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ORA- Experimental Research

Synthesis and Characterization of *Tridhatugarbha Pottali* (TGP) Prepared Using Classical and Modified Electrical Instruments

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ABSTRACT:

Background: *Pottali* is one of the *Parada Murcchana* (a form of mercury compound with therapeutic efficacy), in which a combination of drugs is converted into a conical shape (*Pottali*). The *Paka* of *Pottali* was carried out in melted Sulfur until a specific confirmatory test was observed. The instrument plays an important role in controlling and maintaining the temperature required to maintain the melted state of Sulfur. Nowadays, due to advanced technology, new instruments are developed to control and maintain the temperature. **Objective**: - To compare the organoleptic, physicochemical, and other parameters of *Tridhatugarbha Pottali* (TGP) prepared using Classical *Pottali Yantra* (CPY) and Electrical *Pottali Yantra* (EPY). **Material and Method:** *Tridhatugarbha Pottali* was prepared using Classical *Pottali Yantra* (CPY) and Electrical *Pottali Yantra* (EPY). The TGP was compared using organoleptic parameters, physicochemical parameters, yield, and duration required. TGP was compared for elemental composition, compound formed, and crystal identification using XRF and XRD. **Results:** 22 and 26 hours are required for the preparation of TGP-CPY and TGP-EPY, respectively. There is not much variation in the organoleptic, physical parameters, and elemental composition of TGP-CPY and EPY. However, there is variation in the different compounds found in TGP-CPY and EPY. **Conclusion:** The EPY was easy to use and required less attention to operate than CPY. EPY helps in better control and maintaining the desired temperature than CPY. However, a change in the composition of the final product may affect the therapeutic efficacy. The final product of both the instruments found different compositions of the same element may be because of the varied heating pattern and the quantum of heat applied. Extensive research with a larger number of batches and more sophisticated instrumental analysis may provide the proper decision of using the electrical *Pottali Yantra*.

KEYWORDS: Classical *Pottali Yantra*, Electronic *Pottali Yantra*, *Parada Murcchana, Pottali, Tridhatugarbha Pottali.*

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1. INTRODUCTION

Rasa-aushadhies are mercury-based medicines. They are processed with metals, minerals, precious stones, and poisonous plants into an edible form. *Rasa-aushadhies* have specific therapeutic utility, palatability, and a longer shelf life as compared to herbal medicine. *Parada* (mercury) is used after several processes, such as *Murcchana* and *Jarana*. *Murcchana* is a process where *Parada* is treated with or without *Gandhaka* (Sulfur). This converts it into a stable, non-toxic compound with specific disease-curing capacity. [1, 2]

Pottali (Ayurvedic dosage form prepared in molten Sulfur) has the upper hand among the *Parada Murcchana* formulations. This is because it offers a concise form of medication with maximum potency, even at low dosage, through its synergistic effects. For this reason, *Pottali* formulations are the drug of choice in emergency conditions. [3] The mixture of metals and minerals is levigated with herbal juices or decoction and shaped into *Shikharakar* (conical) form. [4] Dried *Pottali* are kept in molten Sulfur until the desired characteristics appear.

In the *Rasayogasagar* classics, *Gandhaka Drava Paka Pottali* was elaborated in the context of " *Pottali Rahasya*". [4] *Tridhatugarbha Pottali* (TGP) is a *Pottali* prepared by the *Gandhaka Drava Paka* method. It is recommended for *Prameha* (diabetes), *Putimeha* (type of diabetes), *Pradara* (metrorrhagia), and *Shukradosha* (gynaecological disorders in male and female) in the dose of 60-120 mg. It is prescribed for the patient after scraping the *Pottali* with a scrapper. *Haridra* (Curcuma longa Linn.) and *Tulasi Swarasa* (juice of Ocimum sanctum Linn.) used as an adjuvant. [5]

The preparation of *Pottali* requires constant, controlled heat to keep the Sulfur melted for a longer period. [6] In classics, the *Valuka Yantra* (a vessel containing sand as a heat-conducting medium) was used to prevent a sudden rise or fall in temperature. It is also helps to provide a constant controlled temperature. However, it is difficult to control the heat generated by the heating device on which the *Valuka Yantra* is kept. In addition, constant observation is required to prevent temperature change generated by the heating device. In short, improper temperature control and constant labor requirement for observation are shortcomings of the Classical *Pottali Yantra* (CPY). There is a need to use advanced technology to overcome the above shortcomings so that preparing *Pottali* will be simpler. Modified *Pottali Yantra*, i.e. Electrical *Pottali Yantra* (EPY), has a controlling panel that helps to set and maintain the specific temperature. It is helpful to maintain the desired temperature for a longer duration without the requirement of continuous observation. The sand is not required. EPY is handy, small, and durable. The electricity makes it environment friendly. However, EPY is available in small-scale laboratory or personalized Vaidya level practice.

Any modification in the instrument is useful only when it does not alter the quality, safety and efficacy of the product manufactured in that instrument. Even though modification in the instrument can make the preparation easy, simple and cost-effective. There is need to compare the quality and pharmaceutical process of the formulation prepared using classical and modified electrical *Pottali Yantra*. Hence, the present research aimed to compare the synthesis and characterization of *Tridhatugarbha Pottali* (TGP) using Classical *Pottali Yantra* (CPY) and Electrical *Pottali Yantra* (EPY).

2. MATERIAL AND METHOD/ METHODOLOGY

Collection of Raw Drug

Raw materials for TGP were procured from the local market under the brand of a well-known pharmaceutical firm after confirming authenticity as per the API. Other raw materials, such as *Gandhaka*, were collected from Nashik after proper identification and authentication in accordance with the API.

Preparation of *Tridhatugarbha Pottali Kajajli* (TGPK) [4]

Tridhatugarbha Pottali Kajjali (TGPK) was prepared using *Rasasindoora* (3.2 g), *Shudhha Gandhaka* (0.8 g), *Swarna Bhasma* (0.2 g), *Vanga Bhasma* (12.8 g), *Naga Bhasma* (12.8 g), and *Yashad Bhasma* (12.8 g). (Table 1) The total quantity in each batch was 42.6 g.

Table 1 Details of the ingredients of *Tridhatugarbha Pottali Kajjali* (TGPK)

Sr. No.	Ingredients	Ratio	Sample 1	Sample 2	Sample 3
1.	*Swarna Bhasma*	1 P	0.2 g	0.2 g	0.2 g
2.	*Shuddha Gandhaka*	4 P	0.8 g	0.8 g	0.8 g
3.	*Rasasindoora*	16 P	3.2 g	3.2 g	3.2 g
4.	*Yashad Bhasma*	64 P	12.8 g	12.8 g	12.8 g
5.	*Naga Bhasma*	64 P	12.8 g	12.8 g	12.8 g
6.	*Vanga Bhasma*	64 P	12.8 g	12.8 g	12.8 g
			42.6 g	**42.6 g**	**42.6 g**

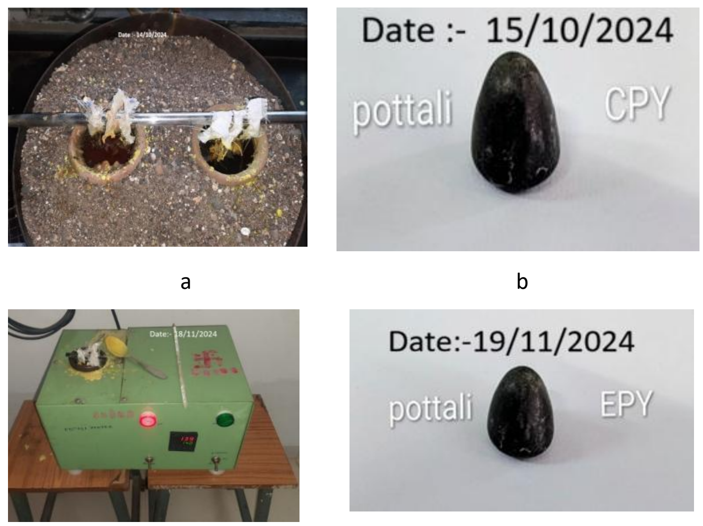
This TGPK was levigated with aloe vera juice. This procedure was repeated six more times. After the levigation procedure, the semisolid paste was converted into a *Shikharakar* (conical) and allowed to dry.

Preparation of *Tridhatugarbha Pottali* (TGP) in Classical *Pottali Yantra* (CPY) [4]

The dried conical TGPK was wrapped in silk cloth and tied firmly. A wide-mouthed iron vessel (diameter of 54 cm, height 20 cm at the bottom) was kept on the heating device. The sand was filled up to a height of 2 cm in the iron vessel. An earthen pot (diameter of 10 cm and height 16 cm) containing Sulfur was kept in the sand. After melting of Sulfur, *Pottalies* were kept in it until a confirmatory sign of *Pottali Paka* does not appear. A thermometer and a thermocouple gun were used to observe the temperature of sand and Sulfur. After complete processing, the *Pottali* were taken out and scraped to remove extra Sulfur. The final product was stored in dry, clean glass containers. (Figure 1)

Preparation of *Tridhatugarbha Pottali* (TGP) in Electrical *Pottali Yantra* (EPY)

The dried conical TGPK was wrapped in silk cloth and tied firmly. The Sulfur was added to an iron pot (diameter 7 cm, height 6.5 cm) present in a modern electronic *Pottali Yantra* (length 26.5 cm, Breadth 35 cm, Height 19 cm), and heat was applied. The temperature was set at 140 °C in the EPY. After melting of Sulfur, *Pottalies* were kept in it until a confirmatory sign of *Pottali Paka* does not appear. The temperature was set and maintained between 120-150 °C using an electronic control panel. After complete processing, the *Pottali* were taken out and scraped to remove extra Sulfur. The final product was stored in dry, clean glass containers. (Figure 1)



a b

c D

Figure 1 *Tridhatu Garbha Pottali* (TGP) Preparation a. Classical *Pottali Yantra* (CPY), b. TGP-CPY, c. *Electronic Pottali Yantra* (EPY), d. TGP-EPY

Characterization of TGP

The TGP-CPY and TGP-EPY were analyzed through organoleptic and physicochemical parameters. Elemental quantification, compound and crystal identification were carried out using sophisticated instruments like X-ray fluorescence (XRF), X-ray Diffraction (XRD).

3. OBSERVATIONS AND RESULTS:

The temperature pattern and observations during the preparation of TGP-CPY and TGP-EPY are presented in Tables 2 and 3.

Table 2. Temperature pattern observed during the preparation of *Tridhatugarbha Pottali* (TGP) using Classical *Pottali Yantra* (CPY)

Hours	Temperature of Sand (^{O}C)	Temperature of Molten Sulfur (^{O}C)	Observations
0	0	0	Start the instrument
2	0-130	0 – 120	Sulfur melts completely
4	130- 120	120- 125	*Pottali* immersed in molten Sulfur. Sulfur fumes appeared, and an air bubble appeared immediately after immersing *Pottali* into molten Sulfur.
6	120- 125	125- 123	Sulfur color appears dark orange-yellow, with mild fumes observed
8	125-119	123-120	----
10	119-170	120	-----
12	170-160	110- 124	Sulfur color appears dark brownish yellow
14	160	124 – 130	----
16	160	130 – 125	Reddish brown color, Viscosity – thin
18	160	125	-----
20	160	125- 123	----
22	160	123- 125	Reddish brown color, Viscosity – Slightly thick
24	160	125- 124	Reddish Brown color with a bluish tint Viscosity – Slightly thick, Metallic sound heard clearly

Table 3. Temperature pattern observed during the preparation of *Tridhatugarbha Pottali* (TGP) using Electrical *Pottali Yantra* (EPY)

Hours	Temperature of Molten Sulfur (^{O}C)	Observations
0	0	Start the instrument
2	140	Sulfur melted completely within 15 min, *Pottali* was immersed in molten Sulfur, Sulfur fumes were observed, Air bubbles were seen immediately after *Pottali* was immersed in molten Sulfur
4	140	Sulfur added, viscosity remains the same, golden yellow color of Sulfur, mild fumes observed
6	140	-----
8	140	Viscosity remains the same, golden yellow color of Sulfur, mild fumes observed
10	140	------
12	140	Golden yellow color of Sulfur, mild fumes observed, viscosity was the same
14	140	Slightly orange-yellow color of Sulfur, viscosity same
16	140	----
18	140	Orange-yellow color of Sulfur, viscosity remains the same, mild fumes
20	140	-----
22	140	Dark orange-yellow color with a bluish tinge, mild fumes, viscosity remains the same
24	140	A slight metallic sound appears
26	140	Reddish brown color with blackish ting, Viscosity – Slightly thick, Metallic sound heard clearly

Organoleptic and Physicochemical Parameters

Organoleptic and Physicochemical Parameters of TGP-CPY and TGP-EPY are shown in Table 4.

Table 4: Organoleptic, Physio-chemical Characteristics of *Tridhatugarbha Pottali Kajjali* (TGPK), *Tridhatugarbha Pottali* (TGP) using Electrical *Pottali Yantra* (EPY) and *Tridhatugarbha Pottali* (TGP) using Classical *Pottali Yantra* (CPY)

Sr. No.	Characteristics Parameters	TGPK	TGP- EPY	TGP- CPY
1	**Color**	Diffused sunlight- grayish black sunlight- grayish black with shine Artificial light- dark grey with shine	Diffused sunlight- grayish black sunlight-grayish black Artificial light-Dark grey Powder:- steel gray with no shine	Diffused sunlight- Dark black Sunlight-carbon black Artificial light- carbon black Dark grey with Shine After powder-dark gray with no shine
2	**Odor**	Strength- strong metallic odor	Strength – strong metallic and Sulfur odor	Strength – weak metallic and Sulfur odor
3	**Taste**	Slightly bitter	Tasteless	Tasteless
4	**Size**	Conical	The shape remains the same as a cone.	Shape slightly change
Classical Parameters				
1. *Nishchandrika* (Lusterless)		Present	Present	Present
2. *Rekha Purnatva* (enter the furrows of fingers)		Present	Present	Present
3. *Varitara* (Floats on the surface of water)		Present	Present	Present
4. *Niswadu* (Tasteless)		Slightly bitter	Present	Present
5. *Nirdhoom* (does not emit fumes when kept on fire)		Not present	Not present	Not present
Physio- Chemical Parameters				
1.	Ash Value	91.63 %	82.69 %	81.37 %
2.	Acid Insoluble Ash	61.45 %	62.55 %	61.02 %
3.	Water Soluble Ash	4.89 %	6.06 %	4.51 %
4.	Water Soluble Extractive	3.58 %	2 %	2.02 %
5.	Alcohol Soluble extractive	1.64%	0.93 %	1.47 %

Elemental Composition:- XRF study

The elemental composition of TGP-CPY and TGP-EPY is given in Table 5**.** Sulfur concentration in TGP-CPY and TGP-EPY is 23.75%, and 20.44%, respectively. TGP-CPY contains lead (16.20%), tin (15.71%), zinc (19.67%), mercury (5.93%), calcium (3.39%), and arsenic (1.23%). TGP-EPY contains lead (15.99%), tin (15.38%), zinc (19.57%), mercury (5.88%), calcium (3.63%), and arsenic (1.24 %). Other elements such as iron, silicate, phosphorus, nickel, chromium, barium, and selenium were found at ppm levels.

Table 5: Elemental Composition of *Tridhatugarbha Pottali* (TGP) prepared using *Classical Pottali Yantra* (CPY) and *Electronic Pottali Yantra* (EPY)

Element	PPM % in TGP-EPY	PPM % in TGP-CPY	Probable Assignment
S	20.44 %	23.75 %	Sulfur from *shuddha gandhaka*, forming metal Sulfides
Zn	19.57 %	19.67%	Zinc Sulfide (ZnS) major phase
Pb	15.99 %	16.20%	Lead Sulfide (PbS) major phase

Sn	15.38 %	15.71 %	Tin Sulfide (SnS / SnS_2) major phase
Hg	5.882 %	5.934 %	Mercury Sulfide (HgS) moderate presence
Ca	3.633 %	3.392 %	Calcium as $CaSO_4$ / $CaCO_3$ residue from processing media
As	1.243 %	1.230 %	Arsenic Sulfides or mineral inclusion
Fe	5450 ppm	5290	Iron from vessel/mineral association
Si	4450 ppm	4990	Silicate contamination or vessel residue
P	2340 ppm	2840	Phosphorus from mineral/plant sources
Ni	158 ppm	155	Nickel trace, likely incidental
Cr	570 ppm	630	Chromium trace from vessel or ore
Ba	430 ppm	540	Barium contamination/mineral residue
Se	225 ppm	217 ppm	Selenium minor trace from Sulfide ores
Mo	240 ppm	236	Molybdenum minor trace, vessel contribution
Ag	210 ppm	200	Silver minor Sulfide trace
Nb	275 ppm	275	Niobium incidental mineral trace
Ti		1010	
LE	16.43 %	12.47 %	Light elements (C, H, O etc.), moderate organic/volatile residue

Compound and Crystal Identification

The compound and crystals of the compound present in TGPK, TGP-CPY, and TGP-EPY were identified using XRD, as shown in Tables 6 and figures 2-4.

Compound and crystal identification of TGPK using XRD (Table 6)

The peaks observed at 2 theta- 44.740 and 52.153 were matched with the cubic gold (Au) crystal. Tin Sulfide (SnS) with orthorhombic Crystal shape was observed at 2 theta-25.542 30.217 36.690. The peaks at 2 theta-10.467, 21.033, and 24.187 matches with lead oxide–lead sulphate hydrate [(PbO)3 (Pb(SO4)) (H2O)], Triclinic crystal shape. The peaks at 2 theta-31.379, 35.030, and 44.629 were identical with peaks of wurtzite 15R zinc Sulfide (ZnS)-trigonal crystal shape. Rosickyite (S8), monoclinic crystal shape was observed at 2 theta-15.501,23.606, and 26.261. Cyclo deodecasulphur (S12), orthorhombic crystal shape was observed at 2 theta-22.638, 26.815, and 30.687.

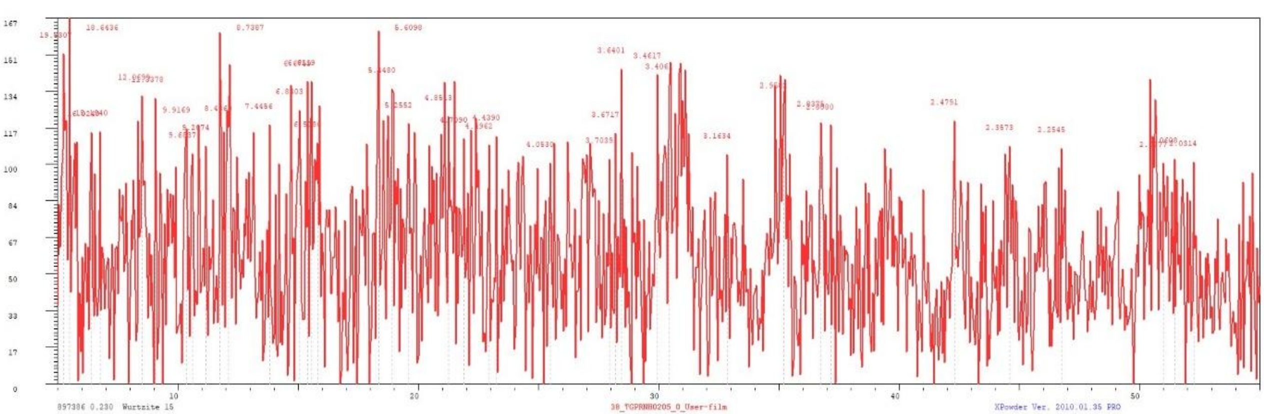


Figure 2. XRD graph of *Tridhatugarbha Kajjali*

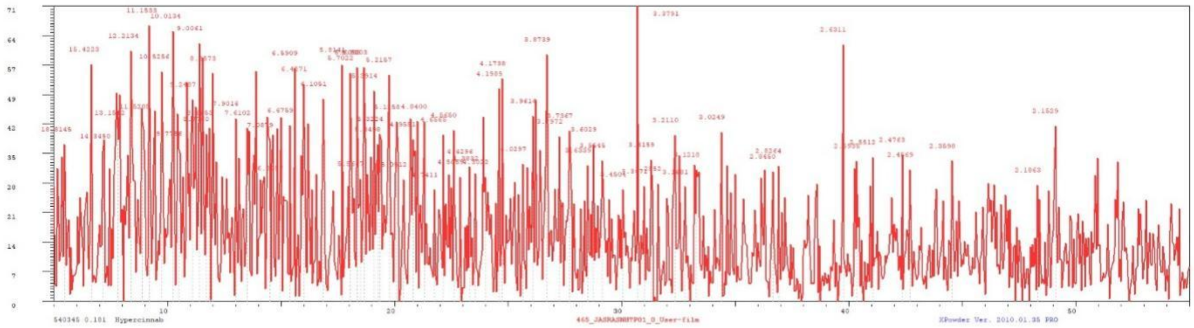


Figure 3: XRD graph of *Tridhatugarbha Pottali* prepared using Classical *Pottali Yantra* (CPY)

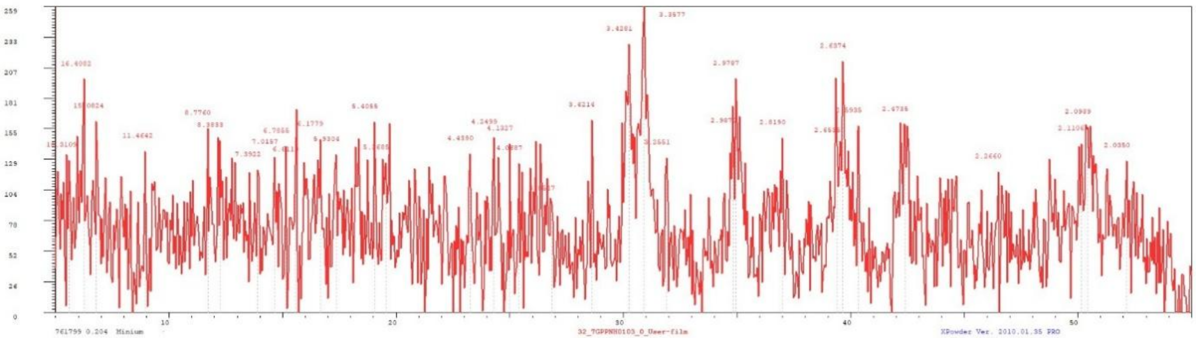


Figure 4. XRD graph of *Tridhatugarbha Pottali* prepared using Electrical *Pottali Yantra* (EPY)

Table 6: Compounds and crystal identified in *Tridhatugarbha Pottali* (TGP) Prepared by Classical *Pottali Yantra* (CPY) and Electrical *Pottali Yantra* (EPY) through XRD

XRD interpretation of TGP-CPY					
Compound	**Composition**	**Crystal Shape**	**2 Theta**	**d Spacing**	**Intensity %**
Zinc Lead Oxide	Zn_2PbO_4	Orthorhombic	11.988	8.5659	77.1
			16.027	6.4165	44.6
			20.840	4.9457	49.0
Calcium Lead Oxide	$CaPbO_3$	Hexagonal axis	20.121	5.1206	60.6
			24.906	4.1481	29.2
			30.394	3.0254	57.1
Anglesite · Lead Sulfate	$Pb(SO_4)$	Orthorhombic	24.159	4.2743	28.0
			28.502	3.6336	46.0
			30.932	3.3480	38.8
Teallite = Lead Tin Sulfide	$PbSnS_2$	Orthorhombic	35.390	2.9429	26.0
			36.635	2.8461	43.8
			51.959	2.0420	14.1
SODIUM TIN - $-beta ·Sodium Tin	NaSn	Tetragonal	18.212	5.6520	34.8
			19.733	5.2201	76.6
			28.364	3.6509	34.0
Calcium Mercury	Ca_5Hg_3	Tetragonal	13.897	7.3940	77.9

			22.638	4.5574	32.7
			29.138	3.5559	47.6
Hypercinnabar, syn = Mercury Sulfide ·	HgS	Hexagonal axis	18.820	5.4708	42.9
			35.832	2.9077	30.46
			51.849	2.0460	47.1
XRD Interpretation TGP prepared by using electrical *Pottali Yantra*					
K6HgS4	K_6HgS_4	Hexagonal axis	11.794	8.7060	44.2
			20.591	5.0049	40.9
			34.726	2.9974	43.6
Schuetteite	$Hg_5S_2O_9$	Hexagonal axis	31.075	3.3393	71.1
			36.164	2.8819	31.6
			40.203	2.6026	32.5
Galena ·Lead Sulfide	PbS	Cubic	30.272	3.4256	87.7
			35.113	2.9653	64.7
			50.466	2.0983	60.6
Scotlandite ·Lead sulfate (IV) ·Lead Sulfate	$PbSO_3$	Monoclinic	30.909	3.3568	100
			31.904	3.32564	50.6
			52.153	2.0349	49.5
Minium Lead Oxide	Pb_3O_4	Pb_3O_4	16.552	6.2141	49.7
			30.743	3.3745	57.8
			39.788	2.6287	46.5
Cassiterite, syn ·Tin (IV) oxide - at 930 K ·Tin Oxide	SnO2	Tetragonal	30.909	3.3568	100
			39.401	2.6535	54.4
			44.242	2.3754	22.6
Zinkosite, syn [NR] = Zinc Sulfate	ZnSO4	S	28.640	3.6164	51.1
			30.286	3.3656	90.0
			52.153	2.0349	49.5
Sulhpur	S	Orthorhombic	23.274	4.4345	51.7
			30.494	3.4014	57.5
			39.373	2.6652	76.6
Sulhpur	S75	Monoclinic	30.798	3.3686	68.9
			31.075	3.3393	71.1
			39.705	2.6339	68.1
Sulfur	S80	Orthorhombic	15.584	6.5976	66.3
			19.706	5.2273	61.7
			38.346	2.6570	76.6
Calcium Gold	Au4Ca3	Trigonal	30.300	3.4226	68.4
			42.499	2.4680	61.0
			50.549	2.0950	60.9

4. DISCUSSION

Instruments are the backbone of drug manufacturing. They help in providing proper desired techniques (heating pattern), ease of preparation, save time, fuel, labour, and prevent damage to the person and the drug. Hence, the instrument plays a vital role in the quality, safety, and efficacy. There is also a need to modify the instrument as per the latest technology without altering the quality, safety, and efficacy of the drug.

In the ancient period, seers used the instruments and fuel sources depending upon the quickly available, cost-effective materials and technology. However, nowadays, the availability of newer materials, fuels, and technologies can lead to the development of new instruments. The paradigm shift from personalized production to bulk production also demanded the development of newer instruments. In the beginning, the development of new instrument was tested at the small laboratory scale. The next step is to develop the instrument for bulk production after successfully producing quality drugs in a small, laboratory-scale instrument.

Pottali preparation using CPY has some drawbacks: improper temperature control over a longer period, and a continuous labor requirement. Modified EPY was designed to overcome these problems. The batch size capacity of EPY is approximately 9.5-10.5 gm.

TGP was prepared using CPY and EPY. TGPK was prepared manually using an ancient mortar and pestle. 110 ml of aloe vera juice was required during each levigation of TGPK (42.6 g).

Batch Size (Figure 5)

In the present study, TGP was prepared in a laboratory-scale instrument. The present study focuses on the quality parameters of TGP and pharmaceutical comparison.

The batch size is fixed depending on the capacity of available classical (10.9-16.5 g) and electrical (9.5-10.5 g) instruments. The present study limited to compare the quality, pharmaceutical processing of TGP prepared using two different instruments. The validation will be the next step if desired product with quality will be achieved.

	Sample 1 CPY	Sample 2 CPY	Sample 3 CPY	Sample 4 EPY	Sample 5 EPY	Sample 6 EPY
Column1						
Series 2	18.9	18.2	18.3	12.5	11.3	11.2
Series 1	16.5	15.5	16.5	9.5	10.5	10.5

Figure 5 Yield of *Tridhatu Garbha Pottali* (TGP) prepared using in Classical *Pottali Yantra* (CPY) and Electrical *Pottali Yantra* (EPY)

Pharmaceutical study

CPY (2 h) requires more time for the Sulfur melting than EPY (15 minutes). More heat is needed to reach the desired sand temperature from the beginning. The longer duration required in CPY is due to indirect heating through sand. It indicate that a lower quantum of energy is required for molten Sulfur in EPY. This may not have any role in the drug preparation. The sand prevents a sudden rise or fall of temperature in CPY. In CPY, the temperature of molten Sulfur (120-130^{0}C) and sand in the *Valuka Yantra* (120-170^{0}C) was manually maintained. There was a need to switch off the heating device (gas stove) in CPY to maintain the temperature in the specific range.

The EPY instrument can easily control and regulate the temperature required to keep the Sulfur molten. The temperature was set and maintained at 140^{O}C in EPY. No sand is required in EPY as the temperature is regulated using electronic control panel. The temperature was controlled and maintained between 120-150^{O}C using an electronic panel. The temperature was selected based on previous research observation on *Pottali*. [7-8]

In CPY, air bubble was observed within 15 minutes after *Pottali* immersion in molten Sulfur. The color of molten Sulfur turns dark orange-yellow after 4 h and dark brownish-yellow after 10 h of heating at 120-150^{O}C. After 14 h, color appears reddish-brown with a thin viscosity. This becomes reddish-brown with a bluish tint and more viscous after 20 h.

In EPY, the color of Sulfur remains golden yellow with no change in viscosity until 11 to 14 h of heating. After that, the Sulfur color changed to slightly orange-yellow and took 22 h to become dark yellow color with bluish tinge. After 26 h, Sulfur turns into reddish-brown, more viscous liquid. Changes in molten Sulfur colors appeared to be slower in EPY as compared to the CPY. In CPY, the temperature was not constantly maintained; it varies from time to time.

Molten Sulfur changes color due to physical and chemical changes according to temperature variation, and due to polymerization. Sulfur melts into a thin, bright yellow at 115^{O}C.It turns dark red or brown as ring shaped molecules break and tangle into long polymer chains, vastly increasing viscosity at 160^{O}C. Above 200^{O}C, molten Sulfur becomes dark, opaque red as the polymer chains shorten again. [9] The temperature, duration, direct/indirect heating, and quantity of Sulfur may led to color changes. A detailed study will be helpful to explore the proper reasons for the color changes at various durations in both instruments.

The appearance of reddish-brown color with bluish tinge, the more viscous nature of Sulfur, and the appearance of metallic sound when *Potallis* were stuck with metal and glass rod are the confirmatory test for the completion of *Pottali Paka*. TGP preparation requires 22 h in CPY and 26 h in EPY.

TGP yield was increased by 13.4 % and 14.7 % in CPY and EPY, respectively. Notably, there is a distortion of a few conical shapes in CPY, while conical shapes remain intact in EPY. Furthermore, the organoleptic parameters and ancient test parameters are similar in TGP-CPY and TGP-EPY. Therefore, aside from the changes in the shape of TGP-CPY, there is no differentiation between TGP-CPY and TGP-EPY on physical examination.

Physiochemical Parameters

Physicochemical parameters are the basic standards of the drug to ascertain batch to batch uniformity. Ash value indicates the inorganic content present in the drug. Acid- insoluble ash indicates estimation of silicious material other than mineral component, while water-soluble ash is important for the absorption of the drug. Extractive value indicates solubility and polarity of phytochemicals in the sample, which is useful for estimating the solubility and polarity of phytochemicals in the sample. Standard parameters for TGP are not available in API.

Ash values of TGP-EPY was 82.69 %, and TGP-CPY was 81.37 %, which were smaller in quantity than TGPK (91.63%). It may be due to more Sulfur attached during the *Pottali* preparation, which evaporates at the temperature applied in ash value. TGP-EPY has slightly more acid-insoluble ash, and water-soluble extractives than TGP-CPY.TGP-CPY has slightly more alcohol soluble extractive than TGP-EPY. This variation was due to changes in the compound formed in both *Pottali*.

Elemental Composition

Both *Pottali* (TGP-CPY and TGP-EPY) have similar elemental compositions, with slight variations in major elements (Zinc, lead, tin, and mercury). Specifically, TGP-CPY contains a slightly higher Sulfur percentage than TGP-EPY*,* as more Sulfur was required in that process. It is noteworthy that *Gandhaka Drava Paka* method of *Pottali* can be defined as *Sagandha Sagni Bahirdhoom Gandhak Jarana*. Here, *Gandhaka Jarana* refers to the process in which *Gandhak* is treated with mercury to increase bioavailability and improve therapeutic efficacy. Importantly, the therapeutic potential of the mercurial preparation is directly proportional to the time of *Gandhak Jarana*. During this process, a variety of organic micromolecules, as well as trace elements are incorporated into the product. However, non-detection of gold in XRF analysis was surprising. This finding highlights a need to determine the reasons for the absence of gold, or to conduct an ICP-AES-like analysis is needed to assess the gold percentage.

Compound and Crystal Identification

TGPK shows cubic gold crystals, Tin Sulfide (SnS), Lead sulfate hydrate $(PbO)_3$ $(Pb(SO_4)$ (H_2O), zinc Sulfide (ZnS), Sulfur in the form of S8 (monoclinic) and S12 (orthorhombic) crystals in XRD graphs. TGP-CPY shows graphs that match compounds like zinc lead oxide (Zn2PbO4), Calcium lead oxide (CaPbO3), Lead sulfate (Pb(So4), Sodium tin (NaSn), Lead tin Sulfide (PbSnS2), Calcium mercury (Ca5Hg3), Mercury Sulfide (HgS), and hexagonal crystals. S8 and S12 forms of Sulfur present in TGPK get converted into various Sulfide.

XRD interpretation of TGP-EPY shows K6HgS4 hexagonal axis, Hg5S2O9 hexagonal axis, PbS in cubic and $PbSO_3$ in monoclinic, SnO_2 in tetragonal, $ZnSO_4$ orthorhombic, Au_4Ca_3 in trigonal, and Sulfur found in S in orthorhombic, S75 in monoclinic, and S80 orthorhombic crystals. It shows that some quantity of Sulfur is not utilized for the formation of Sulfide compounds. It is contrary to TGP-CPY in which free Sulfur is not detected in XRD. S75/S80 are the compounds of elemental Sulfur that are water soluble with 75 and 80% Sulfur content. A more complex structure of lead was found in the sample of CPY as compared to the EPY. Mercury was converted into a complex structure in both samples. Gold was also present in the final product in both samples in complex form.

In TGP-CPY and TGP-EPY, a new complex structure was formed compared to TGPK. It is due to the application of heat in the presence of Sulfur for a longer duration. However, the compounds of TGP-CPY and TGP-EPY are different in nature. No logical explanation was found for this variation. Work that is more elaborate will be done to explore the effect of instrumentation on the final product, along with analysis using more sophisticated instruments.

5. CONCLUSION

Tridhatugarbha Pottali (TGP) is a formulation in which *Sagandha Sagni Murcchana* of *Parada* was done. *Gandhak Drava Paka* is a procedure in which the temperature of sand is maintained between 120 to 170^{O}C . It is done so that Sulfur remains melted without catching fire. When comparing the preparation methods, it is observed that *Tridhatugarbha Pottali,* prepared using electrical *Pottali Yantra* (EPY) requires more time than the prepared using classical *Pottali Yantra* (CPY). This difference may be attributed to the faster polymerization of Sulfur in CPY, possibly due to inconsistent temperature. Furthermore, the Electrical *Pottali Yantra* enables better temperature maintenance and control without manual handling. Notably, *Tridhatugarbha Pottali* prepared using classical and electrical *Yantra* has almost similar organoleptic and physicochemical parameters. However, *Tridhatugarbha Pottali,* produced with classical and electrical instruments shows different compounds and crystals, although these are composed of the same elements. This variation is likely a result of differences in temperature and time. Therefore, further research is needed, including preparation of additional batches and use of more sophisticated analytical instruments, to better understand these effects.

ABBREVIATION

TGP – *Tridhatugarbha Pottali*

TGPK- *Tridhatu Garbha Pottali Kajjali*

CPY – Classical *Pottali Yantra*

EPY – Electrical *Pottali Yantra*

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