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Research Article

Pharmaceutical Standardization and Physicochemical Profile of Tamra Parpati

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Abstract

Tamra Parpati (TP) is a herbo-metallic formulation described in the classical ayurvedic text Rasamritam and also mentioned in the Ayurvedic Formulary of India (AFI). This study aims to establish pharmaceutical standardization of *Tamra Parpati* along with its quality control parameters. Three batches of *Tamra Parpati* were prepared as per the classical method explained in the reference to evaluate the standard manufacturing procedure (SMP). Pharmaceutical procedures such as *Shodhana* (pre-processing) of *Parada* (mercury), *Gandhaka* (sulfur), *Tamra* (copper), *Vatsanabha* (*Aconitum chasmanthum* Stapf ex Holmes), preparation of TP and Physicochemical parameters were carried out at the Department of Rasa shastra and Bhaishajya Kalpana and at the pharmaceutical chemistry Lab, ITRA, Jamnagar, respectively. Three batches of TP after preparation showed an average increase of 1.11% yield. For melting 10.11g of material in all three batches, an average of 5.31 min was required, with the temperature of the *Valuka Yantra* (sand bath apparatus) at 284°C and the temperature of the material at 127°C. Organoleptic characteristics reveal soft and smooth to the touch, black, tasteless, and smell like SO2 when ground. Mean ± standard deviation (SD) of pH (1% solution), loss on drying, ash value, Loss on ignition, acid insoluble ash, CS2 soluble extractive, Benzene extractive, water soluble extractive, and alcohol soluble extractive of TP was 7±0.00, 0.501±0.0784 %w/w, 13.947±0.244%w/w, 85.651±0.896%w/w, 11.397±0.529%w/w, 15.689±1.663%w/w, 12.737±0.605%w/w, 2.388±0.252%w/w and 3.232±0.207%w/w, respectively. The data obtained from the pharmaceutical study and physicochemical parameters may be used for future pharmacological evaluation and clinical validation of *Tamra Parpati*.

Keywords: *Bhasma, Herbo-metallic, Parpati, Standardization, Tamra Parpati*.

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Introduction

Tamra Parpati, a herbomineralo-metallic formulation in Ayurveda mentioned in Rasamritam (1), which has also been mentioned in the Ayurvedic formulary of India (2). Described in various diseases with multiple *Anupanas*. It contains *Shuddha Parada* (Processed Mercury), *Shuddha Gandhaka* (Processed Sulphur), *Tamra Bhasma* (Incinerated Copper) and *Shuddha Vatsanabha Churna*. The dose of *Tamra Parpati* ranges from 125 mg to 1000 mg with the majority of authors recommending for a 250 mg dose, typically considered a therapeutic dosage for humans. The imperative for standardization in traditional medicine is essential for guaranteeing the quality, efficacy, and consistency of the final product. Quality-assured raw materials, along with appropriate in-process quality assessments and final product evaluations are crucial in the manufacturing process. Standardization begins with the procurement of raw materials and extends to the production of the finished products.

The product is manufactured by four GMP-approved pharmaceutical companies in the commercial market. However, the standard manufacturing processes (SMP) and quality parameters for this product are not yet available. This study aims to establish pharmaceutical standardization of *Tamra Parpati* by preparing three batches according to classical reference and to define the quality assessment parameters for the formulation. The results will provide a comprehensive evaluation of the consistency and standard manufacturing process of *Tamra Parpati* confirming its adherence to the necessary quality standards for pharmaceutical applications. Furthermore, these findings may establish a foundation for future research and development in conventional Ayurvedic formulations.

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Aims and Objectives

This study aimed to develop the Standard Manufacturing Procedure and an analytical profile (Physicochemical) of *Tamra Parpati*.

Materials and Methods

Raw materials collection and authentication

Tamra was procured from the local supplier and subjected to tests for purity. *Ashodhita Parada, Ashodhita Gandhaka, Ashodhita Vatsanabha* (*Aconitum chasmanthum* Stapf ex Holmes)*, Sudha (slaked lime), Saindhava Lavana, Cow's Ghee* and *Til Taila (Sesamum indicum L.)* were procured from the pharmacy, ITRA, Jamnagar. *Rasona* (*Allium sativum* L.), *Surana Kanda* (*Amorphophallus campanulatus* Blume ex decne.), *Kulattha seeds* (*Dolichous biflorous* Linn.) and Rice were purchased from the local market of Jamnagar. Cow's Milk and cow's urine were purchased from a local cowshed, while *Arka Patra* (*Calotropis procera* Linn) was collected from the local surroundings of the ITRA campus. Authentication of the herbal raw drug (*Vatsanabha*) was performed at the pharmacognosy lab of ITRA, Jamnagar. Additionally, *Parada* (3), *Gandhaka* (4) and *Tamra* (5) were also authenticated according to the *Grahya lakshana* (acceptable qualities) mentioned in Ayurveda classics. The ingredients used in the formulation are mentioned in Table 1. Three batches of *Tamra Parpati* (TP1, TP2, and TP3) were manufactured in the Department of Rasashastra & Bhaishajya Kalpana, ITRA, Jamnagar.

Methods

Pharmaceutical study

All the required pharmaceutical procedures were carried out in the department of Rasa Shastra & Bhaishajya Kalpana, ITRA, Jamnagar. All materials used during the pharmaceutical procedures were accurately weighed using a digital analytical balance with appropriate sensitivity (least count 0.01 g).

Purification of Raw Materials

The purification of raw materials, such as *Ashodhita Parada, Ashodhita Gandhaka, Ashodhita Vatsnabha*, and *Ashodhita Tamra*, were performed according to classical references. The manufacturing of *Tamra Bhasma,* which includes *Shodhana, Marana* and *Amritikarana,* was also conducted as per the references provided in the classics.

Samanya shodhana* (general processing) of *Tamra

The *Nirvapa* (heating and quenching) method was employed for this process. *Tamra* flakes (1000g) were heated in an iron ladle until they reached a red-hot state, after which they were sequentially quenched in *Tila Taila* (sesame oil), *Takra* (buttermilk), *Gomutra* (cow urine), *Kanji* (sour gruel), and *Kulattha kwatha* (decoction of *Dolichos biflorus* seeds) for a total of seven times in each liquid medium (6). The temperature during the red-hot stage was measured using a digital thermocouple. Fresh liquid media, gravimetrically equivalent to the *Tamra*, were used for each quenching.

Vishesha Shodhana* (specific processing) of *Tamra

Tamra flakes (880g) obtained from general processing were added to a stainless steel vessel, which was filled with 3700 ml of freshly collected cow urine. Later, this SS vessel was placed over a gas stove and subjected to mild heat for 3 hours. After the process was completed, the Tamra flakes were collected and gently washed with warm water, then kept for drying in a shed (7).

Marana* (processing) of *Tamra

Samguna Kajjali was prepared by taking equal amount of *Shuddha Parada* and *Shuddha Gandhaka* (75 g each), half the amount of *Shuddha Tamra* (300g), was placed in a mortar and subjected to *Bhavana* with *Nimbu Swarasa* (wet trituration using lemon juice). Once it achieved a paste-like consistency, it was applied to *Shuddha Tamra* flakes. After drying the mixture in the shade, it was placed in a *Sharava Samputa* (earthen saucer) sealed with a double-layered cloth smeared with *Multani Mitti* and left to dry. It was then processed using the classical *Puta* method. The next day, after *Swangasheetikarana* (self-cooling), the *Sharava Samputa* was removed, and the material was collected and triturated. In the following two *Puta* cycles, half the amount of *Samaguna Kajjali*, equivalent to one *Puti Bhasma*, was added and thoroughly triturated with a sufficient quantity of *Nimbu Swarasa*. From the 4th to the 20th *Puta*, equal amounts of *Shuddha Gandhaka* was used. Total, 20 *Puta*s were administered for *Tamra Marana*, and the entire process required approximately 56 days to complete (8).

Amritikarana* of *Tamra

Tamra Bhasma (60g) and half the quantity of *Shuddha Gandhaka* (30g) were mixed in a mortar, followed by the addition of a sufficient quantity of *Nimbu Swarasa* to form a bolus after thorough trituration. The *Surana Kanda* (500g) was subsequently bisected, and a circular pit within both halves. The dried bolus was positioned in this pit and covered with a double-layered cotton cloth coated in *Multani Mitti*. The *Surana Kanda* was subsequently placed in an electric muffle furnace (E.M.F.) following the process of *Swangasheetikarana* (self-cooling). Upon removal of the *Surana Kanda*, the bolus was separated, pulverised, and preserved in a glass container. Only, one *Puta* was administered for *Amritikarana*, and the entire process required approximately 3 days to complete (9).

***Parada Shodhana* (processing of mercury)**

1500g *Ashuddha Parada* (unprocessed mercury) and an equal amount of *Sudha Churna* were taken in a black stone mortar and triturated for 24 h. The mixture was filtered using double-layered cotton cloth and *Sudha Churna* was separated from the top of the cloth and dissolved in the water to isolate the remaining *Parada*. 1288g Garlic cloves cleaned and peeled, which were processed into a paste using a black stone mortar. *Parada* (1288g), *Rasona Kalka* (1288g), and *Saindhava Lavana* (644g) were taken in a black stone mortar and triturated for 12 h The *Parada* was rinsed with lukewarm water at 45°C. The *Shuddha Parada* (1262g) was collected and stored in a transparent glass vessel (10).

***Gandhaka shodhana* (processing of sulphur)**

1000g *Ashuddha Amalasara Gandhaka* (unprocessed sulphur) was made into a moderately fine powder (sieve no. 44) with the help of an automated mortar and pestle machine, and *Pottali* was prepared from it. 2000ml of cow milk was taken in a spherical vessel, and then *Pottali* was dipped into the cow milk and subjected to the *Swedana* procedure for 24 min. Two litres of cow milk was taken in a cylindrical-shaped steel vessel for the *Dhalana* process and heated up to 75°C. The mouth of this vessel was covered with cotton cloth and was smeared with cow ghee. 125g of cow ghee was taken in a steel vessel and heated on a mild heat. Powdered *Ashuddha Gandhaka* was taken from the *Swedana* procedure, poured into this vessel, and continuous stirring was

done with heating. When *Gandhaka* was completely melted, it was poured (*Dhalana*) into the vessel containing preheated cow milk through a cotton cloth. The vessel with milk was shaken continuously while pouring in melted *Gandhaka* to prevent lump formation. Spherical granules of *Gandhaka* were collected from the bottom of the vessel. The *Gandhaka* obtained was washed with hot water and left to dry; the same process was repeated twice. The final product after these processes was considered *Shuddha Gandhaka* (11).

***Vatsanabha shodhana* (processing of Indian aconite)**

200g *Ashuddha Vatsanabha* was made into *Chanaka Pramana*, i.e., ½ cm in size, and placed in a stainless steel vessel. Now, *Gomutra* was poured into the vessel and kept on the terrace under the sunlight. The next day, *Gomutra* was strained, and fresh *Gomutra* was poured again. This process was repeated for three days, and on the fourth day, the material was collected and washed with warm water; the outer layer of *Vatsanabha* was removed. It was then allowed to dry completely and stored in an airtight glass jar. The *Shuddha Vatsanabha* was subsequently pulverised and sieved using an 80# mesh sieve (12).

Preparation of *Dwiguna Kajjali* (black sulphide of mercury)

The specified amounts of *Shuddha Parad* (75g) and *Shuddha Gandhaka* (150g) were taken in an automated stone *Kharal* machine, and trituration was performed until the desired characteristics of *Kajjali* were achieved (Table 1).

Method of preparation of *Tamra Parpati*

Kajjali is initially manufactured by triturating *Shudha Parada* and *Shudha Gandhaka* until a fine, lustreless black powder (*Kajjali*) was obtained. Subsequently, *Tamra Bhasma* and *Shuddha Vatsanabha Churna* were also added, followed by trituration to achieve a homogeneous mixture. The mixture is thereafter transferred into the stainless-steel spoon, which is coated with a thin layer of ghee, and heated gradually over a low flame until it attains a mud-like consistency. The mixture was continuously stirred with a spatula to achieve homogeneous melting. After melting, the material was poured onto a leaf of *Calotropis procera* Linn., has previously been smeared with a thin layer of ghee and placed over cow dung. Similarly coated leaf is subsequently positioned on the spread material, and unilateral pressure is applied in one direction. After allowing the mixture to cool, *Parpati* flakes were collected. The impact of the leaf is supposed to be evident on the prepared *Parpati*. The *Parpati* flakes were ultimately pulverized into a fine powder and stored in an airtight glass jar. *Tamra Parpati* was prepared in three independent batches using the same ingredients, proportions, and pharmaceutical procedure to ensure reproducibility of the formulation. The batches were prepared under identical experimental conditions (13).

Pharmacognostic study

Pharmacognostic evaluation of *Ashuddha Vatsnabha* was conducted in the Pharmacognosy Lab of ITRA, Jamnagar. Additionally, the organoleptic characteristics, including taste, touch, colour, and odour, of *Tamra Parpati* were also evaluated.

Analytical study

Physico-chemical parameters like pH (14), Loss on drying (15), Ash value (16), Loss on ignition (17), Acid insoluble ash (18), CS2 soluble extractive (19), Benzene extractive (20), Water soluble extractive (21) and Alcohol soluble extractive (22) of *Tamra Parpati* were performed. An analytical study was carried out in the pharmaceutical chemistry laboratory of I.T.R.A., Jamnagar.

Table 1: Ingredients and composition of *Tamra Parpati*

S.N.	Ingredients	Latin/ English Name	Part Used	Quantity
1	*Tamra Bhasma*	Incinerated copper	Processed copper	3 Parts
2	*Shuddha Parada*	Processed *hydrargyrum*	Processed mercury	3 Parts
3	*Shuddha Gandhaka*	Processed Sulphur	Processed sulphur	6 Parts
4	*Shuddha Vatsanabha*	Processed *Aconitum chasmanthum* Stapf ex Holmes (Rt)	Dried tuber	1 Part

Table 2: Quantity of ingredients used in all the three batches of *Tamra Parpati*

S. N.	Ingredients	TP1	TP2	TP3
1	*Tamra Bhasma* (g)	23.33	23.33	23.33
2	*Dwiguna Kajjali* (g)	70	70	70
3	*Shuddha Vatsanabha* (g)	7.77	7.77	7.77
Total		101.11	101.11	101.11

Observations and Results

During the *Samanya Shodhana* process of heating and quenching, *Tamra* flakes become red-hot, and the temperature reaches up to 480°C. When quenching *Tamra* flakes in the designated liquid medium, a hissing sound was generated. Residual powder was found during repeated quenching. Subsequently, *Tamra* flakes were converted into coarse black powder at the end of the process. In the *Vishesha Shodhana* process of *Tamra*, *Gomutra* was started boiling in 30 minutes, and frothing was noticed. At mild heat, the temperature of *Gomutra* was noted from 85°C to 101°C during the process. Following *Swedana*, *Tamra* exhibited a greenish hue, whereas *Gomutra* transformed into a blackish-green color accompanied by a strong, irritating odour. In the *Samanya* and *Vishesha Shodhana* procedures, losses of 10.9% and 0.9% were observed, respectively.

During the *Marana* process of *Tamra* on 1st Puta, bluish-black coloured puffed flakes of *Tamra* were seen with light brown color and shiny crystals on the surface. *Tamra* flakes were extremely fragile and easily breakable after being pressed with two fingers, and they were completely powdered after the 2nd and 3rd *Puta*. Black, smooth, and very fine *Bhasma* was obtained after the 20th Puta with a sign of classical *Bhasma Pariksha* of *Tamra*. The temperature range was 500°C to 722°C during the classical *Puta* method. In the *Marana* procedure total of 3.66% (311g) gain was recorded.

In the *Tamra Bhasma Amritikarana* procedure, three hours of continuous trituration are required to achieve the consistency necessary for bolus formation. After being subjected to EMF (Electric muffle furnace) at 500°C for 3 hours, followed by *Swangasheetikarana* (18 h), *Surankanda* was completely burnt and turned black. The bolus inside was black and breakable by pressing with fingers, and after trituration, it converted to a black, smooth, and fine powder. During the process of *Amritikarana*, 6% (18g) of weight gain was recorded.

In the *Parada Shodhana* procedure, it was observed that *Parada* begins to mix with *Shudha Churna* after 9 h of trituration. After

20 h of trituration, the *Parada* was completely mixed with *Shudha Churna*, and the color of the mixture changed to dark grey. The process was then continued with *Rasona Kalka* and *Saindhava Lavana*. It was observed that after 2 hours of trituration, the *Parada* dissociated into small globules. After completing 10 hours of trituration, the paste turned black. During the *Parada Shodhana* procedure, an average loss of 15.86% was observed.

During the *Swedana* phase of the *Gandhaka Shodhana* procedure, it was observed that after completing the process, the lustre of *Gandhaka* changes from dull to shiny appearance. In the *Dhalana* phase, complete melting of *Gandhaka* was recorded at 119°C in 5:58 min, color of *Gandhaka* changes from shiny yellow appearance to dull yellow after *Shodhana*. A total loss of 1.8% (18g) was observed in both the *Swedana* and *Dhalana* procedures during 1000g of *Ashudhha Gandhaka shodhana*.

In *Vatsnabha Shodhana*, pieces of *Chanaka Praman Vatsanabha* swelled up and became soft after soaking on the 1st day, and the color of *Gomutra* changed from light yellow to dark brown. Simultaneously, frothing was observed in *Gomutra* during the initial stage. After the 3rd soaking, pieces of *Vatsanabha* became soft and easily pierced with a small needle. During the *Shodhana* process, a total of 61% (122g) yield of *Vatsanabha* was observed.

In *Dwiguna Kajjali* preparation, it was found that it requires 32 h of trituration to achieve the main qualities of *Kajjali*, like the smoothness of the mixture. A total of 99.55% (448g) of the final product was obtained.

During the preparation of *Tamra Parpati*, the initial melting of *Kajjali* revealed a granular form, which later transformed into a mud-like consistency. The smell and fumes of sulphur were observed during the process. It took an average time of 3.2 minutes and 5.31 minutes, respectively, from start to complete melting. In all three batches of *Tamra Parpati*, an average yield of 1.1% has been obtained. Details of time, temperature, and comparative results for all three batches of *Tamra Parpati* are presented in Table 7.

The organoleptic characteristics of *Tamra Parpati* are given in Table 3. The results of the physicochemical parameters for three batches of *Tamra Parpati,* named pH, Loss on drying, Ash value, Loss on ignition, Acid insoluble ash, CS2 soluble extractive, Benzene extractive, Water soluble extractive and Alcohol soluble extractive, are given in Table 9.

Table 3: Organoleptic characteristics of *Tamra Parpati*

Organoleptic characteristics	Observation
***Rupa* (colour)**	Black
***Rasa* (taste)**	Tasteless
***Gandha* (Odour)**	Odour of SO_2 on grinding
***Sparsha* (Touch)**	Soft & Smooth

Table 4: Detailed Observation of *Tamra Parpati* Batch-1

TP No.	Initial weight of material (g)	Start Melting			Complete Melting			Final Weight of Material (g)
		Temp. of Material °C	Temp. of Sand °C	Time (min)	Temp. of Material °C	Temp. of Sand °C	Time (min)	
1	10.11	111	265	3.16	125	280	6.52	10.427
2	10.11	105	274	2.25	123	275	5.25	10.206
3	10.11	108	280	3.32	122	278	5.56	9.977
4	10.11	110	276	3.10	128	285	5.12	10.323
5	10.11	115	280	2.25	120	288	6.29	10.341
6	10.11	120	288	1.52	130	300	4.48	10.361
7	10.11	119	285	3.58	128	280	5.58	10.297
8	10.11	120	278	3.13	129	275	5.15	10.190
9	10.11	121	270	3.28	135	282	4.30	10.338
10	10.11	118	275	2.39	130	285	5.46	10.284
Mean ± SD.	10.11 ±0.00	114.7 ±5.774	277.1 ±6.756	2.59 ±1.5	127 ±4.496	282.8 ±7.405	5.37 ±1.9	10.274 ±0.125

Table 5: Detailed Observation of *Tamra Parpati* Batch-2

TP No.	Initial weight of material (g)	Start Melting			Complete Melting			Final Weight of Material (g)
		Temp. of Material °C	Temp. of Sand °C	Time (min)	Temp. of Material °C	Temp. of Sand °C	Time (min)	
1	10.11	111	272	3.44	121	280	5.52	10.063
2	10.11	122	275	3.57	126	278	5.57	10.262
3	10.11	120	280	3.19	124	280	4.19	10.007
4	10.11	118	285	3.34	122	284	5.34	10.225
5	10.11	122	286	2.43	126	288	4.48	10.248
6	10.11	119	288	2.53	128	298	4.53	10.248
7	10.11	121	284	3.15	128	280	5.15	10.060
8	10.11	121	278	3.27	124	285	5.27	10.028
9	10.11	115	285	3.38	126	289	5.38	10.578
10	10.11	118	295	1.52	127	300	4.52	10.203
Mean ± SD.	**10.11**	118.7 ±3.465	282.8 ±6.713	3.14 ±1.3	125.2 ±2.394	286.2 ±7.671	5.15 ±0.50	**10.192 ±0.168**

Table 6: Detailed Observation of *Tamra Parpati* Batch-3

TP No.	Initial weight of material (g)	Start Melting			Complete Melting			Final Weight of Material (g)
		Temp. of Material °C	Temp. of Sand °C	Time (min)	Temp. of Material °C	Temp. of Sand °C	Time (min)	
1	10.11	115	274	3.49	127	282	5.58	10.013
2	10.11	117	284	2.13	125	280	6.13	10.169
3	10.11	118	280	1.52	126	285	5.25	10.279
4	10.11	120	286	3.38	128	288	4.32	10.261
5	10.11	124	278	2.50	130	282	5.50	10.194
6	10.11	117	280	1.52	130	286	5.56	10.136
7	10.11	117	285	3.14	128	280	6.13	10.202
8	10.11	126	279	3.16	132	278	6.25	10.007
9	10.11	118	285	3.30	135	290	5.30	10.502
10	10.11	118	295	2.43	128	298	4.53	10.270
Mean ± SD	10.11 ±0.00	119 ±3.431	282.6 ±5.777	2.53 ±1.14	128.9 ±2.960	284.9 ±5.971	5.41 ±1.4	10.203 ±0.142

Table 7 : Comparative Observations and Results of Three Batches of *Tamra Parpati*

Batch	Initial weight of material (g)	Start Melting			Complete Melting			Final Weight of Material (g)
		Temp. of Material °C	Temp. of Sand °C	Time (min)	Temp. of Material °C	Temp. of Sand °C	Time (min)	
TP1	101.11	114.7	277.1	2.59	127	282.8	5.37	102.74
TP2	101.11	118.7	282.8	3.14	125.2	286.2	5.15	101.92
TP3	101.11	119	282.6	2.53	128.9	284.9	5.41	102.03
Mean ± S.D.	101.11 ±0.00	117.466 ±2.40	280.833 ±3.234	3.2 ±0.33	127.033 ±1.85	284.633 ±1.715	5.31 ±0.14	102.23 ±0.44

Table 8 : Comparative Results of the Yield of *Tamra Parpati*

Batch	Initial wt. of Material (g)	Final wt. of Material (g)	Gain (g)	Percentage gain (%)
TP1	101.111	102.744	1.633	1.616
TP2	101.111	101.922	0.811	0.803
TP3	101.111	102.033	0.922	0.912
Mean±SD	101.111	102.233±0.44	1.122±0.446	1.110±0.441

Table 9: Results of Physicochemical Parameters of Three Batches of *Tamra Parpati*

S.N.	Parameters	Results			Mean±SD
		TP-1	TP-2	TP-3	
1	pH of 1% solution	7	7	7	7±0.00
2	Loss on drying %w/w	0.415	0.521	0.568	0.501±0.0784
3	Ash value %w/w	13.860	14.223	13.759	13.947±0.244
4	Loss on ignition %w/w	86.45	85.821	84.682	85.651±0.896
5	Acid insoluble ash %w/w	11.805	10.8	11.587	11.397±0.529
6	CS2 soluble extractive %w/w	17.561	15.126	14.381	15.689±1.663
7	Benzene extractive %w/w	13.250	12.890	12.070	12.737±0.605
8	Water soluble extractive %w/w	2.619	2.425	2.120	2.388±0.252
9	Alcohol soluble extractive %w/w	3.212	3.448	3.035	3.232±0.207

Discussion

The present study established a reproducible standard manufacturing process (SMP) and analytical profile for *Tamra Parpati*, prepared according to classical Ayurvedic reference. Standardisation of such herbomineral-metallic formulations is vital, as their therapeutic efficacy, safety, and batch-to-batch consistency depend greatly on raw material purification and validated quality parameters. This TP nomenclature is based on the use of *Tamra Bhasma* in the formulation. It is *Sagandha* (which contains sulfur), *Sagni* (associated with heat), *Murchhana* of *Parada*, and a thin, flake-like structure made by pressing the melted material between two surfaces. *Tamra Parpati* is a mixture of metal, mineral, and herbal drugs that undergoes several pharmaceutical procedures, including *Shodhana* (purification process), *Marana* (incineration), the preparation of *Vatsanabha* powder, and *Dwiguna Kajjali*.

On repeated heating and quenching of *Tamra* during the *Shodhana* process, cracks appeared on the surface of the *Tamra* flakes. Simultaneously, the flakes turned black in the red-hot stage, possibly due to the reaction between copper and

atmospheric oxygen and moisture, resulting in the formation of cupric oxide, which has a black appearance. The weight loss observed in successive cycles may be attributed to procedural reasons and adherence to the iron pan. Pharmaceutical observations indicated that both the *Samanya* and *Vishesha Shodhana* processes effectively changed *Tamra* physical properties including color, fragility, and particle size, thereby enhancing its suitability for further processing (23).

During the initial three *Puta* of *Tamra Bhasma* preparation the color of the *Bhasma* was bluish black with shiny crystals on the surface. This may be due to the use of *Marana Dravya Kajjali* (black sulphide of mercury) in the process. Throughout the heat treatment, copper repeatedly transforms into its sulfide form; thus, the TB appeared black because of cupric sulfide (CuS), which is black in color (24). After *Marana*, the weight of 300g of *Shuddha Tamra* increased by 3.11%, resulting in 311g of TB. This is likely because formation of copper oxides and sulfides (25). The inorganic contents of *Nimbu Swarasa* also contributed to the weight gain of TB. In the *Tamra Bhasma Amritikarana* process, EMF was used in place of the traditional *puta* method to avoid variations in the weight and quality of cow dung cake and seasonal variations as well. EMF is an advanced device that allows accurate adjustment of the temperature and duration of heat. For the *Amritikarana*, 60 g of *Tamra Bhasma* and 500 g of *Surana Kanda* were required. After the procedure, it has been observed that a 6% weight increase may be due to the inorganic (mainly calcium oxalate crystals) and organic (carbon) content of *Surana Kanda*. An unstable metallic compound like oxides, can be reduced to its metallic form through the carbon reduction process. This metallic copper can be further converted to sulfide in the presence of sulfur. Consequently, it can be inferred that the *Amritikarana* process eliminates any unstable compound (CuO in this case) and improves the stability of the product (CuS) (26). In the *Shodhana* process, *Parada* was treated with lime and garlic. Garlic contains sulfur, which has the ability to detoxify mercury due to its higher affinity for active sulfhydryl groups (27). Additionally, garlic's impact on heavy metal toxicity has been documented. Therefore, it may be effective in the processing of mercury to mitigate the toxic effects of elemental mercury (28). The weight loss of *Gandhaka* during the *Shodhana* process occurs because molten sulfur adheres to the cotton cloth used during *Dhalana*. Milk and ghee were used for their properties that help in eliminating sulfur toxicity (29). During the *Shodhana* process swelling and softening of the *Chanaka Pramāṇa Vatsanabha* suggested absorption of cow urine. This procedure enhances diffusion and facilitates the hydrolysis of toxic alkaloids, leading to detoxification of *Vatsanabha* (30). The overall yield after the *Shodhana* process decreased to 61% due to the removal of the outer covering of the *Vatsanabha* root. For the preparation of *Kajjali* it took 32 hours of trituration to achieve the chief desired characteristics, such as *Kajjalabhasa* (blackish, similar to *Kajal*), *Slakshnata* (smoothness), *Anjana Sadrusa, Sukshma* (minute, like *Anjana*), and *Rekhapurnata* (very fine powder) (31,32).

The ingredients of TP (Table 2) were properly mixed to form a uniform mixture that was used in all three batches. In each batch, 10.111g of material was heated in 10 cycles to make *Parpati* of a batch size of 101.11g. During the manufacturing process for *Madhyam Paka* of *Parpati*, a modified *Valuka Yantra* (Sand bath apparatus) was used to maintain a controlled temperature. For melting 10.11g of material in all three batches, an average of 5.31 minutes was required, with the temperature of the *Valuka Yantra* at 284°C and the temperature of the material at 127°C (Table 7). The material reached a mud-like consistency more quickly due to its small amount. During the heating process, smell and fumes of sulphur were profoundly observed, likely because the sulphur content in the *Kajjali* was doubled. Cow dung cake was used for immediate cooling of the melted mixture, and, as per the classical reference, Madar leaf was used as a barrier to avoid cross-contamination and to add some therapeutic value to the product. In all three batches of *Parpati* an average weight gains of 1.11% was observed. This is possibly because of the use of *Ghrita* during the intermediate step of *Tamra Parpati* manufacturing. Organoleptic analysis plays a significant role in ensuring the quality of Ayurvedic formulations, despite the advancements in scientific techniques and instrumentation. The final product appears soft and smooth to the touch, black, tasteless, and smells like SO_2 when ground.

Physicochemical analysis of all three batches reveals that the neutral pH (7.0), low moisture content (LOD = 0.50 ± 0.078%), and a high ash value (13.95 ± 0.24%), suggesting thermal stability and substantial inorganic content, as expected in a metal-mineral-based formulation. Loss on ignition values (85.65 ± 0.89%) indicate the predominance of combustible sulphur, organic matter, alongside inorganic metallic oxides. The acid-insoluble ash value (11.39 ± 0.52%) suggests the proportion of insoluble inorganic contents of TP. The CS_2 soluble extractive (15.68 ± 1.66%) and benzene extractive values (12.73 ± 0.60%) indicate the presence of sulfur and lipophilic compounds. While low water and alcohol soluble extractives indicate a minimal presence of polar phytoconstituents, this is due to the formulation being rich in metal and mineral content. Since there are no standard records for comparing the analytical values of TP, each analytical test was repeated three times to minimise errors for samples TP1, TP2, and TP3.

Conclusion

This study standardised the pharmaceutical and analytical profile of *Tamra Parpati* establishing a standard manufacturing process (SMP) and a validated analytical profile based on classical Ayurvedic reference. Pharmaceutical standardisation suggests that melting times, temperatures, and yields were consistent across batches, with an average percentage gain of 1.11 ± 0.44%, confirming process validity. Analytical evaluation of three batches of TP revealed a neutral pH, low moisture content, a significant inorganic composition, and stable organoleptic characteristics, establishing reproducible standards for this formulation, as it is not mentioned in the API (Ayurvedic Pharmacopoeia of India). However, it could not be compared with standard values. The study provides a reference framework that may serve as a basis for future pharmacological evaluation and clinical validation of *Tamra Parpati*.

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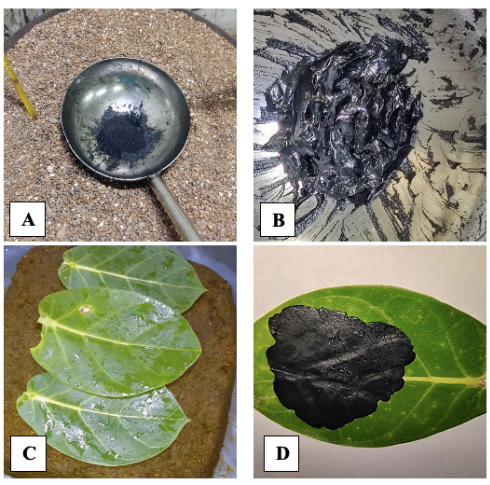
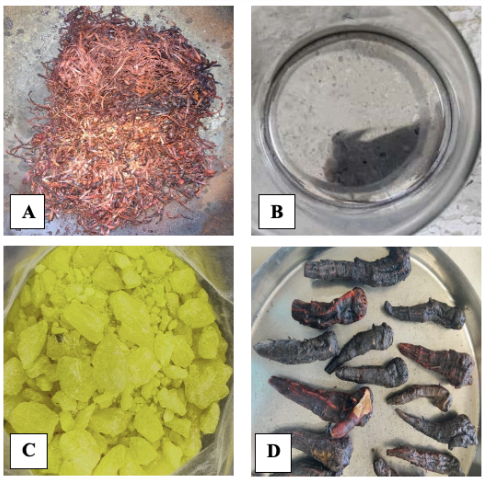
Figure 1 : Manufacturing process of *Tamra Parpati* as per text reference- Rasamritam



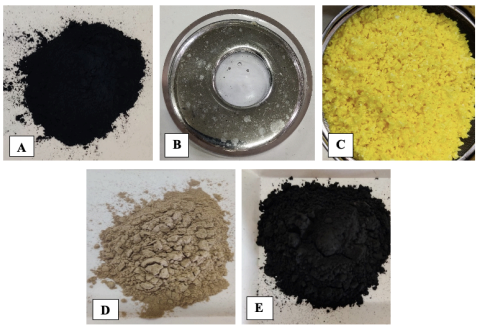
(a) Mixture of TP in a stainless steel ladle kept over a sand bath; (b) Melted mixture of TP; (c) Melted mixture kept between *Arka patra* (madar leaf) ; (d) Final flakes of TP

Figure 2: Ingredients of *Tamra Parpati* (unprocessed)



(a) *Ashuddha tamra*; (b) *Ashuddha parada*; (c) *Ashuddha gandhaka*; (d) *Ashuddha vatsanabha*

Figure 3: Ingredients of *Tamra Parpati* (processed)



(a) *Tamra bhasma*; (b)*Shodhita parada*; (c)*Shodhita gandhaka*; (d) *Shodhita vatsanabha* powder; (e)*Kajjali* (mixture of *Shodhita parada* and *Shodhita gandhaka*)

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