Original Article

Physicochemical characterization of *Shadguna Balijarita Makaradhwaja*: A preliminary study

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Abstract

Background: *Makaradhwaja*, a herbomineral preparation, is a popular aphrodisiac and rejuvenator in traditional medicine. It is prepared from purified gold, mercury, and sulphur in different proportions by the application of gradually increasing heat in modified electrical muffle furnace (*Valuka Yantra)*. To find out major and minor trace elements and structural composition of *Makaradhwaja*, its chemical characterization is needed. **Aim:** This study aims to develop preliminary physicochemical profile of *Shadguna Balijarita Makaradhwaja* (SBM). **Materials and Methods:** Physicochemical characterization of *Shadguna Balijarita Makaradhwaja* was carried out by adopting various techniques, viz. X-ray diffraction, inductively coupled plasma optical emission spectrometry (ICP-OES), and Fourier transform infrared spectroscopy to determine structure and contents. **Results and Conclusion:** *Shadguna Balijarita Makaradhwaja* contains 12131 ppm of gold in inductively coupled plasma optical emission spectrometry study. FTIR study revealed few organic compounds. Structurally, it is a mercuric sulfide having an empirical formula HgS.

Keywords: Cinnabar gold, *Kupipakwa Rasayana*, *Makaradhwaja*, mercuric sulfide

Introduction

Rasashastra, a branch of *Ayurveda* pharmaceutics, mainly deals with mercurial, herbomineral and herbometallic medicinal preparations. Due to its therapeutic efficacy, quicker action, and minimum dosage, it is the most popular branch in the Indigenous system of medicine.[1] Mercurial preparations are the basic ideology of this stream. Different forms of mercurial preparations were mentioned in the classical texts of *Rasashastra*; *Kupipakwa Rasayana* is one of them. These *Kupipakwa Rasayana* differs due to its proportion of mercury and sulphur. The concept of *Balijarana* (heat treatment to purified mercury in the presence of purified sulphur) is one of the prime concepts.[2] In the contexts of *Balijarana*, *Shadguna Balijarana* is mentioned to be more potent than *Samaguna* and *Dwiguna*.[3] However, among all *Kupipakwa Rasayanas* due to gold content, *Makaradhwaja* is therapeutically more potent and popular. Classical texts of *Ayurveda* mentioned *Makaradhwaja* as a drug of choice in many disorders such as *Sandhivata* (arthritis), *Kushtha* (skin disorders), *Madhumeha* (diabetes), *Daurbalya* (fatigue) and used as major *Vajikarana* (aphrodisiac) and *Rasayana* (rejuvenator) agent.[4] Few scholars reported its therapeutic and experimental studies.[5-10] As it contains metal-like gold and heavy metal-like mercury, its structural and chemical analysis is needed, which will help in the pharmacological and therapeutic assessment of the compound. Here, in the present study, *Shadguna Balijarita Makaradhwaja* was prepared and its physicochemical characterization was carried out by using sophisticated techniques such as X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR) and Inductively coupled plasma optical emission spectrometry (ICPOES).

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Materials and Methods

Preparation of *Makaradhwaja*

Test drug *Makaradhwaja* was prepared as per the classical text reference[11] in the departmental laboratory. Raw

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Material *Swarna* (gold) was purchased from local market, and *Hingula* (cinnabar) and *Gandhaka* (sulfur) were collected from the Pharmacy of Gujarat Ayurved University, Jamnagar [Table 1]. Gold was subjected to *Shodhana*[12] and its foils were prepared. Cinnabar was processed to *Shodhana* (purification),[13] and *Parada* (mercury) was procured from its sublimation by using *Nada Yantra* method.[14] Powder of cinnabar was spread over the cotton cloth and wrapped. The wrapped cloth was put inside the earthen pot and ignited, immediately *Nada* (big earthen vessel) was kept over earthen pot. After 24 h, evaporated mercury was found coated at the inner surface of *Nada* and Mercury was collected by rubbing the inner surface of *Nada*. *Gandhaka* (sulfur) was subjected to *Shodhana* by melting it and pouring in cow milk and continuously heated in the same milk for 3 h.[15] Processed gold foils, mercury, and sulfur were taken in ratio of 1:8:48 in weight. Amalgamation was done by adding gold foils to purified mercury. Fine lusterless powder of black sulfide of mercury (*Kajjali*) was prepared by triturating purified sulfur with above-prepared amalgam. *Kajjali* was levigated with juice of *Aloe barbadensis* and juice of flowers of *Hibiscus rosa sinensis* for 3 h consecutively and the levigated *Kajjali* was dried. The fine powder was filled in seven-layer mud-smeared cotton cloth wrapped glass bottle (*KachaKupi*) and heated for 12 h [Table 2]. The heat was provided in controlled manner and gradually increasing temperature in modified electrical muffle furnace (Modified *Valuka Yantra*), i.e., mild heat100°C to 250°C for 2.5 h, *Madhyamagni* (moderate heat) 250°C to 450°C for 4.5 h, and *Tivraagni* (strong heat) 450°C to 600°C for 5 h. After the desired characteristic features of product

Table 1: Quantity of Ingredients use for preparation of *Shadguna Balijarita Makaradhwaja (SBM)*

Gold	Mercury	Sulfur	Juice of *Aloe barbadensis*	Juice of flowers of *Hibiscus rosa sinensis*
5 g	40 g	240 g	75 mL	75 mL
Results after preparation (Average)				
Sample	**Heat duration (h)**	**Weight of *Kajjali* (g)**	***Makaradhwaja* (g)**	**Flame duration (h)**	**Percentage of *Makaradhwaja* obtained**
SBM	12	290.50	42	2:05	91.31

SBM: *Shadguna Balijarita Makaradhwaja*

Table 2: Heating pattern of *Shadguna Balijarita Makaradhwaja*

Time (h)	Temperature setting (°C)	Temperature recorded (°C)	Observations
00:00	100	37	Switch on the furnace
00:30	150	102	Slight sulfur aroma was smelt at the glass bottle mouth white fumes were seen
01:00	200	148	Fumes turns slightly yellowish
01:30	250	202	Fumes turns slightly yellowish
02:00	250	251	Melting of *Kajjali* started and yellowish fumes continued
02:30	300	258	Melting of *Kajjali* with yellowish fumes continued
03:00	300	305	Yellowish color deposition at neck of the bottle
03:30	350	302	*Kajjali*-semi-liquid form, yellowish fumes increased
04:00	350	347	*Kajjali*-molten and yellowish fumes increased
04:30	350	352	*Kajjali*-molten and yellowish fumes increased
05:00	350	356	*Kajjali*-molten and yellowish fumes increased
05:30	400	348	Complete molten *Kajjali* and yellowish fumes increased
06:00	450	403	Yellowish fumes increased, stickiness was found inside the glass bottle
06:30	450	452	Profuse dark yellowish fumes started
07:00	475	454	Fumes disappeared and reddish blue-colored flame was seen
07:30	475	472	Flame increases gradually
08:00	500	479	Flame increases to about 4-5 inches height
08:30	500	501	Flame gradually decreased and slight sulfur deposit found at the neck of the glass bottle. Red tinge at the bottom of the glass bottle was also observed
09:00	550	505	Slight bluish flames persisting at the neck of the glass bottle and red tinge at the bottom was gradually increased
09:30	550	552	Flame disappeared, bottom of the glass bottle was found bright red, cold iron rod test and copper coin test were found positive. Corking was done immediately at 9:10 h
10:00	600	553	Self-cooling
10:30	600	599	
11:00	600	598	
11:30	600	604	
12:00	Stop	599	

preparation, mouth of glass bottle was sealed; furnace was switched off and subjected for self-cooling. Highest recorded temperature was 600°C.[16] Sublimed product was collected at neck of glass bottle [Figure 1]; it was powdered and used for further analysis [Figure 2]. The prepared *Shadguna Balijarita Makaradhwaja* was designated as SBM.

Structural and chemical characterization of *Makaradhwaja*

Physicochemical analysis of prepared SBM was done in pharmaceutical laboratory, XRD, ICPOES, and FTIR of SBM were carried out for determination of structural characterization of SBM.

Observations

Physicochemical analysis

SBM was found tasteless, odorless, smooth, and bright red colored on physical examination [Table 3].

Characterization by X-ray diffraction

Peaks of mercury sulfide were observed in XRD of SBM. No any extra diffraction peaks were observed. Structure of mercury sulfide was observed as hexagonal crystal and having empirical formula of HgS [Figure 3 and Table 4].

Characterization by inductively coupled plasma optical emission spectrometry

Major and minor trace elements in SBM were analyzed by adopting ICPOES. Elements such as mercury, sulfur, gold, lead, arsenic and cadmium were estimated for characterization of SBM. Major elements such as mercury and sulfur were examined as 757700.0 ppm and 107760.0 ppm, respectively, in SBM. 12131 ppm quantity of gold was found present in SBM along with 7.58 ppm of lead whereas, arsenic and cadmium were not detected [Table 5].

Characterization by Fourier transform infrared spectroscopy

FTIR spectra of the sample were taken in the region of 400–4000 cm^{-1}. Large number of functional groups were observed. Sharp peaks were obtained at and around 742.34, 1112.67, 1385.65, 1632.95, 2341.25, 2923.84, 2850.48, and 3431.97 in SBM [Tables 6-8 and Figure 4].

Discussion

Physical analysis showed that SBM is tasteless, odorless, and smooth as prescribed in *Bhasma* examination. It is having unique bright red color as mentioned for *Sindoora* in *Rasashastra*.

Table 3: Organoleptic characters of *Shadguna Balijarita Makaradhwaja*

Parameter	SBM
Taste	Tasteless
Color	Bright orange
Odor	Odorless
Touch	Smooth

SBM: *Shadguna Balijarita Makaradhwaja*

In XRD study, peaks only due to mercury sulfide with an empirical formula of HgS and hexagonal crystal structure were observed. Previous studies support this observation.[17-21] The presence of trace elements was not reflected in XRD pattern.

Figure 1: Sublimed product of *Shadguna Balijarita Makaradhwaja*

Figure 2: Powdered sample of *Shadguna Balijarita Makaradhwaja*

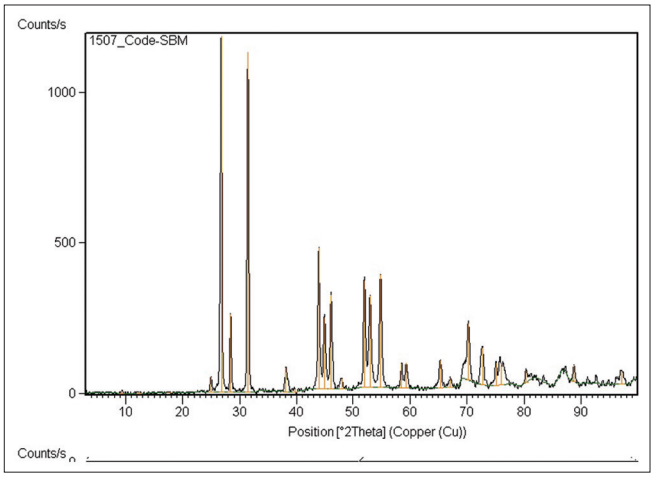

Figure 3: X-ray diffraction analysis of *Shadguna Balijarita Makaradhwaja*

Table 4: Peaks observed in X-ray diffraction analysis of *Shadguna Balijarita Makaradhwaja*

Pos. (°2Th)	d-spacing (Å)	Significance	Rel. Int. (%)	Height (cps)	FWHM (°2Th)	Crystallite size (nm)	Lattice strain	Crystal structure
9.3833	9.42547	0.9156	1.08	8.96	0.492	103.58	0.0262	-
12.3377	7.17427	0.8002	1.06	5.5	0.7872	49.39	0.0318	Cubic
17.6603	5.02221	1.0049	0.61	4.23	0.5904	46.39	0.0166	Orthorhombic
25.0168	3.55955	1.1501	3.73	51.59	0.2952	66.55	0.0058	Hexagonal
26.7597	3.33153	9.2186	100	1184.07	0.3444	53.58	0.0063	Orthorhombic
28.4084	3.14182	3.2311	18.81	259.84	0.2952	59.16	0.0051	Monoclinic
31.4347	2.84592	9.6638	95.53	1131.15	0.3444	46.26	0.0053	Orthorhombic
38.094	2.36235	1.5186	6.85	81.08	0.3444	39.1	0.0044	Orthorhombic
39.6866	2.27114	0.9621	0.77	10.67	0.2952	44.07	0.0036	Monoclinic
43.8604	2.06421	6.235	45.27	469.02	0.3936	30.46	0.0043	Orthorhombic
44.8478	2.02104	2.944	20.11	238.12	0.3444	34.21	0.0036	Orthorhombic
46.0544	1.97086	4.7337	30.28	313.72	0.3936	29.32	0.0040	Orthorhombic
48.0774	1.89255	1.3058	3.85	35.48	0.4428	25.22	0.0043	Hexagonal
51.9959	1.75877	3.9557	30.09	356.31	0.3444	30.61	0.0031	Hexagonal
53.0249	1.72704	4.6704	33.19	305.64	0.4428	23.48	0.0039	Monoclinic
54.8552	1.67367	4.4593	36.13	374.36	0.3936	25.81	0.0033	Orthorhombic
58.5344	1.57694	0.8069	5.01	83.11	0.246	39.58	0.0019	Tetragonal
59.3445	1.55733	0.8379	8.14	84.35	0.3936	24.53	0.0030	Hexagonal
65.3364	1.42826	3.1784	11.14	92.32	0.492	18.58	0.0033	Tetragonal
67.0724	1.39545	1.0818	4.43	30.6	0.5904	15.28	0.0039	Orthorhombic
70.3171	1.3388	3.3686	20.59	189.67	0.4428	19.91	0.0027	-
72.766	1.29967	2.6011	14.87	123.28	0.492	17.68	0.0029	Monoclinic
75.1569	1.26415	0.8886	5.53	76.35	0.2952	29.11	0.0017	-
76.0532	1.25147	0.8466	13.64	70.66	0.7872	10.87	0.0044	-
80.3368	1.19518	0.8487	3.4	40.22	0.3444	24.46	0.0018	Hexagonal
88.7757	1.10211	0.8837	3.94	54.38	0.2952	28.13	0.0013	-
97.2237	1.02673	1.0261	14.19	44.59	0.96	8.70	0.0037	Hexagonal
Average particle size and lattice strain						34.96	0.0060	

FWHM: Full width at half maximum

Table 5: Results of inductively coupled plasma optical emission spectrometry analysis of *Shadguna Balijarita Makaradhwaja*

Element	Wavelength	Instrument detection limit (ppm) mg/L	Observed value (ppm) in SBM	Observed value (%)
Gold (Au)	267.595	0.0310	12131.0	1.21
Lead (Pb)	220.353	0.0420	7.5845	Not detected
Arsenic (As)	193.696	0.0530	Not detected	Not detected
Sulfur (S)	181.975	-	107,760.0	10.78
Mercury (Hg)	253.652	0.0610	757,700.0	75.77
Cadmium (Cd)	228.802	0.002	Not detected	Not detected
Total				87.76

SBM: *Shadguna Balijarita Makaradhwaja*

It might be possible that trace elements were not present on the surface of crystal. XRD analysis of SBM showed its average particle size 34.96 nm which is of nanosize. This observation suggests that not only the *Bhasma* preparation procedures of Ayurvedic pharmaceutics are responsible for creating nanoparticles but also *Kupipakwa Rasa* preparation is responsible for the creation of such nano size medicines. SBM is found majorly in sulfide form which is considered as safe form of mercury; however, there are few peaks in XRD which represent minor oxide forms too. Whether they are solely or bound to herbal phytoconstituents or sulfide forms is not known and hence, it is difficult to interpret active role of oxide phase. SBM contains significant proportion of HgS which is dimorphic with two crystal forms. Red cinnabar (α-HgS, Trigonal) is the form in which mercury is most commonly found in nature. Black, metacinnabar (β-HgS), is less common in nature and adopts the zinc blende crystal structure.[22] Under atmospheric pressure, mercuric oxide has two crystalline forms: one is called montroydite (HgO) (orthorhombic) and the second is analogous to the sulfide mineral

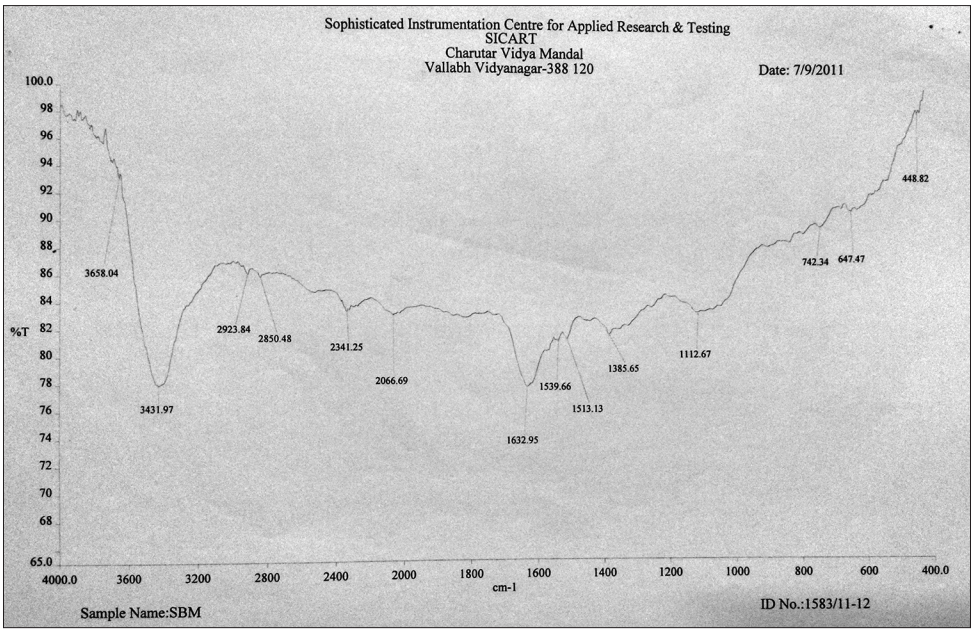

Figure 4: Fourier transform infrared spectroscopy analysis of *Shadguna Balijarita Makaradhwaja*

Table 6: Fourier transform infrared spectroscopy peaks and functional groups detected in sample *Shadguna Balijarita Makaradhwaja*

Bond	Type of bond	Specific type of bond	Standard absorption peak/cm (nm)	Observed peak in sample	Appearance
C—H	Alkyl	Methyl	1380/cm (7246 nm)	1385.65	Weak
		Methylene	2850/cm (3509 nm)	2850.28	Medium to strong
			2925/cm (3419 nm)	2923.84	
C—H	Aromatic	Monosubstituted benzene	700-750/cm (13,333-14,286 nm)	742.34	Strong
C-C	With benzene ring	Dienes	1625/cm (6154 nm)	1632.95	Strong
O—H	Alcohols, phenols	Low concentration	3610-3670/cm (2725-2770 nm)	3658.04	Broad
N—H	Primary amines	Any	3400-3500/cm (2857-2941 nm)	3431.97	Strong
C—N	Aliphatic amines	Any	1020-1220/cm (8197-9804 nm)	1112.67	Often overlapped
C—N	R—N—C (nitro compounds)	Any	2165-2110/cm (4739-4619 nm)	2066.69	Often overlapped
C—X	Chloroalkanes	Any	540-760/cm (13,158-18,519 nm)	647.47	Weak to medium
N—O	Nitro compounds	Aromatic	1520, 1350/cm (7407-6579 nm)	1513.13	Lower if conjugated
C—C	C≡C	Disubstituted alkynes	2190-2360/cm (4425-4566 nm)	2341.25	Very weak (often indistinguishable)
C═O	Carboxylic acids/derivates	Carboxylates (salts)	1550-1610/cm (6211-6452 nm)	1539.66	Weak to medium

Table 7: Fourier transform infrared spectroscopy peaks obtained in *Shadguna Balijarita Makaradhwaja*

Sample	Number of peaks	Obtained peaks
SBM	14	448.82, 647.47, 742.34, 1112.67, 1385.65, 1513.13, 1539.66, 1632.95, 2066.69, 2341.25, 2850.28, 2923.84, 3431.97, 3658.04

SBM: *Shadguna Balijarita Makaradhwaja*

cinnabar (hexagonal); Hg-O chains characterize both. Both these forms are detected in XRD of SBM. At pressures above 10 GPa (pressure at which octaoxygen forms at room temperature), both structures convert to a tetragonal form which is also detected in XRD.[23] The pressure above 10 GPa is near to room temperature, i.e. allowing proper cooling during *Kupipakwa* procedure which, forms tetragonal structure. This observation can be considered as parameter to know whether *Kupipakwa* formulations were collected after complete cooling or not. Orthorhombic and hexagonal structures are found majorly in SBM which is suggestive of mercury sulfate ($HgSO_4$ or HgO_4S).

There was no perfect matching peak in JCPDS and NBS database related to SBM; hence, the correlations were done based on the nearest peak with average 0.1–0.4° 2th difference. The presence of nanoparticle size and the proportion of orthorhombic and hexagonal crystal size can be further applied

Table 8: Fourier transform infrared spectroscopy peaks of sample *Shadguna Balijarita Makaradhwaja* obtained in different regions

Sample	Hydrogen stretching region (3700 to 2700/cm)	Triple bond region (2700 to 1950/cm)	Double bond region (1950 to 1550/cm)	Fingerprint region (1500 to 700/cm)	Unknown region
SBM	2850.28, 2923.84, 3431.97, 3658.04	2066.69, 2341.25	1632.95	742.34, 1112.67, 1385.65, 1513.13, 1539.66	448.82, 647.47

SBM: *Shadguna Balijarita Makaradhwaja*

for comparative estimation of *Samaguna, Dwiguna, Triguna* and *Shadguna Balijarita Makaradhwaja.*

In the present study, gold was observed 12131 ppm (1.2%) in sublimed product of SBM. It is the highest quantity of gold observed in finished product of all types of *Makaradhwaja,* reported till date. In previous studies of SBM prepared by *Astasamskarita Parada* by adopting different operating procedures observed 663.14 ppm,[20] 421.86 ppm,[21] and 5.99 ppm[24] gold content in sublimed product, which is too less than the present value. The observed difference may be due to variable in raw material, heating pattern, and procedure. In another study, 268 ppm[19] and 300.16 ppm[2] gold were observed in the sublimed product in *Triguna Balijarita Makaradhwaja* (TBM) in ICPOES study. For TBM, purified mercury and sulfur are taken in ratio 1:3 while in *Shadguna Balijarita Makaradhwaja*, it is 1:6. *Rasashastra* claims that, therapeutic efficacy of *Shadguna Balijarana* is more than *Triguna Balijarana*.

About 75.77% mercury and 10.78% sulfur were observed in SBM. XRD study revealed that SBM contains mercury sulfide (HgS). Previous researcher reported 81.50% and 10.96% quantity of mercury and sulfur respectively, in finished product of TBM.[2] Comparing both studies, quantity of mercury was found less in the present study. It might possibly be due to excess amount of sulfur used in the procedure which may evaporate mercury during sublimation. Possible change in combining ratio indicates toward the process of *Balijarana* and heating process. It might get more capability to retain sulfur along with other trace elements reported in ICPOES study. While arsenic and cadmium were not detected in SBM. The lead was detected in negligible amount, but the reason behind the presence of lead in the finished product is unknown.

FTIR study revealed that, SBM contains organic compounds and the study was also supported by previous work.[20] Identification of functional group is one of the important analytical measures to understand the chemical nature and possible chemical composition of a sample. FTIR is a well-known tool for detection of presence of functional groups or organic legends. Therefore, prepared sample SBM was analyzed using FTIR analysis which was done using FTIR spectra in the region of 450–3700 cm^{-1}.

Stretching vibrations of C-H at 1385.65, 2850.28, and 2923.84 cm^{-1} represent Alkyl group; however, C-H bond at the wavelength 742.34 cm^{-1} is assigned to aromatic monosubstituted benzene. Medium to strong peak obtained at 1632.95 and 3431.97 cm^{-1} are due to C-C and N-H stretching vibrations which are assigned to dienes with benzene ring and primary amines, respectively. Low concentration of alcohols and phenols has been detected by O-H bond vibration in the range of 3610–3670 cm^{-1} (2725–2770 nm). The multiple and slightly overlapped peaks obtained in the range 1020–1220 cm^{-1} and 2165–2110 cm^{-1} are representative of aliphatic amines and possible nitro compounds. Aromatic nitro compounds are also found at a peak (1513.13 cm^{-1}). Two peaks obtained in triple bond region are due to C-C stretching vibrations of C=C and can be considered as indicators of disubstituted Alkynes; however, this prediction needs furthermore evaluation as obtained peak is very weak. A weak to medium peak obtained at 1539.66 cm^{-1} is due to C=O and it represents carboxylic acids/derivatives, especially carboxylates (salts).

SBM samples showed the presence of large number of functional groups which were represented by 14 peaks. Among these peaks, 4 peaks were obtained in hydrogen stretching region (3700–2700 cm^{-1}). Absorption peaks in this region of 3700–3100 cm^{-1} are ordinary due to various O-H and N-H stretching vibrations, with the former tending to appear at higher wave numbers. Aliphatic C-H vibrations fall in between the region 3000 and 2850 cm^{-1}. Most aliphatic compound has sufficient number of C-H bond to make this prominent peak. Two peaks were obtained in triple bond region (2700–1950 cm^{-1}). There are few compounds which are responsible to create triple bond which is not a common phenomenon. Hence, obtained peak in this region has a significant value which can be taken as parameter for specific drug prepared by adopting specific procedure.

Only one peak was obtained in double-bond region (1950–1550 cm^{-1}). The carbonyl stretching vibration is characterized by absorption through this region. Ketones, aldehydes, acids, amides, and carbonates have absorption peaks at around 1700 cm^{-1}. Esters, chlorides and acid aldehydes tend to absorb at slightly higher wavelengths; that is 1770–1725 cm^{-1}. Conjugation tends to lower the absorption peaks by about 20 cm^{-1}. It is impossible to determine the type of carbonyl that is present solely based on absorption in this region; however, examination of additional spectral region may provide evidence needed for clear-cut identification.

There are five peaks obtained in fingerprint region (1500–700 cm^{-1}). A small difference in the structure and constitution of a molecule result in significant changes in the distribution peaks in this region of the spectrum. Most single bonds give rise to absorption bands at these frequencies.

The C-O-C stretching vibration in ethers and esters are found at about 1200 cm^{-1} and the C-Cl stretching vibration at 700–800 cm^{-1}. Several inorganic groups such as sulfate, phosphate, nitrate, and carbonate also absorb at wave numbers below 1200 cm^{-1}.

All observed peaks indicate the presence of organic compounds in samples of SBM. These may be new chemical entities formed due to unique method of drug processing. It can be interpreted that these organic functional groups were probably impregnated from the herbs used in processing. The organic nature of the drug represents its difference from artificial mercurial compounds as well as mercurial minerals.

These peaks indicate the presence of organic compounds in the drugs. For the purification of raw materials and levigation purpose, herbals were used in the procedure. It may be reason behind observed organic compounds in finished product. It proves definite role of purification (*Shodhana)* and levigation (*Bhavana*) in the preparation of *Rasashastra* medicines.

Conclusion

Shadguna Balijarita Makaradhwaja is a tasteless, bright orange red-colored substance. Chemical characterization by ICPOES study shows that *Shadguna Balijarita Makaradhwaja* contains 12131 ppm of gold as major element along with mercury and sulfur. Structurally, it is mercury sulfide, which contains few organic compounds.

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Conflicts of interest

There are no conflicts of interest.

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हिन्दी सारांश

षड्गुणबलिजारित मकरध्वज का भौतिक रासायनिक गुणधर्म निर्धारण – एक प्राथमिक अध्ययन

संजय खेड़ेकर, प्रशांत बेदारकर, प्रदीप कुमार प्रजापति

मकरध्वज एक खनिज वानस्पतिक , प्रचलित वाजीकरण तथा रसायन गुणधर्मों वाला पारम्परिक औषधि योग है इसे शोधित स्वर्ण पारद तथा गंधक की विभिन्न मात्रा में बालुका यंत्र (इलेक्ट्रिक आधुनिक मफल फरनेन्स) द्वारा क्रमशः आरोही तापक्रम से बनाया जाता है। मकरध्वज के मात्रत: प्रधान तथा गौण तत्वों को जानने हेतु इसके रासायनिक गुणधर्म निर्धारण की आवश्यकता है। प्रस्तुत अध्ययन षड्गुण बलिजारित मकरध्वज का प्राथमिक भौतिक एवं रासायनिक गुणधर्म निर्धारण करने हेतु किया गया जिसमें षड्गुण बलिजारित मकरध्वज का स्वरूप संगठन तथा रासायनिक संगठन जानने हेतु विविध तकनीकों का प्रयोग किया गया जैसे – एक्सरे डिफ्रक्शन-, इंडक्टिवली कपल्ड प्लाज्मा ऑप्टिकल इमीशन स्पेक्ट्रोस्कोपी, फ्यूरियर ट्रांसफार्म इंफ्रारेड स्पेक्ट्रोस्कोपी। परिणाम स्वरूप बलिजारित मकरध्वज में दशमलव भाग में लगभग १२१३९ भाग स्वर्ण, आय.सी.पी.ओ.ई.एस. अध्ययन पाया गया। एफ.टी.आई.आर. अध्ययन में कुछ जैविक रसायन पाये गए। निष्कर्षतः संगठन की दृष्टि से यह मर्क्युरिक सल्फाइड है जिसका रसायनिक सूत्र HgS है।