-i hawai* consisted of an iron tube filled with
gunpowder which on being ignited could be made to fly towards a target.

In the 16th century the *ban* came to be widely used all over India down
to the late 18th century. The Afghan rulers, the Lodis and later the Surs also
frequently relied on this weapon in their siege operations. The description of
accidental explosion at Kalinjar in 1545 which caused to imply the presence of
a large number of rockets in the Afghan camp on that occasion. The massive
use of *bans* by the Mughals during Akbar’s reign can be gauged from the *Ain-i
Akbari*.

In *Ain-i Akbari* we came across a list of weapons used by the Mughal
army. In that list *ban* comes as item No. 77. *Akbarnama* had also made some
casual remarks on rockets as follow : “*Kahak Banha* (rockets) which are a kind
of fire works being discharged against the imperial army and that one of them
fell among thorn bushes and made such a noise that one of the enemy’s most
notable elephants got alarmed and by companion produced a great route among
the foe”. 71

This ban (rocket) was a Chinese innovation while I.A. Khan accepted
that it came to West Asian and North India with the Mongols 72 and Irfan
Habib 73 accepted that Bans have been introduced in India directly from China.

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70 . *Ain-i Akbari* (tr.) Blochmann, H., p. 119.
Cannon:

Use of cannon in India prior to 1526 is an interesting debatable topic. But it is well known fact that Babur was the first who used cannon in the battle of Panipat. I.A. Khan who has traced the evidence of early use of cannon from the surviving Persian sources of medieval India. He accepted that the missile throwing weapon known during the second half of the 15th century as rad or Kaman-i rad was actually a cannon.74

P.K. Gode has also tried to establish that in the second half of the 15th century, cannons were being already used in Gujrat, Malwa and Kashmir.75

The Mughal artillery underwent massive modernization during Akbar’s reign.76 The greatest single factor in this direction was the inventive genius of Shah Fat’hullah Shirazi who joined Akbar’s court as Sadr in 1583. It was this inventive genius who invented 17-barrelled cannon as well the portable cannon, and not, as Abul Fazl had written, Akbar, who invented the above cannons or any of the other mechanical devices ascribed to him.77 The seventeen barreled cannon probably consisted of 17 barrels welded together and having an inter-connected fuse which enabled all 17 barrels to fire successively. This invention, the forerunner of modern machine gun, was till

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76 For an excellent study of Shah Fathullah Shirazi’s mechanical and military innovations, see Alvi and Rahman, Shah Fathullah shirazi – A Sixteenth Century Indian Scientist, INSA, 1968, pp. 4-16, 30-32.
77 Ibid., p. 30.
recently believed to have been used for the first time by Napolean III in the Franco-Prusian war of 1870.\textsuperscript{78}

On the contrary Abul Fazl, Nuruddin Bakshi (author of \textit{Tabaqat-i Akbari}) and Shahnawaz Khan (\textit{Maasir ul Umara}) have all identified such a cannon to have been in Akbar possession.\textsuperscript{79} The other novelty was the portable cannon\textsuperscript{80} which was made up of five parts screwed one into the other. Mounted ordinarily on a light carriage, the parts of gun could be separated and easily carried on top of a hill and rejoined for use.

The \textit{Ain} also mentions smaller cannons which could be carried on the backs of elephants (i.e. \textit{gajnal}) and those carried by infantryman (i.e. \textit{narnal})\textsuperscript{81}.

\textit{Bayaz-i Khushbui} also give informations regarding of cannon (\textit{top-o-tufang}) and cannon ball.\textsuperscript{82}

\textbf{Guns :}

When handguns were first introduced in India is not known with any measure of certainty. But Bbur’s \textit{tufangchis} at Bajaur (1519) and Vijayanagar forces at Raichur (1520) used handguns with great effect in siege operation in India.\textsuperscript{83}

\begin{itemize}
\item \textsuperscript{78} Alvi and Rahman, op.cit., p. 13.
\item \textsuperscript{79} Alvi and Rahman, op.cit., pp. 30-31; \textit{Ain}, Naval Kishore I, p. 143.
\item \textsuperscript{80} Ibid., p. 10.
\item \textsuperscript{81} \textit{Ain-i Akbar}, Naval Kishore, I, p. 145.
\item \textsuperscript{82} \textit{Bayaz-i Khushbui}.
\end{itemize}
Abdul Fazl begins his chapter on handguns (*Ain Banduq*) by comparing the older method of making gun-barrels with the newer one. The former method had involved the rolling of a sheet into a cylinder and welding the edges together lengthwise with the result that the barrel would leak along the welded joint if more than the normal amount (1/4 to 1/3 of the barrel full) gunpowder was used. The method prescribed in the *Ain* consisted of the rolling of a sheet of iron in an oblique direction so that a roll of iron, several folds thick, was obtained. This roll (or barrel) was then heated so as to cause the folds (of iron) to weld together firmly. Barrels were also made by taking cylindrical pieces of iron, heating them and piercing them with pointed rods. “Three or four such pieces (when screwed or welded together) make one gun (barrel)”

The shorter barrels were reported to be 1 1/4 yards in length while the normal size of a barrel (of a hand-gun) was, according to Abul Fazl, two yards. Barrels were subjected to severe quality control and Abul Fazl informs us that after filling the barrels up to 1/3 their length with powder, they are fired off. If there is no leakage (tarawish) along the barrel, the barrel is subjected to another text. After fixing the butt and placing the completed piece on the special stand, which minimized the recoil, the gun was loaded with powder and the bullet was fired at a target. “If the ball issued in a crooked line, the barrel was


heated and straightened by means of a rod introduced into it.\textsuperscript{86} Even the weight of the bullet (ball) was specified at a maximum of 15 tanks (approx. 60 gram)\textsuperscript{87} for larger pieces. The barrels were adorned by the engraver (suhangar)\textsuperscript{88} after which the wooden support and the design of the butt were determined. The fact that two or more types of hand-guns were in use in Akbar’s army is indicated by this mention of variation in butt design.

The \textit{Ain} also gives an interesting reference to a new type of gun namely the wheel-lock. This gun could be “fired off without a match, by a slight movement of the cock”.\textsuperscript{89} This mechanism, known as the buttonlock, had a cock connected by a spring to a button, in place of a trigger. The powder in the priming pan was ignited by the sparks that flew from a pyrite stone fixed just where the cock struck.\textsuperscript{90} From Abul Fazl’s description of gun-making, it is obvious that this imported mechanism was rapidly assimilated by the Mughal armourers and Akbar was personally supervising the manufacture of button lock guns in his armoury.\textsuperscript{91}

The gun, once completed was marked with several interesting data. On it were inscribed the weight of the finished iron, the place from where the iron was supplied, the name of the workman, the place where the gun was made, the data, and its number. Accessories such as the ranrod and the ramrod housing

\textsuperscript{86} Ibid., p. 144.
\textsuperscript{87} Since 1 tanka = 4 masha approx. and 1 masha = 1 gm approx. See Jarrett, III, p. 16n.
\textsuperscript{88} Blochmann, I, (1963), p. 121, translates it as ‘filler’.
\textsuperscript{89} \textit{Ain-i Akbari}, Naval Kishore I, p. 144, Blochmann, H., p. 120.
\textsuperscript{91} \textit{Ain-i-Akbar}, op.cit., I, p. 145.
(Pargaz) were also a part of the regular piece.\textsuperscript{92} Apparently, Akbar showed personal interest and tested the guns at every stage in their assembly and finishing. However, he could only have done so far the guns made for his personal use.\textsuperscript{93}

Habib a maker of fireworks or guns, who (first) manufactured muskets in Kashmir, lived in Zainul Abadin reign and had no rival in his art.\textsuperscript{94}

(b) Fireworks:

The \textit{bana} (rocket) was predominant among the fireworks produced in medieval India. P.K. Gode traces the earliest reference of \textit{bana} or rockets to \textit{Katukachintamani} . The text mentions eight important types of fireworks and most of them were \textit{banas}. \textit{Kautuka-Cintamani} provides formulae for the preparation of \textit{banas}.

\textit{Akasabhairava-Kalpa} spells out three \textit{banas} viz. \textit{Bana-vrksa}, \textit{Camaraka} and \textit{Bana}. One meaning assigned to \textit{Bana-vrksa} is the hanging rockets discharged from trees while the other meaning suggests of the rocket producing tree-like formations with different heights.\textsuperscript{95}

Thus, it seems pretty clear from the foregoing discussion that the early use of \textit{bana} was limited to pyrotechny. The Persian source \textit{Tarikh-i-Firoz Shahi} of Afif also mentions the use of hawai or rocket in fireworks meant for the celebration of the \textit{Shab-i Barat} festivities at Delhi at the behest of the

\begin{itemize}
\item \textsuperscript{92} Ibid.
\item \textsuperscript{93} \textit{Ain-i Akbari}, Naval Kishore, I, p. 145 (tr.) Blochmann, H., 1965, p. 121.
\item \textsuperscript{94} \textit{Tabaqat-i-Akbari}, Khwajah Nizamuddin Ahmad (tr.), Brajendra Nath (ed.) Baini Prasad, p. 657.
\item \textsuperscript{95} Mira Roy, \textit{Pyrotechnics}, p. 329.
\end{itemize}
Sultan Firoz Tughluq. Afif calls the firework as *Hawaiha-i gulrez anbarbez mi bakht* or ‘flower scattering rockets’ which seems an improvisation in pyrotechny.  

Compiled in A.D. 1467-8 *Maasir-i Mahmud Shahi* is a chronicle of the Khalji kingdom of Malwa which describes the display of fireworks at Mandu. I.A. Khan considers that the above mentioned display was not of *naptha* but pyrotechny propelled by gunpowder.  

*Akasabhairava-Kalpa* mentions the use of *Syandanakrti- daruyantra-visesan* as a firework in the form of a wheel ignited by *daru* or gunpowder.  

*Katukachintamani* cites the various pyrotechnics that included fireworks other than *bana*.  

*Bayaz-i Khusbui* refers to numerous fireworks that were in used seventeenth century. The Chapter on *Atishbaazi* in the text gives the following fireworks *Ayar-i-gul, Ayar-i-gul-i Nui-digar, Ayar-i-Tez Amal, Ayar-i-Gule Mahtab, Ayar-i Gule digar, Ayar-i Gule Nargis, Ayar-i- Aftab* etc.

(B) PREPARATION OF ACIDS, ALKALIES, INKS, POISONS, ETC.

ACIDS:

The *Encyclopedia Britannica* defines acid as, “any substance that in water solution tastes sour, changes the colour of certain indicators (e.g. reddens blue litmus paper), reacts with some metals (e.g. iron) to liberate hydrogen,

97. Khan, I.A. Gunpowder Technology in India A.D. 1250-1500. *the Indian Historical Review*, p. 25.
reacts with bases to form salts, and promotes certain chemical reactions (acid catalysis)”. That acids formed an important chemical industry is evident from the information available in both Sanskrit and Persian texts of the period. The important texts in this regard are *Rasarnava, Rasa Ratna Samuccaya*, *Rasapradipa, Rasakaumudi, Ain-i Akbari* and *Khulasah-i Mufidu’l - Insaan*.

The Sanskrit sources of this period indicate that acids were produced from either plants or minerals. B.V. Subbarayappa divides them into organic and mineral acids accordingly. The organic acids included citruses like tamarind, pomegranate and other plant products. While there is no direct reference to mineral acids in earlier texts still it is highly probable that the alchemists involved in transmutation processes were aware of the acidic properties of various minerals.

**Organic Acids:** *Rasa Ratna Samuccaya* furnishes names of various acids “well suited for the purification, dissolution and killing of mercury and the minerals”. *Amlavetasa, Jambira, Nimbu, Bijapuraka, Cangeri, Canakamala, Amalika, Kola, Dadima, Ambastha, Tintidika, Naranga, Rasapanika, Karavenda* along with others are included in *Amlavarga* (group of sour drugs). *Canakamla* and *Amlavetasa* are considered to be of good quality with the former being considered the best.

*Ain-i Akbari* provides the name of *Amalbet*, a sour fruit which had acidic quality. This quality is illustrated with the example of the vanishing of a steel
needle when pierced in the fruit and disappearance of a white shell when immersed in the juice of the fruit. It mentions Chuk was an acid produced from the boiling of Orange and Lemon juice. The text informs that its production was prevalent in Subah of Oudh.

**Mineral Acids:** As discussed above the earlier texts do not describe the preparation of mineral acids. *Rasarnava* and *Rasa Ratna Samuccaya* refer to the distillation of alum and green vitriol respectively still there is no evidence of the resultant acid being used as a solvent in both of the texts. *Rasakaumudi* of Madhava, a 16th century text describes the preparation of mineral acids. *Rasaratnapradipa* of Govindadasa is an iatro-chemical text of the same period. It describes the process of preparing a mineral acid called *Sankhadravaka* or one which dissolves conch-shells. The ingredients used in its preparation were alum, green vitriol, sal-ammoniac, saltpeter, borax, rock-salt and sea-salt. P.C. Ray opines that the earlier texts used the term *dravaka* as a solvent and not mineral acid. It is the *Ain-i-Akbari* which mentions the use of *rasi* (aqua fortis) in the refining of silver. This indicates that the regular application of mineral acids in chemical operations. *Rasi* was a kind of acid prepared from *ashkhar* or impure carbonate of soda and saltpeter. Much earlier in 8th century, a muslim alchemist named Jabir or Geber who discovered the nitric acid. He describes as follow:

“Let us distil a pound of Cyprian virtual (iron or copper sulphate), one and half pound of salt peter, a quarter of pound of alum, and obtain the water (acid). This water dissolves metals very well. Its effect will be even greater by adding a quarter of a pound of salmiac (sal ammoniac) to it (aqua regia). So we find that in India Persian sources give the reference of aqua regia but the Sanskrit text not mentioned the best quality of mineral acid like aqua regia”.

ALKALIS:

The term alkali has been defined by Encyclopaedia Britannica as, “any of the soluble hydroxides of the alkali metals i.e. Lithium, sodium, Potassium, Rubidium and Cesium. Alkalies are strong bases that turn litmus paper from red to blue; they react with acids to yield neutral salts; and they react with acids to yield neutral salts; and they are caustic and in concentrated form are corrosive to organic tissues”.  

Ksara is the term used for alkali in the Sanskrit texts. The method of preparing ksara was recognized in Ayurveda as one of the ten important arts (kala). Both Charaka and Susruta provide valuable information about the different varieties, techniques of preparing bara and its uses. 

A great deal of information about preparation of alkalies, various varieties and their uses have been dealt by medieval texts like Rasahrdyantram, Rasarnava, Rasarnavakalpa, Rasa Ratna Samuccaya and Ain-i Akbari.

Rasahrdyatantram of Govinda Bhagavatpada cites three alkalies viz. sarijikakshara (natron), yavakshara and tankana (borax). It gives the technique of yielding a type of alkaline bida (flux) for the jarana (digestion of the bolus) process of mercury.111

The verses 35-36 of the fifth chapter in Rasarnava provide the names of borax. trona (natron) and yavakshara (carbonate of potash).112 Rasarnavakalpa’s verse 370 mentions four alkalis viz. kadali, apamarga, sesamum and makshika (sea-salt).113

Rasa Ratna Samuccaya too provides the names of three ksaras, yava ksara (carbonate of potash), sarjikaksara (natron or torna) and tahkanaksara (borax). Five alkali containing drugs viz. palasa ksara, muskaka ksara, yava ksara, suvarcika ksara and tila naladbhava ksara are collectively called Ksarapancaka in the text.114 Ain-i Akbari informs that the alkalis tangar (borax) and ashkhar-i kufta (natron) were used in the extraction of silver from the ashes.115

INK:

Ink is such a tiny word, of three letters, but it has played such a important part on the stage of world history.

113 . Rasarnavakalpa, tr. Mira Roy & Subbarayappa, INSA, New Delhi, p. 87.
114 . Rasa Ratna Samuccaya, tr. D. Joshi, INSA, New Delhi, Chapter X, verses 74-75, p. 466.
115 . Ain-i Akbari, op.cit., p. 27.
Fluid or paste of various colours but usually black or dark blue, used for writing and printing was prominent since antiquity. Its greatest impact was to spread knowledge in the form of the printed words. The ancient Egyptians and the Chinese, both developed ink at approximately the same time around 2500 B.C.\(^{116}\) In classical times a mixture of one parts of gum and three parts of carbon black was used.\(^{117}\) Chinese ink was a mixture of two parts of soot, twelve parts of gum one part of glue and one part of khalkantos was used.\(^{118}\)

The ink used in early India since at least from the 4\(^{th}\) century B.C which was an admixture of several chemical components.\(^{119}\) Later in the first century A.D, Greek writers clearly mentioned that 'Indian ink' (\textit{Indickon milon}) was exported from the India port of Babarikon. Pliny in the second century A.D compared this to some of the best inks made in Rome in during his times.\(^{120}\)

Needham observes that the art of ink making in India was borrowed from China\(^ {121}\) although indigenous efforts in this direction cannot be denied. There are many Sanskrit and Persian sources of medieval times which mentioned about the use of ink. The Sanskrit word fro ink is \textit{Mashi} and \textit{Sayahi} in Persian. Generally we find that the ink was of two types\(^ {122}\): (i) Fugitive and (ii) Permanent.

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\(^{118}\) Ibid., p. 237.
\(^{120}\) Sircas, D.C., \textit{Indian Epigraphy}, Delhi, 1965, p. 74.
The former was exclusively used for writing letters and related recording; the latter was used for writing Manuscript and for calligraphy which is still survives in different libraries. The permanent type of ink was a compound of lamp black and other ingredients. Permanent ink was prepared as black ink which are as follows: Firstly, resin of papal tree was ground finely, mixed with water and kept for sometime in an earthen pot, then boiled with a quantity of finely powdered borax and lodhara strained through cloth and then mixed with lamp black obtained from the soot of burning sesame oil in an lamp. 123

Manasollasa of Abhilaṣitartha in tumani written by somadeva 124 in the 12 the century A.D mentioned lamp black for making black colours, or kahhala. Haritala or vermilion was used to paint yellow and letters or portions to be detected from manuscripts. The formula for black golden, silvers and red ink were also known. The recipe for ink was given in Rasa Ratnakara 125 of Nityanatha Siddha, an alchemical treatise of the thirteenth century.

The following ingredients are necessary for making indelible black ink.

1. the three myrobalans,
2. eclipta alba,
3. yellow berveris,

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123  Ibid.
4. semicarpus and cardium marking nut,
5. oleander nericum adorum,
6. bob – a variety of gum,
7. kahhal or lampblack
8. Copper vessel.

The indelible character of the ink is obviously due to the use of marking nuts and myrobalans. This kind of waterproof ink was used in Malabar and other parts of the country. The next important source which also gives the method of making ink is *Lekhapaddhati*. This text had it in the following way. Soot and lotus petals were ground together in a copper vessel, then resin, gum and water were added drop by drop. In the fifteenth century Abdur Razzak (1442) referred to the use of a white-producing soft stone which was cut in the form of kalam and used for writing on black surfaces. It has been stated this colour was durable for long time and writing with this contrivance was held in high esteem. During the Mughal times different colours of ink was common because we get a number of manuscript and painting.

We get indirect information from the *Ain-i Akbari* of Abul Fazl, though this text do not mention the preparation of ink, but clearly mention on the nature of colours and the arts of writing and painting. Abl Fazl writes: “White

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126. Vijaya Jayant Deshpande, op.cit., p. 146.
and black are believed to be the origin of all colours. They are looked upon as extremes, and as the component parts of the other colours. Thus white when mixed in large proportions with an impure black, will yield yellow; and white and black, in equal proportions, will give red. While mixed with a large quantity of black, will give a bluish green. Other colours may be formed by compounding these. Besides, it must be borne in mind that cold makes a juicy white body, and a dry body black; and heart renders that which is fresh black, and while that which is dry. These two powers (heat and cold) produce, each in its place, a change in the colour of a body, because bodies are both qabil, i.e. capable of being acted upon, and muqtaza, i.e. subject to the influence of the heavenly bodies (chiefly the sun), the active origin of heat”.130 The next important source of is Adatul Kitab131 written by Abdullah B. Hasan who lived in India during the reign of Akbar. He wrote a short treatise on the preparation of ink.

POISONS:

Poison has been used by humans from time immemorial in various forms. The ancient Indian texts contain considerable amount of information on various poisons. The medieval Indian Sanskrit and Persian texts like Rasarnavakalpa, Rasa Ratna Samuccaya and Haft Ahbab provide information on the medicinal applications of poison.

130. Ain-i Akbari (tr.) Blochmann, H., p. 102.
Susruta divided poisons into two classes viz. vegetable and animal with the mineral poisons along with others being included in the former. The medieval text *Rasarnavakalpa* cites the method of preparing antidotes. Sulphur with the solution of *Punarnava (Boerhavia diffusa)* had qualities of an antidote according to the text.\(^{132}\) The solution of *Punarnava* contained potassium nitrate and other salts of potassium.\(^{133}\) The antidote prepared by mixing Sulphur and butter (prepared from cow milk) had qualities of destroying the venom of snake or poison (*garala*).\(^{134}\) This text also contains information on the preparation of *Visodakakalpa* (poisonous water), its properties and use. Poisonous water had three kinds viz. red, yellow and black. The three kinds of poisonous water in order of the effectiveness of poison were red, yellow and black. Further, the poisonous water removes the odour of sulphur and destroys the fragrance of musk.\(^{135}\)

The text further elaborates the use of poisonous water for attaining *dehasiddhi* or rejuvenation. The poisonous water needs to be kept in the hollow portion of bitter gourd before taking it in a *palasa* leaf. It is then to be mixed in water with the juices of three myrobalans. After taking it out of the bitter gourd it is to be carefully covered with the leaves of *palasa* and deposited in heaps of paddy for three weeks. Pills of one sana in weight need to be prepared after grains of *sasti* variety of paddy are crushed with the poisonous water and

\(^{132}\) *Rasarnavakalpa*, tr. Mira Roy and B.V. Subbarayappa, INSA, New Delhi, p. 87.
\(^{133}\) Ibid., p. 125.
\(^{134}\) Ibid., p. 87.
\(^{135}\) Ibid., p. 113.
mercury and goat’s milk is mixed. The text states that the pills prepared through this process if taken along with milk for one month leads to dehasiddhi. The user “becomes free from wrinkles and grey hair, attains an appearance like that of a sixteen year old boy”.

Verses 89-90 of *Rasa Ratna Samuccaya* spell out the names of five drugs of *visa varga* (group of poisonous drugs) as Srhgika, Kalakuta, Vatsanabha, Kritima and Pita which it considers best for *Rasa karma*. This group of drugs could be used for the processing of mercury and its solidification. But, its consumption can prove fatal.

The verse 91 of the same text enumerates the drugs belonging to the group of sub-poisonous drugs or *upa-visa varga*. The drugs of this group include Langali, visamusti, karavira, jaya, nilaka, kanaka and araka.

*Haft Ahbab* gives the process of detoxification of mercury. The text identifies seven kinds of poison in mercury. According to the text each of these are called kanchali (by Indian hakims) or ubbek. The text further spots out seven characteristics of every kanchali which need to be removed. Sulphur and khast (brick powder) are mixed with mercury. This leads to the detoxification process which the Indian hakims called maghakaran.

*Ain-i Akbari* informs us about a poisonous flower kaner. It has a special quality that, “whoever puts it on his head is sure to fall in battle [quarrel]”.

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136. Ibid., p. 114.
(c) PAPER TECHNOLOGY

The term paper is supposed to have been derived from Egyptian Papyrus. It is called kaghaz in Persian and kagad in Sanskrit (a late addition). It was originally manufactured and used in China as early as 105 AD.\(^{140}\) It reached Asia, Africa and finally Europe by the twelfth century.\(^{141}\) There are various opinions on the advent of paper in India. S.A. Ghori and A. Rehman argued that paper came to India during the Arab invasion of Sind in the eighth century AD.\(^{142}\) P.C. Ray however pointed out that the technology of its manufacture was brought to India in the tenth-eleventh centuries through Nepal probably by Chinese pilgrims.\(^{143}\) P.K. Gode opines that the first appearance of paper in India was confined to the thirteenth century.\(^{144}\) Moreover, Alberuni in the eleventh century remarked that the Hindus did not use paper. Instead, they wrote on palm leaf in the south and on the bark of the bhurja or tuz\(^{145}\) in the central and northern India.\(^{146}\)

Hence, it appears that the paper-making industry came in India with the establishment of the Delhi Sultanat at the beginning of the thirteenth century. It was Amir Khusrau who first pointed about the manufacture of Damishqi or Shami paper at Delhi.\(^{147}\) Barani mentions that when Balban got certain royal

\(^{140}\) Derry and Williams, Short History of Technology, Oxford, 1960, p. 232.
\(^{141}\) Irfan Habib, “Technological changes and Society (13th and 14th Centuries), pp. 19-20.
\(^{143}\) Ray, P.C., op.cit., pp. 234-35.
\(^{145}\) Tuz was also used as a cover for bows.
\(^{147}\) Amir Khusrau, Qiran us Sadain, ed. Muhammad Ismail, Aligarh, pp. 177, 228-30.
orders cancelled then the papers on which they were inscribed were washed instead of being torn up. This implies that the production of paper was meager.\textsuperscript{148} However the famous fourteenth century sufi work, the \textit{Khairul Majalis}, i.e. the malfuzat of Shaikh Nasiruddin Chiragh of Delhi, informs that the sweet-meat sellers of Delhi could pack their products in paper for their customers.\textsuperscript{149} Citing from \textit{Tarikh-i Firoz Shahi} of Shams Siraj’Afif, Ghori and Rahman have argued that paper-mills might have been erected by Firoz Tughluq. This was possible because scholars, poets and artisans were given royal patronage and several new industries were introduced in India. To reinforce their argument they quote Abu Hamid al-Gharnati (a contemporary of Afif). He said that “the paper made at Balkh favourably compared to that of Iraq, Khurasan and India”.\textsuperscript{150}

\textit{Tarikh-i Kashmir} refers to the establishment of a paper industry in Kashmir by Sultan Zainaul Abidin (1417-1467). The sultan during his stay at Samargand is said to have brought a number of skilled artisans in various trades which included paper makers and book binders. Soon, enough the Kashmiri paper earned a reputation for its excellent quality. The later half of the fifteenth century witnessed the production of quality paper from the pulp of rags and hemp with lime and bleaching soda added for whitening in Kashmir.\textsuperscript{151} According to B.V. Subbarayappa the chemical analysis of various

\begin{itemize}
\item \textsuperscript{148} Barani, \textit{Tarikh-I Firuz-shahi}, Bib. Ind., p. 64.
\item \textsuperscript{149} Hamid Qalandar, \textit{Khairul Majalis}, ed. K.A. Nizami, Aligarh, p. 203.
\item \textsuperscript{151} \textit{Tarikh-i Kashmir} (MS. in Habibganj Collection, A.M.U. Library) vide Ghori and Rahman, op.cit., p. 135.
\end{itemize}
samples of medieval paper shows that cotton rags and flax was used in their preparation. Wood pulp was also used. While the ash content of these papers ranged from 4-9% starch or gum was also used for sizing purposes. Tarikh-i Farishta mentions paper among the various gifts which Sultan Zainul Abidin sent to Sultan Abu Said of Khurasan in return to the latter’s gift of Arab horses and camels of good breed. There are no details about the paper making industry in Ain-i Akbari. It only refers to tuz or the bark of a tree as the writing material. Mufallid or book binder and rangrez or dyer were two kinds of craftsmen mentioned in the text bearing some relation to the paper-making industry. Abul Fazl also remarks that “good paper” was manufactured at Rajgir in the Sarkar of Bihar.

Khulasalu’t Tawarikh of Sujan Rai informs about the various brands of paper produced in Sialkot during or shortly before Jahangir’s reign (AD 1605-1627). This suggests the existence of paper making industry. Man Singhi, Nim Harir and Khasah-i Jahangiri are specially mentioned as fine, white, clean and stout brands. The writer praises the paper made at Azimabad town in the province of Bihar. He writes, "The paper made here is fine".

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156. The text calls rangrez a person who stains the paper with different colours.
**Mirat-i Ahmadi** gives information about the Ahmedabadi paper which was known for its extreme whiteness and glossiness. The author says, “Although Daulatabadi and Kashmiri papers are of fine quality, yet in point of whiteness and luster the two varieties cannot compete with Ahmedabadi paper”. 

**Bayaz-i Khushbui** also refers to the Sialkot paper. The text also provides detail about the method adopted for thickening and starching the paper in order to make it crisp. Fine quality white rice was rubbed twice with edible salt before being washed and then it was put under water for three days and nights to make soft so that it could be meshed with fingers. After rinsing and clean water added, the mixture was placed on a fire to boil and stirred until thickened. After cooling, the paste was spread on a clean wooden block and evenly spread with a piece of white cotton cloth. It has to be covered with *kirpas* (hemp) before being exposed to the sun and the process repeated on the reverse side of the sheet of paper. While the paper was still moist the seals were imprinted and well-defined distinct marks were made. Already discussed in the section on Gun powder, the text also mentions the use of ordinary paper in the manufacture of fireworks or *atishbazi*. Several folio of the source provides information on the

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159. *Bayaz-i Khusbui*, 121a-b.  
161. Ibid., 140a, 141a, 147a.
method of dyeing papers in various shades. Majmatus Sanai of Mir Yahya (c. 164) talks about the various ways of colouring paper.

(D) COSMETICS AND PERFUMES

Cosmetics and perfumery have always served the aesthetic pleasures from time immemorial. The science of cosmetics and perfumery and the art of applying were widely studied and practice. This art fulfilled three necessities of human life, namely religious merit, worldly prosperity and sensual enjoyment. The Sanskrit and Persian texts of the period have a great deal of information on the subject. There are specialized texts on the subjects as well as scantly references. Some important texts of interest are Gandhasara of Gangadhara, Gandhavada (anonymous), Rasaratnakara of Nityanatha Siddha, Ain-i-Akbari of Abul Fazl, Tuzuk-i-Jahangiri of Jahangir, Bayaz-i-Khushbui (anonymous), Itriyat-i Nauras-i Shahi of Nizamuddin Mahmud Tarsan.

P.K. Gode, in his article on Indian Science of Cosmetics and Perfumery, refers to two Sanskrit treaties on the subject, believed to be composed some time between A.D. 1200 and 1600 on the basis of earlier texts, and were composed A.D. 500 and 1000. The two treaties recovered by him are: (1) Gandhasara by Gangadhara and (2) Gandavada by an anonymous author, with a commentary in Marathi.

162. Ibid., 111a, 121b-123b.
The treaties *Gandasara* by Gangadhara contains three chapters.\textsuperscript{165} Chapter one (91 verses) explains the technical processes and terminology of scents and perfumes. Chapter second (392 verses) gives recipes for the preparations of different perfume products, such as *Gandhodaka* (scented water); *Gandhataila* (scented oil); *Snanjalam* (perfumed water for bathing); *Mrgaraja* (production of artificial musks); *Dhupa* (incense); *Vartti* (incense sticks); *Uddhulana* (perfumed powder); *Niryasa* (preparation of artificial fragrant material); etc. Third chapter gives a well classified list of aromatic ingredients to be used for the preparation of cosmetics and perfumes.

There are the classification of aromatic substances in terms of eight *vargas* or categories in the *Gandhasara*:

(i) *Patra Varga* (leaves) – Holy Basil leaves etc.

(ii) *Puspa Varga* (flowers) – Saffron, Campaka flowers, Clove etc.

(iii) *Phala Varga* (fruits) – Peeper, nutmeg, Cardamom etc.

(iv) *Tvak Varga* (barks) – Bark of Camphor tree, bark of cloves tree etc.

(v) *Kastha Varga* (woods) – Sandal wood, fir wood etc.

(vi) *Mula Varga* (roots) – Nutgrass (*Cyperus rotandus*), pavonia odorate (vala) etc.

(vii) *Niryasa varga* (exudations) – Camphor etc.

(viii) *Jiva Varga* (organic products) – Musk, honey, lac, ghee etc.

\textsuperscript{165} Ibid., p. 7.
The text describes six processes for the preparation of perfumes, viz:

1. **Bhavana** – mixture of fragrant powders with liquid
2. **Pacana** – digation of materials.
3. **Bodha** – tempering or revatalising the perfume.
4. **Vedha** – further development of bodha or strengthening process.
5. **Dhupana** – sterilize with aromatic vapours of incense, etc.
6. **Vasana** – preparing scents with perfumes of flowers

P.C. Ray observed that the process described are quite systematic, and appear to be based more or less on a knowledge of physico-chemical principles. The next important Sanskrit sources is *Rasaratnakara* of Nityanatha Sddha, assigned by scholars to the 13th century A.D. This text clearly deal with the preparation of cosmetics and perfumes. These are Sandal, Camphor, Kasturi, Kumkum, Hingula, Vermilion, etc. Amir Khusrau mentions in *Ijaz-i Khusravi* of gulguna and ghaza (red colour with women painted their faces) and sufaida (hair powder) which may be taken as articles of cosmetics.

Women used collyrium on their eyelids to enhance their grace and beauty. Hasan Nizami refers to *Surmai-i Chashm* (collyrium) and *Gulguna* (paint to redder the face). Hindus always adorned their head with a beauty

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166. Ibid.
mark (Tilak). He further tells us about the use of perfumes like musk, ambers, *itr* (a kind of perfume), *ud* (yellow wood) and *argaja* (the name of perfume of yellowish colour compounded of several ingredient).  

Perfume making and scented water was a well organized industry during the Mughal period. The *Ain-i-Akbari* (1590), the magnum opus of Abul Fazal of the royal court of Akbar gives an account of scents as well as their prices which ranged from half a rupee per *tola* for *Zabad* to 55 rupees per *tola* for *Sandalwood*. Akbar had lots of interest in perfume therefore he created a special department called *Khushubu-khana* for religious motives. Abul Fazal state that the Court hall was continually scented with ambergris, aloe wood and lignum etc. which was daily burnt in golden and silver censers. Akbar constantly perfumes his body and the hair of his head with odoriferous oil.

The text has details of the aromatic ingredients, including the use of rose water for the preparation of different kinds of perfumes.

(i) *Santuk*: It was used for keeping the skin fresh

- *Zabad* (civet): 1½ *tola*
- *Chuwa*: 1 *tola*
- *Chambeli essence*: 2 *masha*
- Rose water: 2 bottles

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173. Ibid., p. 79.
(ii) *Argaja*: It was used in summer for keeping the skin cool.

- Sandalwood : 3 *ser*
- Iksir and mid : 2 *tola*
- Chuwa : 2 *tola*
- Violet root : 1 *tola*
- Champhor : \(\frac{1}{2} \text{ masha}\)
- Rose water : 11 bottles

(iii) *Gulkama*: Ambergris : 1 *tola*

- Ladan : \(\frac{1}{2} \text{ tola}\)
- Musk : 2 *tola*
- Ud : 4 *tola*
- Iksir : 8 *tola*

Put all the ingredients into a porcelain vessel mix with it a ser of juice of the flower called *gul-i-surkh*\(^{174}\) and expose it to the sun, till it dries up. Wet it in the evening with rose water and with the extract of the flower called *Bahar*, and pound it again in *Samaq*\(^{175}\) stone. Let it stand for ten days, mix it with the juice of the flower called *Bahar-i-Naranj* (orange flower) and let it dry. During the next twenty days, add occasionally some juice of the blank.

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\(^{174}\) *Gul-i Surkh* in Persian is a pink fragrant rose that blooms in springs.

\(^{175}\) *Summaq* (vide *Sumaq*) is the hardest kind of marble.
Rayhan (also called black Nazbu)\textsuperscript{176}, a part of this mixture is added to the preceding.

(iv) Ruh-afza : Aloewood : 5 ser

\begin{itemize}
\item Sandalwood : 1¼ ser
\item Ladan : 1¼ ser
\item Iksin, luban and dhup : 3¼ tola of each
\item Violet root: 20 tola
\end{itemize}

\textit{Ushna}, called in Hind chharila: 10 tola

Mix all the ingredient till it gets tenacious like syrup. Four bottles of rose water pour into this syrup, for making into discs dry it in the sunlight. This disc (tikiya) was burnt in censers and smell very fine. It was generally used for court hall.

(v) Abirmaya:

\begin{itemize}
\item Aloewood : 4 dam
\item Sandalwood : 2 dam
\item Violet root : 1 dam
\item Sumbultib : 3 dam
\item Duwalak : 3 dam
\item Musk : 4 tola
\end{itemize}

\textsuperscript{176} Sweet basil.
Ladan : 4 dam

Bahar-i-Naranj: 7½ dam

Grind them all together and boil over a slow fire in 10 bottles of rose water. When cooked, they are poured into molds and left to set it into the shade.

(vi) *Kishta* : Aloe wood : 24 tola

Ladan, luban and sandalwood: 6½

Iksir and dhup : 2 tola of each

Violet root and musk : 2 tola

1 tola ushna mix with 50 tola refined sugar and boil gently in two bottles of rose water. It is made into discs. It smells very fine when burnt and is exhilarating.

(vii) *Bukhur* : Aloe wood and sandalwood: 1 ser

Ladan: ¼ ser

Musk : 2 tola

Iksir : 5 tola

Mix all these with two sers of refined sugar and one bottle of rose water over a slow fire.

(viii) *Fatila* : Aloewood : 5 ser

Sandalwood : 72 tola

Iksir and ladan : 20 tola each
Violet root : 5 tola

Luban : 10 tola

Refined sugar: 3 tola

Mix with two bottles of rose water and make into tapers.

(ix) Abir icksir: Sandal wood : $\frac{3}{4}$ ser

Iksir : 26 tola

Musk : 2 tola and masha

Pound it and dry it in the shade.

(x) Barjat : Aloe wood : 1 ser

Ladan : 5 tola

Musk : 2 tola

Sandalwood : 2 tola

Luban : 1 tola

Camphor : $\frac{1}{2}$ tola

*Barjat* was distilled like *Chuwa*, I have already discussed about the distillation process of *Chuwa* under the topic of ‘distillation’. This distillation process was first developed by two talented Arab chemists, Jabir ibn Hayyan (born 722 A.D.) and Al-Kindi (born 801 A.D.) established the perfume industry. Jabir developed many techniques, including distillation, evaporation and filtration, which enabled the collection of the odour of plants into a vapour that could be
collected in the form of water or oil.\textsuperscript{177} Al-kindi, however, was the real founder of the perfume industry. He carried out extensive research and experiments in combining variety of scent products (which contained 107 methods). He elaborated a vast number of ‘recipes’ for a wide range of perfumes.\textsuperscript{178} The industry’s products were exported, being sent for instance from Damascus and Jur to other Muslim countries and even as far east as India and China. Almost all the ingredients (like amber, musk and rose water etc.) which were used in the given recipes of Al-kindi, are almost found in the \textit{Ain-i Akbari}. According to Pelsaert, “They studies night and day how to make exciting perfumes and efficacious preserves, such as \textit{mosseri} or \textit{falroz} containing amber, pearls, gold, amboa, opium and other stimulants”.\textsuperscript{179}

The \textit{Ain-i-Akbari} also presents an account of natural perfumes under fifteen heads\textsuperscript{180}:

(i) \textit{Amber} – It grows at the bottom of the sea. It is of various colours: the white is the best and the black is the worst.

(ii) \textit{Ladan} – from the tree found in the island of Cyprus and Cheops.

(iii) \textit{Camphor} – tree grows in India and China. It is collected from the trunk and the branches.


\textsuperscript{179} Pelsaert, F., \textit{Remonstraitic} or Jahangir’s India, tr. by W.H. Moreland and P. Goyl, Cambridge, 1925, p. 65.

\textsuperscript{180} \textit{Ain-i-Akbari}, op.cit., pp. 83-87.
(iv) **Zabad** (civet) – also called *shakh*. The **Zabad** was brought from the harbor town of Sumatra from the territory of Achin.

(v) **Gaura** – from the animal resembling the civet, also found in Achin.

(vi) **Mid** – resembles the Gaura, but of inferior quality.

(vii) **Ud** - wood of aloes.

(viii) **Chuwa** - a distillate from lignum aloe.

(ix) **Sandalwood** - called in Hindustan as Chandan. The tree grows in China, but planted in India during the Akbar reign. It is of three kind.

(x) **Silaras** (storex) - a tree gum of Syria, both liquid and dry varieties.

(xi) **Kelumbek** -- a tree from Zeerabad, its pars finely powdered and mixed with other perfumes.

(xii) **Malagir** - similar to Kelumbek.

(xiii) **Luban** (frankincense) - a tree gum from Java, and

(xiv) **Azfarut-tib** (scented snail) - resembling shells collected from the nest of an animal.

(xv) **Sugandh gugala** (bdellium) - plant very common in Hindustan, used in perfumes.

Above mentioned recepies which was given by Abul Fazal, we find that rose water was used in plenty in each recepies (in bottles ranging from one to eleven bottles) for the preparation of perfumes. Actually rose was first
produced by Muslim chemists through the distillation of roses for use in the
drinking and perfumery industries. P.K. Gode mentions that there is no
reference either to rose or rose water in Sanskrit literature.

The attar of roses does not find a place in Ain-i-Akbari. The discovery of
itr-i Jahagiri (otto of roses) was invented by Salima Sultana Begum (mother of
Nur Jahan Begum). It is described by Jahangir in his memoirs, Tuzuk-i-
Jahangiri as follows:

“This itr is a discovery which was made during my reign through the
efforts of the mother of Nur Jahan Begum. When she was making rose water, a
scum formed on the surface of the dishes into which the hot rose-water was
poured from the jugs. She collected this scum little by little; when much rose
water was obtained, a sensible portion of the scum was collected. It is of such
strength in perfume that if one drop he rubbed on the palm of the hand, it scents
a whole assembly and it appears as if many reel rose buds had bloomed at once.
There is no other scent of equal excellence to it. It restores hemis that have
gone and brings back withered souls. In reward for that invention I presented a
string of pearls to the inventress. Salima sultana begum (may the lights of God
be on her tomb) was present, and she gave this oil the name of itr-k-
Jahangiri”.181

The next important source of this period is *Bayaz-i-Khushbui*.\(^{182}\) The first chapter of this text deals with perfumery which divided into two parts. The first part of the chapter is copy from *Ain-i-Akbari*. These perfumes are *Santuk, Gulkama, Sokhtan, Akraman, Barajaat* and *Gasul* and the second part discuss about the different kind of perfumes and also describe that which perfume should be applied on particular day in a week.\(^{183}\)

- **Saturday**: *Chuwa*
- **Sunday**: *Zafaran*
- **Monday**: *Argaja*
- **Tuesday**: *Malagir*
- **Wednesday**: *Gehla*
- **Thursday**: *Sandal*
- **Friday**: *Amber and Gulab*

Further in this text, we came to know about the four persons who have given their own method and recipies of making *Chuwa* (a perfume) by the distillation (*chakinidan*) process. These persons are Mir Syed Muhammad Tamar, Mirza Khaleel Kuli, Anub Bhaan and Sheikh Farid. These persons have given their different method and recepies for making the *Chuwa*.\(^{184}\)

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\(^{183}\) Ibid., f. 8.  
\(^{184}\) Ibid., ff. 8-9.
Though *Ain-i-Akbari* clearly describes the distillation process but no mention the recepies while this text vividly mentions the ingredient for making *Chuwa*. The next important source is the *iṭriyat-i-Nauras-i Shahi*<sup>185</sup> (16<sup>th</sup> or 17<sup>th</sup> century) of Nizamuddin Mahmud Tarsan is an important treaty on the preparation of perfumes and scents. It enumerates various animal and vegetable perfumes are included those extracted from ambergris, musk, aloewood, sandalwood and rose water.

**SOAP**

Soap was first produced by the Arabs. Soap manufacture became an important industry, especially in Syria. Coloured perfumed toilet soap as well as some medicinal soaps were made and exported, and Syrian towns like Nablus, Damascus, Aleppo and Sarmin were famous for their products.<sup>186</sup> The basis process used olive oil and al-qali, though sometimes natrum was some treatises of Daud al-Antaki and those of al-Razi sometimes also give recipes for soap.

Soap made from vegetables oils, aromatic oils and sodium lye were first produced by Muslim Chemists in the medieval Islamic world. Soap was possibly introduced into India by the Muslim, though the Hindus had made use before of alkaline lyes for a long time, obtained from the ashes of plants.<sup>187</sup>

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The medieval Persian literature also makes frequent mention of *Sabun* (soap) which used both for washing the body and cleaning the clothes being religious requirements for Muslims, they invented the recepies for true soap which is still in use today and he invented the soap bar.

There are two types of soaps are mentioned in *Ain-i-Akbari*, solid and liquid soap.

*Opatna* was scented soap used for bathing and *Ghasul* was liquid soap which perhaps used for washing hand after using toilet. The text has clearly given the recepies for making both the soaps. These are as follows:

*Opatna*:  
Ladan : 2¾ ser  
Aloewood : 1¼ ser and 5 dam  
Bahar-i Naranj : 1¼ ser and 5 dam  
Sandalwood : 1 saer and 5 dam  
Sumbultip (char) : 1 ser and 4 *tola*  
Apples : 36 *tola*  
Musk : 28½ *tola*  
Pacha leaves : 1 ser and 4 *tola*  
Violet root : 5 dam

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189. *Ain-i-Akbari*, op.cit., p. 79.  
190. Ibid., p. 80.
Dhup : 1 tola and 2 masha

Ikanki (a kind of grass) : 1½

Zurumbad, called in Hind kachur (zerumbet) : 1½ tola

Luban : 1 tola and 2 masha

Rose water: 106 bottles

Pounded the whole into a bowl and boil slowly in rosewater. When it has become less moist let it dry and cut into pieces (tikiya) for easily use.

*Ghasul* : a liquid soap.

Sandalwood : 35 tola

Katul : 1 tola

Musk : 1 tola

Chuwa : 1 tola

Camphor : 2 masha

Mid : 2 masha

Mix with two bottles of rose water.

Further, *Ain-i-Akbari* clearly give the reference of carbonate of soda which was prepared in the tank at Lonar that is yields the material for glass, soap and nitrate (shora).ⁱ⁹¹

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Bayaz-i-khushbui also mentions about Opatna and Ghasul. The text also gives the method how to make the soap. The fat of sheep or goat should be boiled. Thereafter it will be washed ten to fifteen times so that bad smell would be removed form this fat. Then again this fat should be washed three or four times by rose water. Then the remain fat should be kept in the water of singarhar (an odoriferous plant). Then this fat will be boiled for sometime till it will get mixed with singarhar. Again, this mixture will left to cool. The impurities will come on the surface of water and the remain mixture will go down at the bottom. The pure material should be collected and it will be boiled with those water till scum formed on the surface. The remain pure mixture of singarhar and far will be beaten by hard to make it into a semi-liquid. Then this solution will be spread on a cloth. This solution when dried up is cut into small pieces.

Thus we see, that chemical industries of various kinds discussed in the preceding pages were existent since time immemorial. With special reference to India, they existed both in the ancient and medieval period of history. The Persian and Sanskrit sources contain ample information on numerous chemical industries and their progress and development in the medieval period.

192 Bayaz-i khushbui, f. 7.
193 Ibid., ff. 10-12.