



## Research Article

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**TOXICOLOGICAL AND HUMAN RISK ASSESSMENT OF HARATAL (ORPIMENT/AS<sub>2</sub>S<sub>3</sub>)**Sourav Ballav <sup>1\*</sup>, Gouranga Maity <sup>2</sup>, Nisith Kumar Mondal <sup>3</sup><sup>1</sup>Assistant Professor Department of Agadatantra, Jeevan Jyoti Ayurvedic Medical College & Hospital Aligarh, UP, India<sup>2</sup>Assistant Professor, Department of Rachana Sharir, Raghunath Ayurveda Mahavidyalaya, Contai, West Bengal, India<sup>3</sup>Assistant Professor, Department of Kriya Sharir, Raghunath Ayurveda Mahavidyalaya, Contai, West Bengal, India

Received on: 16/11/18 Accepted on: 17/12/18

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DOI: 10.7897/2277-4343.100113

**ABSTRACT**

With the evolution of civilization and its development, chronic heavy metal poisoning came to light, one of them is  $\alpha$ -allotropic form of arsenic; i.e. Haratal (arsenic trisulphide). Agadatantra the special branch of Ayurveda mainly deals with the toxicological aspect of Ayurveda and the pioneer Ayurveda classic "Sushruta Samhita" 1<sup>st</sup> described haratal as a heavy metal and highlight its toxicodynamic, toxicokinetic along with poisoning sign symptoms.

**KEYWORDS:** Arsenic trisulphide poisoning, Heavy metal toxicity, Ayurveda drugs occupational toxicity, Orpiment

**INTRODUCTION**

Heavy metal and minerals compound are most commonly used in the therapeutic management of Ayurveda. Among those compounds the use of Parad (mercury /Hg), Haratal (orpiment/AS<sub>2</sub>S<sub>3</sub>), Manashila (realgar / AS<sub>2</sub>S<sub>2</sub>) and Gouripasana (white arsenic / AS<sub>2</sub>O<sub>3</sub>) etc is common. However reference about the use of metal mentioned in the pioneer ayurveda text charaka samhita but the authentication of metal compound and its medico legal use is well developed by acharya Nagarjuna. However in the present scenario Haratal (orpiment/AS<sub>2</sub>S<sub>3</sub>) has several medical and industrial preparations. Even Haratal (orpiment/AS<sub>2</sub>S<sub>3</sub>) has history as being used in treating Piles, Epilepsy, Erysipelas etc. <sup>1</sup>.

**Toxicological analysis**

Haratal (orpiment) is considered as nucleus of rasaashadhi (herbo-mineral formulations). The word "orpiment" is derived from the latin "*Auripigmentum*" or "golden paint". It is also known for its bright yellow colour. The Ayurveda profession has a long history with regards to the use of Haratal (orpiment/AS<sub>2</sub>S<sub>3</sub>) for knowing its toxic effect. "The father of Indian surgery" - Sushruta first described Haratal as a metallic poison <sup>2</sup>. Haratal (orpiment/AS<sub>2</sub>S<sub>3</sub>) is an inorganic arsenic compound which contains 61% arsenic and 39% sulphur<sup>3</sup>.

Suicidal poisoning is common by taking a large amount of Haratal (orpiment/AS<sub>2</sub>S<sub>3</sub>)<sup>4,5</sup>. Haratal (orpiment/AS<sub>2</sub>S<sub>3</sub>) has been used for suicidal purpose because it is inexpensive, easily available in market, sweet taste and high toxic value. Dr.J.B.Mukherjee and R.N.karmakar in the year of 2000 have cited a case where a lady of West Bengal (India) took a sweetmeat of butter, flour and yellow sulphide of arsenic at 6p.m. toxic signs and symptom appeared 6 hours later and she died after 39 hours. Her stomach contained coarsely powdered of yellow arsenic<sup>6</sup>.

Haratal's (orpiment/AS<sub>2</sub>S<sub>3</sub>) accidental poisoning is not uncommon when the orpiment is widely used as main ingredients of herbo- mineral pharmaceutical industries and as a pigment agent in art industry for painting dolls, toys, and wooden poles<sup>7</sup> and as moderate cytotoxic agent in chemotherapy<sup>8</sup>, aphrodisiacs,

external dermatological application. Injudicious use of haratal (orpiment/AS<sub>2</sub>S<sub>3</sub>) as cytotoxic agent, over dosing of haratal containing medication, improper manufacturing process and therapeutic modification, prolong use of haratal (orpiment/AS<sub>2</sub>S<sub>3</sub>) containing ointment over skin or open wound and applications into uterus for abortion can lead to accidental poisoning. Workers in deferent herbo- mineral pharmaceuticals and art industries are suffered from accidental haratal (orpiment/AS<sub>2</sub>S<sub>3</sub>) poisoning due to exposed of haratal (orpiment/AS<sub>2</sub>S<sub>3</sub>) dust and aerosol. Medicinal and industrial deposition of haratal (orpiment/AS<sub>2</sub>S<sub>3</sub>) may also be a cause of elevated arsenic level in ground water in India<sup>9</sup>.

Previously orpiment was the poison of choice for assassinations creeds. Haratal (orpiment/AS<sub>2</sub>S<sub>3</sub>) when used for homicidal purposes is commonly given in curries and dal, to mask their colour<sup>10</sup>.

Haratal (orpiment/AS<sub>2</sub>S<sub>3</sub>) is very commonly used for abortifacient purpose<sup>11</sup>. It is locally applied on abortion stick in form of paste or ointment and put into uterus for procuring abortion and may leads to systemic poisoning<sup>12</sup>. Bengal chemical examiner in 1945 annual reports has cited a case, where a woman inserted cotton wool swab smeared with haratal (orpiment/AS<sub>2</sub>S<sub>3</sub>) in to her vagina to produce abortion; on having failed to get the desired results, she took orally also and died from its effect. Arsenic was detected in her viscera as well as the cotton wool swab<sup>13</sup>.

**Table 1: Vernacular names Haratal (AS<sub>2</sub>S<sub>3</sub>)**

Native speaker	Name
Assamese	Haratala
Bengali	Haratala
English	Orpiment
Gujarati	Haratala
Hindi	Haratala
Kannada	Haridala, Haratala, Aradala
Malayalam	Aritalam
Oriya	Haratala
Punjabi	Haratala
Tamil	Ardidaram, Vellikuo pashanam

**Table 2: Toxicological properties as per Ayurveda classic**

Book	Rasa	Guna			Virya	Vipak
		Snigdha	Usna	Guru		
A.S.	Kasaya, katu	+			+	+
Ba. R.	Katu	+	+		+	+
Bh.P.	Kasaya, katu	+	+		+	+
R.N	Katu	+	+		+	+
R.Cha.	Katu	+	+		+	+
R.J.	Katu	+	+		+	+
R.K.D.	Katu, kasaya, tikta	+	+	+	+	+
R.M.						+
R.A.					+	
Y.R.	Kasaya, katu	+	+			+
R. Chi.						+
R.R.S.	Katu	+	+		+	+
M.N.P.	Kasaya, katu	+	+		+	+

**Therapeutic Indications:** Arsha (haemorrhoids), Apasmara (epilepsy), Kustha (dermatological disorder), Bhagandara (fistula), Visarpa (erysipelas), Vishama Jwara (viral fever), Vrana (ulcers) etc.

**Availability:** Haratal (Orpiment) is found all over the world. It occurs naturally near volcanic structures and also byproduct coal combustion. In India it is found in Darjeeling district of state West Bengal and Bay of Bengal region and Kashmir naturally and manufactured in Surat.

**Type of haratal:** Haratal is two types i.e - patra haratal and pinda haratal. Patra haratal is golden in colour and it's containing thin layer. Patra Haratal is preferred for the therapeutically purposes.

**Haratal X- RD (X-Ray diffraction):** 250 gm patra Haratal (orpiment /  $As_2S_3$ ) was purchased from West Bengal (India) local market and authenticated at Sri Dharmasthala Manjunatheshwara college of Ayurveda pharmacy, Hassan Karnataka (India). The sample of Haratal was highly crystalline (~100%); monoclinic system pattern by using the powder diffraction. File data base of ICDD-JCPDS showed that it was purely  $As_2S_3$  with graph showed prominent peaks of Arsenic trisulphide with many impurities present in it.

**Table 3: Description of toxicant Haratal**

Formula	$As_2S_3$
Periodic Table	33 <sup>rd</sup>
Specific gravity	3.5
Appearance	Orange crystals
Density	3.43 g cm <sup>-3</sup>
Molar mass	246.04 g mol <sup>-1</sup>
Melting point	310.5 °C
Boiling point	707 °C
Crystallography	Monoclinic
Ash Value	0.78 %
Acid Insoluble Ash	0.42%
Water soluble ash	0.68%
Loss on drying at 110 °C	99.21%
Particle size	6.6-1559 microns
Percentage of Arsenic and sulphar	Arsenic 61% Sulphar 39%
Taste	Sweetish followed by burning sensation in mouth.

**Mode of Absorption**

In order of rapidity of action; Inhaled in gas / vaporous form >IV (intravenous) >IP (intra peritoneum) > SC (subcutaneously) >Ingestion>rectum, vagina, urethra, Sublingual >application on unbroken skin.

**Excretion** – excreted mainly through renal system by producing acute Kidney injury (AKI)

**Sign and symptoms**<sup>14</sup>-As it is inorganic arsenic trisulphide so it may follow arsenic poisoning sign and symptoms.

**Table 4: Acute & chronic poisoning symptoms**

System	Acute poisoning	Chronic poisoning
GIT	Sweetish-metallic taste, nausea, vomiting, garlic odour breath, defecation is frequent and involuntary, odourless and watery resembling rice water.	Nausea, vomiting, loss of appetite, diarrhea /diarrhoea.
Renal	Oliguria, uremia, albumuria, ARDS, micturition	Chronic nephritis ,renal tubular necrosis
CVS	Hypotension, pulmonary oedema, circulatory collapse	Hypotension ,IHD ,cardiac failure
Hepatic	Fatty infiltration	Hepatomegaly ,cirrhosis of liver , jaundice
MS	Pain in limbs , weakness	----- -----
CNS	Headache vertigo ,tremors , convulsions, general paralysis	Peripheral neuropathy ,encephalopathy
Skin	alopecia, skin eruptions	Raindrop pigmentation, Aldrich-Mees lines, alopecia.

**Medicolegal uses of Haratal (Orpiment /  $As_2S_3$ )<sup>15</sup>**

- Depilatory in conjunction with lime in tanning industry
- Orpiment is widely used as pigments in arts and industry for painting dolls and toys, wooden poles etc.
- Orpiment is commonly used for abortifacient purpose
- Used as ingredients of herbomineral formulation.

**DISCUSSION**

The quintessence part of a research work is discussion. It gives the plausible reasons for the observed parameter of the study. Haratal (orpiment/ $As_2S_3$ ) is an inorganic arsenic compound which contains 61% arsenic and 39% sulphur. Arsenic is one of the 12 most abundant elements on earth. Today Arsenic is a common source as an acute heavy poisonous metal. Through drinking water, more than 200 million people globally are exposed to higher than safe levels of arsenic. The most affected areas are West Bengal in India and Bangladesh<sup>16</sup>. Arsenic exists in nature in three allotropic forms,  $\alpha$  (yellow),  $\beta$  (black),  $\gamma$  (grey), of the metallic state and in a number of ionic forms and Haratal is the  $\alpha$  (yellow) allotropic forms of the arsenic. Haratal (orpiment/ $As_2S_3$ ) is main ingredients of herbo-mineral pharmaceutical industries. So haratal (orpiment/ $As_2S_3$ ) is considered as nucleus of rasaashadhi (herbo-mineral formulations) and it is widely used as a pigment agent in art

industry for painting dolls, toys, and wooden poles and as moderate cytotoxic agent in chemotherapy, aphrodisiacs, external dermatological application. Haratal (orpiment/AS<sub>2</sub>S<sub>3</sub>) has been used for suicidal purposes because it is inexpensive and easily available and has high toxicity<sup>17</sup>. Improper purification procedure of haratal (orpiment) in herbo-mineral pharmaceutical industries and art industry, over dose, prolong use or unexpected adverse reactions produce toxic symptoms like convulsion, burning sensation, fainting, cardiac pain and even death. INDIAN MINISTRY OF HEALTH AND FAMILY WELFARE DEPARTMENT declared haratal (orpiment/AS<sub>2</sub>S<sub>3</sub>) as a deadly metallic irritant poisonous substance and enlisted it in schedule "E" of poisonous drug, under THE DRUGS AND COSMETICS and RULES 1945. The experimental animal model showed solubility of Haratal (Orpiment/Arsenic trisulphide) is very low in water and it is poorly absorbed in gastrointestinal tract of Wistar albino rats. Haratal (Orpiment/Arsenic trisulphide) is expelled through urine and fecal matter due to fate of poison<sup>18,19</sup>. So only a small portion of arsenic trisulphide was absorbed and reached to the blood stream which was not adequate to produce acute toxicity and orally safe up to 5gm/kg body weight of Wistar albino rats.

### CONCLUSION

Haratal (orpiment/AS<sub>2</sub>S<sub>3</sub>) is a schedule "E" drug so it can only be dispensed on the prescription of registered Ayurveda medical practitioners. A proper post marketing pharmaco-vigilance surveillance required to observe quality, safety, and efficacy of all Haratal (AS<sub>2</sub>S<sub>3</sub>) containing herbo-mineral formulations like - Kasturi bhairava rasa, Chandakeshwara rasa, Thalaka bhasma, Nithyananda rasa, Vidhyadara rasa, Rasendra gutika, Vatha gajankusha rasa, Vatarakthanthaka rasa, Kaphakethu rasa etc. More dose related toxicity study and toxicogenomical data required of haratal and it is containing substances to avoid the occupational health hazards of herbo-mineral pharmaceutical industries worker and environmental and human risk assessment.

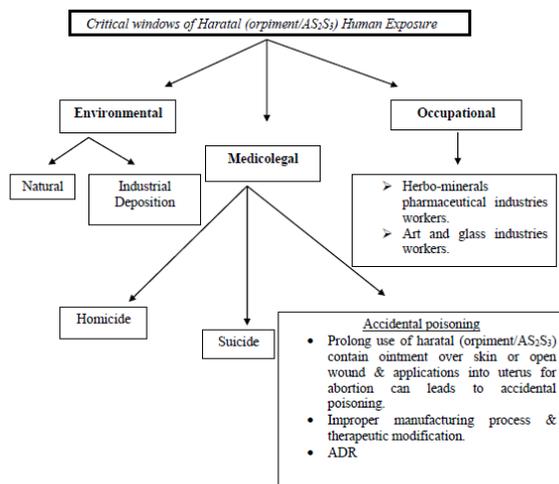


Figure 1: Haratal Human Exposure window



Figure 2: Raw haratal



Figure 3: Haratal powder

### REFERENCES

- Reddy,K. Ramachandra. Uparasaharatal. In: Chaukhambhasanskritbhawan (ed.) Text book of Rasasastra. Varanasi (India): Chaukhambha Sanskrit Bhawan; 2000. p. 266-270.
- Dalhana. Sthavaravishavijan (kalpasthanchapter-2). In: Sharma,P.V (ed.) Susrutasmhita. Varanasi(India): Chaukhambha visvabharati oriental publishers; 2010. p. 16-25.
- Reddy,K.Ramachandra. Uparasaharatal. In: Chaukhambha sanskritbhawan (ed.) TextbookofRasasastra. Varanasi(India): Chaukhambha Sanskrit Bhawan;2000. p. 266-270.
- Ozakin E, Can R, Kaya F, Acar N, Cevik AA. Arsenic Poisoning Due to the Intake of Orpiment. J Clin Toxicol. 2013;3(176):2161-0495.
- Buchanan JA, Eberhardt A, Tebb ZD, Heard K, Wendlandt RF, Kosnett MJ. Massive human ingestion of orpiment (Arsenic trisulfide). The Journal of emergency medicine. 2013 Feb 28; 44 (2):367-72.
- Mukherjee,J.B. Toxicology: Arsenic(chapter12). In: Karmakar,R.N (ed.) Forensic medicine and Toxicology. Kolkata (India): Academic publishers; 2011. p. 837
- Mukherjee,J.B. Toxicology: Arsenic(chapter12). In: Karmakar, R.N (ed.) Forensic medicine and Toxicology. Kolkata (India): Academic publishers; 2011. p. 836
- Zhang L, Tong Y, Zhang X, Pan M, Chen S. Arsenic sulfide combined with JQ1, chemotherapy agents, or celecoxib inhibit gastric and colon cancer cell growth. Drug design, development and therapy. 2015; 9:5851.
- Jomova K, Jenisova Z, Feszterova M, Baros S, Liska J, Hudecova D, Rhodes CJ, Valko M. Arsenic: toxicity, oxidative stress and human disease. Journal of Applied Toxicology. 2011 Mar 1;31(2):95-107
- Mukherjee,J.B. Toxicology: Arsenic(chapter12). In: Karmakar, R.N (ed.) Forensic medicine and Toxicology. Kolkata (India): Academic publishers; 2011. p. 836
- Mukherjee,J.B. Toxicology: Arsenic(chapter12). In: Karmakar, R.N (ed.) Forensic medicine and Toxicology. Kolkata (India): Academic publishers; 2011. p. 836.

12. Mukherjee, J.B. Toxicology: Arsenic (chapter 12). In: Karmakar, R.N (ed.) Forensic medicine and Toxicology. Kolkata (India): Academic publishers; 2011. p. 846.
13. Mukherjee, J.B. Toxicology: Arsenic (chapter 12). In: Karmakar, R.N (ed.) Forensic medicine and Toxicology. Kolkata (India): Academic publishers; 2011. p. 846.
14. Biswas, G. inorganic metallic irritants-Arsenic. In: Biswas (ed.) Review of forensic medicine and toxicology. New Delhi (India): Jaypee brother's medical publishers; 2015. p. 490-494.
15. Mukherjee, J.B. Toxicology: Arsenic (chapter 12). In: Karmakar, R.N (ed.) Forensic medicine and Toxicology. Kolkata (India): Academic publishers; 2011. p. 836.
16. [https://en.wikipedia.org/wiki/Arsenic\\_poisoning](https://en.wikipedia.org/wiki/Arsenic_poisoning) [Accessed 27 January 2018].
17. Buchanan JA, Eberhardt A, Tebb ZD, Heard K, Wendlandt RF, Kosnett MJ. Massive human ingestion of orpiment (Arsenic trisulfide). The Journal of emergency medicine. 2013 Feb 28; 44(2):367-72
18. Liu J, Lu Y, Wu Q, Goyer RA, Waalkes MP. Mineral arsenicals in traditional medicines: orpiment, realgar, and arsenolite. Journal of pharmacology and experimental therapeutics. 2008 Aug 1; 326(2):363-8.
19. Mukherjee, J.B. Toxicology: fate of poison in the body (chapter 12). In: Karmakar, R.N (ed.) Forensic medicine and Toxicology. Kolkata (India): Academic publishers; 2011. p. 781.

**Cite this article as:**

Sourav Ballav et al. Toxicological and human risk assessment of haratal (orpiment/AS<sub>2</sub>S<sub>3</sub>). Int. J. Res. Ayurveda Pharm. 2019;10(1):55-58 <http://dx.doi.org/10.7897/2277-4343.100113>

Source of support: Nil, Conflict of interest: None Declared

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