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REVIEW ARTICLE

Yashada (Zinc) in Ayurveda: A Scoping Review of Classical Concepts, Pharmaceutical Processing, Analytical Characterization, and Therapeutic Applications

Meghna Vaidya[1]*, Abhishek Upadhyay[2]

[1]Professor, Department of Rasa-Shastra and Bhaishajya Kalpana, Mahatma Jyotiba Fule Ayurvedic Medical College and Hospital Harota, Jaipur, Rajasthan, India.
[2]Assistant Professor, Department of Kayachikitsa, National Institute of Ayurveda, Deemed to be University, Jaipur, Rajasthan, India.

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ABSTRACT

Background: Yashada (zinc) is an important metallic drug described in Ayurvedic Rasa Shastra and therapeutically indicated in disorders such as Prameha, Vrana, and Netra Roga. Classical pharmaceutical procedures, including Shodhana and Marana, convert raw metal into Yashada Bhasma, a biologically assimilable medicinal form. Recent analytical and biomedical studies have validated its physicochemical and therapeutic properties.

Objectives: The objective of the study was to critically review classical and contemporary literature on Yashada with emphasis on its historical evolution, pharmaceutical processing, analytical characterization, pharmacological activities, clinical applications, and safety profile.

Methods: Classical references were collected from major Rasa Shastra texts. Contemporary literature was searched through PubMed, Google Scholar, AYUSH Research Portal, and DHARA using keywords including "Yashada", "Yashada Bhasma", and "zinc". Studies were screened and categorized according to Preferred Reporting Items for Systematic Reviews and Meta-analyses-ScR methodology.

Results: Out of 95 identified records, 46 studies were included after screening and duplicate removal. Analytical studies demonstrated conversion of metallic zinc into predominantly zinc oxide nano- and micro-particles following classical processing. Experimental studies reported antidiabetic, antioxidant, immunomodulatory, antimicrobial, wound healing, antiviral, and anticancer activities. Limited clinical studies suggested beneficial effects in diabetes mellitus, wound healing, and dermatological disorders. Safety studies indicated relatively low toxicity of properly prepared Yashada Bhasma, although variability among marketed formulations remains a concern.

Conclusion: Yashada Bhasma represents a promising interface between Ayurvedic metallurgy and modern nanomedicine. However, further standardized analytical studies and well-designed clinical trials are required to establish its safety, efficacy, and translational relevance.

1. INTRODUCTION

Ayurveda, one of the oldest traditional systems of medicine, initially developed predominantly as a plant-based therapeutic science. With the advancement of Rasa Shastra during the medieval period, metals and minerals were systematically incorporated into Ayurvedic pharmaceutics through specialized procedures such as Shodhana (purification) and Marana (incineration). These processes convert raw metals into biologically assimilable formulations known as Bhasma, which are considered therapeutically potent, rapidly acting, and effective even in small doses.

Among the metallic drugs described in Rasa Shastra, Yashada occupies an important place under Puti Loha.[1] Earlier classical texts referred to zinc-containing substances mainly as Rasaka Satva and Kharpara Satva,[2] whereas the term Yashada became prominent in later texts, including Bhava Prakasha,[3] Ayurveda Prakasha,[4] and Rasa Tarangini.[5] Classical Ayurvedic literature recommends Yashada

Corresponding Author:
Meghna Vaidya, Professor, Department of Rasa-Shastra and Bhaishajya Kalpana, Mahatma Jyotiba Fule Ayurvedic Medical College and Hospital Harota, Jaipur, Rajasthan, India.
Email: drvaidyameghna@gmail.com

and its formulations in disorders such as Prameha, Pandu, Netra Roga, Vrana, Kasa, and Shwasa[5] and also describes it as Rasayana and Chakshushya.[3]

Chemically, Yashada corresponds to zinc, an essential trace element involved in numerous physiological processes, including immune regulation, antioxidant defense, wound healing, cellular growth, and insulin metabolism.[6] Zinc deficiency is associated with impaired immunity, metabolic disorders, delayed tissue repair, dermatological conditions, and reproductive dysfunction.[7] Interestingly, several of these biomedical roles correlate with the classical therapeutic indications of Yashada in Ayurveda.

Recent advances in analytical sciences and nanotechnology-based research have generated renewed interest in metallic Bhasmas. Studies on Yashada Bhasma have demonstrated transformation of metallic zinc into predominantly zinc oxide (ZnO) nano- and micro-particles following classical pharmaceutical processing.[8] Experimental investigations have also reported antidiabetic, antioxidant, antimicrobial, immunomodulatory, and wound healing activities, supporting several traditional uses.[9]

Despite increasing scientific interest, available literature on Yashada remains scattered across classical texts and modern experimental studies. Therefore, the present scoping review was undertaken to critically compile and analyze the historical background, pharmaceutical processing, analytical characterization, pharmacological activities, clinical applications, and safety profile of Yashada and Yashada Bhasma in light of contemporary scientific evidence.

2. METHODOLOGY

The present scoping review was conducted using classical Ayurvedic literature and contemporary scientific databases. Classical references related to Yashada were collected from major Rasa Shastra texts for information regarding nomenclature, classification, pharmaceutical processing, properties, and therapeutic applications.

Contemporary literature was searched through PubMed, Google Scholar, AYUSH Research Portal, and DHARA using keywords such as “Yashada,” “Yashada Bhasma,” “Jasada Bhasma,” “Rasaka Satva,” “Kharpara” and “zinc.” Studies related to pharmaceutico-analytical evaluation, pharmacological activity, clinical applications, and safety assessment were screened.

A total of 95 records were identified. After removal of duplicates and screening based on relevance to Yashada as the primary subject, 46 studies were included in the final review. The included studies were categorized into review articles, pharmaceutico-analytical studies, experimental studies, clinical studies, safety/toxicological studies, and case reports following preferred reporting items for systematic reviews and meta-analyses -ScR principles [Figure 1].

2.1. Historical Review and Classical Perspective of Yashada

The concept of Yashada evolved gradually with the development of ancient Indian metallurgical and pharmaceutical knowledge. In early Rasa Shastra literature, zinc was not directly described as Yashada but was referred to mainly as Rasaka, Rasaka Satva, and Kharpara Satva, indicating zinc-containing ores and their metallic extracts. Classical texts such as Rasarnava,[10] Rasa Kamdhenu,[11] Rasa Ratna Samuccaya,[12] and Rasendra Chudamani[13] described different varieties of Rasaka and methods for extraction of metallic essence through Satvapatana. These references indicate that ancient Ayurvedic scholars possessed considerable knowledge of zinc metallurgy and mineral processing.

The term Yashada became more prominent in later texts such as Bhava Prakasha, Ayurveda Prakasha, Rasa Tarangini, and Rasamritam,[14] where detailed descriptions regarding synonyms, pharmaceutical processing, therapeutic applications, and dosage were provided [Table 1]. This transition from mineral ores to purified metallic zinc reflects the progressive advancement of Ayurvedic pharmaceutics.

Yashada is described by several synonyms including Jasada, Rasaka Satva, Kharpara Satva, Ranga Sadrisha, Shwetapatra, and Kharparaja.[15] In Ayurvedic classification, it is included under Dhatu Varga and specifically categorized as Puti Loha[1] due to its low melting point and characteristic metallurgical behavior. Some texts also consider Pittala (brass) as its Upadhatu[16] [Table 2].

Classical Ayurvedic texts have also described specific quality parameters for selecting suitable Yashada. Grahya Yashada is characterized by properties such as Snigdha (unctuous), Mridula (soft), Nirmala (pure), Drutadrava (easily fusible), and Shweta Varna (whitish appearance), indicating purity and suitability for pharmaceutical processing. In contrast, Agrahya Yashada is described as rough, hard, impure, discolored, and difficult to melt, suggesting contamination or inferior quality.[17]

Therapeutically, Yashada Bhasma has been indicated in Prameha, Pandu, Netra Roga, Vrana, Kasa, Shwasa, and skin disorders. It is also described as Rasayana, Chakshushya, and Kaphapittahara [Table 3]. Interestingly, many of these traditional indications correspond with the modern biomedical role of zinc in immunity, wound healing, metabolic regulation, and tissue repair.

2.2. Pharmaceutical Processing and Modern Interpretation

Pharmaceutical processing plays a crucial role in determining the safety, bioavailability, and therapeutic efficacy of Yashada Bhasma. Classical Ayurvedic texts emphasize that raw Yashada should not be used directly for therapeutic purposes and must undergo systematic pharmaceutical procedures, including Shodhana, Jarana, and Marana.

Shodhana is the purification and detoxification process intended to remove physical and chemical impurities while enhancing the therapeutic properties of the metal. Classical texts describe both Samanya and Vishesha Shodhana procedures for Yashada.[18] Commonly, molten Yashada is repeatedly quenched in media such as sesame oil, buttermilk, cow urine, sour gruel, Kulattha Kwatha, Triphala Kwatha, and herbal juices.[19] Repeated heating and quenching reduce brittleness, facilitate further processing, and are believed to impart additional therapeutic attributes through interaction with organic media.[20]

Following purification, Jarana is performed to convert molten Yashada into a powdered intermediate form by continuous heating with herbal substances. Subsequently, Marana involves repeated incineration and trituration with herbal juices such as Kumari Swarasa and Nimbu Swarasa under controlled heating conditions using various Puta methods. The process is repeated until the final product satisfies classical Bhasma Pariksha parameters, including Rekhapurnata, Varitaratva, and Nischandratva, indicating proper incineration and fineness.[21]

Modern scientific investigations suggest that these classical pharmaceutical procedures induce significant physicochemical

transformations in Yashada. Repeated heating and quenching may remove impurities, alter surface characteristics, and facilitate oxidation of metallic zinc. During Marana, metallic zinc is predominantly converted into ZnO, while repeated incineration and trituration reduce particle size to micro- and nano-dimensional ranges.[21]

2.3. Analytical Studies and Standardization of Yashada Bhasma

Recent analytical investigations have provided substantial scientific evidence supporting the classical Ayurvedic pharmaceutical processing of Yashada Bhasma. Several studies have additionally explored the nano-dimensional and physicochemical characteristics of Yashada Bhasma in relation to its pharmacological activity.

Traditional analytical methods such as Varitaratva, Rekhapurnata, Nischandratva, and Namburi Phased Spot Test (NPST) have been used to assess the quality and completion of Marana.[22] A researcher evaluated marketed samples of Yashada Bhasma using NPST and demonstrated characteristic phase reactions confirming proper incineration and authenticity.[23] Comparative NPST studies also revealed variability among marketed preparations, indicating a lack of uniform manufacturing standards.[23]

X-ray diffraction studies consistently demonstrated that Yashada Bhasma predominantly contains crystalline ZnO. Disappearance of metallic zinc peaks following Marana was reported, indicating successful conversion of elemental zinc into stable oxide form.[24,25] Elemental analyses using EDX, X-ray fluorescence, Inductively coupled plasma mass spectrometry, and atomic absorption spectroscopy further identified zinc as the major elemental constituent with reduction of toxic impurities after Shodhana.[26-28]

Microscopic studies using scanning electron microscopy and transmission electron microscopy demonstrated irregular, porous, agglomerated, and microfine particles in Yashada Bhasma preparations. A similar study observed significant particle size reduction after repeated incineration cycles,[29] while another study reported spherical and polydispersed ZnO nanoparticles ranging from approximately 10–50 nm. It also reported formation of ZnO nanoparticles with enhanced Zn^{2+} bioavailability following classical Ayurvedic incineration processes.[30] Similar findings were also reported in particle size estimation studies, demonstrating progressive reduction in particle dimensions after repeated Bhavana and Puta procedures.[31]

Spectroscopic investigations also confirmed characteristic absorption patterns corresponding to ZnO formation.[32] Comparative studies between traditionally prepared and green-synthesized ZnO nanoparticles demonstrated similarities in physicochemical characteristics, supporting the scientific basis of Ayurvedic pharmaceutical processing.[33] However, comparative analyses of marketed and laboratory-prepared samples revealed considerable variation in crystallinity, particle morphology, elemental composition, and standardization parameters.[26,34]

Collectively, these analytical investigations indicate that classical Shodhana and Marana procedures transform raw metallic zinc into stable ZnO nano- and micro-particles with altered physicochemical properties [Table 4]. The observed nano-dimensionality may contribute to enhanced bioavailability and therapeutic efficacy of Yashada Bhasma. However, variability among marketed formulations highlights the need for standardized pharmaceutical protocols and quality control measures.

2.4. Experimental and Pharmacological Studies on Yashada Bhasma

Experimental studies on Yashada Bhasma have primarily focused on validating its classical therapeutic indications using modern scientific parameters. Among the various pharmacological activities investigated, antidiabetic activity remains the most extensively studied. A study demonstrated significant hypoglycemic effects of Yashada Bhasma in streptozotocin-induced diabetic rats, with reduction in blood glucose levels and improvement in diabetic symptoms.[35] Another study similarly reported hypoglycemic activity of Yashada Bhasma and Shilajeet in both normoglycemic and alloxan-induced diabetic animal models.[36] Furthermore, reduction in hyperglycemia, oxidative stress, and altered lipid parameters was observed while establishing the relative safety of Jasada Bhasma in diabetic rats.[37] These findings scientifically support the classical Ayurvedic indication of Yashada in Prameha.

Immunomodulatory and antioxidant activities of Yashada Bhasma have also been investigated. Experimental studies demonstrated enhancement of immune responses and modulation of inflammatory pathways following administration of Yashada Bhasma.[38] Antioxidant screening studies reported significant free radical scavenging activity, suggesting its potential role in reducing oxidative stress-related cellular damage.[39]

Anticancer potential of Yashada Bhasma has also been investigated. Cytotoxic activity of Yashada Bhasma has been demonstrated against human pancreatic cancer cell lines, indicating possible applications as a zinc-based nanomedicine.[40] Antimicrobial and antiviral activities have similarly been reported. Studies showed inhibitory activity against Propionibacterium acnes and suppression of acne-associated inflammation.[41] Antiviral investigations demonstrated cytoprotective effects of Yashada-based nano-formulations against bovine coronavirus.[42]

Experimental wound healing studies further support the use of Yashada-containing formulations in chronic wounds and skin disorders. A study demonstrated improved wound contraction and epithelialization using Ayurveda-based topical formulations containing zinc preparations.[43] The wound healing potential may be attributed to zinc's role in collagen synthesis, epithelial regeneration, antioxidant defense, and immune modulation.[6]

Overall, available experimental evidence suggests that Yashada Bhasma possesses significant antidiabetic, antioxidant, immunomodulatory, antimicrobial, wound healing, antiviral, and anticancer activities [Table 5]. However, many studies are limited by small sample sizes, variable pharmaceutical procedures, and a lack of standardized characterization protocols. Further mechanistic studies and translational research using standardized preparations are therefore required to establish reproducible pharmacological efficacy according to contemporary scientific standards.

2.5. Clinical Studies and Safety Profile of Yashada Bhasma

Clinical evidence on Yashada Bhasma is limited but suggests promising therapeutic potential in metabolic, dermatological, and wound healing disorders. Most available studies are open-label or observational in nature and primarily focus on diabetes mellitus and chronic wound management.

A multicentric open-label prospective study evaluated the efficacy of Nisha Katakadi Kashaya and Yashada Bhasma, individually

and in combination, in the management of type-2 diabetes mellitus (Madhumeha). The study reported improvement in fasting blood sugar, postprandial blood sugar, and associated clinical symptoms, indicating potential therapeutic benefit of Yashada Bhasma as an adjunctive antidiabetic formulation.[44]

Topical applications containing Yashada Bhasma have also shown encouraging results in wound healing and dermatological disorders. A comparative clinical study on Dushta Vrana (diabetic ulcer) reported beneficial effects of Yashada Bhasma Lepa in wound healing and infection control.[45]

In addition to therapeutic studies, several investigations have evaluated the safety profile of Yashada Bhasma. It was reported that administration of therapeutic doses of Jasada Bhasma in experimental models did not produce significant behavioral abnormalities, mortality, or major toxic manifestations.[37] Histopathological evaluations similarly indicated the absence of severe organ toxicity at therapeutic dosage ranges.[46] General toxicological evaluations of Ayurvedic metallic preparations have also suggested that classical pharmaceutical procedures such as Shodhana and Marana substantially reduce toxicity associated with raw metals.[47]

Despite these encouraging observations, currently available clinical and safety evidence remains limited by small sample sizes, short study durations, methodological heterogeneity, and lack of randomized controlled trials. Variability among marketed preparations and insufficient long-term toxicity data further highlight the need for standardized pharmaceutical protocols, chronic toxicity studies, pharmacokinetic evaluation, and well-designed multicentric clinical trials.

Overall, existing evidence suggests that properly prepared Yashada Bhasma may possess an acceptable safety profile along with potential therapeutic benefits, particularly in diabetes mellitus, wound healing, and dermatological conditions. However, robust clinical validation according to contemporary scientific standards is still required.

3. DISCUSSION

The present scoping review highlights the multidimensional significance of Yashada in both classical Ayurveda and contemporary scientific research. Classical Rasa Shastra literature describes Yashada as an important Puti Loha indicated in disorders such as Prameha, Vrana, Netra Roga, and skin diseases. The gradual transition from references to Rasaka Satva and Kharpara Satva toward the direct medicinal use of Yashada reflects the advancement of Ayurvedic metallurgical and pharmaceutical knowledge.

One of the most important observations from the reviewed literature is the scientific relevance of classical pharmaceutical procedures such as Shodhana and Marana. Modern analytical investigations consistently demonstrate that these processes transform metallic zinc into predominantly ZnO nano- and micro-particles.[24,25,29,30] Repeated heating, quenching, trituration, and incineration appear to induce physicochemical modifications including oxidation, particle size reduction, increased surface area, and altered crystallinity. These transformations may contribute to enhanced bioavailability, reduced toxicity, and improved biological interaction of Yashada Bhasma.

The reviewed experimental evidence also supports several classical therapeutic claims. Antidiabetic activity remains the most extensively investigated pharmacological property, with multiple studies demonstrating a reduction in blood glucose levels and oxidative stress in diabetic animal models.[35-37] Immunomodulatory, antioxidant, antimicrobial, antiviral, wound healing, and anticancer activities further indicate the broad therapeutic potential of Yashada Bhasma.[38-41,43] Such findings are particularly relevant in the context of modern nanomedicine, where ZnO nanoparticles are increasingly explored for biomedical applications.

Despite promising analytical and experimental evidence, the available clinical data remain limited. Most clinical studies are observational or open-label investigations with small sample sizes and methodological heterogeneity.[44,45] Similarly, safety studies generally suggest acceptable toxicity profiles for Yashada Bhasma,[37,46,47] but comprehensive long-term toxicological evaluations and pharmacokinetic studies are still insufficient. Another major concern identified in the literature is the considerable variability among marketed formulations with respect to particle size, elemental composition, crystallinity, and pharmaceutical quality.[22,23,26,34] This lack of standardization may significantly influence therapeutic efficacy and safety.

Overall, the reviewed literature suggests that Yashada Bhasma represents a unique interface between traditional Ayurvedic metallurgy and modern nanoscience. However, further multicentric analytical studies, standardized manufacturing protocols, mechanistic investigations, chronic toxicity studies, and well-designed randomized clinical trials are essential to establish its reproducible safety, efficacy, and translational relevance according to contemporary scientific standard

4. CONCLUSION

Yashada occupies an important position in Ayurvedic Rasa Shastra as a therapeutically significant metallic formulation with wide clinical applicability. Classical pharmaceutical procedures such as Shodhana and Marana are designed to transform raw metallic zinc into a biologically compatible and therapeutically potent form known as Yashada Bhasma. Contemporary analytical studies substantiate these classical concepts by demonstrating the conversion of metallic zinc into predominantly ZnO nano- and micro-particles with altered physicochemical characteristics.

Experimental investigations provide encouraging evidence regarding the antidiabetic, antioxidant, immunomodulatory, antimicrobial, antiviral, wound healing, and anticancer potential of Yashada Bhasma. Preliminary clinical studies also suggest beneficial effects in diabetes mellitus, dermatological disorders, and chronic wounds, while available safety studies indicate relatively low toxicity of properly prepared formulations.

Despite promising findings, the current evidence base remains limited by insufficient mechanistic studies, and scarcity of high-quality randomized clinical trials. Therefore, further multidisciplinary research integrating classical Ayurvedic principles with advanced analytical techniques, toxicological evaluation, pharmacokinetic studies, and well-designed multicentric clinical trials is essential to establish the reproducible safety, efficacy, and translational relevance of Yashada Bhasma in contemporary healthcare.

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6. AUTHORS' CONTRIBUTIONS

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10. DATA AVAILABILITY STATEMENT

The data analyzed in this review were obtained from publicly available sources, including peer-reviewed articles, observational studies, and surveys accessible through databases.

11. DISCLAIMER/VIEW AND OPINIONS

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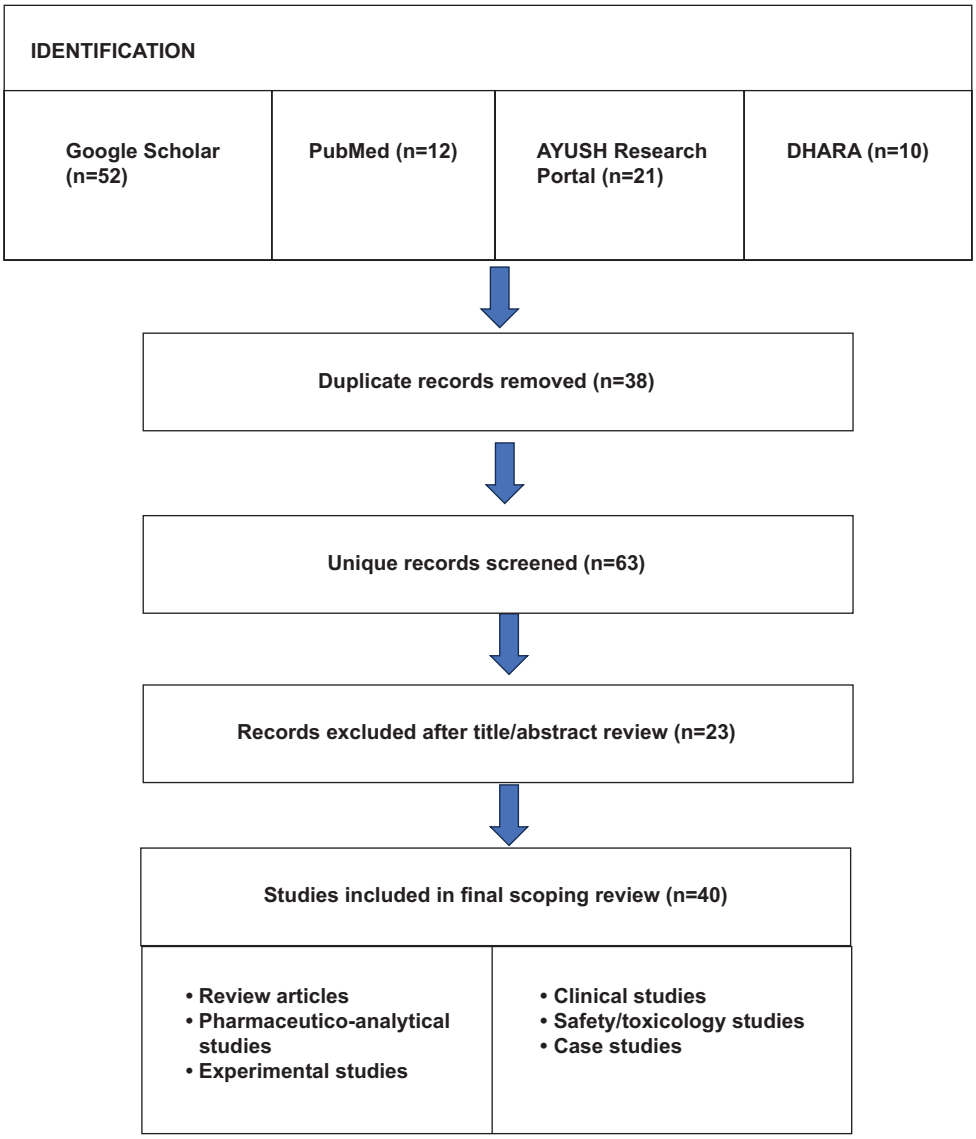

Figure 1: Preferred reporting items for systematic reviews and meta-analyses flow diagram for scoping review of Yashada/Yashada Bhasma

Table 1: Historical background of *Yashada*

S. No.	Reference	Description
1	Madanpal nighantu	Only name is mentioned
2	Bhavaprakasha	Paryaya and Guna
3	Ayurved prakasha	Paryaya, Guna, Vikarshanti, Shodhana, and Marana like Vanga
4	Ras tarangini	Paryaya, Grahya-Agrahya lakshana, Shodhana, Marana, Matra, Guna, and Therapeutic uses
5	Rasamritam	Paryaya, Guna, Shodhana, Marana
6	Brihat Ras Raj Sunder	Matra, Guna, Anupana, Vikara, Vikara shanti, and Marana

Table 2: Classical synonyms and classification of yashada

Aspect	Description
Major synonyms	Rasaka Satva, Kharpara Satva, Jasada, Shwetapatra
Classification	Dhatu Varga, Puti Loha
Upadhatu	Pittala
Grahya Lakshana	Snigdha, Mridula, Nirmala, Shweta
Agrahya Lakshana	Kathina, Malina, Neela Prabha

Table 3: Pharmacological and therapeutic actions of Yashada Bhasma according to Ayurvedic classics

Reference	Rasa	Virya	Guna	Pharmacological actions	Therapeutic uses
Rasamritam	Kashaya Tikta	Sheeta	Sheeta	Kaphapittahrita	Chaksushyaparam Prameha, Pandu, Shwasa
Rasendra Puran	_	_	_	Param Chakshushya	Meha, Pandu, Shwasa
Ras Tarangini	Kashaya, Katu	Sheeta	Sheeta	Kaphapittashamaka Shleshmakalasan kochaka.	Pandu, Prameha, Kasa, Shwasa, Ratrisweda, Kampavata Nashak.
Bhav Prakasha	Tuvara, Tikta	Sheeta	Sheeta	Kaphapittahrit Chakshushya	Prameha, Pandu, Shwas
Brihat Ras Raj Sunder	Tuvara, Tikta	Sheeta	Sheeta	Chakshushya	Prameha, Pandu, Shwasa
Siddha Bheshaja Manimala	Tikta, Kashaya	Sheeta	Sheeta	Kaphpittanashak	Shwas, Kasa, Netra peeda, Halimaka, Prameha

Table 4: Major analytical findings on Yashada Bhasma

Technique	Major findings
XRD	Predominant ZnO phase
XRF/AAS/ICP-MS	Zinc as a major elemental constituent
SEM/TEM	Nano- and micro-sized particles
NPST	Confirmation of proper incineration
Particle size analysis	Nano-dimensionality after repeated Puta

XRD: X-ray diffraction, XRF: X-ray fluorescence, ICP-MS: Inductively coupled plasma mass spectrometry, AAS: Atomic absorption spectroscopy, SEM: Scanning electron microscopy, TEM: Transmission electron microscopy

Table 5: Experimental and clinical activities of Yashada Bhasma

Activity	Major observations
Antidiabetic	Reduction in blood glucose and oxidative stress
Antioxidant	Free radical scavenging activity
Immunomodulatory	Modulation of immune responses
Antimicrobial	Activity against *P. acnes*
Wound healing	Enhanced epithelialization and wound contraction
Anticancer	Cytotoxicity against pancreatic cancer cell lines
Clinical studies	Improvement in diabetes and wound healing