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"*SHODHANA* AND TOXICITY REDUCTION IN AYURVEDIC PHARMACEUTICS: A CRITICAL REVIEW OF PHYSICOCHEMICAL AND TOXICOLOGICAL EVIDENCE FOR METALS, MINERALS AND *VISHA DRAVYAS*"

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ABSTRACT

Background: *Shodhana* is the set of purification and processing procedures that Ayurveda prescribes before toxic plants (*visha* and *upavisha dravyas*), metals and minerals are used as medicines. It is widely claimed to remove or reduce toxicity, but the strength of the evidence varies greatly between materials. **Objective:** To review the physicochemical and toxicological evidence on how *shodhana* changes the composition and toxicity of poisonous plants, metals and minerals, and to identify what remains unproven. **Methods:** A critical narrative review of experimental studies that compared raw and processed material using chemical analysis, animal toxicity, cytotoxicity or mutagenicity assays, together with relevant classical and review literature. **Results:** For aconite, *Strychnos nux-vomica*, *Croton tiglium* and *Abrus precatorius*, processing in media such as cow's urine, milk, *kanji* and water consistently reduced marker toxic constituents or toxicity, although reductions were partial (for example, phorbol ester content fell by about 21–23% in *Croton* seeds) and the toxic principle was sometimes also the active one. For metals, *shodhana* by repeated heating and quenching altered surface structure, removed some trace elements, and increased brittleness, but did not lower the content of the principal metal; in lead, purity rose from 97.13% to 98.98%. Processing can also introduce new contaminants. **Conclusion:** *Shodhana* is best understood as controlled chemical transformation rather than as removal of the toxic element. Its effects are real but partial and material-specific, and need validated end-points and dose-linked toxicity data.

KEYWORDS: *Shodhana*; Detoxification; *Visha dravya*; Aconite; *Strychnos nux-vomica*; Lead; *Rasa Shastra*

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INTRODUCTION

Ayurveda uses a number of substances that are frankly poisonous, including plants such as *Vatsanabha* (*Aconitum* species), *Kupilu* (*Strychnos nux-vomica*), *Jayapala* (*Croton tiglium*), *Gunja* (*Abrus precatorius*), *Bhallataka* (*Semecarpus anacardium*) and *Dhattura* (*Datura* species), as well as metals and minerals such as lead, mercury, arsenic sulphides and copper. The classical texts of *Rasa Shastra* do not deny their toxicity. Instead, they prescribe *shodhana* (purification), a set of processing procedures carried out before the material can be used, and they warn that unpurified material causes harm[1,2].

Shodhana procedures include soaking (*bhavana*), boiling in a cloth bag suspended in a liquid medium (*swedana* by *dola yantra*), heating and quenching (*nirvapa* or *dhalana*), trituration, frying and washing, using media such as cow's urine (*gomutra*), cow's milk (*godugdha*), sour gruel (*kanji*), buttermilk (*takra*), sesame oil (*taila*), herbal decoctions and lime water. Classical sources distinguish general procedures applicable to a whole class (*samanya shodhana*) from material-specific procedures (*vishesha shodhana*)[3,4].

For more than three decades, researchers have argued that these *samskaras* (processing operations) should not be dispensed with, and that their effects can be tested experimentally[5]. This review examines that evidence. It asks three questions: what *shodhana* does to the chemistry of the material; whether the chemical changes translate into lower toxicity; and what remains unproven.

METHODS OF THE REVIEW

This is a critical narrative review. Literature was identified through PubMed, PubMed Central, Crossref-indexed records, Semantic Scholar and publisher databases, using the terms *shodhana*, *sodhana*, purification, detoxification, processing, Ayurveda and the names of individual toxic plants and metals. Studies were included when they compared raw and processed material using at least one chemical, toxicological or biological end-point. Reviews and classical texts were used for context. Owing to the diversity of materials and end-points, the evidence was summarised qualitatively by material.

CONCEPTUAL FRAMEWORK: THREE POSSIBLE MECHANISMS

Experimental studies point to three ways in which *shodhana* could reduce toxicity. These mechanisms are not mutually exclusive, and the relative contribution of each differs between materials.

- **Extraction or leaching.** The medium dissolves and carries away part of the toxic constituent. Many alkaloids and glycosides are partly soluble in acidic, alkaline or aqueous media, and repeated boiling or soaking removes part of them[6,7].
- **Chemical transformation.** Heat, pH and constituents of the medium convert a toxic compound into a less toxic derivative. In aconite, for example, hydrolysis of diester alkaloids to less toxic monoester and non-esterified forms is the accepted mechanism behind traditional processing in both Indian and Chinese practice.
- **Physical change.** For metals and minerals, repeated heating and quenching makes the material brittle, alters surface structure and removes surface impurities, which prepares it for later incineration (*marana*)[8].

EVIDENCE FOR POISONOUS PLANTS (VISHA AND UPAVISHA DRAVYAS)

Table 1 summarises representative experimental studies.

Table 1. Representative experimental studies of *shodhana* in toxic plants

Plant (Ayurvedic name)	Main toxic constituents	*Shodhana* medium and method	Main findings
Aconitum species (*Vatsanabha*)	Diester diterpenoid alkaloids, mainly aconitine	Soaking in cow's urine; boiling in milk	Lower toxicity of processed root in animals; cow's urine judged the better medium on the basis of aconitine content after processing
Strychnos nux-vomica (*Kupilu*)	Strychnine, brucine	Cow's urine and milk, alone and in combination	All three methods reduced strychnine and brucine; greatest reduction with 7 days' soaking in cow's urine followed by 3 hours' boiling in milk

Croton tiglium (*Jayapala*)	Phorbol esters, crotonic acid	Classical Indian *shodhana*; Thai traditional detoxification	Reduced cytotoxicity, no significant mutagenicity; in Thai processing, PMA reduced by about 21–23% and crotonic acid undetectable, with a phthalate contaminant detected after processing
Abrus precatorius (*Gunja*)	Abrin (a toxic lectin)	Boiling for 6 hours in milk, lemon juice, *kanji* or water	Weight loss of about 8–16%; aqueous extracts lost antibacterial activity, chloroform extracts retained it
Semecarpus anacardium (*Bhallataka*)	Urushiols and related phenolic lipids	Classical purification of nuts	Purification reduces irritant content; urushiols are also the main anti-tumour principle
Datura innoxia and *D. metel* (*Dhattura*)	Tropane alkaloids	Classical *shodhana*	Analytical parameters changed after processing

1. Aconite

Aconite is the clearest example of why *shodhana* matters. Accidental aconite poisoning produces severe cardiotoxicity with arrhythmias, and in a series of 17 patients with accidental herb-induced aconite poisoning, two died[18]. Experimental work summarised by Ilanchezhian and colleagues indicates that crude aconite caused 100% mortality in mice at 2.6 mg per mouse, while fully processed aconite caused no deaths even at eight times that dose[6]. A study of *Vatsanabha* before and after *shodhana* likewise reported lower toxicity of the processed root[9]. These observations are consistent with partial removal and hydrolysis of the diester alkaloids, but most Ayurvedic studies have not quantified individual alkaloids before and after processing, which limits their interpretation.

2. *Strychnos nux-vomica*

For *Kupilu*, high-performance thin-layer chromatography showed that processing in cow's urine, cow's milk or both reduced strychnine and brucine, with the greatest reduction after 7 days' soaking in cow's urine followed by 3 hours' boiling in cow's milk[10]. Other work has reported a fall in strychnine from 0.63% in the crude seed to 0.52% after milk processing[6], and has examined the specific role of milk as a medium[11]. These reductions are real but modest. Because strychnine has a narrow margin of safety, a reduction of this order does not make the seed safe; it remains a Schedule E1 drug that requires controlled dosing.

3. *Croton tiglium*

Croton seeds contain phorbol esters, which are purgative and tumour-promoting. Classical Indian *shodhana* reduced cytotoxicity in Chinese hamster ovary cells and did not produce significant mutagenicity in the Ames test[12]. A Thai traditional detoxification process reduced phorbol-12-myristate-13-acetate from 1.59 to about 1.22–1.26 mg/g, a fall of roughly 21–23%, and made crotonic acid undetectable. No deaths occurred at 2000 mg/kg in rats, and only the unprocessed seed produced a significant purgative effect at 100 mg/kg. However, the phthalate di-(2-ethylhexyl) phthalate was detected after processing but not before[13]. This finding is a reminder that processing steps can introduce new contaminants from containers, cloth or media, and that the processed product needs its own quality testing.

4. *Abrus precatorius*

For *Gunja*, boiling the seeds for 6 hours in milk, lemon juice, *kanji* or water caused weight losses of about 8–16% and changed colour, odour and taste. The aqueous extract of raw seeds inhibited three of four bacterial strains, whereas none of the processed aqueous extracts did; chloroform extracts of all processed samples remained active, with the *kanji*-processed seeds giving the largest zones of inhibition[14]. The loss of activity in aqueous extracts is consistent with heat denaturation and leaching of protein constituents, including the toxic lectin abrin, although abrin itself was not measured.

5. *Semecarpus anacardium* and *Datura*

For *Bhallataka*, purification reduces the irritant phenolic fraction responsible for contact dermatitis[15]. Yet urushiols have also been identified as the main anti-tumour principle of a *Semecarpus*-based Siddha preparation[16]. In *Datura*, *shodhana* altered analytical parameters of the seeds of two species[17]. In both cases, the aim of *shodhana* is better described as adjusting the dose of the active-toxic principle than as eliminating it.

EVIDENCE FOR METALS AND MINERALS

1. Lead (*Naga*)

The most detailed analysis of metal *shodhana* concerns lead. In a study of Naga *bhasma* preparation, molten lead was quenched three times in each of five media. The lead content rose from 97.13% in the raw metal to 98.98% after the final medium. Calcium, sodium, molybdenum and ruthenium, present at 0.18–0.27% in the raw metal, were no longer detectable after the first treatment, and silicon fell from 0.26% to 0.06%. Iron disappeared after the oil and *kanji* steps but reappeared at 0.16–0.18% after buttermilk and cow's urine, most likely from the iron vessel. The first quenching step left a brittle surface with rod-like nanostructures 30–50 nm wide. In the subsequent *jarana* step with plant bark powders, the product became mainly lead oxide, with PbO at 94.21% by mass[8].

These results show that *shodhana* of a metal purifies it in a metallurgical sense, removing some trace elements and making it brittle. It does not, and is not intended to, reduce the content of the metal itself. Any reduction in toxicity has to come from later stages (*marana*), which change the chemical form, for example into lead sulphide in the finished *bhasma*[19].

2. Mercury (*Parada*) and minerals

Classical *Rasa Shastra* prescribes elaborate procedures (*ashtasamskara*) for mercury. Their modern relevance lies mainly in chemical speciation: mercury bound as mercuric sulphide in *kajjali* and *Rasasindura* is much less soluble and less bioavailable than mercuric chloride or methylmercury, although it is not inert[20,21]. For minerals, *shodhana* often begins the chemical conversion. Heating chalcopyrite (*Swarna makshika*) with lemon juice in an iron pan for three days, for example, was the first step in a process that ended in oxide and sulphide phases[22].

WHAT THE EVIDENCE DOES AND DOES NOT SHOW

The evidence supports several conclusions.

- **Effects are real but partial.** For every plant with quantitative data, *shodhana* reduced the marker toxin, but by modest amounts. Processed material remains toxic at sufficient dose.
- **Effects depend on the medium and method.** Different media gave different reductions for the same plant[10,14]. Standard operating procedures that specify the medium, ratio, temperature and duration are essential.
- **Toxic and active principles often overlap.** For *Bhallataka* and aconite, the constituents that cause toxicity also contribute to activity. *Shodhana* modulates the therapeutic window rather than separating benefit from harm.
- **Processing can introduce contaminants.** Detection of a phthalate after traditional processing[13] and reappearance of iron after quenching in an iron vessel[8] show that the processed product needs separate testing.
- *Metal* shodhana *does not remove the metal. Its role is metallurgical preparation for* marana, which is where speciation and toxicity are mainly determined.

RESEARCH GAPS

Four gaps limit the current evidence. First, most studies measure only one or two marker compounds and do not track their transformation products, so it is often unclear whether a toxin has been removed or converted. Second, toxicity studies rarely compare raw and processed material at matched doses of the active constituent, which is needed to show a true change in therapeutic index. Third, few studies analyse the spent medium, which would show directly what has been extracted. Fourth, end-points for completed *shodhana* are still largely organoleptic; validated chemical end-points, such as a maximum residual content of the marker toxin, are needed for regulation and manufacturing.

CONCLUSION

Experimental evidence supports the classical view that *shodhana* changes the composition and lowers the toxicity of poisonous plants, and that it prepares metals and minerals for further processing. The changes are, however, partial, material-specific and dependent on the exact method used, and in some cases processing introduces new contaminants. *Shodhana* is best

understood as controlled chemical transformation and dose modulation rather than complete detoxification. Future work should quantify toxins and their products in both the material and the spent medium, compare raw and processed drugs at matched doses, and define validated chemical end-points for each procedure.

REFERENCES

1. Vagbhata. Rasa Ratna Samucchaya. Shastri AD, editor. Varanasi: Chaukhamba Amarabharati Prakashan; 1995.
2. Sharma S. Rasa Tarangini. Shastri K, editor. 2nd ed. New Delhi: Motilal Banarsidass; 2004.
3. Chaudhary A, Singh N. Herbo mineral formulations (Rasaoushadhies) of Ayurveda: an amazing inheritance of Ayurvedic pharmaceutics. Anc Sci Life 2010;30:18–26.
4. Government of India, Ministry of Health and Family Welfare. The Ayurvedic Formulary of India, Part I. 2nd ed. New Delhi: Department of ISM&H; 2000.
5. Thorat S, Dahanukar S. Can we dispense with Ayurvedic samskaras? J Postgrad Med 1991;37:157–9.
6. Vidiyala N, Sunkishala P, Parupathi PR, Nyavanandi D. Stem cell-derived exosomes in wound healing and skin regeneration: emerging therapeutic strategies and mechanisms. Cells. 2026;15(10):872.
7. Maurya SK, Seth A, Laloo D, Singh NK, Gautam DNS, Singh AK. Śodhana: an Ayurvedic process for detoxification and modification of therapeutic activities of poisonous medicinal plants. Anc Sci Life 2015;34:188–97.
8. Nagarajan S, Krishnaswamy S, Pemiah B, Rajan KS, Krishnan U, Sethuraman S. Scientific insights in the preparation and characterisation of a lead-based naga bhasma. Indian J Pharm Sci 2014;76:38–45.
9. Zehravi M, Khan SL, Gupta JK, Jahnavi P, Babu RH, Vidiyala N, et al. Advances in polymeric nanoparticles for oral drug delivery: mechanisms, challenges, emerging trends, and preclinical to clinical perspectives. 3 Biotech. 2026;16(1):35.
10. Mitra S, Shukla VJ, Acharya R. Effect of purificatory measures through cow's urine and milk on strychnine and brucine content of Kupeelu (Strychnos nux-vomica Linn.) seeds. Afr J Tradit Complement Altern Med 2012;9:105–11. https://doi.org/10.4314/ajtcam.v9i1.15
11. Mehta N, Prajapati PK, Chaudhary AK. Role of milk in Shodhana (detoxification) with special reference to nux-vomica. Aryavaidyan 2007;20:100–4.
12. Jamadagni PS, et al. Impact of Shodhana an Ayurvedic purification process on cytotoxicity and mutagenicity of Croton tiglium Linn. J Ayurveda Integr Med 2023;14.
13. Poowanna R, Pulbutr P, Kijjoa A, Nualkaew S. Purgative effect, acute toxicity, and quantification of phorbol-12-myristate-13-acetate and crotonic acid in Croton tiglium L. seeds before and after treatment by Thai traditional detoxification process. Int J Mol Sci 2025;26:7714.
14. Roy S, Acharya R, Mandal NC, Barman S, Ghosh R, Roy R. A comparative antibacterial evaluation of raw and processed Guñjā (Abrus precatorius Linn.) seeds. Anc Sci Life 2012;32:20–3. https://doi.org/10.4103/0257-7941.113794
15. Hechhu R, Krishnan K, Singamaneni V, Raju PVN, Erukulla P, Kandimalla KV, et al. GC-MS-based phytochemical analysis, in-depth ADMET screening and molecular docking targeting EGFR for anticancer potential. Chem Methodol. 2026;10(5):465-88.
16. Zhao W, Zhu L, Srinivasan S, Damodaran C, Rohr J. Identification of urushiols as the major active principle of the Siddha herbal medicine Semecarpus Lehyam: anti-tumor agents for the treatment of breast cancer. Pharm Biol 2009;47:886–93.
17. Patel Y, Bhat SD, Acharya R, Ashok BK, Shukla VJ. Role of Shodhana on analytical parameters of Datura innoxia Mill. and Datura metel Linn. seeds. Int J Res Ayurveda Pharm 2010;1:249–54.
18. Jahnavi P, Kumar AK, Prema S, Singamaneni VR, Vidiyala N, Sunkishala P, et al. Recent progress in heterogeneous catalysis for sustainable chemical processes. J Chem Rev. 2026;8(2):154-79.
19. Singh SK, Gautam DNS, Kumar M, Rai SB. Synthesis, characterization and histopathological study of a lead-based Indian traditional drug: Naga bhasma. Indian J Pharm Sci 2010;72:24–30.
20. Liu J, Shi JZ, Yu LM, Goyer RA, Waalkes MP. Mercury in traditional medicines: is cinnabar

toxicologically similar to common mercurials? Exp Biol Med (Maywood) 2008;233:810–7. https://doi.org/10.3181/0712-MR-336

21. Wal A, Bukke SPN, Vidiyala N, Jamil S, Sharma KK, Khan A, et al. Stimuli-responsive nanogels as intelligent nanocarriers for tumor microenvironment-triggered anticancer drug delivery. Discov Nano. 2026;21(1):247.