



Ayurvedic Bhasmas as Nanomedicine for Cancer Treatment

Niharika Shringi^{1*}, Bhawana Jangir¹, Aruna Sharma¹

¹Department of Chemistry, JECRC University, Plot No. IS-2036 to IS-2039, Ramchandrapura Industrial Area, Vidhani, Sitapura Extension, Jaipur-303905, Rajasthan, India

(Received: 16 February 2026

Revised: 14 March 2026

Accepted: 25 April 2026)

KEYWORDS

Ayurveda, herbo-mineral formulations, Bhasma, nanoparticle s, calcination, cancer treatment

ABSTRACT:

Ayurvedic Bhasma, due to its natural origin, potency and sustainable therapeutic approach, has drawn the interest of researchers, especially for cancer treatment. These herbo-mineral formulations consist of bioactive nanoparticles that have been used to treat various diseases, including cancer. The ancient medical practice of Ayurveda has effectively prevented or treated "arbuda," which has been associated with cancer, using several formulations. Using these nanomedicines, the adverse effects of chemotherapy could be reduced. The metal nanoparticle content in Bhasma enhanced its bioavailability and its anticancer activity against cancer cells. In some pre-clinical trials, Bhasma demonstrated remarkable potential for inhibiting cancer cell proliferation, inducing apoptosis and prohibiting the tumour cell growth. However, limitations such as a lack of proper standardisation of preparation methods, structured pre-clinical trials, clinical trials and scientific documentation need to be addressed to ensure safe use and efficacy of Bhasmas. Use of Ayurvedic Bhasmas is a sustainable approach which can establish an ancient Indian healthcare practice to get global recognition and appreciation.

1. Introduction

Over 5000 years ago, an ancient medical system called Ayurveda developed in India, and has been used constantly throughout history [1]. Ayurveda has a comprehensive approach to health and well-being, in addition to a person's mental health, physical and spiritual attributes. It focuses on the dynamic balance between doshas (bio-energies), dhatus (body tissues), and malas (waste). By using a variety of therapeutic methods and lifestyle modifications, ayurvedic practitioners restore the equilibrium [2]. Ayurvedic formulations are available as single-ingredient and compound preparations originating from plants, animals, and minerals. These compositions have been employed to treat various ailments such as asthma, arthritis, chronic fatigue syndrome, heart disease, hypertension, nervous disorders, and inflammation [2]. Ayurvedic formulations can be further classified as: classical and proprietary or patent formulations [3]. Ayurvedic texts, such as the Charaka Samhita and Sushruta Samhita, described the synthesis of classical Ayurvedic formulations. Examples of these formulations are listed in Table 1 [4].

Table 1. Different Various kinds of classical Ayurvedic Formulations [4]

S. No.	Formulations	Category	Examples	Ref.
1.	Ark	Distillate of herbs	Pudina Ark, Tulsi Ark, Dasmul Ark, Ajwain Ark	[5]
2.	Bhasma	Calcined materials	Abhrak Bhasma, Shankha Bhasma, Swarna Bhasma	[6]
3.	Taila	Medicated oils	Beeja Taila, Neem Taila, Anu Taila	[7]
4.	Ghrita	Medicated clarified butters	Brahmi Ghrita, Saraswata Ghrita, Triphala Ghrita	[8]
5.	Arista	Fermented	Ashokarishta,	[4]



		liquid	Amritarishtam , Dashamularish ta, Kumaryasava	
6.	Kwath or Kashya	Decoctions	Chaturbhadra Kwath, Rasnadi Kwath, Triphala Kwath	[9]
7.	Pak	Herbal granules	Ashwagandha Pak, Musali Pak	[10]
8.	Guggulu	Resins	Varuna Shigru Guggul, Yograj Guggulu, Kanchanar Guggulu	[11]
9.	Ras Rasayan	Herbal mineral medicine	Yakuti Rasayan, Chandrakala Ras	[12]
10.	Avaleh	Jam or paste	Amalakavaleh a, Trivrut avaleha, Kushmanda Avaleha, Chyawanprash Avaleha	[13]

In the present scenario, cancer is still a formidable non-communicable disease in front of the global health system. According to the WHO data, in 2022, 20 million new cases of cancer were reported all over the world, and accounted for 9.7 million deaths [15]. As per the research conducted by The Global Cancer Observatory, a subsidiary body of WHO, in India, 14 lakh new cancer cases were reported, and 9 lakh deaths were observed in 2022 [16]. In the ancient Indian health system, the earliest records of cancer were found in the Atharvaveda, of which Ayurveda is an Upaveda. Herein, this disease was named 'Apacit'. Swellings or lumps located in the deep structures or as chronic ulcers were called 'Arbuda' and 'Asadhya vrana' for non-healing ulcers [17]. Today, various means of treatment

are available for cancer, whose selection depends upon the cancer type, stage, and factors related to the respective patient treatment modalities are available for cancer, with selection depending on the cancer type, stage, and patient-specific factors. The benefits and drawbacks of various kinds of cancer therapy treatments are summarised in Table 2.

Table 2. Benefits and drawbacks of present cancer treatments [18]

Treatment manner	Benefits	Drawbacks
Surgery	<ul style="list-style-type: none"> Complete removal of cancerous tissue Very effective for localised tumours It provides an immediate result due to the physical removal of the tumour Fewer side effects 	<ul style="list-style-type: none"> An invasive procedure More <u>Probability</u> of complications and side effects <u>is more</u> Not <u>functional applicable</u> for advanced cases Not <u>Un</u>suitable for <u>cancers tumour disorders</u> such as leukaemia
Chemotherapy	<ul style="list-style-type: none"> Systemic treatment <u>Capable</u> of targeting cancer cells in any part of the body 	<ul style="list-style-type: none"> <u>High</u> r <u>R</u>isk of <u>significant</u> <u>side</u> <u>after</u> effects such as <u>immunosuppression</u>, <u>nausea</u>, <u>hair loss</u>, and <u>hair loss</u> <u>immunosuppression</u> <u>May</u> produce long-term complications
Radiation therapy	<ul style="list-style-type: none"> <u>Can</u> directly target 	<ul style="list-style-type: none"> <u>Healthy</u> tissues may get damaged



	<ul style="list-style-type: none"> cancer cells Non-invasive therapy 	<ul style="list-style-type: none"> Risk of short- and long-term side effects Less effective on metastatic cancer
Immuno therapy	<ul style="list-style-type: none"> Strengthens the immune response to fight cancer cells Capable of producing long-lasting effects 	<ul style="list-style-type: none"> Possibility of causing immune-related side effects
Targeted therapy	<ul style="list-style-type: none"> Targets only cancer cells with less impact on healthy cells 	<ul style="list-style-type: none"> May develop resistance Various side effects Complicated manufacturing
Hormone therapy	<ul style="list-style-type: none"> Give promising results for hormone-sensitive cancer cases Can reduce the cancer growth or reduce the risk of recurrence 	<ul style="list-style-type: none"> May trigger side effects related to Hormones
Stem cell transplantati on	<ul style="list-style-type: none"> Changes the affected bone marrow with healthy stem cells Effective for cancers such as leukaemia and 	<ul style="list-style-type: none"> A suitable donor match is necessary, and high riskHigh-risk factor and requires a suitable donor match May triggercould result in problems complications

	lymphoma	like graft-versus-hos t disease
Palliative care	<ul style="list-style-type: none"> Emphasizi ng focusing on symptom managemen t and improving the quality of life and managing symptoms Help patientsT# y to help patients manage eepe withtheir pain and discomfort 	<ul style="list-style-type: none"> No cure for cancer

The target therapy has gained remarkable success in cancer treatment—B, but it is costly, may not be effective-successful for all types of cancers and over a period of time, resistance to these therapies can develop over a period of time. Ongoing research is now focusing on other alternatives with fewer side effects and which can be amalgamated with existing therapies to provide comprehensive and personalised cancer care. In Ayurveda, along with botanical remedies, another unique class comprising metal and minerals is also employed for medication and treatment. These are nanosized metal powders, colloquially known as Bhasma. These formulations have a natural origin, excellent potency, and minimal side effects when used as prescribed in the classical guidelines [19]. In this review article, classical preparation methods of Bhasma, its various types and ~~the#~~ therapeutic uses are discussed in detail. To ensure the efficacy of the Bhasma, standardisation methods, including classical and modern approaches, involving various analytical techniques, are also included. In the last part, the applications of Bhasmas for the treatment of various types of cancer are discussed in detail. The limitations



of the anti-cancer activity of Bhasma are also discussed, as this area still requires deep research to ensure its safer use for humankind.

2. AYURVEDIC BHASMAS

Ayurvedic Bhasmas are classical herbo-mineral or metallic formulations synthesised from non-toxic forms of metals and minerals. These have a fine powder texture, purified calcined metals and minerals, combined with herbal components. The ancient Ayurvedic literature 'Rasashastra' contains the detailed Bhasma preparation procedures, entered as 'Bhasmikaran' or 'Calcination'. The main aim of this process is to reduce particle size and transform the toxic attributes of metal and minerals into safer forms with improved therapeutic effectiveness [20]. Modern microscopic and spectroscopic techniques are used now to determine their actual composition [21]. Bhasma is a herbo-mineral metallic material ranging in nano-dimensions of 5-50 nm and has been characterised by various methods. This process is also known as biologically produced nanomedicine, which is similar to the top-down method used in the creation of modern nanoparticles. In India, the ayurvedic market of Bhasma has become a promising medicinal practice due to rising consumer demand based on natural, plant-based wellness solutions. In India, the following companies have been manufacturing these formulations with superior quality (Table 3). ~~and is also known as biologically produced nanomedicine~~ Based on the feedstocks, Bhasmas can be categorised as: a) Metal-based Bhasma, b) Mineral-based Bhasma, and c) Herbal Bhasma. Bhasmas are potent medicines and play a significant role in maintaining optimum alkalinity and mineral balance for good health. The therapeutic benefits of Bhasmas are shown in as shown in Table 4.

Table 3. List of companies manufacturing Bhasma formulations in India

S. No.	Name of Pharmacy company	Marketed Bhasmas	Website link
1.	Baidyanath, Nagpur, Maharashtra	Yashad Bhasma, Trivanga Bhasma, Swarna	https://baidyanath.net.in/shop/bhasma

		Bhasma, Shankh Bhasma, Tamra Bhasma etc.	
2.	Unjha Ayurvedic Pharmacy, Unjha Gujrat	Abhrak Bhasma, Loh Bhasma, Mukta Bhasma, Sphatika Bhasma, Suvrma Bhasma etc.	https://www.unjhaayurvedicpharmacy.com/bhasma-pishti-6383001.html
3.	Patanjali Ayurved Limited, Haridwar, Uttarakhand	Divya Vang Bhasma, Divya Heerak Bhasma, Divya Rajat Bhasma, Divya Abhrak Bhasma, Divya Tamra Bhasma, etc.	https://www.patanjaliayurved.net/category/bhasma/17
4.	Alka Ayurvedic Pharmacy, Ahmedabad, Gujarat	Prawal Bhasma, Nag Bhasma, Mukta Bhasma, Tankan Bhasma, Kodi Bhasma etc.	https://alkapharmacy.com/product/list/bhasma?srsltid=AfmBOooMba2xtRIuuTOyr6ApihCoNbt0MdMHRD9FrUVenq1JTvDBksMx



5.	Sri Navjeevan Rasayanshala, Ramganj Bazar, Jaipur, Rajasthan	Bhasma & Pishti, including Swarna Makshik Bhasma.	https://www.navjeevanayurveda.com/bhasma-pishti.html
6.	Bhartiya Ayurvedic Pharmacy, Sonipat, Haryana	Tribang Bhasma powder	https://www.bhartiyaayurvedicpharmacy.in/
7.	Curoveda Herbals Nakodar, Jalandhar, Punjab	Kapardika Bhasma, Kukkutanatvak Bhasma, Mukta Shukti Bhasma, Sang Jarahat Bhasma, Sphatika Bhasma etc.	https://www.curoveda.com/product-category/ayurvedic-bhasma/
8.	IMIS Pharmaceutical Private Limited, Vijayawada, Andhra Pradesh	Varata Bhasma, Tamra Bhasma, Trivanga Bhasma, Suvarna Bhasma, Mandura Bhasma etc.	https://shop.imisayurveda.com/collections/classical-medicines?sort_by=best-selling&filter.p.m.custom.product_form=Bhasma
9.	Arya Vaidya Sala (Kottakkal), Malappuram, Kerala	Rajatha Bhasma, Sankha Bhasma Capsule, Abhra	https://shop.aryavaidyasala.com/product-listing/bhasma-capsules

		Bhasma Capsule, Yasada Bhasma Capsule etc.	
10.	Shree Dhootapapeshwar Limited, Mumbai, Maharashtra	Kaseesa Bhasma, Vanga Bhasma, Shankha Bhasma, Rajata Bhasma etc.	https://sdlindia.com/shop/retail/bhasma/?srsltid=AfmBOopZo4o74ofDuj7msUYwh0AsV5jJ77kl6F5XZ8N-b0zH7nXzMGJq

Table 4. Marketed Bhasmas products and their therapeutic uses

Product	Main Basic Ingredient	Therapeutic uses	Ref.
Swarna Bhasma	nano and colloidal gold particles	Supports the Immune System; potential therapeutic efficacy in addressing rheumatoid arthritis, an autoimmune disorder.	[22]
Swarna Makshika Bhasma	Copper pyrite ash	Helpful to treat jaundice, skin disease, and worms in the gastrointestinal tract	[23]
Lauh Bhasma (Shatputi)	Iron (Purified)	Helps to reduce iron deficiency	[24]



)		anaemia, hemolytic anaemia, jaundice, and irritable bowel syndrome (IBS). It is also used Used to burn extra body fat around belly and central weight gain.					
Vanga Bhasma	prepared from the tin metal	Used for the treatment of asthma, genitourinary disorders, diabetes, anaemia, gastric ulcers and etc, etc.	[25]				and mood elevator. It also works as a general health tonic to improve immunity. Being mild in nature, it is safe for pregnant women and lactating mothers.
Trivanga Bhasma	Pure form of Purified Purified lead, Purified zinc, Purified tin, a sufficient amount of powdered with powder of Cannabis sativa and Papaver somniferum	Highly effective for treating urinary disorders, impotency, and infertility. Helps regulate blood sugar levels. Also acts as a revitalizer gain strength and vitality.	[26]				It is used Used for the treatment of tonsillitis. It has given effective results in treating Stomatitis.
Moti Bhasma	prepared from Pearl	It is used Used to treat dyspnoea, Phithesis and eye disorders. It is Used as a cardiac tonic	[27]				
Mukta Shukti Bhasma	Oxide of pearl and oyster shell						It is effective Effective in treating blurred vision, has diuretic action, and antiulcer activity
Tankan Bhasma	Prepared from Borax						It is used Used for the treatment of tonsillitis. It has given effective results in treating Stomatitis.
Manikya Bhasma	Incinerate powder of purified ruby, orpiment, and arsenic sulfide						Used as an immunomodulator, appetiser, heart and brain tonic
Mandoor Bhasma	Old iron rust (ferric oxide), Triphala decoction, Cow's urine, Aloe vera juice						It is traditionally used for the treatment of anaemia and liver disorders like jaundice.



Abhrak Bhasma	Purified mica (biotite)	It is u Used to treat diseases related to kidney, lungs, hepatic dysfunction; anaemia, anorexia, leukaemia, stroke, asthma, bone marrow depletion, leukaemia, asthma, and diabetes. It is a Also used as a rejuvenator, anti-ageing and health promoter. Abhrak Bhasma can play a role as an antidiuretic, anti-stress, and anti-cancer.	[32]	Bhasma	powder of copper metal	of anaemia, disorders of the liver and spleen, hyperacidity, and skin disease etc. Recently, Tamra Bhasma is also explored with free radical scavenging activity, anti-oxidant and antimicrobial activity.	
Rajat Bhasma	Raupya Bhasma and Calcined Silver Ash	It is u Used for neurological conditions such as migraine, memory loss, depression, memory loss, etc. It is a Also effective for hyperacidity, insomnia, and urinary tract infections.	[33]	Heerak Bhasma	incinerated diamond powder	Effective for the cure of cancer, rheumatoid arthritis, depression, and immune disorders,	[18]
Tamra	Calcined fine	It is u Used for the treatment	[34]	Yashad Bhasma	incinerated metal ash of zinc	Potential to treat respiratory illness, wound healing, eye disease, diabetes mellitus, and neurological disease.	[35]
				Naga Bhasma	a lead-based formulation	Helpful to cure piles, rheumatoid arthritis, and nervous disorders, nonhealing wounds. Also	[36]



		effective for its antidiabetic properties	
Godanti Bhasma	calcium sulfate particle prepared by calcination of gypsum.	Aids for the cure of gastric ulcers, digestive impairment, and osteoarthritis.	[37]
Shankh Bhasma	made from the shell of a conch	It is u Used to cure hyperacidity, bowel syndrome, acne vulgaris, and loss of appetite, etc.	[38]
Pravala Bhasma	Calcined ash of Pravala (coral)	Effective for the treatment of bone metabolic disorders related to calcium deficiency	[18]
Sphatika (Alum) Bhasma	Calcined Ash of alum	Due to its bleaching agent & anti-septic properties, it can check the growth of pathogens by destroying the infection layer.	[39]
Parad Bhasma	Mercury compounds	Used to treat skin diseases, chronic fevers, anaemia, and reproductive disorders	[40]

Kukkuta ndatwak Bhasma	Eggshell ash	Aids as an antacid, as a phosphate binder, and Lead colic, etc.	[41]
Yasada Bhasma	incinerated ash of zinc metal	It is e Effective in treating neurological disorders, respiratory problems, eye diseases, diabetes mellitus, anaemia, skin problems, etc.	[42]
Mayūrap ucha Bhasma	Calx of a peacock feather	It is e Effective in hiccough, respiratory problems, and vomiting	[43]

3. METHODS OF PREPARATION OF BHASMA

The two basic methods are used for the preparation of Bhasmas, though modifications are also involved according to the particular type of Bhasma: the 'Putapaka' method and the 'Kupipakwa' method [44].

3.1 Putapaka (Calcination) method

- **Shodhan or the purification process:** ~~In this This method procedure, metals or minerals involves are hammered the hammering of metals or minerals~~ into coarse form, and ~~this coarse material is~~ then repeatedly heated till it turns red hot. ~~Then it is repeatedly and~~ simmered in a suitable fluid medium such as oil, milk, or cow's urine ~~several times~~.
- **Bhavan (Levigation or wet trituration):** ~~In a mortar (Khal), the metal or mineral is ground with a particular herbal extract for a fixed time in a mortar, also known as 'Khal', to produce a mass similar to a dough. From This dough, used to prepare pellets known ase~~ known ase



'Chakrikas' are made and ~~placed stored into in~~ an earthen crucible called 'Sharav'. After this, the lid is kept on this crucible, and joints are sealed with ~~multiple even layers (seven layers) of mud smeared clothes~~ ~~cloth soaked with mud~~. This sealed ~~arrangement setup~~ is named 'Sharav Samputa'.

- **Maran or calcination:** ~~Last~~ Finally, this assembly is repeatedly heated ~~using cow dung cakes as fuel and in a a limited restricted~~ air supply in a calcination furnace or 'Putra Bhatti' ~~using cow dung cakes as fuel~~ (Figure 1).
- Finally, the obtained ~~homogeneous uniform~~ powder is called 'Bhasma'.

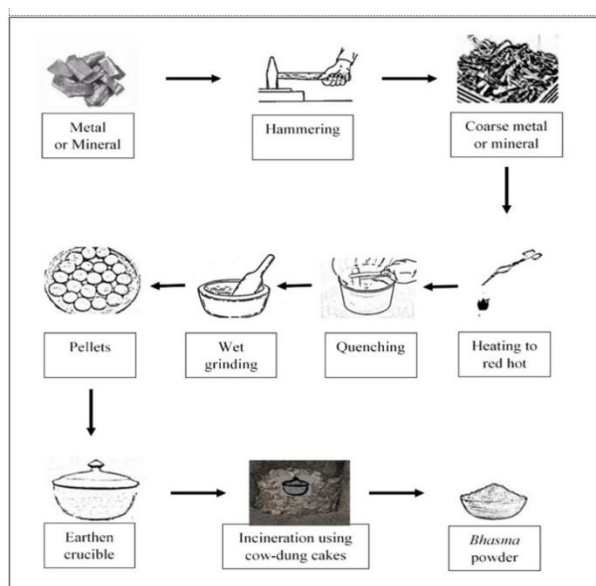


Fig 1. Schematic diagram of the Putapaka method for preparation of Bhasma adapted under Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License [4].

3.2 Kupipakwa method

This method involves purifying metals or minerals using the 'Sodhan' process, then amalgamating them with mercury. The resulting amalgam is ground to a fine powder with sulphur in a mortar until it becomes a black, lustreless, smooth mass. This ~~process~~ ~~cedure~~ is ~~referred~~ ~~alled to as~~ the 'Kajjali' ~~preparation process~~ (Figure 2). The obtained 'Kajjali' is ~~dried in the shade~~ and ~~placed transferred in to~~ a glass vessel called a 'Kachkupi', which is further sealed and wrapped in

seven layers of ~~cloth mud~~-soaked ~~with mud~~ ~~cloth~~. After this, it is placed in a sand bath and cooked repeatedly over a certain period till it becomes Bhasma [44].

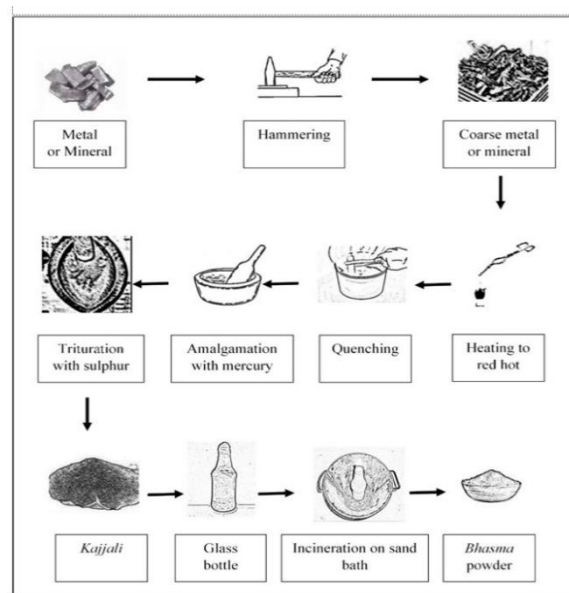


Fig 2. Schematic diagram of the Kupipakwa method for the preparation of Bhasma adapted under Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License [4].

4. QUALITY CHECK OF BHASMA

Traditionally, the following criteria are used to evaluate the quality of the endpoints of the incineration of a metal and its transformation to a Bhasma state [45].

4.1 Physical properties

- Lusterless:** it should be free from Chandrika or metallic lustre (nichandrika).
- Rekhapurnatvam:** On spreading and rubbing the Bhasma between the index finger and thumb, it should be fine enough to get into the lines and crevices of the fingers easily, and should remain in the finger's lines even after washing.
- Varitaratavam:** Bhasma should spread and float on the surface of cold and still water when added in a minute quantity.
- Apurnabhava:** the Bhasma should retain its original state throughout usage.
- Tasteless:** The Bhasma should be tasteless.



f) **Avami:** The Bhasma should not produce nausea on administration.

g) **Amla pariksha:** any change of colour of curd or lemon when the Bhasma is added.

4.2 Chemical properties

The chemical attributes of Bhasma are determined by following the factors [45]:

a) **Apunarbhavata or irreversible:** it implies that the original metallic content cannot be present. In this test, the Bhasma is combined with equal parts of ghee, borax, honey, and *Abrus precatorius* seeds, which are mixed and then heated in a sealed earthen pot. Afterwards, if the Bhasma is found with any lustre particles, then it would indicate its incorrect combustion.

b) **Niruttha or no retrieval of base form:** the Bhasma should not gain weight when heated with silver coins.

c) **Nirdhuma or no fumes if burnt:** the Bhasma should not release any fumes when it is burned in fire. This indicates that Bhasma does not contain any unwanted particles.

d) **Niswadu or tasteless:** the Bhasma should be tasteless.

4.3 Biological properties

Apart from physical and chemical attributes, biological properties also play a significant role in ensuring the quality of the Bhasma [46]:

a) **Shigravyapati:** The Bhasma should be swiftly absorbed by the human body. The nanosized Bhasma can be easily absorbed by the intestinal brush border epithelial cells.

b) **Mrutani Lohani Rasibhavanti:** The Bhasma should quickly reach the blood circulation.

c) **Vichitragunadepti:** It needs to possess the potential to produce unanticipated therapeutic outcomes that were absent in the original raw material.

The prime drawback of the above-described tests is that they are mostly qualitative-based and are deprived of quantitative details on the chemical composition or structure of the obtained Bhasma material. The final product should be free from any heavy metals or toxic

compounds and microbial contamination to ensure safer efficacy for the consumers. The inferior quality of raw material, adulteration, production of poor-quality products, lack of authentication, and the non-availability of standards in raw materials can cause several health problems and deviations in the standard manufacturing practice [47]. To increase the worldwide usage of Ayurvedic medicines requires stringent parameters to ensure batch-to-batch consistency and reproducibility. Table 5 comprises the modern analytical techniques employed to evaluate the properties of the Bhasma.

Table-5: Chemical standardisation of Bhasma by using modern analytical techniques [48, 18]

S. No.	Modern analytical techniques	Physico-chemical information of Bhasma
1.	EPMA	Chemical composition
2.	SEM with EDX analysis	To determine the particle size, shape, and morphology
3.	TEM and AFM	Size of the particle and its distribution
4.	DLS	Measures the zeta potential related to the stability
5.	XRF and particle-induced X-ray emission	Chemical analysis and detection of metals
6.	ESCA	Determination of the electronic nature and oxidation state of the metal present
7.	XRD	Amorphous or crystalline nature and the presence of the metal phases
8.	XPS	The elemental composition, atomic amount, and chemical states of elements present at the surface
9.	AAS or ion chromatography	The quantitative determination of the



		atom and ions (cations and anions)
10.	FTIR	To determine the presence of various organic functional groups
11.	Extraction and chromatography	Extraction of organic matter for advanced analysis
12.	HPLC, NMR, MALDI, and ESI - MS	To separate and analyse complex mixtures and characterise the organic matter present
13.	ICP-MS	To determine the elemental contaminants, if any

EPMA - Electron probe microanalyzer, SEM - Scanning electron microscopy, EDX - Energy-dispersive X-ray, TEM - Transmission electron microscopy, AFM - Atomic force microscopy, DLS - Dynamic light scattering, XRF - X-ray fluorescence, ESCA - Electron spectroscopy for chemical analysis, XRD - X-ray diffraction, XPS - X-ray photoelectron spectroscopy, AAS - Atomic absorption spectrometry, FTIR - Fourier transform infrared spectroscopy, HPLC - High performance liquid chromatography, NMR - Nuclear magnetic resonance, MALDI - Matrix assisted laser desorption/ionization, ESI-MS - Electrospray ionization - mass spectrometer, ICP-MS - Inductively coupled plasma-mass spectrometry.

5. 6BHASMA WITH ANTICANCER ACTIVITY

In 2022, there were about 10 million deaths associated with cancer, and 20 million new cases were reported worldwide. This data is mainly dominated by lung, breast, stomach, colorectal and prostate cancer with high mortality [49]. The latest research has shown anticancer activity of specific Bhasma formulations, which can become reasonable priced medical alternative for those from the lower socioeconomic class. It is crucial to highlight that these results are preliminary and to ensure the efficacy and human safety of Bhasma, advanced research, such as clinical trials, is required. The following section covers some recent

research reports showing the potential of some Bhasma formulations with anticancer activity.

5.1 6Swarna Bhasma (SB)

In Ayurvedic medicine, gold nanoparticles have been traditionally employed to cure various health diseases. Swarna Bhasma (SB) comprises ash with gold nanoparticles along with various herbal mixtures. It is considered an established Indian medicine with anticancer activity [50]. The incinerated gold nanopowder, SB, synthesised from gold foil, successfully reduced the blood concentration of tumour-specific targets and protected from hepatocellular damage in the Ehrlich ascites mice [51]. XRD analysis confirmed the presence of crystalline gold particles in Swarna Bhasma with an average size of approximately 15.24 nm. The TEM analysis revealed finely dispersed and oval-shaped particles (average particle size 7.67 nm). The synthesised SB showed potential to decrease the blood concentration of tumour-related indicators such as carcinoembryonic antigen (CEA), Tumour Necrosis Factor-alpha (TNF- α), Interleukin-6 (IL-6), ALT (Alanine transaminase), and AST (Aspartate aminotransferase) in the treated groups. The anti-tumour effects of SB could be due to the following mechanisms: a) SB suppressed the CEA levels within the tumour region by hindering the expression of c-Myc and inducing an energy-lacking state by downregulating genes related to glycolysis, such as GLUT1 and HK2, b) a decline in TNF levels showed that it may induce apoptosis by activating the JNK route and checked the inflammation-mediated carcinogenic alterations by interacting with the NF- κ B pathway, c) a dose-dependent decrease in IL-6 levels was showed the simultaneous downregulation of pro-inflammatory cytokines and the upregulation of anti-inflammatory molecules, confirmed the ability of SB, d) SB with lower doses also altered AST/ALT ratio while higher doses elevated AST/ALT ratio. These results highlight the remarkable carcinogenic activities of SB; further comprehensive investigation is still required to achieve a deeper understanding and to validate its potential to combat cancer.

5.2 6Manikya Bhasma (MB)

The MB, composed of purified ruby, orpiment, and arsenic sulfide, was explored to treat breast cancer (MCF-7) and lung cancer (A-547) using the MTT assay



[52]. The vibrational modes of the FTIR spectrum of Manikya Bhasma range from 458 to 700 cm^{-1} attributed to metal oxide bonds such as Mg-O, Ca-O, and Si-O. A strong peak is observed at 1084 cm^{-1} attributed to Si-O-Si vibrational modes. The uniform particle distribution with an average particle size of 175 nm was confirmed by FESEM micrograph, as shown in Fig. 3a&b. The anti-cancer activity of MB was assessed against breast cancer (MCF-7) and lung cancer (A-547) cell lines at a concentration range of 0 - $1000\text{ }\mu\text{g/mL}$, showing a clear dose-dependent anti-cancer activity, assuring its potential. This research suggests that MB can serve as an effective nanomedicine for breast and lung cancer, with promising therapeutic relevance of the ancient Ayurvedic formulation in modern medical research.

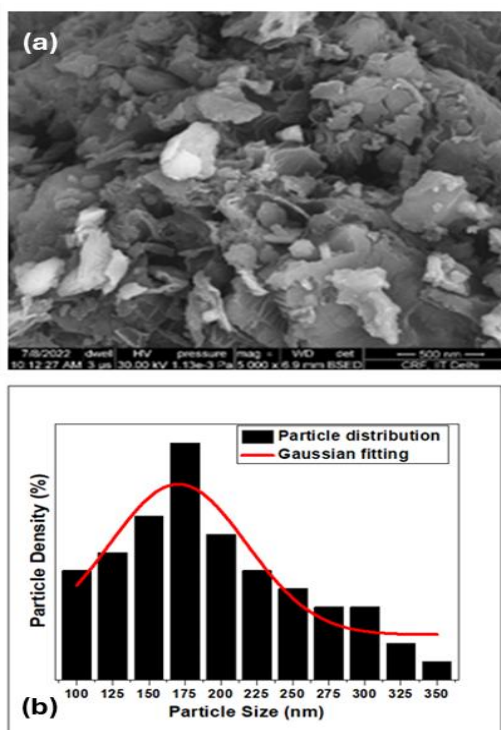


Fig-3: (a) FESEM micrograph and (b) histogram of the particle size distribution of the Manikya Bhasma adapted under Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License [52]

5.3 Abhrak Bhasma

Abhrak (Mica) is one of the unique entities mentioned in classical Ras Shastra. Shataputi and Sahastraputi Abhbrak Bhasma are unique attributes of Abhrak. Shatputi Abhrak Bhasma (SAB) is considered a Rasayan, whose efficacy and therapeutic effects depend

on the number of Putas (incineration in a closed earthen vessel). SAB, at various stages of Putas (20, 50,100), was accessed to in-vitro anticancer activity on three different cancer cells: Lung cancer cell line (HOP62), Leukaemia cell line (U937) and Prostate cancer cell line (DU145) at Tata Memorial Centre- Advanced Centre for Treatment, Research Education in Cancer, Navi Mumbai [17]. The results of the anti-proliferative activity using the SRB (Sulforhodamine B) showed that SAB showed the highest concentration-dependent positive in vitro anti-cancer activity was achieved by prostate cancer cells amongst all three cancer cells. The SAB showed the order of anti-cancer activity as $100\text{ Puti} > 50\text{ Puti} > 20\text{ Puti}$, which revalidates the direct relation between the number of Putas and the efficacy of the drug.

5.4 Rajat Bhasma (RB)

Rajat Bhasma is the incineration ash, prepared by heating fine powder of silver with plant extract at high temperature ($\sim 1,000^\circ\text{C}$). As compared to Swarna Bhasma and Jasada Bhasma, the RB has better and a wider range of anti-microbial, anti-fungal and anti-viral activities [53]. RB was utilised to evaluate its anti-cancer activity for MCF-7 breast cancer cells using the MTT assay [54]. The synthesis of RB involved shodhana, sequential quenching in different liquid media and then incineration with herbal and processed mineral compounds. Later on, it was heated in an electric furnace. To get the desired Bhasma, this procedure was repeated 20 times. The EDAX result showed an atomic composition mainly containing Ag, Si and C. The resulting RB has a reddish-brown colour with a quasi-spherical shape and a particle size of 10 - 100 nm . The anticancer activity of RB showed a value of $78.54\text{ }\mu\text{g/ml}$. The MTT assay confirmed the anti-cancer activity of RB against MCF-7 cell lines.

5.5 Heerak Bhasma (HB)

Heerak bhasma, the nano diamond or incineration ash of diamond, has been widely used due to its multiple therapeutic uses. Heerak Bhasma nanoparticle (HBNP) was assessed to determine its anti-cancer activity on the breast cancer cells [55]. The cell-permeable size of HBNP was analysed by DLS and FESEM analysis, and a cell viability assay confirmed its non-toxic nature. The cellular Mito and Glyco-stress analyses confirmed the HBNP-induced intracellular energy depletion. In



addition, in the presence of HBNP, the generation of reactive oxygen species (ROS) was noticed, followed by the activation of cell apoptosis. HB has shown remarkable interference in the energy-producing pathway, activating the depletion of glycolytic and mitochondrial oxidative phosphorylation in the breast cancer cells, hence limiting the progress of metastatic cancer. It also impeded in the intracellular redox system to trigger DNA damage and the demise of the apoptotic cell to check metastasis of cancer. HBNP demonstrated remarkable antitumor activity by controlling the in vivo stress parameter.

5.6 Yashada Bhasma

Yashada Bhasma, an incinerated processed zinc nanomedicine, has been widely utilised to treat diseases such as diabetes, respiratory disorders, etc. Recently, ZnO nanoparticles anti-tumor activity was investigated by Parada Marita Yashada Bhasma (PMY) and Vanaspati Jarita Marita Yashada Bhasma (JMY), synthesised by following the protocols of pharmaceuticals of Ayurveda [56]. The PMY sample was prepared by mixing molten purified mercury and purified zinc, followed by grinding with an herbal liquid medium until amalgamation was achieved. JMY was prepared by roasting till it transformed into a fine powder in Apamarga Panchanga. Later on, both samples were calcined in an electric furnace to get the Bhasma formulation. Particle size analysis showed that the distribution of JMY particles was observed in the range of ≤ 1 nm to 2300 nm with a Z average of 2300 (d.nm) and -21 average zeta potential (Fig 4). PMY particles were found within the range of ≤ 1 nm –10,000 nm with a 2647 nm Z average. The maximum number of PMY particles had a zeta potential in the range of -14.4 ± 7.50 and an average zeta potential of -9.20 (Fig 4). The anti-cancer activity of these Bhasma formulations was analysed in the pancreatic cancer cell line (MIC PaCa-2) using the in-vitro sulforhodamine B assay, with adriamycin/doxorubicin as a standard control. Antiproliferative effects were also studied after 48 h of incubation. The PMY sample showed more than 97% cell growth inhibition at 80 $\mu\text{g/ml}$ and 50% at 56.7 $\mu\text{g/ml}$. While the drug JMY exhibited a 50 % growth inhibition at >80 $\mu\text{g/ml}$. concentration. Adriamycin cell line showed cytotoxicity (LC 50) at 41.6 $\mu\text{g/ml}$. Cancer-cell growth was inhibited by PMY, JMY and Adriamycin in a dose-dependent manner. PMY and

JMY test drugs exhibited cytostatic attributes rather than cytotoxic properties. Adriamycin and Yashada Bhasma have different toxic behaviour and dosage, and based on concentration, their drug efficacy cannot be compared. To determine the optimum dosage for humans, in vivo studies should be included. Advanced study is required to determine the effect of Yashada Bhasma and its combination effects with traditional anti-cancer drugs.

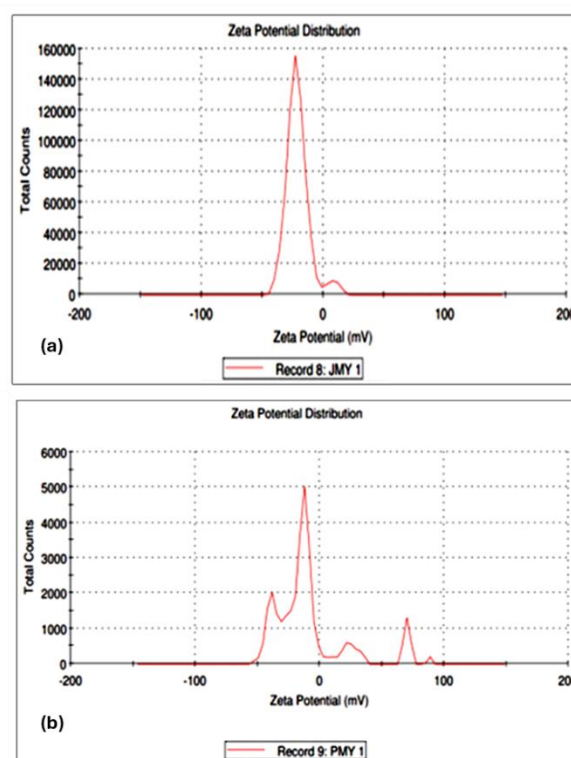


Fig 4 (a) Zeta potential of Vanaspati Jarita Marita Yashada Bhasma (JMY) and (b) Parada Marita Yashada Bhasma (PMY) adapted under Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License [56]

6. LIMITATIONS OF BHASMA IN CANCER TREATMENT

The application of Ayurvedic Bhasma has great potential in cancer treatment, but some limitations require consideration. Firstly, extensive clinical trials are needed to validate the efficacy and safety of these nanomedicines. Second, it is challenging to establish consistent quality and efficacy because of the variability in Bhasma's composition and preparation, which must be standardised. Furthermore, it is unexplained how



Bhasma inhibits the growth of cancer cells and triggers apoptosis. To further optimise therapy approaches, a thorough investigation is required to determine the molecular mechanisms involved. Physicochemical characterisation and toxicity studies of Bhasma have been conducted, but their effect in the long run is not clear [57]. The effect of deposition of heavy metals in the body through Bhasma also raises concerns for human safety assessments [58].

7. CONCLUSION

The Ayurvedic Bhasma formulations have a long history of treating various health problems, including cancer. However, the use of these nanomedicines has decreased in today's time due to limitations such as a lack of standardisation of the preparation process and the absence of proper scientific clinical trials and their documentation. There are a number of ways to get different Bhasmas of the same metal. Therefore, standardisation of processes and quality control, particularly the total absence of heavy metals, is required to reproduce consistent quality and efficacy of the Bhasma product. In conclusion, Bhasma formulations are a sustainable therapeutic approach for humans. Addressing these drawbacks through structured pre-clinical trials using in vitro cell-based and in vivo animal-based models, and further by clinical trials, using proper standardisation of the synthesis process, in-depth mechanistic studies will ensure the safety and sustainable potency of these nanomedicines.

8. REFERENCES

1. Verma S. K., Pandey M., Sharma A. and Singh D., 2024. Exploring Ayurveda: principles and their application in modern medicine. *Bulletin of the National Research Centre* 48, 77. <https://doi.org/10.1186/s42269-024-01231-0>
2. Singh D., Sharma D., Agarwal V., Screening of anti-microbial, anti-biofilm activity, and cytotoxicity analysis of a designed polyherbal formulation against shigellosis. 2021. *J. Ayurveda Integr. Med.* 12, 601-606. DOI: 10.1016/j.jaim.2021.06.007
3. Sumantran V. N., Tillu G., A. Professor 2011. *Ayurvedic Pharmaceuticals and Insights on Personalized Medicine*. Progress in traditional and folk herbal medicine, Daya Publishing House, New Delhi 110002, 13-52.
4. Rajchal B., Bhatta P., Adhikari R., 2025. Exploring the Nanomedicinal Features of Ayurvedic Bhasmas: Insights from Traditional Medicine. *International Journal of Complementary Medicine* 1, 01-25. DOI 10.14302/issn.3070-3360.ijco-24-5294
5. Pant M., Gautam A., Saxena P., Rawat P., Thapliyal S., Kothari D., Husen A., Bajaj S., Raman A. 2025. Sustainable Conservation and Management Strategies of High- Value Medicinal and Aromatic Plants (MAPs). *Genetic Improvement and Conservation Practices of Medicinal Plants* 1–21. DOI: 10.1201/9781003482659-1
6. Asmita W., Gauri N., Ankita K., Galib R., 2025. Pharmaceuticals and standardization of Ayurvedic Bhasma: A comprehensive review. *Journal of Drug Research in Ayurvedic Sciences* 10, 4-21. DOI: 10.4103/jdras.jdras_401_23
7. Thejaswini C., Rao V.R., Shubhashree M.N., Naik R., Bhat S., Shiddamallayya N., Srikanth, N., Acharya R. 2025. A narrative overview of pharmacological activities of Eranda (*Ricinus communis* L.) beeja (seeds) and taila (oil): Ayurvedic and scientific perspectives. *Journal of Drug Research in Ayurvedic Sciences* 10(2), 120-129. DOI: 10.4103/jdras.jdras_96_24
8. Badal R., Ranjan S., Jha S.K., Kumar L., Patel A.K., Yadav P., Prajapati P.K., 2025. GC-MS/MS and HR-LCMS-QTOF analysis of various extracts of Saraswata Ghrita: A comprehensive dataset on phytochemical compounds. *Data Brief* 61, 111675 <https://doi.org/10.1016/j.dib.2025.111675>
9. Patel N., Thummar K., Chauhan S., Vadalia J., 2025. Validation and Quantification of Key Markers in Ayush Kwath, an Ayurvedic Immunity Enhancer Polyherbal Formulation, Through High-Performance Thin-Layer Chromatography. *Revista Brasileira de*



- Farmacognosia 35(1), 238–245
DOI: 10.1007/s43450-025-00619-x
10. A. Banadka, V. Toppo, K. Kashyap, M. Nandhini, B. Akshita, W.N. Sudheer, P. Nagella, 2025. Revolutionizing Ashwagandha Breeding: From Traditional to Modern Breeding Techniques for Indian Ginseng, *Withania somnifera* (L.) Dunal. *Biodiversity and Genetic Improvement of Medicinal and Aromatic Plants II*, Springer Nature Switzerland (2025), pp 1–34, doi:10.1007/978-3-031-81857-8_1
 11. Behera S.K., Modi P.K., Karthikkeyan G., Pervaje S.K., Pervaje R., Raju R., Prasad T.S.K., Subbannayya Y., LC-MS/MS metabolomics profiling of Kanchanara Guggulu to molecular docking and dynamics simulation of quercetin pentaacetate with aldose reductase. 2021 *Bioinformation* 17(11), 911-915. DOI: 110.6026/97320630017911
 12. Panchal V., Panchal M., Deepa, Veena, 2025. Ayurvedic management of uterine fibroids with a cervical Polyp - A case report. *J. Ayurveda Integr. Med.* 16(6), 101221. DOI: 10.1016/j.jaim.2025.101221
 13. Kipps T.J., Stevenson F.K., Wu C.J., Croce C.M., Packham G., Wierda W.G., O'Brien S., Gribben J., Rai K., Nat. Chronic lymphocytic leukaemia. *Rev. Dis. Primers* 3, 101017 (2017). DOI: 10.1038/nrdp.2016.96
 14. Yadav B., Rao B.C.S., Narang R., Jameela S., Khanduri S., Sharma S., Dinesh D., Srivastava A., Bhardwaj R., Gupta B., Srikanth N., 2025. Efficacy and safety of ayurvedic intervention (Sarpagandha Mishran) vs amlodipine for Stage-I primary hypertension- study protocol for a prospective Double-Dummy, Double-Blind, placebo-controlled Randomized Clinical Trial. *BMC Complementary Medicine and Therapies* 2025 25(1), 88. <https://doi.org/10.1186/s12906-025-04802-4>
 15. Bray F., Laversanne M., Sung H., Ferlay J., Siegel R.L., Soerjomataram I., Jemal A., 2024. Global cancer statistics 2022: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA Cancer J. Clin.* 74, 229-263. <https://doi.org/10.3322/caac.21834>
 16. Sathishkumar K., Chaturvedi M., Das P., Stephen S., Mathur P., 2023. Cancer incidence estimates for 2022 & projection for 2025: Result from National Cancer Registry Programme. *Indian J. Med. Res.* 156, 598 DOI: 10.4103/ijmr.ijmr_1821_22
 17. Tamhankar Y.L., Gharote A.P., Effect of Puta on in vitro anticancer activity of Shataputi Abhrak Bhasma on lung, leukemia and prostate cancer cell lines. 2020. *J. Ayurveda Integr. Med.* 11, 118–123 <https://doi.org/10.1016/j.jaim.2017.07.007>
 18. Chatterjee S., Ghosh C., Roy P., Application of Ayurvedic Bhasma for the Treatment of Cancer. 2024. *J. Ayurveda Integr. Med.* KLEU 5, 3-12. DOI: 10.4103/ijaim.ijaim_61_23
 19. Pillai D.S., Karavettekudy A.R. 2025. Abhraka Bhasma (mica based nanomedicine): an ayurvedic herbomineral perspective in breast cancer management. *Front. Pharmacol.* 16, 1656846. doi: 10.3389/fphar.2025.1656846
 20. Bondar S.S., Wadodkar D., Gupta D.S., 2019. A Critical Review on Standardization of Bhasma: Ayurvedic and Modern View. <https://api.semanticscholar.org/CorpusID:237501741>
 21. Hirudkar V.N., Varsha D., Wanjari P., 2024. Bhasma Therapy: Bridging Ayurveda's Rasa Shastra with Modern Nanomedicine. *World Journal of Pharmaceutical and Medical Research*, 10, 346.
 22. Koushik P., Dayma J., 2023. Swarna Bhasma as a Nanomedicine in Ayurveda: A Comprehensive Review on Its Efficacy in Remediation of Rheumatoid Arthritis. *JoNSNEA STM JOURNALS Journal of Nanoscience* 13(3), 16-28. DOI (Journal): 10.37591/JoNSNEA



23. Meena V., Bhushan S., Chaudhary A., Anand J. 2021. Critical review on pharmaceutico-analytical and safety profile of Swarna Makshika Bhasma (chalcopyrite calx). *Drug Res. Ayurvedic Sci.* 6(1), 3-11. DOI: 10.4103/jdras.jdras_4_21
24. Punchihewa B.T., Prashantha M.A.B., Godakumbura P. I., Herapathdeniya S. K. M. K., The chemical role of natural substances used in Lauha Bhasma preparation. 2022. *J. Ayurveda Integr. Med.* 13, 100412 <https://doi.org/10.1016/j.jaim.2021.02.003>
25. Kale B., Rajurkar N., 2019. Synthesis and characterization of Vanga bhasma. *J. Ayurveda Integr. MB. ed.* 10(2), 111–118. <https://doi.org/10.1016/j.jaim.2017.05.003>
26. Jawanjal P., Choudhary S., Bedarkar P., Patgiri B.J., 2022. A comprehensive review of Trivanga bhasma (herbomineral trimetallic formulation). *BLDE University Journal of Health Sciences* 7(2), 198–203 DOI: 10.4103/bjhs.bjhs_108_21
27. Joshi N., Sharma K., Peter H., Dash M.K., 2015. Standardization and quality control parameters for Mukta Bhasma (calcined pearl). *Anc. Sci. Life* 35(1), 42-51. DOI: 10.4103/0257-7941.164542
28. Parajuli S., Dahal A., Bhatta P., 2021. Effectiveness of Tankana Bhasma Kavala in Tonsillitis. *Journal of Ayurveda and Integrated Medical Sciences* 6(1), 80–83. DOI: <https://doi.org/10.21760/jaims.v6i01.1184>
29. Punse T.S., 2020. EFFECT OF TANKAN BHASMA IN THE MANAGEMENT OF MUKHPAK (STOMATITIS): AN OBSERVATIONAL STUDY. *International Ayurvedic Medical Journal* 8, 5227 DOI: 10.46607/iamj0408122020
30. Jha, S., Trivedi V., 2021. Manikya Bhasma is a nanomedicine to affect cancer cell viability through induction of apoptosis. *J. Ayurveda Integr. Med.* 12, 302-311. <https://doi.org/10.1016/j.jaim.2020.11.001>
31. Pangerkar P., Rastogi N., Sidhu K., Goel A., Asore G., Seth S., Phadke A., Udipi S., Joshi J., 2026. Quality Evaluation of Mandur Bhasma, an Ayurvedic Iron Supplement, by Classical Methods and a Semi Quantitative Method: Comparison of In-house Preparation with Selected Marketed Formulations. *Annals of Ayurvedic Medicine* 15(1), 52–62. DOI: 10.5455/AAM.235584
32. Kulala D.S., Prasad K., Reddy P.S., Maruthiyodan S., Joshi M.B., Satyamoorthy K., Guruprasad K.P., 2023. Understanding the effects of Abhraka Bhasma on genotoxicity and its DNA repair potential in mouse model. *Journal of Ayurveda and Integrative Medicine*, 14(2), 100598. doi: 10.1016/j.jaim.2022.100598
33. Pardeshi K., Kadibagil V., Ganti B., 2017. THERAPEUTIC POTENTIAL OF RAJATA (SILVER) BHASMA: A REVIEW. *Int. J. Res. Ayurveda Pharm.* 8, 126–129. DOI: 10.7897/2277-4343.085259
34. Gulati S., Joshi N., Jayakumar R., 2023. Pharmaceutical Processing and Analytical Characterization of Metal-Based Ayurvedic Drug “Tamra Bhasma”. *International Journal of Pharmaceutical Sciences and Research*, 14, 1940. DOI: 10.13040/IJPSR.0975-8232.14(4).1940-53
35. Nille G.C., Bhuyan M., Gupta L.N., Ali M., Tripathi C.S.P., Nille O.S., Mishra S.K., Vibhute A., Kamble P., Ranjan H., Singh A.K., Characterization and potential novel applications of zinc-based traditional medicine, Yashad Bhasma. 2025. *J. Ayurveda Integr. Med.* 16(5), 101188. <https://doi.org/10.1016/j.jaim.2025.101188>
36. Krushnakumar T., Sarika M., Prashant B., Patgiri B., Efficacy and safety of Naga Bhasma and Nisha-Amalaki Churna in the management of Madhumeha (type 2 diabetes) - A double-blind, randomized, controlled clinical trial. *AYU (An International Quarterly Journal of Research*



- in Ayurveda). 44(4), 137-149. DOI: 10.4103/ayu.ayu_290_21
37. Das S.K., Joshi A., Bisht, Goswami V., Faiz A., Dutt G., Sharma S., 2024. Godanti bhasma (anhydrous CaSO₄) induces massive cytoplasmic vacuolation in mammalian cells: A model for phagocytosis assay. *Methods* 230, 158-168. <https://doi.org/10.1016/j.ymeth.2024.08.006>
38. Chavan S., Tayade S., Gupta V., Deshmukh V., Sardeshmukh S., 2018. Pharmaceutical Standardization and Physicochemical Characterization of Traditional Ayurvedic Marine Drug: Incinerated Conch Shell (Shankha Bhasma). *Marine Drugs* 16(11), 450. <https://doi.org/10.3390/md16110450>
39. Sahoo I., More S.S., Jadhav V., Dalai S., Sahoo M., 2019. Clinical Appraisal on Therapeutic Efficacy of Tankana and Sphatika Bhasma with Madhu Pratisarana in Tundikeri. *Journal of Drug Delivery and Therapeutics* 9, 130. DOI: 10.22270/jddt.v9i6.3707
40. V.H. Pavan, P, Agnihotri, S. Nakod, Shiraguppi A.M., 2025. Preparation of Parada Bhasma: A Review on Classical Ayurvedic Formulation. *International Journal of Creative Research Thoughts*, 13(7), 43 2320–2882.
41. Patil S.S., A review on kukkutanda twak bhasma. *Journal of Advanced Research and Reviews*, 17, 564 (2023) DOI: 10.30574/wjarr.2023.17.1.0084.
42. Baranawal A., Srivastava N., Singh B.M., 2020. Atul, B., Niraj, S. and BM, S., 2020. Appraisal of Preventive and Curative Outcome of Yasad Bhasma in Anemic Children. *Indian Journal of Public Health Research & Development*, 11(5), 73.
43. V. S. Kotrannavar, R.S. Sarashetty, and V.G. Kanthi, 2012. Article Details Pharmaceutical Analysis Study of Mayur Puccha Bhasma *Indian Drugs* 49, 23. <https://doi.org/10.53879/id.49.09.p0023>
44. Sarkar P.K., Chaudhary A.K., 2010. Ayurvedic Bhasma: The Most Ancient Application of Nanomedicine. *J Sci Ind Res.* 69(12). 901-905.
45. Pal D., Sahu C.K., Haldar A., 2014. Bhasma: The ancient Indian nanomedicine. *J. Adv. Pharm. Technol. Res.* 5(1), 4-12. DOI: 10.4103/2231-4040.126980
46. Gandhi P.K., Choudhary A.K., Prajapati P.K., 2014. *Journal of Ayurvedic Science, Yoga and Naturopathy, STM J*, 1, 12-8.
47. Kumar P.G., Nataraja Yadav P., Gananadhamu S., Nataraj K.S., 2021. Analytical Methods in Standardization of Bhasmas: A Review. *Journal of Drug Delivery and Therapeutics* 11, 183-192. DOI: 10.22270/jddt.v11i5.4960
48. Telang S., Dafne L., Awale P., Suryavanshi S., Chaudhari H., Nakaneka A., BHASMA AS ANCIENT NANOMEDICINE THROUGH PHYSICO-CHEMICAL CHARACTERIZATION. *World Journal of Pharmaceutical Research* 4(11), 1443-1459.
49. Espina C., Ritchie D., Feliu A., Canelo-Aybar C., D'Souza E., Mitrou P.N., Carvalho A.L., Schüz J., Zeeb H., 2026. Developing evidence-based cancer prevention recommendations: Methodology of the World Code Against Cancer Framework to create region-specific codes. *Int. J. Cancer* 158(1), 9-18. DOI: 10.1002/ijc.70068
50. Khoobchandani M., Katti K.K., Karikachery A.R., Thipe V.C., Srisrimal D., Dhurvas Mohandoss D.K., Darshakumar R.D., Joshi C.M., Katti K.V., 2020. New approaches in breast cancer therapy through green nanotechnology and nano-ayurvedic medicine—pre-clinical and pilot human clinical investigations. *International journal of nanomedicine*, 15, 181-197. <https://doi.org/10.2147/IJN.S219042>
51. Joshi N., Kumar P., Sharma S., Jayakumar R., Mishra A., Harsha V., Dash M.K., 2025. Swarna Bhasma reduces the blood concentration of tumor-specific signatures and protects from



- hepatocellular damages in Ehrlich ascites mice model J. Ayurveda Integr. Med. 16(5), 101152. <https://doi.org/10.1016/j.jaim.2025.101152>
52. Reena, Sharma P., Jasuja N.D., Kumar S., 2024. Manikya Bhasma as Nanomedicine for Cancer Cells Treatment and its Characterization Using Modern Scientific Tools. Asian Pacific Journal of Environment and Cancer 7(1), 47-55. DOI **10.31557/apjec.2024.7.1.47-55**
53. Kalimuthu K., Kim J.M., Subburaman C., Kwon W.Y., Hwang S.H., Jeong S., Cho M.G., Kim H.J., Park K.S., 2020. Characterization of Rajath Bhasma and Evaluation of Its Toxicity in Zebrafish Embryos and Its Antimicrobial Activity. Microbiol. Biotechnol. 30(6), 920 (2020) doi: 10.4014/jmb.1911.11018
54. Naikare T.S., Rao K.S., Kulkarni R.M., Sakhitha K.S., Singh T.R., Chaudhari M., Ingole A.P., 2022. Synthesis and Characterization of Rajat Bhasma and Its In-Vitro Anti-Cancer Activity. NeuroQuantology 20(14), 171-177. DOI: 10.4704/nq.2022.20.14.NQ88024
55. Ruidas B., Sur T.K., Pal K., Som Chaudhury S., Prasad P., Sinha K., Sarkar P.K., Das P., Das Mukhopadhyay C., Molecular Biology Reports 47(5), 3745-3763. <https://doi.org/10.1007/s11033-020-05467-7>
56. Chandran S., Patgiri B., Bedarkar P., Mathat, D., 2019. Anticancer activity of Yashada Bhasma (bioactive nanoparticles of zinc): A human pancreatic cancer cell line study. AYU (An international quarterly journal of research in Ayurveda), 40(1), 58-63. DOI: 10.4103/ayu.AYU_239_17
57. C.A. Philips, Paramaguru R., Augustine P., Ayurveda metallic-mineral 'Bhasma'-associated severe liver injury. BMJ Case Reports CP, bcr-2018-225590 (2018) doi: 10.1136/bcr-2018-225590
58. Kapoor R.C., Some observations on the metal-based preparations in the Indian Systems of Medicine. Indian Journal of Traditional Knowledge 9, 562(2010) <http://hdl.handle.net/2248/3544>