



REVIEW ARTICLE

REVIEW OF PARIBHASHA TERMS IN THE LIGHT OF MODERN CHEMISTRY & METALLURGY

DIVYA NAIR¹ SRIPAL L HIREKERUR²

ABSTRACT

Rasashastra, the ancient alchemical science, is a branch of Ayurveda deals with mainly minerals, metals, poisonous herbs, animal drugs, their processing, use of different instruments and converting them into therapeutically potent herbo-mineral formulations. *Paribhasha Prakarana* is an important chapter in *Rasa Shastra* which is dealt in almost all the books of the subject. The chapter throws light on different terminologies in relation to processing of *Rasa* drugs. Also important *vargas/* group of drugs, *Parada samskaras/* procedures dealing with Mercury are dealt. This article mainly focuses on the various terminologies of *Paribhasha prakarana* in general in the perspective of modern chemistry and metallurgy.

Key words: *Paribhasha*, Technical Terminologies, *Dhatu Vaada*, *Deha Vaada*, *Samskaaras* etc.

¹Asst. Professor, Dept. of Agada Tantra, Dhanwantari Ayurveda College, Hospital and Research centre
Siddapura, Uttara Kannada, Karnataka, INDIA

²Associate professor, Dept. of Rasashastra and Bhaisajya Kalpana, Dhanwantari Ayurveda College, Hospital
and Research centre Siddapura, Uttara Kannada, Karnataka, INDIA

Corresponding Email id: way2drdivya@gmail.com Access this article online: www.jahm.in

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INTRODUCTION:

The literature of *rasashastra* is very wide with several books written by stalwarts of the subject during different time period. Almost every other book written on the subject deals with the chapter *Paribhasha* which signifies its importance. *Paribhasha* [1] explains certain specific technical terminologies used throughout the subject and clarifies the different hidden, untold, half told and doubtful terms. As knowledge of anatomical terminologies are required for studying and thorough understanding of Anatomy, the knowledge of *Paribhasha* is essential for understanding the subject of *Rasashastra*. In this article, an effort is done to understand the terminologies as explained in the classical texts itself and also try to co-relate them with modern metallurgical terms and procedures.

MATERIALS AND METHODS:

When studied thoroughly it is noticed that different *dravya vargas*, technical terminologies and *Parada samskaras* have been included in *Paribhasha* Prakarana. The present article focusses on the technical terminologies only with their relevant scientific explanation. These technical terminologies can be further divided into two: products and the procedures. Products will include *kajjali* etc and procedures will have *bhavanac* etc. With respect to the product its classical term, explanation as told in the classical book will be

defined, an effort to understand compound formed as well as how the procedure helped in the formation of the compound with modern metallurgical view would be dealt. Similarly while explaining about the procedure first the classical term, then its explanation as told in the classical book and its probable correlation with the modern metallurgical process would be explained.

Technical terms: Products and Procedures:

The explanation of all the classical terminologies are from the texts *Rasa ratna samuchaya* [2] or *Rasatarangini* [3]

Products:

Kajjali: When *Gandhaka* (Sulphur) or any other *Dhatus* are added to *Parada* (Mercury) and ground without adding any liquid medium till it becomes a mixture that is soft and fine resembling a *kajjala* (collyrium) is called **kajjali**. The *kajjali* using Sulphur and Mercury could be taken for HgS black formed due to displacement of Hg via S by applying mechanical energy [4]. The application of mechanical energy to a nonstoichiometric mixture of mercury and Sulphur permits formation of metacinnabar-HgS (Black) According to modern SEM studies, microspheres of mercury are produced by means of impact and friction with an adequate superficial tension that favors adhesion of Sulphur particles. The kinetic reaction yields HgS (Black). *Kajjali* is used in itself as a medicine

and also used as a base for preparation of different mineral formulations.

Rasapanka: The mixture of *Parada* and *Gandhaka* etc ground thoroughly along with liquids and the resultant product which appears like Pankha or slush/sludge is called Rasapanka. The procedure applied here could be broadly taken as wet grinding. **Wet grinding** [5] describes a grinding process under addition of water, emulsion or oil. It is a process of taking materials in a liquid form or slurry and reducing particles, such as agglomerates, by breaking them apart or shearing them down in size [6]

Patana pisti. : When *Parada* is ground with 1/4th part of *Swarna* (*gold*) is called **patana pisti**. In place of *Swarna*, *Rajata* (*silver*) could also be used. *Patana pisti* means that which will be subjected to *Paatana* procedure (distillation) and *Parada* is re obtained and such *Parada* is considered to be of superior quality. *Patana pisti* is preparing **Gold amalgam** and then separating Mercury from it. Amalgam is an alloy of mercury with one or more other metals [7]. Precious metals are recovered from the mercury by retorting the mercury. Retorting consists in distilling off the mercury from the amalgam [8]. One of the reason of doing could be that the impurities if present in *Parada* would remain in gold while separating it from the amalgam and pure Mercury may be obtained.

HemaTara Kristi: *Swarna* is incinerated with *Parada*, *Gandhaka* and *swarna bhasma* (medicated ash of Gold) is prepared. Then it is brought back to its original state repeatedly, that *Swarna* is called as *Swarnakristi*. *Tarakristi* is the silver which is incinerated and brought back to original form in the above manner. *Kristi* is useful in making *beeja* (*shuddha swarna* or *shuddha rajata*) for converting *Parada* into *Swarna/Rajata*. The probable mechanism here is **Reduction**. The process of converting metal oxides into metals is called reduction [9]. A reducing environment provided often by carbon formed by **carbonization** [10]. A process which involves conversion of an organic substance into elemental carbon. The *swarna bhasma* prepared will have traces of organic elements because of using the juices of different plants for levigation with *Swarna* before subjecting it to incineration. These organic elements may act as source of carbon. By repeated incinerations and then reducing it to metallic state: The metallic impurities if present in Gold/Silver may be oxidized during incineration. But when reducing them back to metallic state the impurities may stay behind in oxide form itself which can be discarded and pure gold/silver is obtained. So this is a method of extractive metallurgy where first ores are converted to oxides (by incineration) and then by reduction of oxides.

Varaloha : *Tamra* (Copper) along with *Teeksnaloha* (Iron) are melted together and poured into the juice of *lakucha* (Artocarpus lacucha) containing Sulphur. The process is repeated several times. The resulting product is called *Varaloha*. This could probably be an **Alloy of Copper and Iron**. An Alloy is the combination of two or more elements at least one of which is a metal and where the resulting material has metallic properties [11]. Melting of sulfur along with metals may further aid in melting.

Varaloha is added to molten gold which turns into red color and is called **Hemarakti**. This prepared *Hemarakti* when added to molten Gold it further enhances the color of gold. **Tararakti** is also prepared in the same manner and is useful in turning lower metals into Silver and also in improving color of silver. Both *Hemarakti* and *Tararakti* are used to enhance the color of different beejas. **Shuddha swarna or Rajta means** pure Gold and Silver are termed as *Beeja* [12].

Such *Beeja* prepared are useful in *Jarana, Ranjana samskaras* of *Parada*. There are 18 samskaras told for *Parada*. Namely : *Swedana, Mardana, Moorchana, Utthapana, Paatana, Rodhana, Niyamana, Deepana, Graasa, Charana, Garbhadruti, Baahyadruti, Jaarana, Ranjana, Saarana, Kraamana, vedha* and *Sharirayoga* [13]. These are 18 different procedures done to Mercury in order to

remove the impurities present in it, improve the quality and making it a complete medicine. Among these 18, first 8 are called *Ashta samskaaras* and the *Parada* after 8 procedures attains *chikitsa/roghanashana* (curing diseases) and *Rasayana* (rejuvenation) properties. Thus *Ashta samskarita Parada* is mainly told for *Dehakarma* then *Dhatukarma*. The next 10 *samskaras* are for only for *Lohakarma* i.e for transmutation of basic metals to higher metals [14].

Chandradala/ Analadala: If any metal is converted to white color with the help of *mrita* or *baddhaparada* or any other metal it is called **Chandradala**. On the other hand if the metal changes to yellow color it is called **Analadala**. *Baddha Parada* is Mercury that has been made stable by *Aaabhasa samskara/* processing with metals and *Vanaspati* dravyas/plants [15]. This Mercury has the ability to transform colors in other metals. In metallurgy, **chemical metal coloring** [16] -Producing desired colors on metal by a chemical or electrochemical reaction. Mercury gilding is the process in which mercury is mixed with gold to make an amalgam that is applied to the surface of an object. (Mercury silvering uses the same process, but the mercury is mixed with silver.) When the object is then heated in an oven or over a fire, the mercury evaporates and leaves behind a thin coating of gold or silver [17].

Sulbanaga- *Tamrabhasma* (medicated ash of Copper) is prepared using *Swarnamakshika* (copper pyrite) and from this *bhasma*, *Tamra* (metallic Copper) is reobtained by *utthapana*. The process done for 10 times and each time metallic copper is obtained. Similarly *Nagabhasma* is prepared using *Makshika* and *Naga* reobtained by *utthapanaa*. The process repeated for 10times. Such *Tamra* and *Naga* taken 2 pala each is incinerated with *Neelanjana* (Galena) and brought back to metallic state for 7 times. The resultant alloy of *Tamra* and *Naaga* is *sulbanaga*. *Swarnamakshika* is the compound containing Copper, Iron as major components along with Sulphur. Here *Tamra*/Copper and *Naaga*/lead individually are incinerated with *Swarnamakshika* and then reobtained, by doing so some amount of Copper and Lead from the *Maakshika* would be added to the individual components. Hence the resultant product which could be an **Alloy of Copper and Lead**. The mechanism here is the reduction method of Alloying. Reduction is a chemical process in which a compound of one component can be separated from another component, to get a pure metal. This method is performed in an electric furnace [18].

Pinjari- when two metals are melted in a crucible and poured into any liquid and the resultant alloy if attains a pale/yellow colour it is called *pinjari*. This could be taken to

formation of an intermetallic compound and the mechanism of its formation is: Many metals, including gold and platinum, when alloyed with certain other metals at a fixed composition, can form intermetallic compounds, some of which have intrinsically attractive colors. In simple terms, these are analogous to chemical compounds where the different chemical element atoms combine in fixed ratios to form a particular compound such as sodium chloride (NaCl). Some of these exotic colors are intrinsic to the alloy and are obtained by alloying the precious metal with certain other metals in fixed amounts to produce intrinsically-colored special alloy structures known as intermetallic compounds. It is worth noting that, in normal metal alloys, the atoms are held together by metallic bonding, which also causes the color observed; however, in intermetallic compounds, this is replaced by strong co-valent bonding of atoms [19].

Chandrarka- sixteen parts of *tara* (silver) and twelve parts of *tamra* (copper) are melted together to obtain *Chandrarka*. It is an **Alloy of silver with copper**.

Dhanyabhraka: The powder of *abhraka* (mica) is mixed with *shalidhanya* (paddy) and tied in a strong cloth to make a *pottali*. This *pottali* is kept in kanji overnight and then rubbed vigorously by hands by which *Abhraka* in the form of powder comes out of pores of cloth. The intention of doing is because this method

effectively removes the impurities present in the mica. By mixing with rice and keeping it overnight the other physical impurities such as sand etc gets separated. Also due to rubbing mica particles alone come out of the cloth and float in kanji which can be separated. It is called **Dhanyahbraka. Scouring** [20] the wet/dry cleaning process using mechanical scrubbing can be correlated to this process.

Satwa: when a mineral is mixed with *ksharas*, *Amla varga dravyas* and *draavaka gana dravyas* arranged in a hearth and blown, the extract that comes out of mineral is *satwa*. The *satwas* so obtained are used for both *Dhatu vada* as in *Chaarna*, *Jaarana* procedures as well as in *Deha vaada* when they are further subjected to *Shodhana*, *Maarana* procedures. *Ksharas* are caustic alkalis told such as *Sarja kshara* – Sodium carbonate,,*Yava kshara* – ash obtained from Barley containing Potassium carbonate in higher % , *Tankana/Borax*. *Amla varga dravyas* are sour drugs such as *Nimbu/lemon* etc. *Draavaka gana* drugs are *Ghruta/ghee*, *Gunja* – *Abrus precatorius*, *Tankana*, *Madhu/* honey, *Guggulu* – *Commiphora mukul* mainly used for *loha draavana* that is for melting the metals with higher melting point. These drugs help in reducing melting point of the metal and also removal of physical impurities. As such Borax is a well-known flux. **Flux**, in metallurgy, any substance introduced in the smelting of ores to

promote fluidity and to remove objectionable impurities in the form of slag^[21]. Also all these drugs are good source of Carbon thus a reducing environment is formed by carbonization. The rationale for using *Koshti* is to obtain the maximum temperature required for separation of metal from the compound.

Hingulakristaparada- is that *Parada* (mercury) obtained from *Hingula* (cinnabar) by grinding in the juice of *Ardraka* (ginger) keeping it in *vidhyadhara yantra* and subjected to intense heat. The method of obtaining mercury from cinnabar here can be roughly correlated to **Smelting-** a form of extractive metallurgy, its main use is to produce metal from its ore and reducing agent commonly being a source of carbon [22].

Ghoshakristatamra- the powder of *Kamsya* (bell metal) is added with *Haratala* (orpiment) little by little continuously and while mixing, fire is blown with *vankanaala* till only copper remains. *Ghosh* or bell metal is an alloy of Copper and tin in the ratio of 4:1. On heating this in crucible and adding orpiment to it , the Tin reacts with Sulphur in the Orpiment and by blowing with blower, this get separated leaving behind the Copper [23]

Varanaga-equal quantity of *Teekshnaloha* (a type of iron) and *Neelanjana* (galena) are taken in the crucible and intense heat given yield a soft, black, quickly melting alloy called *Varanaga*. It is an **alloy of Iron and Lead**.

Nagasambhuta Chapala- 30 pala (1440g) of *Naga*/ lead is powdered and ground in latex of *Arka* (*Calotropis gigantea*). It is kept in crucible and subjected to *Gajaputa* (incineration). This process is repeated several times till only a *pala* (48grams) of *lead* remains. This resultant material subjected even to thousand *putas* would not lose its weight. This is called *Nagasambhuta Chapala*. The process can be correlated to Cupellation process that is oxidation of molten lead containing gold and silver to produce lead oxide, thereby separating the precious metals from the base metal [24].

Procedures:

Nirvaapana/ nirvahana : The process in which another metal is combined with *sadhyaloha* (the metal which is to be processed) by blowing with the help of *vankanaala* is called **Nirvaapana**. The objective of using *Vankanala*/ blower is that with minimum fuel and in a small space maximum heat can be generated which is sufficient to melt the metal kept in the *Musha* or crucible [25]. This could be taken for **fusion method of alloying**[26]. In this fusion method, correct proportions of pure metals are kept in a furnace and melted together or one of the metals is melted first and the other added to it and dissolved.

Tadana : A process in which one metal is separated from the combination of two metals using *vankanaala* is called **Tadana**. This could be similar to **liquation** of the present

metallurgy which means the separation of a low-melting constituent of an alloy from the remaining constituents, usually apparent in alloys having a wide melting range^[27]. For example a compound of Lead and Silver when heated by the method, lead melts and forms red oxide of lead while silver is left behind as it is. Hence by the method of *Tadana* lead can be separated from silver.^[28]

Utthapana: The process by which original metal is reobtained from a *bhasma* is called **Utthapana**. This can be correlated to **reduction** process of smelting as already explained.

Dwandwana: A process in which two substances are ground and blown in the fire in order to unite them is called **dwandwana**. This could be taken for **fusion method of alloying**.

Anuvarna: The process in which a substance is added in excessive quantity than specified to any other substance is called **anuvarna** or **suvarnaka**. **Master alloy** [29] an alloy, rich in one or more desired addition elements, that is added to a metal melt to raise the percentage of a desired constituent could be the probable correlation.

Bhanjani: When a burning fire is extinguished either with the help of liquids like water or any other substance the process is called **bhanjani**. The four elements needed to sustain combustion are: fuel, oxygen, heat and a chemical chain reaction. Removing any of these components of the fire tetrahedron will stop

the other elements from interacting and not allow combustion to continue [30].

Patangi- if the *loha* or *roupya* attains the colour of *swarna* under the influence of *kalka* of any of drug then it is called *patangi*. **Coloring-** Producing desired colors on metal by a chemical or electrochemical reaction [31].

Phullika- if the above *patangi* colour, retains for few days but vanishes later such a condition is called *phullika*. Under the influence of drugs the metals are made to obtain the color of gold. The color is then separated from the metal by subjecting it to intensive fire or by any other method such a separated color is called ***patangi raga***.

Shodhana : the process by which impurities in a metal/mineral is removed by adopting procedures such as *Peshana*/ grinding etc is *shodhana*. The metal/mineral before using it for medicinal purposes need to be purified. Different methods are explained for *shodhana* being specific to the drug (*vishesha shodhana*) or group of drugs (*samanya shodhana*). The procedures include *bhavana*, *nirvaapa*, *dhaalana*, *pehana*, *prakshalana* etc. The objectives of carrying out *shodhana* are: removal of physical impurities, nullify the toxicity, reduce the particle size, facilitate incineration, enhance therapeutic efficacy.

Bhaavana : The process in which the powders of metals are added with prescribed liquids and ground well in a *Khalwa yantra* (pestle and

mortar) till the mass is dried up, is called *Bhavana*. The utility of *Bhavana* is different based on the need of using it. For example; *Bhavana* procedure in *Shodhana* help in removing the impurities, toxicity of the drug. Using it for *Marana* helps in reduction of particle size. The procedure could be compared to Levigation. **Levigation**³² is the process of grinding an insoluble substance to a fine powder, while wet.

Nirvaapa- substances like metals are heated to red hot in fire and immersed in liquids like water is called *nirvaapa*. Metals like *Loha*/iron with high melting point are subjected to *nirvaapa*. Due to repeated heating and dipping in liquids would make the metal brittle, and decrease the particle size. By this it would facilitate the next process i.e *maarna*/incineration. The process of *nirvaapa* can be correlated to quenching. The rapid cooling of a metal (often steel) from a suitable elevated temperature. Quenching is typically done by immersing the metal in water, oil, a polymer solution, or salt [33].

Though the process of *Nirvaapa* and Quenching are similar in description the purpose served are different. Quenching at present is used to harden metals whereas *Nirvaapa* makes them brittle. The change could probably be because of the media being used for *Nirvaapa*.

Dhaalana: When the molten/ liquefied metal is poured in another liquid, the process is called

Dhalana. Metals such as *Vanga* with low melting point are subjected to *Dhalana*. Even here repeated heating and cooling help in making metal more brittle, reduce the particle size. This could be the combination of melting and then quenching in liquid medium. **Melting** is process by which a pure metal, compound, or eutectic changes from solid to liquid.

Avaapa-it is a process in which any other substance are put into liquefied metals. It is also called *prativapa* or *achadana*. This procedure is used in incineration of metals like Naga(lead), *Vanga*(tin) after purifying them, where in powders of *haridar* (turmeric), *Apamarga* (*Achyranthes aspera*) etc are added to molten metal and stirred continuously till the metal is converted to powder form. Later this metallic powder is further subjected to incineration to obtain the *bhasma*. **Metal Dusting** ^[34] that is a catastrophic form of corrosion that occurs when susceptible materials are exposed to environments with high carbon activities. The corrosion manifests itself as a break-up of bulk metal to metal powder.

Shuddhavarta- the flames which occur when the fire burns intensively indicating retrieving out of *satwa* of the minerals. At present this can be correlated for **white heat**.

Beejavarta- whenever a metal is blown in fire in order to melt it, a specific colored flame pertaining to the color of metal is seen in fire

indicating melting of that metal and this condition is called *beejavarta*. Different metals exhibit different **colors on melting** such as bluish green sby copper, deep yellow by borax ***Swangasheeta, bahisheeta***- while heating a substance on if the substance is let to cool on its own accord, such condition is called *swangasheeta*. For example metals after subjecting to *puta* are allowed to cool itself. This helps in complete utilization of heat given for incinearation of drug. However the substance if removed from the fire and cooled outside it is called *bahisheeta*. For example in preparation of *swarnavanga*, the *kupi* is removed from the *valuka yantra* and then cooled ^[35]

Bhasma Pareekshas: are different tests explained to assess the quality of *bhasmas*. *Bhasmas* are the unique Ayurvedic metallic/mineral preparations obtained when metals or minerals are treated with herbal juices or decoctions, made into pellets and exposed to certain quantum of heat as per *Puta*. There are different parameters classically told to assess the quality of these *bhasmas*. Those which pass all these tests only is fit for therapeutic consumption.

Varitara- The *bhasma* should float on water. This suggests that particle size of *bhasma* is so small that it does not break the surface tension of water.

Rekhapurnata-if the *bhasma* rubbed in between thumb and index finger and if it enters into minute grooves of the fingers. These tests suggests for Microfine particle size of the *bhasma*. *Bhasmas* are the best example of Nano technology & Nano medicine. There is transition from micro particles to nanoparticles which is being proved by SEM tests.

Apunarbhava-The *Bhasma* is mixed with equal quantity of *MitraPanchaka* {seeds of *Gunja* (*Abrus precatorius*), Honey, Ghee, *Tankana* (Borax) and Jaggery}, *chakrikas* are prepared and it is sealed in *Sarava Samputa* (earthen pots), thereafter the similar grade of heat used for the preparation of the particular *Bhasma* is applied and on self-cooling the product is observed. Lustered particles in it if present shows presence of free metal which is indicative of improper incineration while its absence signifies proper incineration. This test further signifies original metal cannot be reobtained.

Niruttha- the *roupya* (silver) is mixed with *bhasma* and blowed vigorously in fire. If not even little amount of *bhasma* mix with *roupya* such *bhasma* is called *niruttha*. This applies when a prepared *bhasma* is subjected to the same temperature level on which it was prepared, with previously weighed piece of silver in a crucible after cooling the weight of silver piece should not be changed. *Niruttha* signifies that the metal is no longer present in

its elemental form because if any elemental form of metal present in the *bhasma* it would react with the molten silver and the weight of silver will increase.

DISCUSSION:

Paribhasha prakarana in *rasashastra* is one of the important topic which deals with different technical terminologies used in the science which are otherwise difficult to understand. These technical terminologies include different products, procedures as well as *bhasma pareekshas*.

Among the products told apart from *Kajjali*, *Dhanyabhraka*, *satwa* of different metals, rest most of them are presently not in use in *rasashastra*. This is because most of the other products described were used by *acharyas* mostly in *dhatuvaada* for conversion of basic metals to higher metals, the concept which has slowly deteriorated over the years. It is evident that the *acharyas* had good knowledge of metallurgy as well as chemistry. They had knowledge of preparing amalgams, preparation of alloys by different methods like fusion etc, and extraction of metals from their ores. The description of *chandradala*, *analadala*, *pinjari* suggest they had keen observation of changes in color and other physical properties a metal undergoes when subjected to heating.

The procedures explained are different methods of alloying *nirvaapana*, *dwandwana*, process of coloring, different methods for

purification of metals, other chemical processes such as *nirvaapa*, *dhaalana*, etc, tests for knowing accuracy of prepared *bhasmas*.

Metallurgy is the science involving metals and alloys. The knowledge of metallurgical terms is necessary to understand the terms explained in *Paribhasha prakarana* and infer as to why it is told.

CONCLUSION:

It is evident that the knowledge of modern metallurgy is necessary to inculcate the terminologies explained in the context of *Paribhasha* and apply them in the present scenario. There is need for detailed pharmaceutical and analytical study of both products and procedures explained in *Paribhasha* chapter. A study team comprising of an Ayurvedic expert (well versed in *rasashastra*), expert in Pharmaceuticals, metallurgical expert should carry out a study thoroughly in this aspect to draw more scientific conclusions. Also many procedures classically told can be studied, analyzed and improvised and can be used in modern metallurgy and pharmaceuticals.

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