

Vimal (Iron Pyrite): A Medicinal Mineral Drug of Ayurveda - An Approach to Develop Its Mineralogical Monograph

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Abstract

Aim: This communication deals with the mineralogical characterization of a mineral named *Vimal* (pyrite of iron) having medicinal importance in Ayurvedic system of medicine. **Background:** *Vimal* is used in the form of *Bhasma* for the treatment of *Jirna Jwara* (chronic fever), *Shotha* (edema), *Pandu* (anemia), *Aruchi* (anorexia), *Arsha* (piles), and *Kamala* (jaundice) and especially indicated in the diseases of *Vata* and *Pitta Dosha* dominancy. However, raw drug standardization plays a pivotal role for assuring the therapeutic potential of the final drug. **Materials and Methods:** The sample of *Vimal* was collected from local vender and authenticated by the subject experts and further analyzed through physical properties of the mineral. **Results and Discussion:** The results showed that *Vimal* is iron pyrite (iron disulfide; FeS₂) with metallic luster, pale dull gold color, cubic crystal habit, and uneven fracture. **Conclusion:** All these physical properties of mineral iron pyrites are very well match with the acceptable characteristics of *Vimal* as described in Ayurvedic classic.

Key words: FeS₂, iron prite, *Maharasa*, mineral, Rasashastra, *Vimal*

INTRODUCTION

The metals and minerals are the treasures of herbomineral formulations of Ayurvedic system of medicine. Rasa Shastra is a branch of Ayurvedic pharmaceuticals, which deals with the pharmaceutical procedures (*Shodhan*, *Jarana*, *Bhavana*, *Maran*, etc.) selectively, specify for the mineral and metals to convert them into a suitable medicine.^[1] *Vimal* is one of useful mineral of iron having medicinal importance in Ayurvedic therapeutics. It is chemically identified as the pyrite of iron (iron disulfide; FeS₂) and commonly known as “fool’s gold” due to its golden luster.^[2] Shree Bhairav Anand Yogi, the author of text *Rasarnava* has mentioned 1st time about its medicinal importance in 10th century A.D. In 12th century A.D., *Rasa Vagbhata*, the author of *Rasa Ratna Samucchaya* elaborately explained its physical properties and categorized under the group of *Maharasa*^[3] (one of the important groups of minerals) Table 1. It is used in the form of *Bhasma* for the treatment of *Jirna Jwara* (chronic fever), *Shotha* (edema), *Pandu*

(anemia), *Aruchi* (anorexia), *Arsha* (piles), and *Kamala* (jaundice) and especially in the diseases of *Vata* and *Pitta* dominancy.^[4]

The Ayurvedic pharmaceuticals more emphasized on the identification and selection of authentic raw samples based their classical acceptable or non-acceptable properties, and then only drugs are processed for further pharmaceutical process. Collection of authentic sample influences the quality of the final product, which is directly related to the therapeutic potential of a drug. Hence, the present study was undertaken to assess the characterization of *Vimal* for its mineralogical characterization through Ayurvedic as well as contemporary methods.

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MATERIALS AND METHODS

Test sample

The samples of *Vimal* were collected from the local market of Varanasi, Uttar Pradesh and authenticated by the subject expert. Further mineral was tested for its physical properties, and then mineralogical characterization was made for acceptability of genuine sample by adopting mentioned methods:

Methods

1. Identification and physical verification of *Vimal* according to *Grahya-lakshanas* (acceptable properties) mentioned in the Ayurvedic classical texts.
2. Analysis of the physical properties of iron pyrite as per the mineralogical description mentioned in the Ayurvedic Pharmacopoeia of India.

3. The mineral chemistry of various phases in the studied sample was carried out by a CAMECA-SXFive electron microprobe (EPMA) at the Department of Geology, Banaras Hindu University, Varanasi.

RESULTS AND OBSERVATIONS

Identification of *Vimal* as per Ayurvedic classics

The procured sample of *Vimal* was identified and verified as per the classical reference.^[5] Observations are depicted in Table 2.

Physical properties

Physical characterization was carried out as per the Ayurvedic Pharmacopoeia of India,^[6] and the mineralogical details of iron pyrite were verified as per the mineralogical description of iron pyrite^[7] as shown in Table 3 and Figure 1.

Table 1: Description of mineral *Vimal* from an Ayurvedic perspective

Category	Details
Broadly classified group	<i>Maharasa</i> (a category of mineral having more therapeutic value); Rasa Ratna Samucchaya <i>Upadhatu</i> ; Ayurveda Prakash 3/4-5
Types and their important uses	<i>Hema (Swarna)</i> - Yellow colored and used for <i>Hema Kriya</i> (conversion of the lower metal into gold), best one <i>Tara (Raupya)</i> - White colored and used for <i>Raupya Karma</i> (conversion of the lower metal into silver) <i>Kansya Vimal</i> - Red colored having medicinal value (used in the preparation of medicines)
<i>Grahya Lakshan</i> (acceptable characteristics)	<i>Kansya Vimal</i> (therapeutically accepted variety) <i>Vartula</i> (circular), <i>Snigdha</i> (smooth), <i>Sakona</i> (angular projection), and <i>Saphalak</i> (with surface)
<i>Shodhana</i>	<i>Swedana</i> : In <i>Dola Yantra</i> with <i>Vasaka (Adhatoda vasica)</i> <i>Swarasa</i> or <i>Kwatha</i> , <i>Nimbu Swarasa</i> (juice of <i>Citrus limon</i> L. Osbeck)
<i>Marana</i>	<i>Gajaputa</i> (~1000°C): <i>Shuddha Vimal</i> + <i>Shuddha Gandhak</i> (purified sulphur)+ <i>Bhavana</i> with <i>Lakucha (Artocarpus lacucha)</i> <i>Swarasa</i> and <i>Nimbu (Citrus limon</i> L. Osbeck) <i>Swarasa</i> subjected to <i>Gajaputa</i> ×10 times
<i>Bhasma</i> color	Red colored
Therapeutic properties	<i>Snigdha</i> , <i>Guru</i> , <i>Vrushya</i> (aphrodisiac), <i>Rasayana</i> , and <i>Vata-Pitta nashak</i>
Indications	<i>Jirna Jwara</i> (chronic fever), <i>Shotha</i> (edema), <i>Pandu</i> (anemia), <i>Prameha</i> (urinary disorders), <i>Aruchi</i> (anorexia), <i>Kamala</i> (jaundice), <i>Arsha</i> (piles), <i>Netra Roga</i> (diseases of eye), and diseases of <i>Vata</i> and <i>Pitta</i> .
Dose	60–125 mg with Triphala, Trikatu, Ghee, honey
Antidote	<i>Meshashringi (Gymnema sylvestre)</i> <i>Churna</i> with sugar, <i>Kullatha Kwatha</i> or <i>Dadimatwak Kwatha</i>
Important formulations	<i>Kshayakeshari Rasa*</i> , <i>Navaratnarajamraganka Rasa</i> , <i>Rasendrachudamani Rasa</i> , <i>Madana Sanjivini Rasa</i> , and <i>Shigra Prabhava Rasa</i>

*Yogaratanakara, Rajyakshma Chikitsa, p. 330

The EPMA study for the mineral chemistry and elemental assay of various phases of the studied sample is presented in Figure 2 and Tables 4.

DISCUSSION

The present study was aimed to focus the mineralogical characterization of mineral *Vimal* according to *Grahyalakanas* as explained in Ayurvedic classics as well as the mineralogical standards as mentioned in the Ayurvedic Pharmacopoeia of India. In India, the main deposits of iron pyrites are found at Hajaribag, and Singhabhumi in Bihar, in Chitradurga, Kolar, Raichur and Uttar Kannada districts of Karnataka, in Karbi Anglong district of Assam and also in the states of Orissa, West Bengal, Rajasthan, and Andhra Pradesh. Pyrite is usually found associated with other sulfides or oxides in quartz, sedimentary rock, metamorphic

rock, coal beds, and as a replacement mineral in fossils. For the study, raw sample of *Vimal* was collected from local vender and authenticated by the subject experts.

Vimal is categorized under *Maharasa* group by Acharya Rasa Vagbhata.^[3] Some of the commentators considered as *Raupyamakshika*. Madhavaacharya, the author of Ayurveda Prakash, mentioned that it is originated from the banks of river Tapti. *Vimal* is further classified into three subtypes, namely *Swarna*, *Raupyam*, and *Kansya Vimal*.^[9] Among all verities, *Swarna Vimal* is comparatively best one due to its golden luster. Iron sulfide presents different crystalline phases such as troilite, marcasite, pyrrhotite, and pyrite. Pyrite's metallic luster and pale brass-yellow hue give it a superficial resemblance to gold. In nature, Pyrite or iron (II) disulfide, FeS₂ (cubic), and gold are frequently occurred together.^[10,11] Due to its similarity in color and shape to gold, it is called as "Fools Gold," although both can very easily be distinguished by simple observation.

The physical properties of minerals are directly related to their chemical and structural characteristics. The most useful

Table 2: *Grahyalakshan* (acceptable properties) of *Vimal* as per Ayurvedic classics

Acceptable property	Physical property	Observations
<i>Vartula</i>	Circular	-
<i>Kona samyukta</i>	Angular projection	+
<i>Snigdha</i>	Smooth	+
<i>Phalaka</i>	Surface	+

Table 3: The results of physical properties of *Vimal* (iron pyrites)

Physical Characteristics	Iron pyrites	Sample
Category	Mineral	+
Chemical formula	Iron disulfide (FeS ₂)	+
Color	Pale, with golden luster	+
Crystal habit	Cubic with sharp, well-formed faces	+
Cleavage	Poor	+
Fracture	Uneven	+
Hardness	6–6.5 at Mohs scale	+
Luster	Metallic	+
Streak	Greenish-brown-black	+
Smell (while heated)*	Sulfur	+
Specific gravity	4.95–5.10	+
Melting point**	1.177–1.188°C	-
Solubility	Insoluble in water	+
Magnetism	Paramagnetic	+

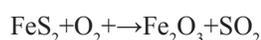
*While heated in open air produces sulfur smell. Its sulfur content is evaporated as SO₂ leaving reddish powder of Ferric Oxide.

**Not verified in the present study, data taken from authentic source^[9]

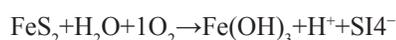


Figure 1: Test conducted for physical properties verification of *Vimal* (iron pyrite)

physical properties for identifying the minerals are color, luster, streak, hardness, cleavage, fracture, and crystal form.^[12] Some other properties such as reaction with acid, magnetism, specific gravity, tenacity, taste, and odor are helpful in identifying certain minerals.^[12] The most of the physical properties verified in this study are very well match with the standard of Iron pyrite^[7] [Table 3 and Figure 1]. The properties mentioned in classical text such as *Vartula*, *Konasanyukta*, *Snigdhtawa*, and *Phalaka Sadarsh* are very well matched with crystal habit, luster, nature, etc., physical properties of mineralogy. However, collection of sample from different geological sources may affect the physical properties of any sample. Pale dull gold colored iron pyrite leaves slight greenish and brownish-blackish line on streak test. Luster describes the appearance of a mineral when the light is reflected from its surface.^[13] Its metallic luster reflects the presence of metal (Fe). However, while, heated on charcoal with sodium carbonate, pyrite gives a magnetic residue and gives off SO₂ fumes.



Iron pyrite is insoluble in water and HCl, but a fine powder will dissolve in concentrated HNO₃. Pyrite's chemical reaction with water and oxygen showed following reaction:



The EPMA study confirmed that the presence of Fe, and S in major proportion and formed the structure of FeS₂. The

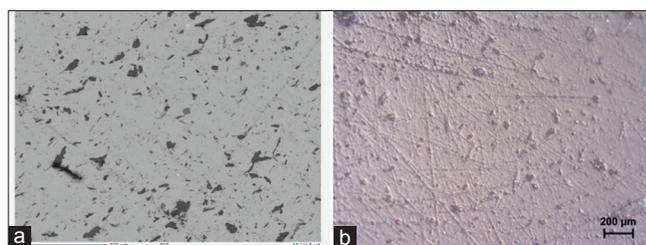


Figure 2: (a and b) Backscattered electron microscopy of mineral *Vimal* by electron probe microanalysis

elements of Cu, Ni, Pb, Sn, S, As, Sb, Ba, Mg, Si, Al, and Na are presented in trace amount Table 4.

In industries, iron pyrite (iron disulfide) is used in industries as an absorbing semiconductor in solar cells,^[14] as well as for stripping mercury^[15] and removing industrial pollutants.^[16] One of the studies suggested that iron (pyrite) disulfide nanocrystals could be excellent antimicrobials.^[17] Biocompatible iron disulfide nanocrystals did not significantly influence the cytotoxicity, which proves it non-toxic metallic sulfide and their potential biomedical applications.^[17]

The present study confirms the authenticity of *Vimal* by following the standards of classical as well as contemporary references. However, therapeutically *Vimal* is used after proper *Shodhana*^[18] and *Marana*^[19] with proper combination of other drugs, dosage, and selection of suitable vehicles. In Ayurveda, *Vimal* and other metals or minerals are used in the form of *Bhasma*. In current trend, these *Bhasmas* are considered as nanomedicine due to most of the particles in nano (1–100) nm range and biomedical application of nanomedicine is well understood and one of the emerging trend in medicine.^[20,21]

CONCLUSION

Ayurveda has mentioned acceptable properties of every metals and minerals. However, it is necessary to validate and establish those properties on the basis of contemporary knowledge for the selection of genuine sample, because raw drug standardization plays a pivotal role in assessing final drug for better therapeutic effects. The Ayurvedic Pharmacopoeia of India has mentioned 21 monographs of single metals and minerals. However, *Vimal* is not included in that list. Hence, this study may be helpful in some extent to develop its standard monograph.

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Table 4: The elemental assay of mineral *Vimal* analyzed by EPMA

Element S. NO.	Fe	Cu	Ni	Pb	Sn	S	As	Sb	Ba	Mg	Si	Al	Na
1	45.62	0.23	0.39	0.45	0.47	52.02	0.12	0.15	0.34	0.06	-0.00	-0.06	-0.22
2	44.36	0.26	0.47	0.39	0.48	52.60	0.06	0.15	0.15	0.02	-0.02	-0.04	-0.21
3	46.22	0.44	0.45	0.50	0.55	52.34	0.12	0.17	0.31	0.03	-0.03	-0.06	-0.22
4	41.21	0.40	0.44	0.32	0.46	49.59	0.07	0.18	0.50	0.35	0.32	0.94	0.04
5	45.07	0.31	0.25	0.35	0.49	52.45	0.12	0.16	0.49	0.03	-0.0.05	-0.04	-0.19
6	46.38	0.29	0.15	0.39	0.49	52.50	0.13	0.16	0.19	0.01	-0.03	-0.07	-0.20
7	43.75	0.28	0.39	0.46	0.43	46.80	0.12	0.13	0.03	0.07	0.30	0.18	-0.17
8	46.38	0.06	0.50	0.53	0.55	51.54	0.08	0.17	0.28	0.04	-0.02	-0.06	-0.21

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