

A Brief Review on Progress in Chemistry in Ancient India

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Abstract: *In ancient India, ayurveda played an important role in the development of chemistry. Science and technology in ancient and Medieval India covered all major branches of human knowledge and activity. In all ancient civilizations, metallurgy remains a fundamental activity of all civilizations from the Bronze and Iron Age to all subsequent civilizations. The Indus Valley Civilization was the first society of India, the early chemical history starts here. There are traces of cement in the time of Mohenjodaro. According to the Rig Veda, leather tanning and cotton dyeing were carried out during this period. After a classic text by Veda, provide valuable information about chemicals. The main chemicals during this period were glass and paper, soap, coloring, cosmetics and perfume, alcohol wanis, pharmaceuticals, gun powder and salt. Nagarjuna (metallurgist) and Kanadar were ancient chemists. Indian and Persian armies used iron arrow tips. During the Gupta period metallurgy operations were in great use. The statue of the dancing god Nataraja is made of five metals (panch dhatu) and iron pillars, Delhi are silent witnesses to the amazing metallurgical craft of the Indians. The paintings found on the walls of Ajanta and Ellora also testify to the advances chemical science achieved in ancient India.*

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1. Introduction

Ancient India, an important role in the development of chemistry was made by Ayurveda which used a variety of minerals. Chemistry in Ancient India was called Rasayan Shastra, Rasatantra, Rasa Kriya or Rasa Vidya roughly translating to 'Science of Liquids'. Science and technology in Ancient and Middle Ages in India had knowledge and activities including mathematics, Astronomy, physics, chemistry, medicine and surgery. The ancient India was a land of wise and foresightful saints. As a country of scholars and scientists. Ancient Indian contributions to science and technology include the principles of chemistry, which are not abstract but are expressed in various disciplines: Practical activities such as the distillation of perfumes, aromatic substances, manufacture and extraction of liquids, dyes and pigments. Metallurgy remained in earlier civilizations It was a central activity in all civilizations from the Bronze Age, Iron Age, and all subsequent civilizations.

2. Major Areas of Chemistry Development

a) Alchemy (Rasa Shastra): In ancient India, chemical practices were closely associated with alchemy, primarily driven by the pursuit of converting base metals into gold and achieving immortality through the “elixir of life.” ‘Rasa Shastra’, a branch of Ayurveda, is dedicated to the use of minerals and chemicals, particularly mercury and sulfur, for medicinal purposes. This early chemical knowledge contributed significantly to metallurgy and medicine.

Alchemy was closely related to Rasayana, which can be understood as the science of chemicals, elixirs, and metals. It played an essential role in early Ayurveda and Siddha medicine. The Indian alchemical tradition is described extensively in texts like the Rasashastra, a branch of Ayurveda.

Salient features of Indian Alchemy:

Rasayana (Elixirs and Longevity): Rasayana focuses on rejuvenation, enhancing vitality, and potentially attaining immortality through various chemical and herbal concoctions. Alchemists sought a substance called rasa (mercury) and believed it could transform base metals into gold, just as it was thought to have restorative and life - extending properties when ingested or applied.

Mercury and Metals: Mercury was central to Indian alchemy and was considered both a divine and a potent substance with the ability to purify the body and the soul. The transmutation of metals was linked with metaphysical concepts such as the purification of the soul and spiritual enlightenment. Gold was revered not only for its material value but also for its association with purity and immortality.

Medicine: Alchemists (called Rasavadins) also experimented with various herbs, metals, and minerals to develop potent medicines. These remedies were believed to cure diseases, enhance longevity, and promote overall health. Alchemical knowledge contributed significantly to traditional medicine systems like Ayurveda.

Noted philosopher and alchemist, Nagarjuna is credited with contributions to both alchemy and Buddhist thought. He is said to have written important texts on alchemy and chemistry, like Rasaratnakara.

b) Metallurgy: Ancient India had advanced knowledge of metallurgy, particularly in extracting and refining metals like copper, bronze, iron, and zinc. Zinc distillation was a major achievement, with the oldest zinc mines discovered in Zawar (Rajasthan) dating back to 200 BCE to 100 CE. Indian blacksmiths also produced high - quality steel, notably ‘Wootz steel’, which was exported and highly valued across the ancient world.

Metallurgy in ancient India was highly advanced and played a significant role in the development of materials, tools, and structures. Indian metallurgists mastered the extraction, purification, and alloying of metals, and their expertise significantly contributed to ancient construction, weaponry, and art.

Salient features of Ancient Indian Metallurgy:

Iron and Steel Production: One of the most renowned achievements of ancient Indian metallurgy was the production of Wootz Steel. It was a high - carbon steel, known for its strength, durability, and ability to hold a sharp edge, which became famous globally. It was traded as far as the Middle East and Europe, where it influenced the making of Damascus steel.

Iron Pillar of Delhi: The Iron Pillar in Delhi, dating back to around the 4th century CE, is a testament to the corrosion - resistant iron technology developed by Indian metallurgists. Despite being exposed to the elements for over 1, 600 years, the pillar shows minimal rusting.

Copper and Bronze: Indus Valley Civilization used copper extensively. Archaeological findings reveal that copper was used to make tools, weapons, ornaments, and vessels. They also developed bronze by alloying copper with tin, which was used in casting statues and making artifacts. The famous Dancing Girl statue from Mohenjodaro (circa 2500 BCE) is an example of their bronze - casting skills.

Zinc Production: India was the first to develop the technique of zinc extraction by distillation. The Zawar mines in Rajasthan are believed to have been operational as early as 6th century BCE. The ancient Indians used a method called the "downward distillation" to extract zinc from ore, a remarkable feat for that time. India also played a role in the production of brass, an alloy of copper and zinc.

Gold and Silver: Gold and silver metallurgy was well - developed, with evidence of gold smelting dating back to the Indus Valley Civilization. These metals were primarily used for jewelry, coinage, and religious artifacts.

The use of Swarna Bhasma (gold ash) in Ayurveda is another example of the knowledge and use of metals in various cultural and medicinal contexts.

Techniques and Innovations in Metallurgy:

Crucible Technique: Indian metallurgists used crucibles to melt metals, a significant innovation for smelting and refining processes.

Carburization: The process of adding carbon to iron to make steel, particularly in the production of Wootz steel, was mastered in India long before it spread to other regions.

c) Dyeing and Textile Industry: The Indian subcontinent was known for its skill in dyeing, using natural dyes derived from plants like indigo and madder. Indian textiles dyed with natural chemicals were highly prized in international trade, especially during the Roman and Islamic periods.

The dyeing and textile industry in ancient India was highly advanced and well - regarded, with evidence dating back to the Indus Valley Civilization (around 2500 BCE). Indian artisans had perfected the art of weaving, dyeing, and creating textiles, and their products were highly sought after in global markets, especially in regions like the Roman Empire, Persia, and Southeast Asia. Here's an overview of the key aspects.

Materials Used

Cotton: India was one of the first places where cotton was cultivated, and the cotton textiles produced in regions like Gujarat and Bengal became world - famous. Indian cotton fabrics were known for their fineness, durability, and beautiful designs.

Silk: Silk weaving also has a long history in India, with the famous mulberry silk being produced in South India and Bengal. India's association with silk was strong, especially through trade with China via the Silk Road.

Wool: In colder regions like Kashmir and the Himalayas, wool was an essential material for textiles, including the renowned pashmina.

Dyeing Techniques

- **Natural Dyes:** Ancient Indian textile makers were adept in using natural dyes derived from plants, minerals, and insects. Common natural dyes included:
- **Indigo:** This deep blue dye, derived from the indigo plant (*Indigofera tinctoria*), was one of the most important and famous dyes. India was a major producer and exporter of indigo.
- **Madder:** Extracted from the roots of the *Rubia* plant, it produced shades of red and was used extensively.
- **Turmeric:** Used to produce yellow hues.
- **Kusuma (Safflower):** Gave a range of colors, from light yellow to bright red.
- **Lac:** A resinous secretion from insects, used for red and purple shades.
- **Pomegranate Rinds:** For producing yellow and greenish dyes.
- **Mordanting:** Mordants such as alum and iron salts were used to fix dyes on fabric and enhance their brightness. India had a deep understanding of mordanting techniques, making their colors vibrant and durable.

Types of Weaves and Patterns

- **Muslin:** This fine cotton fabric, especially from Bengal, was famous for its delicate texture and was often called "woven air." It was highly prized both in India and abroad.
- **Chintz:** A printed cotton fabric, often glazed, that became highly fashionable in Europe. Indian chintz with floral designs and patterns was exported in large quantities.
- **Ikat:** A complex dyeing technique where the yarn is tie - dyed before weaving, resulting in intricate patterns. Ikat fabrics were produced in Gujarat, Orissa, and Andhra Pradesh.
- **Bandhani (Tie - Dye):** A resist dyeing technique in which fabric is tied and then dyed, producing distinctive patterns. This was practiced widely in Rajasthan and Gujarat.

Centers of Textile Production

- Gujarat: Known for producing cotton and silk textiles, especially block - printed fabrics, and was a hub for indigo dye production.
- Bengal: Famous for its muslin and silk fabrics. Dhaka in Bengal was especially known for its fine muslin production.
- Kashmir: Known for its fine woolen textiles, especially pashmina and shahtoosh shawls.
- Madurai (Tamil Nadu): A center for producing dyed cotton fabrics and the famous Madurai cotton sarees.

d) Chemistry of Medicines: In ancient India, the use of chemicals and minerals in medicine was an integral part of the traditional medical system, especially in Ayurveda and Rasashastra. The ancient Indian texts describe a wide variety of substances derived from natural sources like plants, minerals, and metals that were used for their medicinal properties. Some of the key elements related to the use of chemicals in medicine in ancient India are discussed below.

Rasashastra (Alchemy and Chemistry)

Rasashastra is a specialized branch of Ayurveda that deals with the preparation and use of chemicals, minerals, and metals for medicinal purposes. It emerged between the 8th and 12th centuries CE and combined alchemy with Ayurvedic principles.

Rasa (meaning "mercury") is a key component in Rasashastra, and it was believed to have the power to rejuvenate and prolong life. The practice involved purifying metals like mercury, gold, and silver for medicinal use.

Bhasmas (calcined mineral and metallic compounds) were prepared through alchemical processes and used to treat various diseases. For example, Swarnabhasma (gold ash) and Tamrabhasma (copper ash) were used for their therapeutic properties.

Metals and Minerals in Medicine

Ancient Indian physicians used metals like gold, silver, iron, copper, lead, and tin to prepare remedies for different ailments. These metals were purified, detoxified, and processed before being administered.

Mercury was extensively used in the form of purified and processed compounds in Rasashastra. It was believed to have rejuvenating properties and was used in many formulations to treat chronic diseases and promote longevity.

Sulfur and arsenic were also common ingredients, used after careful purification, in treatments for skin diseases and other disorders.

Plant - Based Chemicals

Alkaloids and other chemicals derived from plants were key components of Ayurvedic medicine. Plants like Aconitum ferox (Indian aconite), Cannabis sativa, and Datura were known for their potent medicinal and sometimes toxic properties.

Ashwagandha (*Withania somnifera*) contains compounds like withanolides, which have been shown to have anti-inflammatory, anti-cancer, and neuroprotective effects.

Herbs like Sarpagandha (*Rauwolfia serpentina*), used for treating hypertension, contain reserpine, a chemical that became important in modern medicine for managing blood pressure and psychiatric conditions.

Herbo - Mineral Formulations

Many Ayurvedic preparations involved a combination of herbal and mineral ingredients. These are called Rasaushadhis, which were believed to have potent therapeutic effects, especially for chronic diseases and ailments like diabetes, asthma, and digestive disorders.

An example is Triphala Rasayana, which contains three fruits combined with minerals to enhance health and promote longevity.

Detoxification of Harmful Substances

Ancient Indian practitioners were aware of the potential toxicity of metals and chemicals. They developed sophisticated purification processes, called Shodhana, to detoxify metals and minerals before their use in medicine. These procedures often involved heating, grinding, washing, and combining with herbs to make the substances safe and beneficial.

For instance, mercury was subjected to various purification methods like triturating with herbal juices and exposure to heat, to remove its toxic effects.

3. Conclusion

Ancient India's contributions to chemistry were vast, ranging from practical applications in medicine and metallurgy to theoretical advancements in atomic theory. These developments laid important foundations for both the traditional Indian systems of knowledge and later contributions to global chemistry.

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