

## Chemistry of Kupipakwa Rasayanas – A Review

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### Abstract :

Kupipakwa Rasayanas are very popular and commonly prescribed preparations among the Ayurvedic physicians, and are looked upon as panacea. These are prepared in a specially designed glass bottle by gradual heating immersion in sand bath (Valuka Yantra). Particular chemical processes are involved in these preparations which also bear testimony to the great chemical knowledge prevailing in ancient India. In the present review, the probable chemistry of Kupipakwa Rasayanas has been discussed.

**Key words** : Rasasindura, Makaradhwaja, Malla-sindura, Shilasindura, Talas-indura, Rasakarpura, Rasapushpa, Swarna Vanga.

### Introduction :

Chemistry in ancient India had its origin in the development of practical arts to meet the demand for the necessities of life, as also in the speculation about the nature and composition of matter. Since the beginning of this civilization, the evaluation of chemistry may be said to have proceeded in a more or less uninterrupted course in spite of numerous political and social changes in the country. Use of various metals and minerals and transformation of these into effective drugs in *Ayurvedic* system of medicine serve as evidence for this fact<sup>1</sup>. Metallic and mineral preparations are unique in *Ayurveda* and are known by the name of *Bhasma*, *Kupipakwa Rasayana*, etc.

The terminology '*Kupipakwa*' itself denotes the pharmaceutical processing that is involved in these preparations by heating in glass bottle. The products thus obtained are very favourite and frequently used remedy by the *Ayurvedic* physicians. These are

reputed to be panacea for a variety of ills that human flesh is heir to<sup>2</sup>. The general belief is that by association with mercury and sulphur, these products acquire the most potent efficacy.

The process of *Kupipakwa Rasayana* preparation employs many of the alchemical principles and observations. In these processes mercury (Hg) has been used extensively to bring about the desired chemical changes in the final product. The other element used freely is sulphur (S). High chemical reactivity of both these elements is well known today<sup>3</sup>, and it seems that the *Ayurvedic* scholars were conscious of their properties. Many studies have so far been carried out on various *Kupipakwa Rasayana* preparations, and the properties and chemical composition of these preparations have been reported<sup>4,5,6</sup>.

### Preparation of Kupipakwa Rasayana :

The authentic raw metals or minerals (*Parada* (Mercury), *Gandhaka* (Sulphur) and other metals and minerals) are procured first, and are subjected for *Shodhana* (purification) procedure according to classical *Ayurvedic* references. Then specified quantity of *Shuddha* materials (mostly *Parada* and *Gandhaka*) are mixed and triturated together for several hours until the mixture is converted into a black, lusterless, fine, impalpable powder of uniform consistency. This is known as '*Kajjali*'. In some preparations (*Makaradhwaja*, etc.), *Shuddha Parada* is rubbed with *Shuddha Dhatu* (metal like gold, etc.) to make an amalgam. *Shuddha Gandhaka* is added to the amalgam and the whole are triturated for several hours until the mixture is converted into '*Kajjali*'. Other purified materials (*Haritala*(orpiment), *Manahshila* (realgar), etc.) are mixed with the prepared '*Kajjali*' for different *Kupipakwa Rasayana* preparations (*Talasindura*, etc.). The '*Kajjali*' is then levigated by specific liquid media. The prepared *Kajjali* is then placed in a specially designed glass bottle (with seven layers of mud smeared clothes), and the heating process is carried out by immersing the filled bottle in *Valuka Yantra* and gradually increasing temperature for specific duration. On cooling the prepared *Kupipakwa Rasayana* is found to be deposited in the inner surface of either the neck or bottom of the bottle and is collected by breaking the bottle.

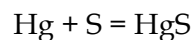
### Various Kupipakwa Rasayana and their Chemistry:

#### Rasasindura :

Equal quantity of *Shuddha Parada* (purified mercury) and *Shuddha Gandhaka* (purified sulphur) are triturated together for several hours until the mixture is converted into a black, lusterless, fine, impalpable powder of

uniform consistency. This is known as '*Kajjali*'. The '*Kajjali*' is then levigated by liquids like aloe gel (leaf pulp juice of *Aloe barbadensis* Mill.) or juice of leaf buds of *Ficus bengalensis* Linn. (*Vatankura Swarasa*). It is allowed to complete dryness. The dried '*Kajjali*' is then placed in a long neck, narrow mouthed bottle (beer bottle) and is gradually heated on a sand bath (*Valuka Yantra*). On cooling *Rasasindura* is found to be deposited in the inner surface of the neck of the bottle and is collected by breaking of the bottle<sup>7</sup>.

**Chemistry :** *Rasasindura* is identical with red sulphide of mercury and has the same composition as that of the mineral cinnabar, HgS. During trituration and when heated to about 50°C, the black mass of mercuric sulphide (metacinnabar) is formed. And when heated, it slowly becomes red and crystalline and sublimed in the long necked glass bottle.



The black sulphide becomes red on sublimation; the unstable black form is being converted into stable red form on heating<sup>8</sup>.

#### Makaradhwaja :

Eight parts of *Shuddha Parada* (purified mercury) and one part of *Shuddha Swarna* (purified gold) leaf are rubbed together in a stone mortar to make an amalgam. Sixteen parts of *Shuddha Gandhaka* (purified sulphur) are added to the amalgam and the whole are triturated for several hours until the mixture is converted into '*Kajjali*'. Further procedures are same as *Rasasindura* preparation. The only difference is, here levigation is done with juice of *Gossypium arboreum* Linn. (*Rakta Karpasa*) flower<sup>9</sup>.

**Chemistry:** *Makaradhwaja* is also identical with red sulphide of mercury and has the

same composition as that of the naturally occurring cinnabar, HgS. It also contains very minute quantity of gold in combination with mercuric sulphide<sup>10</sup>.

### Malla / Tala / Shila Sindura :

Equal quantity of *Shuddha Parada* (purified mercury) and *Shuddha Gandhaka* (purified sulphur) are triturated together to make '*Kajjali*', then varying proportion (equal or half or quarter) of purified arsenicals (*Shuddha Malla*, arsenite, As<sub>2</sub>O<sub>3</sub> and/or *Shuddha Haratala*, orpiment, As<sub>2</sub>S<sub>3</sub> and/or *Shuddha Manahshila*, realgar, As<sub>2</sub>S<sub>2</sub>) are mixed and triturated. Further procedures are same as *Rasasindura*<sup>11</sup>.

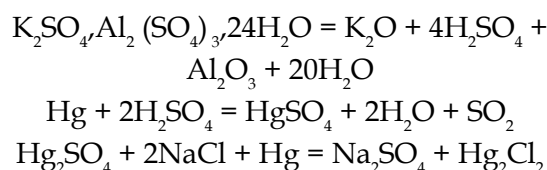
**Chemistry** : *Malla/Tala/Shila Sindura* are also identical with red sulphide of mercury and have the same composition as that of the mineral cinnabar, HgS. These also contain varying quantity of arsenic in combination with mercuric sulphide<sup>12,13</sup>.

### Rasakarpura :

Specified quantity of *Shuddha Parada* (purified mercury), *Shuddha Sphatika* (purified alum), *Shuddha Kasisa* (purified ferrous sulphate), *Saidhava Lavana* (rock salt), and other substances like brick powder, *Gairika* (red ochre), etc. are triturated together for several hours until the mixture is converted into lusterless, fine, impalpable powder of uniform consistence. The mixture is subjected in a long neck glass bottle (bear bottle) and is gradually heated on a sand bath (*Valuka Yantra*). After self-cooling the prepared *Rasakarpura* is collected from the neck of the bottle after breaking<sup>14</sup>.

**Chemistry** : Alum or ferrous sulphate, when heated, yields some sulphuric acid. This reacts with rock salt to liberate hydrochloric acid. The latter undergoes

aerial oxidation in contact with ferric oxide from the brick dust, *Gairika* (red ochre), clay, etc., acting as catalyst, and sets free chlorine, which attacks the mercury, giving rise to calomel (Hg<sub>2</sub>Cl<sub>2</sub>). Alumina from alum or from clay may also catalyze the reaction to a certain extent like the ferric oxide<sup>15</sup>.



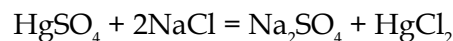
### Rasakarpura of Rasatarangini:

*Shuddha Parada* (Purified mercury) is mixed with one and half times its weight of *Gandhakamla* (sulphuric acid) and heated. Thus the white moistureless powder formed, is mixed with equal quantity of powdered *Saindhava Lavana* (rock salt) and triturated. The fine, lusterless, uniform mixture is placed in a long necked bottle (beer bottle) and is subjected on mild heat gradually on a sand bath (*Valuka Yantra*). After self-cooling the sublimed material is collected from the neck of the bottle by breaking it<sup>11</sup>.

**Chemistry** : Mercury when boiled with one and a half times its weight of concentrated sulphuric acid, mercuric sulphate (HgSO<sub>4</sub>) is formed.



On heating the dry mixture of equal weights of mercuric sulphate and rock salt, mercuric chloride is prepared. It separates by sublimation on the cooler upper part of the bottle. It forms colourless needle shaped crystals having melting point 277°C and boiling point 320°C<sup>16</sup>.



### Rasapushpa :

Equal quantity of *Shuddha Parada* (purified mercury) and *Shuddha Kasisa* (purified ferrous sulphate) are mixed and triturated together, until a lusterless, fine, impalpable powder is formed, then equal part of *Saindhava Lavana* (rock salt) is added with the mixture and triturated again. The mixture is then placed in a long necked glass bottle (beer bottle) and heated gradually on a sand bath (*Valuka Yantra*). On cooling, *Rasapushpa* is found to be deposited in the inner surface of neck of the bottle and is collected by breaking of the bottle<sup>11</sup>.

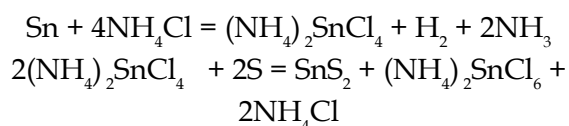
**Chemistry:** During trituration of mercury and ferrous sulphate, mercuric sulphate is formed and some part of mercury remains free. The intimate mixture of converted mercuric sulphate, mercury and rock salt are, when heated mercurous chloride is formed. It sublimes to the cooler upper part of the bottle and the crust of the sublimate is collected. It sublimes at 380°C<sup>17</sup>.



### Swarna Vanga :

*Shuddha Vanga* (Purified tin) is melted and mixed with equal quantity of *Shuddha Parada* (purified mercury) and rubbed together in a stone mortar to form an amalgam. Equal parts of *Shuddha Gandhaka* (purified sulphur) and *Shuddha Navasagara* (purified ammonium chloride) are added to the amalgam and the whole are triturated for several hours until the mixture is converted to lusterless, fine, homogeneous powder. The mixture is then placed in a glass bottle and is gradually heated on a sand bath (*Valuka Yantra*), until the fumes disappear completely. On cooling, the golden-yellow coloured crystalline *Swarna Vanga* is collected from lower part of the bottle by breaking it<sup>18</sup>.

**Chemistry:** *Swarna Vanga* is obtained as golden yellow scales of crystalline  $\text{SnS}_2$ , better known as mosaic gold. By heating a mixture of tin, sulphur and ammonium chloride in glass bottle, a stannate and thio-stannate is formed<sup>19</sup>.



### Discussion :

The *Kupipakwa Rasayanayas* are prepared in especially prepared glass bottle, designed instrument, known as '*Valuka Yantra*'. The glass bottle with a long neck (beer bottle) is wrapped with several folds of cloth smeared with clay, and then dried in the sun. That makes the bottle more heat stable. The bottle is buried up to its neck in sand placed in an iron pot; heat is applied from under the pot. This arrangement helps in gradual and homogeneous heating.

Mercury and sulphur are the elements mostly used in preparation of various *Kupipakwa Rasayanayas*. In many processes mercury has been used to amalgamate with the metals and form an intermediate product, which could increase the surface reactivity of the metal with other chemical. Sulphur facilitates the formation of respective sulphide. In these cases mercury and sulphur have acted as promoters for the final chemical reaction. Mercury itself is being in liquid state, readily reacts with sulphur to form  $\text{HgS}$  (black sulphide)<sup>3</sup>. When mercury is amalgamated with metals, it gets converted into semisolid mass and easily reacts with sulphur to form black sulphide,  $\text{HgS}$ , and thus it promotes the high temperature reaction with other metals.

Most of the chemical reactions involve in *Kupipakwa Rasayana* preparations are heterogeneous kinetics i.e. reaction between solid-gas or solid-liquid and it is known that the rate of such reactions is proportional to the interfacial area. During such reactions, at first a surface layer of the chemical is readily formed (chemical rate controlled) and afterwards the rate of reaction becomes diffusion, rate controlled and slow. The ancient *Ayurvedic* scholars were conscious of these facts and overcame this problem firstly by increasing the primary surface area and secondly by removing the chemical layer formed on the metal particles and thus exposing new metallic surface. These conditions were achieved by intermittent trituration. In solid-solid reaction, trituration increased the chemical rate kinetics<sup>1</sup>.

Sublimation is the chemical process, involved in most of the *Kupipakwa Rasayana* preparation. It is the unique process converting a solid directly into vapour and condensing the vapor into solid state having the same composition<sup>3</sup>. The ancient scholars of *Rasashastra* (12<sup>th</sup> cen. AD) may be acknowledged as the pioneers of the sublimation process. The gradual heating pattern, use of sand bath (*Valuka Yantra*) for indirect and homogeneous heating and long necked glass bottle for providing adequate space for re-solidification, should be considered as examples of great knowledge of chemical processes.

Now a days electric muffle furnace is brought into practice instead of '*Valuka Yantra*' for preparation of *Kupipakwa Rasayanas* with added advantage of easy regulation of temperature, lack of need of fuel (coal), elimination of smoke and dust, etc. But there are some disadvantages also like high product cost due to electricity charges, and difficulty in large scale production. The temperature pattern in

muffle furnace for preparation of *Kupipakwa Rasayanas* is also being standardized, like for mild temperature (*Mriduagni*) the temperature range will be 150°C - 200°C, for moderate temperature (*Madhyamagni*) the temperature range will be 200°C - 400°C and for higher temperature (*Tivragni*) the temperature range will be 400°C - 600°C<sup>20</sup>.

The temperature pattern and duration for preparation of all the *Kupipakwa Rasayanas* are different, but gradual heating system is followed for all. Preparation of *Rasasindura*, *Makaradhwaja*, *Malla/Tala/Shila Sindura* need almost same grade of heating but duration depends on amount of free sulphur in the '*Kajjali*', here required highest temperature is around 600°C. For preparation of *Rasakarpura* the highest temperature should not exceed 300°C and required duration is 9 h. The highest temperature and duration for preparation of *Rasapuspha* are 400°C and 9 h respectively. For preparation of *Swarna Vanga* the highest temperature given is 450°C and is needed for longer duration, not less than 12 h.

It must be remembered that all the *Kupipakwa Rasayanas* are not pure chemical compound, rather cocktail of many trace elements also. Those make the product therapeutically more potent and less toxic<sup>16</sup>. The drugs for levigation (*Bhavana Dravyas*) may contribute these trace elements to the final product.

### **Conclusion :**

In conclusion it may be said that all the *Kupipakwa Rasayanas* are product of complex chemical processes. The modern analysis of these processes confirms the high level of understanding of the physico-chemical principles and the skill achieved at an early date in ancient India.

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