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QUALITATIVE CHEMICAL ANALYSIS OF AMALGAMATION OF MERCURY AND SULPHUR (KAJJALI) IN THE METALLIC PREPARATIONS OF SIDDHA DRUGS

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ABSTRACT

Mercury is one of the extensively used metal in the preparations of siddha medicine after purification process. Amalgamation of purified mercury and purified sulphur is called Kajjali. Current issue has raised causing doubtful condition in using certain Siddha drugs that contains metallic raw materials, hence purification of them is very essential in order to avoid the side effects of the drugs. So the objective of the study is to identify the chemical state of mercury and sulphur after purification and in formation of amalgam (Kajjali) of both. For this, an experimental qualitative chemical analysis was conducted in the Department of Chemistry, University of Jaffna, Sri Lanka. After proper purification of both mercury and sulphur according to siddha literature, the amalgamation was made by combining them in the pharmacy, Unit of Siddha Medicine, University of Jaffna, Sri Lanka. Qualitative analysis was done with suitable reagents. As per to the observations, the relevant data's regarding the precipitations collected and justified. Results of the qualitative analysis suggested that each purified mercury and purified sulphur contains inorganic precipitations of certain substances and the amalgamation (kajjali) also contains both the combination of them. The findings indicated that purification of mercury and sulphur in amalgamation (kajjali) resulted in obtaining a chemical change from the base substances into inorganic forms of them which are nontoxic, to be used in medical preparations and industrial purposes. Apart from this, poor quality drugs which are of inappropriately detoxified raw materials can produce major illnesses. This is a vast problem arising from unauthorized dealers or persons who did not have qualified siddha medicine degree.

KEYWORDS: Siddha, Amalgamation, Mercury, Qualitative, Inorganic.

INTRODUCTION

Alchemy actually has its origin in the Siddha system and the use of metals, minerals, chemical products are predominant and advanced in comparison to other traditional medicine system. Rasam (Mercury) which is considered as a deadly poison is made into a lifesaving medicine by Siddhars using various processes by adding certain organic juices and subjected it to various processes of shodhana and marana before using it for medicinal preparations. Siddha texts does not advise single use of Rasam (Mercury) because of its two prime properties namely quickness & liquid state. The fine black powder obtained from trituration of Rasam (Mercury) with Kanthagam (Sulphur) without addition of any liquid substance is known as Kajjali. Most siddha formulations use Kajjali as a basic ingredient. Yogavahi - Organo-metallic compounds that work as carriers known as yogavahi. They make the drug available at the site of action very fast and also act as catalyst so as to increase the bioavailability of herbs. Kajjali is used in many siddha formulations as a bioavailability enhancer. It also acts as an anti-ageing agent. Kajjali owns properties like Rasayana (antiageing) & Yogavahi (as catalyst), (anti-microbial), (broad spectrum agent) Kajjali increases the bio-availability of drug which helps to obtain greater efficiency of drug.

JUSTIFICATION OF STUDY

Mercury is used extensively in the preparation of Siddha medicines after purification. Mercury is a major toxic metal. Mercury toxicity following unauthorized Siddha medicine intake causes serious illnesses clinically. In the future, wherein the traditional science will be devoid of the precious derivatives of mercury which have proven efficacy over 1500 years, because of improper usage and withdrawal of metallic preparations.

Shuddhi is a process of purification and detoxification by which physical and chemical blemishes and toxic materials are eliminated and substances are subjected for further processing. However it is imperative to undertake studies on chemical analysis, collate data's on kajjali and its ingredients after purification.

OBJECTIVE

The objective of the study is to identify the chemical format of Rasam (Mercury) and Kanthagam (Sulphur) after purification and in the formation of Amalgam (Kajjali) of both.

Specific objective

Confirming removal of toxic elements of raw materials (Rasam and kanthagam) and Kajjali.

MATERIALS AND METHODS

The ingredients were procured from the pharmacy of the Unit of Siddha Medicine University of Jaffna, Kaithady, Sri Lanka and thoroughly screened by experts of Gunapadam Unit.

Materials

- Rasam(Mercury)
- Kanthagam (Sulphur) & things used for purifications process, Yantras

Methods

Rasa Shuddhi (Mercury Purification)

Rasam (Mercury) was purified in a grinder (kalvam) with brick powder, then a mixture of Turmeric Choornam, grinding with each powder for per hour. Mercury was collected in an earthen pot. It was heated with a precise volume of (*Acalypha indica*) herb juice. Then, washed thoroughly.

Rasam grinding with Brick powder

Rasam grinding with Turmeric Choornam

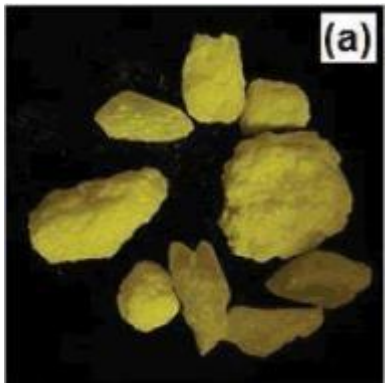
Heating with *Acalypha indica* juice

Washed thouroughly with water

Kanthagam shuddhi (Sulphur Purification)

About 70 g of raw sulphur was added to an equal amount of ghee into a steel pan on a stove and heated slowly to melt. The molten sulphur was then poured onto an earthen pot

containing about 250 ml of cow milk and set to cool. The solidified sulphur so formed was removed from the ghee- milk mixture through cotton-fabric sieve and gently washed with warm water. The solidified sulphur was again added to fresh ghee and the sulphur melting-washing cycle was repeated. This was performed ten times, as described in the Siddha text.



Raw Sulphur

Sulphur + Ghee Heated

Poured into Cows milk

Set to cool

Sieved & Washed With warm water

Let to solidify

Preparation of Kajjali

Purified Rasam (Mercury) and Kandhagam (Sulphur) were taken in equal quantities in a Khalva yantra and Mardhana (grinding) was done until it becomes very fine black powder, and the dazzling particles of Rasam (Mercury) completely disappeared.

For each,

- Purified Rasam (Mercury)
- Purified Kanthagam (sulphur)
- Amalgamation of Rasam and kanthagam (Kajjali)

Qualitative chemical analysis was done with suitable reagents with the perspectives of Cations and Anions Identification.

RESULTS AND DISCUSSION

According to the observations made from Qualitative Chemical Analysis, the relevant data regarding the precipitations collected and justified.

Purified Mercury

PROCEDURE	OBSERVATION	INFERENCE
TEST FOR CATIONS		
1. The small of the above solution was taken and it was dissolved in aqua regia and filtered.	Yellow colour solution was observed.	
2. The above filtrate was taken and dil HCL was added to it.	Clear colourless solution was observed.	Group I Cations ($Hg2^{2+}$, Pb^{2+}, Ag^{+}) were absent.
H2O2 was added and it was boiled.	Clear colourless solution(B) was observed.	
3. H2S gas was passed through the above solution(B).	Yellowish black colour precipitate was observed (X).	Group II Cations (Sn^{2+}, Sb^{3+}, As^{5+}, Bi^{3+}, Cu^{2+}, Cd^{2+}, Pb^{2+}, Hg^{2+}) may be present.
4. Above yellowish black colour precipitate was filtered.	Clear colourless solution was observed (C).	
5. A part of above solution (C) was taken in a test tube and potassium ferrocyanide was added to it.	Green colour solution was observed.	Fe^{3+} was absent.
6. A part of above solution (C) was taken in a test tube and potassium ferricyanide was added to it.	Dark green colour solution was observed.	Fe^{2+} was absent.
7. A part of above solution (4) was taken in a boiling tube. Then Con. HNO3 and 1 g dil. NH4Cl and excess of NH4OH were added to it. Then it was boiled.	Clear colourless solution was observed	Group III Cations (Fe^{3+}, Cr^{3+}, Al^{3+}) were absent.
8. (NH4)2S was added to the above solution and then it was warmed.	Clear colourless solution was observed.	Group IV Cations (Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}) were absent.
9. (NH4)2CO3 was added to the above solution and then it was warmed.	Clear colourless solution was observed.	Group V Cations (Ca^{2+}, Sr^{2+}, Ba^{2+}) were absent.
10. A part of above solution (9) was taken in a boiling tube. Then magneson reagent and dil. NaOH were	Reddish brown colour solution was observed.	Mg^{2+} was absent.

added to it. Then it was boiled.		
11. A part of above solution (9) was taken into an evaporating dish and it was evaporated. Then sodium cobaltinitrite and con. acetic acid were added to it.	Blue colour mass was observed.	K^+ was absent.
Group II Separation Above yellowish black colour precipitate (X) + 5 mL ammonium polysulphide + 50-60^oC heat.	Black colour precipitate was observed (Y).	Group IIA Cations (Bi^{3+}, Cu^{2+}, Cd^{2+}, Pb^{2+}, Hg^{2+}) may be present.
Above precipitate (Y) was filtered	Yellow colour solution was observed (Z).	
Solution (Z) + Con. HCl was added	Pale yellow colour precipitate was observed.	Group IIB Cations (Sn^{2+}, Sb^{3+}, As^{5+}) were absent. S was present.
Precipitate (Y) + 5 mL dil. HNO3 + boil	Black colour precipitate was observed (R)	HgS, Pt and Au may be present.
Above precipitate (R) was filtered	Clear colourless solution was observed (T)	Pb, Bi, Cu, Pd and Cd may be present.
Precipitate(R)+ KCl + dil. HCl were added	Clear colourless solution was observed (S)	Pt was absent Hg^{2+} and Au may be present.
Solution (S) +dil. NaOH +oxalic acid +boiled	Clear colourless solution was observed (V).	Au was absent Hg may be present.
Solution (V) +few drops of SnCl2	White colour precipitate was observed	Hg was present
Solution (T) + Con.NH3	Clear colourless solution was observed (U)	Cu and Cd may be present Bi was absent.
Solution (U) + dil. Acetic acid + potassium ferrocyanide were added	Yellow colour solution was observed.	Cu was absent
Solution (U) + KCN +H2S were added	Clear colourless solution was observed.	Cd was absent
Purified Sulphur		

PROCEDURE	**OBSERVATION**	**INFERENCE**
TEST FOR ANIONS		
1. The given sample was taken in a boiling tube and dil. H2SO4 was added to it. Then it was warmed.		CO32-, SO 2- & S2O 2-3 3 were absent. SO^{2-} & $S_2O_3^{2-}$ were absent.
A) Evolved gas was passed through the lime water.	Clear colourless lime water was observed.	
B) The evolved gas was tested with acidified K2Cr2O7.	Orange colour filter paper was observed.	
2. The sample was taken in a boiling tube and con. H2SO4 was added to it. Then it was warmed. The evolved gas was passed through the lime water.	Clear colourless lime water was observed.	C_2O^{2-} was absent. 4
3. Sample was placed in a watch glass. Ethanol and con. H2SO4 were added to it. Then this mixture was tested in the blue flame by using glass rod.	Blue colour flame was observed.	B_4O^{2-} was absent 7
4. Na2CO3 extract was prepared	Clear colourless solution (A) was observed.	
5. Solution (A) was acidified with dil. HNO3.	Clear colourless solution	CrO42-/Cr_2O^{2-} were

	was observed.	7 absent.
6.A part of above solution (A) was taken in a test tube and excess dil. HNO3 and AgNO3 were added to it.	Clear colourless solution was solution observed.	The halogens (Br^-/I^- /Cl^-) were absent.
7.A part of above solution (A) was taken in a test tube and excess dil. HNO3 and BaCl2 were added to it.	White colour precipitate was observed (Q)	SO42- may be present.
Confirmatory test for $SO4^{2-}$ Con. HNO3 was added to the above precipitate (Q) and boiled	White colour precipitate was observed	SO42- was present
8. A part of above solution (A) was taken in a boiling tube and excess con. HNO3 and (NH4)2MoO4 were added to it. Then it was warmed.	Clear colourless solution was observed.	PO43-/AsO43- were absent.
9. A part of above solution (A) was taken in a boiling tube and and dil. HCl was added to it. Then H2S gas was passed through this solution.	Clear colourless solution was observed.	AsO33- was absent.
10. A part of above solution (A) was taken in a boiling tube and and con. HCl was added to it. Then it was warmed. Then H2S gas was passed through this solution.	Clear colourless solution was observed.	AsO43- was absent.
11. A part of above solution (A) was taken in a test tube. Dil.H2SO4 and FeSO4 were added to it. Then con. H2SO4 was added along the side of the test tube.	Clear colourless solution was observed.	NO3-/Br^-/I^- were absent.

Detoxified Mercury and Sulphur (Kajjali)

PROCEDURE	OBSERVATION	INFERENCE
TEST FOR CATIONS		
1. The small of the above solution was taken and it was dissolved in aqua regia and filtered.	Yellow colour solution was observed.	
2. The above filtrate was taken and dil HCL was added to it.	Clear colourless solution was observed.	Group I Cations (Hg22+, Pb^{2+}, Ag^{+}) were absent.
H2O2 was added and it was boiled.	Clear colourless solution (B) was observed.	
3. H2S gas was passed through the above solution (B).	Yellowish colour precipitate was observed (X).	Group II Cations (Sn^{2+}, Sb^{3+}, As^{5+}, Bi^{3+}, Cu^{2+}, Cd^{2+}, Pb^{2+}, Hg^{2+}) may be present.
4. Above yellowish black colour precipitate was filtered.	Clear colourless solution was observed (C).	
5. A part of above solution (C) was taken in a test tube and potassium ferrocyanide was added to it.	Green colour solution was observed.	Fe^{3+} was absent.
6. A part of above solution (C) was taken in a test tube and potassium ferricyanide was added to it.	Dark green colour solution was observed.	Fe^{2+} was absent.
7. A part of above solution (4) was taken in a boiling tube. Then Con. HNO3 and 1 g dil. NH4Cl and excess of NH4OH were added to it. Then it was boiled.	Clear colourless solution was observed	Group III Cations (Fe^{3+}, Cr^{3+}, Al^{3+}) were absent.
8. (NH4)2S was added to the above solution and then it was warmed.	Clear colourless solution was observed.	Group IV Cations (Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}) were absent.
9. (NH4)2CO3 was added to the above	Clear colourless solution was observed.	Group V Cations (Ca^{2+}, Sr^{2+}, Ba^{2+})

solution and then it was warmed.		were absent.
10. A part of above solution (9) was taken in a boiling tube. Then magneson reagent and dil. NaOH were added to it. Then it was boiled.	Purple colour solution was observed.	Mg^{2+} was absent.
11. A part of above solution (9) was taken into an evaporating dish and it was evaporated. Then sodium cobaltinitrite and con. acetic acid were added to it.	Blue colour mass was observed.	K^{+} was absent.
Group II Separation		
Above yellow colour precipitate (X) + 5 mL ammonium polysulphide + 50-60^{o}C heat.	Black colour precipitate was observed (Y).	Group IIA Cations (Bi^{3+}, Cu^{2+}, Cd^{2+}, Pb^{2+}, Hg^{2+}) may be present.
Above precipitate (Y) was filtered	Yellow colour solution was observed (Z).	
Solution (Z) + Con. HCl was added	Pale yellow colour precipitate was observed.	Group IIB Cations (Sn^{2+}, Sb^{3+}, As^{5+}) were absent. S was present.
Precipitate (Y) + 5 mL dil. HNO3 + boil	Black colour precipitate was observed (R)	HgS, Pt and Au may be present.
Above precipitate (R) was filtered	Clear colourless solution was observed (T)	Pb, Bi, Cu, Pd and Cd may be present.
Precipitate(R)+ KCl + dil. HCl were added and the solution was concentrated	Clear colourless solution was observed (S)	Pt was absent Hg^{2+} and Au may be present.
Solution (S) +dil. NaOH +oxalic acid +boiled	Clear colourless solution was observed (V).	Au was absent Hg may be present.
Solution (V) +few drops of SnCl2	White colour precipitate was observed	Hg was present
Solution (T) + Con.NH3	Clear colourless solution was observed (U)	Cu and Cd may be present Bi was absent.
Solution (U) + dil. Acetic acid + potassium ferrocyanide were added	Yellow colour solution was observed.	Cu was absent
Solution (U) + KCN +H2S were added	Clear colourless solution was observed.	Cd was absent

DISCUSSION

Results of the qualitative chemical analysis suggested that each purified Rasam (Mercury) and purified Kanthagam (Sulphur) contains inorganic precipitations of each substances and the Amalgamation (Kajjali) also contains both the combination of them with the use of anion and cation group separations. The need of scientific evidenced studies are much important these days because, metals and minerals are used more predominantly in siddha medicines than other systems after purification and detoxification. Among the several heavy metals (lead, arsenic, gold, mercury), mercury is used extensively in siddha medicine after detoxification. The branch of siddha science that deals with mercury-based medicine is called Rasa shastram or Rasavatham. Rasa means elixir of life. It denotes state of liquidness. Mercury is denoted as rasa and is considered as kingdom of minerals. Mercury-based Siddha medicines are widely used by Siddha physicians. In Siddha medicine preparations, mercury is

used in five forms such as Rasam (Mercury), Lingam (Red sulfide of mercury), Veram (mercury perchloride), Pooram (mercury sub chloride), Rasa-chinduram (Red Oxide of Mercury). They are known as pancha sutha.

CONCLUSION

The findings indicated that purification of Rasam (mercury) and Kanthagam (Sulphur) in Amalgamation (kajjali) resulted in obtaining a chemical change from the elemental Mercury into inorganic forms of them which are nontoxic, to be used in medical preparations and industrial purposes. Apart from this, poor quality drugs which are of inappropriately detoxified raw materials can produce major illnesses. This is a vast problem arising from unauthorized dealers or persons who did not have qualified Siddha medicine degree. Mercury in naturally occurred forms (elemental mercury) and organic forms are toxic to the human body. Hence, much importance is given to the purification of Rasam (Mercury) to obtain inorganic mercury (nontoxic form – Vaalai rasam) to be used in medical preparations, so ancient siddhars took utmost care to evolve the specific methods for the detoxification of Mercury. Various processes are involved in purification of mercury to remove 15 layers of toxicity (8 Doshas + 7 Sattaigal). This detoxification method is followed till now for preparation of Siddha medicines. Scientific chemical analysis like this will identify what chemical change occurs during detoxification. There is a need of hour has raised to justify and characterize Herbo-metallic preparations and their toxic properties minutely using the best of the modern techniques available. (Mass spectrometry, IR and UV- spectroscopy).

Further work needs to be undertaken involving multidisciplinary experts in Physical, Chemical, Biological sciences along with Medicine and will require concerted participations of Governments, Semi Government, Academics, Physicians and Scientists.

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