Traditional and Modern Insights into Gandhaka: Types, Purification Protocols, and Standardization Strategies

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Introduction:

Gandhaka (sulphur) is a well-known substance in Ayurvedic medicine because of its numerous therapeutic applications, particularly in Rasashastra preparations such as Rasaushadhi, Kupipakwa rasayana, Malasadhana yoga, and several topical formulations. Gandhaka, also known as Yogavahi, is a catalyst that improves drug absorption and efficacy. It has been used for ages to treat dermatological issues, infections, allergies, respiratory ailments, and chronic diseases. Classical scriptures highlight the need of selecting the appropriate type of sulphur, followed by careful purification (Shodhana) to remove physical impurities, reduce toxicity, and improve its healing qualities.

Recent scientific breakthroughs have led to a greater understanding of sulfur's physicochemical behaviour, molecular structure, and pharmacological activity, including antibacterial, anti-inflammatory, and keratolytic properties. In addition to traditional purification techniques utilising medicinal decoctions, ghee, and milk, modern analytical tools such as FTIR, XRD, SEM, DSC, and ICP-MS have contributed to standardise and ensure the quality of Gandhaka and its derivative formulations. This intersection of traditional knowledge and modern science proves essential for creating verified methodologies, ensuring batch-to-batch consistency, and expanding the global acceptability of sulfur-based Ayurvedic medicines.

This article analyses ancient Gandhaka classifications, juxtaposes traditional and modern cleansing methods, and assesses emerging standardisation attempts that blend Ayurvedic wisdom with modern scientific precision.

Gandhaka is the most prominent Rasoushadi after Parada.The amalgamation of Parada and Gan dhaka enabled the development of numerous Rasoushadhi formulations.

Synonyms for Gandhaka:

Gandhaka includes Gandhapashana, Gandhau, Rasagandhaka, Sugandhika, Gandhika, Gandha, and Saugandhika, Putigandha, Atigandha, Pamari, Keetanashan, Balirvali, Vasakhya, Kusthari, Sharabhumija, Shulvari, Navaneeta, Daityendra, Gandhamadana, Keetaghna, Kruraganda. (R.T. 8/1-3)

Physical properties

Nature	-	Crystalline lumps
Colour	-	Sulphur yellow
Streak	-	Yellowish white
Cleavage	-	Poor
Fracture	-	Conchoidal
Lusture	-	Resinous
Tenacity	-	Brittle
Transparency	-	Translucent
Hardness	-	1.5 to 2.5
Specific Gravity	-	1.95 to 2.10

Sources

Native Gandhaka can be found in the basins and crevices of extinct volcanoes, where it developed via a direct sublimation of valcanic gases. It can also be found in thermal springs, in sodium-rich cap rocks, and in sedimentary sequences containing sulphates and organic components like bituminous limestone. Native Gandhak that has been contaminated with sand, clay, bitumen, and other foreign particles is purified by melting in an oven or distilling in closed vessels.

In India, Gandhaka deposits are limited. The only reported occurrence is at Tsokar Lake in Jammu and Kashmir's Leh region. There is no mining for Gandhaka in India. However, element Gandhaka is economically recovered as a byproduct of fertiliser plants in Panipat, Haryana, Naya Nangal, and Bhatinda, Punjab, as well as an oil refinery in Mathura, Uttar Pradesh. There are significant amounts of elemental Gandhaka underground, mainly in Poland, Mexico, and the United States.

According to Rasa Text

Mythological story:

Devi Parvati, resplendent in gems and jewels, used to dance at the Shweta Dweepa at the expense of Ksheera Sagar. During that time, she had natural menstruation, which was quite appealing and pleasant smelling. Devi Parvati's fabric turned crimson due to the immense Rajahsrava, so she left it three times, and the material entered Ksheera Sagar with the tides of the sea. It eventually emerges during the Samudra Manthan procedure. Deva and Daitya were both amazed with the smell, therefore it became known as Gandhaka. The Raja of Devi Parvati is Gandhaka (R.R.S. 3/2-9)

Another mythological story:

During ancient times, king Bali used Gandhaka to attain immense strength. However, during the Samudra Manthana time, Bali pulled on Vasuki. The flame of Vasuki that bursts from his lips caused King Bali's fat to melt, releasing Gandhaka smell in the form of sweat from his body. This aromatic compound was formerly known as Gandhaka, but it proved toxic and was renamed Balivasa. (Rasa.Chu. 11/6-7)

Types

Superiority can be categorised into three types:

1. Shukachanchu (Red): Shrestha (Superior).

2. Pita Varna (Yellow): Madhyam (Moderate).

3. Shukla (White): Varna Adhama (Inferior). (R.R.S. 3/12)

Gandhaka is also of four types

(R.R.S. 3/13-15)

S No	Varna	Name	Uses
1	Shweta	Khatika	Lepa and Loha Marana
2	Pita	Amalasar/ Shukapicchha	Shrestha Rasa Rasayana,
3	Rakta	Shukatunda	Dhatuvada
4	Krishna		Jaramrityu Nashan

Allotropic Forms of Sulphur

Sulphur

- Amorphous
- Crystalline
- Colloidal
- Milk of Sulphur
- Monoclinic
- Rhombic
- Plastic Prismatic or (Octahedral or a Sulphur or b Sulphur)

Grahya and Agrahyata Lakshana

Gandhaka is superior to others because to its colours, which include Shukapichchha (yellow), Navaneeta Prabha (shining like butter), Mrisana (soft touch), Kathina (hard), and Snigdha(smooth). (A.P. 2/20)

Doshas

Shila Churna and Visha are two Malas found in Gandhaka. (R.J.N. II part II Chap. p. 131**)**

Shodhana

1. Gandhaka is melted with cow ghee and poured into an earthen jar filled with cow milk, with a cotton rag tied around the mouth. This Gandhaka is now undergoing the Swedana process for one Ghati. Following that, it is removed and thoroughly cleaned with warm water. Gandhaka is free of stones and other pollutants after undergoing the Shodhana treatment. Visha was present with Gandhaka, which was absorbed in the ghee and eliminated by heating with ghee. Gandhaka Shodhita prepared in this manner does not create Vikriti even if Pathya is not followed; otherwise, if consumed, it is harmful as Halahal. **(R.R.S. 3/20-21)**

2. Gandhaka is melted, poured into Bhringraja Swarasa, and then removed; this is repeated seven times. (R.R.S. 3/23)

Gandhaka used in Kustha Chikitsa (Charaka Samhita)

Applying gandhaka (sulphur) and/or suvarnamakṣika with rasa (mercury) may eradicate any medical condition, including kushtha. Similarly, kushtha patients should take parada (mercury) on a regular basis, in combination with vajra shilajatu or yogaraja, to assist with medical management of all diseases. C S Chi 7/71-72

Discussion:

1.Types and Traditional Interpretations of Gandhaka

Ancient writings categorise Gandhaka based on colour, lustre, texture, and geographic origin. The Rakta, Shweta, Peeta, and Krishna varieties are extensively discussed, with Rakta Gandhaka perceived as superior pharmacologically. Traditional descriptors are congruent with current mineralogical variations, which reflect differences in crystallinity, impurity profile, and elemental composition. The Ayurvedic emphasis on perceptual inspection is comparable with current quality standards, highlighting the value of traditional diagnostic approaches.

2. Purification (Shodhana): Classic Protocols

Gandhaka purification is a vital step in Ayurveda since it not only removes external pollutants but also modifies the internal structure of sulphur, making it therapeutically safe and effective.

Important Shodhana processes include:

Dhalana (melting and pouring) with cow's milk, Dashamoola decoction, or Ghrita eliminates inorganic contaminants by altering sulphur solubility and melting behaviour.

Svedana (sudation) is the process of exposing sulphur to medicinal media via steaming, resulting in the transfer of bioactive ingredients from medicinal plants.

Mardana (trituration) with herbal juices like Nimba, Aragwadha, or Eranda boosts antibacterial and anti-inflammatory activity.

According to research, these mechanisms modify the particle size of sulphur, lessen its toxicity, and add organic components that may boost bioactivity. Classical purification procedures thus work as both detoxifying and bio-functionalizing treatments.

3. Modern Analytical Techniques for Purified Gandhaka.

Shodhana's effects may now be scientifically evaluated using contemporary technologies.

FTIR and Raman spectroscopy indicate differences in S-S bond properties, as well as the existence of organic substances.

XRD study verifies changes in crystal structure, which often demonstrate enhanced amorphous properties following Shodhana.

SEM produces smaller particle sizes and better surface shape, which may boost absorption.

ICP-MS/AAS can measure heavy metal contamination and assess purification effectiveness.

These data show that normal procedures induce considerable physicochemical changes, which supports empirical Ayurvedic assertions.

4. Standardisation Strategies.

Standardising Gandhaka includes establishing uniform norms for its identity, purity, safety, and efficacy. Researchers analyse colour, odour, texture, and crystalline structure at both macroscopic and microscopic levels.

Physicochemical tests include melting point, ash value, drying loss, and particle size distribution.

Elemental profiling include determining thresholds for arsenic, lead, cadmium, and other toxic metals.

Phytochemical Integration: Evaluating the medicinal components used during Shodhana.

Antimicrobial, anti-inflammatory, and antioxidant tests are used during pharmacological evaluation to determine therapeutic value.

These characteristics contribute to align traditional methods with conventional manufacturing practices, hence increasing the global acceptability of Gandhaka-based products.

5. Integrating Traditional Wisdom with Modern Science

The mutual reinforcement of ancient Ayurvedic knowledge and contemporary analytical validation leads to a comprehensive understanding of Gandhaka. Traditional documents provides precise, time-tested methodologies, whilst modern science provides tools for quality assurance, toxicological evaluation, and mechanistic understanding. Together, they constitute a comprehensive framework that transforms Gandhaka from a traditional medication to a scientifically proven therapeutic substance.

Probable Physico-chemical Changes

Characters Raw Sulphur Processed Sulphur

Characters	Raw Sulpur	**Processed Sulphur**
Colour	Shiny yellow Yellow	Yellow
Appearance	Highly crystalline, Sharp and shiny appearance Amorphous, not	Amorphous, not Sharp, no shiny appearance
Texture	Hard, rough	Soft, Smooth
Melting point	96(^{0}C)	110(^{0}C)
Density (g/cc)	2.07	1.95
Smell	Foul	No found smell
Sulphur concenntration (%)	99.52	98.61

Temperature is an important consideration during processing:

At temperatures below 96^{0}C, sulphur has a rhombic structure; at temperatures above 96^{0}C, it is monoclinic. It is noteworthy to note that at temperatures of 96^{0}C or higher, rhombic sulphur converts into prismatic or Kaleidoscopic sulphur, whereas at temperatures below 96^{0}C, prismatic transforms into rhombic sulphur.

Medicated therapeutic Yoga:

1.Rasa Parpati
2.Kajjali
3.Rasa Sindoora
4.Gandhaka Rasayana
5.Gandhaka Druti
6.Arogyavardhini Rasa
7.Svarna Vanga
8.Malla Sindoora
9.Shankha Vati
10.Makaradhwaja

Research updates:

A study was conducted on Bhringraj Shodhita and Godugdha Shodhita Gandhaka to test immunomodulatory activity using the Neutrophil Function Assay Test, and both samples had a significant immunomodulatory effect. The entire study of both samples from 5ml concentrations to 100 ml found no significant change (P>0.05).

Shodhita Gandhaka was investigated and analysed using sophisticated techniques such as ICP-AES, XRD, and SEM. The SEM images of both sulphur samples reveal the presence of an extraneous element on the raw sample's SEM surface image that does not appear in the treated sample particle. The 2q values in XRD ranged from 23.74 to 29.340, which is typical of alpha Sulphur and occurs in both patterns.

The XRD pattern of raw sulphur indicated a highly intense peak at 2q of 52.7 with a d=7.14, which dropped in intensity to 200 Lin counts in treated sulphur. The finger printing zone (1400 cm-1 to 900 cm-1) in processed sulphur was found to be more complicated than that in raw sulphur, indicating the presence of organic compounds.

Conclusion

Gandhaka (Sulphur) is an excellent representation of how traditional Ayurvedic treatments may be effortlessly combined with modern scientific methodologies. Its classification, purification, and therapeutic uses are well documented in traditional literature; however, recent study has strengthened the comprehension of its pharmacognostic behaviour, chemical transformations during Shodhana, and pharmacological potential.

Purification processes, based on millennia of practical knowledge, not only purify sulphur but also impart therapeutic characteristics via interactions with medicinal plant substances. Modern analytical technologies complement these changes by giving chemical and structural evidence to back up Ayurvedic assertions. Standardisation methods ensure that Gandhaka employed in medication meets high quality, safety, and efficacy standards.

Gandhaka may benefit both ancient Ayurvedic formulations and modern integrative therapeutic procedures by merging traditional knowledge with advanced scientific evaluation. This collaborative approach serves as essential for gaining global acceptance, ensuring patient safety, and sparking innovation in Ayurvedic pharmaceuticals.

References:

1. Sharma, S. (Ed.). (2009). *Rasa Tarangini* (8/1–3). Varanasi: Chaukhambha Bharati Academy.
2. Sharma, P. V. (Ed.). (2007). *Rasa Ratna Samuccaya* (3/2–9; 3/12; 3/13–15; 3/20–21; 3/23). Varanasi: Chaukhambha Bharati Academy.
3. Shastri, K. (Ed.). (2011). *Rasendra Chudamani* (11/6–7). Varanasi: Chaukhambha Sanskrit Series Office.
4. Government of India. (2001). *The Ayurvedic Pharmacopoeia of India* (Part 2, p. 20). Ministry of AYUSH.
5. Bhattacharya, N. (Ed.). (1998). *Rasa Jala Nidhi* (Vol. II, Part II, p. 131). Kolkata: Khemraj Shrikrishnadas.
6. Acharya Charaka. (2012). *Charaka Samhita* (Chikitsasthana 7/71–72), translated by P. Kashinath & G. Chaturvedi. Varanasi: Chaukhambha Bharati Academy.
7. Rajalakshmy, P., Archana, R., Raghuram, T. C., & Joy, M. (2017). Physicochemical transformation of sulphur during pharmaceutical processing in traditional Indian medicine. *Indian Journal of Pharmaceutical Sciences*, 79(5), 794–800.
8. Gaikwad, B., & Baragi, P. C. (2019). Immunomodulatory effect of *Bhringraj Swaras* Shodhit Gandhak and *Godugdha* Shodhita Gandhaka: A comparative in-vitro study. *Ayushdhara*, 6(2), 2079–2088.
9. White, S.H., et al. (2006). **"Structural properties of elemental sulfur and its allotropes."** *Journal of Physical Chemistry A*, 110(7), 2479–2485.
10. Tharmalingam, N., et al. (2018). **"Antibacterial activity of sulfur nanoparticles."** *Materials Research Express*, 5(3), 035403.

11. Shah, R., & Seth, A.K. (2010). **"Role of Shodhana in detoxification and enhancement of drug action: A review."** *Ayu*, 31(2), 196–201.
12. Patgiri, B.J., et al. (2014). **"Traditional methods of purification (Shodhana) of metals and minerals."** *Ancient Science of Life*, 33(4), 212–218.
13. Kothari, A., et al. (2015). **"Analytical evaluation of Gandhaka after Shodhana through herbal media."** *Journal of Ayurveda and Integrative Medicine*, 6(2), 120–125.
14. Shubhashree, M.N., et al. (2018). **"Effect of purification on physicochemical properties of sulfur used in Ayurveda."** *International Journal of Green Pharmacy*, 12(3), 189–194.
15. Jayaweera, D.M.A. (2006). *Medicinal Plants (Indigenous and Exotic) Used in Sri Lanka*. National Science Foundation.
16. Gupta, R., et al. (2017). **"Elemental analysis and safety evaluation of purified sulfur (Gandhaka)."** *Pharmacognosy Research*, 9(2), 185–190.
17. Choudhary, N., et al. (2012). **"SEM and XRD analysis of purified sulfur used in Ayurvedic formulations."** *Journal of Pharmaceutical Sciences and Research*, 4(3), 1786–1790.
18. Gaikwad B, Baragi P.C. Immunomodulatory effect of Bhringraj Swaras Shodhit Gandhak and Godugdha Shodhita Gandhaka: A comparative invitro study; Ayushdhara; March-April 2019; vol 6; (2) p 2079-2088.
19. Rajalakshmy *et al.* Physico chemical Transformation of Sulphur during parmaceutical processing in Traditional Indian Medicine. Indian J. Pharm. Sci 2017;79(5);794-800.