



## X-RAY DIFFRACTION ANALYSIS OF SAMAGUNA BALIJARITA KAJJALI (BLACK SULPHIDE OF MERCURY)

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### ABSTRACT

In the system of Ayurveda, mercurial medicines are performing major role in the treatment of various diseases. Scholars also described Rasachikitsa as the best treatment. The Present work illustrates the chemical characteristics of Kajjali obtained by the well-defined processes in the Rasashastra text, which is prepared with the equal quantities of purified Parada and Gandhaka. X-Ray Diffraction is a technique for detecting the presence of diffraction peaks corresponding to various d-spacing and 2-Theta positions, which are characteristics of a given material. Kajjali analyzed using X-ray Diffraction (XRD) showed that, it contains strongest peaks of HgS (Metacinnabar) present at 2-Theta scale between 26.5, 30.5, 43.8, 51.8 degrees. The d-spacing of HgS were present at 3.4, 2.95, 2.08, 1.8 and the structural and chemical characteristics of the HgS found as cubic. The free S (Sulphur) also found 23, 27.8, 28.8, 30.0 degrees in 2-Theta scale. The d-spacing of Sulphur at 3.88, 3.33, 5.19, 3.13 and the structural and chemical characteristics of the Sulphur found as Orthorhombic.

**Keywords:** Samaguna balijarita Kajjali, Black Sulphide of Mercury, Structure and Chemical Characters, X-Ray Diffraction Study

### INTRODUCTION

The purified Parada (mercury) is ground well with, either metals like Suvarna (gold) or with purified Gandhaka (sulphur) without adding any liquid till it becomes uniform mixture. This fine mixture is very soft and resembles “Kajjala” (collyrium, a black soft substance which is applied over the edges of eyelids), is called Kajjali<sup>1</sup>. It is added to different Parada yoga (mercurial formulations) and such formulations are also called as Kajjali bandha<sup>2</sup>. It can be prepared by adding half the quantities, equal quantities, double quantities etc., of Gandhaka to Parada<sup>3</sup>. By the internal administration, Kajjali cures many disorders, pacifies the Tridosha (disorder of the three humours of the body) and acts as Vrushya (an aphrodisiac). Further, it is also used as Sahapana (taking together with the medicine) and Anupana (a vehicle taken after the medicine)<sup>4</sup>. In addition to above, it is also one of the prime ingredient in various Rasayoga (herbo-mineral formulations)<sup>5</sup>.

In the present study, Kajjali was prepared with the equal parts of purified Parada and Gandhaka. These were procured from the local market of Vijayawada, Andhra Pradesh, India and all the herbal and mineral material were thoroughly screened by experts of Rasashastra, Dr.N.R.S.Govt.Ayurvedic College, Vijayawada based on the Grahya lakshanas (to be taken or accepted characters) mentioned in the Ayurvedic classics.

Structural and chemical characteristics of Kajjali by X-Ray Diffraction was carried out in the Department of Laboratory of X-ray Crystallography, Indian Institute of Chemical Technology (IICT), Tarnaka, Uppal Road, Hyderabad.

### MATERIALS AND METHODS

In the present study includes preparation of Kajjali and its analytical study through X-Ray Diffraction.

The raw materials (viz., Parada and Gandhaka) were purified before made them in to Kajjali.

#### Purification of the Ingredients

##### Purification of Parada (Mercury)

Parada (250gm) is taken with Nagavalli svarasa (50ml of juice of betel leaf), Ardraka svarasa (50ml of ginger juice) and Trikshara (50gm each of alkalies of Yava, Sarja, Tankana) in a clean Khalva yantra (mortar and pestle) and grind eight hours daily for three days<sup>6</sup>. The obtained material was washed with the help of lukewarm water for several times until clean and clear Parada is obtained (Figure 1). Approximately 230gm Parada was obtained after this purification process.

##### Purification of Gandhaka (Sulphur)

A wide mouth Ghata (earthen vessel) is taken and filled with 2 litres of Gokshira (Cow's milk) and 150 ml of Goghrita (Cow's ghee) then the mouth of vessel is covered by a cloth and tied by iron wire. Coarse powder of Gandhaka (500gm) spread upon the cloth and closed with another earthen vessel by placing in up-down position. The edges of both the vessels are sealed with Multani mitti (Fuller's earth.) smeared cloth for ten times and allowed it to dry under sunlight. This Yantra (apparatus) is kept inside a pit (1.5 feet) beneath the surface of soil in such a way that, the brim of the vessel should be at ground level. Empty space of the pit around the apparatus was filled by soil. Cow dung cakes were kept on above said brim of the vessel and set on fire. The Sulphur, after melting by fire flows down through cloth into the vessel, which contained milk and ghee. After Svngasita (self-cooling), the apparatus is taken out from the pit and Sandhibandhana (seal) was opened carefully.

Purified Gandhaka (470gm, in granules form) was collected from the bottom of vessel and washed with hot water<sup>7</sup> (Figure 2).

**Preparation of the Kajjali**

Purified Parada and Gandhaka were taken in equal quantities (250gm each) in a Khalva yantra and Mardhana (grinding) was done until it becomes very fine black powder, like collyrium and the dazzling particles of mercury completely disappear<sup>8</sup> (Figure 3). Approximately 470gm of Kajjali was obtained.

**X-ray Diffraction (XRD) Study**

X-ray diffraction (XRD) is a versatile, non-destructive technique that reveals detailed information about the chemical composition and crystallographic structure of natural and manufactured/ synthetic materials<sup>9</sup>.

X-Ray Diffraction study is a powerful tool for detecting the presence of various phases in a given sample. The basic principle of the phase analysis using powder XRD

technique lies the presence of diffraction peaks corresponding to various inter planar ( $d_{hkl}$ ) spacings which are characteristics of a given material. The relative intensities of various peaks occurring at different d-spacing are also different for different phases.

**Analytical Procedure**

The sample preparation for the analysis was done using standard XRD procedure. The powder was then spread onto a double-side tape with a spatula, and then placed on a cavity with plastic holder. Care was taken to fill the powder uniformly into the mount. It was exposed to x-ray beam of intensity 35KV and 20MA. All the peaks were recorded on the chart, and the corresponding  $2\theta$  values were calculated. Results are summarized in figure no.4 and Table 1.

The strongest peak identified in Kajjali was HgS and other phases were identified as Sulphur.

**Table 1: Kajjali showing 2  $\theta$  vs d-spacing values**

S.No.	Position (2Th)	Height (cts)	d-spacing (Å)	Chemical structure
1.	23	600	3.88	Sulphur
2.	26.5	1250	3.4	Metacinnabar
3.	27.8	370	3.33	Sulphur
4.	30.5	250	2.95	Metacinnabar
5.	43.8	400	2.08	Metacinnabar
6.	51.8	350	1.8	Metacinnabar
7.	28.8	180	5.19	Sulphur
8.	30.0	150	3.13	Sulphur
9.	70	100	1.35	Metacinnabar
10.	72	90	1.3	Metacinnabar



**Figure 1: Purification of Parada (Mercury)**



Figure 2: Purification of Gandhaka (Sulphur)



Figure 3: Preparation of Kajjali

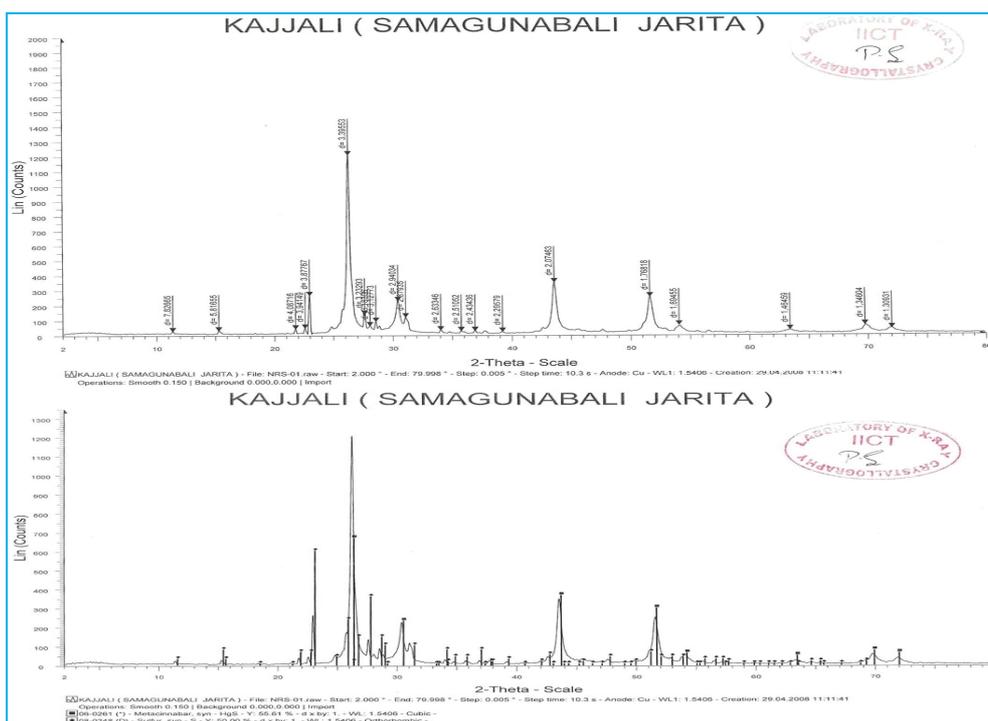


Figure 4: XRD Pattern of Kajjali

## RESULTS

In XRD of Kajjali shows very high concentration peaks of the HgS (Metacinnabar), structure of the HgS is Cubic.

In XRD Graph of Kajjali d-spacing [Å] values of major peaks are compared with standard JCPDS card table for Mercuric Sulphide CARD and Sulphur. Hence, this card studied for crystal structure of the sample as Cubic and Orthorhombic (Figure. 5) which represents Mercuric Sulphide (HgS) and free Sulphur (S), respectively.

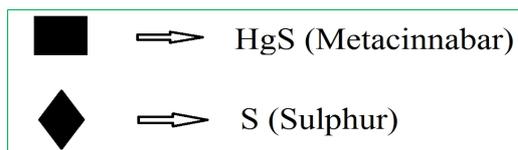


Figure 5: Structures of the Kajjali containing compounds

The X-ray diffraction pattern confirms that the prepared Kajjali resembles the characteristics of compound Mercuric Sulphide (HgS), which finds the cubic crystal structure. The XRD method illustrates the structure of Kajjali for the presence of Mercuric Sulphide in the preparation.

## CONCLUSION

X-Ray Diffraction is a technique for detecting the presence of diffraction peaks corresponding to various d-spacing and 2-Theta positions which are characteristics of a given material. Kajjali analyzed using X-ray Diffraction (XRD) shows strongest peaks of HgS (Metacinnabar) present at 2-Theta scale between 26.5, 30.5, 43.8, 51.8 degrees. The d-spacing of HgS were present at 3.4, 2.95, 2.08, 1.8 and the structural and chemical characteristic of the HgS found as cubic. The free S (sulphur) also found 23, 27.8, 28.8, 30.0 degrees in 2-Theta scale. The d-spacing of Sulphur at 3.88, 3.33, 5.19, 3.13 and the

structural and chemical characteristic of the Sulphur found as Orthorhombic.

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## REFERENCES

1. Rasaratna Samuccaya Translated by Dr. Ashok. D. Satpute, Published by Chaukhamba Sanskrit Pratishthan, Delhi. Reprint :2006; Chapter 8/5, p.181
2. Rasaratna Samuccaya Translated by Dr. Ashok. D. Satpute, Published by Chaukhamba Sanskrit Pratishthan, Delhi. Reprint :2006; Chapter 11/75, p.261
3. Sadananda Sharma, Rasatarangini, edited by Kashinatha Shastri, Motilal Banarasidas Publications New Delhi, Reprint 2004, Taranga 6/108-111, p. 124-125
4. Sadananda Sharma, Rasatarangini, edited by Kashinatha Shastri, Motilal Banarasidas Publications New Delhi, Reprint 2004, Taranga 6/12, p. 126
5. The Ayurvedic Formulary of India Part-1, Second Edition, Published by the Ministry of Health and Family Welfare, Department of Indian System of Medicine and Homeopathy, Government of India. p. 255-287.
6. Sadananda Sharma, Rasatarangini, edited by Kashinatha Shastri, Motilal Banarasidas Publications New Delhi, Reprint 2004, Taranga 5/34-35, p. 81
7. Sadananda Sharma, Rasatarangini, edited by Kashinatha Shastri, Motilal Banarasidas Publications New Delhi, Reprint 2004, Taranga 8/13-17, p. 177
8. Sadananda Sharma, Rasatarangini, edited by Kashinatha Shastri, Motilal Banarasidas Publications New Delhi, Reprint 2004, Taranga 6/108-111, p. 124-125
9. <http://www.panalytical.com/index.cfm?pid=135> (accessed on 12<sup>th</sup> March 2012)

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