

# A Critical Review on *Haratala* (An Arsenical Compound)



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## ABSTRACT

**Background:** *Haratala* is described as the *Dhatu visha* and it contains arsenic and sulfur. Arsenic is a heavy metal that may lead to acute or chronic heavy metal toxicity. Although *Haratala* is effective and popular as *Rasamanikya*, it is not used as *Rasayana* or therapeutic drug in routine practice either in pure or in *Bhasma* form. It is used as a main drug or an auxiliary drug to prepare formulation.

**Aim:** To focus on the various utilities of *Haratala*, so that it can be safely used in the clinical practice in a wide range of indications.

**Review results:** In the literature available, it is observed that along with therapeutic utility of *Haratala*, *Haratala Bhasma* is used as *Rasayana*. But arsenic present in *Haratala* may cause toxicity if *shodhana* and *marana* of *Haratala* are not conducted properly. It is observed from the previous research that *shodhana* may enhance the synergistic effect of *Haratala* in cellular apoptosis for the treatment of leukemia. *Marana* may provide safer bioassimilability before their use in most of the formulations in which it may act as an antagonist and subside the toxicity of the formulations.

**Conclusion:** *Haratala Bhasma* is indicated in various disease conditions. Hence, it can be used as *Avasthika Rasayana*. But during its use, safety of the drug should be ensured by following proper *shodhana* and *marana* procedures.

**Clinical significance:** Studies should be conducted to observe its efficacy in healthy individuals as *Rasayana* and in patients of acute promyelocytic leukemia (APL) as an adjuvant drug.

**Keywords:** *Avasthika Rasayana*, Critical review, *Dhatu visha*, *Haratala*, *Marana*, *Shodhana*.

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## BACKGROUND

*Somala*, *Haratala*, and *Manahshila* are the three arsenic compounds mentioned in Ayurveda. *Dhatu visha* is described in Ayurveda by Sushruta with its two examples as *Phenashma* and *Haratala*. It is categorized in *sthavara visha* as it is originated from soil. *Haratala* is orpiment or arsenic trisulfide ( $As_2S_3$ ). *Rasadravya* are classified as *Maharasa*, *Uparasa*, and *Sadharana Rasa*. *Haratala* is included in *Uparasa* and described as one of the seven *Upadhātu* mentioned in *Rasa Grantha*.<sup>1</sup> This mineral is in therapeutic use since Charaka Samhita period. Books of Rasashastra have explained about it in details. Among all *Visha Dravya*, *Haratala* is the only mineral mentioned in the treatment of various acute and chronic diseases.<sup>2</sup> *Haratala* is enlisted in schedule E(I) of poisonous drugs under Drugs and Cosmetic Rules 1945.

*Haratala* is identified as arsenic trisulfide also known as yellow sulfide, orpiment, jarda, and senko. It is a yellow solid opaque mass. It takes its name from the Latin auripigmentum (aurum—gold + pigmentum—pigment) because of its deep yellow color.

It was an important item of trade in the Roman Empire and was used as a medicine in China, though it is highly toxic. It was also used as a fly poison and to poison arrows. Because of its striking color, it was also a favorite with alchemists searching for a way to make gold, both in China and in the West.<sup>3</sup>

Orpiment was ground, processed, and used for centuries as a pigment in painting, being one of the few clear, bright yellow pigments available to artists up until the 19th century. Orpiment presented problems, however, such as its extreme toxicity and its incompatibility with other common pigments such as lead and copper-based substances. The use of orpiment as a pigment matter ended almost entirely with the advent of the cadmium yellows and the various dye-based colors of the 19th century. It is presently used in the production of infrared-transmitting glass, oil cloth, linoleum; in

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semiconductors and photoconductors, as a pigment; for depilating hides and in fireworks.

Although *Haratala* is a toxic substance, it can be used for various therapeutic purposes with the help of *shodhana* procedures mentioned in Ayurveda. Hence, the article aims to highlight the therapeutic uses of *Haratala*.

## REVIEW RESULTS

*Haratala* is mentioned as one of the seven *Upadhātu* mentioned in *Rasa Grantha*.<sup>1</sup> For the first time in Charaka and Sushruta Samhita, *Phenashma* (arsenic trioxide) and *Haratala* ( $As_2S_3$ ) are mentioned in the context of *Sthavara Dhatu Visha*.<sup>4</sup> *Haratala* is a combination of arsenic and sulfur. It is a natural mineral just like

yellow prism. Its synonyms are *Haritala*, *Taal*, *Talak*, *Nagabhushana*, *Natamandanaka*, *Shailushabhushana*, *Bidalaka*, *Chitragandhaka*, *Pinjara*, *Vanshapatraka*, *Aala*, *Pitanaka*, *Mallagandhaja*,<sup>5</sup> *Taalmaala*, *Maala*, *Pinjaka*, *Romaharana*, and *Pita*.<sup>6</sup> It is of two types: *Patra* (*Barki*) *Haratala* and *Pinda Haratala*.<sup>7</sup>

In Siddha, *Haratala* is of four types: *Bagadadi*, *Godanti*, *Tabaki*, and *Panda*. They are less potent, respectively. *Vansha Patri Haratala* is poisonous. It is lustrous, smooth, and yellow like gold. One sheet of *Haratala* is arranged on another. Sheets can be separated easily. It is also known as *Bagadadi Haratala* and it is found in Iran and it is best for medicinal use. *Haratala* is *Katu*, *Snigdha*, *Kashaya*, and *Ushna*. It is used in *Visha*, *Pama*, *Kotha*, *Kushtha*, *Rakta Vikara*, *Kapha*, *Pitta Roga*, and *Roma* diseases. It is indicated in all the diseases and it rejuvenates the body. It increases vigor and vitality. *Haratala* is soluble in acid, ammonia, and *Javakhara*. *Kritrima* (synthetic) *Haratala* is prepared from three parts of *Somala* (arsenic trioxide) and two parts of *Gandhaka* (sulfur). They are first purified and triturated together. Then they are kept on fire in *Damaru Yantra*. They are very poisonous and not used in treatment.<sup>8</sup>

In Charaka Samhita, *Haratala* is used as an external application in various skin disorders and in the subject of *Shirovirechana* as an ingredient of *Dhumapana*. *Haratala* is indicated for skin diseases apart from *Unmada* (insanity), *Hikka* (hiccups), *Shwasa* (dyspnea), *Kasa* (cough), and in *Visha Chikitsa* (toxicosis) in the form of oil and *Sura*. It is also used for *Pradeha*, *Pralepa* (the external applications), *Dhumapana* (smoking), *Anjana* (collyrium), and in the form of powder and *Agada* for internal uses.

In Sushruta Samhita, *Haratala* is indicated for *Vrana Sodhana* (wound cleaning), *Pandu Karma* (coloring the skin after scars of wounds), *Arsha* (piles), various skin disorders, *Granthi* (nodules), *Upadamsa* (syphilitic pimples), *Visarpa* (spreading poisonous wounds), and as a hair remover in different *Yogas* and in *Lutadansa Chikitsa*. It is also used for worms, eye diseases, skin diseases, and several pediatric disorders in the form of oil, powder, and *Dhumapana*. In Sangraha Granthas, Vagbhata has applied *Haratala* mainly on *Nasa Rogas* (nasal diseases), *Sotha* (edema), *Vrischika Dansa* (scorpion sting), for *Vidarana* action, i.e., self-opening of the abscess.

Bhela Samhita, Kasyapa Samhita, etc., have described the indications of *Haratala*. From the age of Nagarjuna, the description of orpiment with regard to its properties, indications, and contraindication, *sodhana*, *marana*, *satvapata*, etc., are more elaborately described. He has utilized this drug for various alchemical processes for converting basic metal into noble one.

Though *Haratala* is a toxic substance, it can be used for various therapeutic purposes with the help of following *shodhana* procedures mentioned in Ayurveda (Table 1).

*Shuddha Haratala* is not used as a single drug in treatment. Rather it is used as a main ingredient or as an auxiliary ingredient in various Ayurvedic formulations. The formulations of *Haratala* are *Rasamanikya*, *Talakeshwara Rasa*, *Kasturibhairava Rasa*, *Talasindura Rasa*, *Samirapannaga Rasa*, *Smrutisagara Rasa*, *Nityananada Rasa*, *Vatagajankusha Rasa*, *Talakodaya malahara*, *Navajware Bhankusha Rasa*, *Haritaladi Yoga*, etc. *Haratala Bhasma* is used in the treatment of various diseases. Different methods of preparation of *Haratala Bhasma* are mentioned.<sup>16,18,19</sup> Acharya has also described a qualitative test to ensure the best quality of *Haratala Bhasma*. *Haratala Bhasma* is said to be the best when it is put on fire, with no fumes appearing.<sup>20</sup> Acharyas may be expecting complete evaporation of sulfur which is responsible to produce fumes, resulting in the conversion of arsenic trisulfide into arsenic oxide.

The variations in the dose of *shuddha Haratala* and *Haratala Bhasma* according to different literature (Table 2).

**Table 1:** Various methods of *Haratala shodhana*

S. no.	Method	Yantra	Media	Time
1	Swedana <sup>9</sup>	Dolayantra	Nimbu swarasa	One prahara (one yama)
2	Swedana <sup>9</sup>	Dolayantra	Gruhadhoom jala	One prahara (one yama)
3	Swedana <sup>10</sup>	Dolayantra	Kushmanda swarasa Churnajala or triphala kwatha	One prahara (one yama) Two prahara (two yama)
4	Swedana <sup>11</sup>	Dolayantra	Tila kshara jala	One prahara (one yama)
5	Swedana <sup>12</sup>	Dolayantra	Shalmali moola swarasa	One prahara (one yama)
6	Bhavana <sup>12</sup>	Khalva yantra	Shalmali moola swarasa	Seven times
7	Bhavana <sup>13</sup>	Khalva yantra	Churna jala	Seven times
8	Swedana <sup>14,15</sup>	Dolayantra	Chuna and kanji, Kushmanda swarasa, tila taila, triphala kwatha	One prahara each separately
9	Swedana <sup>16</sup>	Dolayantra	Kanji	One prahara (3 hours)
10	Swedana <sup>17</sup>	Dolayantra	Kushmanda swarasa, Churnodaka and tila taila	One prahara each three or seven times

**Table 2:** Dose of *Haratala* and *Haratala bhasma*

S. no.	Dose of <i>Haratala</i>	Dose of <i>Haratala bhasma</i>
1	1/4–1/2 Ratti (30–60 mg)	1/4–1/2 Ratti (30–60 mg) <sup>21</sup>
2	One rice grain with sugar and <i>Jiraka</i> powder <i>Pathya</i> : <i>Sathi</i> rice and <i>Godugdha</i>	1/8th part of <i>Ratti</i> (15 mg) with <i>Godugdha</i> . In <i>Kshaya</i> and old age <sup>22</sup>
3	–	One <i>Ratti</i> (120 mg) <sup>16,23</sup>

## HARATALA AS RASAYANA<sup>2</sup>

The use of *Haratala Bhasma* as a *Rasayana* is exclusively mentioned in Ayurved Prakash along with its dose, duration, and benefits. *Haratala Bhasma* ingested for 21 or 40 days in a dose equal to one rice grain or one *Ratti* with proper *Anupana* cures 18 types of *Kushtha*; 13 types of *Sannipata*; 8 types of *Maharoga*; 80 types of *Vataroga*; 40 types of *Pitta Roga*; 20 *Kapha Roga*, old age, *Prasuti Roga*, *Apasmara*, *Paparoga*, *Bhagandara*, *Nadivrana*, *Vatarakta*, *Upadansha*, *Phiranga*, *Shleepada*, *Granthi*, *Sarvanga Shotha*, and *Madhumeha*; and 20 types of *Prameha*, *Vruddhi*, *Arbuda*, *Gandamala*, *Aamavata*, *Ghridhrasi*, *Moodhavikara*, *Kshaya*, and *Shoshavikara*. It improves strength, complexion, courage, vigor, sex power, and vision. Hence, *Haratala Bhasma* can be used in various diseases with different *Anupana* according to the diseases (Table 3).

*Marich*, *Kajjali*, *Shuddha Vatsanabha*, and *Shuddha Haratala*, each in equal quantity is triturated with water and made into a tablet of one *ratti* is indicated for *Sannipatika Jwara Pralapa*, *Mohayukta Jwara*, and Malaria. *Shuddha* copper sulfate one part,

**Table 3:** Internal use of *Haratala bhasma* in various diseases with different *Anupana*<sup>24</sup>

S. no.	Indication	Anupana
1	Shwasa (asthma)	Vasa swarasa/kantakari swarasa
2	Rakta Vikriti (blood disorders)	Amragandhi Haridra swarasa
3	Apsmara (epilepsy)	Vacha and jeeraka churna
4	Kushtha Roga (leprosy)	Decoction of Panchatikta kashaya
5	Vatarakta vikara upadrava (complications of gout)	Devadali swarasa
6	Visarpa (erysepalus)	Vyandhyakarkotaki rasa
7	Twacha Roga (skin diseases)	Kumari Swarasa
8	Arsha (haemorrhoids)	Haritaki Churna
9	Pandu (anaemia)	Haridra Swarasa
10	Vatarakta (gout)	Guduchi Satwa
11	Kshaya roga (tuberculosis)	Tambool
12	Prameha (diabetes)	Tulasi Swarasa
13	Jalodara (ascitis)	Aja Mutra
14	Agnimandya	Pippali Churna and Madhu
15	Shukra prameha	Lavanga, Dalchini, Kesara
16	Pratishyaya (common cold)	Jatipatra, Kesara
17	Vatanadi Shoola (nervine pain)	Trikatu Churna, Tamra Bhasma
18	Balavardhana (strengthening)	Jayaphala Churna

*Shankha Bhasma* two parts, and *Shuddha Haratala* three parts are triturated with *Kumari Swarasa*, sealed in *Sharawa Samputa*, and *Laghuputa* is obtained. It is indicated in *Vishama Jwara* and *Visha Krimijanya Jwara*, in dose equal to one *Yava*. *Tamra Bhasma*, *Kajjali*, and *Shuddha Haratala* each taken in equal quantity is triturated 14 times with *Nimba swarasa*. It is consumed in one *Ratti* dose, 3 hours before malarial fever.

## EXTERNAL USES OF HARATALA

In *Vrishchika Dansha*, *Lepa* of *Haratala* and *Nausadara Churna* are applied. In *Lingarsha*, *Lepa* of *Apamarga Moola Twaka* and *Hartala* in water are applied. *Talakodaya Malahara* is used in *Vicharchika*, *Dadru*, *Kushtha*, *Pama*, *Visphota*, and *Nadivrana*.<sup>25</sup>

## ANTIDOTE FOR HARATALA POISONING

As *Haratala* contains arsenic as a heavy metal, it can cause acute or chronic toxicity, if the formulations containing *Haratala* are not prepared properly or *shodhana* and *marana* are not performed according to classical texts. Symptoms of arsenic toxicity can be observed in such cases.

If poisoning occurs due to the consumption of *Ashuddha Haratala* or overdose of *Shuddha Haratala* or *Haratala Bhasma*, *mishri* (sugar) and *jiraka* powder in equal quantity in a dose of three *masha* with honey or *Kushmanda Rasa* (*Benincasa hispida*) three *Tola* with *Mishri* three times a day for 3 days should be consumed as an antidote.<sup>26</sup> *Madya*, *Thila thaila*, and *Paribadra Pushpa dala kashaya* are described as *Prativisha* (antidote) for *Haratala* toxicity.<sup>27</sup>

## DISCUSSION

*Haratala* ( $As_2S_3$ ), *Manahshila* ( $As_2S_2$ ), and *Gauripashana* ( $As_2O_3$ ) are the arsenical compounds used in Ayurveda since thousands of years for various indications. In Bhaishajya Ratnawali alone, 91 formulations of *Haratala*, 61 formulations of both *Haratala* and *Manahshila*, one formulation of *Haratala* and *Somala* (*Gauripashana*) in combination, and 3 formulations of all three arsenicals are mentioned. Out of them, maximum formulations were used for the treatment of *Jwara* (Pyrexia).<sup>28</sup> In Ayurved Prakasha<sup>2</sup> and Rasatarangini,<sup>29</sup> *Haratala* is mentioned as *Rasayana*. It causes remission of high-grade fever due to infections. It is a great immunomodulator and helps in the formation of new red blood corpuscles and hence very useful in erythropoiesis and ultimately fights severe anemia. It is effective in a wide range of indications as *Rasayana*. It is popularly used in various blood and skin disorders. Still scientific research on *Rasayana* property is not conducted.

*Ashuddha Haratala* causes severe *Daha*, *Kshobha*, *Sharir Kampa*, *Toda*, pain, *Raktadushti*, *Kushtha*, loss of beauty, and deadly diseases of *Vata Kapha*.<sup>30</sup> It is life-threatening *Mehakaraka* and causes *Tapa*, *Sphota*, and *Angasaankocha*.<sup>16</sup> Hence, its *shodhana* is very much essential. Though *Haratala* is a toxic drug, it is used in the treatment after *shodhana* process with a number of acidic and alkaline media of organic origin. *Rasamanikya* prepared with *Haratala* processed in *Kushmanda Swarasa* is proved to be safe in rats when administered at therapeutic and at five times therapeutic exposure dose levels.<sup>31</sup> Safety may be achieved as *Kushmanda* [*Benincasa hispida* (Thunb.) Cogn.] *Swarasa* is an antidote for *Haratala* poisoning. Studies have shown that curcumin is an active compound in *Benincasa hispida* (Thunb.) Cogn, a kind of ribosome-inactivating protein and has high rate of cell apoptosis.<sup>32</sup> Hence, purification by the above agents may enhance the synergistic effect of *Haratala* in cellular apoptosis for the treatment of leukemia.

During *Bhasmikiranana* process under high heat, sulfur gets evaporated from sulfur-containing arsenic minerals and sulfide of arsenic and trioxide of arsenic [ $As_2O_3$ ] are formed.<sup>33</sup> Palbag et al. proved that after *Bhasmikiranana* of *Haratala*, apart from sulfur and arsenic, *Haratala Bhasma* also contains oxygen with wt% of 13.56, due to the formation of oxides of arsenic.<sup>34</sup> On the basis of these research, it can be said that *marana* or *Bhasmikiranana* of *Haratala* may provide safer bioassimilability before their use in most of the formulations in which it may act as an antagonist and subside the toxicity of the formulations. *Bhasmikiranana* process may enhance the bioavailability of the drug and hence potentiate its action.

The US Food and Drug Administration has approved arsenic trioxide as the standard treatment of relapsed acute promyelocytic leukemia (APL). It is given in a dose of 5–10 mg intravenously for APL, but severe adverse effects like cardiac injury, such as QT prolongation, arrhythmias, cardiac arrest, skin lesions, gastrointestinal symptoms, neuropathy, and liver dysfunction are reported with long-term arsenic trioxide use.<sup>35</sup>

The oxides of arsenic formed during *Bhasmikiranana* of *Haratala* are not toxic and proved safe in many animal experiments. Mandal et al. found *Haratala Bhasma* safe in both acute and subacute toxicity study where no immediate and evident toxic signs were observed with classical dose of *Haratala Bhasma*.<sup>36</sup> *Rasamanikya* which is prepared only from *Haratala* is also found safe in animals in 90 days study.<sup>37</sup> Moreover, patients of APL have low immunity and hence they suffer from intermittent fever, thus resembling the symptoms of *Visham Jwara*. *Haratala Bhasma* is mentioned to be

more beneficial to improve their immunity and strength as well as fever and other associated symptoms. Hence, there is a huge scope of the cellular apoptosis property of arsenic-containing *Haratala Bhasma* in combating leukemia.

*Rasayana Dravya* provides physical strength, youth, immunity, sharp memory, intellect and longevity, glow, skin luster, tolerance, adaptation, voice, stability of speech, complexion, and freedom from illness. Mode of action of *Rasayana Dravya* is a complex process. Hence, it can be explained in terms of properties such as antioxidant, immune-modulator, adaptogen activity, tissue protection, and regeneration, bactericidal and antimicrobial activity and cardiogenic effect. Acharya Charaka has mentioned *Rasayana* effects in terms of properties such as *Vayasthapana*, *Ayushkara*, *Medhakara*, and *Ujaskara*. It indicates that the *Rasayana Dravya* may act at the level of *Rasa* by improving specific nutritional values of *Poshaka Rasa* to obtain excellent quality of *Dhatu*. The *Rasayana Dravya* possessing the properties such as *Ushna*, *Laghu*, *Ruksha* and *Katu*, *Tikta*, and *Kashaya Rasa* may act at the level of *Agni*, vitalizing the organic metabolism leading to an improved structural and function pattern of *Dhatu*. They may cause *Srotoshodhana* and production of the *Rasayana* effects. *Rasayana Dravya* which influences *Oja* is supposed to induce *Bala* and *Vyadhikshamatva* (immunity). *Haratala* is *Katu*, *Snigdha*, *Kashaya*, and *Ushna*. It may act at the level of *Agni*, improve metabolism, and *Dhatwagni* leading to production of good quality of *Dhatu*. It ultimately leads to improved *Oja* or immunity. Hence, it is helpful in various types of *Jwara*, infections, blood disorders, and leukemia where *Agni*, *Dhatu*, and *Oja* (immunity) are disturbed. *Haratala Bhasma* is described in various disease conditions. Hence, it can be used as *Avasthika Rasayana*.

Although *Haratala* is effective and popular as *Rasamanikya*, it is not used as *Rasayana* or therapeutic drug in routine practice either in pure or in *Bhasma* form. The doses are different and the duration of its consumption is not mentioned in the classical texts. The duration is mentioned only in the context of its use as *Rasayana*, i.e., 21 or 40 days. Hence, long-term use can cause chronic arsenic toxicity if not used under observation.

## CONCLUSION

Although Acharya has described the uses of *Shuddha Haratala* and *Haratala Bhasma*, in various diseases, they are not used in practice in the current scenario. *Shuddha Haratala* is used to prepare various formulations as a main ingredient or as an auxiliary drug. As *Bhasmikarana* may improve bioavailability and potentiate the action of drug, *Haratala Bhasma* can be used as *Avasthika Rasayana* in disease conditions. As *Haratala* contains arsenic, to avoid arsenic toxicity due to formulations of *Haratala*, proper *shodhana* and *marana* methods mentioned in classical texts should be followed. *Haratala* is a toxic substance, hence precautions should be taken during its prescription as the doses are variable and duration of consumption is not mentioned.

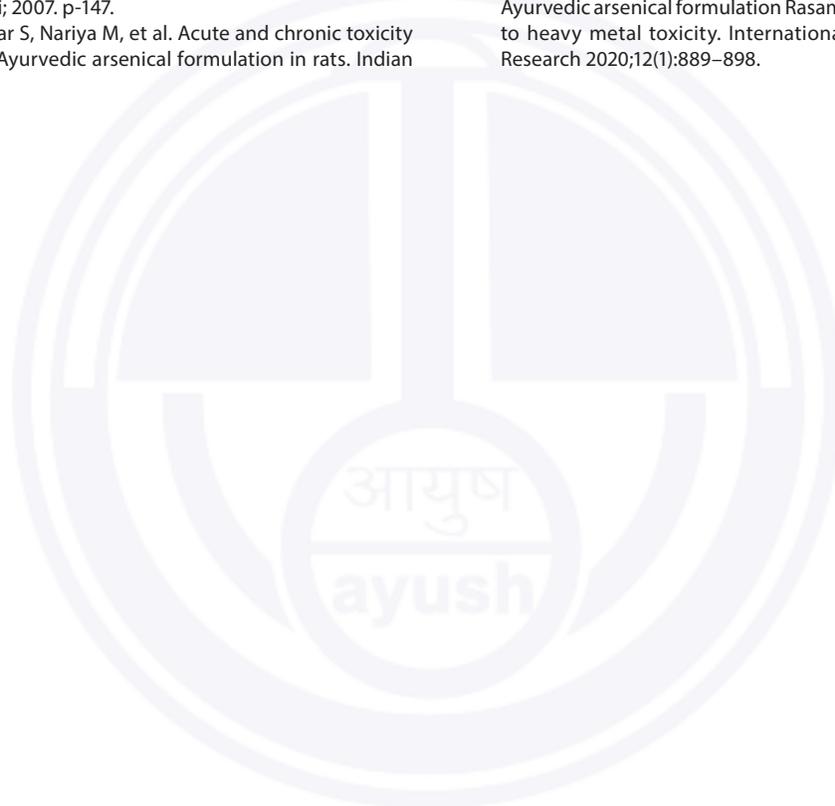
## CLINICAL SIGNIFICANCE

Studies should be conducted to observe its efficacy in healthy individuals as *Rasayana* and in patients of APL as an adjuvant drug.

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## हिंदी सारांश

हरताल (एक आर्सेनिक योग) की आलोचनात्मक समीक्षा

**पृष्ठभूमि:** *हरताल* को *धातु विष* के रूप में उल्लिखित किया गया है और इसमें आर्सेनिक और गंधक होते हैं। आर्सेनिक एक हेवी मेटल है जो कि एक्यूट अथवा क्रोनिक हेवी मेटल विषाक्तता कर सकती है। यद्यपि *हरताल*, *रसमणिक्य* के रूप में प्रभावी एवं लोकप्रिय है, दैनिक अभ्यास में इसका उपयोग *रसायन* अथवा चिकित्सकीय औषधि के रूप में शुद्ध अथवा *भस्म* रूप में नहीं किया जाता है। योग को तैयार करने के लिए इसका उपयोग एक मुख्य औषधि अथवा सहायक औषधि के रूप में किया जाता है।

**उद्देश्य:** *हरताल* की विभिन्न उपयोगिताओं पर ध्यान केंद्रित करना ताकि इसे नैदानिक अभ्यास में रोगों की विस्तृत श्रृंखला में सुरक्षित रूप से उपयोग किया जा सके।

**समीक्षा परिणाम:** उपलब्ध साहित्य में यह देखा गया है कि *हरताल* की चिकित्सीय उपयोगिता के साथ *हरताल भस्म* का उपयोग *रसायन* के रूप में किया जाता है। लेकिन यदि *हरताल* के *शोधन* और *मारण* को उचित रूप से संचालित नहीं किया जाता है तो *हरताल* में उपस्थित आर्सेनिक विषाक्तता का कारण बन सकता है। पूर्ववर्ती शोध से पाया गया है कि *शोधन* ल्यूकेमिया के उपचार के लिए कोशिकीय एपोप्टोसिस में *हरताल* के सहक्रियात्मक प्रभाव को बढ़ा सकता है। *मारण* अधिकांश योगों में उनके उपयोग से पहले सुरक्षित बायोएसिमिलबिलिटी प्रदान कर सकता है जिसमें यह एक प्रतिपक्षी के रूप में कार्य कर सकता है और योगों की विषाक्तता को कम कर सकता है।

**निष्कर्ष:** *हरताल भस्म* को विभिन्न रोगावस्थाओं में निर्देशित किया जाता है। इसलिए इसका प्रयोग *आवस्थिक रसायन* के रूप में किया जा सकता है। लेकिन इसके प्रयोग के दौरान उचित *शोधन* और *मारण* प्रक्रियाओं का पालन करके औषधि की सुरक्षा सुनिश्चित की जानी चाहिए।

**नैदानिक महत्व:** स्वस्थ व्यक्तियों में *रसायन* के रूप में और एक्यूट प्रोमायलोसाइटिक ल्यूकेमिया (एपीएल) के रोगियों में एक सहायक औषधि के रूप में इसकी प्रभावकारिता का पता लगाने के लिए अध्ययन किए जाने चाहिए।

**मुख्य शब्द:** *आवस्थिक रसायन, आलोचनात्मक समीक्षा, धातु विष, हरताल, मारण, शोधन।*