Published online in http://ijam.co.in
ISSN: 0976-5921


**Research article**

# A concept of *Sodhana* (Purification) w.s.r. to *Parada* (Mercury)

**Srinivasulu Bandari*, Bhadra Dev P[1], Murthy P H C[2]**

1. Professor & Head, 2. Gazetted-Lecturer,
Dept. of Rasa-Shastra, Dr.N.R.S.Govt. Ayurvedic College, Vijayawada, Andhra Pradesh.

## Abstract

*Sodhana* (Purification) is an important and principal pharmaceutical procedure for removing the impurities before the conversion of metals and minerals into *Bhasma*. There are different procedures like *Svedana* (vapouring), *Mardana* (grinding), *Prakshalana* (performing frequent ablutions), *Galana* (straining fluids), *Avapa* (substances are added into the liquefied metals), Nirvapa (metals are burnt to red hot and dipped in liquids), *Bhavana* (maceration), *Bharjana* (frying in pan) etc. specific process are described for the *Sodhana* of different metals and minerals.

*Sodhana* of *Parada* (Mercury) was done in the specific mediums i.e. equal quantity of *Nagavalli svarasa, Ardraka svarasa* and *Trikshara (Sarja, Yava, Tankana).* Atomic Absorption Spectrometry study reveals that the higher levels of various elements and heavy metals are found in the *Parada* after the purification when compared with the *Sodhana* process. The raw *Parada* contains of Iron (4.7800), Copper (4.5840), Zinc (1.2280), Silver (0.304), Tin (3.7560), Cadmium (2.0534), Lead (2.3400), Arsenic (2.6500) elements in ppm levels before the purification. After the purification the analysis with AAS the results of elememts are Iron (2.5760), Copper (2.6520), Zinc (0.2800), Silver (0.044), Tin (1.6090), Cadmium (0.1330), Lead (0.9036), Arsenic (1.0146) ppm levels.

This process adopted by the thesis work of Pharmaceutical Standardization of Panchavaktra Ras And Clinical Study In *Amavata* (Rheumatoid Arthritis) done by dr. B. Srinivasulu, Post Graduate Department of *Rasashastra*, Dr. Nori Rama Shastry Government Ayurvedic College, Vijayawada-2, Andhra Pradesh.

**Keywords:** *Sodhana, Parada, Nagavalli svarasa, Ardraka svarasa, Trikshara,* Purification, Atomic Absorption Spectrometry.

## Introduction:

*Ayurveda*, the immortal science of life is practiced in the Asian subcontinent since *Vedic* period have given vital importance to the practice of metal and mineral based therapies, includes use of drugs originated mainly from metals and minerals after going through systemic procedure of *Sodhana* (purification) and *Marana* (incineration/calcification). Altered politico-socioeconomic compulsions made the development in *Rasasastra* consistent for centuries and thousands of formulations were formulated for the demanding society.

Drugs used in *Ayurveda* broadly classified into three categories, viz., (a) Vegetable products, (b) Animal products, and (c) Metals and Minerals. In the *Vedic* literature and in *Ayurvedic* classics mostly vegetable drugs were prescribed for the

***** Corresponding Author:
Dr. Bandari Srinivasulu
Senior Research Fellow (*Ayurveda*)
National institute of Indian Medical Heritage, Osmania Medical College building, Putlibowli, Hyderabad
E.mail: dr.vaasu@rediffmail.com
Ph.No: 09347000599

Published online in http://ijam.co.in
ISSN: 0976-5921
*International Journal of Ayurvedic Medicine, 2011, 2(3), 119-127*

treatment of different categories of ailments. Very few animal products and still fewer metals and minerals were described in those texts. Metals described in these works include Iron, Copper, Gold, Lead, Tin, Silver and Copper pyrite. Metals for internal use were processed by impregnating with different kinds of decoctions as well as the juice of herbs, and thereafter, by drying in sun or shade. These metals were then reduced to a fine powder form by grinding in a mortar and pestle, and administered to the patient either alone or in combination with several other drugs. Making a *Bhasma* or alkaline calcined powder of these metals was not very popular among the physicians of those days. (1)

The literal meaning of the term '*Sodhana*' is the purification. The term used particularly for *Sodhana* or processing of mercury is *Samskara*. *Caraka* has explained *Samskara* as *Gunantaradhana* (2). During the process of samskara or *Sodhana*, the metal or mineral acquires a different property which is useful therapeutically and which overcomes original harmful effects of the metal.

**Purpose of processing:**

During the classical age, metals and minerals were impregnated with decoctions, juices of various types of vegetable drugs and then reduced to a state of fine particle by grinding process. If these are used in raw form or even in unprocessed powder form, they will not be digested, absorbed, metabolized and assimilated to the tissue cells of the body. Thus, they will be therapeutically ineffective. On the other hand, these heterogeneous drugs are likely to produce serious toxic effect in the body. To make them non-toxic, to make them easily digestible and absorbable, to make them suitable for metabolic changes and assimilable by the tissue cells, and to make them therapeutically potent, for this purpose several methods for processing of metals and minerals have been prescribed. Depending upon the nature of the metal and the disease for which they are meant to be used, the specific process for purification vary from one metal to the another and the process is repeated for several times.

**Concept of *Sodhana* (Purification):**

The process of eliminating the impurities of the metallic substances by means of *Svedana* (vapouring), *Mardana* (grinding), *Prakshalana* (performing frequent ablutions), *Galana* (straining fluids), *Avapa* (substances are added into the liquefied metals), *Nirvapa* (metals are burnt to red hot and dipped in liquids), *Bhavana* (maceration), *Bharjana* (frying in pan) etc. specific process and techniques with the help of specifically mentioned *Aushadha dravya* (plant juices or animal products), is known as *Sodhana* (3).

**Types of *sodhana*:**

*Sodhana* process is subdivided into two major categories: (4)

**(1) *Samanya sodhana* (General purification) (5):**

It is used as universal procedure for *sodhana* of all drugs of a particular group, in other words these drugs should be purified individually through the same procedure. e.g., *samanya sodhana* of metals and minerals.

**(2) *Visesha sodhana* (Specific purification):**

It is used as specific procedure for particular drug material individually. This process should be useful after *Samanya sodhana*. e.g., *Loha* (iron) *Sodhana* processed with *Triphala* decoction. (6)

**Changes during *Sodhana* process:**

**Physical changes:**

**(a) Elimination of physical impurities:**

The contamination is often natural and it takes place in the mines or some

material is available in combination with other ones. e.g., *kampilla* (mallotus philippensis LAM.) is separated from brick powder (7); *Guggulu* (*Commiphora mukul* Engl.), *Silajatu* is separated from insoluble physical impurities. (8)

**(b) Reduction in hardness:**

By repeated heating and quenching, hardness of the metals and minerals become brittle and makes them suitable for *Marana* procedure. (9)

**(c) Increase brittleness:**

By repeated heating and quenching in liquid media, cracks are seen on the surface of metals and minerals and become brittle. e.g., *Abhraka* (mica) flakes and *Loha* are burnt on fire and dipped in *Triphala* decoction for seven times, by this the flakes of *Abhraka* and *Loha* become soft, brittle and minute and can be made into *Bhasma* easily. (10)

**Chemical change:**

**(a) Elimination of chemical impurities:**

In the mines, metals are available in combination with other metals and found as metallic ores or compounds. During *Sodhana* of *Makshika* (Copper pyrites- $CuFeS_2$) impurities like arsenic get eliminated by the heating.

**(b) Formation of chemical compounds:**

*Loha* (iron) when heated up to red hot, reacts with atmospheric oxygen to form ferric oxide ($Fe_2O_3$), which possesses therapeutic potentials. Similarly when *Makshika* is fried, Sulphur is eliminated (11), iron and copper converts into oxide.

**(c) Change into desired compound:**

During *Bharjana* of *Tankana* (Borax- $Na_2B_4O_7$ $10H_2O$) the chemical compound of borax changes into $Na_2B_4O_7$ $5H_2O$ (12) and *Kamkshi* (alum- $k_2Al_3$ $(SiO_3)$ $24H_2O$) water portion is evaporated and desired chemical compound is obtained.

**Biological changes:**

A Physico-chemical change of the material helps to increase its biological availability, means to potentiate its biological efficacy on the human body. Reduction in particle size helps in absorption, smoothness leads to non-irritability, chemical changes make the material homologous to the tissue cells, the toxicity is reduced and acceptability to the cells is increased.

The *Jaipala* seeds (*Croton tiglium* Linn.) do posses the property of producing spasm in intestine, after purification with lemon juice which possess antispasmodic property. (13)

*Anjana* (stibnite) purified in juice of *Bhrngaraja* (*Eclipta alba* (L) Hassk.) is proved non-toxic to eyes in experimenting animals.

*Sodhita Vatsanabha* (*Aconitum chasmanthum* Stapf.) when purified in cow's urine is converted into cardiac stimulant, where as crude *Vatsanabha* is claimed to be cardiac depressant. (14)

The seeds of *Kucala* (*Strychnos nuxvomica* Linn.) purified in cow's milk show CNS depressant activity, pentabarbitone hypnosis potentiation, inhibited morphine induced catalepsy and least toxicity in mice, albino rats and chicks. (15)

**Role of media:**

Liquid medium facilitates easy and smooth grinding, it eliminates the problem of dust. In this process during grinding, the minute particles of the material come in contact with the liquid. Pellets are prepared after proper levigation, and hence it can be utilized for further processing. Liquid impregnate its active principles to the material and make the material organic. Liquid medium acts as a binding agent, due to its binding property it is easy to prepare pills in case of *Kharaliya* preparations.

Published online in http://ijam.co.in
ISSN: 0976-5921
*International Journal of Ayurvedic Medicine, 2011, 2(3), 119-127*

**Purification of *Parada* (16):**

Genuine raw drugs are selected only after proper purification. Many methods of *Sodhana* are prescribed in our texts, but the method, which is easy, effective and practicable is followed here. When the processing methodology is completed, then the purified drugs are fit for internal administrations.

**Materials: (Figures 1-7)**

1. *Parada* (percury)
2. *Nagavalli svarasa* (Juice of betel leaf)
3. *Ardraka svarasa* (Ginger juice)
4. *Yava kshara*
5. *Sarja kshara*
6. *Tankana kshara* (borax)

**Equipments:**

*Khalva yantra*, Vessels, Mixer, Lukewarm water.

**Procedure:**

1. *Parada* is taken with *Nagavalli svarasa*, *Ardraka svarasa* and *Trikshara* in a clean *khalva yantra*.
2. The above said materials are rubbed in *Khalva yantra* for eight hours per day for three days.
3. The obtained material is washed and pours out with the help of lukewarm water for several times until we get clean and clear *Parada.*

**Observations (Table – 1):**

1. In the process of *Mardana*, the *Parada* in liquid form is separated. Initially it appears like small, shiny pearl like substance and when it is grinded for few hours it is converted into a fine paste.

**Precautions:**

1. Utmost care is taken during *mardana* so as to prevent the spilling of *Parada*.

**Table1: Observations during *Parada sodhana***

| S.N | Details | Experiment-1 | Experiment-2 | Experiment-3 |
|---|---|---|---|---|
| 1. | Quantity of raw *Parada* | 250 gm | 250 gm | 250 gm |
| 2. | Betel leaves | 100 gm | 100 gm | 100 gm |
| 3. | *Nagavalli svarasa* | 50 ml | 50 ml | 50 ml |
| 4. | Ginger | 100 gm | 100 gm | 100 gm |
| 5. | *Ardhraka svarasa* | 50 ml | 50 ml | 50 ml |
| 6. | *Trikshara* (each of 50 gm) | 150 gm | 150 gm | 150 gm |
| 7. | pH value this mixture | 10 | 10 | 10 |
| 8. | Obtained *Sodhita parada* | 235 gm | 230 gm | 235 gm |
| 9. | Difference | 15 gm (loss) | 20 gm (loss) | 15 gm (loss) |
| 10. | Total duration | 24 hrs | 24 hrs | 24 hrs |
| 11. | Total expenditure | 350 Rs | 350 Rs | 350Rs |
| 12. | Date of commencement | 30-10-2006 | 17-02-2007 | 14-01-2008 |
| 13. | Date of completion | 02-11-2006 | 20-02-2007 | 17-01-2008 |

**Quantitative chemical analysis of raw *Parada* and *Sodhitha Parada:***

The final drug was prepared three times, for the therapeutic purpose. Same purification method was followed in these 3 batches of drugs. For the analytical purpose, only first sample of *Parada* was sent to the laboratory to find the amount of elements in ppm level.

**Aim:**

To analyze the pure and impure mercury by using AAS technique

To determine the impurities present in the mercury and rule out the quantity of these impurities.

**Instrument: Atomic Absorption Spectrometry (17):**

Atomic absorption spectrometry (AAS) is an analytical technique that measures the concentrations of elements. Atomic absorption is so sensitive that it can measure parts per billion of a gram (µg $dm^3$) in a sample. The technique makes use of the wavelengths of light specifically absorbed by an element. They correspond to the energies needed to promote electrons from one energy level to another higher energy level.

**Principle:**

Atomic absorption is the process that occurs when a ground state atom absorbs energy in the form of light of a specific wavelength and is elevated to an excited state. The amount of light energy absorbed at this wavelength will increase as the number of atoms of the selected element in the light path increases. The relationship between the amount of light absorbed and the concentration of analysis present in known standards can be used to determine unknown sample concentration by measuring the amount of light they absorb.

The absorption of light is proportional to the concentration of free atoms in the flame. It is given by Lambert-beer law.

Absorbance (A) = $\log_{10} I_0/I_t$ = k.c.l

Where,

$I_0$ = intensity of incident radiation emitted by the light source

$I_t$ = intensity of transmitted radiation

c = concentration of sample (free atoms)

k = consent

l = path length

**Methodology for Metal Analysis:**

**a. Sample collection:**

The dried drugs samples are then grounded and powdered in an agate pestle and mortar. Samples are labelled and stored in pre-cleaned polyethylene bottles for further analysis.

**b. Reagents and apparatus:**

All the reagents such as $HNO_3$, HCl, $H_2O_2$, Sodium Borohydride ($NaBH_4$), Sodium Hydroxide (NaOH) etc. are purchased from MERCK. Millipore water is used for all analytical works. All the digestion vessels, Polyethylene bottles (sample container) Micro Pipette tips and others are washed with 10 % HCl, rinsed with de-ionized water before preparing standards, reagents and samples.

**c. Digestion of samples (Sample Preparation):**

A Multiwave 3000 Micro oven system (from Anton paar, USA) with 16 position teflon vessels with capping was used for digestion process. The digestion vessels are provided with a controlled pressure, temperature and release valve. Before use, all Teflon vessels are soaked with 10% $HNO_3$. The system is initially programmed by giving gradual rise of 20%, 40%, and 50% power for 5, 15 and 20 minutes, respectively for the due warming up. The powder samples are being used without any further treatment for sample preparation. 0.2 gm of sample is weighed into the Teflon vessels, followed by digestion mixture of $HNO_3$, HCl & $H_2O_2$ in the ratio of 3:1:1 according to the nature of samples is being applied.

The resulting solution after microwave digestion is filtered through whatman # 40 filter paper (if necessary) and diluted to 50 ml with Millipore water. A sample blank containing only acid mixture is prepared at the same time. The method of standard addition is generally adapted to calibrate the instrument before going for the observation of the samples.

Published online in http://ijam.co.in
ISSN: 0976-5921
*International Journal of Ayurvedic Medicine, 2011, 2(3), 119-127*

**Determination of Metals:**

All the atomic measurements are carried out with Perkin Elmer model 400/HGA900/AS800 coupled with Mercury Hydride System-15 (MHS-15). Electrode-less Discharge Lamp (EDL) for Cd, Pb, Hg & As and Hollow Cathode Lamp for Sn Fe, Cu, Zn etc analysis are used as a light source to provide specific wavelength of the elements to be determined and high purity (99.999 %) Acetylene is used to provide constant thermal energy for atomization process. Argon gas is used as carrier gas for purging purposes of Graphite furnace to the analysis of As and Hg by Mercury Hydride System (MHS-15).

**Calibration of instruments:**

More than three working standard solutions of the respective element to be determined have to be prepared. Before the analysis of samples, the instrument is calibrated with prepared working standard solution. The calibration curve is obtained for concentration vs. absorbance data by statically analyzed mode. Calibration of the instrument is repeated periodically during operations and blanks are carried with each set of 10 samples or aspirate any one of the prepared working standards for every 10 samples to check the instrument drift and to validate analytical procedures and performance. Reagent blank reading is taken and necessary correction is made during the calculation of concentration of various elements.

Standard Certified Reference (SRM) of National Institute of Standard and Technology (NIST) is used for day-to-day evaluation of methods of analysis or test and for long-term quality assurance of measurements.

**Sn, Fe, Cu, Zn, Cd, Pb, As etc., analysis by Flame AAS/Graphite furnace:**

After calibrating the instrument with prepared working standard, the digested liquid sample solution is subjected to analysis of Sn, Fe, Cu, Zn Cd, Pb, As etc by flame/Graphite furnace with specific instrumental conditions as given by instrument's manufacturer. Introduce the solution into flame, record the reading, using the mean of the three readings. The quantity of the concentration of the respective metal is provided after verifying the programmed calibration of the reading with the standard calibration curve of the respective element obtained from Concentration vs. Absorbance of the prepared known concentration on the day of the analysis.

**Hg analysis by Cold Vapour Method using Mercury Hydride System (MHS-15):** After calibrating the instrument with prepared working standard, the 10 ml of digested liquid sample is pipetted out to a specific container of Mercury Hydride system analyzer followed by adding 10 ml 1.5 % of HCl as diluent for each flask and blank, 3 % of $NaBH_4$ solution in 1 % of NaOH in reaction flask. The digested sample is run through the reaction flask to quartz cell. It is done without any heating. As there is a standard curve already calibrated in the programmed, the values are printed out after calibrating with the standard curve obtained from concentration vs absorbance of the prepared known concentration on the day of the analysis.

**Interferences and matrix modification:**

Other chemicals that are present in the sample may affect the atomization process. For example, in flame atomic absorption, phosphate ions may react with calcium ions to form calcium pyrophosphate. This does not dissociate in the flame and therefore results in a low reading for calcium. This problem is avoided by adding different reagents to the sample that may react with the phosphate to give a more volatile compound that is dissociated easily. Lanthanum nitrate solution is added to samples containing

calcium to tie up the phosphate and to allow the calcium to be atomized, making the calcium absorbance independent of the amount of phosphate. With electro thermal atomization, chemical modifiers can be added which react with an interfering substance in the sample to make it more volatile than the analyzed compound. This volatile component vaporizes at a relatively low temperature and is removed during the low and medium temperature stages of electro thermal atomization.

**Table 2. Showing the analysis of Mercury before and after purification**

| Sample Name | Impure Mercury | Pure Mercury |
|---|---|---|
| Iron (ppm) | 4.7800 | 2.5760 |
| Copper (ppm) | 4.5840 | 2.6520 |
| Zinc (ppm) | 1.2280 | 0.2800 |
| Silver (ppm) | 0.304 | 0.044 |
| Tin (ppm) | 3.7560 | 1.6090 |
| Cadmium (ppm) | 2.0534 | 0.1330 |
| Lead (ppm) | 2.3400 | 0.9036 |
| Arsenic (ppm) | 2.6500 | 1.0146 |

**Conclusion:**

In the text of *Rasasastra*, there are many purification methods for metals and minerals. Depending on the toxicity few are purified with the general purification methods and some with specific methods. By the purification physical and chemical impurities are removed, and hence metals are free from toxicity and metals become suitable for the further procedures like *Marana*.

*Parada* is available in liquid state and it can absorb the metals and minerals easily. For the purification of *parada* many methods are adopted in the rasa text, but in the *rasataraṅgini* the method adopted by which the equal parts of *Parada, Nagavalli svarasa, Ardraka svarasa* and *Trikshara* are ground together in the *Khalva yantra* for eight hours per day for three days. Afterwards it is washed with lukewarm water for several times to obtain purified *Parada*. By this method purified *Parada* was analyzed by the Atomic Absorption Spectrometry (AAS).

The raw *Parada* contains of Iron (4.7800), Copper (4.5840), Zinc (1.2280), Silver (0.304), Tin (3.7560), Cadmium (2.0534), Lead (2.3400), Arsenic (2.6500) elements in ppm levels before the purification. After the purification with the help of AAS analysis, the results of elements are Iron (2.5760), Copper (2.6520), Zinc (0.2800), Silver (0.044), Tin (1.6090), Cadmium (0.1330), Lead (0.9036), Arsenic (1.0146) ppm levels. Hence by above mentioned purification method, the ppm levels of the elements are greatly reduced.

Therefore the purification done by the above method is best and out come of mercury was used for the medicinal purpose without any drawbacks. After purification of metals and minerals must be used for the further procedures without delay, especially mercury, as it can absorb the other elements from the air.

**Reference:**

1. Alchemy and Metallic Medicines in Ayurveda by Vaidya Bhagwandash, published by Concept Publishing Company, New Delhi. Reprint: 2003; ISBN: 81-7022-077-7; Page no: 17
2. Charaka Samhita by Ram Karan Sharma & Vaidya Bhagwan Dash, published by Chowkambha Sanskrit Series office, Varanasi. Reprint: 2009; ISBN: 81-7080-013-7; Vol- II; Page no: 124
3. Rasa Tarangini by Pranacharya Sri Sadananda Sharma edited by Pandita

Kashinath Shastry published by Motilal Banarasidas, New Delhi. Reprint: 2004; ISBN: 81-208-2542-X; Page no: 22
4. A text Book of Rasashastra by Dr. Vilas A. Dole & Dr. Prakash Paranjpe published by Chaukhamba Sanskrit Pratishthan , Delhi Reprint: 2006; ISBN: 81-7084-229-0; Page no: 272
5. Rasaratna samuchchaya by Dr. A. D. Satpute, published by Chaukhamba Sanskrit pratishthan, Delhi. Reprint: 2006; ISBN: 81-7084-206-2; Page no:110
6. A text Book of Rasashastra by Dr. Vilas A. Dole & Dr. Prakash Paranjpe published by Chaukhamba Sanskrit Pratishthan , Delhi Reprint: 2006; ISBN: 81-7084-229-0; Page no: 273
7. Rasashastra the Mercurial System by P. Himasagara Chandra Murthy, Published by Chowkhamba Sanskrit Series Office, Varanasi. 1st Edition 2008; ISBN:978-81-7080-276-8; Page no: 285
8. Ibid; Page no: 235
9. A text Book of Rasashastra by Dr. Vilas A. Dole & Dr. Prakash Paranjpe published by Chaukhamba Sanskrit Pratishthan , Delhi Reprint: 2006; ISBN: 81-7084-229-0; Page no: 85
10. Ibid Page no: 184 & 303
11. Ibid Page no: 193
12. Pharmaceutical Standardization Of Panchavaktra Ras And Clinical Study In Amavata (Rheumatoid Arthritis) thesis done by dr. B. Srinivasulu, Post Graduate Department of Rasashastra, Dr. Nori Rama Shastry Government Ayurvedic College, Vijayawada-2, Andhra Pradesh
13. A text Book of Rasashastra by Dr. Vilas A. Dole & Dr. Prakash Paranjpe published by Chaukhamba Sanskrit Pratishthan , Delhi Reprint: 2006; ISBN: 81-7084-229-0; Page no: 85
14. Sarkar P K, Shubha, Prajapati P K., Importance of media in shodhana of vatsanabha, AYU 2009; 20:01:52-56.
15. Sarkar P K, Chaudhary A. K, Role of milk in shodhan (Detoxification) with special reference to Nux Vomica. Aryavaidyan 2007; XX: 100-104
16. Rasa Tarangini by Pranacharya Sri Sadananda Sharma edited by Pandita Kashinath Shastry published by Motilal Banarasidas, New Delhi. Reprint: 2004; ISBN: 81-208-2542-X; Page no: 81
17. Analysis, 2000, 28, 850 -854. ©EDP Sciences, Wiley –VCH 2000; Analytical Sciences April 2000 Vol.16, © The Japan Society for Analytical Chemistry; The Sciences, (2); 74-77 March-April 2001

***Śodhana dravya* of *Parada*:**

Figure 1: *Parada*

Figure 2: *Sarja kshara*

Figure 3: *Yava kshara*

Figure 4: *Tankana kshara*

Figure 5: *Nagavalli* leafs

Figure 6: *Nagavalli svarasa*

Figure 7: *Ardraka*

Figure 8: *Ardraka svarasa*

*****