

**DEVELOPMENT OF STANDARD OPERATING PROCESS (SOP) OF GANDHAK
SHODHANA AS PER AYURVED PRAKASH****Dr. Sathe Ninad^{*1}, Dr. Punde Ashish², Vd. Hardas Shweta³ and Vd. Sukhada Joshi⁴**¹Professor, Department of Rasashastra & Bhaishajya Kalpana, Dr. G.D. Pol Foundation's Y.M.T. Ayurvedic Medical College, Navi Mumbai.²Lecturer, Department of Rasashastra & Bhaishajya Kalpana, Dr. G.D. Pol Foundation's Y.M.T. Ayurvedic Medical College, Navi Mumbai.^{3,4}PG Scholar, Final Year, Department of Rasashastra & Bhaishajya Kalpana, Dr. G.D. Pol Foundation's Y.M.T. Ayurvedic Medical College, Navi Mumbai.***Corresponding Author: Dr. Sathe Ninad**

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Article Received on 18/08/2022

Article Revised on 08/09/2022

Article Accepted on 28/09/2022

ABSTRACT

Shodhana is a process by which physical and chemical impurities are removed from a particular substance. *Shodhana* also makes the substance easy to digest and facilitates better absorption through effective metabolism. Mercury, to be used as an ingredient in a formulation, had to be treated with other metals and minerals. *Gandhak* (Sulphur) is an important element in purification (*shodhana*) and further processes of mercury and in its formulations as well. *Ayurved Prakash* is one such treatise that compiles various methods of purification of *Gandhak*. In present study, *gandhak* (S) was procured from market and its purification was done according to the classical reference of *Ayurved Prakash* using cow milk and cow ghee. It was analysed by XRF at various stages and found to have *gandhak* (S) 99.41%. The other impurities were potassium (K) (0.11%), calcium (Ca) (0.30%) and iron (Fe) (0.18%). Also, this impure *gandhak* (S) was analysed by gravimetric method. The other impurity was found to be of selenium (Sn) (126.6mg/lit). It was observed that 100% *gandhak* (S) was obtained at the end of 2nd purification itself. All the impurities were transferred to cow milk as the traces were found in XRF. Hence, it might be concluded that purest form of *gandhak* (S) can be obtained after 2nd purification process mentioned in classical text of *Ayurved Prakash*.

KEYWORDS: *Gandhak shodhana*, Purification, SOP, *Ayurved Prakash*.**INTRODUCTION**

Rasashastra revolves around *Parad* (Mercury). Ancient scientists had mentioned immense power of mercury in acquiring expensive metals (*Lohavaad*), in curing disease and rejuvenation (*Dehavaad*). Yet it is not advisable to consume mercury directly in the body as it might harm. *Shodhana*^[1] is a process by which physical and chemical impurities are removed from a particular substance. *Shodhana* also makes the substance easy to digest and facilitates better absorption through effective metabolism. Mercury, to be used as an ingredient in a formulation, had to be treated with other metals and minerals. These procedures reduce its harmful flaws and increase its penetration capacity.

Gandhak (Sulphur) is an important element in purification and further processes of mercury and in its formulations as well. *Gandhak* had got a mythological and scientific references, that support its importance and value in *Rasashastra*. *Gandhak* also needs to be gone under *Shodhana* (purification) in order to make any

formulation or in purification of mercury. Classical texts of *Rasashastra* had compiled all the available procedures in detail to make *gandhak* (S) palatable and easy to digest.

Ayurved Prakash is one such treatise that compiles various methods of *Shodhana* (purification) of *Gandhak*. In this treatise, *Gandhak* had been purified in four different ways viz; 1. Cow ghee, 2. Cow milk, 3. Cow ghee and *triphala kwatha*, 4. *Bhringraj swaras*. These variety of *Shodhana* (purification) is on the basis of desired effects and its further usage.

The current study is done to develop a standard operating process and to understand the effects of *Shodhana* (purification) of *gandhak* (S) by the special reference of *Ayurved Prakash*.

MATERIAL AND METHODS

Material

1. Sulphur (*Gandhak*): Sulphur was obtained from M/s Merck Specialities Pvt. Ltd. The specifications of company were: Sulphide (S) $\leq 0.001\%$, Arsenic (As) $\leq 0.004\%$, Selenium (Se)- Passes test, Residue on ignition $\leq 0.25\%$.
2. Cow milk: Cow milk was purchased as per requirement from local market of Varana brand.
3. Cotton cloth: White cotton cloth used for the process (8m) and was purchased from the local market.
4. Cow ghee: Cow ghee was purchased from local market of Govardhan brand.
5. Iron vessel: Iron vessel (3L) used for *gandhak shodhana* was from the institute itself.

Method

Gandhak shodhana (purification of sulphur).

Ingredients	Quantity
<i>Ashuddha gandhak</i> (Raw Sulphur)	2 kg
<i>Godugdha</i> (Cow milk)	12 L (4 \times 3L)
<i>Goghrita</i> (Cow Ghee)	11 kg

Step I- 1st purification *gandhak* (S)

Cow milk (4 L) was poured into a SS vessel and covered with white cloth at its mouth. An iron vessel was placed on a burner and 500g of cow ghee was heated on a low flame. On liquification of cow ghee, impure *gandhak* (S) powder (2kg) was added to it. The mixture was further heated on a low flame till signs of *gandhak* (S) melting

were evident. This melted *gandhak* (S) was poured into the vessel containing cow milk.

The white cotton cloth on the vessel mouth filtered the contents resulting in a blackish slush formation on its surface indicating the separation of impurities from *gandhak* (S). 1890g of purified *gandhak* (S) was obtained after the first process of purification. 100g of blackish slush was formed on the cotton cloth and 10g of sulphur went attached to the utensils and was lost during cleansing. 10g of this purified *gandhak* (S) was sent for XRF analysis.

Step II 2nd Purification of *gandhak* (S)

300g of cow ghee and 4l of cow milk were used to treat the remaining 1880g of partly purified *gandhak* (S). The above-mentioned procedures were repeated in the similar manner. This sulphur presented a dull blackish shade with the slush formation on the cotton cloth presenting a slight brownish tinge to its appearance. The purified *gandhak* (S) presented in much brighter shade. 1770g of *gandhak* (S) was obtained after the second purification. 10g of this purified *gandhak* (S) was sent for XRF analysis.

Step III-3rd Purification of *gandhak* (S)

The procedure mentioned above was repeated for the third time with 1760g of partly purified *gandhak* (S) with 200g of cow ghee and 4L of Cow milk. 1660g of purified *gandhak* (S) was obtained after the third purification. 10g of final purified *gandhak* (S) was sent for XRF analysis.

OBSERVATIONS AND RESULTS

Process of *gandhak shodhana*



Fig. 1: Powdered *gandhak*



Fig. 2: Cow ghee in iron wok



Fig. 3: *Gandhak* and cow ghee.



Fig. 6: *Shuddha gandhak*



Fig. 5: *Gandhak* after filtration.



Fig. 4: *Gandhak* in cow milk.

Purification of *gandhak* (S)**Comparative study of analysis of *gandhak* (S) at different stages of purification:**

Elements	Sulphur			
	Before Purification	After 1 st purification	After 2 nd purification	After 3 rd purification
Sulphur	99.41	99.41	100.00	100.00
Potassium	0.11	0.00	0.00	0.00
Calcium	0.30	0.36	0.00	0.00
Iron	0.18	0.23	0.00	0.00

Analysis of *gandhak* (S)

Parameters	Before Purification (mg/lit)	After Purification (mg/lit)	Method
Selenium (Se)	126.6	92.9	Gravimetric

XRF analysis of cow ghee used for purification of *gandhak* (S):

Elements	Line	1 st Purification			2 nd Purification			3 rd Purification		
		Mass (%)	2sigma (%)	Intensity (cps/ μ A)	Mass (%)	2sigma (%)	Intensity (cps/ μ A)	Mass (%)	2sigma (%)	Intensity (cps/ μ A)
Sulphur (S)	K	92.63	1.31	2.539	83.01	1.24	2.550	96.20	1.01	1.238
Potassium (K)	K	2.05	0.97	0.027	2.75	0.93	0.043	-	-	-
Calcium (Ca)	K	2.45	0.90	0.041	4.80	0.74	0.095	-	-	-
Iron (Fe)	K	2.86	0.38	0.830	6.53	0.45	2.111	-	-	-
Silicon (Si)	K	-	-	-	2.92	0.61	0.038	3.80	1.01	0.023

XRF analysis of cow milk used for purification of *gandhak* (S):

Elements	Line	1 st Purification			2 nd Purification			3 rd Purification		
		Mass (%)	2sigma (%)	Intensity (cps/ μ A)	Mass (%)	2sigma (%)	Intensity (cps/ μ A)	Mass (%)	2sigma (%)	Intensity (cps/ μ A)
Potassium (K)	K	31.57	4.00	0.098	31.72	4.82	0.099	36.29	3.40	0.117
Sulphur (S)	K	-	-	-	-	-	-	2.87	1.40	0.005
Calcium (Ca)	K	68.43	4.00	0.163	68.28	4.82	0.163	60.84	3.51	0.152

XRF analysis of *gandhak* (S) after purification:

Elements	Line	1 st Purification			2 nd Purification			3 rd Purification		
		Mass (%)	2sigma (%)	Intensity (cps/ μ A)	Mass (%)	2sigma (%)	Intensity (cps/ μ A)	Mass (%)	2sigma (%)	Intensity (cps/ μ A)
Sulphur (S)	K	99.41	0.18	6.442	100.0	0.00	4.525	100.00	0.00	0.00
Calcium (Ca)	K	0.36	0.18	0.014	0.00	-	0.00	-	-	-
Iron (Fe)	K	0.23	0.05	0.164	0.00	-	0.00	-	-	-
Potassium (K)	K	0.00	-	-	-	-	-	-	-	-

XRF analysis of impurities obtained from purification of *gandhak* (S):

Elements	Line	1 st Purification			2 nd Purification			3 rd Purification		
		Mass (%)	2sigma (%)	Intensity (cps/ μ A)	Mass (%)	2sigma (%)	Intensity (cps/ μ A)	Mass (%)	2sigma (%)	Intensity (cps/ μ A)
Sulphur (S)	K	90.94	0.39	11.568	80.17	0.64	5.934	-	-	-
Potassium (K)	K	1.01	0.18	0.063	3.75	0.36	0.141	-	-	-
Calcium (Ca)	K	3.70	0.22	0.298	6.83	0.44	0.321	-	-	-
Iron (Fe)	K	1.73	0.12	2.403	6.83	0.27	5.121	-	-	-
Silicon (Si)	K	2.62	0.27	0.150	2.42	0.35	0.074	-	-	-

DISCUSSION**Purification of *Gandhak* (S)**

Gandhak was procured from market. It was analysed by XRF and found to have *gandhak* (S) 99.41%. The other impurities were K (0.11%), Ca (0.30%) and Fe (0.18%). Also, this impure *gandhak* (S) was analysed by gravimetric method. The other impurity was found to be of selenium (126.6mg/lit). In the literature, generally the

following dravas have been prescribed for the purification of *gandhak* (*shodhana*) 1. Cowmilk, 2. Cow ghee, 3. Bhringraj swaras, 4. Cow ghee and triphala *kwatha* etc. The *gandhak* (S) was purified by a method described by *Ayurved Prakash* using cow milk and cow ghee.

1st purification of *gandhak* (S)

In the 1st purification 2000g impure *gandhak* (S) was heated with 500g cow ghee on a low flame. After melting, the *gandhak* (S) was poured into the vessel containing cow milk. The white cloth on the vessel of mouth filtered the content resulting in a blackish slush formation on its surface, which indicated the separation of impurities from *gandhak* (S). In the 1st purification 5.55% loss of *gandhak* (S) was evident. The visible changes in the *gandhak* (S) were noted. It was found that, as the process continues the colour of the *gandhak* (S) became fresh light yellow. XRF analysis showed that, mass of *gandhak* (S) was unchanged i.e. 99.41%, but the Calcium and Iron levels were slightly increased. The increased mass of iron was remarkable from 0.18% to 0.23%, which may be because of iron vessel used for the purification process. Also, it was observed that the Potassium was completely removed from *gandhak* (S) after 1st purification i.e. from 0.11% to 0.00%. This potassium was found in XRF analysis of cow ghee, cow milk and also impurities separated after 1st purification. It was found that the *gandhak* (S) was present in the cow ghee in the amount of 92.63% but was absent in cow milk. Iron was also present in the cow ghee in the amount of 2.86% which may be because of iron vessel used for purification process. XRF analysis of impurities showed that sulphur (90.94%), potassium (1.01%), calcium (3.70%), iron (1.73%) and silicon (2.62%) were present in the slush. The evidence of potassium in the impurity shows that the sulphur was partly purified.

2nd purification of *gandhak* (S)

In this procedure 5.85% loss of *gandhak* (S) was noted. It was observed that for the 2nd purification, the quantum of cow ghee (300g) required for melting of *gandhak* was 200g less than that of 1st process (500g). The conspicuous observation was the total absence of calcium and iron from the 2nd time purified sulphur. Also, the 100% mass of pure *gandhak* (S) was found after this process. This indicates that 100% mass of pure *gandhak* (S) can be obtained after 2nd purification itself. XRF analysis showed that sulphur content in the cow ghee was 83.01%, which is comparatively less than the *gandhak* (S) content in cow ghee which was used for 1st purification. But, the mass of potassium, calcium, iron and silicon was remarkably increased. This shows the importance of cow ghee in the purification of *gandhak* (S). It was found that calcium and potassium were present in the cow milk. But the values were similar to the cow milk used for the 1st purification. In XRF analysis it was found that sulphur (80.17%), potassium (3.75%), calcium (6.83%), iron (6.83%) and silicon (2.42%) were present in the slush.

3rd purification of *gandhak* (S)

In this procedure 5.68% loss of *gandhak* (S) was seen. It was observed that during the 3rd purification the quantum of cow ghee required for melting was 200g, which was 100g less to the amount required for 2nd purification. This purified *gandhak* (S) was subjected for

XRF analysis. 100% mass of pure *gandhak* (S) was found in this procedure. It was found that the *gandhak* (S) content in the cow ghee was 96.20%, which was comparatively more than that of cow ghee used for the 2nd purification. Also, total absence of calcium, potassium and iron was found after 3rd purification. But the mass of silicon was remarkably increased. In the XRF analysis of milk, it was found that sulphur (2.87%), potassium (36.29%) and calcium (60.84%) were present in the cow milk used for the 3rd purification.

This purified *gandhak* (S) was subjected to gravimetric analysis. This analysis showed a remarkable decrease in the quantity of selenium i.e. from 126.6mg/L to 92.9mg/L.

Gandhak (S) itself is extremely hot in potency and if ingested without proper purification can cause burning micturition. Whereas, cow ghee and cow milk are cool in potency, hence used for *gandhak* purification which limits the hot potency of *gandhak* (S). Milk contains proteins which are good chelating agents for transition of metal cations. Cow ghee may contain free fatty acid which may form Na, K, Ca salts and remove them from sulphur.

CONCLUSION

1. The selected classical purification process from ayurved prakash definitely removes the impurities of *gandhak* (S).
2. Such a process needs to be repeated as all metals were not removed in one operation alone.
3. Though the reference books suggest three cycles of purification, in current study, 100% of pure *gandhak* was obtained after 2nd purification itself.
4. In this study, total 17% loss in weight of *gandhak* (S) was evident after purification.

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