CHEMISTRY IN ANCIENT INDIA

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ABSTRACT

In ancient India, chemistry was called "Rasayana" in Sanskrit, the language in vogue. Rasayana derived its name from "Rasa," which means "extract," maybe from roots, leaves, and stems of plants. Ancient India's development in chemistry was not confined but found development in a variety of practical activities. In any early civilization, metallurgy has remained an activity from the Bronze Age and the Iron Age, to all other civilizations that followed.

INTRODUCTION

In India , certain objects testify to the higher level of metallurgy achieved by the ancient Indians. By the side of Qutub Minar, a World heritage site, in Delhi, stands an Iron Pillar. The pillar is believed to be cast in the Gupta period around circa 500 AD. The pillar is 7.32 meters tall, tapering from a diameter of 40 cm at the base to 30 cm at the top and is estimated to weigh 6 tonnes. It has been standing in the open for last 1500 years, withstanding the wind, heat and weather, but still has not rusted, except very minor natural erosion. This kind of rust proof iron was not possible till iron and steel was discovered few decades before.

The advance nature of ancient India's chemical science also finds expression in other fields, like distillation of perfumes and fragment ointments, manufacturing of dyes and chemicals, polishing of mirrors, preparation of pigments and colours. Paintings found on walls of Ajanta and Ellora (both World heritage sites) which look fresh even after 1000 years, also testify to the high level of chemical science achieved in ancient India.

Alkaloids were extracted by simply grinding specific parts of plants into a slurry, but eventually, the ancient sage doctors designed sophisticated apparatus for distillation. "Damaru Yantra" was an apparatus mentioned in Ayurveda comprising of two equal earthen vessels placed in such a way that the rims of both met each other and were sealed with a mud-smeared cloth. The apparatus was then heated from the bottom while a cool cloth was applied to the top, which allowed the medicine vapor to condense and stick to the inside bottom surface of the top vessel.

Indian alchemists tried to produce gold out of mercury by treating many plants and mineral products. Nagarjuna, a great ancient Indian physician of the 8th century AD, could extract mercury ("Parad" in Sanskrit) by roasting Cinnabar ore, extensively found in the hills of "Gandhara" (now called Afghanistan), in the air and condensing the vapor. Initially, Mercury was used as a color, but subsequently, "Parad bhasma," "Makardhwaj," "Rasakapur," "Parad gandhak," "Kajjali," "Rasa Parpati," etc., were prepared from mercury and used as medicines.

Rasaratnakara of Nagarjuna : It is a Tantra of the Mahayanist school and as such its invocations are addressed to all the Buddhas and in one place there is a pointed reference to Prajnaparamita (Perfection of wisdom) appearing before Nagarjuna in a dream and revealing to him the ingredients

of a recipe (consisting of steel, copper, mica, pyrites etc.) A noteworthy feature of this work is that some chemical processes are discussed in the form of a dialogue between Shalivahana, Nagarjuna, Ratna Ghoshal and Mandavya. These last two names are held equally in veneration with Nagarjuna and grateful acknowledgements to their services occur in some later chemical treatises such as Rasaratna Samuchchaya. On the basis of internal evidences it can be said that, it is one of the earliest works extent on the Indian alchemy, belonging to about 7th or 8th century A.D. This work contains: Methods of purification of the maharajas (important minerals). The methods of purification with regard to - rajabrata (lapis lazuli), gandhaka (sulphur), rasaka (calamine), dardaa(cinnabar), makshika (pyrites), hema(gold), tara(silver) and shulva(copper), killing of diamond and the metals, methods of extraction of the essence of minerals like Vaikranta (tourmaline/black oxide of manganese), makshika and tapya (varieties of the pyrites), rasaka (calamine), darada (cinnabar) and abhrak(mica) etc. along with dissolution of gems (pearls etc). by digestion in vegetable acids, e.g. sour gruel (impure vinegar) and the juice of certain acid plants and the process of fixation of mercury etc. Recipe for an elixir; "Mercury is to be rubbed with its equal weight of gold and then(the amalgam) further admixed with sulphur, borax etc. The mixture is then to be transferred to a crucible and its lid put on, and then submitted to gentle roasting. By partaking of this elixir (i.e .the sublimate) the devotee acquires a body not liable to decay" and a recipe for Kajjali or Aethiops mineral etc. According to Acharya Prafulla Chandra Roy,The sage physicians probably knew the importance of iron and, hence, used iron as a food supplement, like Loha Bhasma, to treat anemia and weakness. This implies that the sage physicians knew that iron forms an integral part of hemoglobin molecules responsible for carrying oxygen through the blood. Patanjali was another scientist during the birth of the Christ stated in his book, “Lekhashastra,” that rust-free steel was produced by melting iron stones (ores) in small ovens of charcoal. The Ashoka Pillars erected by emperor Ashoka the Great are living examples of the developed iron technology of ancient India. The pillars were manufactured from wrought iron by forge welding. The pillar’s resistance to corrosion is due to a passive protective film at the iron-rust interface. The presence of high amounts of phosphorus and slag and unreduced iron oxides in the microstructure of the iron, and the alternate wetting-drying in atmospheric conditions are the main factors in the formation of that protective passive film. Another important metal, arsenic, was discovered to treat many ailments.

TYPES OF RASAYANA

- Pranamya – Promoter of vitality and longevity
- Medhakamya – Promoter of intelligence.
- Srikamya – Promoter of complexion.
- Naimittika Rasayanas help to fight a specific disease.

EXTRACTION OF METALS

- **Copper from the pyrites:** "Makshika, repeatedly soaked in Kshudra (honey), gandharva taila (oil of Ricinus communis), gomutra (urine of cow), ghrita (clarified butter) and kadali

kanda sara (the extract of the bulbous root of Musa sapientum) and heated in a crucible, yields an essence in the shape of copper"

- **Extraction of Zinc from calamine:** "Rasaka" mixed with wool, lac, Terminalia Chebula and borax and roasted in a covered crucible, yields an essence of the appearance of tin; of this there is no doubt".

ORIGIN OF ALCHEMY

In India the origin of alchemy can be traced back to the Vedic age. Medicinal plants are classified into two categories according to Atharvaveda; ayusani (promoting longevity) and bhaisajya (curing diseases). In the Ayurvedic period the term ayusani gave place to Rasayana. Therefore Rasayana represents drugs which improve the circulation of body fluids and thus helps in prolongation of life8 .The Vedic people had a strong appeal for gold and for an exhilarating drink called soma. Both were exalted to a divine position. The Atharva Veda mentions about gold as a heavenly blessing which confers longevity on a person who wears it. Soma rasa according to Rig-veda was drink of immortal gods. The extraction of juice of soma was itself an elaborate ritual. It was offered to the gods by priests. Soma rasa like gold was also considered to bring immortality.

BENEFITS OF RASAYANA

About the benefits of Rasayana, Alberuni has written, “its principles restore the health of those who were ill beyond hope, and give back youth to fading old age, so that people become again what they were in the age at puberty; white hair become black again, the keenness of senses is restored as well as the capacity for juvenile agility, and even for cohabitation and life of the people in this world is extended to a long period” 23 . Rasayana was believed to control premature ageing, weakness, disease and even death. Thus through Rasayana benefits to be achieved were; prolongation of life, boosting memory and intelligence, regulating immunity against diseases, keeping up a youthful state , improving complexion and voice, enhancing body strength and strength of sense organs etc . Susruta Samhita mentions about the treatment of diseases of ear generally by the practicing rasayana . According to Ayurvedic texts two types of Rasayana were practiced.

1) Kuti Praveshika

2) Vatatapika

1) Kuti Praveshika: It was undertaken in a specially built three chambered (concentric) house. By this method every cell of the body gets rejuvenated. It is designed on the basis of first state of life in mother's womb.

2) Vatatapika: This method was for those who who found it impossible to undergo the first method because of its strict rules. In this method one was exposed to sun and wind during Rasayana therapy .

MATERIAL AND PROCESS

During medieval period alchemists were busy in their activities. In order to develop new methods they used earlier knowledge of metals, minerals and plant materials. different types of inorganic substances such as; minerals including gems and metals and organic substances which include plant as well as animal products were used but it was inorganic products that were largely used .Among the metals most frequently used were gold, silver, iron, lead, copper, zinc, tin and mercury. Besides these arsenic, sulphur, orpiment (arsenious sulphide, As2S2), realgar (arsenic sulphide, As2S3) and cinnabar (mercuric sulphide Hg2S2) were also used .The important minerals were generally called rasas which were further divided into maha (superior) and upa (subsidiary) rasas. The metals were called dhatus. Although mercury is a metal but it was considered maharasa, the king of rasas. In the alchemical texts it is mentioned by various names like; parada, sita, rasendra, svarnakaraka (maker of gold), sarvadhatupati, Sivaja (born of Siva), Siva virya (semen of Siva) and Harabija (seed of Siva).

The metals which have been mentioned in rasashastra texts are gold, silver, copper, & iron which are considered pure while lead and tin are considered as odorous (puti). In the alchemical texts various plants have been mentioned some of which have medicinal value. The roots, leaves or seeds of these plants aid indigestion. According to Alberuni most of the medicines prepared in Rasayana Were from plant sources .Regarding animal products, their excreta, flesh or some other parts of their bodies were processed and used but comparatively the use of metals and minerals in alchemy was more pronounced. According to rasavadins minerals and metals couldn‟t give desired alchemical

properties unless they were treated or digested with some medicinal plant. Even mercury that was considered the king of rasas had to undergo treatment with different plants . It was solidified using plant juices, metals and sulphur. Gold was also used in preparing a variety of medicine. Various methods of preparing compounds of mercury having medicinal value were developed by the alchemists.

The alchemical texts have given the details of processes for the preparation of different types of bhasmas. In the preparation of bhasmas the desired substance is heated for a long period which plays an important role in obtaining an effective product of fine particle size. Some of the bhasmas prepared by rasavadins showing their experimental skills are:

Gold bhasma: In this thin gold leaves were to be coated with a paste made of mercuric sulphide and the juice of custard lime, dried and incinerated. This process was to be repeated ten times, after which bhasma could be used as medicine. It could also be prepared by a process that involved cinnabar, sulphur, realgar and sal ammoniac (ammonium chloride) as well as gold and citrus juice.

Silver bhasma: One method of preparing this was that silver foils were to be coated on both sides with kajali prepared from mercury and sulphur, and ground in citrus juice. These were dried and powdered sulphur was spread over them above and below. These were then placed between two earthen plates, sealed and heated in a sand-bath for a day, over a strong fire. When it got cold, the product was mixed with powdered pyrites in equal quantities and ground well with lime juice and then heated for a long time till the silver was reduced to its bhasma form.

Copper bhasma: It was prepared by keeping copper leaves immersed in cow's urine for 15 hours and then taken out. Copper leaves are placed in the paste of Cangeri (oxalis corniculata) and kajali (prepared from mercury and sulphur) is also put in it. The pot was closed with lid and heated on high flame for three hours. After cooling it, the mass is powdered and thus the product called copper bhasma became ready for use.

Lead bhasma: For its preparation mercury was added to molten lead along with barks of arjuna (Terminalia arjuna), vibhitaki (Terminalia belerica), ashwagandha (Withania somnifera),

pomegranate and apamarga (Achyranthes aspera). These were heated together for 21 nights, all along constantly stirring by an iron ladle. The product obtained is finely powdered. According to alchemical texts lead bhasma was excellent for rasayana therapy.

Laboratories & Instruments:

The rasavadins also set up their laboratories called rasashala. In these laboratories different apparatus, appliances, instruments for heating, steaming, distilling etc. were kept. The laboratory was to be erected in a place rich in medicinal herbs. It had to be spacious, furnished with four doors and decorated with portraits of divine beings. The apparatus included kosthi (for the extraction of essences), pair of bellows, pestle and mortar, sieves of varying degrees of fineness, earthen material for crucibles of various types, dried cow dung cakes for heating purposes, retorts of glass, iron pans, conch-shells etc . As rasavadins used to have extensive knowledge of metals and minerals, they by their frequent experiments also prepared mineral medicines which were later in use along with Ayurvedic and Unani medicines .Alberuni writes that he could not learn from Hindus the methods and the elements (whether mineral, animal or a vegetable) used by them in this science. But he had heard Hindus speaking about some processes such as; sublimation, calcination, of analysis, waxing of talc etc. These processes are generally used in alchemy .

Metallurgy,Glass making, pottery, jewellery making, dyeing of clothes and tanning of leather etc. were the major chemical arts and crafts in the early periods. As a result of this expanded activity, the alchemical knowledge increased. Following were the major chemical products that contributed to the development of chemistry

1. **Metallurgy** : One of the other interesting developments came in metallurgy which is unique to indian culture and civilization.Excavations in Middle Gangetic Valley conducted by archaeologist Rakesh Tewari show iron working in India have begun as early as 1800 BC.But the advancements they made during that time is staggering.The iron pillar of Delhi is a 7 meter high pillar which is notable for the composition of the metals used in its construction. The pillar is 98% pure wrought iron, and is a testament that high level of skill achieved by

ancient Indian ironsmiths at that time. It has catches the attention of both archaeologists and metallurgists all over the world as it has withstood corrosion for over 1,600 years in the open environment.

2. **GLASS** : Glass is a fused solid mixture of a number of substances like lime, sand, alkali and metallic oxides. It is of various kinds - transparent, opaque, coloured and colourless. No glass objects were found at the sites of the Indus valley civilization, except for some glazed and faience articles. A number of such glass objects were found at Maski in south India (1000-900 BC) , Hastinapur and Taxila (1000-200 BC). In this period glass and glazes were coloured by the addition of colouring agents like metal oxides. *Ramayana*, *Brihat Samhita*, Kautilya's *Arthashastra* and *Sukraniti Sara* mention the use of glass. There is ample evidence to suggest that ancient India glass making was quite widespread and a high degree of perfection was achieved in this craft.
3. **PAPER** : From the Chinese traveller I-tsing account it appears that paper was known to India in the seventh century AD. In the beginning the process of papermaking was simple and more or less similar in all parts of the country. The main centers of paper making in medieval India were Sialkot, Zafarabad, Murshidabad, Ahmedabad, Mysore etc.
4. **SOAP** : For washing clothes ancient Indians used certain plants and their fruits like the soap nuts of Reetha and Shikakai. Fruits like *Sriphala And Sarsapa* (*Brassica campestris*) were also used to wash different kinds of clothes. Guru Nanak's prayer written in the late sixteenth century AD contains the earliest reference to soap. There were references to soap like substances called *Phenaka* in the second and third century AD texts like *Manusmriti* and *Yajnavalkya Smriti*. Indians definitely began to make proper soaps in the eighteenth century AD. In Gujarat, the oil of Eranda (*Ricinus communis*), seeds of plant Mahua (*Madhuca indica*) and impure calcium carbonate were used by them. These were used for washing but gradually soft soaps for bathing were made.

5. **DYEING** : Plants and their products like madder, turmeric and safflower were the principal dyeing materials. Orpiment and some insects like lac, cochineal and kermes were the other materials used for dyeing. A number of classical texts like *Atharvaveda* (1000 BC) mentioned some dye stuffs. Dyes were extracted from inorganic substances by repeatedly soaking and mixing them in water and allowing the materials to settle. Then the solution was taken out and spread on a pot and evaporated to get the dry dye.
6. **COSMETICS AND PERFUMES**: A large number of references to cosmetics and perfumes in Sanskrit literature were found like in *Brihat Samhita* of Varahamihira. Cosmetics and perfumes making were mainly practised for the purpose of worship, sale and sensual enjoyment. The Bower Manuscript (*Navanitaka*) contained recipes of hair dyes which consisted of a number of plants like indigo and minerals like iron powder, black iron or steel and acidic extracts of sour rice gruel. *Gandhayukti* gave recipes for making scents.
7. **INK** : An inkpot was unearthed during the excavations at Taxila, which suggests that ink was known and used in India from fourth century BC. The Ajanta caves displayed some inscriptions that were written with coloured ink, made from chalk, red lead and minimum. Chinese, Japanese and Indians had used Indian ink for quite a long time. The recipe for ink was also given in *Rasaratnakara* of Nityananda.

CONCLUSION

Thus it can be concluded that the concept of Rasayana or alchemy in India originated with the importance attached to a healthy body and desire for long life since ancient times. It originated in different countries independently but influencing each other‟s practices due to cultural exchange. In India it kept on developing in medieval times. Various alchemists came into prominence in medieval India. Indian alchemists were actively engaged in doing alchemical experiments. The rasavadins were actively engaged in their laboratories doing experiments and were well versed with the nature and properties of various metals and plant essences and thus prepared different types of medicines in the form of bhasmas etc. which were used as medicines and these bhasmas are still used in

Ayurvedic and Siddha systems of medicine. Along with medicine, Rasayana also gave rise to the science of metallurgy. Due to the frequent experiments performed by rasavadins on various metals, there was growth in the science of metallurgy also. Various alchemical treatises on Rasayana were also written in medieval period. "

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