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Scientific Analysis of Satvapatana (Process of Extraction of Metals from Ores)

[1]Dr. Pallabi Mahanta, [2]Prof (Dr.) Abhaya Kumar Mishra
[1]Assistant Professor, [2]Professor and Head,
[1,2] Dept. of Rasashastra & Bhaishajya kalpana, Sri Sri College of Ayurvedic science and Research hospital, Sri Sri University, cuttack, Odisha, India
Email: [1]drpallabimahanta@gmail.com

Abstract: *Rasashastra is Ayurvedic Iatrochemistry that deals with the various pharmaceutical processes of Shodhana (purification/potentiation), Marana (incineration/calcination), Jarana (polling), Murchhana (a procedure by which substances, particularly mercury, are transformed for therapeutic application), and other detailed descriptions of metals, minerals, poisonous plants, and animal products. Satvapatana is a Rasashastra process for extracting the Satva (essence) of metals and minerals from their natural source. Satvapatana's main objective is to get the active component of ore and minimise the dose of Dhatu (metals) while maintaining its medical efficacy. Satvapatana was first stated by Acharya Nagarjuna in Rasendra Mangala. It is also mentioned in various ancient texts such as Anandakanda, Rasarnava, Rasa Hridaya Tantra, Rasendra Chudamani, Rasa Ratna Samucchayam, and Rasa Ratna Samucchayam. Satvapatana is likened to metallurgy in contemporary science. However, the goal of Satvapatana is not the same as the goal of metallurgy. Satvapatana tries to extract therapeutically active material, while metallurgy aims to obtain the purest form of metal for commercial interests.*

Key Words: *Satvapatana, Satva (essence), metals, minerals, metallurgy.*

1. INTRODUCTION:

Satvapatana is one of the most important Rasashastra techniques for obtaining the Satva (essence) of metals and minerals from their original source. To get the satva, a mineral is combined with kshara (alkali), amla (sour), and dravaka varga and heated in a koshthi/Musa (crucible). [1]Satvas are not only valuable for mercurial processing, but they may also be used for medicinal reasons after being subjected to Shodhana, Mridukarana, and Marana. Satvapatana has two stages: Beejavarta and Shuddhavarta. Beejavarta represents material melting, whereas Shuddhavarta represents the period for Satva extraction. The quantity of heat needed and the sort of Mushas (Crucible) used for Satva extraction are determined by the nature of Dravya. These Satvas have a variety of applications, for example, Abhraka Satva is used as Rasayana[3], Mudrika (ring) created with Tuttha Satva and Bhunaga Satva is used to alleviate Shoola, in Netraruja, in healing Charachara Visha (poison), and so on. Before employing Satva for medicinal reasons, it must undergo processes such as Shodhana (purification), Mridukarana (softening), and Marana (incineration). Acharyas have described Dravaka Gana for Satva extraction, which contains Gunja (Abrus precatorious), Madhu (honey), Guda (jaggery), Ghrita (clarified butter), Tankana (borax), and Guggulu (Gum of Balsamo dendron). Tankana (borax) acts as a flux, assisting in the development of slag and lowering the melting point of the metal. During reduction, a chemical known as flux is introduced to the ore, which mixes with impurities to generate an easily fusible product known as slag, which is known as Kitta in Ayurveda. Poling is a process of purifying metals that have oxidised impurities. In the past, trees were employed as wooden poles. The sap in these poles functions as a reducing agent. The metal oxides generated are decreased by interacting with the released hydrocarbon gases. Guggulu, a plant substance, might aid to speed up this process. Organic substances like Guda and some organic acids of Gunja are converted to carbon in its purest form, which then functions as a reducing agent. Gunja organic acids may potentially work as catalysts since its extracts are thermostable. Kasisa is ferrous sulphate that when heated loses its water, melts, and is transformed to anhydrous ferrous sulphate. Further heating converts it to ferric oxide, which is red in colour and looks precisely like Kasisa Bhasma. To prevent this formation, we must utilise carbon since carbon is more reactive than iron and hence displaces iron from iron complexes. Bhavana of Dravakagana is fed to Kasisa to provide organic carbon that will not react with oxygen and

so limit the production of Bhasma. So, the inclusion of Dravakagana is the most crucial factor in Kasisa Satvapatna pharmaceutical research.

2. SATVAPATANA:

The Process of the Dhatu extraction from any of the "Dhatu Dravya" through various Pharmaceutical procedures is called as "Sattvapatana".

E.g-Abhraka sattva, Haratala, Chapala

Dhatu → Trituation → Kshara Amla / Dravaka Dravya → Musha

↓

Sattvapatana kosthi → Sattva

3. CLASSIFICATION:

Based on Source

↓ ↓

Dhatu Roopa (Metal form**)** **Adhatu Roopa (**Non-Metal form**)**

E.g-Abhraka Sattva, Swarnamakshika Sattva E.g-Haratala

Based on Origin

i. Mineral- Abhraka, Vakranta
ii. Animal –Bhunaga, Mayurpiccha
iii. Herbal-Kankushtha

Based on Collection

i. Sublimating form of Sattva (Hg)
ii. Non-Sublimating form of Sattva (Fe,Cu)

4. NEED OF SATVAPATANA:

Even after purification, some minerals, such as Vaikranta (tourmaline), Kantapashana (ore of magnetic iron), Sasyaka (bornite ore), Makshika (copper pyrite), Vimala (iron pyrite), etc., cannot be mixed with other Satva, and neither Dhatu nor Parada (mercury) can eat it. Satvas are especially advised for Mercury Charana and Jarana Samskara. Sattva is employed in the processing of mercurial because minerals may include contaminants. Abhrakasatva is said to be the finest for cutting the wings (Pakshachhedana) of mercury, making it thermostable. Making it thermostable without severing the wings of mercury would be like attaining Moksha (freedom) without having control over the senses. Satvas are not only beneficial for mercurial processing, but they are also valuable for therapeutic reasons after being subjected to Shodhana(Purification) and Marana(Incineration). These may be more helpful therapeutically than their minerals.

5. BASIC REQUIREMENTS FOR SATVAPATANA:

- **Sattvayukta Materials:** Only those metals and minerals with Satva are utilised for Satvapatana. The extracted satva may take the form of a metal or a mineral. There are several methods for obtaining various Satvas. Herbal extracts, for instance, are made by crushing and macerating the plants in water, followed by sedimentation. Metals having lower melting or vaporisation points may have their Satva removed by sublimation, such as Parada. Dravaka gana is used to extract the Satva from metals with higher melting points.
- **Dravaka Varga:** Metals are displaced from the source by Dravaka Varga and Mitrapanchaka (Gunja, Madhu, Guda, Grutha, Tankana, and Guggulu).

Flux: A compound added to the melted metals that bonds with impurities may be easily removed, such as Tankan (acts: decreasing MP (Melting point) and assisting in slag formation)

Slag: waste material that is taken from

Poling: Green log of wood which is used to stir the molten metal (Metal oxides-reduced-reacting with hydrocarbon gases that are liberated) Guggulu-helps to accelerate the process

Reducing Nature of Carbon: Carbon Reacts with Oxygen in 2 ways→

$C + O_2 \rightarrow CO_2$-------- (1) @932°K

$2C + O_2 \rightarrow 2\ CO$-------- (2) @>932°K

Law of Thermodynamics – <932°K- Carbon monoxide-energetically a better reducing agent than carbon
Auto reduction: Some reduction reaction does not require the reducing agents.
Cations- least electropositive metals- reduced without use of any additional reducing agents. Also called as

AIR REDUCTION:
E.g: extraction of Pb, Hg, Cu etc**.**
In manufacture of Mercury the Sulphide ore (Cinnabar) is heated in a current of air when following reactions occur-

$$\mathbf{2HgS+3O_2 \rightarrow 2HgO+2SO_2}$$
$$\mathbf{2HgO \rightarrow 2Hg+O_2}$$
$$\mathbf{2HgO+HgS \rightarrow 3Hg+SO_2}$$

Similarly, for Cu, where the sulphide and the oxide act together, at an elevated temperature to give the metal

$$\mathbf{Cu_2S+2Cu_2O \rightarrow \quad SO_2 + 6Cu}$$

Catalyst: Organic acid of a plant source- **Gunja -** extract of gunja are thermo stable

- **AGNI (HEAT):** Depends upon the dravya involved in Satvapatana.

In a closed Musha, high heat is often used when doing Satvapatana. Not all operations always call such intense heat. Again, it depends on the Dravya from which the Satva is to be extracted. For example, Abhraka requires Tivragni (high heat), but Rajavarta requires Khadirangara (heat with embers from the Khadira plant). Acharyas have said that the Satvapatana is made from the Charcol of Khadira (Acacia catechu) and Mahua (Madhuca longifolia) plants.

- **MUSHA:** Vajra Musha (intense heat) Samanya Musha (Mild to Moderate heat).

Crucibles, or mus muhas, are inert containers with exceptional thermal tolerance. Temperature-resistant organic and inorganic materials are used in their preparation. There are several Mushas for various temperature patterns, such as those that are resistant to high temperatures. Vajra Musha is employed whereas Vrintaka Musha is chosen for the extraction of Satva from Kharparadi Dravyas.

- **KOSHTI:** Angara Koshti **(**Katina Dravya**),** Patala Koshti **(**Mrudu Dravya**),** Gara Koshti (Mishra Dravya)

The fireplace is crucial because it maintains the proper temperature for Satvapatana. Different Koshtis exist based on the kind of Dravya, such as Angara koshti for Mishra dhatu Satvapatana, Patala koshti for Mridu (soft) Dravyas, and Gara koshti for Katina (hard) Dravyas Satvapatana.

5. MODERN TECHNIQUE OF METAL EXTRACTION:

The reactivity of the metals determines how they are extracted from the ore in which they are located. e.g Less reactive metals, like iron, may be removed by reduction with carbon or carbon monoxide. Reactive metals, like aluminium, are extracted by electrolysis. Concentration of ore, calcination, roasting, reduction to free metal, and refining/purification are the four stages of metal extraction.

- **CONCENTRATION OF ORE:** The process of eliminating gangue particles from ore in order to increase the amount of metal in the ore is known as concentration of ore, also known as dressing, benefaction, or ore enrichment. Ore may be concentrated using a variety of techniques, including hand picking, gravity separation, magnetic concentration, electrostatic concentration, and froth flotation.
- **CALCINATION:** It is a method that involves heating ore to a high temperature below its melting point without any or very little air. The ore releases volatile impurities including carbon dioxide and sulphur dioxide as well as organic debris and moisture.
- **ROASTING:** In the presence of too much air, ore is heated to a high temperature below its melting point. Moisture escapes, and phosphorus, arsenic, and sulphur impurities are converted to volatile oxides.
- **REDUCTION TO FREE METAL:** When a metal oxide is reduced, oxygen is taken out in order to purify the metal and restore it to its free condition. Smelting, air heating, aluminium reduction, electrometallurgy, amalgamation, and hydrometallurgy are some of the procedures used to refine metals.

- **REFINING/PURIFICATION:** Refining is a process for eliminating impurities and producing high-purity metals. Liquidation, the distillation process, electrolytic refining, vapour phase refining, etc. are some examples of refining techniques.

Beejavarta and Shuddhavarta are the first and second phases of Satvapatana, which happens according to temperature. In Beejavarta, a specific hue flame is created for a certain substance, signifying the material is melting. Beejavarta also goes by the name Rekhavarta, according to Ananadkanda. According to Rasaarnav, various Dhatus emit various coloured flames at a certain temperature, which are as follows:

TABLE NO-01, DIFFERENT DHATU (METALS) WITH THEIR PARTICULAR FLAME[4, 5]

Sl No	Dhatu (Metals)	Colour of Flame
01	Swarna(Gold)	Peeta i.e Yellow
02	Rajata(Silver)	Seeta i.e White
03	Tamra(Copper)	Neela i.e Bluish
04	Loha(Iron)	Kapila i.e Brownish red
05	Tikshna loha(without iron)	Krishna i.e Black
05	Naga(Lead)	Dhumaka i.e Greyish Black
06	Vanga(Tin)	Kapota i.e Bluish grey

TABLE NO-02, DIFFERENT RASA DRAVYAS AND COLOUR OF THEIR SATVA: [6]

Sl No	Rasa Dravyas	Colour of Satva
01	Abhraka(Mica)	Lohanibha (like Loha), Swarnavarna (colour of gold), Kamsyanibha (like bell metal)
02	Vaikranta (Tourmaline)	White like Shankha (chonch shell), Kunda and Chandra (moon)
03	Makshika(Chalcopyrite)	Gunjanibha (red colour)
04	Vimala (Iron Pyrite)	Sisha sannibha (white or greyish), Chandrika Samkasaha (white)
05	Adrija (Black bitumen)	Lohasannibha (like iron)
06	Sasyaka / Tuttha (Blue vitriol)	Indragopa samkasha, Kinshukprabhama, Kirtundasaprabhama, Shobhanam, Tamrakam, Tamramayam, Tapayajsamam (Rakta & mridu), Shonitabindu, Shuka Picchanta, Kanchanbindhubhi, Tamrarupa (red in colour)
07	Rasaka (Zinc ore)	Sishopama, Vangabha (white colour)
08	Hartala (Orpiment)	White
09	Gauripashana (White Arsenic)	White
10	Hingula (Cinnabar)	Sutasamkasha (White)
11	Mriddarashringa (Litharge)	Nagasankasha (like lead)
12	Bhunaga (Earthworms)	AbharvataSatva (vyomvat), Sushobhanama, KharSatvama, Ravakana sukshmana, Nagatamra, Shonitabindu, Tamravata (like copper)
13	Mayurapiccha (Peacock's feathers)	Nagatamra, Tamraabham, Tamravata Satvam (like copper)

6. DISCUSSION & CONCLUSION:

The amount of heat used to the ores to extract the satva varies according on their hardness. Tivragni (high heat) is given for Abhraka, Vaikranta, Makshika, for Vimala-heat with six prasastha (4608g) of kokila (charcoal), for Tuttha, heat in Baluka yantra (sand as a media to give more heat), for Talaka (orpiment), and for Rajavarta (lapis lazuli). Satvapatana is likened to metallurgy in current science. But the goal of Satvapatana is not the same as the goal of metallurgy. Satvapatana is concerned with obtaining therapeutically active material, while metallurgy is concerned with obtaining the purest form of metal for commercial interests. Every science grows when it understands its fundamental phenomena. Satvapatana is the process of extracting essence from its natural state. Satvas are employed in both mercurial processing and form. Satvas are utilised for mercurial processing and are more effective therapeutically than their minerals. Satvapatana is therefore a vast region that has to be studied further.

Conflict of interest - Nill

REFERENCES:

1. Vagbhata, Rasa Ratna Samuchaya with suratnoojvala commentary of Ambikadatta Shastri, 8th Ed. Varanasi: Chaukhamba Amarabharati Prakashana; 2011; p.138.
2. Yadavji Trikamji Acharya, Rasamrutam, Reprint Edition, Varanasi;Chaukhamba Sanskrit Sansthana;2007.pg 282.
3. Vagbhata, Rasa Ratna Samuchaya with suratnoojvala commentary of Ambikadatta Shastri, 8th Ed. Varanasi: Chaukhamba Amarabharati Prakashana; 2011; p.43.
4. Ttipathi I.D, Rasachadrika Hindi Commentary on Rasarnava or Rasatantram, Chaukhasmba Sanskrit series office, Varanasi, Edition fourth; 2001,chapter 4, verse no 49-51, p51.,
5. Mishra G.S and Sharma S.K , Suvariti Haindi commentary on Rasakamadhenu by shri chudamani mishra, chaukhamba orientalia, Varanasi, Edition third ; 2007, part first, chapter -2, verse 14-16,p68.
6. Hussain G. Concept of satvapatan: a review. Journal of drug delivery and therapeutic 2019 jan15; 9(1): 271-2.