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'COMPARATIVE STUDY OF PHYSICO-CHEMICAL CHARACTERISTICS OF SWARNAMAKSHIK BY DIFFERENT SHODHAN METHODS W.S.R. TO RASARATNA SAMUCHCHYA'

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ABSTRACT

The purpose of *shodhan* is to enhance medicinal or beneficial properties and to limit or nullify the harmful or unwanted properties of *Swarnamakshik*. Present work is concerned with *Swarnamakshik Shodhan* by three different processes of *shodhan* with special reference to *Rasaratna Samuchchaya*. In first *Shodhana* process, *Swarnamakshik* will be roasted in the *Eranda Tail* and *Matulungambu*. In second Shodhana process, *Swarnamakshik* will be subjected to *Swedana* in *Kadali kanda Swarasa*, whereas in third process, *Nirwapana* of *Swarnamkshik* in *Triphala Kwatha* for 7 times will be done. Their physico-chemical characteristics by organoleptic as well as modern techniques like Gravimetric analysis, XRD, SEM-Edax of these *Shuddha Swarnamakshik* carried out. From above study it can be concluded that there are differences in physicochemical characters *Shuddha Swarnamakshik* prepared from three different *Shodhan* procedures.

KEYWORDS- Shuddha Swarnamkshik, Gravimetric analysis, XRD, SEM-Edax.

INTRODUCTION

Rasashastra is one of the special branch of *Ayurveda* which deals with the usage of various minerals along with their identification, purification, incineration & therapeutic utility. After the development of Rasashastra metals like *Swarn, Rajat, Tamra* etc. were found

therapeutically useful after processing them to various pharmaceutical process such as *Shodhan, Marana, & Amritikarana*.

Swarnamakshik is one among *Maharasa*. It is also included in *Upadhatu*. On reviewing Ayurvedic classics, it is evident that therapeutic use of *Swarnamakshik* has been in practice since samhita period. *Swarnamakshik* is copper pyrite or chalco pyrite (Cu_2S Fe_2S_3). It is compound of Copper, Iron, & Sulphur. So it is also called as '*Tamragandhaayas*'. *Swarnamakshik* has given very much importance in both *Dehavada* and *Dhatuvada.* Impure *swarnamakshik* can cause *mandanala, kushtha, halimak, akshibadha* etc. so it is necessary to purify impure *Swarnamakshik* by *shodhan* methods. The purpose of shodhan is to enhance medicinal or beneficial properties and to limit or nullify the harmful or unwanted properties of *Swarnamakshik.* Different shodhan methods has been mentioned in many Rasashastra *granthas*. So an attempt has been made to compare physico-chemical characteristics of *shuddha Swarnamakshik* purified by different *shodhan* methods w.s.r. to *Rasaratna Samuchchaya.*

MATERIALS AND METHODS

It was carried out in three steps.

Step 1

Equipments: Weighing balance, Iron mortar and pestle, Iron pan, Iron ladle, Charcoal furnace, Glass beaker, Holder.

Procedure

Extraction of *Matulungambu- Matulunga* were taken, cut at the centre and juice was extracted by manual method, filtered through a clean cloth and the juice was collected in the beaker. Impure *Swarnamakshik* was taken & weighted. *Swarnamkshik* was powdered with the help of iron mortar and pestle. A clean and dry iron pan was then heated on charcoal furnace. In iron pan mix fine powder of *Swarnamakshik* and castor oil uniformely and subjected to intense heat. After some time mixture caught the fire. Then *Matulungambu* was added on mixture of *Swarnamakshik* and castor oil. Heat was given till it becomes dry powder. *Sharav* was kept over iron pan and kept it for self cooling.

Step 2

Equipments: Weighing balance, Cloth, Gas burner, Measuring cylinder, Glass beaker, Filter paper, Thermometer.

Procedure

Impure *Swarnamakshik* was taken & weighted. *Swarnamakshik* was then tied in a cotton cloth to form a *pottali.* It was hanged in a glass beaker. Care was taken to see that it does not touch bottom of vessel. The vessel was filled with *Kadali kanda swarasa* until the *pottali* was fully immersed. The level of *Kadali kanda swarasa* was marked. Heat was given to the beaker until the *Kadali kanda swarasa* just starts boiling. The temperature was measured with thermometer and maintained throughout. When the level of *Kadali kanda swarasa* started reducing, *Kadali kanda swarasa* of same temperature was added to maintain it. The heat was given continuously for 2 *Ghatika* (48 minutes). After that, when *Kadali kanda swarasa* attained room temperature, *Swarnamkshik* was removed from *Pottali.* It was wiped and weighed. It was stored in a labeled airtight container.

Step 3

Equipment's: Weighing balance, Gas burner, Measuring cylinder, Glass beaker, Filter paper, Forceps.

Procedure

Impure *Swarnamakshik* was taken & weighted. The *Swarnamakshik* was placed in fire till it turned red hot. *Triphala Kwath* was taken in glass beaker. The red hot *Swarnamakshik* was immediately quenched in *Triphala kwath*. When *Swarnamakshik* acquired the room temperature, it was completely drained and wiped clean. Then again *Swarnamakshik* was placed in fire. The same procedure was repeated for 7 times. Each time, different glass beaker containing *triphala kwath* was used. In procedure, the time required for the *Swarnamakshik* to become red hot (Heating time) and the time taken to acquire the room temperature (Cooling time) were noted.

RESULT AND DISCUSSION

Percentage of Copper in Raw *Swarnamakshik* By Gravimetric Analysis:

Sample	**Cu %**
Raw *Swarnamakshik*	9.44%
According to API Standards	Not Less than 5%

Percentage of Iron in Raw *Swarnamakshik* By Gravimetric Analysis:

Sample	**Fe %**
Raw *Swarnamakshik*	46.21%
According to API Standards	Not Less than 20%

Percentage of Sulphur in Raw *Swarnamakshik* By Gravimetric Analysis:

Sample	S%
Raw *Swarnamakshik*	33.08%
According to API Standards	Not Less than 12%

Analysis of Raw *Swarnamakshik*

Total Ash- 91.63%

Acid Insoluble Ash- 24.13%

Water Insoluble Ash- 86.06%

Table showing Cu%, Fe%, S% of *Swarnamkshik* of all batches of 3 Samples A, B, C By Gravimetric Analysis:

Samples	Batches	Cu%	Fe%	S%
Raw *Swarnamakshik*		9.44%	46.21%	33.08%
Sample A	Batch 1	0.11%	43.88%	33.01%
	Batch 2	0.23%	43.92%	33.08%
	Batch 3	0.12%	43.91%	33.12%
Sample B	Batch 1	5.42%	40.23%	33.48%
	Batch 2	5.42%	40.21%	33.50%
	Batch 3	5.41%	40.24%	33.40%
Sample C	Batch 1	3.80%	39.74%	32.69%
	Batch 2	3.88%	39.78%	30.12%
	Batch 3	4.10%	39.79%	31.70%

Table showing The Observations And Results in all 3 Shodhan Processes:

Sr. No.	Parameter	Sample A	Sample B	Sample C
1	Appearance	Reddish Brown	Greyish Black with more shining	Black
2	Density	2.08	2.5	2.0
3	ASH	88.46%	90.11%	90.98%
4	Acid Insoluble Ash	20.92%	20.12%	24.93%
5	Water Insoluble Ash	85.86%	89.20%	88.87%
6	Brittleness	No change as it was taken in powder form	not Brittle	Most Brittle
7	Average loss of Weight	10.33	6	21.33
8	Average Cu%	0.153%	5.416%	3.92%
9	Average Fe%	43.90%	40.226%	39.77%
10	Average S%	33.07%	33.46%	31.50%
11	XRD findings	Hematite, Sulphur, Iron Sulphide	Magnetite, Iron, Chalcosite	Pyrrhotite, Sulphur.

Table showing XRD Analysis of all 3 Samples of Shuddha Swarnamakshik

Samples	Compounds	Structure
A	Hematite (Fe_2O_3),Sulphur ,Iron Sulphide(FeS_2)	Hexagonal
B	Magnetite (Fe_3O_4), Iron, Chalcosite(Cu_2S)	Hexagonal
C	Pyrrhotite ($Fe_{.95}S_{1.05}$), Sulphur.	Hexagonal

Table Showing particle size of samples of *Shuddha Swarnamakshik* by SEM analytical technique.

Samples	Magnification	Particle Size
Sample A	20,000	0.17 µm to 0.35 µm
Sample B	25,000	0.66 µm to 1.99 µm
Sample C	10,000	0.08 µm to 0.17 µm

Table showing Edax (Energy dispersive spectroscopy) analysis was done for elemental composition of Shuddha Swarnamakshik (Sample A).

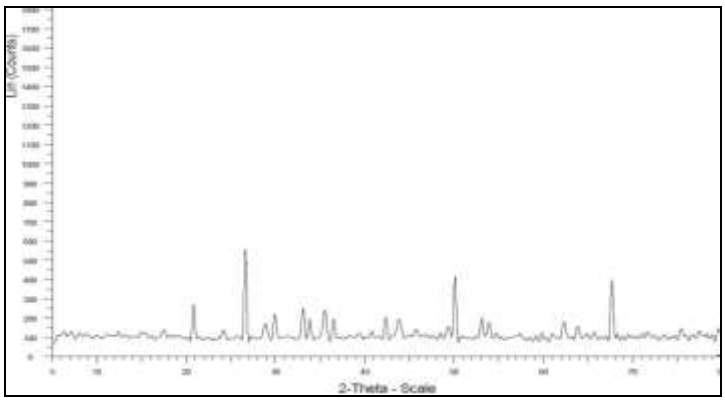
Element%	Weight%	Atomic%
S	24.25	35.79
Fe	75.75	64.21
Cu	00	00

Table showing Edax (Energy dispersive spectroscopy) analysis was done for elemental composition of Shuddha Swarnamakshik (Sample B).

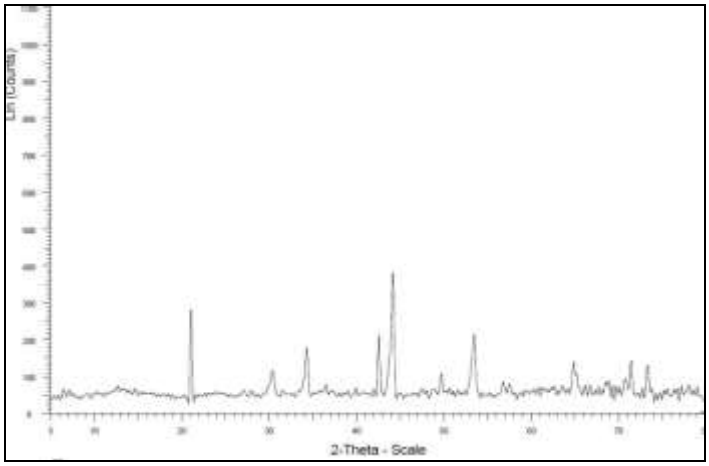
Element%	Weight%	Atomic%
S	29.64	40.39
Fe	68.35	52.36
Cu	2.01	7.25

Table showing Edax (Energy dispersive spectroscopy) analysis was done for elemental composition of Shuddha Swarnamakshik(Sample C).

Element%	Weight%	Atomic%
S	34.28	46.70
Fe	64.32	49.20
Cu	1.40	4.10



XRD Analysis of Shuddha Swarnamakshik Sample A:



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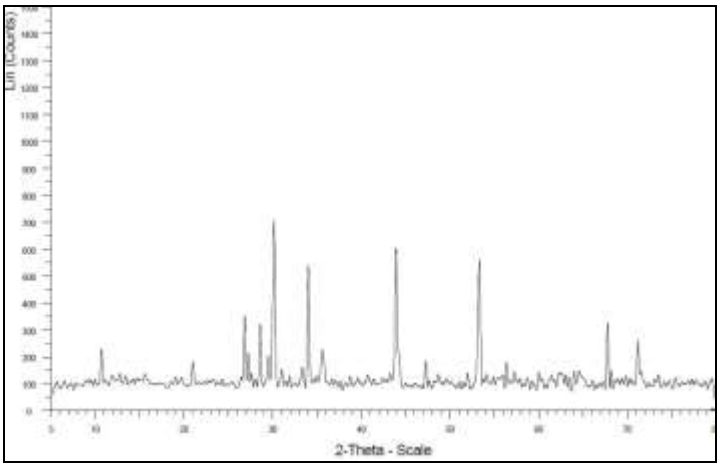
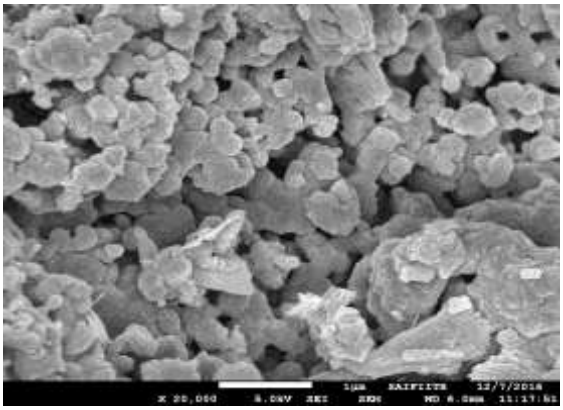
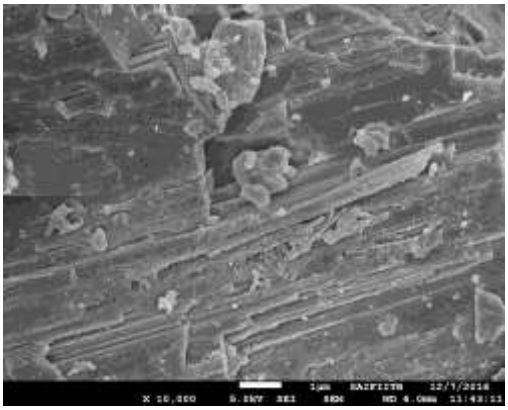


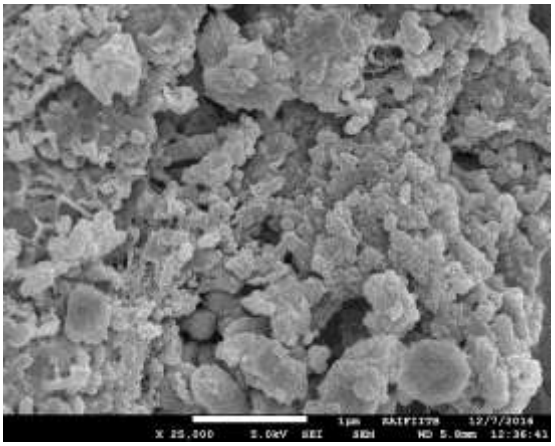
XRD Analysis of Shuddha Swarnamakshik Sample C:



SEM analysis of Sample A



SEM analysis of Sample B



SEM analysis of Sample C

DISCUSSION

A study entitled "Comparative study of physicochemical characteristics of Swarnamakshik by different shodhana methods w.s.r. to Rasaratna Samuchchya" aims at finding out the effects on physicochemical characteristics of Shuddha Swarnamakshik formed by three different Shodhan methods w.s.r. to Rasaratna Samuchchaya. Different Shodhana methods have been stated in classics. Shodhan is a remarkable process described in Ayurveda. It is aimed at purification. According to Monograph mentioned in Ayurvedic Pharmacopoeia of India Part 1 Volume 7 it should contain Copper not less than 5% and also Iron not less than 20% and Sulphur not less than 12%. Raw Swarnamakshik used in this work is procured from Khetri Mines Rajasthan, which contains 9.44% Copper, 46.21% Iron and 33.08% Sulphur. Also procured Swarnamkshik has golden lustre, heaviness, no angle of projections and black line appearance while ribbing on hand which satisfy the all parameters for Grahyata mentioned in the classics.

Swarnamakshik Shodhan in Eranda Tail And Matulungambu

Swarnamkshik was powdered with the help of iron mortar and pestle. Then it was subjected to intense heating in iron pan in open air on charcoal furnace. From 100 gms of Ashuddha Swarnamakshik 91gms, 88gms, 90 gms of Shuddha Swarnamakshik was obtained in three batches The loss of 9gms, 12gms, 10 gms were due to removal of physical impurities & while heating some Swarnamakshik got stuck in vessel. Ashuddha Swarnamakshik powder was greyish with golden tint while Shuddha Swarnamakshik was Reddish Brown in colour. Cu% was done in Ashuddha and Shuddha samples of Swarnamakshik by gravimetric method. The Ashuddha Swarnamakshik(Cu%) and Shuddha Swarnamakshik (Cu%) were found to contain 9.44% and 0.11%, 0.23%, 0.12% of Copper. Fe% was done in Ashuddha and Shuddha

samples of Swarnamakshik by gravimetric method. The Ashuddha Swarnamakshik(Fe%) and Shuddha Swarnamakshik (Fe%) were found to contain 46.21% and 43.88%, 43.92%, 43.91% of Iron. S% was done in Ashuddha and Shuddha samples of Swarnamakshik by gravimetric method. The Ashuddha Swarnamakshik(S%) and Shuddha Swarnamakshik (S%) were found to contain 33.08% and 33.01%, 33.08%, 33.12% of Sulphur. The difference in percentage of copper, iron, sulphur can be due to addition of organic contents while Shodhana. Because the Ricinolic acid present in the castor oil may reacts with Chalcopyrite and convert the copper into copper Ricinolate which is soluble in water and thus copper can be separated and removed. After addition of juice of citrus medica the remaining copper & iron are converted into their copper & iron water soluble salts. Or it may be stick to the iron pan used during the procedure of Shodhan. Due to limitations of study, the exact cause of this difference cannot be determined. Further study is required to find the reasons for these differences.

Swarnamakshik Shodhan in Kadalikandatoy

Swarnamakshik shodhan was carried out according to reference of R.R.S.2/78 where Swedana of Swarnamkshik was carried out for 2 Ghatika (48 minutes) in Kadalikandatoy. From 100 Gms of Ashuddha Swarnamakshik 94gms, 93gms, 95 Gms of Shuddha Swarnamakshik was obtained in three batches the loss of 6 Gms, 7 Gms, 5 Gms were due to removal of physical impurities. Colour of Kadalikanda swaras was changed from reddish brown to black. Ashuddha Swarnamakshik was greyish with golden tint while Shuddha Swarnamakshik was greyish black with more shining. Cu% was done in Ashuddha and Shuddha samples of Swarnamakshik by gravimetric method. The Ashuddha Swarnamakshik(Cu%) and Shuddha Swarnamakshik (Cu%) were found to contain 9.44% and 5.42%, 5.42%, 5.41% of Copper. Fe% was done in Ashuddha and Shuddha samples of Swarnamakshik by gravimetric method. The Ashuddha Swarnamakshik(Fe%) and Shuddha Swarnamakshik (Fe%) were found to contain 46.21% and 40.23%, 43.21%, 40.24% of Iron. S% was done in Ashuddha and Shuddha samples of Swarnamakshik by gravimetric method. The Ashuddha Swarnamakshik(S%) and Shuddha Swarnamakshik (S%) were found to contain 33.08% and 33.48%, 33.50%, 33.40% of Sulphur. The difference in percentage of copper, iron, sulphur can be due to chemical constituent present in Kadalikandatoy which reacted with chalcopyrite. Due to limitations of study, the exact cause of this difference cannot be determined. Further study is required to find the reasons for these differences.

Swarnamakshik Shodhan in Triphala Kwath

Swarnamakshik shodhan was carried out according to reference of R.R.S.2/78 where quenching of red hot Swarnamakshik in Triphala Kwath was done for 7 times. Fragility of Swarnamakshik was found in this process of purification and not in above two process of purification. Brittleness of Swarnamkshik was increase after every successive nirwaap. Shining surface was lost after second nirwaap in Triphala Kwath. From 100 Gms of Ashuddha Swarnamakshik 78 Gms, 82 Gms, 76 Gms of Shuddha Swarnamakshik was obtained in three batches the loss of 22 Gms, 18 Gms, 24 Gms were found. Colour of Triphala kwath was changed from brown to black. Ashuddha Swarnamakshik was greyish with golden tint while Shuddha Swarnamakshik was black. Cu% was done in Ashuddha and Shuddha samples of Swarnamakshik by gravimetric method. The Ashuddha Swarnamakshik(Cu%) and Shuddha Swarnamakshik (Cu%) were found to contain 9.44% and 3.80%, 3.88%, 4.10% of Copper. Fe% was done in Ashuddha and Shuddha samples of Swarnamakshik by gravimetric method. The Ashuddha Swarnamakshik (Fe%) and Shuddha Swarnamakshik (Fe%) were found to contain 46.21% and 39.74%, 39.78%, 39.79% of Iron. S% was done in Ashuddha and Shuddha samples of Swarnamakshik by gravimetric method. The Ashuddha Swarnamakshik(S%) and Shuddha Swarnamakshik (S%) were found to contain 33.08% and 32.69%, 30.12%, 31.70% of Sulphur. The difference in percentage of copper, iron, sulphur can be due to chemical constituent present in Triphala which reacted with Chalcopyrite. Due to limitations of study, the exact cause of this difference cannot be determined. Further study is required to find the reasons for these differences.

Ash Values

Total Ash indicates all the inorganic matter occurring naturally or been adulterated in the drug. Water soluble Ash indicates water soluble inorganic matter occurring naturally in the drug while Acid insoluble Ash indicates inorganic matter like silica, dust etc. adulterated in the drug. Total ASH of Ashuddha Swarnamakshik and three samples of Shuddha Swarnamakshik was 91.63%, 88.46%, 90.11%, 90.98% respectively. Water insoluble ash was 86.06%, 85.86%, 89.20%, 88.87% respectively. Acid insoluble ash 24.13%, 20.92%, 20.12%, 24.93% respectively.

XRD analysis of Samples of Shuddha Swarnamakshik

XRD analysis of all the samples showed presence of peaks of Iron and Sulphur in all three samples. But the strongest peak identified in Sample A was Hematite (Fe_2O_3) and the other

phases were identified as Iron Sulphide (FeS_2). The strongest peak identified in Sample B was Magnetite (Fe_3O_4) and the other phases were identified as Chalcosite(Cu_2S), Iron. The strongest peak identified in Sample C was Pyrrhotite i.e. Iron Sulphide ($Fe_{.95}S_{1.05}$) and the phase were identified as Sulphur, the crystal structure was found to be Hexagonal in structure.

SEM Analysis of Shuddha Swarnamakshik Samples

From SEM analysis it can be concluded that there is lot of variation in particle size from 0.08 µm to 1.19 µm. Further magnification will be required to find exact particle size. The Particle size shows variation among three samples of Shuddha Swarnamakshik. As our three samples are not uniform exact size of particles cannot be determined. Small particle is seen in Sample C while large particle is seen in Sample B.

Edax analysis of samples of Shuddha Swarnamkshik

Elemental analysis of a small area of the particles was done by magnification using Edax technique.

It can be said that there were changes in the elemental composition of all the three Samples of Shuddha Swarnamkshik. There was difference in Cu% of all three samples of shuddha Swarnamakshik. Cu % was found zero in small particle of sample A as copper may not be present in that small particle. Cu% was found in Sample B and Sample C were 2.01% & 1.40% (weight %). Due to limitations of the study the exact cause of this difference cannot be determined. Further study is required to find the reasons for these differences. There was difference in Fe% of all three samples of shuddha swarnamakshik. Fe% in small particle of three samples A, B, C, were 75.75%, 68.35%, 64.32% (weight %) respectively. Due to limitations of the study the exact cause of this difference cannot be determined. Further study is required to find the reasons for these differences. There was difference in S% of all three samples of shuddha swarnamakshik. S% in small particle of three samples A, B, C, were 24.25%, 29.64%, 34.28% (weight %) respectively. Due to limitations of the study the exact cause of this difference cannot be determined. Further study is required to find the reasons for these differences.

Further higher technique is required to understand the different elemental analysis of different Samples of Shuddha Swarnamakshik.

CONCLUSION

In this study entitled"Comparative study of physicochemical characteristics of Swarnamakshik by different shodhana methods w.s.r. to Rasaratna Samuchchya" an effort was made to find out difference in physicochemical characteristics of Shuddha Swarnamkshik made by three different Shodhan methods. Swarnamakshik is a Chalcopyrite (Cu_2S,Fe_2S_3), containing Copper, Iron, Sulphur. According to Standards described in API Part 1 Volume 7, Swarnamakshik should contain Copper not less than 5%, Iron not less than 20%, Sulphur not less than 12%. Swarnamakshik used in this work contains Cu 9.44%, Fe 46.21%, S 33.08% analyse by Gravimetric method which fulfil the standards. This study was carried out in two steps. The first step deals with shodhan of Ashuddha Swarnamkshik by three different methods as described in R.R.S. The second step deals with analytical study of the three Shuddha Swarnamakshik Samples made by three different shodhan methods.

Following conclusions were drawn from the observations and results obtained in this study. Shodhan of raw Swarnamakshik showed significant changes in their organoleptic characters like appearance, colour, and texture. Raw Swarnamakshik was greyish with golden tint while the colours of three samples of Shuddha Swarnamakshik were reddish brown, greyish black with more shining and black.

Duration required for second process of purification was less i.e. 2 Ghatika (48 minutes) compared with other two process of purification.

100 gm of Ashuddha Swarnamakshik was taken for every process of purification but average loss in weight was found more in third process of purification as the Swarnamakshik got fragile while heating.

Total ASH of Ashuddha Swarnamakshik and three samples of Shuddha Swarnamakshik was 91.63%, 88.46%, 90.11%, 90.98% respectively. Water insoluble ash was 86.06%, 85.86%, 89.20%, 88.87% respectively. Acid insoluble ash 24.13%, 20.92%, 20.12%, 24.93% respectively.

XRD analysis of 3 samples of Shuddha Swarnamakshik showed the presence of different compounds. Sample A showed the presence of Hematite (Fe_2O_3), Sulphur, Iron Sulphide (FeS_2). Sample B showed the presence of Magnetite (Fe_3O_4), Chalcosite (Cu_2S), Iron. Sample

C showed the presence of Pyrrhotite i.e. Iron Sulphide ($Fe_{.95}S_{1.05}$) and sulphur. The crystal structure of the product was found to be hexagonal in all samples.

Different compounds were found in XRD analysis of three different samples of Shuddha Swarnamakshik because of chemical reaction occurred between Chalcopyrite n different materials used for shodhan.

From SEM analysis it can be concluded that there is lot of variation in particle size from 0.08 µm to 1.19 µm. Further magnification will be required to find exact particle size. The Particle size shows variation among three samples of Shuddha Swarnamakshik.

Elemental analysis of a small area of the particles was done by magnification using Edax techniques.

It can be said that there were changes in the elemental composition of all the 3 samples of Shuddha Swarnamakshik. Edax analysis showed presence of Oxygen in samples which was from the processing done in open air during shodhan. Cu% in small particle of three samples A, B, C, were 0.00%, 2.01%, 1.40% (weight %) respectively. Fe% in small particle of three samples A, B, C, were 75.75%, 68.35%, 64.32% (weight %) respectively. S% in small particle of three samples A, B, C, were 24.25%, 29.64%, 34.28% (weight %) respectively.
Hence it can be concluded that there are differences in Shuddha Swarnamakshik prepared from three different Shodhan procedures.

Gravimetric analysis of Ashuddha Swarnamakshik showed presence of 9.44% Cu, 46.21% Fe, 33.08% S. Average Cu% in three samples of Shuddha Swarnmakshik was 0.15%, 5.41%, 3.92% respectively. Loss of Cu% found more in sample A compared with other two samples. Average Fe% in three samples of Shuddha Swarnamakshik was 43.90%, 40.22%, 39.77% respectively. Loss of Fe% found more in sample C compared with other two samples. Average S% in three samples of Shuddha Swarnamakshik was 33.07%, 33.46%, 31.50% respectively. Loss of S% found more in sample C compared with other two samples.

Hence it can be concluded that there are differences in Shuddha Swarnamakshik prepared from three different Shodhan procedures. From above study it can be concluded that their physicochemical characters are also different. Further higher technical study is required to understand the difference in the % of Copper, Iron and Sulphur in different Shuddha Swarnamakshik prepared by different Shodhan procedures.

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