RESEARCH PAPER

Safety Profile of Ayurvedic Bhasma: A Scientific Review of Contemporary Scenario and its Clinical Significance

Shilpa Patil[1*], Nisha Munishwar[2], Rakesh Brahmankar[3], Laxmi Narayan Gupta[4], Anand Kumar Chaudhary[5]

[1*]Assistant Professor, Department of Rasa Shastra and Bhaishajya Kalpana, All India Institute of Ayurveda, Dhargal, Pernem, Goa | Email: drshilpapatil66@gmail.com (Corresponding Author)

[2]Associate Professor, Department of Kayachikitsa, SAMCH, Sumandeep Vidyapeeth Deemed to be University, Vadodara, Gujarat | Email: nisha.munishwar8@gmail.com

[3]Professor, Department of Rasa Shastra and Bhaishajya Kalpana, SAMCH, Sumandeep Vidyapeeth Deemed to be University, Vadodara, Gujarat | Email: rbramhankar1986@gmail.com

[4]Assistant Professor, Department of Rasa Shastra and Bhaishajya Kalpana, Faculty of Ayurveda, Institute of Medical Sciences, Banaras Hindu University, Varanasi | Email: narayanlaxmi1968@gmail.com

[5]Professor, Department of Rasa Shastra and Bhaishajya Kalpana, Faculty of Ayurveda, Institute of Medical Sciences, Banaras Hindu University, Varanasi | Email: anandyubhu@gmail.com

ABSTRACT

Rasa Shastra, a branch of Ayurvedic pharmaceutics, deals with the pharmaceutical processing of dosage forms derived from herbal, animal, metal, and mineral sources, prepared according to the formulations described in the authoritative texts of Ayurveda. Owing to their metal–mineral content, these formulations have become subjects of controversy and scientific scrutiny. This article is a sincere attempt to explore the safety aspects of these formulations as described in ancient Ayurvedic literature and supported through various scientific studies. The review focuses on the significance of pharmaceutical processing, characterization techniques for identification of compounds, particle size analysis, crystal structure evaluation, and toxicity studies including acute, subacute, and chronic toxicity assessments. It also highlights experimental studies conducted to establish the safety and efficacy of these formulations, along with clinical studies validating their therapeutic indications.

Keywords: Not provided.

How to cite this article: Patil S, Munishwar N, Brahmankar R, Gupta LN, Chaudhary AK. Safety Profile of Ayurvedic Bhasma: A Scientific Review of Contemporary Scenario and its Clinical Significance. Int J Drug Deliv Technol. 2026;16(55s): 163-171. DOI: 10.25258/ijddt.16.55s.18

Source of support: Nil.

Conflict of interest: None.

Introduction:

Ayurveda system of medicine is practice in the Indian subcontinent since time immemorial. Rasa Shastra (Ayurvedic Pharmaceutics) In spite of availability of wide range of pharmaceutical products Rasa Shastra upholds the supreme position for providing quality, safety and efficacious medicines owing to their lower dosages, quicker action, palatability and longer shelf life. Ancient Acharnya design these formulations in such a manner that the ultimate product is nontoxic at a very low dosage. The series of pharmaceutical procedure followed like *Shodhan* (purification), *Bhavana* (levigation), *Chakrika nirman* (pelletization) and *Maran* (Incineration) which are very specific to specific material depending upon its physical, chemical properties. Selection of the raw material whether they are suitable or not for the further pharmaceutical procedures are written very meticulously and the completion tests of *bhasmas* are also address very well for all *bhasma* in common and in specific to the specific *bhasma* in Rasa Shastra texts.

Why this question – Why the safety profile of Ayurvedic Bhasmas is questioned? Articles published by Robert Saper et.al in JAMA in 2004 and in 2008 dealing with the safety concern about the Ayurvedic Medicines that contains lead, arsenic and mercury. [1,2] Unknowing the facts that our Ancient Acharyas designed the protocol for procurement of raw materials, its pharmaceutical procedures its completion parameters, recommended dosage of forms, its adjuvant, duration of medication, dos and don'ts while on medication, how one can question the intelligence and wisdom of Rasa Shastra. Where the western failed to utilize the mercury therapeutically Indian scholars developed the technology of *Shodhan (Purification), Ashta Samsakar* (Eight purificatory methos), *Marana* (Incineration), *Murchhana* (convering the mercury in therapeutic useful form) and *Jarana* (Digition of metals or minerals in mercury) to convert the mercury into the nontoxic therapeutically usable dosage forms like *Kharaliya Rasayan* (Prepared by trituration), *Parpati* (prepared in flake like form), *Kupipakwa* (prepared in glass

bottle and *Pottali* (prepared as compact and bolus form). All these preparations were uses therapeutically considering dose, anupana, duration of intake ,Pathya- apathya etc. While focusing on the content, If whole medicine is composed of arsenicals like *Hartal, Manahshila* or *Gauripashan* then by detecting it with any technical tool like XRD, TEM, EDAX it will show not only the traces but the percentage amount of arsenic. What matter is the chemical compound form which is the resultant of all the pharmaceutical procedures. *Bhasma* are generally in the sulphide form, oxide form and some like calcium containing compounds are finally prepared as carbonate form. Mercury mostly used with the sulphur to convert it into the least toxic sulphide form all these are the finding of the current resaches and publications in the field of Rasa Shastra.[3,4,5]

The Ancient Authentic Therapeutic Applications – There is wide range of therapeutic applications of *bhasmas* indicated in Rasa Shastra. *Bhasmas* can be administered individually or they can be a part of any formulation. Therapeutic range of *bhasmas* as indicated in classics is described as under

Table no1: Therapeutic applications of some commonly used *bhsama* [6-13]

S.N.	*Bhasma*	Therapeutic Attributes	Therapeutics Indications	Therapeutic Dose	Adjuvant	Reference
1.	*Swarna bhasma*	*Balya, varnya, medhya, keshya, Rasayana*	*Rajayakshma, Vishamjwara, Unmad, Phiranga, Mushkashotha*	1/8-1/4 *ratti*	*Ghrita Gomutra*	R.T.-15/,71-80,84,91,96
2.	*Rajat Bhsma*	*Balya, varnya, medhya, lekhan ,Rasayana*	*Kshaya,Prameha,bhrama,Garbhashaya Shodhana, Udar roga,Nadishoola*	¼-1 *ratti*	*Ghrita , Mishri*	R.T-16/ 46-51,54,57,70
3.	*Tamra bhasma*	*Deepan, vaman, virechan*	*Krimi, Kasa, Shwas,Grahani, Netraroga,Sthaulya*	1/8-1/2 *ratti*	*Sheet jala, Ghrita*	R.T-17/46,52,54
4.	*Lauha bhasma*	*Vrishya, Varnya, Balya, Medhya, Lekhan*	*Kshya, Gulma, Pleeha, Pandu, Krimi, Udar, Visarpa*	¼-2 *ratti*	*Madhu Triphala Churna*	R.T.20/83,84,85,98 ,101,104
5.	*Vanga bhasma*	*Ruchya, Chakshushya, Preenan, Balya, Vrishya, Shukravriddhikara*	*Kshaya, Prameha, Vrana, Shwet pradar, Pandu*	1-2 *ratti*	*Madhu , Ghrita*,	R.T-18/40,41,46,47,48
6.	*Naga bhsma*	*Agnidipak, Lekhan, Ushna, Guru*	*Vataroga, Prameha, Grahani, Arsha Gulama, Raktapradar*	¼-1 *ratti*	*Madhu*	R.T-19/,44,45,46,50
7.	*Yashad bhsma*	*Bala, virya vivek, smriti kara, strav shodhak ,Grahi, Netrya*	*prameha, Pandu, Kasa, Shwas, Nishaswedhara, Shelshmakala sankochaka,Kampavatahara*	½-1 *ratti*	*Puran Ghrita Madhu*	R.T-19/120-124,125,1282132
8.	*Swarna makshik bhasma*	*Vrishya, Rasayan, Chakshushya, Swarnya*	*Kshaya, Arsha, Prameha, Pandu, Kushta, Apasmara, Anidra*	½-1 *ratti*	*Madhu*	R.T.21/26-28,29,31

Pharmaceutical Proficiency

For ensuring the safety of *bhasmas* there are series of Pharmaceutical procedures involved in its preparation like *Samanya shodhan* (applicable to all metals), *Vishesh shodhan* (Specific to specific metal or mineral), *Bhavana* (levigation), *Chakrikanirman* (pettetization), *Sharav samputikaran* (sealing of the dried pelletes in closed earthen crucibles), *Puta* (application of quantum of heat) and repetition of the cycle till the achievement of chief desired characteristics.

Shodhan involves the physico-chemical purification (*Shodhan*) of metals and facilitation to the further processing of *bhasmikaran.* Priciple phramaceutical process includes-

1. Elimination of harmful matter from the drug

2. Modification of undesirable physical properties of the drug
3. This makes the mineral brittle and helps in particle size reduction.
4. Conversion of some of the characteristics of the drug to different stages
5. Enhancement of the therapeutic action. [14]

Samanya shodhana

Samanya shodhan of materials involves various procedure depending upon the specific group of the material. It includes *Bhavana*(Levigation), *Swedan*(fomentataion), *Nirvap*(Heating and quenching) etc.Significance of *nirvap* is that in each of the steps in *samanya shodhana* (normal purification), progressive increase in surface area and reduction in particle size, probably due to micro cracks formed during heat treatment is there. Repetition in heating and cooling causes disruption in compression tension equilibrium and leads to increased brittleness, reduction in hardness, and finally reduction in the particle size**.** After removing the hydrophobic impurities using sesame oil (*tila taila*) treatment, oxide scales are formed due to atmospheric oxidation of the raw material, which are removed by treatment with aqueous media viz., butter milk (*takra*), rice gruel (*kanji*), cow urine(*gomuta*), and horse gram decoction(*kullatha kwatha*). [15] These medias posses metals chelation property. *Tila taila* acts as metal chelator.[16] Lactic acid from *Takra* dissolve the minerals and leach them. [17] Cow urine contains ammonia. Ammonia can be used as a leaching reagent. [18,19] *Kullatha* is excellent sources of polyphenols. They are capable of removing free radicals and chelating metal catalysts. [20] *Kanji* prepared by fermentation of rice causes increase in total phenolic content which are responsible for metal chelation. [21]

Vishesh Shodhan

It is very specific to particular metal and mineral it involves various process like, *Avap, Nirvap, Bhavana, Dhalan, Galan, Kshalana, Nirjlalikar* etc. these process are aimed at purification, potentiation and to facilitate the further process of *bhasmikarn.*

Bhavana

The pharmaceutical process in which metallic and mineral as well as herbal powders are subjected to *mardan* (grinding) with liquid media (*swarasa*, *kwatha* etc.) till complete absorption of liquid by the powder is known as *bhavana.* Grinding, the central manufacturing process involved in particle size reduction, production of large surface area and also responsible for liberation of valuable chemical from their matrices. It is energy consuming process, which may be responsible for lattice rearrangements and mechanochemical reactions (reshuffling of interlaced structure) depending upon the nature of materials. Furthermore, energy can be consumed between friction of the particles and the grinding media as well as between particle and particle. [22]

Chakrika Nirman

The bolus obtained as a resultant product of *bhavana* subjected to form the pellets of uniform size, shape and diameter to ensure the uniform heat transformation throughout and final product should be of same physical and chemical nature. [23]

Samputikaran

Dried pellets are arranged in an earthen crucible (sharav) and sealed to provide an anaerobic environment which is required for particular redox reaction at a particular temperature, volume and pressure. it should be observed meticulously for the various laws of thermodynamics involve therein. [24]

Puta

It is that optimum heat required to ensure the complete conversion of purified metals or minerals to the ash form i.e. bio assimilable. This invites for intellectual analysis technology involved in creation of *bhasma* in ancient time. *bhasma* are prepared by particle reduction technology (grinding with presence of small quantity of liquid) followed by high temperature synthesis. Application of the heat is very specific depending upon the physico-chemical property of the material. The variety of *Puta* (*Mahaputa, Gajaputa, Varahputa, Kukkut Puta Kapot Puta etc.*.) are indicated in Rasa Shastra for complete conversion of metals and minerals to therapeutically potent medicinal form at prescribed doses. [25]

Quality control of *bhasmas*

There are various tests to confirm the finally prepared *bhasmas* like *varitar*(floating of *bhasma* over the surface of stagnant water), *rekhapurnatva*(fix inside the furrows of fingers when rubbed in between), *uttam* (floating of *bhasma* over the surface of stagnant water inspite of keeping rice grain particle) *sukshmatva* (finesses) *slakshnatva* (smoothness), *Nirutthava* and *Apunarbhava* (does not attain the original metallic form), *Varna* (color specific to the material) etc. these tests ensures the final preparation as well as safety and efficacy of the product. [26]

The Contemporary Concurrence with Safety Data

There are ample proofs of evidences suggesting the safety aspect of the *Rasaushadhis* these can be summarized as follows

Table no2: Safety profile of Rasaushadhis

S. N.	Rasaushadhis	Study	Subjects	Safety profile	Reference
1.	*Swarna Bhasma*	Toxicity study and Zebrafish behvioural study	Holtzman rats	No significant macroscopic or microscopic alteration observed in any organ and anxiolytic effect is observed upto 30 days after withdrawl of the drug	Biswas S et al 2020 [27]
2.	*Lauha bhasma Tamra Bhasma Yashad Bhasma*	Acute and Chronic Toxicity Study	Charles Foster albino rats	The animals of all the test drug groups did not manifest any signs of toxicity and no exitus was observed upto 40 times more than the therapeutic equivalent dose	Prajapati PK et al. 2006 [28]
3.	*Tamra Bhasma*	Acute and Subchronic toxicity study	Wistar albino rats	*Tamra bhasma* prepared from *Shodhita Tamra* is safe even at five-fold to therapeutic equivalent doses (27.5 mg/kg).	Jagtap CY et.al. 2013 [29]
4.	*Yashad Bhasma*	Safety and bioactivity study	Swiss mice	No bio accumulation of zinc in major organs and no harmful effect on liver and kidney	Chavare A et.al 2017 [30]
5.	*Naga Bhasama*	Histopathological study	Albino rats	*Naga bhasma* was found to be totally safe in histopathology study on rats at a dose of 6 mg/100 g/day.	Singh SK et.al 2010 [31] .
6.	*Rasa Sindoor*	Acute and chronic toxicity study	Albino rats	*Rasasindura* along with adjuvant is not toxic on acute administration at a maximum oral dose level of 2000 mg/kg. However, on chronic administration of test drug for 90 days produced mild to moderate adverse changes in the kidney, liver, intestine, and stomach of rats at TED×10 dose level	Gokarn RA et.al.2017 [32]
7.	*Makardhwaj*	Ninty days toxicity study	Wistar rats	The dose level 27 mg/kg of Makaradhwaja was found as NOAEL and dose level 13.5 mg/kg of Makaradhwaja was found as NOEL.	Jamadagni S et.al 2017 [33]

8.	*Vasanta Kusumakara Rasa*	neurobehavioral activity	Wistar rats	Does not have appreciable adverse effects on brain which demonstrates the non-toxic nature of	Kumar G et.al 2012 [34]
9.	*Arogyavardhini vati*	Safety evaluation on Brain, Liver and Kidney	Wistar rats	No significant change in behavioral parameters, acetyl-cholinesterase activity, liver function (ALT, AST, ALP and bilirubin) and kidney (serum urea and creatinine) function tests at all doses of *Arogyavardhini vati*	Kumar G et.al 2012 [35]
10.	*Hridayarnava Rsa*	genotoxicity study evaluated through Chromosomal aberration and sperm abnormality assay	Swiss albino mice	Hridayarnava Rasa does not possess genotoxic potential under the experimental conditions and can be safely used	Jagtap CY et.al. 2014 [36]

The Current Clinical Corroboration

Now a days the life style disorders are more prevalent than communicable disease. *Bhasma* has proven its beneficial effect in management of life style disorders. *Bhasmas* are gaining its importance and invited researchers to prove the effects claimed in the classics. Following are some clinical applications of *bhasmas*.

S.N.	***Bhasmas* as dosage form**	**activity**	**Subjects**	**Proven efficacy**	**Reference**
1.	*Swarna Bhsma*	The preclinical in vitro and in vivo anti-tumor	Mice and Human	pre-clinical investigations of the Nano-Ayurvedic medicine gold nanoparticles-based drug to demonstrate acceptable safety and excellent efficacy results in human breast cancer patients.	Khoobchandani M et.al 2020 [37]
2.	AgNPs, CuONPs, AuNPs, and ZnONPs	Antibacterial, antifungal, antiviral, antiamebial, anti-cancer, anti-angiogenic, anti-inflammatory agents	review of work done previously	antibacterials effects of AgNPs, CuONPs, AuNPs, and ZnONPs on gram positive and gram negative bacteria has been established	López ES et.al.2020 [38]
3.	Shataputi Abhrak Bhasma	in vitro anticancer activity	CANCER CELL LINE	It was found that Abhrak Bhasma shows concentration dependent positivein vitroanticanceractivity on all three cell lines with highly significant activity on prostate cancer cell lines.	Tamhankar YL et.al.2020 [39]
4.	ZnONPs	anti-influenza activity	In vitro study	ZnO-NPs could be a novel, effective, and promising antiviral agent against H1N1 influenza virus infection,	Ghaffari H et.al. [40]
5.	*Yashad Bhasma*	Anti-diabetic	review of work done previously	Zinc a has beneficial effects on glucose	Umrani RD et.al. [41]

				metabolism. Inhibition of intestinal glucose absorption by zinc has been reported By inhibiting fructose 1,6-bisphosphatase zinc favors glycolysis as opposed to gluconeogenesis in the cell. Zinc induces the translocation of glucose transporters (GLUT4) to plasma membrane in adipocytes thus increasing glucose uptake and reducing blood glucose levels.	
6.	*Swarna Prashan*	Immuno-modualtory activity	Albino rats	Histopathological studies show that Swarna Prashana increased the cellularity in spleen and lymph node	Khedekar S et.al 2016 [42]
7.	*Arogyavardhini Rasa*	Hepatoprotective activity	Albino rats	hepatoprotective action of AVR against PCM-induced hepatotoxicity in rats.	Sapkota YR et.al 2017 [43]
8.	*Swarna Bhasma*	Anti-Tumor	Human	response was best in rectal cancer group 70% (7/10). Nearly 41.02% patients survived for 1 year after treatment but after 5 years this came down to 15.38%	Das S,et.al 2012 [44]
9.	Navjeevan Rasa, Aarogyawardhini, TribhuvanKirti ras, Shwaskuthar Ras, Shrunga Bhasma.	Anti-Tumor	Single patient- case report	Investigations after six months showed complete tumor regression and also there was no progression of the disease. Findings from this patient suggest that Rasayana therapy can be an effective therapeutic option for Lung cancer patient who fails to respond to first line Chemotherapy and Radiotherapy	Bendale Y et.al.2015[45]
10.	Hridayarnava Rasa	Antihyperlipidemic activity	Albino rat	Hridayarnava Rasa has shown mild antihyperlipidemic activity in experimental animals.	Chaudhari SY et.al 2018 [46]

11.	*Tamrabhasma and somnthi tamra bhasma*	*Shvasa*, *Amlapitta*, *Kasa*, *Yakrit-Pliha Vriddhi*, and *Grahani Roga*.	*Human*	effect of STB is reported to be more significant than the *Tamra Bhasma*. No adverse effects were reported in any of the clinical studies.	Chaudhari SY et.al 2013 [47]

The Regulatory Rationale with Rasoushadhis

The last important parameter to support the safety of Rasoushadhis is the rules and regulations of Rasaushadhies in India. Unless the rules and regulations involved no one is going to trust the worth of these worthy medicines. The Rasoushadhis are deal in Drug and Cosmetic Act 1940 as Schedule E1 drugs that comes under the poisonous category. [48] Rule 161 B of Drug and Cosmetic rule 1945 deals with the shelf life of these Rasoushadhis. [49] Schedule T of Drug and Cosmetic rule 1945 Deals with Good Manufacturing Practices where each and every aspect of creating the quality medicine is ensured. [50] CTRI came up with the strict rules to register the patients prospectively while conducting any of the clinical study from January 2018.[51] CCRAS, Ministry of AYUSH updating the various guidelines for drug development where volume II exclusively deals with the safety and toxicity study of Ayurvedic Formulations. [52] Ayurvedic pharmacopoeia of India Volume 7, part I deal with these metals and minerals with 21 monographs. [53]

Conclusion

In nut shell we can count our Rasoushadhis are SAFE because what is not poisonous on the earth? Each and all substances have positive as well as the negative aspect what count is the 'use' and 'abuse'. with the rationale use a poison can be a panacea and with irrational use of panacea it can become a poison. It is the responsibility of every stakeholder of Ayurveda specifically Rasa vaidya to ensure the pharmaceutical proficiency, perfect diagnosis of disease condition, deciding dose of medicine depending upon the *Dashavidha pariksha*, suggest dietary regimen and tell dos and don'ts to the patients and timely follow up.

References

1.Saper R.B., Kales S.N., Paquin J., Burns M.J., Eisenberg D.M., Davis R.B. et.al. Heavy metal content of ayurvedic herbal medicine products. JAMA. 2004 15;292(23):2868-73

2. Saper R.B, Phillips R.S., Sehgal A., Khouri N., Davis R.B., Paquin,J.et.al. Lead, Mercury, and Arsenic in US- and Indian-Manufactured Ayurvedic Medicines Sold via the Internet JAMA. 2008 27; 300(8): 915–23.

3. Arya R.J.,Characterization of Bio-Active Nanoparticles – Bhasma an Indian Ayurvedic Drug. Indian Journal of Pharmaceutical Education and Research. 2014 ;48 (1):61-8.

4.Ramanan N., Lahiri D., Rajput P., Varma R.C., Arun A., MuraleedharanT.S., et.al. Investigating structural aspects to understand the putative/claimed non-toxicity of the Hg-based Ayurvedic drug Rasasindura using XAFS. J. Synchrotron Rad. 2015; 22: 1233-41.

5. Vadnere G.P., Pathan A.R, Singhai A.K., Characterization of indigenous Traditional medicine - Muktashukti Bhasma. Indian J of Traditional Knowledge.2013; 12 (3):483-88.

6. Shastri Pandit Kashinath, editor. Rasa Tarangini of Sadananda Sharma. XI ed. Varanasi: Motilal Banarsidas; 1979. p. 227 [Chapter 15], Verse 71-80,84,91,96.

7. Shastri Pandit Kashinath, editor. Rasa Tarangini of Sadananda Sharma. XI ed. Varanasi: Motilal Banarsidas; 1979. p. 227 [Chapter 16], Verse 46-51,54,57,70.

8. Shastri Pandit Kashinath, editor. Rasa Tarangini of Sadananda Sharma. XI ed. Varanasi: Motilal Banarsidas; 1979. p. 227 [Chapter 17], Verse 46,52,54.

9. Shastri Pandit Kashinath, editor. Rasa Tarangini of Sadananda Sharma. XI ed. Varanasi: Motilal Banarsidas; 1979. p. 227 [Chapter 20], Verse 83,84,85,98,101,104 .

10. Shastri Pandit Kashinath, editor. Rasa Tarangini of Sadananda Sharma. XI ed. Varanasi: Motilal Banarsidas; 1979. p. 227 [Chapter 18], 40,41,46,47,48.

11.Shastri Pandit Kashinath, editor. Rasa Tarangini of Sadananda Sharma. XI ed. Varanasi: Motilal Banarsidas; 1979. p. 227 [Chapter 19], 44,45,46,50.

12. Shastri Pandit Kashinath, editor. Rasa Tarangini of Sadananda Sharma. XI ed. Varanasi: Motilal Banarsidas; 1979. p. 227 [Chapter 19], 120-124,125,1282132 .

13. Shastri Pandit Kashinath, editor. Rasa Tarangini of Sadananda Sharma. XI ed. Varanasi: Motilal Banarsidas; 1979. p. 227 [Chapter21], 26-28,29,31.
14. Wadekar M.P., Rode C.V., Bendale Y.N., Patil K.R., Gaikwad A.B., Prabhune A.A., Effect of calcination cycles on the preparation of tin oxide based traditional drug: Studies on its formation and characterization. J Pharm Biomed Anal 2006;41:1473-8.
15. SinghT.R., GuptaL.N.,Kumar N.,Standard manufacturing procedure of *Teekshna lauha bhasma*J Ayurveda Integr Med. 2016 ; 7(2): 100–8**.**
16.. Ibukun E.O, Fermentation Attenuates The Free Radical Scavenging and Antioxidant Activities of Sesame Seed (Sesanum indicum), *International J Pharmaceutical Applications*, 2012 ;3(2);324-31.
17.Astuti W., Hirajima T., Sasaki K.,Okibe N.A., Comparison of effectiveness of citric acid and other acids in leaching of low grade Indonesian saprolitic ores, *Minerals Engineering*, 2016; 85 :1–16
18.Lebeda M., Concentration of ammonia in the urine of dairy cows given green feed rations and winter feed rations, *Veterinarni Medicine(Praha*), 1984 ;19(7): 387-400.

19.Deniz T.M., Atalay U.N., Altun E, Extraction of Zinc from Smithsonite by Ammonia Leaching,*Proceedings of the 3 rd World Congress on Mechanical, Chemical, and Material Engineering (MCM'17)* Rome, Italy , 2017,130-1 -130-6.

20..Ranasinghe R..LD.., Ediriweera, E.R.H.S.S., Medicinal and Nutritional Values of Macrotyloma uniflorum (Lam.) Verdc (Kulattha): A Conceptual Study., *Global J Pharmacy & Pharmaceutical Sciences*,2017; 1(2) :1-10.

21.Oliveira MDS, Pereira CPI, Bad E &Furlong LDS, Phenolic compounds and antioxidant activity in fermented rice (Oryza sativa) bran, *Ciênc. Tecnol. Aliment.Campinas*,32(3)2012, 531-537.

22. Yadav K.D., Chaudhary A.K., Verma A.K.,.Bioavailability Enhancement of Partially Water Soluble Solid Medicament in Traditional System of Medicine. Indian Journal of Pharmaceutical Sciences.2017;79(5):667-73.
23. Sharma R, Bedarkar P, Timalsina D, Chaudhary A, Prajapati PK. *Bhavana*, an Ayurvedic Pharmaceutical Method and a Versatile Drug Delivery Platform to Prepare Potentiated Micro-Nano-Sized Drugs: Core Concept and Its Current Relevance. Bioinorg Chem Appl. 202229;2022:1685393.
24. Pal D, Sahu CK, Haldar A. Bhasma : The ancient Indian nanomedicine. J Adv Pharm Technol Res. 2014 ;5(1):4-12.
25. Rajput DS, Tekale GS. Study on Bhasma Kalpana with special reference to the preparation of Kasisa Bhasma. Ayu. 2011 Oct;32(4):554-9.
26. Rajput D, Tekale GS, Patgiri B. Comparative study on Kasisa Bhasma prepared by two different methods. Anc Sci Life. 2011 Oct;31(2):62-72.
27. SnehasisBiswas, Rohit Dhumal , NilakashSelkar Sharad Bhagat MukeshChawda Kapil Thakur , Ramacharya Gudi Geeta Vanage , Jayesh Bellare Physicochemical characterization of Suvarna Bhasma, its toxicity profiling in rat and behavioural assessment in zebrafish model
J Ethnopharmacol 2020 1;249:112388.
28. P. K. Prajapati, Prasanta Kumar Sarkar, Suhas V. Nayak, Renuka D. Joshi and B. Ravishankar. Safety And Toxicity Prof Ile of Some Metallic Preparations of Ayurveda. Ancient Science of Life 2006;25(3and 4):57-63
29.C. Y. Jagtap**,**B. K. Ashok, B. J. Patgiri, P. K. Prajapati, and B. Ravishankar. Acute and Subchronic Toxicity Study of *Tamra Bhasma* (Incinerated Copper) prepared from *Ashodhita* (Unpurified) and *Shodhita* (Purified) *Tamra* in RatsIndian J Pharm Sci.2013;75(3): 346–352.
30.Aparna Chavare , Praneeth Chowdari , Sandipto Ghosh , Priyanka Pawar , Meena Patkar , Suresh Dakave , Vikram Gota et al. Safety and bioactivity studies of Jasad Bhasma and its in-process intermediate in Swiss mice.J Ethno pharmacol 2017;197:73-86 .
31.S. K. Singh, D. N. S. Gautam, M. Kumar, and S. B. Rai Synthesis, Characterization and Histopathological Study of a Lead-Based Indian Traditional Drug: *Naga Bhasma*
Indian J Pharm Sci.2010;72(1): 24–30.
32**.** R. A. Gokarn, M. B. Nariya, B. J. Patgiri and P. K. Prajapati. Toxicological Studies of Rasasindura, an Ayurvedic Formulation. Indian J Pharma Sci 2017;79(4):6633-640.

33.Shrirang Jamadagni, Pallavi Shrirang Jamadagni, Rajendra Kumar Singh, Sachchidanand Upadhyay, Sudesh N. Gaidhani1 , Jayram Hazra Ninety days repeated dose oral toxicity study of Makaradhwaja in Wistar rats . Ayu 2017;38:171-8.
34. Gajendra Kumar ,Yogendra Kumar Gupta.Evidence for safety of Ayurvedic herbal, herbo-metallic and *Bhasma* preparations on neurobehavioral activity and oxidative stress in rats Ayu. 2012; 33(4): 569–575

35. Gajendra Kumar Amita Srivastava S K Sharma Y K Gupta. Safety evaluation of an Ayurvedic medicine, Arogyavardhini vati on brain, liver and kidney in rats J Ethnopharmacol 2012 6;140(1):151-60
36. Chandrashekhar Y Jagtap ,Swapnil Y Chaudhari ,Jalaram H Thakkar· R Galib P K Prajapati Assessment of genotoxic potential of hridayarnava rasa (a herbo-mineralo-metallic ayurvedic formulation) using chromosomal aberration and sperm abnormality assays. Toxicol Int 2014;21(3):242-7
37. Khoobchandani M ,Katti KK, Karikachery AR, Thipe VC, Srisrimal D, Dhurvas Mohandoss DK, Darshakumar RD, Joshi CM, Katti KV. New Approaches in Breast Cancer Therapy Through Green Nanotechnology and Nano-Ayurvedic Medicine – Pre-Clinical and Pilot Human Clinical Investigations. *Int J Nanomedicine*. 2020;15:181-197.
38. Elena Sanchez-Lopez , Daniela Gomes , Gerard Esteruelas, Lorena Bonilla , Ana Laura ,Lopez-Machado, Ruth Galindo. Metal-Based Nanoparticles as Antimicrobial Agents: An Overview Namomaterials 2020;10(292):1-39
39. Yogesh L. TamhankarArchana P. Gharote. Effect of Puta on in vitro anticancer activity of Shataputi Abhrak Bhasma on lung, leukemia and prostate cancer cell lines Journal of Ayurveda and Interative Medicine.2020;11:118-123.
40.Hadi Ghaffari , Ahmad Tavakoli1 , Abdolvahab Moradi Alijan Tabarraei, Farah Bokharaei-Salim, Masoumeh Zahmatkeshan et al Inhibition of H1N1 influenza virus infection by zinc oxide nanoparticles: another emerging application of nanomedicine Journal of Biomedical Science 2019 26(70): 1-10.
41. Sanjay Khedekar,Anu Priya,Patgiri B, Nariya M, Prajapati PK . J Ayu Med Sci 2016; 1(2): 90-6.
42. Rinku D. Umrani and Kishore M. Paknikar *Jasada bhasma*, a Zinc-Based Ayurvedic Preparation: Contemporary Evidence of Antidiabetic Activity Inspires Development of a Nanomedicine Evidence based Complementary and Alternative Medicine 2015:1-9
43. YugaRaj Sapkota, Prashant Bedarkar, Mukesh B. Nariya , Pradeep K. Prajapati Hepatoprotective evaluation of Arogyavardhini Rasa against paracetamol-induced liver damage in rats. BLDE Univ J Health Sci 2017;2:44-9.
44.Soumen Das, Mangal C. Das, Retina Pau. Swarna Bhasma in cancer: A prospective clinical study AYU 2012 ;33(3):365-367.
45.Yogesh Bendale, Vineeta Bendale , Poonam Birari-Gawande, Avinash Kadam. Tumor regression with Ayurvedic Rasayana therapy in Squamous Cell Carcinoma of lungs. Rasamruta 2015;7(15):1-5
46.Chaudhari SY, Nariya MB, Ruknuddin G, Prajapati PK, Hazra J. Antihyperlipidemic activity of Hridayarnava Rasa (an Ayurvedic herbo-metalo-mineral formulation) in Charles Foster albino rats. J Curr Res Sci Med 2018;4:52-7.
47.Swapnil Y. Chaudhari, Chandrashekhar Y. Jagtap, R. Galib, Prashant B. Bedarkar, Biswajyoti Patgiri, and Pradeep Kumar Prajapati[5] Review of research works done on *Tamra Bhasma* [Incinerated Copper] at Institute for Post-Graduate Teaching and Research in Ayurveda, Jamnagar Ayu. 2013;34(1): 21–25.
48.Malik V., Law relating to Drug and Cosmetic 2010, 21st d. Eastern Book Company, Lucknow.pp. 331
49. Malik V., Law relating to Drug and Cosmetic 2010, 21st d. Eastern Book Company, Lucknow.pp. 218.
50. Malik V., Law relating to Drug and Cosmetic 2010, 21st d. Eastern Book Company, Lucknow.pp. 540-557.
51. f https://ctri.icar.gov.in/.
52. http://www.ccras.nic.in/content/general-guideline-series
53. The Ayurvedic Pharmacopoeia of India. Minerals and Metals. 1st ed. Part I. Vol. 7. New Delhi: Ministry of Health and Family Welfare, Govt. of India, The Controller of Publications; 2008.