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Research Article

EVALUATION OF *VELLULLI PARPAM* BY FOURIER TRANSFORM INFRARED SPECTROSCOPY AND SCANNING ELECTRON MICROSCOPY

S. Dharani[1]*, C. Meenakshi[2]

*[1]PG Scholar, [2]Guide, Associate Professor, Department of Gunapadam, Government Siddha Medical College, Chennai, Tamil Nadu, India.

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ABSTRACT

Vellulli Parpam (VP) is a traditional *Siddha* herbo-mineral medicine commonly prescribed for the treatment of *Gunmam* and related digestive disorders. *Siddha* formulations are prepared through specific purification, trituration, and calcination procedures to enhance their medicinal value and safety. The present study aimed to evaluate the physicochemical properties of *Vellulli Parpam* using Fourier Transform Infrared Spectroscopy (FTIR) and Scanning Electron Microscopy (SEM). FTIR analysis identified various functional groups present in the formulation, including hydroxyl, aliphatic C–H, aromatic, C–O, and metal–oxygen groups. These spectral findings indicate the presence of both herbal and mineral constituents within the drug. SEM analysis was performed to evaluate the morphology and particle size of the formulation. The SEM micrographs revealed uneven and clustered particles with sizes ranging from 4.977µm to 7.508µm, confirming a polydisperse particle distribution. The micron-sized particles produced during traditional *Siddha* processing may improve the surface area and facilitate better absorption of the formulation. The combined analytical findings demonstrate the physicochemical stability and quality of *Vellulli Parpam* and provide scientific evidence supporting the traditional preparation methods followed in *Siddha* medicine.

INTRODUCTION

Siddha Medicine is a well-established traditional healthcare system practiced predominantly in South India. The *Siddha* system is based on the principle of maintaining equilibrium among the three vital humors: *Vatham, Pitham*, and *Kabam*. *Siddha* formulations prepared from herbal, mineral, and metallic sources have been extensively used for treating chronic ailments and digestive disorders. Among the various pharmaceutical preparations, *Parpam* formulations are considered highly potent due to their fine particle size, stability, and enhanced therapeutic action[1,2]. *Vellulli Parpam* is a traditional Siddha formulation containing garlic *(Allium sativum)* as a major ingredient. Garlic is known for its digestive, antimicrobial, antioxidant, and anti-inflammatory properties.

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In *Siddha* literature, *Vellulli Parpam* is commonly indicated for the management of *Gunmam*, a gastrointestinal disorder associated with abdominal discomfort, indigestion, bloating, altered appetite, and disturbances in digestive function. The formulation is traditionally prepared through purification and calcination procedures that are believed to improve the medicinal efficacy and reduce toxicity. Scientific validation of traditional Siddha medicines has become essential to establish their quality, safety, and pharmacological significance. Advanced instrumental techniques are widely employed for characterization and standardization of herbo-mineral formulations. Fourier Transform Infrared Spectroscopy (FTIR) is an important analytical method used to identify functional groups and molecular interactions present in medicinal preparations. FTIR analysis provides valuable information regarding the chemical nature of bioactive compounds and inorganic constituents present in the formulation[3]. In addition, Scanning Electron Microscopy (SEM) is used to examine the surface morphology, particle distribution, and microstructural characteristics of drug particles. The

particle size and surface architecture observed through SEM analysis may influence the absorption and bioavailability of the formulation[4]. Therefore, integration of traditional Siddha concepts with modern analytical techniques contributes to the scientific standardization of Siddha medicines.

MATERIALS AND METHODS

Collection of the raw drug

All raw materials, except *Vellaipoondu* (*Allium sativum*), were bought from a certified siddha store in Chennai. Fresh *Vellaipoondu* was purchased from a local market in Chennai.

Identification and Authentication of the drug

All the raw drugs, including the fresh garlic bulbs, were identified and confirmed by experts from the Department of Gunapadam, Government Siddha Medical College, Chennai.

Purification of the drug

The raw drugs were purified according to the traditional siddha text *Sikitcha Ratna Deepam* [5].

Preparation of *Vellulli Parpam* (VP)

Table 1: Composition of *Vellulli Parpam* (VP)

S.No	Name of the drug	Part used	Botanical name	Quantity
1	*Vellaipoondu*	Bulb	*Allium sativum*	1 *Padi* (1.3kg)
2	*Karunjeeragam*	Seed	*Nigella sativa*	2 ½ *Palam* (87.5g)
3	*Paal Perungayam*	Resin	*Ferula asafoetida*	1 ¼ *Palam* (43.75g)
4	*Chukku*	Rhizome (dried)	*Zingiber officinale*	1 ¼ *Palam* (43.75g)
5	*Milagu*	Fruit	*Piper nigrum*	1 *Palam* (35g)
6	*Thippili*	Unripe fruit	*Piper longum*	1 *Palam* (35g)
7	*Karpoga arisi*	Seed	*Psoralea corylifolia*	1 *Palam* (35g)
8	*Inthuppu*		*Sodium chloride impura*	1 ½ *Palam* (17.5g)

Procedure

All ingredients except fresh *Vellaipoondu* (*Allium sativum*) were placed in an earthen mud pot, which was then closed with a suitable lid. The junction between the pot and lid was sealed airtight using a mud-smeared cloth, and the sealed pot was subjected to incineration by *Kukkuda Pudam* using 10 dried cow dung cakes. After self-cooling, the incinerated material was transferred to a stone mortar *(Kalvam)* and ground into a fine powder. Fresh *Vellaipoondu* (*Allium sativum*) was ground into a fine paste, triturated with the incinerated powder, and the final product was dried and stored in an airtight container.

Figure 1: Preparation of *Vellulli Parpam*


Sealed earthen pot


Incineration process


Incinerated material


Powdering in kalvam


Trituration of *Vellaipoondu*


Dried trituration paste


Final product of Parpam

Administration of the drug:

Form of the medicine: *Parpam*

Route of administration: Internal

Dosage: *Moondru viral alavu* (1.25g), Morning only

Duration: 40 days

Indication: 8 *Vagai Gunmam*, 18 *Vagai Soolai*, *Peruvayuru*, *Anda Vayu*.

Instrumental analysis

FT-IR (Fourier Transform Infrared Spectroscopy)[6,7]

Fourier Transform Infrared Spectroscopy is an important analytical technique used to identify functional groups and chemical constituents present in herbal, mineral, and pharmaceutical preparations. It works based on the absorption of infrared radiation by molecules at specific wavelengths, producing a characteristic spectrum known as an infrared spectrum. The infrared spectrum obtained from the analysis was used to identify characteristic absorption bands corresponding to different molecular vibrations The spectral interpretation was performed by comparing the observed peaks with standard reference values available in published scientific literature. Each peak corresponds to a specific functional group present in the sample. FT-IR analysis is widely used in Siddha and pharmaceutical research for characterization, standardization, purity assessment, and identification of organic and inorganic compounds. The main advantages of FTIR include rapid analysis, minimal sample preparation, high sensitivity, and non-destructive nature. In medicinal research, FTIR helps to confirm the presence of bioactive compounds and supports the evaluation of physicochemical properties of formulations like *Parpam, Chenduram* and herbal drugs.

Principle

When infrared radiation passes through a sample, specific frequencies are absorbed by molecular bonds, causing vibrational transitions. The fourier transform converts the raw interferogram into a readable spectrum showing absorbance versus wavelength or wavenumber.

Applications

- Identification of functional groups
- Drug characterization and standardization
- Detection of impurities
- Quality control of herbal and mineral medicines
- Structural analysis of compounds

SEM (Scanning Electron Microscopy)

Scanning Electron Microscopy (SEM) is an advanced analytical technique used to evaluate the surface morphology and microstructural properties of materials. In SEM, a focused electron beam scans the specimen surface and generates signals that produce highly magnified images with detailed structural information[4]. SEM analysis is commonly used in pharmaceutical and traditional medicine research to determine particle size, shape, texture, and surface arrangement of formulations. In Siddha, herbo-mineral preparations, SEM helps to identify changes occurring during purification and calcination processes, thereby supporting standardization and quality assessment[8]. The technique provides high-resolution images and greater depth of field, allowing visualization of porous nature, agglomeration, crystalline characteristics, and uniform distribution of particles. Due to its accuracy and rapid imaging capability, SEM is widely applied in biomedical, metallurgical, and nanotechnology research [9].

RESULTS

Instrumental analysis

FT-IR (Fourier Transform Infrared Spectroscopy) [10,11]

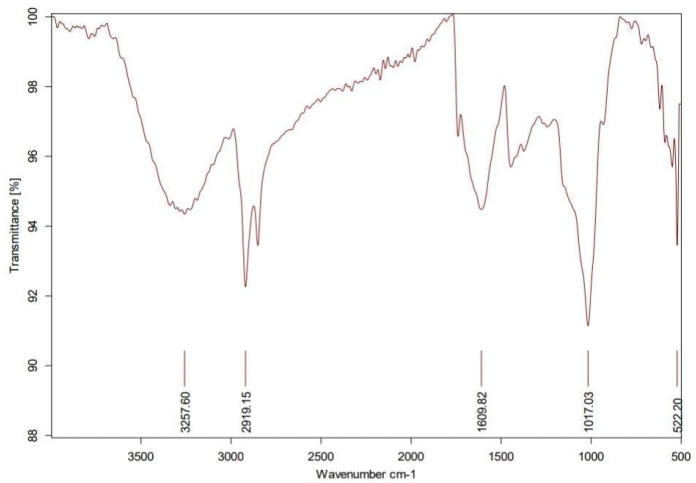


Fig: 2 FT-IR absorption frequencies of Organic functional group in VP

Fig: 2 represents the FTIR spectrum of VP, showing characteristic absorption peaks at 3257.60, 2919.15, 1609.82, 1017.03, and 522.20cm^{-1}. These peaks indicate the presence of different functional groups and chemical constituents in the formulation.

FTIR Interpretation

Table: 2 FTIR Interpretation of VP

S.No	Peak	Functional group assignment	Interpretation
1	3257.60 cm^{-1}	O–H stretching / N–H stretching	Indicates the presence of hydroxyl groups, alcohols, phenolic compounds, or moisture content.
2	2919.15 cm^{-1}	C–H stretching	Represents aliphatic hydrocarbons and organic constituents present in the sample.
3	1609.82 cm^{-1}	C=C stretching / amide group	Suggests aromatic compounds or protein-related functional groups.
4	1017.03 cm^{-1}	C–O stretching / Si–O stretching	Indicates alcohols, ethers, or inorganic silicate compounds.
5	522.20 cm^{-1}	Metal–oxygen vibration	Suggests the presence of metal oxide or mineral components in the formulation.

Table 2 shows the FTTR Interpretation of VP, FTIR spectrum revealed characteristic absorption bands corresponding to both organic and inorganic functional groups present in the sample. The broad absorption peak observed at 3257.60cm^{-1} indicates O–H stretching vibrations, suggesting hydroxyl-containing compounds. The peak at 2919.15cm^{-1} corresponds to aliphatic C–H stretching vibrations. The absorption band at 1609.82cm^{-1} may be attributed to aromatic C=C stretching or amide functional groups. The strong peak at 1017.03cm^{-1} indicates C–O stretching vibrations, while the low-frequency band at 522.20cm^{-1} suggests metal–oxygen interactions, confirming the presence of inorganic mineral constituents in the formulation.

Scanning Electron Microscopy (SEM) [5]

Fig: 3 SEM Analysis of *Vellulli Parpam* (VP)

Fig: 3 A

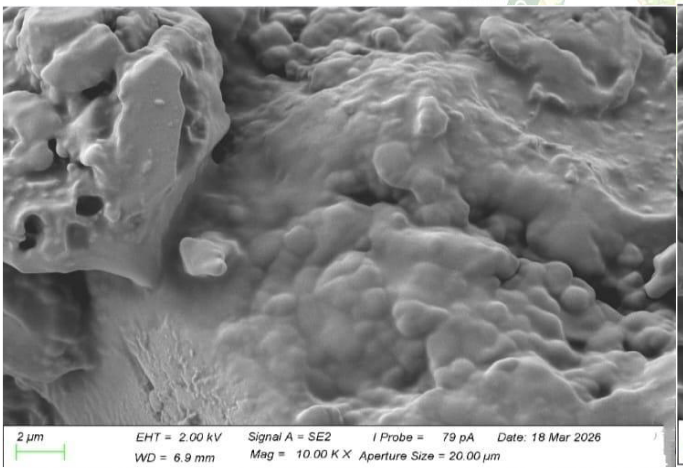


Fig: 3 B

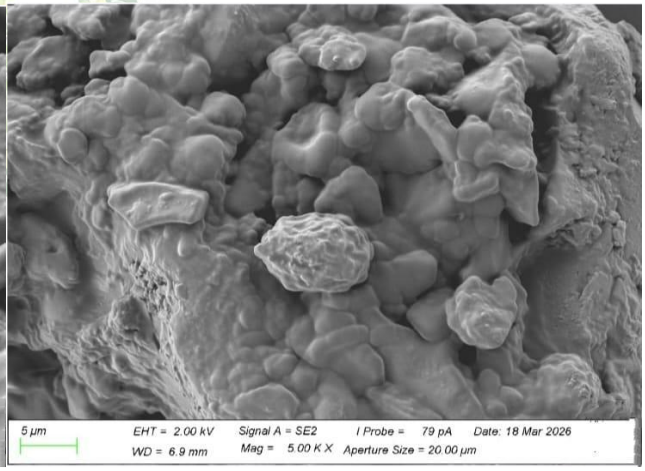


Fig: 3 C

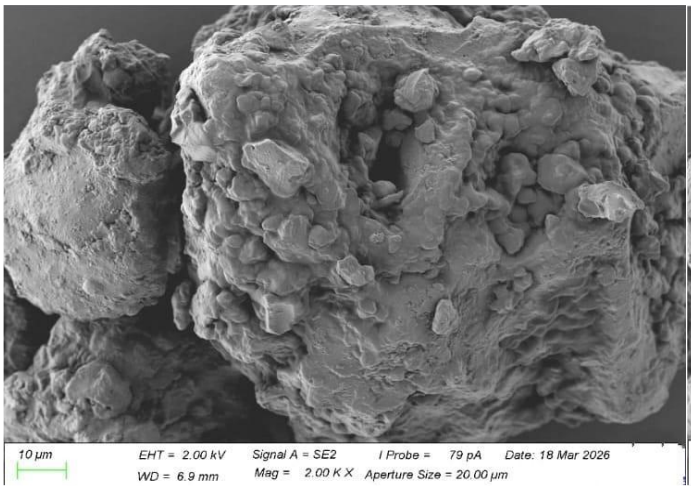
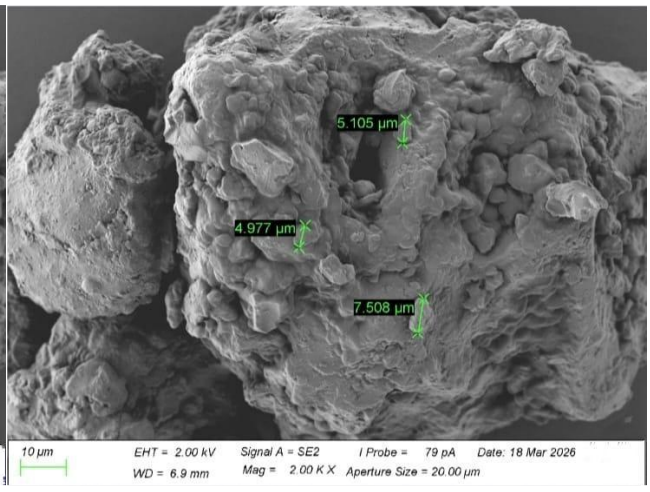


Fig: 3 D



SEM examination was performed at an accelerating voltage of 2.00 kV with a working distance of 6.9mm, using magnifications of 2.00kX, 5.00kX, and 10.00kX and scale bars of 10µm, 5µm, and 2µm, respectively. Particle size analysis from the SEM micrographs indicated that the particle dimensions ranged approximately from 4.977µm to 7.508µm, confirming a polydisperse distribution of particles.

DISCUSSION

The present study employed Fourier Transform Infrared Spectroscopy (FTIR) and Scanning Electron Microscopy (SEM) analyses to characterize the physicochemical properties of the Siddha formulation. The FTIR spectrum demonstrated the presence of both organic and inorganic functional groups, indicating the complex nature of the formulation produced through traditional Siddha processing techniques. The broad absorption band observed at 3257.60cm^{-1} corresponds to O–H stretching vibrations, suggesting the presence of hydroxyl-containing compounds such as phenols, alcohols. These hydroxyl groups may originate from herbal constituents incorporated during the preparation process and are known to contribute to antioxidant and therapeutic properties. The peak identified at 2919.15cm^{-1} is attributed to aliphatic C–H stretching vibrations, confirming the presence of organic carbon-containing compounds within the formulation. The absorption band at 1609.82cm^{-1} may be associated with aromatic C=C stretching or amide groups, indicating the possible presence of bioactive phytoconstituents and proteinaceous materials. Furthermore, the strong absorption peak at 1017.03cm^{-1} corresponds to C–O stretching vibrations, which are commonly related to alcohols, ethers, or polysaccharide structures. The low-frequency band observed at 522.20cm^{-1} represents metal–oxygen bonding, thereby confirming the mineral nature of the formulation and supporting the incorporation of inorganic constituents during calcination. These findings are consistent with earlier studies on Siddha Herbo-mineral preparations, where FTIR analysis demonstrated the coexistence of organic functional groups with mineral components after repeated purification and incineration procedures.

SEM analysis further provided information regarding the surface morphology and particle distribution of the formulation. The micrographs obtained under different magnifications revealed irregular and aggregated particles with sizes ranging from 4.977µm to 7.508µm, indicating a polydisperse particle distribution. In Siddha pharmaceutics, repeated grinding *(Kalvam),* trituration, and calcination processes are traditionally employed to achieve fine particle size, which is believed to enhance drug absorption, bioavailability, and therapeutic efficacy. The observed micron-sized particles support the classical Siddha quality parameters such as particles entering the lines on finger and floating on water, which indicate proper fineness and complete processing of *Parpam* formulations. The presence of polydisperse particles may also increase the effective surface area of the formulation, thereby facilitating improved dissolution and interaction with biological systems. Smaller particle dimensions are generally associated with enhanced cellular penetration and better pharmacological activity.

The combined FTIR and SEM findings confirm that the formulation contains stabilized organic functional groups along with mineral constituents in finely divided form, supporting the traditional claims regarding the efficacy and physicochemical stability of Siddha Herbo-mineral medicines used in the management of *Gunmam*.

CONCLUSION

The present study demonstrated the significance of FTIR and SEM analyses in the characterization of the Siddha formulation. FTIR analysis confirmed the presence of both organic and inorganic functional groups, indicating the coexistence of phytochemical constituents and mineral components within the formulation. The identified absorption peaks corresponding to hydroxyl, aliphatic, aromatic, C–O, and metal–oxygen groups suggest that the formulation retained important bioactive and mineral characteristics even after traditional processing procedures. SEM analysis revealed irregularly shaped particles with sizes ranging from 4.977µm to 7.508µm, confirming a polydisperse distribution. The micron-sized particles indicate effective grinding and calcination processes, which are essential quality parameters in Siddha pharmaceutics. The reduced particle size may enhance surface area, dissolution, absorption, and therapeutic efficacy of the formulation. Overall, the combined findings of FTIR and SEM analyses scientifically support the traditional Siddha preparation methods and provide evidence for the physicochemical stability and quality of the formulation *Vellulli Parpam* used in the management of *Gunmam*. These analytical techniques may therefore serve as reliable tools for the standardization and quality evaluation of Siddha Herbo-mineral medicines.

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***Address for correspondence**
Dr. S. Dharani
PG Scholar,
Department of Gunapadam
Government Siddha Medical College,
Chennai, Tamil Nadu.
Email: dharanis2512@gmail.com