SHODhana OF GANDHAKA WITH CHURNODAKA AND LAVANA DRAVAKa WITH SPECIAL REFERENCE TO HEAVY METAL QUANTITY

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ABSTRACT
Rasa Shastra, the alchemical division of Ayurveda has described the use of several metal and minerals in treatment of diseases and maintenance of health. One such mineral, Gandhaka - the sulphur is prescribed in several diseases of skin but is restricted to be used unprocessed, as it may contain heavy metal impurities and other generic impurities of mines. In present study, the heavy metal analysis was checked by Inductively Coupled Plasma-Atomic Absorption Spectroscopy in raw Gandhaka and ShodhitaGandhaka with Churnodaka (lime water) and Lavana Dravaka (hydrochloric acid). The quantitative analysis shown that in raw sample lead, cadmium, mercury and arsenic were 9.64 ppm, 0 ppm, 1.15 ppm and 0.10 ppm respectively. Here it is observed that after Shodhana all four elements were not detected.

KEYWORDS: Gandhaka, Heavy metal, Shodhana.

INTRODUCTION
Rasa Cikitsa (treatment with metals and minerals) is considered to be one among the best therapies as they are able to show effect on diseases that are considered as Asaadhiya (incurable).1 These drugs have no taste and show quick relief, even when used in lesser quantity.2 Above all Rasa Cikitsais irrespective to Dosha, Dushya, Pumsa (gender), Desha (habitat) and Kala (season).3 Among the several Rasa (Parthiva) Dravyaand their classifications, the Gandhaka(sulphur) is given an auspicious importance and is classified under Uparasaby various Acharya.4,5 Despite its auspiciousness Gandhakacauses Chitta Vibhrama (mental errors)and Raktaja Vikara (disorders related toblood) by increasing the body heat and hampers Prasamath(miseryness), Sarupata (good shape), Shareerabandha (compactness of body) and Prabha (lustre)when it is used in Ashuddha (impure) form,6 due to presence of Shila Churna (particles of stone and sand) and Talaka-Pashanadi Visha(arsemic and other elements / compounds).7 The arsenic and other such elements are classified as heavy metals and are considered dangerous to health.

Heavy metals are often assumed to be highly toxic or damaging to the environment.8 The term “heavy metal” has particular application to cadmium, mercury, lead and arsenic all of which appear in the World Health Organisation’s list of 10 chemicals of major public concern.9 Chromium, arsenic, cadmium, mercury and lead have the greatest potential to cause harm on account of their extensive use, the toxicity of some of their combined or elemental forms and their widespread distribution in the environment.10 These five elements have a strong affinity for sulphur; in the human body, they usually bind, via thiol groups (-SH), to enzymes responsible for controlling the speed of metabolic reactions. The resulting sulphur-metal bonds inhibit the proper functioning of the enzymes involved; human health deteriorates, some fatally.11,12 The clinical presentations on exposure to heavy metals are as follows,13,14

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Table 1: Effects of exposure to heavy metals.

<table>
<thead>
<tr>
<th>Element</th>
<th>Acute exposure (usually a day or less)</th>
<th>Chronic exposure (often months or years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cadmium</td>
<td>Pneumonitis</td>
<td>Lung cancer, osteomalacia, proteinuria &amp; kidney damage</td>
</tr>
<tr>
<td>Mercury</td>
<td>Diarrhoea, fever &amp; vomiting</td>
<td>Stomatitis, nausea, nephrotic syndrome, neurasthenia, parageusia &amp; pink disease</td>
</tr>
<tr>
<td>Lead</td>
<td>Encephalopathy</td>
<td>Anaemia, palsy, encephalopathy &amp; nephropathy</td>
</tr>
<tr>
<td>Arsenic</td>
<td>Nausea, encephalopathy, vomiting, diarrhea, arrhythmia &amp; neuropathy</td>
<td>Diabetes, cancer &amp; hypopigmentation/ hyperkeratosis</td>
</tr>
</tbody>
</table>

Hence Shodhana (purification) of Gandhakais advised before any formulation. The Shodhanaof Gandhakais described by various Acharyawith various methods and media.[16][17]

The heavy metals are validated quantitatively by several analytical techniques which includes Inductively Coupled Plasma & Atomic Absorption Spectroscopy (ICP-AAS). The spectroscopy uses Inductively Couple Plasma to produce excited atoms and ions that emit electromagnetic radiation at wavelengths characteristic of a particular element.[18] AAS is an analytical technique used to measure a wide range of elements concentration in samples, where the free atoms of the sprayed element solution absorbed the radiation of the hollow cathode lamp of the analyzed element.[19] The Gandhakawas analysed for heavy metals before and after Shodhana.

The metals and minerals are mined from earth which results in presence of impurities to a large extent. Hence Shodhana, the combination of processes which removes unwanted portion from the drug; control the unwanted or toxic effect and enhances the medicinal properties of drug and make it suitable for desired action is employed. To cleanse, to extract, to sort, to clarify, to dehydrate, to stream, to de husk, to mix, to shift, to filter, to wash etc. words can be used to define the procedure of Shodhana.[20]

**MATERIALS AND METHODS**

1. **Collection of raw materials**

Amlasara Gandhaka having Harita-pita varnam (greenish-yellow colour), Sudha Churna (lime powder) and Lavana Dravakam (hydrochloric acid) were procured and the Shodhanawas carried out as described[21] in 3 batches.

2. **Gandhaka Shodhana**

Gandhaka Shodhana was done in Rasa Shastra&Bhaishajya Kalpana Laboratory, Parul Institute of Ayurved, following the classical guidelines of Rasa Tarangini.[22] The whole process took 60 minutes for completion.

Table 2: Ingredients for shodhana.

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>English name</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ashuddha Gandhaka Churna</td>
<td>Sulphur</td>
<td>100g</td>
</tr>
<tr>
<td>Churna Jala</td>
<td>Lime water</td>
<td>650ml</td>
</tr>
<tr>
<td>Lavana Dravaka</td>
<td>Hydrochloric acid</td>
<td>60ml</td>
</tr>
<tr>
<td>Ushna Jala</td>
<td>Warm water</td>
<td>QS</td>
</tr>
</tbody>
</table>

**Method**

Lime stones measuring 975g are taken, 3 times of water measuring 2925 ml is added to it and the clear water above called Churnodaka(lime water) is taken for use. 13 Parts of collected lime water measuring 650ml is taken and 2 parts of Gandhaka measuring 100g is mixed to it and heated in strong fire, till the mixture attains Kapila Varnam (reddish colour). It is filtered with a big clean cloth into a glass vessel. When it gets cooled, it is stirred by adding little by little of Lavana Dravakam measuring 60 ml, till all the particles of Gandhaka settled down. Later the Gandhaka is collected and washed several (10) times in water and dried and thus the Gandhaka is purified.

Table 3: Quantitative observation of shodhana.

<table>
<thead>
<tr>
<th>Batch</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantity of Churnodaka(in ml)</td>
<td>650</td>
<td>650</td>
<td>650</td>
</tr>
<tr>
<td>Quantity of GandhakaChurnat(in g)</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Temperature of Kapila Varnam(in °C)</td>
<td>125</td>
<td>127</td>
<td>125</td>
</tr>
<tr>
<td>Quantity of Lavana Dravakaused (in ml)</td>
<td>60</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Number of times washed</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Gandhaka quantity obtained after washing and drying (in g)</td>
<td>79</td>
<td>84</td>
<td>72</td>
</tr>
<tr>
<td>Weight loss (in g)</td>
<td>21</td>
<td>16</td>
<td>28</td>
</tr>
</tbody>
</table>
OBSERVATIONS
i. Practically, the Gandhakadosn’t melt until all water portions evaporate and the Kapila Varnais attained only after evaporation of water. Hence the melted Gandhakais filtered through the clean cloth, into the glass bowl and is treated with Lavana Dravaka, measured sufficiently to submerge the Gandhaka.

ii. As a method of precaution, the above mixture was diluted with enough water before being taken for wash.

3. Inductively Coupled Plasma- Atomic Absorption Spectroscopy
An Inductively Coupled Plasma or Transformer Coupled Plasma is a type of plasma source in which energy is supplied by electric currents which are produced by electromagnetic induction, that is, by time-varying magnetic fields. [23]

Atomic Absorption Spectroscopy or Spectrophotometry is used in the heavy metal elements and some non-metal elements in the atomic state. It is designed to determine the concentration of an object element in a sample, utilizing the phenomenon that the atoms in the ground state absorb the light of characteristic wavelength passing through an atomic vapour layer of the element.

Table 4: Report of heavy metal analysis

<table>
<thead>
<tr>
<th>Elements</th>
<th>Limit as per API Quantity (in ppm)</th>
<th>Ashuddha Gandhaka Quantity (in ppm)</th>
<th>Shuddha Gandhaka Quantity (in ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead</td>
<td>10</td>
<td>9.64</td>
<td>ND</td>
</tr>
<tr>
<td>Cadmium</td>
<td>0.3</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Mercury</td>
<td>1</td>
<td>1.15</td>
<td>ND</td>
</tr>
<tr>
<td>Arsenic</td>
<td>3</td>
<td>0.10</td>
<td>ND</td>
</tr>
</tbody>
</table>

Abbreviations
API- Ayurvedic Pharmacopeia of India
ppm- parts per million

DISCUSSION
Importance of Shodhana
A formulation processed without purification is mere poison and can possibly be fatal, hence avoid a medicament to cause adverse effects, it is subjected to Shodhana. [26] A poison readily spread throughout body and shows its noxious effects but with etiquette handling it can work like an elixir and cure diseases. [27] Every Acharya of Rasa Shastra has mentioned the importance of Shodhana of Rasa and Visha Dravya. The importance of Shodhana is mentioned by a comparison of the ill-effects of the impure drugs with the medicinal effects of purified drugs, so that a Rasashastri obey the norm forever.

As described earlier Shodhana in Rasa Shastra and Bhaishajya Kalpana does not merely mean purification, it means something more by which Sa-indriyatva is achieved by the drug to be administered as medicine. [28] This is why despite the availability of any element in their purest form they are supposed to be subjected for Shodhana, before addition to a formulation.

The light of characteristic wavelength emitted from a cathodic discharge lamp is absorbed when it passes through the atomic vapour generated form sample containing the element of examination atomised to ground state. [24]

The obtained resultants were weighed, 25% from each batch was collected by simple random sampling and mixed and the analytical study was carried out.

Simple Random Sampling [28]
The method of experimental study is applicable when the population is small, homogeneous and readily available. The principle of this method is that, every unit of population has equal chance of being selected. Hence this method is also called “unrestricted random sampling”.

RESULT
i. An average of 21.66% loss was observed in Shodhana of Gandhaka.

ii. Instrumental analysis: ICP-AAS

Site of Commencement: Vasu Research Centre, GIDC Makarpura, Vadodara.

i. Churnodaka is an alkaline soluble extract of calcium carbonate commonly called as milk of lime. CaCO3 + H2O + CO2→ Ca(HCO3)2

The milkiness disappears since calcium bicarbonate is water-soluble.

In industries it is used to clean toxic sulphur gases. Ca (OH)2 + SO2→ CaSO3+ H2O

It is indicated in treatment of Visha, Krumiand Pittaja Vikarain Rasa Tarangini.

ii. Lavana Dravaka, the hydrochloric acid is a corrosive, strong mineral acid with many medical uses. As per modern references, it was discovered by alchemist Jabir ibn Hayyan around the year 800 AD [29],[30] and was historically called acidum salis, muriatic acid and spirits of salt because it was produced from rock salt and green vitriol by Basilius Valentinus in the 15th century and later from the chemically similar common salt (Saindhava) and sulphuric acid (Gandhaka Dravaka) by Johann Rudolph Glauber in the 17th century.

Hydrochloric acid has been used for dissolving calcium carbonate, i.e. such things as de-scaling kettles and for
cleaning mortar off brickwork, but it is a hazardous liquid which must be used with care. When used on brickwork the reaction with the mortar only continues until the acid has all been converted, producing calcium chloride, carbon dioxide and water:

\[ \text{CaCO}_3 + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{CO}_2 + \text{H}_2\text{O} \]

iii. As the lime water has an affinity towards the toxins, on heating Gandhak with lime water, the Gandhakamels and loses its toxic contents into it. Then the added Lavana Dravaka asbsorbs the solidified lime with its impurities to leave behind pure sulphur on wash.

CONCLUSION
i. The method of Shodhana proves effective in removal of heavy metals. Comparative clinical study is necessary to determine the effect of this method of Shodhana.

REFERENCES
