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Research Article

PHARMACEUTICS & THERAPEUTICS OF KAJJALI (BLACK SULPHIDE OF MERCURY) - A REVIEW

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ABSTRACT

Rasashastra has been using herbo-mineral metallic preparations in therapeutics since decades. Rasashastra texts does not advised single use of Mercury because of its two distinct properties namely quickness & liquid state. To surmount these intricacies Scholars mentioned certain mercury bonding procedures (Kajjali Bandha), one of them is Kajjali Bandha. The fine black powder obtained from pounding of mercury with metals, sulphur & other substances, without the addition of any liquid substance is known as Kajjali. Most of Rasashastra formulations used Kajjali as fundamental ingredient. Different Khalvi Rasayana (drugs prepared in mortar & pestle) has been reviewed to identify percentage of Kajjali in single dose. Present article is focused on manufacturing, analysis & therapeutics & toxicological aspect of Kajjali.

KEY WORDS: Kajjali, Khalvi Rasayana, Kajjali Bandha, Rasashastra

INTRODUCTION

Ayurveda has used mineral and herbo-mineral preparations in the therapeutics since time immemorial. As Ayurved pharma is upcoming field in international market, it is now reaching to each and every part of world. About 80% of the Rasa Kalpas used are Khalvi Rasayana in which Kajjali is key ingredient. Kajjali is also used in preparation of different dosage forms like Parpati, Kupipakwa Rasayana & Pottali. So importance of Kajjali being basic ingredient is untouched. Kajjali was well known since ancient period & used in Rasashastra from decades. Description of Kajjali was given first by Nagarjuna in 8th century [1]. Though Kajjali (Black Sulphide of Mercury) is familiar to European countries since 10th century but they were not conversant about its medicinal properties.

Mercury is core ingredient of Rasaushadhis (herbo-mineral preparations). It has properties like Chanchalyatwa (quickness), Dravatva (only metal in liquid state) which made it unsuitable to use it in natural form [2]. To overcome these difficulties scholars of Rasashastra mentioned the procedures to control the unsteadiness of mercury are known as Rasa Bandha (Mercurial Bonds). There are total 25 types of Parada Bandha (Mercury bonding procedures) mentioned in Rasa Ratna Samucchaya [3]; one of them is Kajjali Bandha. Trituration of purified Mercury and Sulphur till formation of black powder (Kajal) is called Kajjalika. Kajjali was firstly used in preparation of Rasa Parpati by Chakrapanidatta [4]. It is used in the preparation of various dosage forms like Khalvi Rasayana, Parpati, Kupipakwa Rasayana & Pottali Rasayana. In this study an attempt is made to congregate pharmaceutical, analytical & therapeutical importance of Kajjali under one roof including its toxicological aspect.

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Definitions of Kajjali

The fine black powder obtained from pounding of mercury with metals, sulphur & other substances, without addition of any liquid substance is known as *Kajjali* [5]. *Kajjali* is also called *Kajjal* or *Kajjalika*. Sulphur can be added to mercury either in equal quantity or half quantity and can also be added as *dwiguna*, *triguna*, *chaturguna*, *shadguna*, *ashtaguna*, *shodashguna* [6]. (i.e.1:1, 1/2, 2, 3, 4, 5, 6, 8, 16 parts). In the preparation of *Kajjali* purified Mercury and Sulphur are constantly triturated under pressure at atmospheric temperature; initially the silvery white mercury and greenish yellow sulphur gradually turn into black mixture. Tiny mercuric particles absolutely disappear. At the end amalgam of Mercury - Sulphur resemble '*Kajjal*' (naturally occurring Collyrium) [7].

Steps Involved In Preparation of Kajjali

- Purified Mercury and Sulphur are triturated in mortar & pestle.
- As time proceeds, mixture changes to blackish yellow colour in which mercury particles are visible.
- After some time the whole mixture get converted in to black compound.
- As trituration process continues, mixture converted into fine, black, smooth, lusterless, *Kajjal sadrusha* (Collyrium) powder.
- This compound passes *Rekhapurnatva* & *Varitaratva* tests mentioned in Rasashastra texts.

Types of Kajjali

There are different types of *Kajjali* according to ratio of Mercury & Sulphur [6]. Details are given in Table no. 1

Murchana

Murcchana is the processes in which mercurial compounds develop definite *Vyadhighatakatva* property (Definite disease curing capacity) or potency. In this mercury with or without sulphur converts in such a suitable compound, from which it could be used internally in body for curing diseases even without being reduced

/converted to ashes [8]. Through this process mercury & mercurial compounds develops definite disease curing capacity & after *Murcchana* mercury doesn't return to its original form.

Kajjali is *Sagandha* (with Sulphur) & *Niragni* (without fire) *Murcchana*. *Sagandha Murcchana* of Mercury doesn't create any untoward effect on body even if its intake is continued after the disease is cured [9].

Kajjal Bandha

Bandha means to bind in various ways in which Mercury can be converted into solid or compound form. Bonding processes have been described in texts, in which Mercury is combined either with Sulphur, plant, animal products or oceanic products. *Kajjali* is a type of Mercury bonding process. Mercury obtained from its various ores is subjected to purification process. Purified Mercury cannot be used due its two distinct properties namely *Chanchalya* (quickness) & *Durgrahatva* (Difficult to embrace) which make it difficult to assimilate in body. So it is necessary to convert mercury in bonded form to enhance its therapeutic efficacy [3].

Analysis of Kajjali

Prepared *Kajjali* can be assessed by *Ayurvedic* as well as modern parameters

Ayurvedic Parameters

- *Shabda* – Not Applicable
- *Sparsha* – *Shlakshna* [10] (Soft fine powder), *Rekhapurnatva*
- *Rupa* – Black [11], lusterless [12]
- *Rasa* – Not Applicable
- *Gandha* – Not Applicable

Modern Parameters

- Total Ash
- Acid Insoluble Ash
- Water Soluble Ash
- Moisture Content
- XRD (X-ray Diffraction Studies)
- SEM (Scanning Electron Microscopy)
- ICP-AES (Inductively coupled plasma Atomic Emission Spectroscopy)

- AAS (Atomic Absorption Spectroscopy)
- EDAX (Energy Dispersive X-Ray Analysis)

Therapeutic Uses of Kajjali

When *Kajjali* is consumed especially with *anupana* (Vehicle) it cures all types of diseases. It normalizes the *Tridosha* and has *Vrishya* (aphrodisiac) property [13]. Enumerable formulations, small drug dose, rapid action, desired results, long lasting effects, palatability are specialties of *Kajjali*. [14]. Rasarnava coated that all mercurial preparations penetrates through skin, muscle, bones and later in bone marrow. In this context *Kajjali* has similar 'Vedhana' action [15].

Therapeutic uses of *Kajjali* [16] mentioned by Sadanand Sharma in his text *RasaTarangini* can be summarized in Table 1 *Vaidya* Vishwanath Dwivedi has mentioned *Kajjali* Formulations [17] which is summarized in Table 2.

Bharat Bhaishajya Ratnakara has mentioned *Kajjali* described by Nighanturatnakara which is advised in treatment of *Vrushanvrudhi*

(hydrocele) [18] & Rasachandanshu has mentioned its therapeutic use in *Upadansha* (Syphilis).

Kajjali Rasayana

Kajjali is prepared from 1 part purified Mercury and 1 Part purified Sulphur. Honey, Ghee, *Shilajeet* and *Amaltas* powder should be taken in equal quantity. The mixture is advised in dose of 2 g. per day. When it will be taken for a month, it works as anti-ageing [19].

Percentage of Kajjali in Different Khalvi Rasayana Formulations

Common *Khalvi Rasayana* formulations mentioned in different *Rasashastra* texts reviewed for percentage of *Kajjali* and summarized in Table no 4 & conclusions drawn are as follows

- Total average percentage of *Kajjali* is minimum dose : 30.92 mg.
- Total average percentage of *Kajjali* in maximum dose : 53.90 mg.
- Total average percentage of *Kajjali* in formulation : 24.52 mg.

Table 1: Types of Kajjali (Black Sulphide of Mercury)

Ratio (Hg : S)	Nomenclature	Ratio (Hg : S)	Nomenclature
1 : 1/6	<i>Sadamsa</i>	1 : 1 ½	<i>Sardha Samaguna</i>
1 : ¼	<i>Chaturthamsa</i>	1 : 2	<i>Dviguna</i>
1 : 1/3	<i>Tritiyamsa</i>	1 : 3	<i>Triguna</i>
1 : ½	<i>Ardhaguna</i>	1 : 4	<i>Chaturguna</i>
1 : 1	<i>Samaguna</i>	1 : 5	<i>Panchaguna</i>
1 : 1 ¼	<i>Sapada Samaguna</i>	1 : 6	<i>Shadguna</i>

Table 2: Therapeutic uses of Kajjali

<i>Disease</i>	<i>Type of Kajjali</i>	<i>Anupana</i>
<i>Vamana</i> (Vomiting)	<i>Samabhag Kajjali</i>	Powder of Cardamomam, Piper nigrum, Camphor, Mesua ferrea, Nagarmotha, Clove and Bermingi with Honey
<i>Trisha – Vaman</i> (Thirst – Vomiting)	<i>Dwiguna Kajjali</i>	Powder of <i>Karpura</i> (Camphor), <i>Khus</i> , <i>Maricha</i> (<i>Piper nigrum</i>), <i>Shailaya</i> (<i>Parmelia Perforate</i>), Sugar & water.
<i>Bahya – Abhyantar Vidhridhi</i> (Internal & External) Abscess	<i>Dwiguna Kajjali</i>	Decoction of <i>Varunadi Gana Dravya</i>
<i>Bahya – Abhayantar Vidhridhi</i> (Ext. Int. Abscess)	<i>Dwiguna Kajjali</i>	<i>Shigru</i> (Drum Stick Plant) and Honey
<i>Visarpa</i> (Erycephalus)	<i>Dwiguna Kajjali</i>	<i>Karavellaka</i> (Bitter Gourd) Juice.
<i>Swasa – Kasa</i> (Asthma and Bronchitis)	<i>Dwiguna Kajjali</i>	Juice of <i>Vanatulasi</i> (<i>Ocimum sanctum</i>) leaves and powders of <i>Yastimadha</i> (<i>Glyceriza glabra</i>), <i>Vasa</i> (<i>Adhatoda vasaka</i>), <i>Haritaki</i> (<i>Terminalia chebala</i>), <i>Behada</i> (<i>Terminalia belerica</i>) <i>Pippali</i> (<i>Piper longum</i>)
<i>Ajirna</i> (Indigestion)	<i>Samabhag Kajjali</i>	<i>Nimbukamla</i> (Citric Acid) <i>Nagara</i> (Dry Ginger) and <i>Pippali</i> (<i>Piper longum</i>)
<i>Swapnameha</i> (Night Fall)	<i>Samabhag Kajjali</i>	Powders of <i>Eaila</i> (Cardamom), <i>Ahiphena</i> (<i>Papaver somniferous</i>), <i>Karpura</i> (Camphor), <i>Jatiphala</i> (<i>Myristica fragrance</i>), <i>Lavang</i>
<i>Charmadal</i> (Warts)	<i>Samabhag Kajjali</i>	<i>Shinshapa</i> Oil or butter ointment is locally applicable
<i>Kandu – Pama</i> (Scabies – Itching)	<i>Samabhag Kajjali</i>	<i>Dhatura Metal</i> leaves mixed with <i>Chitrak</i> (<i>Plumbaga zelenica</i>) and advised application externally
<i>Gandamalika</i> (Cervical lymphadenopathy)	<i>Samabhag Kajjali</i>	Mixed with <i>Saindhava</i> (Rock Salt) and triturated with <i>Ravi Dughdha</i> (latex of <i>Calotropis procera</i>) use : local application
<i>Vat Rog – Sarva Amaya</i> (<i>Vata</i> diseases and all types diseases)	<i>Samabhag Kajjali</i>	<i>Triphala</i> powder (<i>Terminalia chebula</i> , <i>Emblia officinalis</i> , <i>Terminalia belerica</i> , <i>Guggulu</i> (<i>Commiphora mukul</i>), <i>Vatari Taila</i> (Castor Oil)
<i>Upadansha</i> (Syphilis)	<i>Dwiguna Kajjali</i>	Cow's butter
<i>Gajacharma</i> (Skin disorder)	<i>Samabhag Kajjali</i>	Cow's butter local application
<i>Madatyaya</i> (Alcoholism) mixed with	<i>Samabhag Kajjali</i>	Sugar and <i>Amla</i> (Juice of <i>Emblia officinalis</i>)
<i>Sannipataj Vyadhi</i>	<i>Samabhag Kajjali</i>	Juice of <i>Dhatura Metal</i> Seeds and <i>Trikatu</i> powder Used for <i>Nasya</i> (inhalation through Nasals)
<i>Vrana</i> (wounds) for healing and cleaning purpose, <i>Nadi Vrana</i> (Fistulated wounds) and all types of <i>Vrana</i> .	Kajjali Malahar - Samabhag Kajjali	Pure <i>Siktha</i> Oil, <i>Shuddha Mruddharshringa</i> (Pure litharge or PbO), <i>Kampilaka</i> (<i>Mellotus philipinensis</i>), <i>Vimalam</i> (Pure copper sulphate CuSo ₄ H ₂ O) all ingredients mixed together and triturated in mortal.

Table: 3 Kajjali Formulations

<i>Kajjali Kalpa</i>	<i>Dose</i>	<i>Disease</i>
<i>Priyangu Kajjali</i>	1 gm tds	All types of <i>Jwara</i> , <i>Raktapitta</i> & <i>Vatarakta</i>
<i>Kutaj Kajjali</i>	1 gm tds	<i>Jirna Atisara</i> & <i>Pravahika</i>
<i>Rudanti Kajjali</i>	1 gm tds	<i>Kasa</i> , <i>Shwasa</i> , <i>Vata-kapha Jwara</i> , <i>Raktapitta</i> & <i>Rajayakshma</i>
<i>Sudarshana Kajjali</i>	1 gm tds	<i>Sheeta Jwara</i> , <i>Angamarda</i> , <i>Pratishyaya</i> .
<i>Pushkarmoola Kajjali</i>	240-480 mg.	<i>Shwasa</i> , <i>Kasa</i>
<i>Kushtha Kajjali</i>	360 – 480 mg. qid	<i>Shwasa</i> , <i>Kasa</i> , <i>Parshwa Shoola</i> , <i>Pratishyaya</i>
<i>Madhuyashti Kajjali</i>	240-480 mg. tds	<i>Kasa</i> , <i>Parshwa Shoola</i> , <i>Pratishyaya</i> , <i>Shiro Vedana</i>

DISCUSSION

Kajjali plays a vital role in creation of *Rasaushadhis* (herbo-mineral preparations in *Ayurveda*). Various types of *Rasaushadhis* like *Khalvi*, *Kupipakwa*, *Parpati*, *Pottali* contains *Kajjali* as a key Ingredient.

Kajjali is prepared by continuous trituration process called as *Mardana Sanskara*. It is invariable to note that, constant and consistent pressurized trituration of mercury and sulphur has its definite role to play in properties of *Kajjali*. Trituration time and saturation of mercuric pearls with sulphur molecules is directly proportional to formation *Kajjali bandha*. Classical and traditional concepts at every stage should be followed, otherwise results may vary. *Mardana* procedure is used to mix all ingredients uniformly and super finely to enhance the specific property of processing drugs. *Kupipakwa*, *Parpati* and *Pottali Rasayana* uses the energy provided by external source while in preparation of *Kajjali* heat energy is obtained by *Mardana* (trituration process). This heat is used for obtaining *Sukshma* (Super fine), *Laghu* (lightness) *Vyavayi*, *Vikasi* properties in formulation [20].

Prepared *Kajjali* when assessed by modern parameters it proves the importance of Textual confirmatory tests like *Nischandratva*, *Rekhapurnatva* etc. Santhosh B et al in his study of *Kajjali* by SEM shows that particle

size of prepared *Kajjali* was in the range of 0.16-0.73 microns. This sample possesses maximum number of smaller size particles which in turns proves the *Rekhapurnatva* of *Kajjali* mentioned in texts [21]. Bandari Shrinivasulu et al observed very high concentration peaks of HgS (Metacinnabar) in XRD study of *Kajjali* & structure of HgS was found to be cubic. Free sulphur was also found in compound. The absence of free Mercury confirms *Nischandratva* test [22]. Bandari Shrinivasulu et al in his another study shows the surface of the *Kajjali* grains was irregular and sharp having approximately size of 3 μm to 10 μm . The presence of trace elements can be detected by XRD & EDAX [23].

Mote D in his study documented that *Samaguna Kajjali* has not shown any signs of sub-acute toxicity by oral route in male albino rats at the dose level of 45mg/kg of body weight which was confirmed on the basis of histo-pathological parameters [24]. According to Table no. 4 common *Khalvi Rasayanas* contains *Kajjali* in average weight of 24.52 mg. By comparing this with above study it can be concluded that none of the above mentioned formulations cause any kind of toxicity when prepared as per SOP mentioned in Ayurved texts. *Kajjali kalpas* are found to be effective in diseases of almost all *srotasas* (Systems). The effect may be multi dimensional, free radicals scavenging, antioxidant, antimicrobial, catalytic, pro-enzymatic, immunomodulator activities [25].

Table 4: Percentage of Kajjali in Different Khalvi Rasayana Formulations

Name of Preparation	Type of Kajjali	Recommended Dose (Min & Max.)	Quantity of Kajjali in per dose	Percentage of Kajjali in preparation
Agasti Sutraj Ras (Sangrahani)	Samabhaga	30mg – 120mg	7.5mg –30mg	25%
Agnikumar Ras (Yakrutpliha)	Samabhaga	60mg – 240mg	10mg–40mg	16.6%
Agnitundi Ras (Agnimandya)	Samabhaga	30mg – 120mg	1.87mg-3.75mg	6.24%
Ashwakchuki Ras (Shwasa)	Samabhaga	120mg –180mg	30 – 60 mg	16.66%
Anand Bhairav Ras (Shwasa)	Samabhaga	125 mg	31.25 mg	25%
Arogyavardhini (Kushtha)	Samabhaga	240mg – 720mg	13.32–39.96 mg	5.5%
Ichhabhedhi Ras (Udara)	Samabhaga	120mg – 360mg	30 – 90 mg	25%
Shwaskuthar Ras (Shwasa)	Samabhaga	120mg –240mg	9.6 – 19.2 mg	8%
Kamdheni Ras (vandyatwa)	Samabhaga	120mg – 360mg	45 – 90 mg	25%
Kushtakutur Ras (Kushtha)	Samabhaga	120mg – 40mg	25.24 – 50.49 mg	10.52%
Krumimudgar Ras (Krumi)	Dwiguna	250mg – 500 mg	35.7 – 71.4 mg	14.28%
Krumikuthar Ras (Krumi)	Samabhaga	375mg –750mg	49.98–99.97 mg	13.33%
Ekangvir Ras (Pakshagat)	Samabhaga	60mg – 120mg	10.90–21.81 mg	18.18%
Gandmala Kandan Ras (Gandmala)	Ardhaguna	360mg – 720mg	15.18-30.38 mg	4.22%
Grahani Kapat Ras (Grahani)	Samabhaga	60mg – 180mg	18.86-32.72 mg	18.18%
Chandrakala Ras (MutraKrucha)	Dwiguna	60mg – 240mg	12 – 48 mg	20%
Trimurti Ras (Medorog)	Samabhaga	120mg – 240mg	79.99–159.98 mg	66.66%
Narach Ras (Gulma)	Samabhaga	240mg – 480mg	68.56-137.13 mg	28.57%
Nityanand Ras (Shlipada)	Samabhaga	120mg – 360mg	13.33–26.66 mg	7.40%
Pratapankeshwar Ras (Sutikajwar)	Samabhaga	240mg – 480mg	14.11-28.23 mg	5.88%
Pradarantak Ras (Pradar)	Samabhaga	120mg – 240mg	30 – 60%	25%
Pradararipu Ras (Pradara)	Samabhaga	240mg – 480mg	39.98-79.96 mg	16.66%
Bolbaddh Ras (Pradara)	Samabhaga	240 mg – 280 mg	79.99–159.98 mg	33.33%
Mahavatvidhvasan Ras (Vatvyadhi)	Samabhaga	60mg – 120mg	7.74-15.48 mg	12.90%
Chandramrut Ras (Kasa)	Samabhaga	60mg – 120mg	30 – 60 mg	50%
Sutsekhar Ras (Amlapitt)	Samabhaga	120mg – 240mg	14.11–28.23 mg	11.76%
Hridayarnav Ras (Hidroga)	Samabhaga	120mg – 240mg	79.99-159.99 mg	66.66%
Lakshmi Vilas Ras (Jwaar)	Samabhaga	125mg – 250mg	25 – 50 mg	20%
Shwas Kas Chintamani (Shwasa)	Dwiguna	62.5mg – 125mg	16.16–32.32 mg	25.86%
Smrutisagar ras (Apasmara)	Samabhaga	125mg – 125mg	41.66–41.66mg	33.33%

Kajjali own properties like *Rasayana* (anti-ageing) & *Yogavahi* (as catalyst) [26], *Jantughnata* (anti-microbial), *Sarva-amayahara* (broad spectrum) [26]. These properties of *Kajjali* are essential to enhance efficacy & potency in prepared drug. *Yogvhitwa* property has importance in pharmacokinetics of drug as it drags whatever is mixed with it towards the target tissue down in to the deeper and most inaccessible parts of

the system. When mixed with other medicines they become more potent and act in low doses. *Kajjali* increases the bio-availability of drug which helps to obtain greater efficiency of drug. *Kajjali* has property of *Rasayana* (Rejuvenating) *Karma*. It prevent diseases, delays the ageing process and works as a preventive medicine which is the basic concept of Ayurveda.

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