



Research Article

PHARMACEUTICO-ANALYTICAL STUDY OF *LOHA BHASMA* PREPARED BY CLASSICAL
AYURVEDIC METHODS

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ABSTRACT

Loha Bhasma is a classical Ayurvedic metallic preparation obtained through a series of pharmaceutical processes including *Shodhana* and *Marana*. Proper execution of these procedures is essential for achieving the desired physicochemical characteristics and classical *Bhasma* qualities. **Objective:** The present study was undertaken to prepare *Loha Bhasma* according to classical Ayurvedic references and to evaluate the pharmaceutical processes and final product using classical *Bhasma Pariksha* and modern analytical techniques. **Materials and Methods:** Raw *Loha* was subjected to *Samanya Shodhana* through repeated *Nirvapa* in *Tila Taila*, *Takra*, *Gomutra*, *Kanji* and *Kulatha Kwatha*, followed by *Vishesha Shodhana* using *Triphala Kwatha*. Purified *Hingula* was used as the *Marana* adjunct and *Ghrithkumari Swarasa* as the *Bhavana* medium. The prepared material was subjected to seven *Putra*. The final *Loha Bhasma* was evaluated for organoleptic characters and classical *Bhasma Pariksha*. Instrumental analysis included particle size analysis, FTIR, XRD and XRF. **Results:** The initial 450gm of purified *Loha* yielded 463.3gm of final *Loha Bhasma*, corresponding to a yield of 102.96%. The final product was a fine, purple-coloured, soft and smooth powder and passed *Rekhapurnatva*, *Varitaratva*, *Nischandratva* and *Unnama Pariksha*. FTIR showed characteristic absorption peaks at 473.4, 551.6, 2374.3, 3570.8, 3652.8, 3712.4 and 3753.4 cm^{-1} . XRD indicated the presence of hematite (Fe_2O_3) as the identified crystalline phase. XRF demonstrated iron as the major element, with Fe content of 67.48%. **Conclusion:** The sequential pharmaceutical processing of *Loha* resulted in a product fulfilling the assessed classical *Bhasma* characteristics and exhibiting an iron-rich oxide phase on instrumental analysis. The study demonstrates the importance of integrating classical pharmaceutical procedures with modern analytical characterization for the standardization of *Loha Bhasma*.

INTRODUCTION

Rasa Shastra is a specialized branch of Ayurveda dealing with the pharmaceutical processing of metals, minerals and other inorganic substances. Classical pharmaceutical procedures such as *Shodhana*, *Bhavana*, *Marana* and *Putra* are employed to transform raw metallic substances into therapeutically suitable preparations^[1].

The systematic application of these processes is considered essential for obtaining a properly processed *Bhasma*.

Loha is an important metallic substance described in classical Ayurvedic literature. Its conversion into *Loha Bhasma* involves sequential pharmaceutical processing designed to modify its physical and chemical characteristics. In the present work, *Loha* was subjected to *Samanya Shodhana*, *Vishesha Shodhana* and subsequent *Marana* using purified *Hingula* and *Ghrithkumari Swarasa*. The pharmaceutical procedure included repeated *Nirvapa* and seven *Putra*, followed by evaluation of the finished product.

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Modern analytical techniques provide additional information regarding the physical, structural and elemental characteristics of *Bhasma*. Therefore, the present study combined classical *Bhasma Pariksha* with particle size analysis, FTIR, XRD and XRF to characterize the prepared *Loha Bhasma*. The analytical study included evaluation at the Drug Testing Laboratory, Dr. Sarvepalli Radhakrishnan Rajasthan Ayurved University, Jodhpur and Jeevanrekha Analytical Services (OPC) Private Limited, Deolai, Aurangabad.

AIM AND OBJECTIVES

1. To prepare *Loha Bhasma* according to classical Ayurvedic references.
2. To document the pharmaceutical changes occurring during *Shodhana* and *Marana*.
3. To assess the prepared *Loha Bhasma* by classical *Bhasma Pariksha*.

4. To characterize the prepared *Loha Bhasma* using particle size analysis, FTIR, XRD and XRF.

MATERIALS AND METHODS

Collection and Authentication of Raw Materials

Three samples of raw *Loha* were procured from different sources. *Hingula* was procured from Shree Ram Herbals, Jaipur, while pharmaceutical media including sesame oil, *Takra*, *Gomutra* and other required materials were procured locally from Jodhpur. Fresh *Kumari* (Aloe vera) was collected from the herbal garden of Dr. SRRAU, Jodhpur. The collected raw materials were authenticated by experts from the postgraduate departments of *Rasa Shastra* and *Bhaishajya Kalpana* and *Dravya Guna*.

Samanya Shodhana of Loha

Preparation of Kanji^[2]

Date of initiation: 11/07/2025

Date of completion: 19/08/2025

Duration: 40 days

Table 1: Ingredients used for preparation of Kanji

S.No.	Ingredient/Material	Quantity
1	Rice grains	600 g
2	Water	8.4 L (14 times)
3	<i>Manda</i> obtained after cooking	7 L

The porcelain jar was washed, sun-dried and fumigated with *Kushta*, *Jatamansi*, *Guggulu* and *Gandhaka*. Rice (600g) was cooked with 8.4L water and the obtained *Manda* (~7L) was transferred into the fumigated jar along with a small quantity of cooked rice. The jar was filled up to two-thirds, sealed with *Kapad-Mitti*, covered with cloth and kept for fermentation. On the 21st day, preliminary observations and tests were performed, after which the jar was resealed. On completion of 40 days, the prepared *Kanji* was assessed for organoleptic and physicochemical parameters.

Table 2: Physicochemical characteristics of Kanji

S.No.	Parameter	Observation
1.	Colour	Transparent
2.	Odour	Strong, pungent
3.	pH	3.0

Preparation of Kulatha Kwatha^[3]

Reference: *Sharngadhara Samhita*, *Madhyama Khanda* 2/1(4) [Ref. 6]

Principle: *Kwatha Kalpana* (decoction)

Date of initiation: 28/08/2025

Date of completion: 04/09/2025

Table 3: Batch-wise quantity of ingredients used for Kulatha Kwatha

Batch	<i>Kulatha</i> Seeds	Water (16 times)	Final Volume (1/8)
I	1.5 kg	24 L	3 L
II	1.5 kg	24 L	3 L
III	500 g	8 L	1 L
Total	3.5 kg	56 L	7 L

Kulatha seeds were cleaned, washed and soaked overnight in the required quantity of water. The soaked seeds were subsequently boiled in an uncovered stainless-steel vessel over moderate heat until the volume was

reduced to approximately one-eighth of the initial quantity. The decoction was filtered through clean cotton cloth and collected for further pharmaceutical processing.

Table 4: Observations and physicochemical characteristics of *Kulatha Kwatha*

S.No.	Parameter	Observation
1.	Total quantity of <i>Kulatha</i> seeds	3.5 kg
2.	Total <i>Kwatha</i> obtained	7 L
3.	Colour	Dark brown
4.	Odour	Significant
5.	pH	6.58

***Nirvapa* (Quenching process) of *Loha*^[4]**

Date of Initiation- 2/07/2025

Date of Completion- 1/09/2025

Samanya Shodhana of *Loha* was performed by repeated heating and quenching (*Nirvapa*) in five liquid media, namely *Tila Taila*, *Takra*, *Gomutra*, *Arnala (Kanji)* and *Kulatha Kwatha*. *Loha* was heated to a red-hot state and immediately quenched in 1 L of freshly prepared medium. The process was repeated seven times in each medium sequentially, using fresh medium for every quenching cycle.

Table 5: Quantity of Materials Used for *Samanya Shodhana*

S.No.	<i>Nirvapa</i> Medium	Quantity per <i>Nirvapa</i>	Total Quantity	Average Time
1	Raw <i>Loha</i>	500 g	500 g	
2	<i>Tila Taila</i>	1000 ml	7 L	28.29min
3	<i>Takra</i>	1000 ml	7 L	23.71 min.
4	<i>Gomutra</i>	1000 ml	7 L	19.43 min.
5	<i>Kanji</i>	1000 ml	7 L	16.00 min.
6	<i>Kulatha Kwatha</i>	1000 ml	7 L	15.00 min.

Table 6: Weight Changes During *Samanya Shodhana*

S.No.	<i>Nirvapa</i> Medium	Weight Before <i>Nirvapa</i> (g)	Weight After <i>Nirvapa</i> (g)	Change in Weight (g)
1	<i>Tila Taila</i>	500.0	505.0	+5.0
2	<i>Takra</i>	505.0	493.0	-12.0
3	<i>Gomutra</i>	493.0	498.2	+5.2
4	<i>Arnala/Kanji</i>	498.2	489.5	-8.7
5	<i>Kulatha Kwatha</i>	489.5	483.8	-5.7
	Overall	500.0	483.8	-16.2

Table 7: Pharmaceutical Observations

Medium	Observations during <i>Shodhana</i>
<i>Tila Taila</i>	<i>Loha</i> changed from metallic grey to dark grey/black; metallic luster decreased; brittleness and porosity increased. Oil changed from light yellow to light brown with increased viscosity. Ignition, pungent odour and dense black fumes were observed during quenching.
<i>Takra</i>	<i>Loha</i> changed from black to reddish-black and partially converted into coarse/fine powder. Boiling and foamy froth were observed, along with phase separation and a burning-milk odour.
<i>Gomutra</i>	<i>Loha</i> changed from reddish-black to light reddish-black and became more brittle, with partial conversion into fine powder. Boiling, hissing and sizzling were observed, accompanied by a strong pungent odour.
<i>Arnala/Kanji</i>	<i>Loha</i> changed from light reddish-black to brown and became brittle with progressive powder formation. Boiling, agglomeration and floating of fine particles were observed. The medium changed from transparent to brownish with a characteristic burning odour.
<i>Kulatha</i>	<i>Loha</i> changed from blackish-brown to deep brown and became finer. Some particles adhered to

<i>Kwatha</i>	the ladle and minor powder loss occurred. The <i>Kwatha</i> changed from brown to reddish-brown, became thicker, and showed boiling with an unpleasant characteristic odour.
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The weight of *Loha* changed from 500gm initially to 483.8gm after completion of *Samanya Shodhana*. During repeated *Nirvapa*, *Loha* gradually became finer and more brittle, resulting in the formation of fine powder. A small quantity of this fine powder was lost due to dispersion during quenching and vapour generation.

Vishesha Shodhana of Loha

Preparation of *Triphala Kwatha*^[5]

Principle: *Kwatha Kalpana*

Date of initiation: 19/09/2025

Date of completion: 27/09/2025

Table 8: Ingredients and quantity used for preparation of *Triphala Kwatha*

S.No.	Ingredient	Quantity
1	<i>Haritaki</i>	Equal proportion
2	<i>Amalaki</i>	Equal proportion
3	<i>Bibhitaka</i>	Equal proportion
4	<i>Triphala</i>	350 g
5	Water	2800 ml
6	Final volume of <i>Kwatha</i>	700 ml

Equal quantities of *Haritaki*, *Amalaki* and *Bibhitaka* were mixed and coarsely powdered (*Yavakuta*). *Triphala* (350g) was soaked overnight in 2800ml water and subsequently boiled over moderate heat until reduced to one-fourth (700ml), requiring approximately 2 h. The decoction was filtered through clean cotton cloth. The procedure was repeated seven times for *Vishesha Shodhana* of *Loha*.

Table 9: Observations of *Triphala Kwatha*

S.No.	Parameter	Observation
1.	Colour	Dark brown
2.	Taste	<i>Kashaya, Amla</i>
3.	Odour	Characteristic
4.	pH	3.47
5.	Approx. time required	2 h
6.	Reduction	2800 ml → 700 ml
7.	Number of repetitions	7

***Nirvapa (Quenching) in Triphala Kwatha*^[6]**

Date of Initiation- 19/09/2025

Date of Completion- 30/09/2025

Materials: *Samanya Shodhita Lauha* – 483.8 g;

Triphala Kwatha – 700 ml for each *Nirvapa*.

Samanya Shodhita Loha (483.8gm) was subjected to *Vishesha Shodhana* by repeated *Nirvapa* in freshly prepared *Triphala Kwatha*, following the procedure described in *Rasa Ratna Samuccaya*. The *Loha* was heated to red-hot condition and quenched seven consecutive times in *Triphala Kwatha*. Changes in weight and pharmaceutical characteristics were recorded after completion of the procedure.

Table 10: Result of *Vishesha Shodhana*

S.No.	<i>Nirvapa</i> Media	Weight Before <i>Vishesha Shodhana</i> (g)	Weight After <i>Vishesha Shodhana</i> (g)	Total Loss (g)	Yield (%)
1	<i>Triphala Kwatha</i>	483.8	455.4	28.4	94.13

Pharmaceutical Observations

During repeated heating, a reddish flame and crackling sound were observed. Fine particles of *Loha* adhered to the ladle and a small quantity was dispersed during quenching. The colour of *Loha* gradually changed

to dark black, while the *Triphala Kwatha* changed from brown to greyish-black. Boiling and occasional overflow of the decoction were observed during quenching. The final weight of *Loha* after *Vishesh Shodhana* was 455.4gm, with an overall yield of 91.08%.

Marana of Loha

Shodhana of Hingula^[7]

Date of starting:10/11/2025

Date of completion:18/11/2025

Materials

- *Ashuddha Hingula* – 402.61 g
- *Nimbu Swarasa* – 200ml
- Fresh lemons required for *Nimbu Swarasa* – 500.16 g

Duration: 9 days for seven *Bhavana* cycles

Ashuddha Hingula was initially triturated in a *Khalva Yantra* to obtain a fine powder. *Nimbu Swarasa* was added gradually and the material was subjected to thorough levigation until the liquid was completely absorbed and the mass became dry. This constituted one *Bhavana*. The process was repeated for a total of seven *Bhavana* cycles. The quantity of *Nimbu Swarasa* required and duration of each *Bhavana* were recorded. After completion of the seventh *Bhavana*, the processed material was subjected to *Prakshalana* (washing) with warm water, followed by drying under sunlight. The dried material was weighed and stored in an airtight glass container.

Table11: Details of Seven Bhavana Cycles of Hingula

Bhavana	Media	Nimbu Swarasa Used (ml)	Time Taken	Endpoint
1 st	<i>Nimbu Swarasa</i>	50	1 h 16 min	Complete absorption
2 nd	<i>Nimbu Swarasa</i>	40	2 h	Complete absorption
3 rd	<i>Nimbu Swarasa</i>	35	1 h	Complete absorption
4 th	<i>Nimbu Swarasa</i>	25	1 h	Complete absorption
5 th	<i>Nimbu Swarasa</i>	20	1 h 14 min	Complete absorption
6 th	<i>Nimbu Swarasa</i>	15	1 h 30 min	Complete absorption
7 th	<i>Nimbu Swarasa</i>	15	2 h	Complete absorption
Total	—	200	10 h	—

RESULTS

Table 12: Weight Variation of Hingula Before and After Shodhana

S.No.	Initial Weight of Hingula (g)	Final Weight of Hingula (g)	Net Weight Gain (g)	Net Weight Gain (%)	Yield (%)
1	402.61	407.61	5.00	1.24	101.24

Pharmaceutical Observations

During processing, the brown crystalline *Hingula* gradually transformed into a reddish powder. *Nimbu Swarasa* was strongly acidic (pH 2.14) and no effervescence or appreciable heat evolution was observed on mixing with *Hingula*. *Hingula* remained insoluble in the levigating medium. With successive *Bhavana* cycles, the material became increasingly adhesive and tended to adhere to the pestle. A progressive reduction in the quantity of *Nimbu Swarasa* required for each *Bhavana* was observed. After drying, the processed *Hingula* exhibited a reddish-orange colour with complete loss of its characteristic crystalline luster.

The increase in weight may be attributed to the incorporation and retention of constituents of *Nimbu Swarasa* during repeated *Bhavana*, along with

adsorption of the levigating medium by the finely powdered material.

Preparation of Kumari Swarasa^[8]

Ingredient: Fresh *Kumari* (*Aloe vera*) leaves.

Fresh *Kumari* leaves were collected during the morning hours and thoroughly washed with water to remove adhering impurities. The leaves were dried and weighed. The thorny margins, apex and outer cuticular layer were removed carefully, and the mucilaginous pulp was separated. The pulp was triturated in a mixer to obtain a homogeneous juice. After settling of the froth, the juice was filtered through a sieve and collected in a clean stainless-steel vessel for further pharmaceutical processing.

Table 13: Organoleptic Characteristics and Yield of Kumari Swarasa

S.No.	Parameter	Observation
1.	Initial quantity of fresh <i>Kumari</i> leaves	3440.92 g
2.	<i>Kumari Swarasa</i> obtained	1980ml
3.	Yield (%)	57.54
4.	Colour	Watery
5.	Taste	Bitter
6.	Odour	Pungent

Marana of Loha^[9]

Starting date of *Putra* preparation- 21/11/2025

Completion date of *Putra* preparation- 4/02/2026

Materials

- *Shuddha Loha* – 1 part
- *Shuddha Hingula* – 1/12 part
- *Ghrithkumari Swarasa* – Quantity sufficient

Marana of *Shuddha Loha* was carried out according to the procedure described in *Rasendra Sara Sangraha*. Purified *Loha* (450gm) was mixed with 1/12th part of purified *Hingula* and triturated with

sufficient quantity of freshly prepared *Kumari Swarasa* to obtain a homogeneous paste. The paste was converted into uniform *Chakrikas*, dried completely, sealed in *Sharava Samputa* using *Kapad-Mitti*, and subjected to seven consecutive *Putra* in a horizontal electric muffle furnace. During each *Putra*, the temperature was maintained at 750°C for 1 hour^[10], followed by self-cooling (*Swangasheeta*). After each cycle, the material was triturated again with *Hingula* and *Kumari Swarasa*, and the same procedure was repeated until completion of seven *Putra*.

Table 14: Pharmaceutical Profile of Seven *Putra* during *Marana of Lauha*

<i>Putra</i>	<i>Shuddha Loha</i> (g)	<i>Shuddha Hingula</i> (g)	<i>Ghrithkumari Swarasa</i> (ml)	<i>Bhavana Time</i>	Dry <i>Chakrika</i> Weight (g)	Time to Reach 750°C	Total <i>Putra</i> Duration	Weight After <i>Putra</i> (g)
1 st	450.00	37.50	200	3h 12 min	495.22	1h	2h	456.75
2 nd	456.75	38.07	200	6h 25 min	508.87	1h 4 min	2h 4 min	452.40
3 rd	452.40	37.75	245	6h 6 min	508.60	1h 10 min	2h 10 min	461.10
4 th	461.10	38.42	245	7h 30 min	503.20	1h 9 min	2h 9 min	462.50
5 th	458.20	38.18	250	8h	501.90	1h 10 min	2h 10 min	461.10
6 th	461.10	38.42	285	9h 48 min	501.40	1h 13 min	2h 13 min	462.00
7 th	462.00	38.50	275	8 h	502.20	1h 16 min	2h 16 min	463.30

Observations during *Marana*

During the first *Putra*, the *Bhavana* mass was brownish and the dried *Chakrikas* were greyish-black. After *Putra*, a light reddish-purple colour was observed and magnetic attraction was evident.

In the second *Putra*, the *Chakrikas* exhibited a purple-black colour with a faint maroon shade. Approximately 60% *Rekhaupurnata* and slight *Varitaratva* were observed.

By the third *Putra*, the material developed a dark purple colour resembling *Pakva Jambuphala*. Complete *Rekhaupurnata* and approximately 40% *Varitaratva* were observed. The material became smooth, and *Chandrika* was observed at a few places. Magnetic attraction was markedly reduced.

During the fourth and fifth *Putra*, *Varitaratva* progressively increased to approximately 50% and 60–70%, respectively. *Chandrika* was observed occasionally, while magnetic attraction persisted mainly in the finer fraction.

After the sixth *Putra*, approximately 80% *Varitaratva* was observed. After the seventh *Putra*, the material exhibited the desired physical characteristics and passed the classical *Bhasma Pariksha*. Complete *Rekhaupurnata*, satisfactory *Varitaratva* and positive *Unnama Pariksha* were observed. The final product was soft, smooth and powdery, resembling face powder, and *Chandrika* was absent.

Results

Table 15: Pharmaceutical Yield of Lauha Bhasma

S.No.	Parameter	Observation
1.	Initial weight of <i>Shuddha Loha</i>	450 g
2.	Final weight of <i>Lauha Bhasma</i>	463.3 g
3.	Total weight gain	13.3 g
4.	Net weight gain (%)	2.96%
5.	Yield (%)	102.96%

Table 16: Overall Pharmaceutical Course of Marana

S.No.	Parameter	Observation
1	Initial purified <i>Loha</i>	450 g
2	<i>Hingula</i> proportion	1/12 part
3	<i>Bhavana</i> medium	<i>Ghritkumari Swarasa</i>
4	Number of <i>Putra</i>	7
5	Final <i>Loha Bhasma</i>	463.3 g
6	Total weight gain	13.3 g
7	Final yield	102.96%

Analytical Evaluation

The analytical studies were carried out at-

- Drug Testing Laboratory, Dr. Sarvepalli Radhakrishnan Rajasthan Ayurved University, Jodhpur
- Jeevanrekha Analytical Services (OPC) Private Limited, Deolai, Aurangabad.

Organoleptic Evaluation

The final *Loha Bhasma* was evaluated for appearance, colour, touch, odour and taste.

Table 17: Organoleptic Characters of Loha Bhasma

S.No.	Parameter	Observation
1	Appearance	Fine powder
2	Colour	Purple (<i>Pakwa Jambuphala Varna</i>)
3	Touch	Soft and smooth
4	Odour	Odourless
5	Taste	Tasteless

Classical Bhasma Pariksha

The prepared *Loha Bhasma* was subjected to *Rekhapurnatva*, *Varitaratva*, *Nischandratva* and *Unnama Pariksha*. All four tests were positive.

Table 18: Classical Bhasma Pariksha Results

S.No.	Test	Result
1	<i>Rekhapurnatva</i>	Positive
2	<i>Varitaratva</i>	Positive
3	<i>Nischandratva</i>	Positive
4	<i>Unnama Pariksha</i>	Positive

Particle Size Analysis

Particle size analysis was carried out using BIOVIS PSA 2000 equipped with digital microscopic imaging and particle analysis software. Multiple fields were examined to obtain representative particle-size and morphological data.

The particle size analysis of the prepared *Loha Bhasma* was carried out using microscopic image analysis to evaluate the fineness and distribution pattern of the particles. The results revealed that a total of 18,834 particles were analysed across five microscopic fields, among which 18,341 were single particles and 493 were agglomerates. This indicates that the majority of the particles existed in a discrete form with minimal aggregation.

For single particles, 10% were below $0.15\mu\text{m}$, 50% were below $0.27\mu\text{m}$, and 90% were below $0.44\mu\text{m}$, demonstrating a predominance of ultrafine particles within the submicron range. In contrast, agglomerates exhibited comparatively larger dimensions, with $d_{10}=0.18\mu\text{m}$, $d_{50}=0.47\mu\text{m}$, and

$d_{90}=0.92\mu\text{m}$, indicating the presence of minor particle clustering resulting from interparticle cohesive forces. Despite this aggregation, the overall particle population remained highly fine and uniformly distributed.

The remarkably small particle size obtained in the present study reflects the effectiveness of the repeated *Shodhana*, *Bhavana*, and *Marana* processes employed during the preparation of *Loha Bhasma*. Reduction of particle size to the submicron level significantly increases the surface area-to-volume ratio, thereby enhancing the interaction of particles with biological fluids and improving their dissolution, absorption, and bioavailability. Such characteristics are considered desirable for *Bhasma* preparations, as they facilitate better assimilation and therapeutic efficacy. The observed particle size distribution therefore supports the pharmaceutical quality and fineness of the prepared *Loha Bhasma*.

Sample name: <i>Loha Bhasma</i>		Sample code: JAS/BSM/SCLB/01	
1.	Field Scanned	05	
2.	Total particle count	18834	
3.	Number of single particles	18341	
4.	Number of agglomerates	493	
Single particle	d 10	10% particles are below 0.15 microns.	
	d 50	50% particles are below 0.27 microns.	
	d 90	90% particles are below 0.44 microns.	
Agglomerate	D10	10% agglomerates are below 0.18 microns.	
	D50	50% agglomerates are below 0.47 microns.	
	D90	90% agglomerates are below 0.92 microns.	

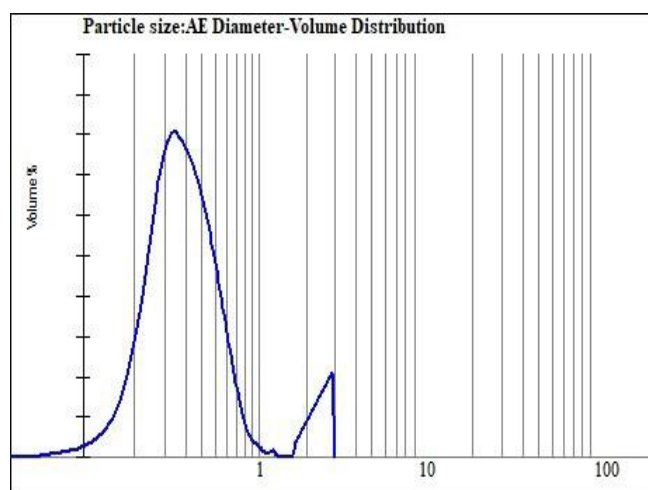


Figure 1

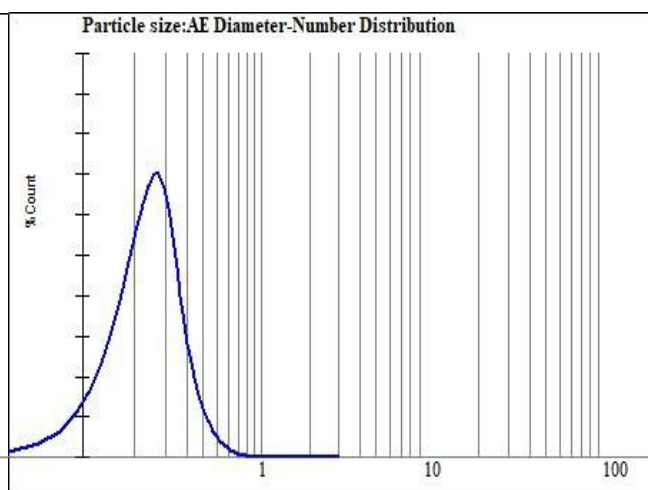


Figure 2

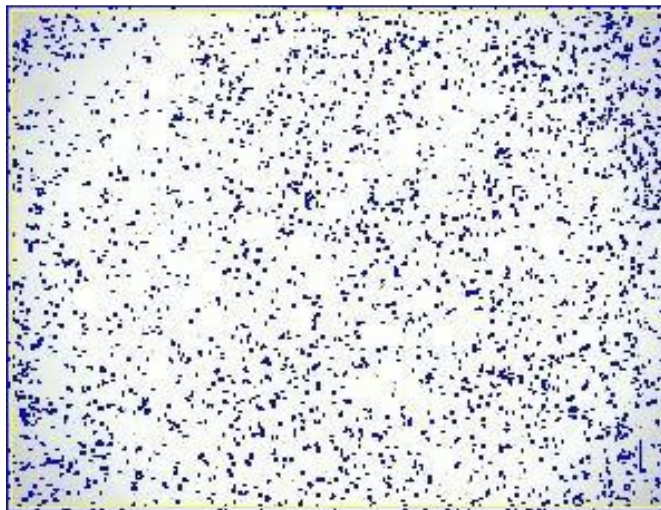


Figure 3



Figure 4

FTIR Analysis

FTIR

FTIR analysis was performed using an Agilent Cary 630 FTIR spectrometer with ATR attachment. The spectrum was recorded from $4000\text{--}400\text{cm}^{-1}$ using 32 scans at 4cm^{-1} resolution.

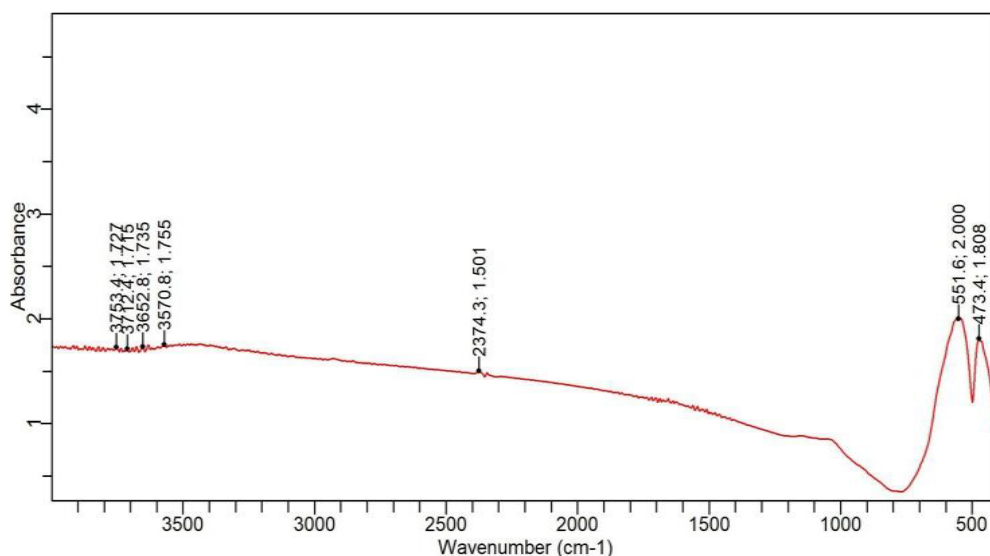
The Fourier Transform Infrared (FTIR) spectroscopy of the prepared *Loha Bhasma* revealed characteristic absorption bands corresponding to iron oxide functional groups and surface hydroxyl moieties. The observed peaks provide evidence of the chemical transformations occurring during the *Shodhana* and *Marana* processes, confirming the successful conversion of metallic iron into stable oxide forms.

- **Bands between $3571\text{--}3753\text{cm}^{-1}$ (O-H Stretching Vibrations)**- The absorption bands observed in the region of $3571\text{--}3753\text{cm}^{-1}$ are attributed to O-H stretching vibrations of surface hydroxyl groups. These hydroxyl groups may arise from moisture adsorption or hydroxylated iron oxide surfaces formed during pharmaceutical processing. The presence of O-H groups indicates the interaction of the mineral matrix with atmospheric moisture and may contribute to the physicochemical stability of the *Bhasma*.
- **Band at 2374cm^{-1} (Atmospheric Carbon Dioxide Absorption)**- A weak absorption band was observed around 2374cm^{-1} , corresponding to atmospheric carbon dioxide. This peak is commonly encountered in FTIR spectra and does not represent a major constituent of the

formulation. Its presence is generally attributed to environmental CO_2 absorbed during spectral acquisition.

- **Band at 552cm^{-1} (Fe-O Stretching Vibration)**- The absorption band around 552cm^{-1} is characteristic of Fe-O stretching vibrations and confirms the presence of iron oxide phases within the formulation. This peak indicates the successful oxidation of metallic iron during the *Marana* process and supports the formation of stable iron oxide compounds in the final *Loha Bhasma*.
- **Band at 474cm^{-1} (Fe-O Bending Vibration)**- The absorption band observed at 474cm^{-1} corresponds to Fe-O bending vibrations, further confirming the existence of iron oxide structures. The presence of both Fe-O stretching and bending vibrations provides strong evidence for the conversion of raw iron into oxide forms, which is a characteristic feature of properly prepared *Loha Bhasma*.

The FTIR findings collectively demonstrate the predominance of iron oxide functional groups in the prepared *Loha Bhasma*. The presence of characteristic Fe-O bands below 600cm^{-1} confirms the successful transformation of metallic iron into stable oxide phases during pharmaceutical processing. These observations are in agreement with the XRD results, which identified Hematite (Fe_2O_3) as the major crystalline phase, thereby validating the quality and successful preparation of the *Loha Bhasma*.

Table 19. FTIR Peaks of Loha Bhasma


Peak No.	Wavenumber (cm ⁻¹)	Intensity
1	473.4	1.808
2	551.6	2.000
3	2374.3	1.501
4	3570.8	1.755
5	3652.8	1.735
6	3712.4	1.715
7	3753.4	1.727

X-Ray Diffraction Analysis

XRD analysis was carried out using an Olympus XRD Terra-II diffractometer. The obtained diffraction pattern was compared with reference data from the ICDD database for phase identification.

The X-ray diffraction (XRD) analysis of the prepared *Loha Bhasma* confirmed the presence of a well-defined crystalline phase, indicating the successful transformation of metallic iron into a stable oxide form during the pharmaceutical processing. The diffraction pattern exhibited characteristic peaks corresponding to Hematite [Iron (III) Oxide, Fe₂O₃], confirming it as the predominant crystalline constituent of the formulation.

1. Hematite [Iron (III) Oxide (Fe₂O₃)] – Trigonal Crystal Structure

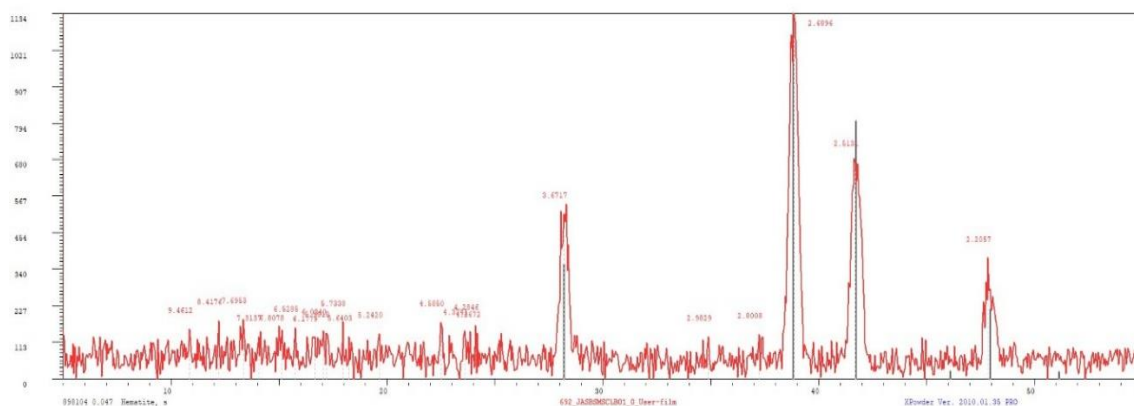
The major diffraction peaks observed at 2θ values of 28.087°, 38.820°, and 41.641° correspond to Hematite (Fe₂O₃), which possesses a trigonal crystal structure. The high-intensity reflections, particularly the peak with an intensity of 86.8%, indicate good crystallinity and confirm Hematite as the dominant phase in the prepared *Loha Bhasma*.

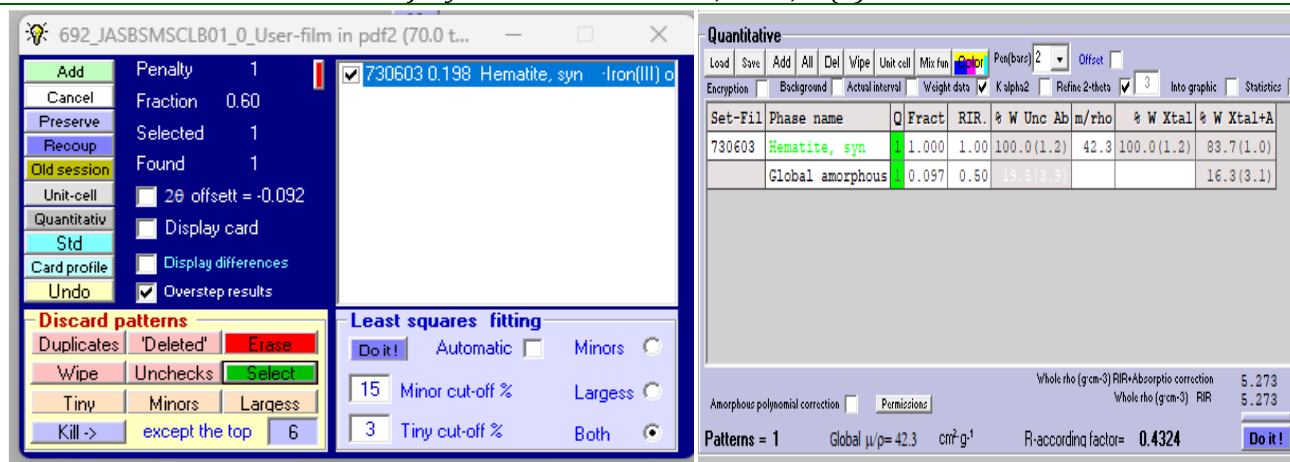
The formation of hematite can be attributed to the repeated *Shodhana*, *Bhavana*, and *Marana* procedures employed during the preparation of *Loha*

Bhasma. During the incineration process, metallic iron undergoes progressive oxidation under controlled heating conditions, resulting in the conversion of elemental iron into stable iron oxide phases. The repeated cycles of trituration and calcination facilitate uniform oxidation and phase transformation, ultimately yielding crystalline Hematite as the final product.

From a pharmaceutical perspective, the presence of hematite is considered a characteristic feature of properly prepared *Loha Bhasma*. The conversion of metallic iron into a stable oxide form reduces its metallic nature and enhances its biocompatibility, making it suitable for therapeutic use. The crystalline Fe₂O₃ phase is reported to possess improved stability and assimilation compared to raw iron, which supports the classical Ayurvedic concept of transforming metals into a biologically acceptable form through *Bhasmikaarana*.

Thus, the XRD findings confirm the successful formation of crystalline hematite (Fe₂O₃) in the prepared *Loha Bhasma*, demonstrating effective phase transformation during pharmaceutical processing and supporting the quality, stability, and standardization of the final formulation.



Table 20: XRD Results of *Loha Bhasma*

Identified Phase	Composition	Crystal System	2θ (°)	d-spacing (Å)	Intensity (%)
Hematite syn ·Iron(III) oxide - \$-alpha ·Iron Oxide	Fe ₂ O ₃	Trigonal	28.087	3.6862	35.6
Hematite syn ·Iron(III) oxide - \$-alpha ·Iron Oxide	Fe ₂ O ₃	Trigonal	38.820	2.6916	86.8
Hematite syn ·Iron(III) oxide - \$-alpha ·Iron Oxide	Fe ₂ O ₃	Trigonal	41.641	2.5165	60.3

X-Ray Fluorescence Analysis

XRF analysis was performed using a Vanta Handheld XRF Analyzer. The analysis demonstrated iron as the principal elemental constituent, with Fe accounting for 67.48%.

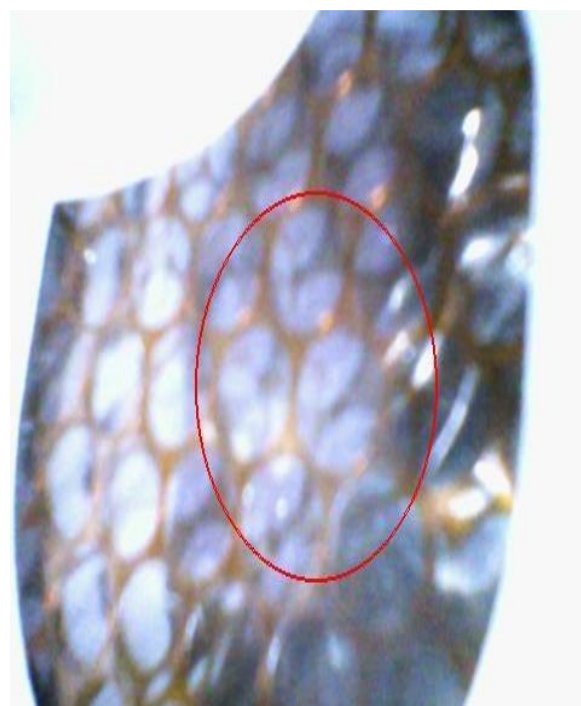
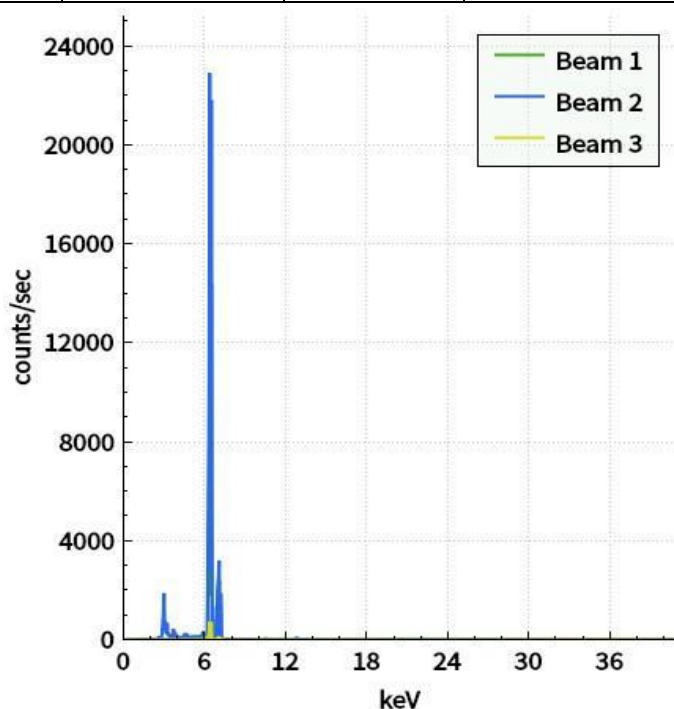
X-ray fluorescence analysis demonstrated that iron was the principal element, with a concentration of 67.48%, confirming the iron-rich elemental composition of the prepared *Loha Bhasma*. Other detected elements included aluminium (1.19%), silicon (5600 ppm), phosphorus (2370 ppm), sulphur (580 ppm), chlorine (980 ppm), calcium (6280 ppm) and manganese (2560 ppm), along with several trace elements. These elements may represent associated inorganic mineral constituents, processing-related residues or matrix-associated components.

The predominance of iron in the XRF profile is consistent with the intended identity of *Loha Bhasma* as an iron-based preparation. The detection of calcium, silicon, aluminium and other mineral elements indicate the presence of additional inorganic constituents in the analysed sample. Trace elements such as chromium, copper, zinc, tin and others were also detected.

Table 21: Major and Relevant Elemental Composition of *Loha Bhasma*

Element	Concentration	±3σ / Limit	Interpretation
Al	1.19 %	0.14	Aluminium- Major aluminosilicate/earthy mineral contribution; indicates associated inorganic mineral matrix or process-derived mineral residue.
Si	5600 ppm	470	Silicon- Silicate/mineral matrix contribution; indicates siliceous or earthy inorganic matter associated with the sample.
P	2370 ppm	150	Phosphorus- Phosphate/phosphorus-containing contribution; may indicate inorganic phosphate, ash, or matrix-associated phosphorus.
S	580 ppm	120	Sulfur- Minor sulfur-containing inorganic/organic contribution; may be associated with sulfate/sulfide/mineral or processing matrix components.
Cl	980 ppm	150	Chlorine- Chloride/salt contribution; indicates presence of chloride-containing salts or inorganic residue.
Ca	6280 ppm	110	Calcium- Notable alkaline earth/mineral contribution; may represent calcium salts, carbonate/phosphate matrix, or mineral

			residue.
Ti	500 ppm	240	Titanium- Trace mineral/soil-derived contribution, commonly associated with earthy or mineral matrix.
Cr	102 ppm	47	Chromium - Trace metallic/mineral signal; monitor as minor process-derived or matrix-associated impurity where specification applies.
Mn	2560 ppm	120	Manganese - Notable trace mineral contribution; may be naturally associated with mineral matrix or processing media.
Fe	67.48 %	0.39	Iron - Principal/major element; indicates iron-rich inorganic matrix consistent with Lauha/iron-based bhasma material.
Cu	162 ppm	35	Copper - Trace metallic/mineral contribution; monitor as associated trace element or process/contact-related impurity.
Zn	94 ppm	28	Zinc - Trace mineral contribution; may be associated with mineral matrix or minor contamination.
Sr	15 ppm	8	Strontium - Trace alkaline earth element; may accompany calcium-rich mineral matrix.



RESULTS AND DISCUSSION

The pharmaceutical preparation demonstrated progressive modification of *Loha* during successive *Shodhana* and *Marana* procedures. During *Samanya Shodhana*, repeated heating and quenching resulted in loss of metallic luster, increased brittleness and progressive conversion of the material into finer particles. The weight changed from 500g to 483.8g after *Samanya Shodhana*. Subsequent *Vishesh Shodhana* with *Triphala Kwatha* further reduced the weight to 455.4g, indicating removal of material during repeated processing.

During *Marana*, repeated *Bhavana* with *Ghrithkumari Swarasa* followed by seven *Putra* progressively altered the physical characteristics of the material. The final product developed a characteristic purple colour, soft and smooth texture and absence of

metallic luster. The final yield was 463.3gm from 450gm of purified *Loha*, representing a 102.96% yield. The increase in weight may be associated with incorporation of material from the processing media and repeated *Bhavana* during *Marana*.

The classical *Bhasma Pariksha* results were positive for *Rekha purnatva*, *Varitaratva*, *Nischandratva* and *Unnama*. These findings indicate adequate fineness, lightness and absence of metallic luster of the prepared product.

The analytical findings collectively provide physicochemical, morphological, spectroscopic, elemental, crystalline and chromatographic characteristics of the prepared formulation. The physicochemical evaluation demonstrated measurable extractive and ash values, while particle size analysis

confirmed the finely divided nature of the preparation, with a D50 of 0.27µm for single particles. FTIR demonstrated characteristic Fe–O vibrations, XRF confirmed iron as the major elemental constituent (67.48%), and XRD identified hematite (Fe₂O₃) as the principal reported crystalline phase. These findings collectively support the transformation of iron into an iron-oxide-containing *Bhasma* during pharmaceutical processing. Overall, the combined analytical profile establishes characteristic quality-control parameters for the prepared *Loha Bhasma*-containing formulation.

CONCLUSION

The present study demonstrated that *Loha Bhasma* could be prepared through a systematic sequence of classical pharmaceutical procedures involving *Samanya Shodhana*, *Vishesha Shodhana* and seven *Putra*. The final product exhibited the characteristic purple colour, fine and smooth texture and positive results for the assessed classical *Bhasma Pariksha*. Instrumental characterization demonstrated a characteristic FTIR profile, hematite (Fe₂O₃) as the identified crystalline phase by XRD and iron as the major elemental constituent by XRF. The combined pharmaceutical, classical and instrumental evaluation provides a systematic basis for characterization and standardization of the prepared *Loha Bhasma*.

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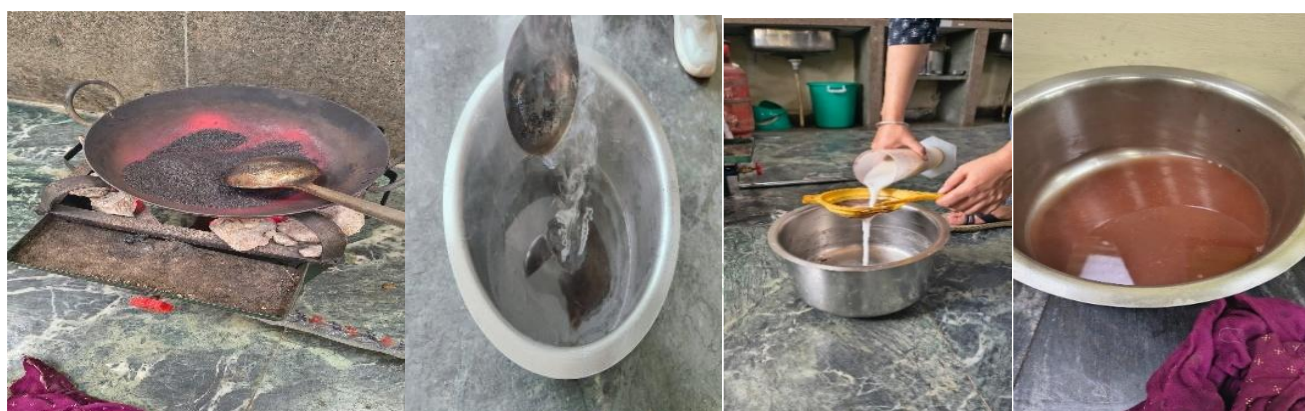
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3 Type Loha sample, Hingula, Magnet Loha powder select for Shodhana



Heating and quenching (Nirvapa) in five liquid media, Tila Taila, Takra, Gomutra, Kanji and Kulatha Kwatha. Loha image after Samanya Shodhana



Triphala Kwatha, Loha image after Vishesh Shodhana



Hingula shodhana



Suddha Loha Marana process



After 1st Puta



After 3rd Puta



After 7th Puta



Bhasma pariksha Rekhapurnatva, Varitaratva, Nischandratva, Unnama Pariksha Magnetic property reduce

