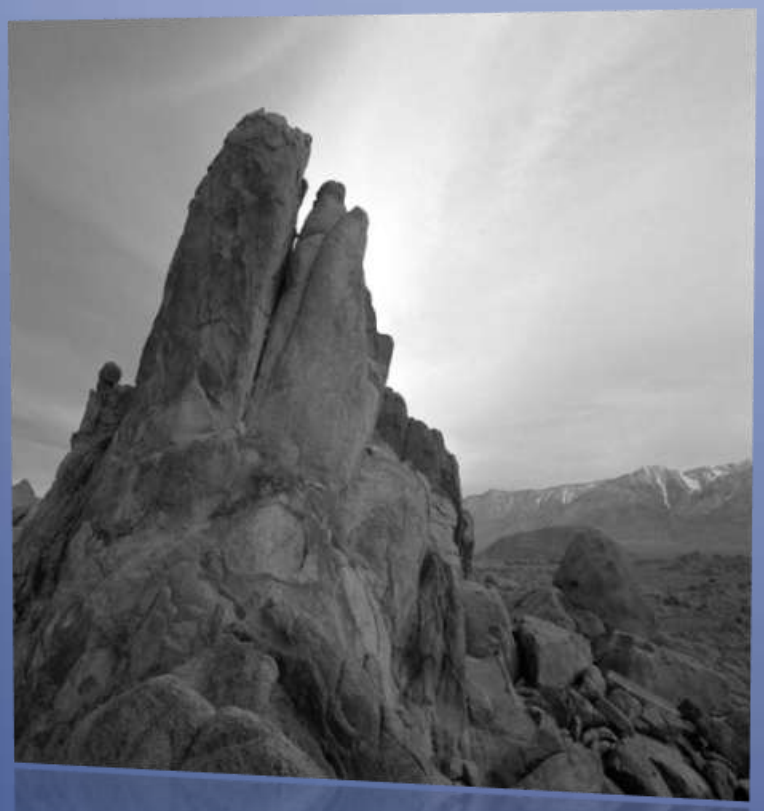

International Journal of Ayurveda and Pharmaceutical Chemistry

Volume 7 Issue 2 2017

www.ijapc.com

Int J Ayu Pharm Chem

RESEARCH ARTICLE

www.ijapc.com

e-ISSN 2350-0204

Characterization of *Bhasmas* of Cast and Wrought Iron

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ABSTRACT

Bhasmeekarana of metals and minerals is a unique technique in *Rasashastra.* In order to obtain a safe and effective Bhasma, a good quality raw material and specific preparation procedure plays a vital role. Standard operative procedure with respect to procedure of *Bhasmeekarana* of *Lauha* is already set, but a standard to select raw material (Iron) is not yet established.

Discarded Iron is usually selected to prepare *Lauha bhasma* but its details like chemical composition; percentage of other impurities etc is unknown. Hence a study was taken up to clear this obscurity and ensure a desired quality of *Lauha bhasma* by selecting two types of Iron with definite composition viz., Cast iron identical to *Munda lauha* and Wrought iron identical to *Teekshna lauha.* They were subjected to *Bhasmeekarana*as per the reference of *Rasendra saara sangraha* and physico-chemical analysis and instrumental validations like XRD, FTIR, SEM-EDAX were then carried out. Both the *Bhasmas* obtained were appraised based on pharmaceutical and analytical grounds. *Munda lauha* attained Bhasma siddhi lakshanas faster than *Teekshna lauha* but the latter was found to be of superior quality by inferring the results of analytical study.

KEYWORDS

Bhasmeekarana, Mundalauha, Teekshnalauha, Cast iron, Wrought iron

Greentree Group

Received 16/08/17 Accepted 03/09/17 Published 10/09/17

INTRODUCTION

Rasashastra is an appendage of Ayurveda. It mainly deals with therapeutic utilization of metals and minerals. It was only in the medieval period that these metals and minerals were used in the incinerated form known as *BHASMA* for therapeutic purpose. This dosage form revolutionized Ayurvedic treatment as it possesses best qualities of a medicine like low dosage and quick action[1].

Among all metals, *Lauha* (Iron) is an essential bio elementfor most forms of life. Hence *Acharya Vagbhata* considers Lauha kalpa to be superior than other *Kalpanas*[1].

सम्यगौषधकल्पानां लोहकल्पः प्रशस्यते ।

तस्मात्सर्वप्रयत्नेन शुद्धं लोहं हि मारयेत् ॥

Among the three types of *Lauhas* mentioned in our *Rasa* texts, *Kanta Lauha* is said to be the best but is not freely available. The next best Iron recommended by our *Acharyas* is *Teekshna Lauha.* It is compared to Wrought Iron which is the most pure form of Iron available now with least percentage of Carbon and other impurities. *Munda lauha* is considered as inferior for therapeutic purpose. It is compared to Cast Iron which contains higher percentage of Carbon and other impurities.

In the present study, an attempt has been made to prepare *Lauha bhasma*(As per *Rasendra Saara Sangraha*)[2] from two types of Iron having different composition viz, Cast Iron and Wrought Iron to discern the coherence of superiority and inferiority of the same based on pharmaceutical and analytical validation.

AIMS AND OBJECTIVES

- To prepare Lauha bhasma from Cast and Wrought Iron as per *Rasendra saara sangraha*.
- To carry out analytical tests for the above mentioned samples.

MATERIALS AND METHODS

Materials

1. Cast Iron was procured from Micromatic Technology Ltd, Somapura Village, Nelamangala Taluk, Bengaluru. (Figure no – 1)

Figure 1 Raw Cast Iron

2. Wrought Iron was procured from Jindal Vijayanagar Steel Ltd, Bellary. The

composition of both types of Iron is depicted

Figure 2 Raw Wrought Iron

Note - The composition of both is mentioned in Table no – 1

Table 1 Composition of Cast iron and Wrought iron

COMPOSITION	CAST IRON (% by wt)	WROUGHT IRON (% by wt)
Iron	93.938	98.936
Carbon	3.19	0.1
Silicon	1.83	0.02
Manganese	0.74	0.9
Sulphur	0.066	0.011
Phosphorous	0.071	0.013
Chromium	0.165	0.02

Methods

The steps followed to procure the *Bhasma* of Cast and Wrought Iron is as follows -

i. **Samanya shodhana**[2] – The thin spiral filings of Cast and Wrought iron were heated to red hot and dipped in *Tila taila, Takra, Gomutra, Kanji* and *Kulatha kwatha* media for seven times in each media (*Nirvapa*).*(Figure no – 3)*

ii. **Visheshashodhana**[2] – *Samanya shodhita* Cast and Wrought iron was once again subjected to *Nirvapakriya* in *Triphala kwatha* media for seven times.*(Figure no – 3)*

iii. **Bhanupaka**[2] – For this two kgs of *Triphala kwatha churna* was boiled in four litres (double quantity) of water on medium flame to reduce it to one litre and then filtered. The *Vishesha Shodhita* Cast iron and Wrought Iron were separately immersed in thus prepared *Triphala kashaya* separately and kept in sunlight till all the water content evaporated. This process of immersing and exposing to sunlight was repeated thrice with intermittent stirring.

Figure 3 Heating of Iron

iv. **Sthalipaka**[2] –900g (thrice the quantity) of *Triphala kwatha churna* was boiled in 14.4 litres (16 times) of water on medium flame till it reduced to 1.8 litres. *Bhanupakita* Cast Iron and Wrought Iron were separately immersed in 1.8 litres of *Triphala kashaya* and heated in medium flame till all the water content evaporated.

v. **Putapaka**[2] – The *Sthalipakita* Cast and Wrought Iron samples were separately ground with *Triphala kashaya* for four hours *(Bhavana)* and *Chakrikas* were made and

kept for drying. *Samputeekarana* of these dried *Chakrikas* were done and kept in the hearth of woodfire till it reached its optimum temperature. Upto 6thPuta, a peak temperature of 750^{0}C was given and for further *Putas*, it was reduced to 650^{0}C. It was then transferred to the chamber below the hearth containing the collection of red hot Charcoal from the burnt woodfire and allowed for self cooling. Later, the *Samputeekarana*was unsealed, pellets were collected and powdered. This procedure was carried out separately but simultaneously for both Cast Iron and Wrought Iron for 18 and 20 times respectively *(Figure no – 4and 5)*

Figure 4 Putapaka

Figure 5 Putapaka

OBSERVATIONS AND RESULTS

Bhasma of Cast Iron and Wrought Iron was prepared simultaneously by following the same procedure.During the process of *Bhasmeekarana*, all the physical characteristics of the materials were observed and noted down.

Pharmaceutical observation – Significant observations of the procedure are depicted in Table no- 2 & 3.

PARTICULARS	Average temperature required to heat Iron to red hot	Change in weight after the process	Weight gain / loss
Samanyashodhana of Cast Iron	852^{0}C	300g to 275g	25g loss
Visheshashodhana of Cast Iron	858^{0}C	275g to 285g	10g gain
Samanyashodhana of Wrought Iron	865^{0C}	300g to 325g	25g gain
Visheshashodhana of Wrought Iron	862^{0}C	325g to 375g	50g gain

Table 3 Results of Bhanupaka and Sthalipaka

TYPE OF PROCESS	CAST IRON			WROUGHT IRON		
	Total weight		Weight gain	Total weight		Weight gain
	Before	After		Before	After	

BHANUPAKA	285g	575g	290g	375g	600g	225g
STHALIPAKA	575g	800g	225g	600g	825g	225g

Classical analytical parameters –The detailed result of organoleptic and other testes are mentioned in table no – 4.

Table 4 Results of classical analytical parameters

PARAMETERS	MUNDA LAUHA BHASMA	TEEKSHNA LAUHA BHASMA
Colour	Reddish brown	Dark brown with a tinge of red colour
Luster	Lustreless from Bhanupaka	Lustreless from Bhanupaka
Taste	Tasteless from 4thPuta	Tasteless from 4thPuta
Odour	Odourless from 1stPuta	Odourless from 1stPuta
Appearance	Smooth & soft from 3rdPuta	Smooth & soft from 5thPuta
Rekhapurnata	Positive	Positive
Varitara	80%	80%
Unnama	Positive	Positive
Apunarbhava	Positive	Positive
Nirutha	Positive	Positive

Table 5 Results of physico-chemical parameters

PARAMETERS	CAST IRON BHASMA	WROUGHT IRON BHASMA
Ph	12	12
Total ash	98.51%	99.53%
Acid insoluble ash	2.66%	1.28%
Loss on drying	0.85%	0.39%
Loss on ignition	3.23%	1.47%
Iron assay	58.34%	65.07%

Physico-chemical parameters –The values of these parameters are outlined in table no – 5.

Instrumental parameters – The details of XRD, SEM-EDAX, FTIR are portrayed in table no – 6,7,8,9 and 10 and the graphs are depicted in Figure 7, 8, 9, 10, 11and 12.

Figure 6 Final Product of Bhasma of Cast And Wrought Iron

DISCUSSION

Discussion on pharmaceutical study

In pharmaceutics, the process of preparation plays a vital role in deciding the therapeutic

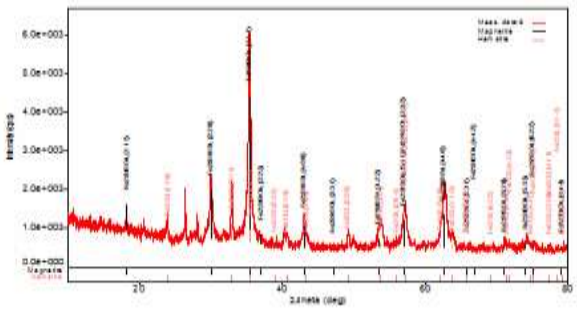

Figure 7 XRD of Bhasma of Cast Iron

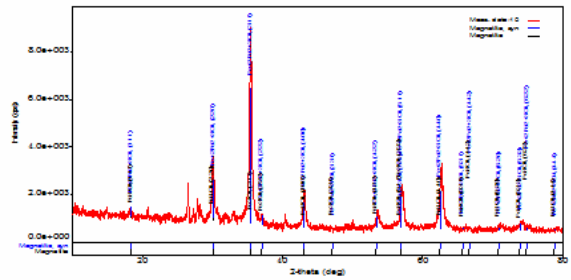

Figure 8 XRD of Bhasma of Wrought Iron

efficacy of the drug. The prime step to prepare an optimum, efficacious *Lauha bhasma* is to select a good quality Iron for incineration. Hence in this study, genuine Cast iron and Wrought iron with a definite

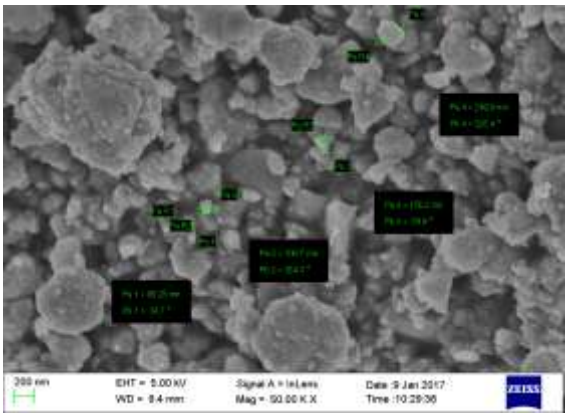

Figure 8 Sem of Bhasma of Wrought Iron

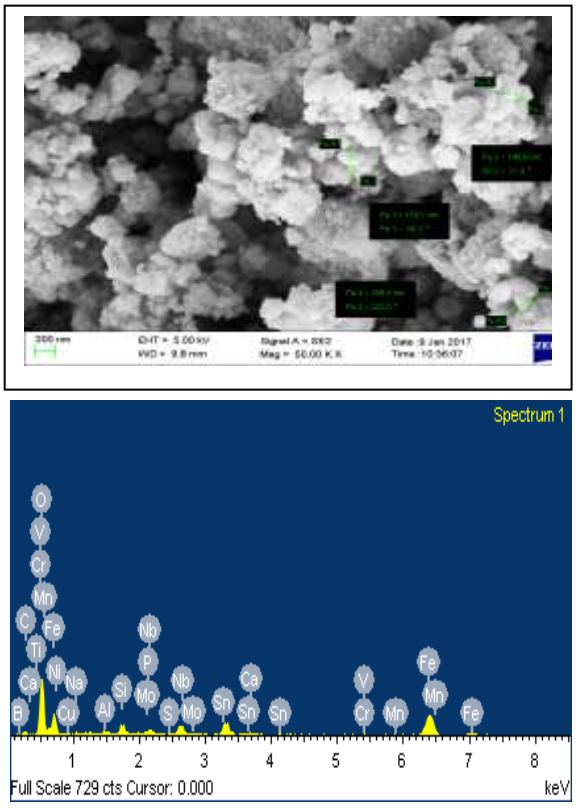

Figure 9 Sem of Bhasma of Cast Iron and EDAX Of Bhasma of Cast Iron

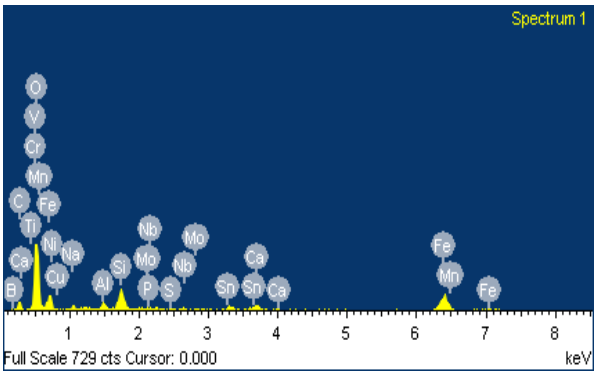

Figure 10 Edax of Bhasma of Wrought Iron

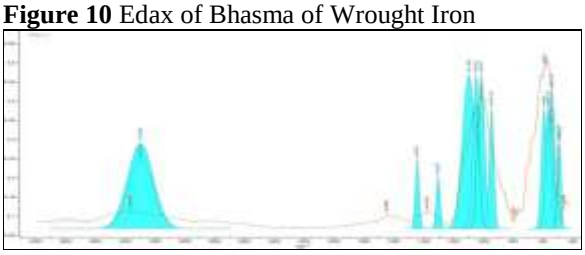

Figure 11 FTIR of Bhasma of Cast Iron

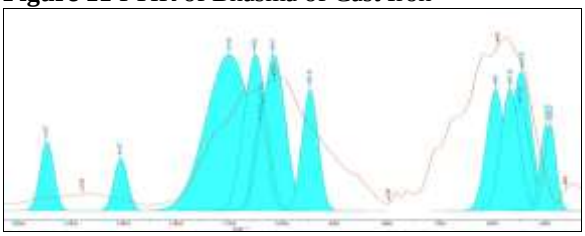

Figure 12 FTIR of Bhasma of Wrought Iron

composition was procured from authenticated source to prepare *Bhasmas*.

The first method adopted for *Bhasmeekarna* of both the samples of *Lauha* was *Nirvapa* method. In this process, when Iron was heated to a temperature above 727^0C (Eutectoid temperature), the crystal structure from Ferrite might have changed to Austentite which is basically ɤ-Fe phase Iron. When quenching was done immediately, the metal might have experienced a large lattice distortion and transferred into Martensite. This Martensite is needle-like in structure which causes the

Iron to become brittle[3]. This method was adopted in *Taila, Takra* etc which initiated the formation of various Iron complexes and eradication of unwanted soluble substances[4]. As per the observation of this study, there was weight loss in Cast Iron after *Samanya shodhana* due to elimination of impurities present in large quantity compared to Wrought iron and also due to removal of water soluble impurities and chelated Iron complexes. But weight gain was observed in Wrought Iron due to addition of contents of quenching media. Weight gain was observed in both types of Iron after *Vishesha shodhana* owing to the incorporation of organic matter of *Triphala kwatha* which is proved in EDAX report (table no – 9) with an increase in Carbon content.

The next method adopted was *Bhanupaka* where the ratio of drug and water to prepare *Triphala kwatha* was 1:2, reduced to 1/4th.[2]The rationale behind this might be to increase the concentrations of the phyto constituents of *Triphala* available to react with Iron. It is proved that Tannic acid which is one of the constituent of *Triphala,* in the concentration of 500 ppm viz, 500 mg per litre can reduce all the Iron into Ferrous form at pH of more than 4[5].The quantity of *Triphala qwatha churna* taken for *Sthalipaka* was three fold to that of Iron. The rationale behind this might be to increase the amount of organic matter for interaction with Iron.

During repeated treatment of *Triphala kashaya* under sunlight in *Bhanupaka* and on flame in *Sthalipaka,* there is slow reaction of formation of co-ordinate compounds between metal and the organic constituents. This reaction proceeds slowly from the outer surface towards the central region under prolonged exposure to UV radiation in *Bhanupaka* and by the process of heating in *Sthalipaka*[6].It leaches out desired soluble form of Iron separating it from the insoluble impurity which gets evaporated during the process.

In the present study, there was considerable weight gain in both Cast and Wrought iron at this stage due to inclusion of solid matter and Carbon content from *Triphala kwatha.* It had not merely adhered to the surface of *Lauha* but had formed a bond with the internal structure of Ferrum. This is validated by EDAX report (Table no – 9). Both the type of Iron had turned jet black due to high Carbon content and *Krishneekarana* property of *Vibheetaki*[7]. Further in *Putapaka, Bhavana*was given in grinder for four hours for each *Puta.*

Table 9 Results of EDAX report

ELEMENTS	CAST IRON BHASMA		WROUGHT IRON BHASMA	
	Wt%	At%	Wt%	Wt%
C	7.28	15.18	12.77	21.72
O	36.27	56.80	46.38	59.22
Na	1.15	1.25	1.87	1.57
Al	0.67	0.62	1.81	1.37
Si	2.93	2.62	5.83	4.24
Ca	1.87	1.17	2.58	1.32
Fe	49.84	22.36	58.86	10.56

Table 10 Results of FTIR report

FUNCTIONAL GROUP	CAST IRON BHASMA	WROUGHT IRON BHASMA
Alkane [-C-H]	+	+
Nitro [N-O]	+	
Ester [C-O]	+	
Aromatic [-C-H]	+	+
Amine [C=C]	+	+
Alcohol [C-N]		+
Amide		+
Alkene		+

Further in *Putapaka*, *Bhavana*was given in grinder for four hours for each *Puta.* During this procedure, few trace elements like Na, Al etc were induced which is proved by the EDAX report (Table no – 9) in the final *Bhasma.* The speciality of *Marana* of *Lauha* mentioned in *Rasendra saara sangraha* is the use of *Triphala kwatha* throughout the procedure. This has the following advantages-

1. It acts as *Rechaka* and thus avoids constipation which is an adverse effect of Iron intake[8].
2. *Lauha bhasma* contains both Ferrous and Ferric form of Iron. Iron is absorbed only in Ferrous (Fe^{2+}) form intestinally. The constituents of *Triphala* like Ascorbic acid, chebulagic acid, ellagic acid etc acts as chelating agents by forming exogenous and endogeneous ligands with Ferric form of *Lauha bhasma*. They form complexes which allow them to remain soluble at neutral to alkalinepHof the intestinal fluid (Iron chelation hypothesis by Saltman)

Woodfire and charcoal were used as a fuel for *Bhasmeekarana* due to non-availability of cowdung cakes. *Sidha yoga sangraha, Rasa Jala Nidhi* and few others have mentioned the usage of the same as a source of fuel to prepare *Bhasma.* The advantages are as follow-

1. It is a cost effective method
2. It is difficult to procure cowdung cakes in this era.
3. The temperature can be well regulated by the addition or removal of logs of wood.

4. High temperature required for *Gajaputa,* especially for *Lauha bhasma* can be attained easily and quickly.

5. The red hot charcoal collected below the wood fire hearth maintained the temperature and allowed for slow cooling of *Sharava samputa.*

Thus, it can be adopted as an alternative fuel source.

Swangasheeta, a crucial step in *Bhasmeekarana* is called annealing in metallurgy. During this procedure, the atoms in compound form migrate in the crystal lattice and the number of dislocations of atoms decreases leading to reduction in hardness[3] and brings about *Shlakshnata.*

In this study, Wrought iron (*Teekshnalauha)* has taken more number of *putas* for its conversion into a *Bhasma* which might be due to its high percentage of Fe compared to Cast iron (*Mundalaauha).*

Discussion on analytical study

Colour – In our classics, different colours have been mentioned for different *Bhasms.* The colour depends on the parent drug, drugs used for processing, method of preparation, oxidation of the drug, wavelength of the absorbed light and the particle size of the *Bhasma.* In this study, the colour of Cast iron *Bhasma* was reddish brown in colour due to the presence of both hematite and magnetite. Hematite by nature is red in colour and magnetite is brownish black. Thus a combination of both produced reddish brown coloured *Bhasma.* The colour of Wrought iron *Bhasma* was dark brown with a tinge of red due to the presence of mainly Magnetite. Magnetite by nature is brownish black in colour.

Luster- Metals are shiny as they contain free electrons that vibrate when they come in contact with light. When the electrons vibrate, they produce their own light. This is reflected back and makes the metal lustrous. When a metal does not shine, it indicates the presence of bond and absence of electrons[3].Both*Lauhas* turned lusterless after *Bhanupaka* process as it underwent vigorous oxidation by *Triphala* and UV radiations resulting in conversion of Ferrum to its different oxide forms. Thus it lost its luster.

Varitara – Iron as a general rule should sink in water owing to its high density. But during *Maarana* of *Lauha,* it gets converted to their different oxide forms and the percentage of Fe also decreases. Thus it acquires the capacity to displace more water thereby increasing the buoyancy. The particle size also gets reduced to nano-particles and hence it cannot break the surface tension of water. Due to the above reasons, *Lauha bhasma* passed the test.

Apunarbhava– This was carried out to check the stability of the Bhasma. *Mitrapanchaka* acts as a reducing agent and a flux. Flux is a substance which is nearly inert at room temperature but which becomes strongly reducing at elevated temperatures[3].*Mitrapanchaka*consists of both organic and inorganic fluxes. They perform dual functions[3]–

1. They act as activators by exposing the unoxidised metal.
2. They act as oxygen barrier by preventing oxidation.

If the *Bhasma* is unstable, the metallic oxide formed can get reduced back to its metallic state on the temperature in which it was produced. In this study, no shiny particles were observed after the process indicating that both the *Bhasmas* were stable.

Niruttha–This was carried out to check the stability of *Bhasma*. Silver was used for the test asit is an electro positive metal. An electro positive metal can accommodate any free metal into it. As ion/ electron donation takes place from the free metal, the silver gains weight. During the test with *Lauha bhasmas*, silver did not gain weight indicating that the *Bhasmas* formed were stable in nature.

Instrumental Studies– As per the XRD report (Table no – 6 and 7), Cast iron *Bhasma* contained both Fe_2O_3 (Ferric form) and Fe_3O_4 (Ferrous and Ferric form) whereas in Wrought iron *Bhasma*, only Fe_3O_4 (Ferrous and Ferric form) was present. Iron gets absorbed in the body in ferrous form. Thus Wrought iron *Bhasma* might get better absorbed in the body than Cast iron *Bhasma*.

As per SEM report (Table no – 8), the particle size of Wrought iron *Bhasma* (148.02 nm) is smaller than Cast iron *Bhasma* (160.33 nm).

A per FTIR report (Table no – 10), it contains various functional groups, among which Tropolone is a good ligand precursor with metal cations that undergoes deprotanation to give chelate complexes[3].There was also presence of Napthoquinone, a phenolic compound, a product of secondary metabolism of higher plants which possess some specific pharmacological properties[3].

CONCLUSION

From the present study, it can be concluded that, pharmaceutically Cast iron could be made into *Bhasma* faster. But the analytical report showed desirable results in Wrought iron *Bhasma* and from instrumental analytical report, one can infer that the pharmacokinetics in terms of absorption of

Wrought iron *Bhasma* might be more effective. Hence, Wrought iron (Teekshna *lauha*) is an ideal raw material to prepare a standard and quality *Lauha bhasma.*

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