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RESEARCH ARTICLE

^{57}FE MÖSSBAUER SPECTROSCOPY REVEALS PRESENCE OF TOXIC IRON PHASES IN TRADITIONAL IRON RICH MEDICINES

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ABSTRACT

Chemical phases of iron in large number of the Ayurvedic bhasma are investigated through Mössbauer Spectroscopy. Iron is found in oxide form as Fe_2O_3 or Fe_3O_4 or both in all the bhasma studied here irrespective of their nature their mode of preparation. The size distribution of iron particles is different for different bhasma. It is known that iron oxide is toxic to human body and it is also not easily absorbed in it. Mössbauer studies point to iron oxide being present in these bhasma and thus not safe for human consumption.

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INTRODUCTION

Iron is so important that without it all life would cease to exist. Every living thing: plants, animals, human beings, bacteria (good and bad) and yes, even cancer cells all need iron to survive and grow. Animals and humans need iron mainly to make hemoglobin, which delivers oxygen to the cells of body for production of energy. Iron is also needed to make myoglobin in muscles and there are many enzymetic reactions in body (Tripathi *et al*., 1975). Humans can get iron from their food. Due to poor dietary habits, increase in demand (as in pregnancy) or due to some diseases the person may suffer from iron deficiency called iron deficiency anemia. Due to anemia sufficient oxygen delivery to body cells is hampered causing many type of patho-physiological problems in the body. One of the major causes of mortality and morbidity is iron deficiency anemia. So replenishment of iron in order to correct anemia is mandatory. For this purpose different 'system of medicines' recommends different types of drugs in order to improve hemoglobin and ferritin. The commonly used allopathic medicines for treatment of iron deficiency anemia consist of various salts of iron like ferrous sulfates, ferrous fumerate, or ferrous gluconate etc. given in the form of tablets/syrup/injection. The alternative system of medicines 'AYUSH' i.e. Ayurveda, Yoga & Naturopathy, Unani, Siddha and Homoeopathy are also using various iron bearing medicines for the same purpose. Since these medicines are frequently utilized and are impacting more than 60% of the population, it becomes very important to study the various aspects of these hematinic medicines especially those given in Indian system of medicines for which very little scientific information is available on the nature of iron present in them. Ayurveda is another system of medicine, originated in India several thousand years ago and is gaining worldwide attention due to its supposedly much less side effects. For detail one can refer ancient books like CharakSamhita-Sutra Sthana and SushrutaSamhita-SharirSthana (CharakSamhita and Sutra Sthana, (Ancient book, written by Charak Second century A.D. SushrutaSamhita and SharirSthana, (Ancient book, written by Sushruta Sixth century BC)).

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In Ayurveda, iron and other metals are given in the form of *bhasma* (substance obtained by calcinations) prepared by heating raw material at high temperatures under predefined conditions. *Bhasma* are basically calcined preparation in which the gem or metal is converted into ash. Preparation of *Bhasma*, is an elaborate process involving *Sodhana (purification), marana (detoxification)* and *bhasmikaran* (process by which substance which are otherwise bio-incompatible are made bio-compatible). Metals are first purified through a process called *sodhana*, during which the metal is repeatedly heated and cooled in herbal extracts which forms the matrix in which the metal is dispersed. *Marana* involves grinding of the material with appropriate herbal juice for extended periods, may be several weeks. This possibly reduces the particle size, increasing the surface area for quick chemical reactions. This is followed by *bhasmikaran* where the product of *shodhana/marana* is repeatedly triturated with herbs *(bhavana*) and calcined in closed earthen crucibles in a pit, to obtain *bhasma*. This process is repeated as many times as prescribed in the classical texts for each preparation. Hence we have *dasa puta* (10 cycles), *satha puta* (100 cycles), *sahastra puta* (1000 cycles), etc.

Though *bhasma* preparations are widely used in Ayurveda, practically there is no information available about the chemical state of iron in which iron is present in various *bhasmas*. The aim of present is study is to ascertain if compounds present in iron rich Ayurvedic *bhasma's* are safe or not for human consumption. This information is needed because large number of persons uses these drugs all over country. For this purpose we have used Phase sensitive technique Mössbauer spectroscopy as major research tool to characterize these iron containing *bhasma* because ^{57}Fe Mössbauer technique probe only iron atom and provides crucial information about the chemical state of iron present in the sample. For excellent review on the use of this technique in variety of fields is found in reference (Tominaga and Minai, 1984). It should be further noted that though many workers associated with Ayurvedic stream have reported on using various methods about the toxicity of iron bhasmas (Prahjapati *et al*., 2006; Sarkar *et al*., 2009). But none of study ever identified conclusion about the presence of chemical state of iron (iron phase) in these bhasmas. Our basic aim is to identify the chemical state of iron present in these bhasmas. In the present investigation we have used two types of samples. First, fresh samples prepared by us in the PAB Rasayanshalla of Dr. Vishwa Vasu Gaur using same classical method given in reference and secondly drugs which are sold under different brands were purchased from market.

The latter once are marked as * in Table 2.

In present study, Mössbauer spectroscopic investigation of many drugs prepared in PAB Rasayanshalla has been carried out including Lauh bhasma (normal), Lauh bhasma 6 putty, Lauh bhasma 12 Putty, Lauh bhasma 20 Putty, Lauh bhasma 100 putty, Lauh bhasma1000 Putty, Swarn Makshik Bhasma (normal), Swarn Makshik bhasma 1 putty, Swarn Makshik bhasma 8 putty, Swarn Makshik bhasma 20 putty, Mandoor bhasma 2 putty, Mandoor bhasma 13 putty, Punarnva Mandoor, Prabhaker Bati.

Drugs purchased from market are as follows:

Lauh bhasma (Shailendra Aushadh Nirmanshala, Jodhpur), Swarn Makshik bhasma (Baidyanath), Lauhbhasma 100 Putty, Abhrak bhasma (normal), Abhrak bhasma 100 putty, Mandoor bhasma (Krishna Kaleda, Udaipur), Mandoor bhasma (Dabur), Mandoor bhasma (Baidyanath), Saptamrit Lauh (Baidyanath), Saptamrit Lauh (Shailendra Aushadh Nirmanshala, Jodhpur), Saptamrit Lauh (Dabur), Sarvajwarhar Lauh (Krishna Kaleda, Ajmer), Sarvajwarhar Lauh (Dabur), Navayas Lauh (Dabur), MadhuMandoor bhasma(Baidyanath).

Experimental Detail

Mössbauer spectra of all the samples were obtained by using a conventional constant acceleration Mössbauer spectrometer with ^{57}Co in Rh matrix as the Mössbauer source. Mössbauer absorbers were prepared by sandwiching finely ground drug powder between two paper discs in a 25 mm diameter sample holder. Computer programme written by Meerwal (Mǿrup *et al*., 1985) and at IIT Kanpur were used after suitable modifications for fitting of room temperatures spectra. The programs assume the spectrum to be a sum of Lorentzians. The isomer shift (IS) values are reported with respect to the centroid of a pure iron absorber. In most of the cases, the width and the intensity of two halves of a quadrupole doublet were considered to be equal. In case of sextets, intensity of first and sixth, second and fifth, and third and fourth lines, were considered to be equal. Also, widths of all the six lines were constrained to be equal. XRD analysis was carried out at Indian Institute of Technology, Delhi using Panalytical XRD system. CuK_α target was used as the target while keeping the scan speed as 1.2°/min.

RESULTS AND DISCUSSION

Table – 1 gives standard room temperature Mössbauer parameters (Mǿrup *et al*., 1985) for different oxide phases of iron which are commonly found in natural samples and also appear as end product when iron compounds are heated. This table will be helpful in interpreting our results. Mössbauer parameters for various samples are given in Table-2 along with phases identified. The XRD graph of Lauh bhasma (normal) and Lauh bhasma 100 putty are shown in Figure 1. All the major peaks of the two patterns correspond to Fe_2O_3 crystal structure as indexed in the Figure. The peaks widths for Lauh bhasma100 putty are sharper than the corresponding peaks of Lauh bhasma (normal) showing that repeated heating results in grain growth. In Figure 2 (a), (b), (c), (d), (e), (f), (g) we display typical Mössbauer spectra of various Lauh bhasmas samples. Lauh bhasma is the most commonly prescribed drugs. Though the XRD patterns of the Lauh bhasma (normal) and Lauh bhasma 100 putty show pure Fe_2O_3 phases, it can be seen from Figure 2(a), 2(b) their Mössbauer spectra are quite different. While the spectrum for Lauh bhasma 100 putty corresponds to a single sextet that for Lauh bhasma needs at least two sextets for reasonable fittings. Mössbauer parameters given in Table 2 show that both samples contain α- Fe_2O_3 (HMF~510kOe). While no other iron phase is found to be present in Lauh bhasma 100 putty, the sample of Lauh bhasma shows an additional sextet of somewhat lower HMF of 497kOe. Such a sextet of lower HMF can show up if the particle size in the sample is such as to allow collective magnetic excitation where the particle's magnetic moment makes oscillations about an easy axis of magnetization. Thus the sample Lauh bhasma has iron in α- Fe_2O_3 form but part of it is in fine particle form giving the additional sextet. The larger line width in the XRD of this sample supports this proposition. When the sample is repeatedly heated the grain growth is complete and we get single sextets of α- Fe_2O_3 in the case of Lauh bhasma 100 putty.

When there is sever deficiency of iron in the body Swarna Makshik bhasma is preferred. Though the name contains swarna (gold), this preparation does not contain gold. However it comes from a gold looking ore which contains iron in good proportion. Mössbauer spectrum obtained for this drug (Figure 4(a), (b), (c), (d), (e)) shows presence of two well grown sextets, one corresponding to α- Fe_2O_3 and the other probably the same oxide with reduced particle size. This phase is close to what is observed in Lauh bhasma. However, unlike Lauh bhasma, a central doublet is also present in the Mössbauer spectrum of Swarn Makshik bhasma.

Table 1. Room Temperature Mössbauer Parameters of some commonly Occurring Iron oxide in Nature

Name of mineral	Approximate range of isomershift (IS) (mms^{-1})	Approximate range of quadrupole splitting (QS), (mms^{-1})	Approximate range of Hyperfine magnetic field (HMF) (kOe)
α-Fe_2O_3	0.31-0.38	-0.10 - -0.12	507-515
Fe_3O_4 :			
site -A	0.63	0.05	460
site -B	0.27	~ 0	490
α - FeOOH	0.38	-0.10 - -0.14	~ 0 – 361

Table 2. Room Temperature Mössbauer parameters obtained for various Types of Lauh Bhasma

S.No	Medicine Sample	Doublet/ Sextet	IS (mms^{-1})	QS (mms^{1})	LW (mms^{-1})	HMF (kOe)	Relative Area %	Identify Phases
1.	Lauh bhasma	Sextet-1	0.28	0.03	0.41	497	38.0	Fe_3O_4
	(normal)	Sextet-2	0.35	-0.06	0.54	517	62.0	α-Fe_2O_3
2.	Lauh bhasma 100 Putty	Sextet-1	0.34	-0.06	0.42	514	100	α-Fe_2O_3
3.	Lauh bhasma 6 putty	Sextet-1	0.38	-0.15	0.56	524.97	37.78	α-Fe_2O_3
		Sextet-2	0.28	0.13	1.11	497.92	53.16	Fe_3O_4
		Doublet-1	0.09	0.27	0.69	-	9.06	-
4.	Lauh bhasma 12 Putty	Sextet-1	0.399	-0.17	0.40	526.65	37.88	α-Fe_2O_3
		Sextet-2	0.43	0.044	1.70	504.36	62.12	α-Fe_2O_3
5.	Lauh bhasma 20 Putty	Sextet-1	0.38	-0.05	0.66	525.17	100	α-Fe_2O_3
6.	Lauh bhasma 1000 Putty	Sextet-1	0.51	-0.17	0.40	502.29	100	α-Fe_2O_3
7.	* Lauh Bhasma	Sextet-1	0.31	-0.17	0.31	525.09	36.16	α-Fe_2O_3
	(Shailendra, Jodhpur)	Sextet-2	0.34	-0.058	1.04	494.17	65.9	Fe_3O_4
8	SwarnMakshik	Sextet-1	0.41	-0.16	0.372	516.36	54.2	α-Fe_2O_3
	Bhasma	Sextet-2	0.19	0.03	0.374	498.25	28.86	Fe_3O_4
	(normal)	Doublet-1	0.25	0.71	0.466	-	16.94	-
9	SwarnMakshik bhasma 1 putty	Sextet-1	0.56	-0.18	1.21	526.24	76.66	α-Fe_2O_3
		Doublet-1	0.41	1.25	0.375	-	13.26	-
		Doublet-2	0.30	0.64	0.381	-	10.06	-
10	SwarnMakshik bhasma 8 putty	Sextet-1	0.64	-0.16	1.158	528.76	70.48	α-Fe_2O_3
		Doublet-1	0.31	0.56	0.364	-	25.4	-
		Doublet-2	0.31	1.014	0.31	-	4.1	-
11	SwarnMakshik bhasma 20 putty	Sextet-1	0.31	-0.16	0.381	524.63	100	α-Fe_2O_3
12	* SwarnMakshik Bhasma	Sextet-1	0.32	-0.17	0.463	524.63	91.58	α-Fe_2O_3
	(Baidyanath)	Doublet-1	0.55	1.66	0.588	-	8.42	-
13	* Abhrak Bhasma	Sextet-1	0.37	-0.20	1.87	467.23	93.54	Fe_3O_4
		Doublet-1	0.13	0.52	0.39	-	7.9	-
14	*Abhrak Bhasma 100 putty (Shailendra)	Sextet-1	0.36	0.17	1.63	447	75.04	Fe_3O_4
		Doublet-1	0.21	0.86	0.37	-	24.96	-
15	Mandoor bhasma 2 putty	Doublet-1	1.20	2.81	0.597	-	100	-
16	Mandoor bhasma 13putty	Sextet-1	0.41	-0.12	0.735	524.53	85.5	α-Fe_2O_3
		Doublet-1	0.31	0.85	0.478	-	9.34	-
		Doublet-2	0.02	0.27	0.25	-	5.16	-
17	* Mandoor bhasma (Krishna Kaleda, Udaipur)	Sextet-1	0.31	-0.17	0.408	525.33	100	α-Fe_2O_3
18	*Mandoor bhasma (Dabur)	Sextet-1	0.32	-0.19	0.36	525.53	100	α-Fe_2O_3
19	*Mandoor bhasma	Sextet-1	0.41	-0.14	0.387	512.08	49.86	α-Fe_2O_3
	(Baidyanath)	Sextet-2	0.52	-0.19	0.722	462.78	37.54	Fe_3O_4
		Doublet-1	0.03	0.45	0.455	-	12.56	-
20	*Saptamrit Lauh (Baidyanath)	Sextet-1	0.32	-0.19	0.29	525.03	100	α-Fe_2O_3
21	*Saptamrit Lauh	Sextet-1	0.31	-0.136	0.237	526.42	38.58	α-Fe_2O_3
	(Shailendra)	Sextet-2	0.308	-0.13	1.24	505.08	61.44	α-Fe_2O_3
22	*Saptamrit Lauh (Dabur)	Sextet-1	0.316	-0.204	0.331	525.86	100	α-Fe_2O_3
23	*Sarvajwarhar Lauh (Krishna Kaleda, Ajmer)	Sextet-1	0.31	-0.16	0.334	525.43	100	α-Fe_2O_3
24	*Sarvajwarhar Lauh (Dabur)	Sextet-1	0.315	-0.17	0.31	525.46	100	α-Fe_2O_3
25	*Navayas Lauh	Sextet-1	0.35	-0.21	0.295	509.98	88.42	α-Fe_2O_3
	(Dabur)	Doublet-1	0.79	1.81	0.544	-	11.56	-
26	Punarnva Mandoor	Sextet-1	0.56	-0.18	0.763	522.82	73.78	α-Fe_2O_3
		Doublet-1	0.25	0.91	0.592	-	16	-
		Doublet-2	0.83	1.87	0.349	-	10.24	-
27	*Madhu	Sextet-1	0.34	-0.18	0.378	506.56	46.58	α-Fe_2O_3
	Mandor Bhasma(Baidyanath)	Sextet-2	0.51	-0.2	1.143	474.47	47.22	Fe_3O_4
		Doublet-1	0.21	0.86	0.558	-	6.7	-
28	Prabhaker Bati	Sextet-1	0.40	-0.14	0.325	529.03	24.4	α-Fe_2O_3
		Sextet-2	0.34	-0.08	1.805	504.97	71	α-Fe_2O_3
		Doublet-1	0.05	0.28	0.416	-	4.6	-

* means medicines purchase from market

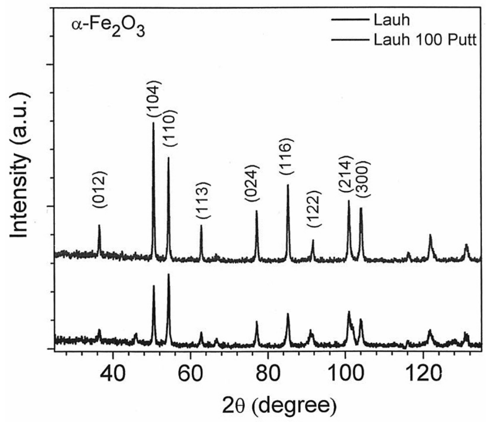


Fig. 1. XRD pattern of Lauh Bhasma (normal) and Lauh Bhasma 100 putty

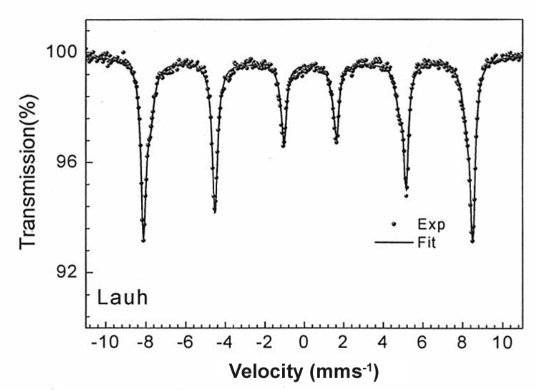


Fig. 2(a). Mössbauer Sprctrum of Lauh Bhasma (normal)

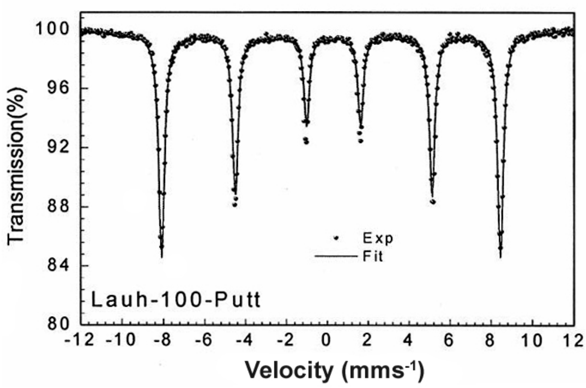


Fig. 2(b). Mössbauer Spectrum of Lauh Bhasma 100 putty

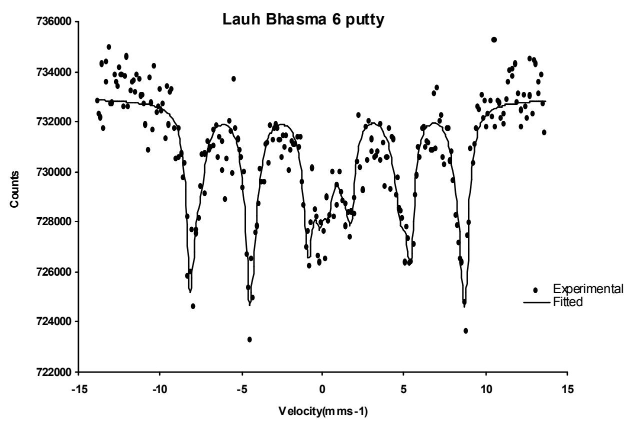


Fig. 2(c). Mössbauer Spectrum of Lauh Bhasma 6 putty

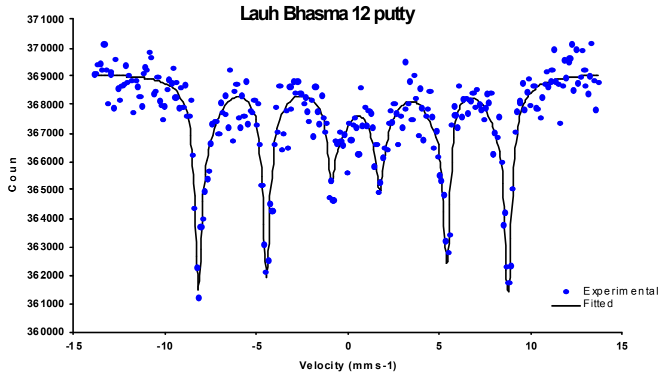


Fig. 2(d). Mössbauer Spectrum of Lauh Bhasma 12 putty

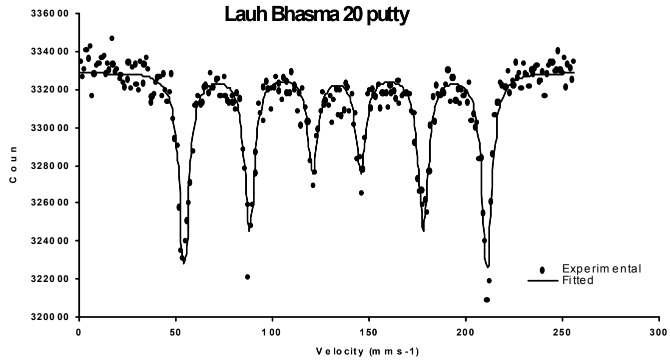


Fig. 2(e). Mössbauer Spectrum of Lauh Bhasma 20putty

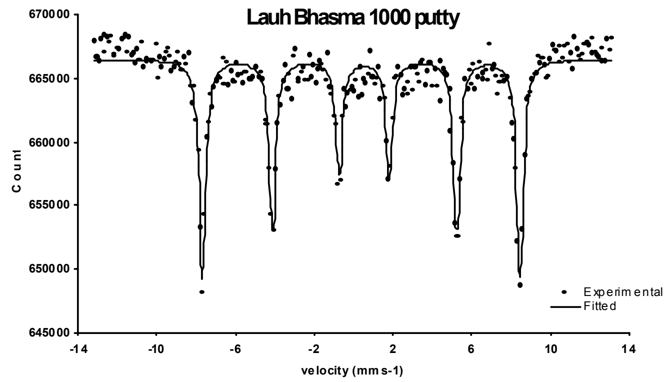


Fig. 2(f): Mössbauer Spectrum of Lauh Bhasma 1000 putty

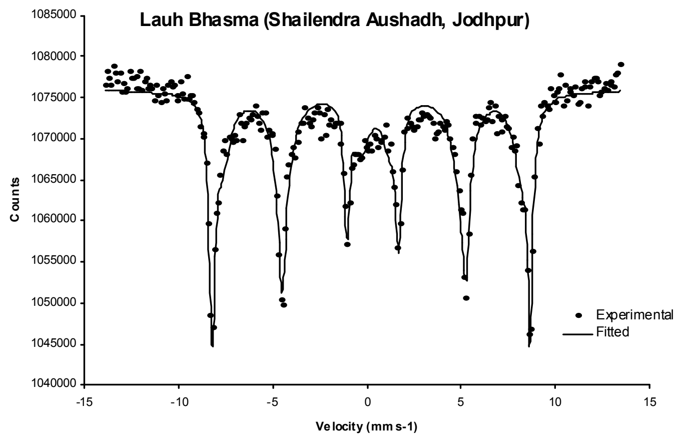


Fig. 2(g): Mössbauer Spectrum of Lauh Bhasma (branded)

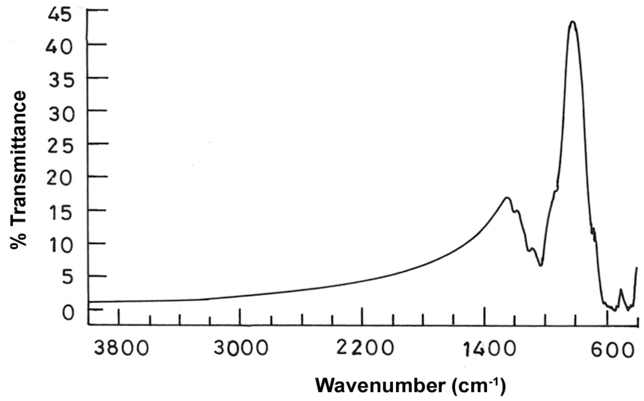


Fig. 3(a): FTIR Spectrum of Lauh Bhasma (normal)

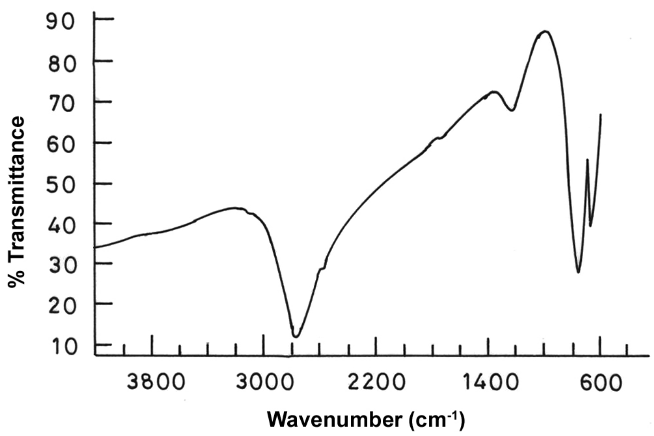


Fig. 3(b): FTIR Spectrum of Lauh Bhasma 100 put

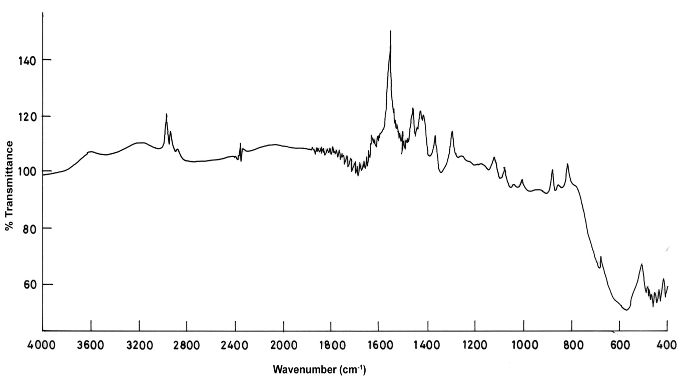


Fig. 3(c): FTIR Spectrum of Lauh Bhasma 6 putty

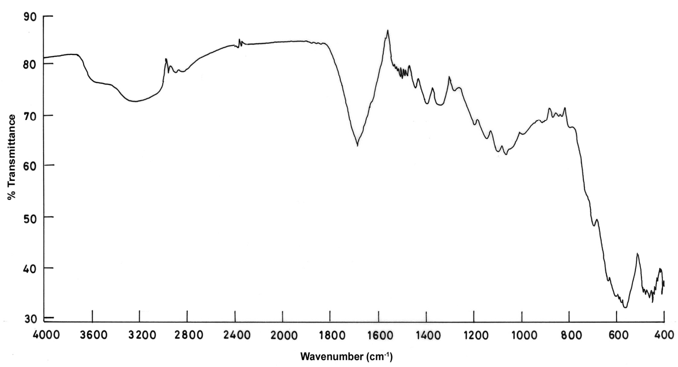


Fig. 3(d): FTIR Spectrum of Lauh Bhasma12 putty

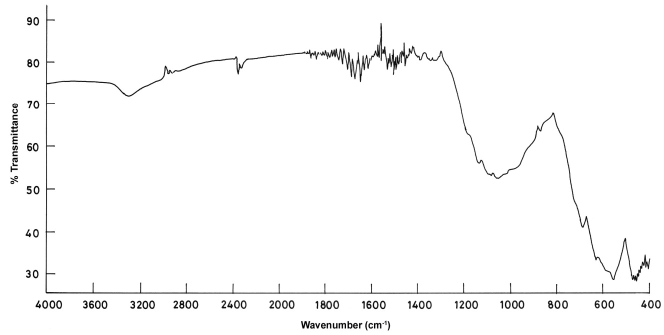


Fig. 3(e): FTIR Spectrum of Lauh Bhasma 20 putty

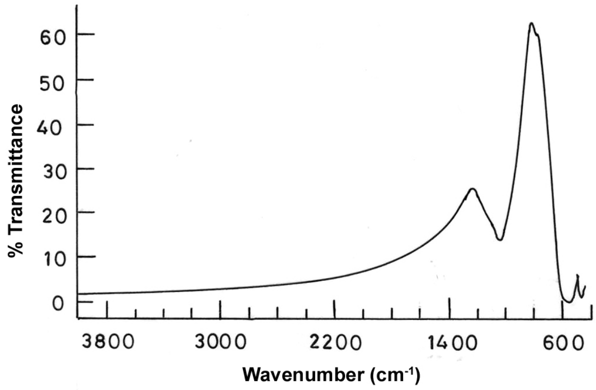


Fig. 3(f): FTIR Spectrum of Lauh Bhasma 1000 putty

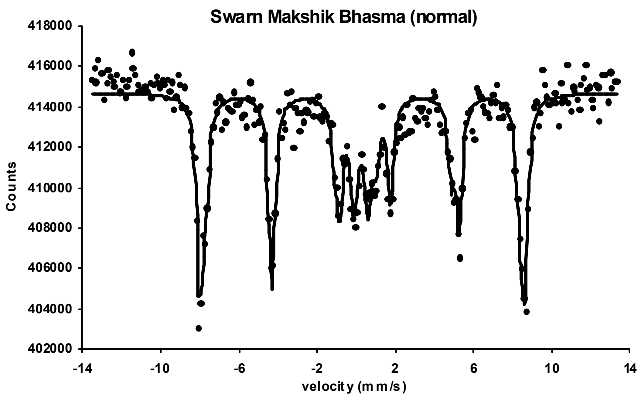


Fig.4(a): Mössbauer Spectrum of Swarn Makshik Bhasma (normal)

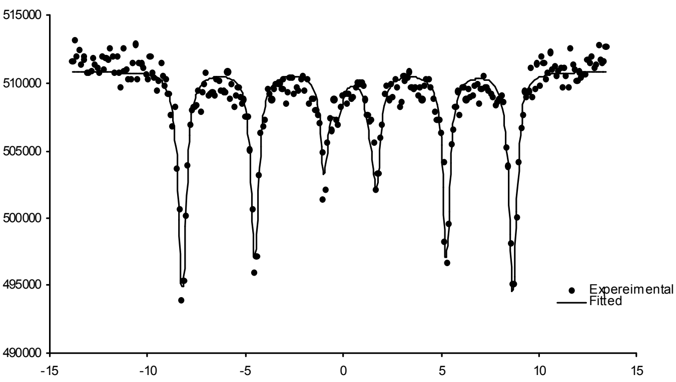


Fig. 4(b): Mössbauer Spectrum of Swarn Makshik Bhasma (branded)

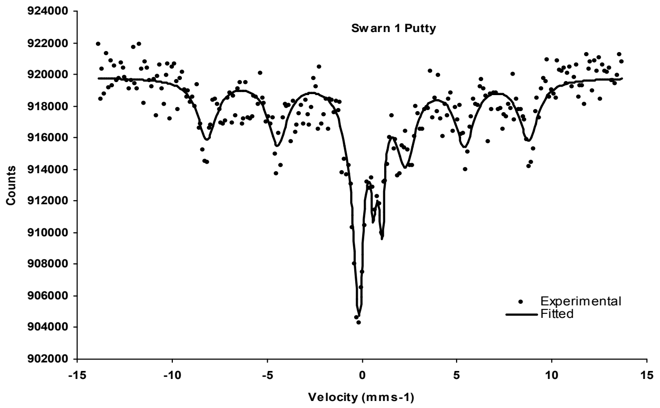


Fig. 4(c): Mössbauer Spectrum of Swarn Makshik Bhasma 1 putty

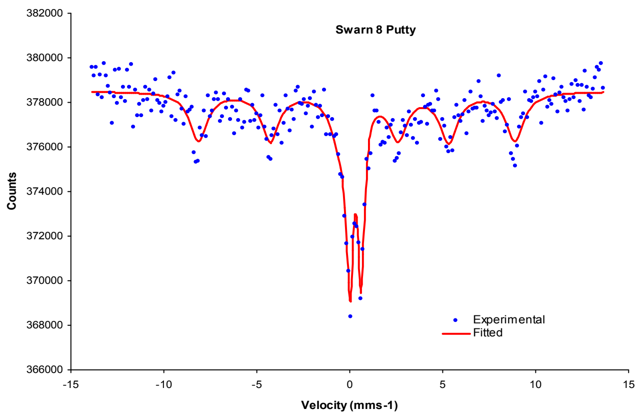


Fig. 4(d): Mössbauer Spectrum of Swarn Makshik Bhasma 8 putty

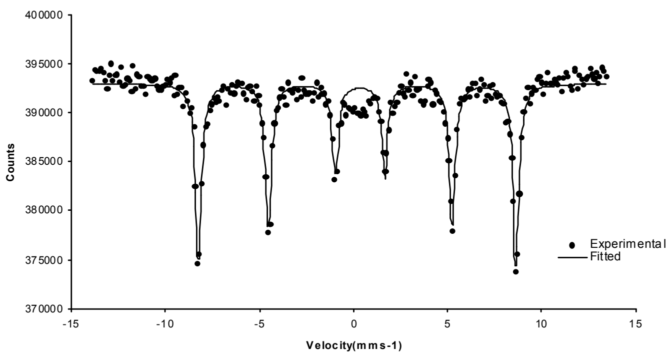


Fig. 4(e): Mössbauer Spectrum of Swarn Makshik Bhasma 20 putty

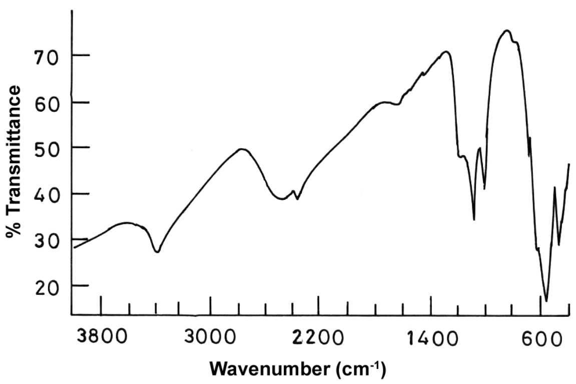


Fig. 5(a): FTIR Spectrum of Swarn Makshik Bhasma (normal)

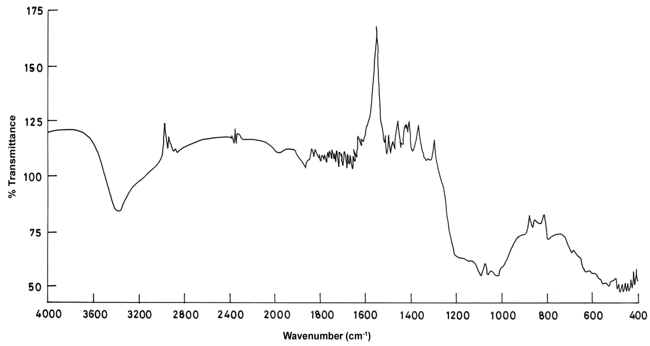


Fig. 5(b): FTIR Spectrum of Swarn Makshik Bhasma 1 putty

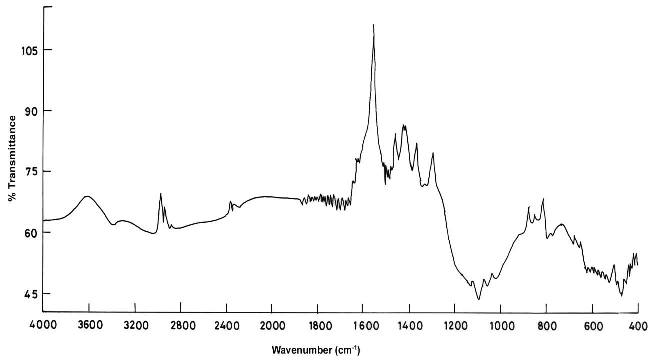


Fig. 5(c): FTIR Spectrum of Swarn Makshik Bhasma 8 putty

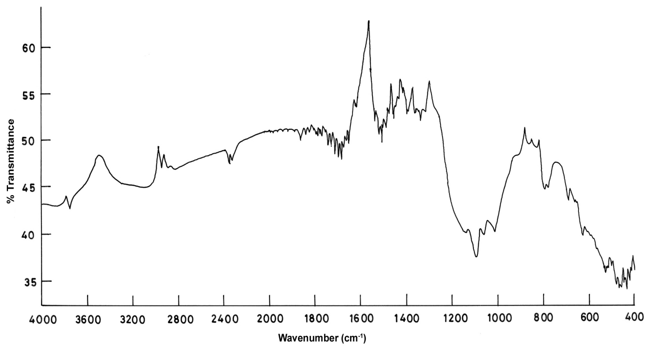


Fig. 5(d): FTIR Spectrum of Swarn Makshik Bhasma 20 putty

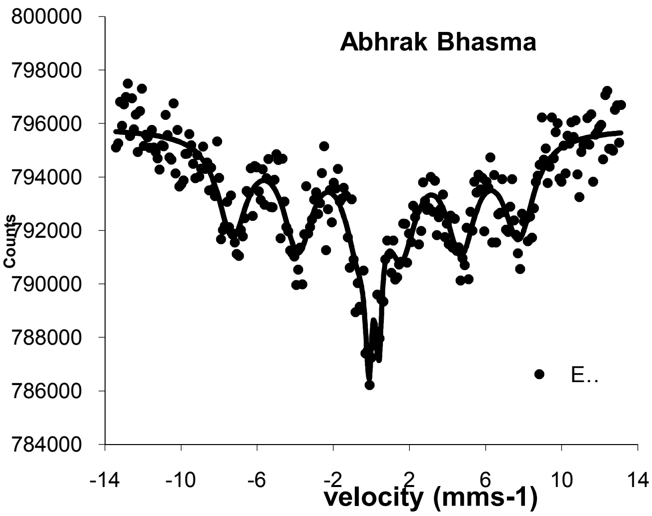


Fig. 6(a): Mössbauer Spectrum of Abhrak Bhasma (normal)

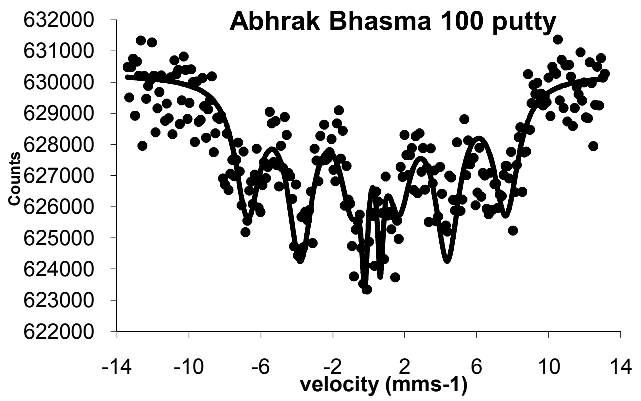


Fig. 6(b): Mössbauer Spectrum of Abhrak Bhasma100 putty

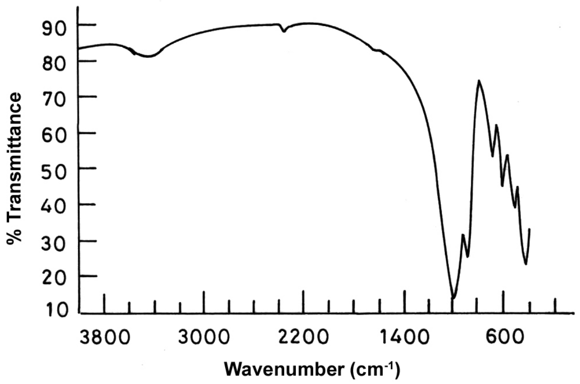


Fig. 7(a): FTIR Spectrum of Abhrak Bhasma (normal)

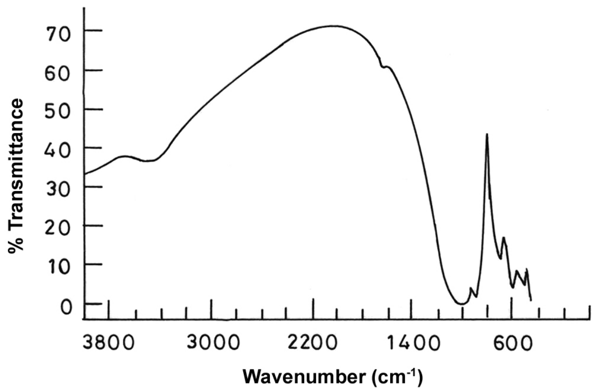


Fig. 7 (b): FTIR Spectrum of Abhrak Bhasma 100 putty

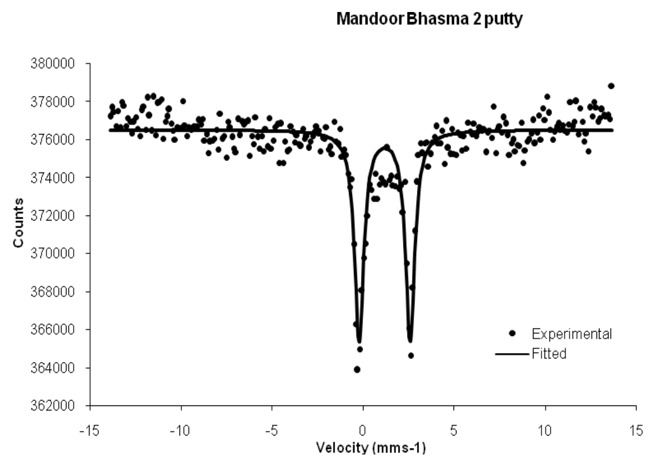


Fig. 8(a): Mössbauer Spectrum of Mandoor Bhasma 2 putty

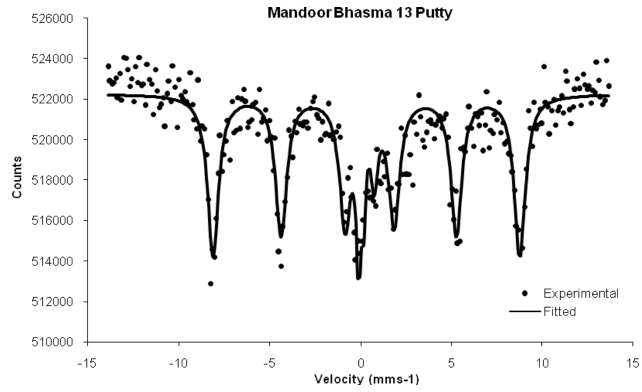


Fig. 8(b): Mössbauer Spectrum of Mandoor Bhasma 13 putty

MandoorBhasma (Krishna Kaleda, Udaipur)

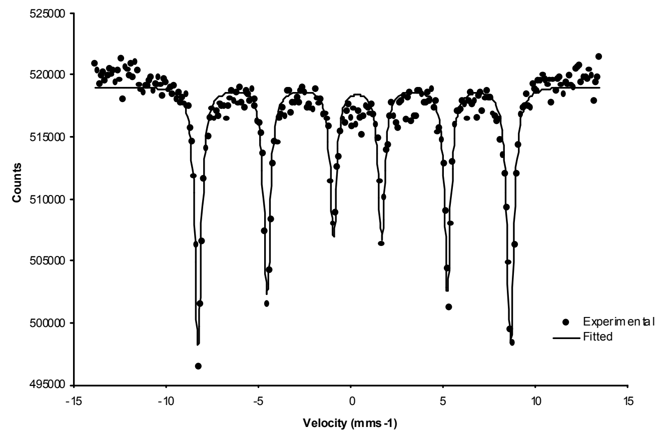


Fig. 8(c): Mössbauer Spectrum of Mandoor Bhasma (branded)

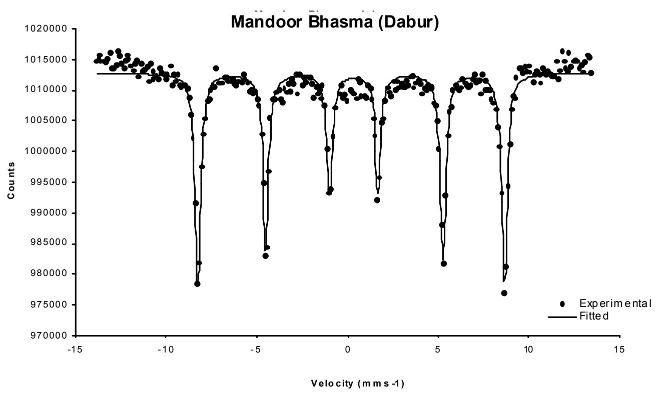


Fig. 8(d): Mössbauer Spectrum of Mandoor Bhasma (branded)

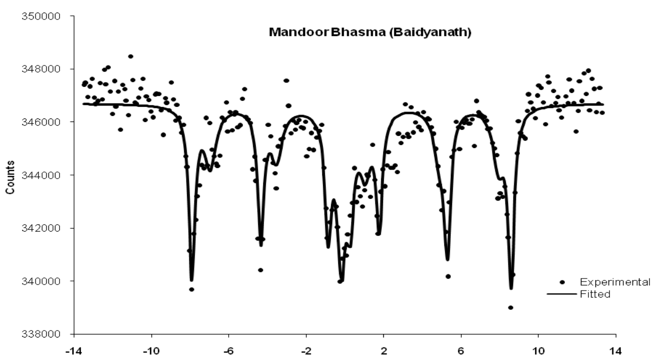


Fig. 8(e): Mössbauer Spectrum of Mandoor Bhasma (branded)

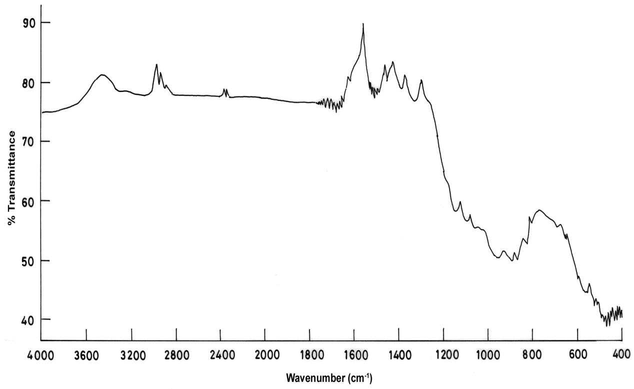


Fig. 9(a): FTIR Spectrum of Mandoor Bhasma 2 putty

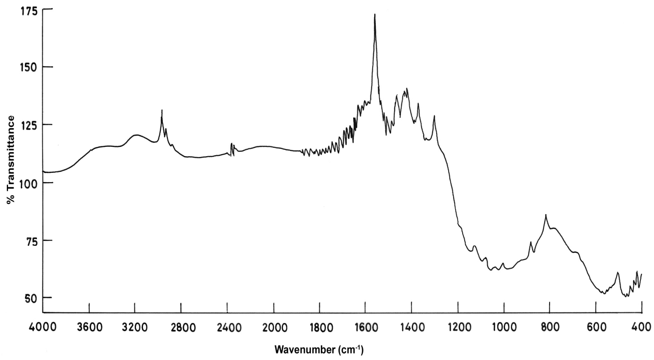


Fig. 9(b): FTIR Spectrum of Mandoor Bhasma 13 putty

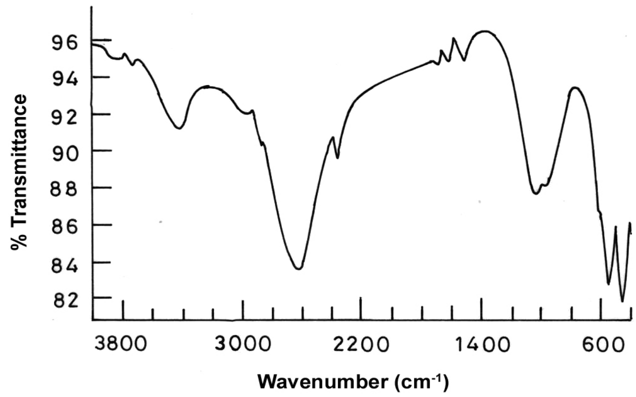


Fig. 9(c): FTIR Spectrum of Mandoor Bhasma (Baidyanath)

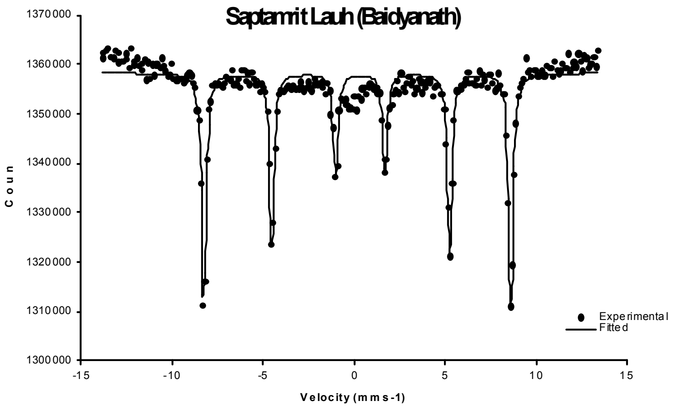


Fig. 10 (a)

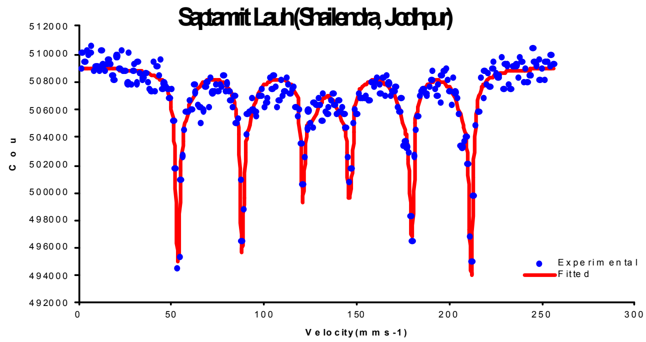


Fig. 10 (b)

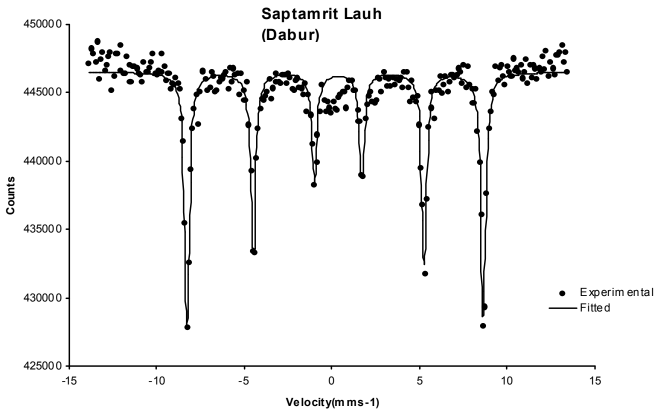


Fig. 10(c)

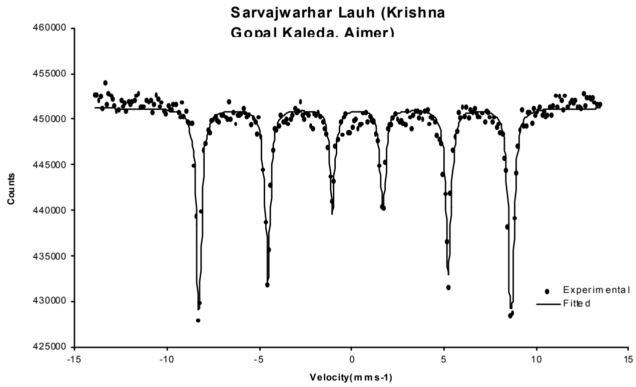


Fig. 10 (d)

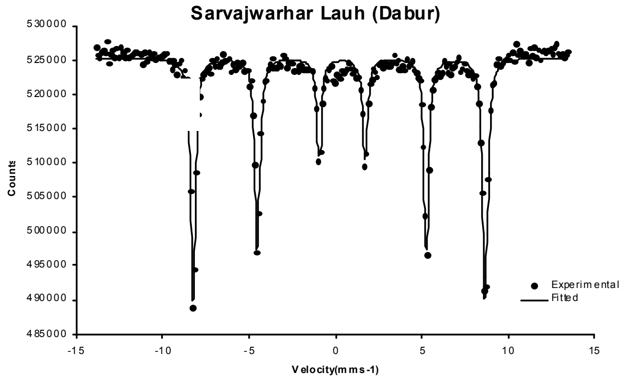


Fig. 10 (e)

Figure 10: Mössbauer Spectrum of branded drugs- (a) Saptamrit Lauh (Baidyanath), (b) Saptamrit Lauh (Shailendra Aushadh, Jodhpur), (c) Saptamrit Lauh (Dabur) (d) Sarvajwarhar Lauh (Krishna Gopal Kaleda, Ajmer) and (e) Sarvajwarhar Lauh (Dabur)

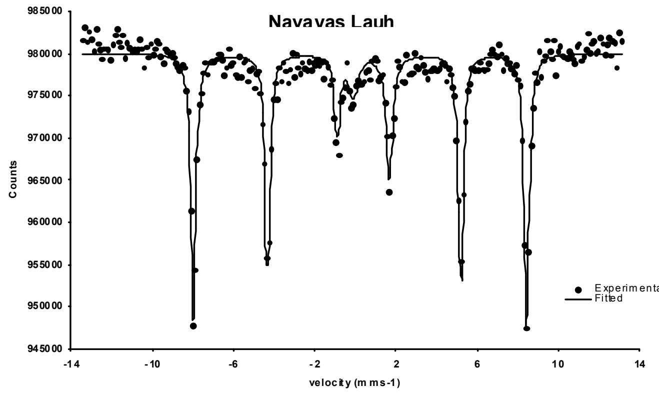


Fig. 10(f): Mössbauer Spectrum of Navayas Lauh (Dabur)

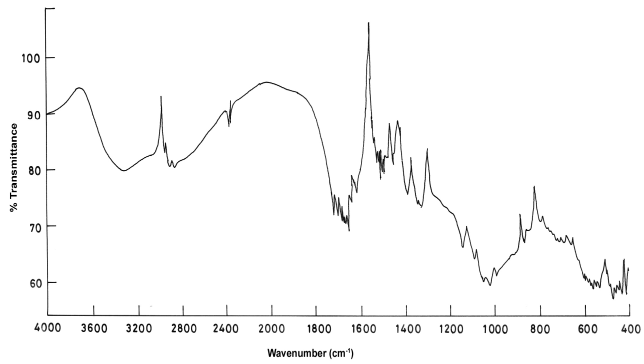


Fig. 11(a): FTIR Spectrum of Punarnva Mandoor

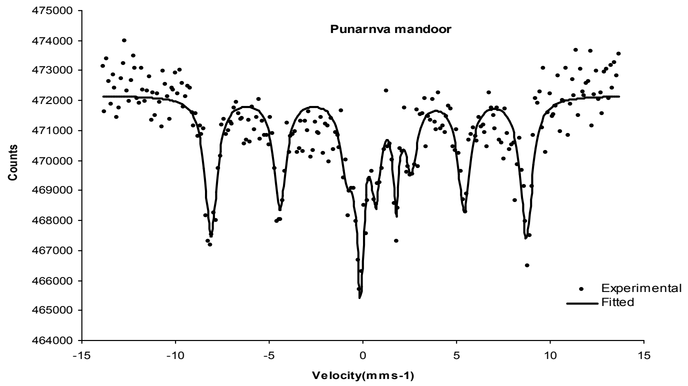


Fig. 10 (g): Mössbauer Spectrum of Punarnva Mandoor

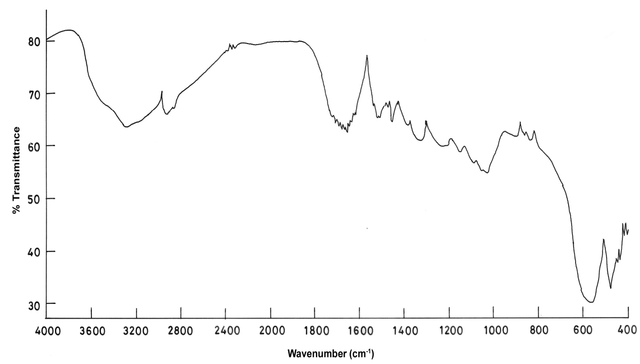


Fig. 11(b): FTIR Spectrum of Sarvajwarhar Lauh (Dabur)

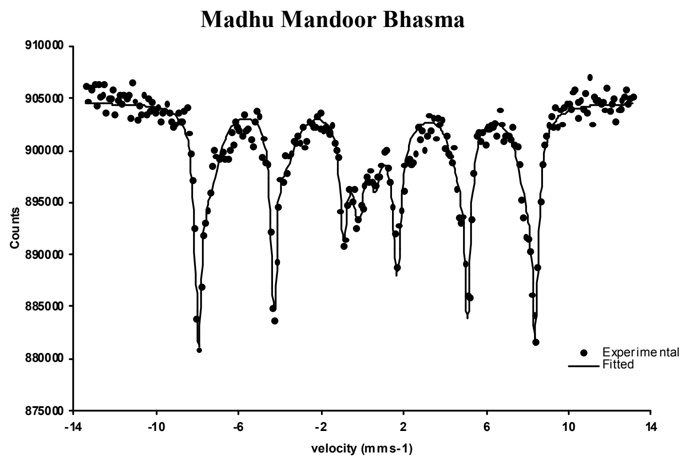


Fig. 10 (h): Mössbauer Spectrum of Madhu Mandoor Bhasma

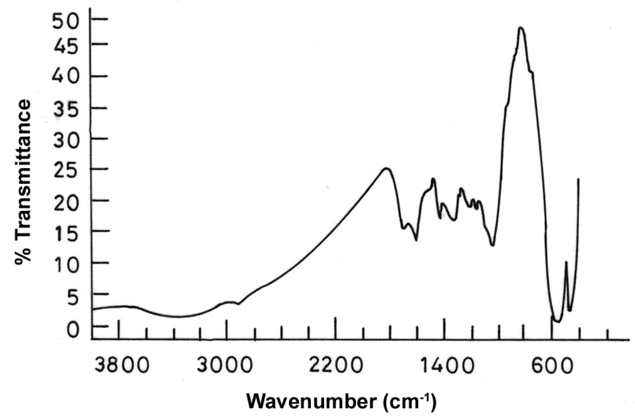


Fig. 11(c): FTIR Spectrum of Navayas Lauh

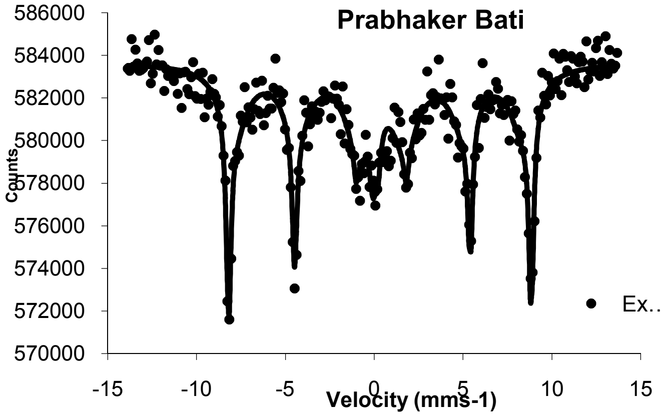


Fig. 10(i): Mössbauer Spectrum of Prabhakar Bati

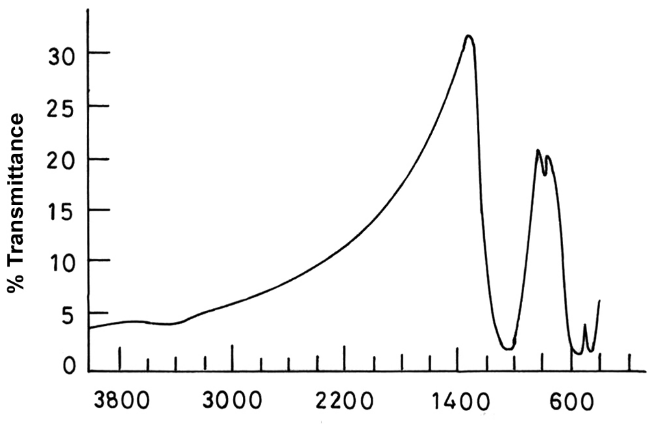


Fig. 11(d): FTIR Spectrum of Madhu Mandoor Bhasma

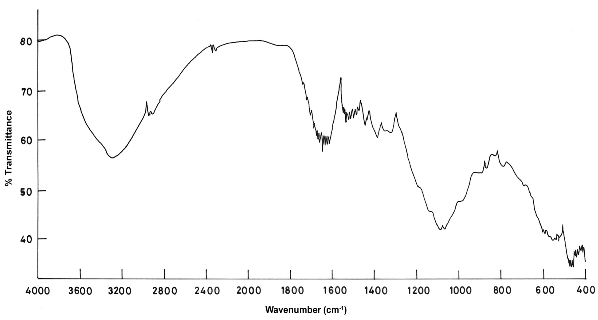
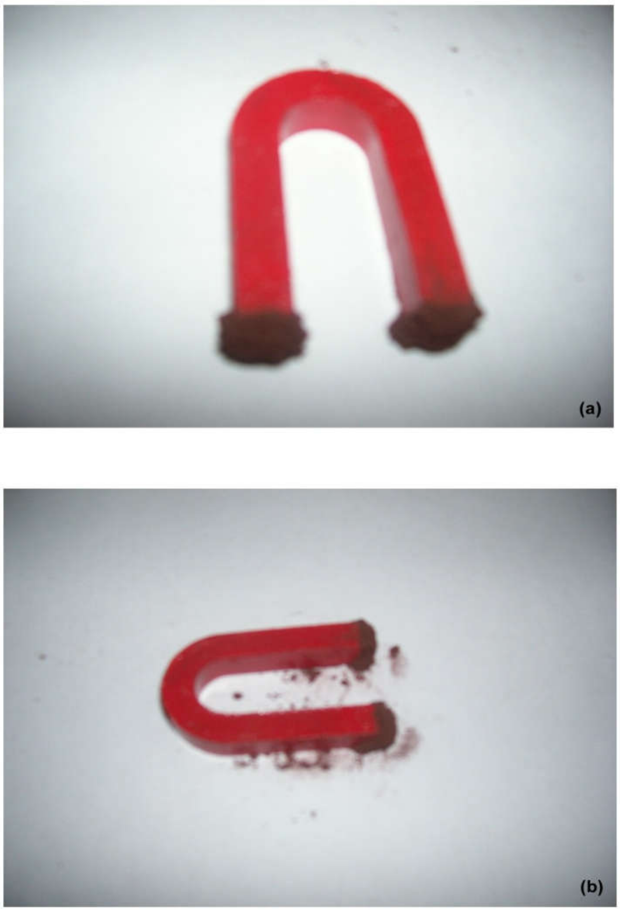


Fig. 11(e): FTIR Spectrum of Prabhakar Bati

Plate - 2



Magnetic behaviour of (a) Lauh Bhasma (normal) and (b) Lauh Bhasma 100 putty.

Fig. 12: Magnetic behavior of (a) LauhBhasma (normal) and (b) LauhBhasma 100 putty

Lauh Bhasma (normal)

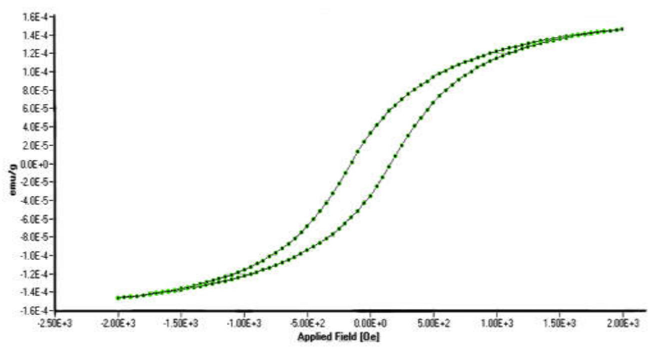


Fig. 13(a): Hysteresis curve of Lauh Bhasma (normal)

Lauh Bhasma 100 putty

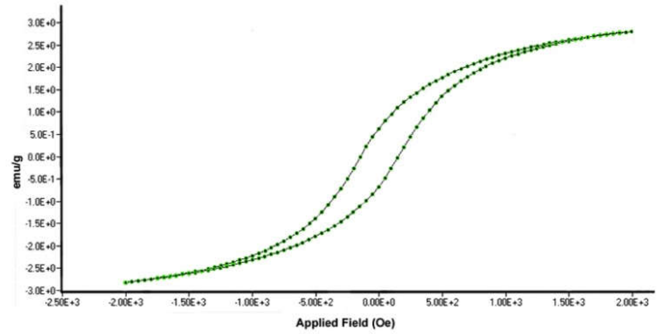


Fig. 13 (b): Hysteresis curve of Lauh Bhasma 100 putty

This doublet is most likely coming from ultra fine oxide particles as these go through superparamagnetic relaxation with flipping time smaller than the measurement time of Mössbauer spectroscopy. This typically occurs for iron oxides when the particles size goes below 10 nm. The presence of these ultra fine particles could be the reason of its increased efficacy making this drug more effective. It seems that the preparation leads to two distinctly different groups of particles- one which have grown well and the other for which the grain growth is restricted. Other commonly used drug is Abhrak bhasma. Mössbauer spectrum for Abhrak bhasma is exhibited in Figure 6(a), (b). It exhibits relaxed Mössbauer pattern instead of full grown sextet obtained for other samples. Such a spectrum reveals that the whole sample is of nano size, though there will always be a size distribution. The presence of Abhrak (mica) during bhasmikaran step should be responsible for arresting the grain growth. The extensive study has been done by (Tripathi *et al*., 1978) on the decomposition pattern of iron rich mica like biotite from which these Abhrak bhasmas are prepared. In these studies and in many more studies it is established that when particle size is of the order of nano meters, instead of full grown sextet, a relaxed spectrum appears due to superparamagnetism. The relaxed Mössbauer spectra obtained in the present study indicate that most of the iron oxide particles in Abhrak bhasma are in nanometer size range. It can be seen from Figure 8 and 10 that in all the drugs iron is mainly present in the form of α-Fe_2O_3. All the samples studied here exhibit magnetic character that is they attract towards hand magnet (Figure 12). Their magnetic character can be seen in hystersis curve given in Figure 13(a) and (b).

As it is well known that iron oxide and magnetite are not absorbed by human body and they are toxic in nature. From Table -2 it can be seen that all bhasmas contain iron oxide as dominant phase irrespective of nature and mode of preparation. So from Mössbauer spectroscopic point of view, all bhasmas which have been studied here should not be safe for human consumption. FT-IR spectra of these drugs are different for different bhasma given in Figure 3(a), (b), (c), (d), (e), (f), (g) 5(a), (b),(c), (d), 9(a), (b),(c) 11(a), (b), (c), (d), (e) the names of bhasmas are given in itself.

Results of present study can be summarized as follow:

(1) All the bhasmas exept Abhrak bhasma are prepared using rusted iron as a initial material. Generally initial iron phases is as goethite (FeOOH) which is the commen rust component when. This rusted iron is heated at large

temperature finally it get converted in to the α-Fe_2O_3 have showing magnetic property.

Fe-- → FeOOH → Fe_2O_3
Metallic Rusted Heat

But in case of Abhrak bhasma, iron oxide is produced due to the decomposition (above 800c) of abhrak (Mica). Generally biotite (mica) for the prepare Abhrak bhasma. Biotite (which is commonly known as black mica) contain appreciable amount of iron. In all the bhasmas the chemical state of iron is iron oxide exhibiting some magntic characterstic. Mössbauer spectrum and XRD pattern confirm the presence of iron oxide in all the bhasmas.

(2) But FT-IR pattern of each bhasmas is characteristically different. Though they exhibit characteristic band corresponding oxide of iron ($500cm^{-1}$) but at higher wave number bands are significantly different. This difference observed in the FT-IR pattern in different bhasma can be understood because these bhasmas are processed in different chemical environment using both organic and organic medium/matrix before final product is obtained have already discussed in introduction part.

(3) As we know that α-Fe_2O_3 is not easily soluble and being a rust product it have toxic property also. We have also confined that α-Fe_2O_3 is not easily attacked by acids. Hence from Mössbauer spectroscopy point of view α-Fe_2O_3 present in iron bhasma should not digested by usual human being. From Mössbauer it can conclude that these drugs should have little therapeutic values in treating various disorders. Hence efficacy of these drugs should be carefully analyzed. Though our study indicate that very little use as iron supplement.

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