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Analytical Study and Preparation of *Praval Garbha Pottali*

Research Article

Sucheta K Pilankar[1], Arati P Dubewar[2], Sonali C Chitali[1], Nilima S Dharkar[3*]

1. PG scholar, 2. Professor HOD, 3. Professor, Department of Rasa Shastra and Bhaishajya Kalpana,
Dr. D. Y. Patil Vidyapeeth deemed to be University.
Dr. D. Y. Patil College of Ayurved and Research Center, Pimpri, Pune India.

Abstract

The *Pottali Rasayana Kalpana* is one among the four types of rejuvenation formulations (Chaturvidh *Rasayana Kalpana*) of Mercury (Parad). They are known for its specific method of preparation, unique end product, optimum potency, smaller dosage, and larger therapeutic applicability. *Praval Garbha Pottali* is a herbo-mineral complex formulation. *Gandhak drava paka* (boiling in molten sulphur) method was selected for preparation as it is the most commonly used procedure. It also is the best method to enhance the efficiency of the drugs and keep them in a concise form. The description of Pottali Rasayana Kalpana is found in numerous *Rasagranthas* (Classical books of Rasa shastra); however, very less research work is carried out on them, and minimal research is carried out on *Praval Garbha Pottali. Pottali Rasayana Kalpana* are not well-versed in current ayurvedic practice due to the lack of research studies. XRD, FTIR, and EDS mapping are carried out on the prepared *Praval Garbha Pottali*.

Keywords: *Pottali Rasayana Kalpana, Praval Garbha Pottali*, XRD, FTIR, EDS mapping.

Introduction

Pottali Rasayana is a very potent form of medication due to its distinctive method of preparation, quick action, palatability, longer shelf life, and the way of administration (1). In *Rasayogasagar*, the author has explained in detail regarding *Garbha Pottali* in the chapter called *Pottali Rahasya* (2).

The present generation of Ayurvedic physicians are not well aware of the efficiency and utilization of the *Pottali Rasayana*. So, to bring awareness regarding its utility there is a need for proper research work. To initiate the process, the first step to be taken is to analyze the safety of the medication for internal intake. It is the need of an hour to explore the pharmaceutical aspect of the formulation *Praval Garbha Pottali*.

The present study tried to set a standard manufacturing procedure for *Praval Garbha Pottali*. It is indicated in Anemia (*pandu*), Ascites (*Udara*), Cough (*Kasa*), Asthma (*Shwasa*), Tumor (*Gulma*), and pediatric diseases (*Balrog*) as per the reference (2). It contains Coral ashes (*praval bhasma*), Pearl oyster ashes (*muktashukti bhasma*), Cypraea ash (*pita kapardika bhasma*), Conch ash (*shankha bhasma*), Gypsum ash (*godanti bhasma*), Mercury (*shuddha parad*), Purified sulphur (*Shuddha Gandhak*), thin silver foil (*rajat tantu khanda*). The contents were divided into two equal proportions and named PGP-A and PGP-B. PGP-A triturated with aloe vera juice (*Kumari swaras*) and PGP-B triturated with slurry of gum acacia (*babbula*).

Praval Garbha Pottali is one such formulation mentioned in classics, which is prepared by *Gandhakadrava* method, the procedure in which the prepared *Praval Garbha Pottali* is subjected to paka (boiling in molten sulphur) in a pot containing molten sulphur which is given indirect heat through Sand bath device (valukayantra).

*** Corresponding Author:**
Nilima S Dharkar
Professor, Department of Rasa Shastra and Bhaishajya Kalpana, Dr. D. Y. Patil Vidyapeeth deemed to be University. Dr. D. Y. Patil College of Ayurved and Research Center, Pimpri, Pune. India.
Email Id: suchetapilankar1@gmail.com

Aims and objectives

Aim

Analytical standardization of *Praval Garbha Pottali* by sophisticated analytical testing such as XRD, FTIR, and EDS mapping.

Objective

- Preparation of *Praval Garbha Pottali* by *Gandhak drava* method, in two different batches, first batch (PGP-A sample) triturated with aloe vera juice (*Kumari swaras*), and the second batch (PGP-B sample) triturated with gum acacia (*babbula*).
- XRD, FTIR, and EDS mapping of the PGP-A and PGP-B for chemical characterization.

Materials and Methods

Chief reference: Rasa yoga sagar.

Pharmaceutical steps involved in the preparation of *Praval Garbha Pottali*

Purification of Coral, Pearl oyster, Cypraea, Conch, Gypsum

Purification of Coral, Pearl oyster, Cypraea, Conch, and Gypsum was done by soaking them in

warm water for 12 hours and washing them afterward. Later Coral (3), Pearl oyster (4), Cypraea(5), and Conch (6) were subjected individually to dola yantra swedana for 3 hours with lemon juice. Purification of Gypsum was done in dola yantra with lemon juice and was boiled for 1 hour and 30 minutes (7). Then they were rinsed with warm water after *swedana* procedure and stored in a clean airtight container. Purification media, weight changes, total time taken for the purification process, and % loss is mentioned in the 'Table 1'.

Incineration of Coral, Pearl oyster, Cypraea, Conch, and Gypsum

Incineration of Coral was done by making fine powder of purified Coral (*praval*) and triturating it with aloe vera juice and round flat cakes (chakrika) were prepared from the paste and dried under shade. After drying, the round flat cakes were placed in the amidst of the earthen plates (*sharav*) of equal dimensions sealed with a mud-smeared cloth. When the sandhi bandhan was completely dried, it was subjected to incineration in a muffle furnace at 600°C for 6 hours. The process was repeated 3 times. Each time the round flat cakes were obtained from the earthen plates and triturated with aloe vera juice, and after the third puta it was triturated into fine powder and the *praval bhasma* was obtained (8). Name of the media used for the incineration process, weight changes, time taken for *Bhasma* preparation, and % loss details are given in 'Table 2'.

Incineration of Pearloyster (*muktashukti*) was done by making fine powder of purified Pearloyster and triturating it with rose water (*gulabjala*). Round flat cakes were made out of the paste and dried under shade. Later the round flat cakes were subjected to laghu puta at 300 for 4 hours for three times. *Bhasma* pariksha was done and the Pearloyster (*muktashukti*) *bhasma* was obtained (9).

Incineration of cypraea (*pita kapardika*) (10) and conch (*shankha*) (11) was done by making fine powder of purified cypraea and triturating it with aloe vera juice (*Kumari swaras*). Round flat cakes were made, dried, and subjected to puta at 600°C for 6 hours. The procedure was repeated for three times and cypraea (*pita kapardika*) *bhasma* and Conch (*shankha*) *bhasma* was obtained.

The purified pieces of Gypsum (*godanti*) were kept amidst the earthen plates (sharav) of equal dimensions sealed with a mud smeared cloth, dried and subjected to incineration at 600° C for 6 hours for three times. White coloured *godanti bhasma* was obtained (12).

Purification (*shodhan*) of mercury and Sulphur:

Purification of mercury was carried out by trituration of mercury in chalk powder for 3 days and later in garlic paste till the garlic paste turns blackish in color. Later the paste is washed off with warm water and purified mercury is obtained(13). 'Table 3' shows the amount of impure mercury taken, obtained purified mercury, time taken for purification process, total time of trituration, weight loss, and % loss of mercury.

Table 1: Details of purification of medications like purification media, time taken, total loss during the procedure

Name of the medication	Purification media	Weight of unpurified form	Weight of obtained purified form	Time taken	Total loss	% Loss
Coral	Lemon juice	100 gm	90 gm	3 hours	10 gm	10%
Pearl oyster	Lemon juice	100 gm	95 gm	3 hours	5 gm	5%
Cypraea	Lemon juice	100 gm	95 gm	3 hours	5 gm	5%
Conch	Lemon juice	100 gm	94 gm	3 hours	6 gm	6%
Gypsum	Lemon juice	200 gm	180 gm	1 hour 30 min	20 gm	10%

Table 2: Details of incineration procedure, media for incineration, weight variation, time taken, and total loss

Name of the medication	Name of the media (quantity sufficient)	Weight before incineration	Weight after incineration	Time taken	Total loss	% Loss
Coral	Aloe vera juice	90 gm	80 gm	18 hours	10 gm	10%
Pearl oyster	Rose water	95 gm	88 gm	18 hours	7 gm	7.36%
Cypraea	Aloe vera juice	95 gm	85 gm	18 hours	10 gm	10%
Conch	Aloe vera juice	94 gm	90 gm	18 hours	4 gm	4.25%
Gypsum	Aloe vera juice	90 gm	82 gm	18 hours	8 gm	8.88%

Table 3: Mercury purification

Purification media (Shodhan	Impure mercury taken	Purified mercury	Time taken	Total time of trituration	Weight loss	% Loss
Chalk powder-2o	20 gm	16 gm	3 days	36 hours	4 gm	20%
Garlic paste- 16	16 gm	11 gm	7 days	28 hours	5 gm	31.25%

Purification of Sulphur (*Gandhak*) was carried out by melting Sulphur (*Gandhak*) in equal quantity of cow's ghee and pouring the molten sulphur (*Gandhak*) through cloth in the milk. The procedure was repeated for three times (14). 'Table 4' shows the amount of *ashuddha Gandhak* taken, shodhan dravya quantity, obtained *Shuddha Gandhak*, time taken for the purification process, total loss, and % loss of sulphur (Gandhak). Fig 1 shows the purified Gandhak.

Table 4: Sulphur purification

Purification media (Shodhan Dravya)	Impure sulphur (Ashuddha Gandhak) taken	Purified sulphur (Shuddha Gandhak) obtained	Time taken	Total loss	% Loss
Cow ghee- 500 gm and milk- 2 liters	500 gm	450 gm	1 hour 30 min	50 gm	10%

Table 5: *Kajjali* preparation

Purified mercury and sulphur taken	Kajjali obtained	Time taken	Total loss	% Loss
12+ 6 gm= 18 gm	15 gm	36 hours	3 gm	16.66%

Fig 1: Purified sulphur (Gandhak)

Preparation of black collyrium of mercury sulphide (*kajjali*)

Mercury 12 gm was added to the *khalva yantra* and slowly the Sulphur 6 gm was added and the trituration was carried out. Double quantity of mercury and sulphur is taken considering the loss during trituration. 'Table 5' shows the quantity of mercury and sulphur taken, *kajjali* obtained, time taken, and total loss during the process of trituration. Trituration procedure was carried out till the *nishchandratva* (free from shining particles) lakshan of black collyrium of mercury (*kajjali*) was obtained and jet-black colored powder was obtained. The *kajjali* was examined by adding a drop of water on palm with prepared *kajjali* and mixed by rubbing and let it dry. Now see the palm in natural daylight, if a particle of mercury is not shining, *kajjali* is prepared and 15 gm is obtained. 9 gm of black collyrium of mercury sulphide (*kajjali*) was taken for *Pottali* preparation. *Kajjali* should be soft and smooth in touch, and it has the *bhasma* properties like *rekhapurnatva* (*Bhasma* getting lodged in fine finger lines), *Anjana sannibham* (jet black color), and *nishchandratva* (boiling in molten sulphur) method. The quantity of the ingredients is taken as per the reference in RasaYogaSagar for *Praval Garbha Pottali* and is mentioned in 'Table 6'.

Table 6: *Praval Garbha Pottali* reference as per *Rasa yoga sagar*

Name of the medication	Quantity taken as per the reference in Rasa yoga sagar
Coral	48 gm
Pearl oyster	48 gm
Cypraea	48 gm
Conch	48 gm
Gypsum	96 gm
Mercury	6 gm
Sulphur	3 gm for Pottali, 447 gm for Gandhak drava paka (boiling in molten sulphur) procedure
Silver foil	360 mg

Two equal samples of the mixture were made.

- PGP-A- Trituration of *kajjali, bhasma* of Coral, Pearl oyster, Cypraea, Conch, Gypsum, Silver foil, with aloe vera juice in *khalva yantra*.
- PGP-B- Trituration of *kajjali, bhasma* of Coral, Pearl oyster, Cypraea, Conch, Gypsum, Silver foil, with gum acacia in *khalva yantra*.

Prepared *Pottali* from the mixture of PGP-A and PGP-B. Allow the *Pottali* to dry in the sunlight for 1-2 days.

Gandhak drava paka (boiling in molten sulphur) method

The dried *Pottalis* from PGP-A and PGP-B were taken and wrapped in silk cloth. The initial weight of the *Pottali* was measured and noted. The four layers of silk cloth was taken and purified sulphur powder was sprinkled on each layer of silk cloth and tied to the stick with the help of silk thread. The earthen pots were taken and placed in the *valuka yantra*. Purified sulphur was filled in the earthen pots. The wrapped *Pottalis* were fried in the molten purified sulphur till the *vyoma varna* (dark bluish color) of *Gandhak* was observed. The *Pottalis* were then taken out and the silk cloth and molten sulphur was removed. The *Pottali siddha lakshanas* were observed. The final weight of *Pottalis* was measured and noted. 'Table 7' shows the time during the procedure, temperature, and color of the molten Sulphur during the process of preparation of *Praval Garbha Pottali*. 'Table 8' shows the variation in the weight observed after the process of *Gandhak drava* paka (Boiling *Praval Garbha Pottali* in molten sulphur). Fig 2 shows the procedure of PGP-A and PGP-b boiled in molten sulphur (*Gandhak drava paka*).

Table 7: Time, temperature chart, and changes in color of sulphur

Time	Temperature of molten sulphur	Color of molten sulphur
11:30a.m.	115°C	Bright yellow
12 p.m.	136°C	Bright yellow
12:30 p.m.	154°C	Light orange
1:00 p.m.	170°C	Dark orange
1:30 p.m.	200°C	Dark red
2:00 p.m.	220°C	Dark brown
2:30 p.m.	236°C	Blackish brown

Table 8: Weight variation post *Gandhak drava paka* (Boiling in molten sulphur)

Samples	Initial average weight	Final average weight	Weight dfference
PGP-A	6.91 gm	7.71 gm	0.8 gm
PGP-B	9.05 gm	9.46 gm	0.41 gm

Fig 2: Procedure of PGP-A and PGP-B boiled in molten sulphur (*Gandhak drava paka*)

XRD

XRD patterns of the two samples, PGP-A and PGP-B were obtained on a powder X-ray diffractometer Make Rigaku Model MiniFlex 600 with X ray CuK α radiation having a scanning rate of 2 dpm and step size of 0.02 deg at PDEA Baburaoji Gholap College, Sangvi, Pune. X-ray diffraction uses x-rays to investigate and quantify the crystalline nature of materials by measuring the diffraction of x-rays from the planes of the atoms within the materials. XRD is the key technique for said state drug analysis benefiting all stages of drug development, testing, and production.

FTIR

FTIR of PGP-A and PGP-B were obtained on Make Bruker, Germany and Model 3000 Hyperion Microscope with Vertex 80 FTIR System with single point detector ranges from 4000-450 $^{cm-1}$ performed at Sophisticated Analytical Instrument Facility, IIT Bombay, Powai. Infrared Spectroscopy gives information on the vibrational and rotational modes of motion of a molecule and hence an important technique for the identification and characterization of a functional group. The infrared spectrum of an organic compound provides a unique fingerprint, which is readily distinguished from the absorption patterns of all other compounds.

EDS mapping

PGP-A and PGP-B were tested for EDS mapping by the machine JEOL JSM-7600F. The JSM-7600F successfully integrates a full set of detectors that make it ideal for nanotechnology, material science, biology, compositional and micro-structural analysis.

Results

XRD

The XRD spectrum of PGP-A (see Fig 3) revealed the presence of chalcogenide of telluride series, which has a high melting temperature and is non-toxic in nature. Cervantite is a secondary mineral found in antimony deposits. Haycockite was also observed and is closely related to *Suvarnamakshik bhasma*, and the presence of chalcopyrite. Calcite is a carbonate mineral $CaCO_3$, and the most stable polymorph of calcium carbonate (calcite, aragonite, and vaterite). The specific gravity of the mineral is 2.71 g/cm3. The calcite in purest form contains 56.03% CaO and 43.97% CO_2. Calcite is rhombohedral crystal system is the thermodynamically stable phase of calcium carbonate. Mooihoekite is a closely related to chalcopyrite like Haycockite. It is a copper iron sulphide. The structure is a sphalerite like arrangement of metal and sulphur atoms with two additional metals at interstitial sites. Mawsonite is a sulpha salt mineral, containing copper, iron, tin, and sulphur, having a tetragonal crystal structure. Melilite occurs in thermally metamorphosed impure limestones and some types of alkaline rocks, and is relatively aluminium-rich, and becomes progressively magnesium-rich with falling temperature. The sample contains more than 462 compounds which comprise mainly of Calcite, most stable organic calcium. PGP-A is calcium-rich, with majorly aluminium and magnesium compounds. The other significant group consists of the iron, sulphur, and copper compounds. It is crystalline in structure, crystal system trigonal (hexagonal axes). 'Table 9' reveals the XRD data of PGP-A. Fig 5 reveals the XRD diffraction pattern of PGP-A co-relating with Tb55 (Ge O4)12 O59.

PGP-B also contains calcite, the stable compound of calcium carbonate. Various forms of calcium, magnesium, platinum sulphide (Cooperite), nonasodium lanthanum (III) bis [hexaselenodigermanate (III)], nickel bismuth iodide, bavsiite, selenium, disodium manganese chromium fluoride, Krieselite and more than 207 other compounds with majority of above-mentioned compounds. Cooperite is a grey mineral consisting of platinum sulfide, generally in combinations with sulfides of other elements such as palladium and nickel. Selenium is a naturally occurring mineral element that us distributed widely in nature in most rocks, and soils. In nature, it is usually combined with sulfide or with silver, copper, lead, and nickel minerals. Krieselite is a compound containing majorly germanium, aluminium, gallium, oxygen, and traces of hydrogen and carbons. The data was interpreted with the help of Match Analysis Application and crystallographic open database. 'Table 10' reveals the XRD date for PGP-B and Fig 4 reveals the XRD pattern of PGP-B. Fig 6 reveals the XRD diffraction pattern of PGP-B co-relating with $CaCO_3$ calcite.

PGP-A

Table 9: XRD data of PGP-A

No.	2-theta(deg)	d(ang.)	Height(cps)	FWHM(deg)	Int. I(cps deg)	Int. W(deg)	Size(ang.)
1	20.659(19)	4.296(4)	63(10)	0.36(6)	37(4)	0.59(16)	236(42)
2	21.757(14)	4.082(3)	73(11)	0.17(4)	13(4)	0.19(8)	486(114)
3	22.948(11)	3.8723(18)	1429(49)	0.175(10)	406(7)	0.284(14)	484(29)
4	24.857(17)	3.579(2)	81(12)	0.20(5)	22(5)	0.27(10)	430(109)
5	25.351(6)	3.5105(8)	1319(47)	0.204(6)	371(7)	0.281(15)	416(12)
6	25.734(7)	3.4590(9)	383(25)	0.174(16)	92(6)	0.24(3)	488(45)
7	26.273(8)	3.3893(10)	975(40)	0.305(11)	409(13)	0.42(3)	279(10)
8	26.579(6)	3.3510(8)	286(22)	0.16(3)	65(10)	0.23(5)	517(81)
9	27.623(8)	3.2267(10)	429(27)	0.187(11)	105(4)	0.25(2)	456(27)
10	28.538(4)	3.1252(4)	711(34)	0.178(11)	188(5)	0.26(2)	480(31)
11	29.297(3)	3.0460(3)	6322(103)	0.180(2)	1520(15)	0.240(6)	477(5)
12	29.715(5)	3.0041(4)	1081(42)	0.247(10)	357(11)	0.33(2)	348(14)
13	30.429(10)	2.9352(9)	164(17)	0.35(3)	77(4)	0.47(7)	243(18)
14	31.260(8)	2.8591(7)	733(35)	0.180(12)	180(4)	0.245(18)	479(31)
15	31.67(3)	2.823(2)	78(11)	0.34(6)	36(5)	0.46(13)	255(48)
16	34.02(5)	2.633(4)	112(14)	0.20(5)	28(4)	0.25(6)	445(105)
17	35.884(9)	2.5005(6)	780(36)	0.264(12)	344(8)	0.44(3)	330(15)
18	36.95(5)	2.431(3)	79(11)	0.10(5)	9(4)	0.11(7)	849(441)
19	38.57(3)	2.3321(15)	233(20)	0.18(2)	48(4)	0.21(3)	486(59)
20	39.311(7)	2.2901(4)	1077(42)	0.209(6)	268(6)	0.249(15)	421(12)
21	39.828(11)	2.2615(6)	184(18)	0.23(3)	50(4)	0.27(5)	386(44)
22	40.758(10)	2.2120(5)	186(18)	0.27(3)	67(5)	0.36(6)	332(38)
23	42.629(11)	2.1192(5)	145(16)	0.13(3)	26(4)	0.18(5)	691(183)
24	43.069(8)	2.0985(4)	979(40)	0.191(11)	257(7)	0.262(18)	467(27)
25	43.616(14)	2.0735(7)	472(28)	0.360(19)	234(9)	0.50(5)	248(13)
26	47.021(13)	1.9310(5)	320(23)	0.28(5)	129(21)	0.40(9)	319(55)
27	47.393(9)	1.9167(3)	1240(45)	0.237(10)	419(22)	0.34(3)	382(17)
28	48.401(10)	1.8791(4)	1156(44)	0.291(11)	445(12)	0.39(2)	313(12)
29	49.073(19)	1.8549(7)	177(17)	0.37(4)	87(8)	0.49(9)	247(27)
30	51.092(13)	1.7862(4)	97(13)	0.19(4)	20(3)	0.21(6)	476(105)
31	51.693(11)	1.7669(3)	198(18)	0.71(3)	149(8)	0.75(11)	130(5)
32	52.91(2)	1.7292(6)	60(10)	0.28(6)	18(3)	0.30(10)	327(74)
33	53.788(17)	1.7029(5)	111(14)	0.22(3)	43(3)	0.39(8)	420(66)
34	55.70(2)	1.6489(5)	160(16)	0.26(3)	59(3)	0.37(6)	365(46)
35	56.495(17)	1.6276(5)	168(17)	0.22(3)	41(3)	0.24(4)	437(52)
36	57.314(11)	1.6062(3)	390(26)	0.311(12)	136(4)	0.35(3)	304(12)
37	57.95(2)	1.5901(5)	76(11)	0.44(6)	37(3)	0.49(12)	217(28)
38	58.967(13)	1.5651(3)	50(9)	0.09(3)	5.1(13)	0.10(4)	1048(313)
39	60.570(14)	1.5274(3)	350(24)	0.28(2)	126(8)	0.36(5)	339(29)
40	60.959(16)	1.5186(4)	144(15)	0.21(4)	38(6)	0.26(7)	465(93)
41	61.314(11)	1.5107(2)	187(18)	0.18(2)	43(3)	0.23(4)	534(67)
42	62.19(3)	1.4916(6)	57(10)	0.19(3)	11.4(19)	0.20(7)	515(94)
43	62.927(16)	1.4758(3)	100(13)	0.157(16)	17.6(19)	0.18(4)	621(64)
44	64.599(9)	1.44157(17)	276(21)	0.247(11)	72.7(18)	0.26(3)	397(18)
45	65.485(13)	1.4242(2)	258(21)	0.384(12)	106(2)	0.41(4)	257(8)
46	66.81(3)	1.3990(6)	44(9)	0.32(13)	18(4)	0.41(17)	312(129)
47	69.13(3)	1.3577(5)	70(11)	0.21(4)	15.4(19)	0.22(6)	486(101)
48	70.10(5)	1.3412(8)	106(13)	0.44(4)	50(4)	0.47(10)	228(21)
49	71.44(5)	1.3194(8)	45(9)	0.8(2)	67(8)	1.5(5)	122(30)
50	72.83(3)	1.2975(4)	165(17)	0.23(4)	57(4)	0.34(6)	446(72)
51	76.25(2)	1.2477(3)	55(10)	0.18(6)	13(2)	0.24(8)	577(186)
52	77.090(12)	1.23618(16)	124(14)	0.23(3)	38(4)	0.31(7)	456(68)
53	78.51(9)	1.2174(12)	27(7)	0.14(9)	4(3)	0.15(14)	773(476)

PGP-B

Table 10: XRD data of PGP-B

No.	2-theta(deg)	d(ang.)	Height(cps)	FWHM(deg)	Int. I(cps deg)	Int. W(deg)	Size(ang.)
1	23.374(13)	3.803(2)	397(26)	0.325(12)	157(5)	0.40(4)	261(9)
2	25.777(6)	3.4534(8)	896(39)	0.334(7)	393(5)	0.44(2)	255(5)
3	26.735(8)	3.3318(10)	717(35)	0.454(10)	427(6)	0.60(4)	188(4)
4	28.922(7)	3.0847(7)	288(22)	0.313(16)	117(5)	0.41(5)	274(14)
5	29.701(3)	3.0055(3)	4282(84)	0.311(3)	1725(23)	0.403(13)	276(3)
6	30.145(5)	2.9622(4)	653(33)	0.236(15)	200(16)	0.31(4)	364(24)
7	30.84(2)	2.897(2)	85(12)	0.49(7)	54(7)	0.63(18)	177(24)
8	31.662(5)	2.8237(4)	412(26)	0.366(11)	196(4)	0.47(4)	235(7)
9	34.79(3)	2.577(2)	38(8)	0.41(10)	19(4)	0.5(2)	211(50)
10	36.268(4)	2.4749(3)	544(30)	0.561(11)	343(7)	0.63(5)	156(3)
11	38.931(18)	2.3115(10)	192(18)	0.31(3)	83(6)	0.43(7)	280(30)
12	39.700(13)	2.2685(7)	799(36)	0.300(16)	332(9)	0.42(3)	294(15)
13	41.14(3)	2.1925(15)	186(18)	0.29(5)	88(6)	0.47(8)	310(49)
14	43.435(13)	2.0817(6)	713(34)	0.306(15)	253(16)	0.35(4)	292(15)
15	43.974(14)	2.0575(6)	357(24)	0.50(5)	206(16)	0.58(8)	180(18)
16	45.97(4)	1.9727(17)	39(8)	0.40(12)	17(6)	0.4(2)	224(66)
17	47.721(4)	1.90427(14)	953(40)	0.346(9)	468(9)	0.49(3)	262(7)
18	48.770(4)	1.86575(13)	1069(42)	0.321(10)	487(9)	0.46(3)	284(9)
19	49.400(16)	1.8434(6)	191(18)	0.43(4)	117(9)	0.61(11)	211(19)
20	52.064(12)	1.7552(4)	148(16)	0.87(4)	155(6)	1.04(15)	106(4)
21	55.99(2)	1.6410(6)	101(13)	0.34(3)	38(3)	0.38(8)	278(28)
22	56.826(16)	1.6189(4)	146(16)	0.22(3)	35(2)	0.24(4)	435(56)
23	57.668(19)	1.5972(5)	362(25)	0.330(16)	134(6)	0.37(4)	287(14)
24	58.32(2)	1.5810(6)	100(13)	0.41(6)	45(5)	0.46(11)	233(33)
25	60.908(15)	1.5198(3)	337(24)	0.29(4)	119(25)	0.35(10)	334(41)
26	61.48(3)	1.5069(7)	149(16)	0.68(13)	125(23)	0.8(2)	142(27)
27	63.34(6)	1.4673(12)	62(10)	0.35(9)	39(4)	0.63(16)	275(69)
28	64.925(12)	1.4351(2)	258(21)	0.290(14)	86(2)	0.34(4)	339(17)
29	65.810(14)	1.4180(3)	252(20)	0.356(15)	103(3)	0.41(4)	278(12)
30	67.14(3)	1.3930(6)	40(8)	0.41(12)	20(4)	0.5(2)	241(68)
31	69.41(3)	1.3529(5)	51(9)	0.27(6)	15(2)	0.29(9)	376(90)
32	70.38(3)	1.3367(5)	112(14)	0.43(4)	51(3)	0.45(9)	238(20)
33	71.85(9)	1.3129(14)	38(8)	1.05(14)	43(4)	1.1(3)	97(13)
34	73.09(3)	1.2937(4)	127(15)	0.40(3)	54(4)	0.43(8)	256(21)
35	74.18(7)	1.2774(11)	37(8)	0.91(14)	36(4)	1.0(3)	114(17)
36	76.51(3)	1.2441(4)	39(8)	0.44(9)	18(3)	0.47(17)	239(49)
37	77.302(15)	1.2333(2)	93(12)	0.36(4)	36(3)	0.38(8)	295(36)
38	78.88(4)	1.2126(6)	48(9)	0.18(4)	9(3)	0.19(9)	608(136)

Fig 3: XRD pattern for PGP-A

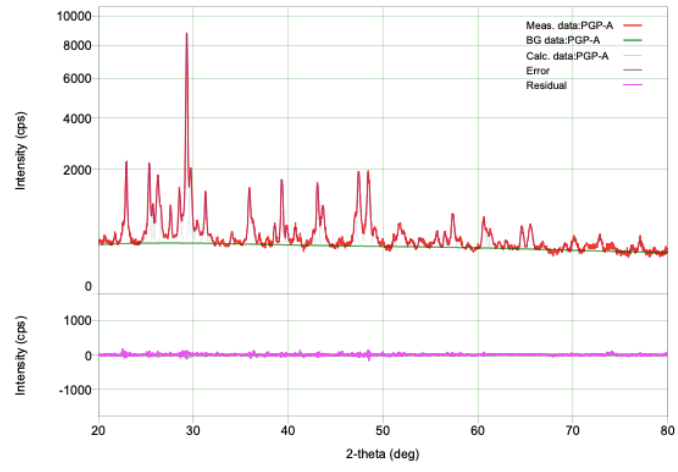


Fig 4: XRD pattern of PGP-B

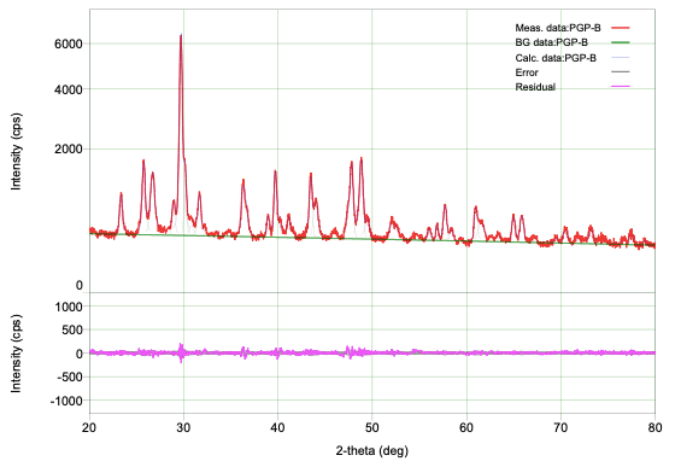


Fig 5: XRD diffraction pattern of PGP-A co-relating with Tb55 (Ge O4)12 O59

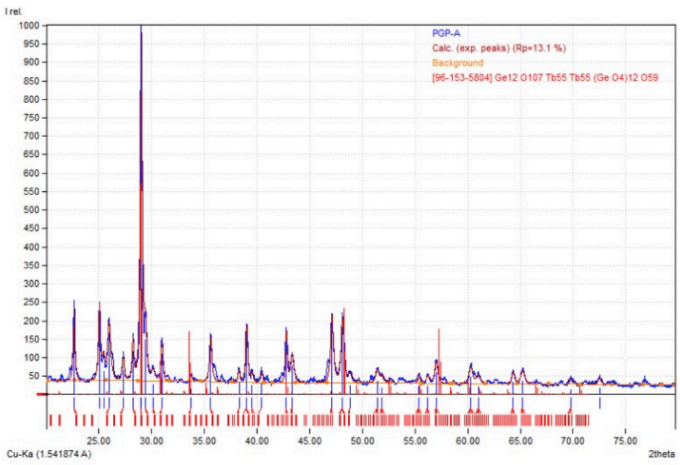
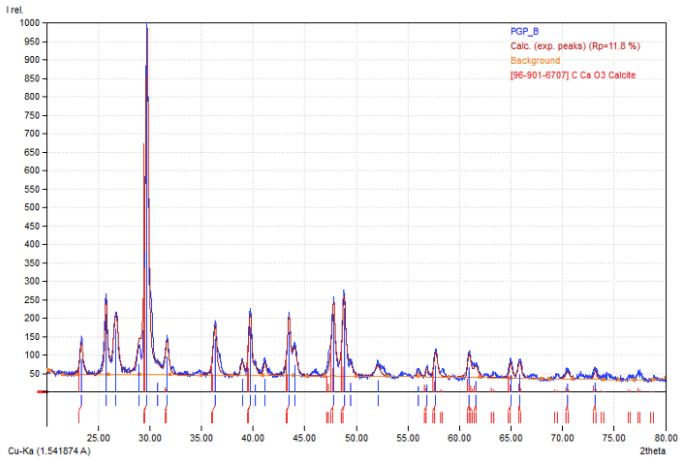


Fig 6: XRD diffraction pattern of PGP-B co-relating with $CaCO_3$ calcite



FTIR

The FTIR of PGP-A sample showed 18 peaks (Fig 7 and Table 11), and PGP-B showed 19 peaks (Fig 8 and Table 12). Each compound has its own unique absorption pattern in the fingerprint region ~1500 to 650 cm^{-1}. The FTIR spectra of both samples reveal significant vibrational bonds with similarities. FTIR of PGP-A shows the presence of hydroxyl O-H stretching bands at 3676.08 cm^{-1}. The strong intermolecular O-H stretching bond at 3430.27 was observed in the PGP-B sample. The presence of calcium carbonate is confirmed in PGP-A and PGP-B samples due to strong vibrational band frequencies prevailed at 1430.63 cm^{-1}/1431.57 cm^{-1}, 875 cm^{-1}/875.46 cm^{-1}, and 711.97/ 712.16 cm^{-1} [6]. The presence of alkane C-H bands is observed around ~3000 to 2840 cm^{-1}. Acid halide C=O stretching prevailed at 1797.18 cm^{-1}/1798.42 cm^{-1}. Carboxylic acid may be characterized by O-H bond observed close to 2512 cm^{-1} and 1430 cm^{-1}. C-N bond at 1154.16 cm^{-1} and 1123.12 cm^{-1}, C-F stretch at 1017.89 cm^{-1} indicating the presence of aliphatic fluoro compounds. Carbon single bond with chlorine, bromine, and iodine was observed between 711.97 cm^{-1} to 534.40 cm^{-1}. S-S stretch known as aryl disulphide bonds is observed between 466 cm^{-1} to 451 $cm^{-1}$and K-Br stretch observed at 424.54 cm^{-1}/424.99 cm^{-1} (15). This peak indicates the presence of organic compounds in the drugs. This arises probably from the herbs used in the purification of mercury (*parad*), sulphur (*Gandhak*), Coral (*Praval*), Cypraea (*pita Kapardika*), Pearloyster (*muktashukti*), Conch (*Shankha*), Gypsum (*godanti*).

Table 11: FTIR frequency and associated functional groups for PGP-A

Frequency (cm^{-1})	Bonds	Specific type of bonds	Functional groups
3676.08	O-H stretching	Medium	Alcohol
2919.26	C-H stretching	Medium	Alkane
2850.87	C-H stretching	Medium	Alkane
2512.00	OH stretching	Strong	Carboxylic acid
1797.18	C=O stretching	Strong	Acid halide
1430.63	O-H bending	Medium	Carboxylic acid
1154.16	C-N stretching	Medium	Amine
1123.12	C-N stretching	Medium	Amine
1017.89	C-F stretch	Strong	Aliphatic fluoro compound
875.27	C-O-O stretching	Strong	Peroxides
711.97	C-Cl stretching	Strong	Halo compounds
672.17	C-Br stretching	Strong	Halo compounds
613.78	C-Br stretching	Strong	Halo compounds
595.15	C-I stretching	Strong	Halo compounds
534.40	C-I stretching	Strong	Halo compounds
466.30	S-S stretching	Strong	Aryl disulfides
451.84	S-S stretching	Strong	Aryl disulfides
424.54	K-Br stretching	Strong	Alkali halide

Table 12: FTIR frequency and associated functional groups for PGP-B

Frequency (cm^{-1})	Bonds	Specific types of bonds	Functional groups
3676.92	O-H stretching	Medium	Alcohol
3430.27	O-H stretching	Strong	Intermolecular bonded
2919.27	O-H stretching	Strong	Carboxylic acid
2874.01	C-H stretching	Medium	Alkane
2514.62	O-H stretching	Strong	Carboxylic acid
1798.42	C=O stretching	Strong	Conjugated acid halide
1431.57	O-H bending	Medium	Carboxylic acid
1154.66	C-F stretching	Strong	Fluoro compound
1126.15	C-N stretching	Medium	Amine
1019.13	C-F stretching	Strong	Fluoro compound
875.46	C-Cl stretching	Strong	Halo compound
712.16	C-Cl stretching	Strong	Halo compound
672.31	C-Br stretching	Strong	Halo compound
614.14	C-Br stretching	Strong	Halo compound
595.55	C-I stretch	Strong	Halo compound
534.88	C-I stretch	Strong	Halo compound
466.70	S-S stretch	Strong	Aryl disulfides
452.44	S-S stretch	Strong	Aryl disulfides
424.99	K- Br stretching	Strong	Alkali halide

Fig 7: FTIR spectroscopy PGP-A

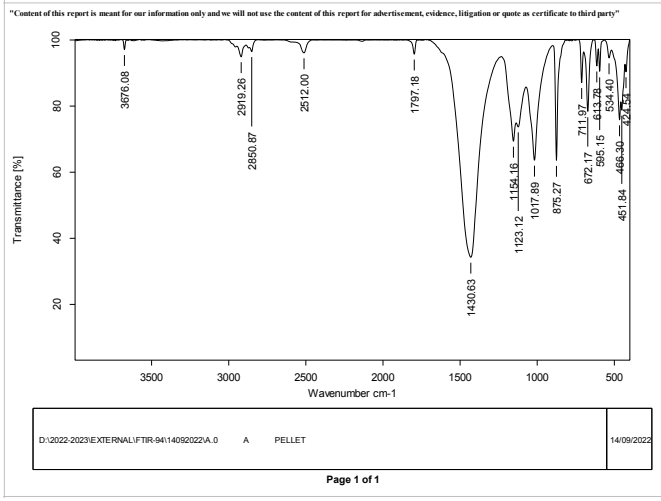
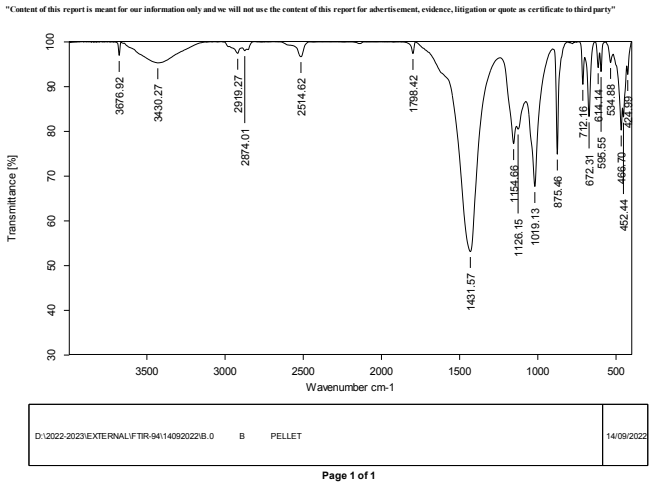


Fig 8: FTIR spectroscopy PGP-B



EDS mapping

EDS mapping study of PGP-A showed presence of carbon, oxygen, sodium, magnesium, silica, phosphorus, sulphur, potassium, calcium, manganese, silver, and mercury. The table 13 represents the quantitative presentation of elements in PGP-A. Fig 9 shows the pictorial presentation of EDS mapping of PGP-A.

PGP-A

Table 13: EDS mapping representing the elements present in PGP-A

Element	App conc.	Intensity Corn.	Weight%	Weight% sigma	Atomic%
C K	1.32	0.3327	2.66	0.23	4.23
O K	102.50	1.2334	55.67	0.15	66.54
Na K	0.00	1.0548	0.00	0.00	0.00
Mg K	20.94	0.9189	15.27	0.06	12.01
Si K	30.51	0.8948	22.85	0.08	15.56
P K	0.00	1.0817	0.00	0.00	0.00
S K	0.69	0.8337	0.56	0.02	0.33
K K	0.00	1.0052	0.00	0.00	0.00
Ca K	3.91	0.9568	2.74	0.03	1.31
Mn K	0.00	0.7849	0.00	0.00	0.00
Au M	0.00	0.6143	0.00	0.00	0.00
Hg M	0.26	0.6847	0.26	0.06	0.02
	Total:-		100.00		

PGP-B

EDS mapping studies of PGP-A showed presence of carbon, oxygen, sodium, magnesium, silica, phosphorus, sulphur, potassium, calcium, manganese, silver, and mercury. Table 14 represents the quantitative analysis of the elements present in PGP-B. Fig 10 reveals the pictorial presentation of EDS mapping of PGP-B.

Table 14: EDS mapping representing the elements present in PGP-B

Element	App conc.	Intensity Corn.	Weight%	Weight% sigma	Atomic%
C K	8.20	0.4051	17.44	0.36	25.16
O K	58.60	1.0131	49.79	0.24	53.92
Na K	0.00	1.0557	0.00	0.00	0.00
Mg K	12.92	0.9169	12.14	0.07	8.65
Si K	19.26	0.9103	18.22	0.10	11.24
P K	0.00	1.1272	0.00	0.00	0.00
S K	0.33	0.8565	0.33	0.02	0.18
K K	0.01	1.0069	0.01	0.02	0.00
Ca K	2.10	0.9543	1.89	0.03	0.82
Mn K	0.02	0.7746	0.02	0.03	0.01
Au M	0.00	0.6355	0.00	0.00	0.00
Hg M	0.13	0.7059	0.16	0.07	0.01
	Total:-		100.00		

Fig 9: EDS mapping of PGP-A

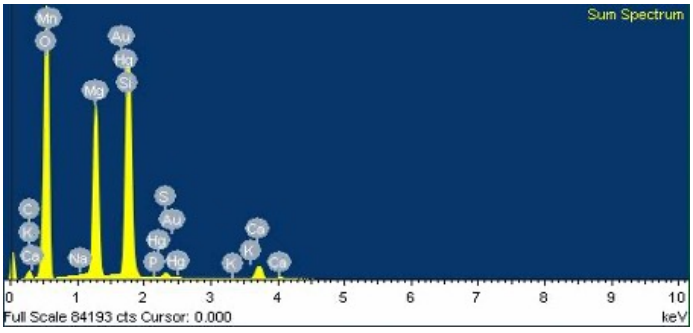
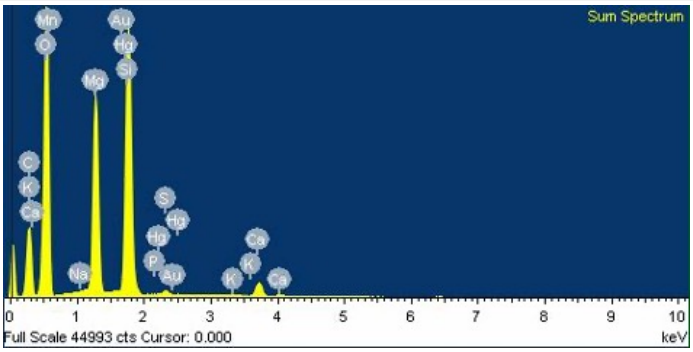


Fig 10: EDS mapping of PGP-B



Discussion

The components used for the preparation of *Praval Garbha Pottali* are predominantly rich in calcium such as Coral (*praval*), Pearloyster (*muktashukti*), Cypraea (*pita kapardika*), Conch (*shankha*), gypsum (*Godanti*). Black collyrium of mercuric sulphide (*Kajjali*) enhances the pharmacological action of the medication. All the components were initially purified and the incineration of all except *kajjali* was performed. After purification the components losses its shiny texture and whitish form is observed. Coral (*praval*) turns into light pink in colour. During *Gandhak drava paka* (boiling in molten sulphur) method, the bright yellow colour of Sulphur (*Gandhaka*) was converted into dark red in next 2 hours and was blackish brown in colour in next 1 hour. Total time taken for *Gandhak drava paka* (boiling in molten sulphur) method was 3 hours. The blackish colour of sulphur (*Gandhak*) *Vyoma varna* (dark bluish color) is considered complete for the paka (boiling in molten sulphur) method of *Praval Garbha Pottali*. The *Pottali siddha lakshanas* were monitored. As the temperature increases the colour of sulphur changes to red and eventually darkens further. The color is caused by the presence of a small amount of red S3 and S4 molecules (16). At about 154-200°C the color of Sulphur becomes dark red and its viscosity sharply increases. In this preparation, sulphur may react with organic matters present in the silk cloth as well as in *Pottali* to form sulphur associated functional group, which may later add to the compound formation of *Pottali* with functional group formation for maximum bioavailability (17).

XRD study reveals the presence of chalcogenide of telluride series in PGP-A and it has components which are closely associated with S*uvarna makshik bhasma*. It might be due to the use of aloe vera juice (*kumari swaras*) for trituration and the components used for purification and incineration process. PGP-B reveals the presence of calcite, the most stable polymorph of calcium carbonate. The colour is milky white due to transparency with a yellow tint. The lustre is vitreous with a white streak. The calcite in its purest form contains 56.03% CaO and 43.97% CO2. Calcite is rhombohedral crystal system that is the thermodynamically stable phase of calcium carbonate. It also has components associated with magnesium.

The FTIR study of both samples shows similarities in the functional groups. EDS mapping of PGP-A and PGP-B samples shows equivalency in the elements with minor differences in the apparent

concentration, concentration of the elements, intensity corrn and atomic%.

Conclusion

The *Gandhak drava paka* (boiling in molten sulphur) method method was achieved in 3 hours, and the *Praval Garbha Pottali* revealed the *Pottali siddha lakshan*. Analytical aspect regarding XRD, FTIR, and EDS mapping shows the predominance of calcite, the most stable form of calcium carbonate. The preparation done by two types, naming it PGP-A and PGP-B has no significant difference in the components. Analytical study of XRD showed minor significant difference in the two samples.

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