ISSN: 2322 - 0902 (P)
ISSN: 2322 - 0910 (O)

International Journal of Ayurveda and Pharma Research

Research Article

CHEMISTRY OF *KUPIPAKVA RASAYANA* W.S.R. TO *TAMRA SINDOORA*

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ABSTRACT

Kupipakva rasayana are unique pharmaceutical procedure in the field of *Rasashastra* where in Mercury along with other minerals and metals are sublimated by subjecting it to gradual increase in temperature for specific time. They are more potent and quick acting even in smaller dose. *Tamra Sindoora* is one such *Kupipakva Rasayan* which is not that much popular and widely used in daily practice. But it is having a wide range of therapeutic utility. It is a combination of *Parada* (mercury), *Gandhaka* (sulphur) and *Tamra* (copper) in the ratio of 1:1:1/2.

Chemistry itself includes the determination of chemical and biological incompatibilities among the various ingredients of a prescription. Here we will come to know about various synthetic methods by which natural substances are converted into products with more favourable therapeutic or pharmaceutical properties. In the present paper will discuss about probable chemistry of *Tamra Sindoora*.

KEYWORDS: *Kupipakva Rasayana, Tamra Sindoora*, Chemistry.

INTRODUCTION

Pharmaceutical chemistry is a science that makes use of the general laws of chemistry to study drugs i.e., their preparation, chemical nature, composition, structure, influence on an organism. It includes the various synthetic methods by which natural substances are converted into products with more favourable therapeutic or pharmaceutical properties.

Kupipakva Rasayana[1] is a popular and commonly prescribed preparation which bears a unique place in *Rasashastra* because of its mercurial preparation with quicker action and synthetic effects in the body at very low dose. As name itself indicates it is prepared in a *Kachakupi*. The heat is given in specific heat pattern. The role of temperature is very important to get the desired and beneficial effect in the final product

Tamra Sindoora is one such *Kupipakva Rasayana* composed of *Parada* (Mercury), *Gandhaka* (Sulphur) and *Tamra* (Copper). As these are the only metals and minerals, there will be desired chemical changes in the final product.

Review of literature: Chemistry of *Kupipakva rasayanas* – Review by Prasant Kumar Sarkar. In this article the author has explained the chemistry of *Kupipakva rasayana* in short by taking examples of many *Kupipakva rasayanas*.

Rationale: In the previous study they explained just shortly about the chemistry of *Kupipakva rasayana* i.e., only end product changes. But here would like to explain the complete chemistry from beginning of the process to formation of end product. The chemistry itself includes the determination of chemical and biological incompatibilities among the various ingredients of a prescription. Here we will come to know about various synthetic methods by which natural substances are converted into products with more favourable therapeutic or pharmaceutical properties.

Aim and Objective

Aim

To study the probable chemistry of *Kupipakva rasayana* w.s.r *Tamra sindoora.*

Objective

1. To prepare the *Tamra sindoora* according to *Ayurveda Sara Sangraha*.
2. To do the physio chemical analysis of *Tamra Sindoora*.
3. To do the analytical study of *Tamra Sindoora*.
4. Through physio chemical analysis and analytical study assess the probable chemistry of *Tamra Sindoora*.

Materials and Methods

Major Raw drugs required: *Parada, Gandhaka* and *Tamra*

Minor drugs required: *Sudha churna, Lashuna, Saindava lavana, Godugdha, Go grita, Tila taila, Takra, Go mutra, Kanji* and *Kulatta.*

Equipments required: *Khalva yantra*, Vessel, Gas stove, *Valuka yantra, Kachakupi* and *Bhatti.*

Procedures included

1. *Parada shodhana*
2. *Gandhaka shodhana*
3. *Tamra samanya shodhana*
4. *Tamra vishesha shodhana*
5. Preparation of *Kajjali*
6. Preparation of *Tamra Sindoora*

Method of preparation

***Parada shodhana*[2]**

First *Parada* with *Sudha curna* was triturated for 3 days and washed it with warm water. Then again triturated with *Lashuna* (1 part) and *Saindava lavana* (1/2 part) till it gets into black color. Then washed it with warm water and collected the pure *Parada*.

***Gandhaka shodhana*[3]**

Gandhaka was melted in pan containing ghee. Then it was immediately poured into the vessel containing milk and its mouth was tied with cloth. The same procedure was repeated for 3 times.

***Tamra samanya shodhana*[4]**

Tamra was heated red hot and dipped (*Nirvapa*) in *Tila taila* for 7 times. Same procedure was repeated with *Takra, Gomutra, Kanji* and *Kulatta kwatha*. In each liquid media 7 times *Nirvapa* was done**.**

***Tamra vishesha shodhana*[5]**

Samanya shodhita tamra was boiled with *Gomutra* and *Saindava lavana* for 3 hours.

Preparation of *Kajjali*[6]

Shuddha parada and *Shuddha gandhaka* were taken in equal quantity. They are triturated continuously till we get the *Siddha lakshanas* i.e., black color like *Kajal*, fine powder and *Nishchandratva* (no shining particles).

Preparation of *Tamra Sindoora*[7]

Step 1 - Prepared the *Kachakupi* by putting 7 layers of cloth smeared with *Multhani mitti*.

Step 2 - Filled *Kajjali* (1Part) and *Tamra curna* (1/4 Part) in the *Kupi.*

Step 3 - Placed this *Kupi* in centre of *Valuka yantra*.

Step 4 - Fixed the *Valuka yantra* in the *Bhatti*.

Step 5 - Kramagni was given for 36hrs.

Mrudu agni – Upto 250^{0}C - 8hrs

Madyamagni – 250- 450^{0}C - 15hrs

Teekshnagni - Above 450^{0}C - 13hrs

Step 6 - After getting *Suryodaya lakshana*, copper coin test positive, cork test positive corking was done. During this time *Agni* was completely stopped.

Step 7 - Again *Agni* was given till it reached to its peak temperature.

Step 8 - Allowed it for *Swangasheeta* (self cool)

Step 9 - Brook the bottle using a thread dipped in kerosin and lighting up.

Step 10 - Collected the *Tamra sindoora* from the neck of *Kupi* which was conical in shape and silver shiny in appearance.

Observations

Parada was smoky in appearance and after *Shodhana* it became shiny silvery in appearance. This was because of removal of all the impurities from it. Even chemically the changes were observed i.e., the raw *Parada* was containing Iron, Copper, Zinc, Silver, Tin, Cadmium, Lead, Arsenic elements. After purification the amount of above elements got reduced.[8]

Gandhaka was crystal in structure and dirty yellow in color. After *Shodhana* it became smooth, light yellow colored powder. Here the *Guru, Snigda* and *Sheeta veerya* of milk pacifies the *Teeksna, Usna guna* of *Gandhaka*. Chemically *Gandhaka* remained as Sulphur only but the shape of particles changed from Monoclonic to Rhombic crystal structure.[9]

Tamra which was hard in nature was turned to powder form after *Shodhana*. Even chemically the copper changed to Cuprite form and the crystal structure changed from hexagonal to monoclinic.[10]

$$Cu + O_2 \rightarrow CuO$$

When *Parada* was mixed with *Gandhaka* initially the color changed to yellowish grey in color. As the *Parada* completely mixed with *Gandhaka* the color of *Kajjali* became black. At the end, we got Mercuric sulphide as end product.[11]

$$Hg + S \rightarrow HgS$$

When the heat started after sometime the white fumes were observed which was due to organic material burning. On starting of *Mandagni* yellow fumes were seen which was due to free sulphur gets burnt up in the presence of atmospheric oxygen. Due to continuous heating more sulphur in free state escape out and slowly makes a dense cloudy appearance at the neck portion. Due to this oxygen becomes unable to combine with free sulphur and there was choking of bottle at the neck was observed. To release it hot *Shalaka* was inserted, so that sulphur gets burnt up and making a space for oxygen

to enter and react with sulphur fumes. When whole free sulphur burnt up, torch test was done, where we saw sunrise sign (*Suryodaya lakshan*) at the bottom. That time, cold *Shalaka* was used to confirm whether any substance is still there or not. Also copper coin test was also done to confirm if mercury starts evaporating. After confirmation, corking of bottle was done and intensive high heat was given and sand at the neck was removed for HgS sublimation. Due to this intense heat, inside the bottle chemical reactions goes on and helps in formation of end product which gets sublimated at the neck. As in *Tamra Sindoora*, there was *Tamra* which was a metal with high boiling point and melting point this heat is not much efficient to let copper to evaporate and sublimate at neck. So the properties of *Tamra* were taken by the Hg and Hg itself gets sublimated at the neck.

$$HgS + Hg + S + Cu \rightarrow HgS + CuO$$

Table 1: Showing Chemical composition of *Kajjali* and *Tamra Sindoora*

Sample	*Kajjali*	T.S
Total Hg	45.60%	31.95%
Total S	28.05%	3.15%
Copper	-	15.24%

Table 2: Showing report of XRD of Tamra Sindoora

Peak no	**Identified**		**Standard**		
	Angle 2 θ	**d space** [Å]	**Angle2 θ**	**d space** [Å]	**Intensity** [%]
1	26.761	3.32858	26.767	3.32787	100
2	28.429	3.13700	28.435	3.13641	35.3
3	31.478	2.83974	31.482	2.83941	52.8
4	38.124	2.355862	38.119	2.35889	6.3
7	46.050	1.96940	46.058	1.96908	14.9
8	51.950	1.75876	51.948	1.75884	5.3
9	52.971	1.72725	52.981	1.72693	18.5
11	58.455	1.57758	28.465	1.57733	6.3
12	59.281	1.55756	59.271	1.5578	6.2
15	69.294	1.35492	69.291	1.35498	4.6
18	74.891	1.26692	74.889	1.26695	8.6
	Name of standard : Mercury Sulphide (HgS) Crystal structure : Hexagonal JCPDS No : 26 – 0476				

Table 3: Showing report of XRD of *Kajjali*

Peak no	**Identified**		**Standard**		
	Angle 2 θ	**d space** [Å]	**Angle2 θ**	**d space** [Å]	**Intensity** [%]
2	27.036	3.29540	27.029	3.29623	100
4	31.816	2.81030	31.813	2.81065	14
5	44.250	2.04525	44.262	2.04471	69.3
6	52.254	1.74924	52.255	1.74921	62.4
10	72.471	1.30315	72.475	1.30309	12.8
	Name of standard : Hypercinnabar, Mercury Sulphide, Meta cinnabar (HgS) Crystal structure : Hexagonal, Cubic JCPDS No : 26 – 0476				

DISCUSSION

The chemical changes were observed starting from the *Shodhana* of raw drugs. Then in next stage the chemistry can be understood when the heating process gets started.

The *Parada* when it was in raw form it had so many impurities both chemically and physically. When we did the *Shodhana* the physical impurities has been removed. Even chemically *Parada* has been changed by decrease in quantity of impurities like Iron, Copper, Zinc, Silver, Tin, Cadmium, Lead, Arsenic elements.

During *Shodhana* of *Gandhaka* first we have to melt the *Gandhaka*. At this point the sulphur molecules are separating. In this form the atoms are covalently bonded to form rings of 8. These rings slide easily over one another but cannot connect or tangle, that is why the liquid is not viscous. When this light yellow molten sulphur is poured into milk it solidifies as crystalline sulphur. The crystal structure of sulphur changes from Monoclinic to Rhombic. This will indicate the decrease in particle size and increased surface area. Lesser the particle size easy to enter the blood stream, more the surface area and more the absorption. Absorption means not only in the body, while doing further preparation more the surface area the drug easily interacts with the other drugs.

The *Tamra shodhana* has been done by *Nirvapa* method. During application of force in the form of heat, leads to weakening of electrostatic forces, crystal lattice of metal deform and increase in the interatomic distance. Also heating increases the rate of diffusion of atoms within a solid by providing the energy needed to breakdown the bonds. When the copper was heated until it glows dull red in the presence of Oxygen, the heat speeds up oxidation and copper oxide is formed. The area of copper exposed to Oxygen only may converted into oxide and becomes powder form. During cooling, recrystallization occurs along with the reformation of grain boundaries. In this reconstructed structure, each grain is surrounded by the molecules of liquid media, may be imposing its properties on purified metal. Repeated *Nirvapa* increases the brittleness, decreases the hardness, and finally decreases the particle size. Slower the quench rate, longer the thermodynamic forces have a chance to alter the microstructure and vice verse.

In *Kajjali* preparation while doing *Mardana* with *Gandhaka* the *Parada* is reduced to fine particles and come into contact with each other. Thus gets soluble in each other.

In the process of preparation of *Tamra Sindoora* the first step starts from selection of *Kupi*. Here one has to select the green colored beer bottle. The specification is for its chemically inert, vapours do not escape out, does not break easily, outer surface of drug becomes soft, for easy separation of drug. Even after having these much properties it should be smeared with 7 layers of *Kapadmitti.* This one is to strengthen bottle and for regulation and maintenance of temperature.

Only one third of *Kupi* should be filled to provide enough space for melting and boiling of *Kajjali*. Also prevents the overflow of boiling *Kajjali*. Here *Valuka* is used which helps in maintaining the uniform and sustained heat to the *Kupi.* In this *Kupi* is kept at the centre so that it gets enough heat from all the side.

The heating pattern helps to provide sufficient time for the ingredients to react with each other and form a complex compound under pressure. While giving *Agni* we observed different chemical changes that are occurring inside the *Kupi*.

The white fume which was observed initially was due to the burning of the organic materials and also it indicates that the sulphur started to melt. Then the yellow fumes were observed which indicates the suphur starts forming long polymer chains and thus its viscosity increases and appear with thick yellow fumes. During this time we inserted the cold Shalaka to assess the state of *Kajjali*. Because of increased chain reaction and formation of polymorphs of sulphur chocking of sulphur occurs at the neck of *Kupi.* This sulphur becomes more viscous and produces dense clouds and appears like dense yellow fumes. During this time the red hot *Shalaka* was inserted to clear the neck part and allowed for further oxidation. After repeated insertion of hot *Shalaka* at a particular period sulphur gets completely burnt up and again white fumes start to appear. In the next stage we can see, *Kajjali* tends to attain its boiling point and about to sublime, this is the stage where in the *Kajjali* from semisolid phase attains the gaseous stage and tends to move towards cooler part of *Kupi*. To allow it for sublimation we have to remove the sand around the neck of *kupi*. Then we have to do the copper coin test to assess compound formation and to avoid evaporation of mercury. At last we have to do *Mukamudrana* and allow it for sublimation by giving highest heat. As *Tamra* is having the high boiling point and melting point it was not sublimated at the neck but as *Parada* was there as an ingredient it engulfs the properties of *Tamra* and sublimate with *Gandhaka.*

At last we got the end product as Mercuric sulphide only but the difference between *Kajjali* and *Tamra Sindoora* is that the *Kajjali* was in micro form

and *Tamra Sindoora* is in nano form. *Kajjali* is in cubic and Hexagonal in shape, *Tamra Sinddora* is Hexagonal in shape. *Kajjali* contains Mercury 45.60% and Sulphur 28.05% whereas *Tamra Sindoora* contains Mercury 31.95% and Sulphur 3.15%. Even in *Tamra Sindoora* traces of copper was present which was in cupric form.[12]

CONCLUSION

Knowing the method of preparation of a drug and its indication is not sufficient. One should know the chemistry of that drug so that one can understand mode of action of the drug. Here effort has been put to explain the chemistry of *Kupipakva rasayana* w.r.s *Tamra sindoora*. Here though *Tamra* is the main drug for this preparation it was not found in end product or even if we found it was in traces. But we see the effect of *Tamra* at the end. This can be understood by the property of mercury which has the capacity of engulfing the properties of a drug in which it is added. The end product i.e., *Tamra Sindoora* is hexagonal in crystal structure, nano particle in size and Mercuric Sulphide in form. Based on its structure and particle size it is understood that it is easily absorbed in the body and shows its action very fastly. It shows this process of preparation of *Tamra Sindoora* is not a simple chemical reaction it is a complex chemical compound.

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Cite this article as:
Anitha T M, Shashidhar Jeeru. Chemistry of Kupipakva Rasayana w.s.r. to Tamra Sindoora. International Journal of Ayurveda and Pharma Research. 2019;7(4):57-63.
Source of support: Nil, Conflict of interest: None Declared

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1.Ashudda Parada

2. Shuddha Parada

3.AshuddhaGandaka

4.Shuddha Gandaka

5.Ashuddha Tamra

6. Tila Taila

7. Takra

8. Gomutra

9. Kanji

10. Kulatta Kwatha

11. Shuddha Tamra

12.Vishesha shoadhana

13. Vishesha shodhita Tamra

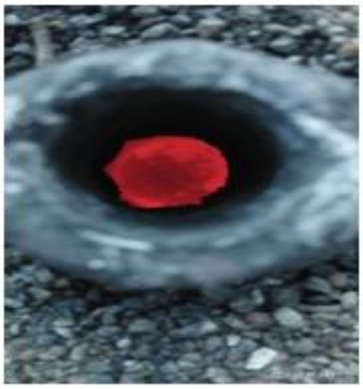
14 Parada+Gandaka

15. Kajjali

16. Bhatti

17. Yellow Fumes

18.HotShalakaInsertion



19. Suryodaya Lakshana

20.Copper coin test

21. Mukamudrana

22. Breaking of Bottle

23. Tamra Sindoora