Pharmaceutical Standardization

Standard manufacturing process of Makaradhwaja prepared by Swarna Patra – Varkha and Bhasma

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Abstract

Makaradhwaja is an important Kupipakwa Rasayana. It is prepared by using Swarna (gold), Parada (mercury) and Gandhaka (sulfur) in different ratios, i.e. 1:8:16, 1:8:24 and 1:2:4, respectively. The amount of Gandhaka in the Jarana process is directly proportional to the increase in therapeutic efficacy and reduces the toxicity of the product. Specific temperature pattern for the preparation of Makaradhwaja has been followed. In the present study Swarna, Parada and Gandhaka were taken in the ratio 1:8:24, respectively, and 12 h of heating for a specified amount of Kajjali (i.e., 400 g) in a Kacha Kupi 1/3rd of its capacity. There are some controversies regarding the form of Swarna (i.e., Swarna Patra Swarna Varkha or Swarna Bhasma) used in the preparation of Makaradhwaja. Therefore, in the present study, the samples of Makaradhwaja were prepared by Swarna Patra, Varkha and Bhasma in different batches. It was found that the use of Varkha produced a good-quality product along with the maximum amount of gold, i.e. 268 ppm, in comparison with Patra, i.e. 131 ppm, and Bhasma, i.e. 19 ppm, respectively.

Key words: Bhavana, Hingulotttha Parada, Kupipaka, Standard manufacturing process, Shodhana

Introduction

Makaradhwaja is a popular Kupipakwa Rasayana, prepared with the Swarna (gold), Parada (mercury) and Gandhaka (sulfur) in a specified ratio. It was first described by Rasendra Chintamani\(^1\) by the name of Chandrodaya Rasa, although the word Makaradhwaja was first coined by Rasaratnakara. The term Makaradhwaja is composed of two words, i.e. Makara and Dhwaja. The term Makaradhwaja is also a synonymous of Kamadeva,\(^2\) the God of beauty. When it is used for therapeutic purposes, it produces Rasayana and Vrishiya (in literary meaning, Makara indicates the aphrodisiac because Makara Retasa has been described as best Shukrula\(^3\) while Dhwaja [straight rod or flagpole] indicates its sexual potency. It is directly correlates the Dhwajabhanga, i.e. non-erection of penis.) property. A total of 30 formulations\(^4\) are found described by the name of Makaradhwaja and Chandrodaya, and two types of instruments are used for its preparation, i.e. Valuka Yantra and Khalb Yantra. Nowadays, Makaradhwaja is generally prepared as per the reference of Rasendra Chintamani due to easy and convenient preparation method; here, Swarna, Parada and Gandhaka are used in 1:8:16 ratio, but in different Rasa classics it is found described that the amount of Gandhaka is directly proportional to the therapeutic activity.\(^5\) Therefore, in this study, the ratio was followed as per the Bhaishajya Ratnavali, i.e. 1:8:24.

Aims and objective

The aim of the study was to develop the Standard Manufacturing Process (SMP) for Makaradhwaja prepared by Swarna-Patra-Varkha and Bhasma by Electrical Muffle Furnace (EMF).

Materials and Methods

Swarna was collected from a local authentic hallmark-certified Jeweler from Jamnagar. Hingula, Tila Taila, Gandhaka and Kulattha were collected from the Pharmacy, Gujarat Ayurved University, Jamnagar. Yakra, Kanji, Kulattha Kwatha, Japakusuma Swaras, Kamari Swaras, Nimbu Swaras etc. were taken as per the classical reference and processed through prescribed methods. The whole process has been divided into the following:
**Shodhana of raw materials**

Kantakavedhi Swarna Patra was prepared from 24 carat gold biscuits on the machine that had 2.5 cm breadth, 150 cm length and 0.5 mm diameter. For Samanya shodhana, these Kantakavedhi Swarna Patra were heated up to red hot through a Gas blower and dipped into prescribed liquid media three times. [6] Gandhaka[7] was melted along with Goghruta and poured into the Godugha. Then, Swedana (heating under liquid bath) was done for 3 hrs. After that, it was washed with hot water, dried and powdered [Table 1].

**Hingulottha Parada Nirmana**

Shodhana of Hingula was done by giving Bhavana of lemon juice three times.[8] After that, it was washed, dried and stored. The required amount of Parada was extracted from Hingula by Nada Yantra method. Fine powder of Shuddha Hingula was wrapped in cotton cloth (equal weight of Hingula) and burnt under the pot. Thus, due to heat, the sulfur part of Hingula burns and leaves the Parada, which gets evaporated as vapor and is collected on the inner side of the pot. Parada was collected by rubbing with cloth and then washing with hot water and filtering through four folders of cloth. This Parada was used to prepare Makaradhwaja [Table 2].

**Preparation of Swarna Varkha**

Shodhita Swarna Patra was cut into small pieces (2 cm × 4 cm length). Then, these Patra were continuously hammered with the help of an iron hammer in the leather bags up to the Varkha formation. This procedure was performed in Ahmedabad under supervision. The thickness of the Varkha was not measured because it was too thin. This Varkha was then used in the preparation of Swarna Pishti.

**Preparation of Swarna Bhasma**

Shuddha Swarna Patra was cut into fine pieces and triturated with the Hingulottha Parada up to Pishti (amalgam) formation and then this amalgam was kept between Shuddha Gandhaka in Sharava, i.e. Swarna Pishti was covered completely by Shuddha Gandhaka. Sharava Sampata was prepared and after complete drying, it was subjected to heat. After each Puta, Parada was reduced by 1/16th from the quantity of the initial Parada and the Gandhaka was in equal quantity of Swarna up to the last Puta. But, here, a total of 30 Puta were required for the preparation of Swarna Bhasma up to Kumkum colored without shining of particles.[9]

**Preparation of Swarna Pishti**

Shuddha Swarna patra were cut into small pieces. Hingulottha Parada was taken in Simaka Khulvanyastra and, after that, Shuddha Swarna Patra pieces were added one by one to it with proper trituration. The mixture was triturated up to a homogeneous form. The Nimbu Swarasa was added for proper preparation of amalgamation. Thus, semisolid, soft Swarna Pishti (amalgam of gold) was formed.[10]

The second batch of Swarna Pishti was prepared from Swarna Varkha and Hingulottha Parada; Nimbu Swarasa was not needed because it was prepared within few minutes by simple trituration.

The third batch of Swarna Pishti was prepared from Swarna Bhasma and Hingulottha Parada, with the addition of Nimbu Swarasa. But, for this, a large quantity of Nimbu Swarasa and a longer period of trituration was required even it was not properly prepared so that an equal amount of Saindhava Lavani[11] was added to it and again triturated till the formation of Pishti [Table 3].

**Preparation of Kajjali of Makaradhwaja**

The Swarna Pishti (amalgam of gold) was taken in a Simaka Khulvanyastra and Shuddha Gandhaka was added to it in the prescribed quantity. Mardana was done for 24 hrs till fine, soft, Nishebandra Kajjali was formed [Table 4]. This was subjected to Bhavana Dravya of Jatpakusma Swarasa, which was added to it in an adequate amount to wet the Kajjali (Rasapankavat) semisolid and Mardana was carried out for 3 hrs, till the homogeneous, soft mass was formed and then it was dried in sunlight[12] [Table 5]. The same procedure was repeated by adding the Bhavana Dravya, i.e. Kumari Patra Swarasa, and it was taken 1/4th of the total amount of Kajjali as it was found to be sufficient to wet the total material.[13] The observations of Kupibharana of Makaradhwaja are shown in Table 6.

**Preparation of Makaradhwaja Apparatus**

Mortar and pestles, Kanchakupi, Multani mitti, cloth, Loha shalakas-2, kerosene oil, matchbox, thread, enamel tray, glass container, cork, copper coin, torch, knife; Electric muffle furnace: Outer length: 40 cm, breadth: 40 cm, height: 50 cm, Inner hearth length: 15 cm, breadh: 15 cm, depth: 30 cm, Kanchakupi: Amber-colored beer bottle, capacity: 625 ml, total height: 28 cm, cylindrical part: Height: 14 cm; circumference: 24.5 cm; diameter of the bottom: 6.5 cm, conical part: Height: 14 cm; diameter of the mouth: 2cm, weight: Before Kapadamitti: 450 g; after Kapadamitti: 590 g.

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**Table 1: Observation of Shodhana of the raw materials**

| Drug        | Media           | Method     | Initial weight (ml) | Final weight (ml) | Loss/gain (ml) | Duration (days) |
|-------------|-----------------|------------|---------------------|-------------------|---------------|-----------------|
| Swarna      | Tila taila      | Nirvapa    | 155                 | 155               | 00↓           | 1               |
| Samanya     | Takra, gomutra, Kanji, Kulattha Kwatha | 3 times in each |                      |                   |               |                 |
| Shodhana    | Godugdha        | Dhalana    | 5000                | 4810              | 190↓          | 1               |

**Table 2: Observation of extraction of Parada from Hingula**

| Quantity of Hingula (g) | Quantity of cotton cloth (g) | Method                          | Time taken (hrs) | Procured amt. of Parada (g) | Procured amount of Parada (%) |
|-------------------------|-------------------------------|---------------------------------|------------------|-----------------------------|-------------------------------|
| 3000                    | 3000                          | Urduhvapatan by Nada yantra     | 8                | 2196                        | 73.20                         |
Table 3: Observations of Swarna Pishti from Swarna Patra, Varkha and Bhasma

| Batch | Weight of Swarna Bhasma (g) | Weight of H.Parada (g) | Nimchandratva, Rekharupurtavata of Kajjali (h) | Weight of Saindhava Lavana (g) | Duration (h) |
|-------|-----------------------------|------------------------|-----------------------------------------------|-----------------------------|--------------|
| MP    | 125                         | 1000                   | 90                                            | -                           | 12           |
| MV    | 30                          | 240                    | -                                             | -                           | 1            |
| MB    | 40                          | 320                    | 150                                           | 40                          | 32           |

MP: Makaradhwaja prepared by Swarna Patra, MV: Makaradhwaja prepared by Swarna Varkha, MB: Makaradhwaja prepared by Swarna Bhasma

Table 4: Observations during preparation of Kajjali of Makaradhwaja

| Batch | Weight of Swarna Pishti (g) | Weight of S.Gandhaka (g) | Total | Nimchandratva, Rekharupurtavata of Kajjali (h) | Weight of Mardana period (h) | Weight of Kajjali after Mardana (g) | Weight loss during Mardana (g) |
|-------|-----------------------------|--------------------------|-------|-----------------------------------------------|----------------------------|----------------------------------|----------------------------------|
| MP    | 1098                        | 3000                     | 3098  | 16                                            | 24                         | 3028                             | 70                               |
| MV    | 270                         | 720                      | 990   | 12                                            | 24                         | 973                              | 17                               |
| MB    | 360                         | 960                      | 1320  | 16                                            | 24                         | 1292                             | 28                               |

Table 5: Observations during Bhavana processing of Kajjali of Makaradhwaja

| Batch | Weight of Kajjali after Mardana (g) | Japakusuma Swaras (ml) | Total Mardana period (hrs) | Kumari Swaras (ml) | Total Mardana period (hrs) | Weight of Kajjali after Bhavana (g) | Weight increased due to Bhavana Weight (g) |
|-------|-------------------------------------|------------------------|---------------------------|-------------------|---------------------------|-------------------------------------|------------------------------------------|
| MP    | 3028                                | 750                    | 3                         | 750               | 3                         | 3183                                | 155                                       | 4.86                                      |
| MV    | 973                                 | 250                    | 3                         | 250               | 3                         | 993                                 | 20                                        | 2.10                                      |
| MB    | 1292                                | 325                    | 3                         | 325               | 3                         | 1341                                | 49                                        | 3.79                                      |

Table 6: Kupikabharana of Makaradhwaja

| Batch | No. of Kupi | Sub batch | Weight of Kajjali (g) | Duration of heat (hrs) |
|-------|-------------|-----------|-----------------------|------------------------|
| MP    | 9           | MP1       | 424                   | 12                     |
|       |             | MP2       | 424                   | 12                     |
|       |             | MP3       | 424                   | 12                     |
|       |             | MP4       | 424                   | 12                     |
|       |             | MP5       | 424                   | 12                     |
|       |             | MP6       | 424                   | 12                     |
|       |             | MP7       | 424                   | 12                     |
|       |             | MP8       | 424                   | 12                     |
|       |             | MP9       | 424                   | 12                     |
| MV    | 3           | MV1       | 330                   | 12                     |
|       |             | MV2       | 330                   | 12                     |
|       |             | MV3       | 330                   | 12                     |
| MB    | 4           | MB1       | 330                   | 12                     |
|       |             | MB2       | 330                   | 12                     |
|       |             | MB3       | 330                   | 12                     |
|       |             | MB4       | 330                   | 12                     |

Procedure

The Bhavita Kajjali of Makaradhwaja was taken, triturated well in Khalvayantra and filled in Kanchakupi [Table 6]. The Kupi was placed exactly at the center of the electric muffle furnace and fixed in proper position with the help of firebrick blocks. The heating process was carried out in a Kramagni pattern, i.e. increasing order but intermediate heating. Heat was gradually increased over a period as per the schedule, i.e. 3 hrs Mandagni (120-250°C), 6 hrs Madhyamagni (250-450°C), 3 hrs Tivragni (450-600°C). The temperature of the furnace was recorded after intervals of 30 min. During the course of heating, the hot Shalaka was repeatedly inserted into the mouth of the Kupi to burn the accumulated sulfur at the neck of the bottle to prevent blocking. After achieving the confirmative test, the mouth of the Kupi was corked and the temperature was increased up to 600°C and it was maintained for the next 2 hrs. [Table 7]. Then, the Muffle furnace was switched off and left for self-cooling. After Swangsheeta, Kanchakupi was taken out from the muffle furnace and the outer covering was removed; a thread (which was soaked in kerosene) was tied below 1 inch from the final product and ignited. Then, a few drops of water were sprinkled, which leads to break the Kupi, and finally, Makaradhwaja was collected from the neck of the Kupi. Swarna powder was collected from the bottom of the Kupi. The Makaradhwaja was triturated well in Khalva yantra up to a fine red color powder [Table 8]. Makaradhwaja samples were analyzed by employing various possible organoleptic, physical and chemical parameters [Tables 9 and 10]. The same procedures were followed for all three samples of the Makaradhwaja, i.e. for Swarna Patra, Swarna Varkha and Swarna Bhasma. A total of 17 batches were prepared to determine the SMP [Tables 8 and 11].

Discussion

For the preparation of Kupipakwa rasayana, preparation of Kajjali and heating pattern are the most important factors to obtain maximum quantity of yield and to increase efficacy of the product without any untoward effect. As per classical texts, the Kramagni heating pattern should be provided during processing of any Kupipakwa rasayana. It means temperature pattern should...
Table 7: Observations during Kupipaka of Makaradhwaja (MP, MV and MB avg)

| Time (hrs) | Temp. setting (°C) | Temp. recorded (°C) | Observations |
|-----------|--------------------|--------------------|--------------|
| 00:00     | 100                | 37                 | Switch on the furnace |
| 00:30     | 150                | 105                | Slight sulfur aroma was smelt at the Kupi mouth White fumes started |
| 01:00     | 200                | 156                | Fumes turn slightly yellowish |
| 01:30     | 250                | 204                | Fumes turn slightly yellowish |
| 02:00     | 250                | 251                | Melting of Kajjali started and yellowish fumes continued |
| 02:30     | 300                | 254                | Melting of Kajjali with yellowish fumes continued |
| 03:00     | 300                | 305                | Yellowish color deposition at the neck |
| 03:30     | 350                | 302                | Kajjali-semi liquid form, yellowish fumes increased |
| 04:00     | 350                | 347                | Kajjali-molten and yellowish fumes increased |
| 04:30     | 400                | 352                | Complete molten Kajjali and yellowish fumes increased |
| 05:00     | 400                | 399                | Persisting yellow fumes |
| 05:30     | 400                | 398                | Persisting yellow fumes |
| 06:00     | 450                | 403                | Yellowish fumes increased, stickiness was found inside the Kupi |
| 06:30     | 450                | 452                | Profuse dark yellowish fumes started |
| 07:00     | 475                | 454                | Profuse yellowish fumes |
| 07:30     | 475                | 478                | Fumes disappeared and reddish blue-colored flame started |
| 08:00     | 500                | 476                | Flame increases to about 4-5 inches height |
| 08:30     | 500                | 501                | Flame gradually decreased and slight sulfur deposit found at Kupikantha (neck of the Kupi). Red tinge at Kupitala (bottom of the Kupi) was observed |
| 09:00     | 550                | 499                | Slight bluish flames persisting at the neck of the Kupi and red tinge at the bottom gradually increased |
| 09:30     | 550                | 554                | Flame disappeared, bottom of the Kupi was found bright red, Sheeta Shalaka test and copper coin test were found to be positive. Corking was done immediately at 9.25 hrs |
| 10:00     | 600                | 553                | Temperature maintained till the completion of heating |
| 10:30     | 600                | 599                | Temperature maintained till the completion of heating |
| 11:00     | 600                | 598                | Temperature maintained till the completion of heating |
| 11:30     | 600                | 604                | Temperature maintained till the completion of heating |
| 12:00 stop|                    |                    | Furnace was switched off and left for self-cooling |

MP: Makaradhwaja prepared by Swarna patra, MV: Makaradhwaja prepared by Swarna Varkha, MB: Makaradhwaja prepared by Swarna Bhasma

Table 8: Results of preparation of Makaradhwaja of the different batches

| Batch | No. of Kupi | Sub batch | Weight of Kajjali (g) | Makaradhwaja (g) | % of Makara obtained | Residue (g) | % res |
|-------|-------------|-----------|----------------------|------------------|----------------------|-------------|-------|
| MP    | 9           | MP1       | 424                  | 92               | 86.85                | 20          | 4.7   |
|       |             | MP2       | 424                  | 89               | 83.96                | 20          | 4.7   |
|       |             | MP3       | 424                  | 96               | 90.56                | 15          | 3.5   |
|       |             | MP4       | 424                  | 101              | 95.28                | 15          | 3.5   |
|       |             | MP5       | 424                  | 102              | 96.22                | 19          | 3.5   |
|       |             | MP6       | 424                  | 95               | 89.62                | 21          | 4.4   |
|       |             | MP7       | 424                  | 109              | 102.83               | 21          | 4.9   |
|       |             | MP8       | 424                  | 101              | 95.28                | 30          | 7.0   |
|       |             | MP9       | 424                  | 114              | 107.54               | 18          | 4.2   |
| Avg.  |             |           | 99.88                | 94.22            | 19.88                | 4.6         |
| MV    | 3           | MV1       | 330                  | 55.6             | 59.78                | 31          | 9.3   |
|       |             | MV2       | 330                  | 77               | 82.79                | 12          | 3.6   |
|       |             | MV3       | 330                  | 81               | 87.09                | 12          | 3.6   |
| Avg.  |             |           | 71.2                 | 76.2             | 18.3                 | 6.1         |
| MB    | 4           | MB1       | 330                  | 79               | 84.94                | 11          | 3.6   |
|       |             | MB2       | 330                  | 82               | 87.66                | 12          | 3.9   |
|       |             | MB3       | 330                  | 86               | 92.14                | 12          | 3.9   |
|       |             | MB4       | 330                  | 81               | 86.78                | 13          | 4.2   |
| Avg.  |             |           | 82                   | 87.8             | 12                   | 3.9         |
be an increasing order but intermediate heating process. In can be divided into three stages, i.e. Mridu, Madhya and Tivra agni. Here, Mriduagni indicates the melting stage of Kajjali, Madhyamanagni indicates the boiling stage of Kajjali and Tivra agni means immense heating, which takes place a confirmative test of the final product. One such effort had been done by Prajapati et al.,[13-15] who has given the temperature range for the particulars of Agni, such as-Mridu Agni 120-250°C (6 hrs), Madhyama Agni 250-450°C (6 hrs), Tivra Agni 450-650°C (6 hrs). This standardization was done in an electric muffle furnace for the preparation of Makaradhwaja in the ratio of 1:8:16, and the same was also followed by Chinta Durga et al.,[16] and Patgiri et al.[17,18]

But, for the present study, to prepare the Triguna Balijarita Makaradhwaja in minimum heat duration, the heating pattern was changed. As the proportion of Gandhaka increases with Parada, i.e. balijarana, it was observed that there is an increase in the heating duration for the Jarana. Here, an attempt was made to prepare the same in minimum time with least consumption of energy while maintaining its therapeutic efficacy. Therefore, the duration of Mriduagni and tivraagni period was decreased without disturbing the madhyamagni duration (i.e., Mriduagni for 3 hrs, Madhyamaagni for 6 hrs and Tivraagni for 3 hrs). Because of a higher amount of Kajjali in Makaradhwaja prepared by the Swarna Patra sample, each batch was prepared with 424 g of Kajjali whereas in the Varkha and Bhasma samples, because of the lesser amount, it was prepared with 330 g of Kajjali in the same heat duration for the standardization purpose.

The Hingulottha Parada was used because as per classical text, its properties are equal to those of Astasamskrarita Parada.[19] For the preparation of Swarna Pishiti of Varkha, only 1 hr was required as compared with 12 hrs required for Swarna Patra, which may be because the particle size of Swarna Varkha is too fine as against that of Swarna Patra. In the preparation of Pishiti of Swarna Bhasma 32 hrs were required, which was too much in comparison with that required for Swarna Varkha and Swarna Patra; the reason behind this may be that the Swarna Bhasma is not in elemental form, which leads to the extra time taken for the amalgamation with Parada [Table 3].

The Nischandratva and Rekhapurnatva tests of Kajjali were passed in 16 hrs, but 24 hrs trituration was done for the fineness. The weight of Kajjali was found to be increased (3.5% on an average) after Bhavana, which may be due to the added solid contents of Japakusuma Swarasas and Kumari Swarasas [Table 5].

It was observed during a trial and error study that the amount of Gandhaka is directly proportional to the burning period. Therefore, as per the classical notes, a specific temperature pattern was mentioned for the Samguna Kajjali Sindura, i.e. Mridu Agni, Madhyama Agni and Tivraagni in an equal ratio. In this, Gandhaka was just in the melting stage in the Mriduagni while in the Madhyama Agni stage, Gandhaka boils and burns and in the Tivra Agni period, Parada with Gandhaka sublimes. Thus, the temperature required for the melting of Gandhaka and sublimation of the product is not dependent on the amount of Gandhaka. Taking note of this, the period of Mridu and Tivra Agni was not changed but the period of Madhyama Agni was increased twice of the normal ratio due to which an excess amount of Gandhaka gets more period for the burning, which is the main aim. Also, in the previous study, it was found that Samaguna and Dwigruna Sindura were prepared in 16-20 hrs. Here, an attempt was made to prepare the Triguna

### Table 9: Classical analytical tests of the Makaradhwaja samples

| Pariksha | MP | MV | MB |
|----------|----|----|----|
| Varna    | Red| Red| Red|
| Sparsh   | Slakshana| Slakshana| Slakshana|
| Gandha   | Not specific | Not specific | Not specific |
| Rasa     | Tasteless | Tasteless | Tasteless |
| Shabda   | +ve | +ve | +ve |
| Rekhapurthamata | +ve | +ve | +ve |

*+ve - Compiles as per classics, MP-Makaradhwaja prepared by Swarna patra, MV-Makaradhwaja prepared by Swarna Varkha, MB-Makaradhwaja prepared by Swarna Bhasma*

### Table 10: ICP analysis of the Makaradhwaja sample

| Element | Sample results of MP mg/kg (ppm) | Sample results of MV mg/kg (ppm) | Sample results of MB mg/kg (ppm) |
|---------|----------------------------------|----------------------------------|----------------------------------|
| Au (mg/kg) | 131 | 268 | 19 |
| Hg (%) | 82.9 | 80.1 | 81.6 |

*MP-Makaradhwaja prepared by Swarna patra, MV-Makaradhwaja prepared by Swarna Varkha, MB-Makaradhwaja prepared by Swarna Bhasma*

### Table 11: Standard manufacturing procedure for the preparation of Makaradhwaja

| No. of process | Quantity of ingredient | Method | Yantra | Temp. | Duration (hrs) |
|---------------|------------------------|--------|--------|-------|----------------|
| Swarna Pishiti | Swarna Patra + Hingulottha Parada | Mardon | Kajjali yantra | - | 12:00 |
| Swarna Varkha | Shuddha Swarna | Mardon | Kajjali yantra | - | 01:00 |
| Swarna Bhasma | Bhasma + Hingulottha Parada | Mardon | Kajjali yantra | - | 32:00 |
| Kajjali | Swarnapishiti + 24-times Shuddha Gandhaka | Mardon | Kajjali yantra | - | 24:00 |
| Bhavana | 1. Japakusuma Swarasas | Mardon | Kajjali yantra | - | 03:00 hrs each |
| | 2. Kumari Swarasas | | | | |
| Kupipaka | Makaradhwaja kajjali | Kupipaka | EMF | Kramagni up to 600°C | 12:00 |
Balijarita Makaradhwaja in a minimum heating period, which was 12 hrs (Tables 6 and 7). For this, many trial and error studies were carried out to finalize the temperature pattern. During the Kupipaka, flame of sulfur occurred at the neck of the Kajj after 7.30 hrs on an average, which was continued for 1.45 hrs (Table 7).

An average of 94.22% of the Makaradhwaja was prepared by the Swarna Patra with residue (gold powder) of 4.6%, also 76.2% of Makaradhwaja and 6.1% of gold powder was prepared by Swarna Varkha with 87.8% of Makaradhwaja and 3.9% gold powder was prepared by Swarna Bhasma (Table 8).

The first sample of Makaradhwaja prepared by Swarna Varkha was not properly sublimed due to irregular electrical power so that the average percentage of the final product of Makaradhwaja was decreased and residue (gold powder) was increased compared with the other two samples. Analytically, there were no changes found in loss on drying, ash value, acid-insoluble ash and carbon disulfide extract.

But, in the ICP analysis for gold content, it was found to be 268 ppm in Makaradhwaja prepared by Swarna Varkha whereas in a previous study (Patgiri et al.),[29] Makaradhwaja prepared by Swarna Patra found only 7.5 ppm and also by author prepared Makaradhwaja prepared by Swarna Patra and Bhasma was found to be 131 ppm and 19 ppm. This variation found in the gold content may be due to the particle size of the raw material (gold), because the particle size of Swarna Varkha is least compared with the Swarna Patra and, in the Bhasma form, gold is not as elemental as the form of gold. Thus, here, it is observed that least particle size of elemental gold increases the gold content in the sublimed Makaradhwaja. This increased concentration of gold content in sublimed Makaradhwaja enhances the therapeutic efficacy of Makaradhwaja, which has been also observed in comparative clinical trials of Makaradhwaja prepared by Swarna Patra-Varkha and Bhasma on Madhumeha (diabetes mellitus),[21] and pharmacological studies also supports this.

Figure 1: The average temperature pattern for preparation of Makaradhwaja through the electrical muffle furnace

**Conclusion**

Makaradhwaja has been standardized in terms of time and temperature for 330-424 g. Kajjali (average), i.e. Mrudu Agni: 100-250°C (2.5 hrs), Madhyamagni: 250-450°C (5 hrs), Tirragni: 450-600°C (4.5 hrs). Makaradhwaja prepared by least particle size of elemental gold increases the concentration of gold content in the sublimed Makaradhwaja [Figure 1].

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