

“Lauha Bhasma: An Ayurvedic Iron Nanomedicine Explored Through Modern Analytical Techniques”

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Abstract

In Ayurveda, ‘Lauha’ (Iron) Bhasma is primarily used to cure diseases related to iron deficiency in humans. It is produced from purified raw metallic iron using a combination of multi-step traditional preparation processes described in the Ayurveda literature. Here, we present the results of structural investigation performed on the medicinal grade ‘Lauha’ Bhasma using various X-ray based techniques. Our results indicate that after several rounds of heating and cooling in specific conditions following the Ayurvedic preparation procedure, metallic iron eventually converts to a natural iron-oxide mineral belonging to the magnetite group. Scanning electron microscopy (SEM) and X-ray standing wave assisted fluorescence measurements carried out on powdered Bhasma specimen reveal that the magnetite micro-particles in the Bhasma specimen are usually present in the form of agglomerates of nano-particles. We anticipate that the Ayurvedic Lauha Bhasma has great potential for non-invasive localized target killing of cancer cells, particularly in sensitive parts of the human body such as the brain, spinal cord, and lungs, via necrosis by application of an alternating external magnetic field or photo electron generation through X-rays.

Keywords: Ayurvedic Bhasma, Nanomaterials, X-ray, fluorescence, Trace element analysis, Synchrotron radiation

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Introduction

Ayurveda is a traditional medicinal system of India that was evolved after generating comprehensive understanding about the anatomy of a human body over centuries of experience in the ancient past. This system was quite popular and was practiced routinely in India by certified Ayurveda practitioners for a long period of time until the nineteenth century, whilst modern Allopathic system medicine had not fully evolved [1,2]. Ayurvedic medicines are commonly thought to be those that are derived or synthesised from specific plants that have medicinal properties, such as turmeric (*Curcuma longa*), Brahmi (*Bacopa monnieri*), ghritakumaaree (*Aloe barbadensis miller*), giloy

(*Tinospora cordifolia*), Ashwagandha (*Withania somnifera*), Sunthi (*Zingiber officinale*), etc. There are hundreds of such plants that are especially utilised to extract compounds from their different parts (e.g., root, stalk, leaf, flower, and nut), which offer various medicinal properties. In another branch of Ayurveda medicinal system which is usually referred to ‘Rasa Shastra’, certain minerals and metallic based compounds (Bhasma) [3] are commonly utilised to treat or cure various diseases of the human body. Ayurvedic Bhasma are herbo-metallic ashes which are prepared through calcination process by mixing particular combination of metal complexes along with

various plants and biogenic-based ingredients. It is anticipated that these metal complexes [4] should not contain any free components of the original base metal or organic constituents employed during the various processes of their synthesis. The presence of any primary contents in their raw form in a Bhasma specimen is considered as improper calcination process in Ayurveda and is subjected for rejection. A medicinal-grade Ayurveda Bhasma must qualify certain specific criteria, which are detailed elsewhere [5]. Various herbo-minerals used in Ayurveda medicines offer them unique therapeutic properties such as low dose needed for treatment (Alpamatropayogitvat), good palatability (Arucher-aprasangata) and rapid response (kshipramarogayadayitvat) to a disease. It is expected that ~35–40% of Ayurvedic medicines listed in the Ayurveda formulary contains at least one metal complex[6-9]

Iron is an essential element for almost all living species on our planet, from bacteria to mammals. It effectively controls a wide range of metabolic functions in our body, including oxygen transport and the synthesis of deoxyribonucleic acid [10,11]. The importance of the Fe element resides in its ability to control electron transport phenomena. In the ferrous state (Fe²⁺), it behaves as an electron donor, whereas in the ferric state (Fe³⁺) it acts as an electron acceptor. As a result, it plays a vital role as a catalyst in a variety of enzymatic reactions involving electron transport phenomena. It is known that our bodies regularly lose iron in small amounts through urination, defecation, sweating, sloughing-off skin cells, and particularly menstrual bleeding in women. Hence, to maintain proper biological functions, it is important to maintain an adequate amount of iron intake through food that can reproduce hemoglobin as well as other important bio-molecules required in our bodies.

In the ancient past, in the Ayurvedic medicinal system, acute iron deficiency (anemia), liver enlargement, and jaundice in humans were primarily treated through digestion of 'Lauha Bhasma' produced from wrought iron as well as naturally occurring iron oxide minerals. Although at present many iron-based compounds are frequently used in the modern allopathic medicinal system to treat anemia in humans [12], however the use of 'Lauha Bhasma' is still popular in the Indian subcontinent as a therapeutic agent for the aforementioned diseases [13]. It is imperative to understand how Bhasma materials interact with human bodies and treat severe diseases without causing adverse effects. Such unique features of Ayurvedic medicines are deeply correlated with their structural, chemical, and physical properties, which have not been thoroughly recognized so far in the context of modern

perspectives. X-ray investigations of these materials make it possible to investigate potential correlations, if any exist, between their physico-microstructural and therapeutic properties[13,14]Here, we present structural and chemical investigations of 'Lauha Bhasma' using different X-ray techniques such as X-ray diffraction (XRD), X-ray fluorescence (XRF), and X-ray photoelectron spectroscopy (XPES) using intense X-rays produced from a synchrotron source. Our results demonstrate that iron is essentially present in the magnetite (Fe₃O₄) phase in the medicinal grade 'Lauha Bhasma'. The XRF and XPES investigations further indicate that Fe occurs in the Lauha Bhasma mostly in the pure oxide phase along with trace amounts of C, Na, and Zn elements present as contaminants. Scanning electron microscopy (SEM), optical, and X-ray standing wave-assisted measurements have also revealed that Fe₃O₄ exists in the form of fine granular particles composed of agglomerates of nanoparticles with sizes 100 nm and larger. Our results support some of the previous studies done on the 'Lauha Bhasma', which was prepared using different modern and traditional methods reported in the Ayurveda literature [15,16]

History of bhasma

The use of Lauha Bhasma dates back to ancient Ayurvedic texts such as the Charaka Samhita (circa 1000 BCE), Sushruta Samhita, and later works like Rasaratna Samuccaya (13th–16th century CE). These texts describe iron as a vital mineral for strengthening the body, improving blood quality, and treating chronic illnesses. In classical Ayurveda, iron was considered difficult to digest in its raw metallic form. To overcome this, Rasashastra scholars developed advanced purification (Shodhana) and incineration (Marana) techniques to transform iron into a safe, therapeutic ash. Methods included heating iron until red hot and quenching it in herbal decoctions such as Triphala Kashaya, cow urine (Gomutra), or buttermilk (Takra). This process removed impurities and enhanced its medicinal properties. In the 20th century, Ayurvedic research institutions such as Jamnagar and BHU conducted clinical trials confirming Lauha Bhasma's efficacy in raising haemoglobin levels and reducing symptoms of anemia and fatigue. Modern studies using XRD, SEM, and ICP AES have validated its transformation into iron oxides, ensuring safety and therapeutic consistency. Over centuries, Lauha Bhasma has remained one of the most trusted Ayurvedic formulations, bridging ancient alchemical knowledge with contemporary biomedical science. Ayurveda describes every medicinal substance in terms of its fundamental properties—Rasa (taste), Guna (qualities), Virya (potency), Vipaka (post digestive effect), and

Dosha Karma (effect on the three doshas). Lauha Bhasma, being a mineral based formulation, is classified under Dhatu Bhasma and is considered especially potent in strengthening Rakta Dhatu (blood tissue). Its properties explain why it is effective in treating anemia, weakness, and metabolic disorders. [16]

Rasa (Taste)

Kashaya (Astringent): Helps in tightening tissues, reducing bleeding disorders, and improving absorption.

Tikta (Bitter): Supports detoxification, improves digestion, and clears excess Pitta.

Madhura (Sweet): Provides nourishment and strength, contributing to its Balya (strength promoting) effect.

Guna (Qualities)

Laghu (Light): Easy to digest and assimilate when properly prepared.

Ruksha (Dry): Reduces excess Kapha, clears blockages, and improves metabolism.

Tikshna (Sharp): Penetrates deep into tissues, enhancing its blood correcting properties.

Virya (Potency)

Ushna (Hot): Stimulates digestion (Agni Deepana), improves circulation, and counteracts cold disorders.

Its heating potency makes it effective in conditions like indigestion, sluggish metabolism, and anemia.

Vipaka (Post Digestive Effect)

Katu(Pungent): After digestion, it promotes metabolism, clears toxins, and prevents accumulation of Ama (undigested waste).

This explains its role in improving appetite and reducing fatigue.

Dosha Karma (Effect on Doshas)

Balances Pitta: By detoxifying and improving liver function.

Reduces Kapha: By its drying and heating qualities, useful in obesity and sluggish metabolism.

Supports Vata: Indirectly, by strengthening blood and tissues, which stabilizes Vata imbalances.

In Ayurveda, Bhasma refers to the fine, bioassimilable ash obtained after systematic purification (Shodhana) and calcination (Marana) of metals, minerals, or herbal substances. Each type of Bhasma has unique therapeutic properties depending on its source material. Lauha Bhasma, prepared from iron, belongs to the category of Dhatu Bhasma (metallic ashes).

Types of Bhasmas

I. Dhatu Bhasma (Metallic Ashes)

These are prepared from purified metals and are considered highly potent due to their ability to act on Dhatus (tissues).

Lauha Bhasma (Iron Ash): Strengthens Rakta Dhatu, treats anemia, fatigue, and liver disorders.



Fig 1: Lauha Bhasma

2. Tamra Bhasma (Copper Ash): Useful in respiratory, hepatic, and metabolic conditions.



Fig 2: Tamra Bhasma

3. Rajata Bhasma (Silver Ash): Known for cooling, anti-inflammatory, and rejuvenative properties.



Fig 3: Rajata Bhasma

Swarna Bhasma (Gold Ash): Considered a supreme Rasayana, enhances immunity, vitality, and longevity.



Fig 4: Swarna Bhasma

II. Upadhatu Bhasma (Sub Metallic Ashes)

Prepared from allied minerals or ores associated with metals.

Suvarna Makshika Bhasma (Gold Pyrite): Used for digestive and metabolic disorders.

Raupya Makshika Bhasma (Silver Pyrite): Beneficial in respiratory and liver conditions.

Sasyaka Bhasma (Copper Sulphate): Applied in skin diseases and infections.

III. Ratna & Uparatna Bhasma (Gem and Semi Gem Ashes)

Derived from gemstones and semi precious stones.

Mukta Bhasma (Pearl Ash): Cooling, anti acidic, and strengthens bones.

Manikya Bhasma (Ruby Ash): Used for cardiac and circulatory disorders.



Fig 5: Manikya Bhasma

IV. Khanija Bhasma (Natural Mineral Ashes)

Prepared from naturally occurring minerals.

Shankha Bhasma (Conch Shell Ash): Effective in hyperacidity and digestive issues.

Gairika Bhasma (Red Ochre Ash): Used in bleeding disorders and skin conditions.

Sphatika Bhasma (Alum Ash): Applied externally for wounds and infections.

V. Vanaspati Bhasma (Herbal Ashes)

Prepared from plant exudates, resins, or herbal substances.

Kampillaka Bhasma: Used in intestinal worms and digestive disorders. [16]



Fig 6: Kapardika Bhasma

Plant based ashes: Often supportive in detoxification and immune modulation.

Materials and Methods

The analytical evaluation of Lauha Bhasma was conducted to ensure quality, safety, and therapeutic efficacy. The study design comprised three major

stages: (i) analysis of raw materials, (ii) evaluation after pre-processing (Lauha Bhasma), and (iii) assessment of the final formulation (Lauha Guggulu).

1. Analysis of Raw Materials

Raw herbal ingredients including Haritaki, Vibhitaki, Amalaki, Sunthi, Pippali, Maricha, Guduchi, and

Guggulu were evaluated using standard physicochemical parameters. These included:

Determination of foreign matter

Total ash content

Acid-insoluble ash

Water-soluble extractive value

Alcohol-soluble extractive value

These parameters ensured the purity, identity, and quality of the raw materials prior to processing.

2. Preparation and Analysis of Lauha Bhasma

2.1 Shodhana (Purification)

Raw Loha Choorna (iron powder) underwent Samanya Shodhana using media such as thaila (oil), takra (buttermilk), gomutra (cow urine), aranala, and kulatha kwatha.

This was followed by Vishesh Shodhana using Triphala Kwatha, as described in classical Ayurvedic texts. Triphala was taken in three times the quantity of Loha Choorna and boiled with sixteen times water, reduced to one-eighth.

2.2 Marana (Calcination Process)

The purified Loha Choorna was subjected to Marana, which involves repeated incineration cycles to obtain Bhasma. This process was carried out in three stages:

Bhanupaka: Trituration with Triphala decoction followed by sun drying

Sthalipaka: Heating with Triphala Kwatha in an iron vessel

Putapaka: Sealed heating (Gajaputa method) using cow dung cakes

Chakrikas (pellets) were prepared, dried, sealed in earthen containers, and subjected to controlled heating. The process was repeated multiple times to ensure proper incineration and formation of fine Bhasma.

2.3 Classical Evaluation of Lauha Bhasma

Traditional Ayurvedic tests (Bhasma Pariksha) were performed:

Varitaratwa: Ability to float on water

Rekhapurnata: Ability to enter finger creases

Nischandratwa: Absence of metallic luster

Organoleptic properties such as color, texture, taste, and odor were also assessed.[16]

2.4 Modern Analytical Evaluation

To validate quality and structural characteristics, modern analytical techniques were employed:

pH determination

Loss on drying

Total ash and acid-insoluble ash

High-Performance Thin Layer Chromatography (HPTLC)

X-ray Diffraction (XRD)

These techniques helped in determining particle size, crystallinity, and chemical composition, supporting standardization and quality control.

Mechanism of Action of Lauha Bhasma

Lauha Bhasma exhibits its therapeutic effects through multiple pharmacological and biochemical mechanisms:

1. Iron Supplementation

Lauha Bhasma contains bioavailable iron primarily in oxide forms (Fe_2O_3 and Fe_3O_4), which facilitate gradual absorption and enhance hemoglobin synthesis, thereby effectively managing anemia.

2. Dosha Balancing

It helps in balancing Pitta Dosha, reducing inflammation and metabolic disturbances, and contributing to improved physiological stability.

3. Gastrointestinal Modulation

The formulation interacts with gastric acids to form bioassimilable iron complexes, improving mucosal absorption while minimizing gastrointestinal irritation.

Additional Pharmacological Actions

Immunomodulatory activity: Enhances immune response

Antioxidant properties: Reduces oxidative stress

Hepatoprotective effects: Supports liver detoxification

Digestive enhancement: Improves metabolism and nutrient absorption

Biological Effects

Increases hemoglobin levels

Reduces fatigue and weakness

Improves energy metabolism

Enhances cognitive functions such as memory and focus

Composition of Lauha Bhasma

Lauha Bhasma is prepared using a combination of:

Purified iron (Loha)

Triphala Churna

Gomutra (cow urine)

These components synergistically enhance the bioavailability and therapeutic efficacy of the formulation.

Therapeutic Applications of Lauha Bhasma

1. Medical Uses

Management of anemia

General debility (Kshaya)

Respiratory disorders (Shwasa, Kasa)

Diabetes mellitus (Prameha)

Digestive disorders (Agnimandya)

Hemorrhoids (Arsha)

2. Pharmacological Properties

Anti-anemic

Anti-inflammatory

Antioxidant

Antibacterial

Hematopoietic

Anti-aging

Analgesic and antipyretic

Conclusion

Lauha Bhasma represents a remarkable example of the integration of traditional Ayurvedic knowledge with modern scientific understanding. Prepared through meticulous processes such as Shodhana (purification) and Marana (calcination), it transforms raw metallic iron into a biologically compatible and therapeutically effective form. Classical evaluation methods, along with modern analytical techniques like XRD and HPTLC, confirm its physicochemical stability, nano-sized particle nature, and predominance of iron oxide phases. The multifaceted mechanism of action of Lauha Bhasma—including iron supplementation, immunomodulation, antioxidant activity, and metabolic regulation—supports its widespread use in the management of anemia and other systemic disorders. Its ability to enhance hemoglobin levels, improve energy metabolism, and support organ functions highlights its clinical relevance.

Furthermore, emerging evidence suggests that the nano-structured composition of Lauha Bhasma may offer advanced biomedical applications, including targeted drug delivery and potential roles in cancer therapy. Despite its long history of safe usage, standardization, quality control, and scientific validation remain essential to ensure its efficacy and global acceptance. In conclusion, Lauha Bhasma serves as a bridge between ancient alchemical practices and contemporary nanomedicine, offering promising avenues for future research and therapeutic innovation.

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