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FTIR Spectroscopic analysis of *Siddha* herbo-mineral drug *Sanjeevi theeneer.*

Dr. N. Sornalatha[1], Dr. M. D. Saravana Devi[2]
1.Corresponding Author, 2.Guide,
1*Corresponding author's address
N. Sornalatha
PG Scholar,
Department of PG Gunapadam,
Government Siddha Medical College,
(Affiliated to The Tamil Nadu Dr. M.G.R. Medical University)
Chennai, Tamil Nadu, India.
Email ID: sornalatha1997@gmail.com

ABSTRACT: In Siddha medicine the use of metals and minerals are more predominant in comparison to other Indian traditional medicine systems in which Traditional Medicine requires quality control and standardization recommended by WHO. *Sanjeevi theeneer*(ST) is a herbo mineral distillate drug in the literature of *Cikitcha Ratna Deepam*, for *MaarbuNoi*. Aim is to characterise the ST by the Fourier Transform Infrared Spectrophotometer (FTIR) spectroscopic method. Drug authentication was done in PG Department of Gunapadam and Medicinal Botany Department, Govt. Siddha Medical College, Arumbakkam, Chennai. FTIR Spectra were recorded at SRM Institute of Science and Technology, Kattankalathur. FTIR is perhaps the most powerful tool for identifying the types of chemical bonds (functional groups) present in compounds. The wavelength of light absorbed is characteristic of the chemical bond as can be seen in the annotated spectrum. In FTIR spectra analysis, this sample (ST) exhibits the Peak value at 3327.21, 2370.51, 2196.92, 2106.27, 1637.56, 1392.61, 1276.88, 468.70, 432.05. This indicates the presence of organic functional groups such as Aliphatic primary amine, Alcohol, Flavonoids, Carboxylic acids, Nitrile containing phytochemicals, proteins, glycosidic bonds, polysaccharids, alkaloids, natural inorganic content. Present work can be considered as the first step towards the identification of heavy metals and functional groups in ST.

Keywords: *Sanjeevi theeneer*, *Maarbu noi*, FTIR, Metabolomics, Traditional Medicine.

1. INTRODUCTION

Despite advancements in modern medicine, herbal remedies remain widely popular due to their natural origin and perceived lower risk of side effects. The World Health Organization (WHO) provides guidelines for the quality control and standardization of herbal medicines, focusing on ensuring their safety, efficacy, and quality[1]. Metabolomics is emerging as a comprehensive approach for quality control of herbal drugs(2). It involves the simultaneous study of phytochemicals and metabolites in herbal samples, enabling detailed analysis, identification, and quantification of these compounds. This approach provides a holistic understanding of the chemical nature of metabolites in biological samples, whether from plants or animals. WHO recommends several instrumental methods for standardizing herbal medicines, such as: HPLC, GC-MS, TLC, HPTLC, XRPD(3).

The FT-IR spectrometry can be used as a valuable tool for the metabolic fingerprinting that simultaneously analyses a wide range of primary metabolites like carbohydrates, amino acids, proteins, polysaccharides and secondary metabolites like phenolics, alkaloids and steroids, flavonoids etc in the plants. The FTIR fingerprint provides information about the functional groups of molecules on the basis of specific wavelengths. So it supports in identification of the multiple phytochemicals present in the herbal extracts or powders on the basis of diagnostic functional group patterns(4). Understanding the chemical nature of phytochemicals and functional groups in medicinal plants is crucial for determining their therapeutic properties. By identifying specific band vibrations associated with different functional groups, FTIR provides insights into the relative concentrations of these groups, offering a deeper understanding of the plant's composition(4). Therapeutic activity of a herbomineral formulation depends on its functional group. *Sanjeevi theeneer* is a herbo mineral distillate medicine in the literature of *Cikicha Ratna deepam ennum vaithiya nool* for *Cardiac ailments(5)*. The aim of the present work is to investigate the metabolomics of *Sanjeevi theeneer* by chemical characterisation using FTIR analytical technique.

2. OBJECTIVE

To Characterise the *Sanjeevi theeneer* the FTIR spectroscopic method.

3. MATERIALS AND METHOD

3.1. INGREDIENTS

Following ingredients were used to prepare *Sanjeevi Theeneer.*

1 *Chukku (Zingiber officinale) - 10 thola (120g)*
2 *Thippili (Piper longum) - 10 thola (120g)*
3 *Milagu (Piper nigrum) - 10 thola (120g)*
4 *Kadukkai thol (Terminalia chebula) - 12 thola (144g)*
5 *Nellivatral (Phyllantus emblica) - 8 thola (96g)*
6 *Thaandrikaai thol (Terminalia bellerica) - 4 thola (48g)*
7 *Omam (Carum capticum) - 4 thola (48g)*
8 *Vaaivilangam (Embelia ribes) - 4 thola (48g)*
9 *Chithramoola ver pattai (Plumbago zeylanica) - 5 thola (60g)*
10 *Korai kizhangu (Cyperus rotundus) - 4 thola (48g)*
11 *Panag karkandu (Palm sugar) - 3 ser (840g)*
12 *Irumbu podi (Ferrum - iron) - 10 thola (120g)*
13 *Neer (Water) - 9 padi (13.6l)*

3.2. Authentication of drug

Post Graduate Department of Gunapadam and Medicinal Botany Department, Govt. Siddha Medical College, Arumbakkam, Chennai, authenticate the identification of Herbo mineral drug.

3.3. Purification of raw drugs

The purification of this drug is as follows as illustrated in *Sarakkukagalin suththi sei muraigal..*

3.4 Preparation method

All the purified ingredients will be dried and infused in the water for about one week for fementation process. On the eight day, Medicated distillate water is obtained by distillation process using Distillation apparatus and preserved in glass container(5).

3.5.Details regarding the analysis

FTIR Spectra were recorded at SRM Institute of Science and Technology (Deemed to be University), Kattankulathur, Tamil Nadu, India.

3.6 Fourier Transform Infrared Spectrophotometer (FTIR)

Fourier Transform Infrared Spectrophotometer (FTIR) is perhaps the most powerful tool for identifying the types of chemical bonds (functional groups) present in compounds. The wavelength of light absorbed is characteristic of the chemical bond as can be seen in the annotated spectrum. By interpreting the infrared absorption spectrum, the chemical bonds in a molecule can be determined(3).
The *Sanjeevi theeneer* was scanned by IR spectroscopy and the result were analysed.

FTIR in Pharmaceuticals

FTIR (Fourier Transform Infrared) spectroscopy is widely used in the pharmaceutical industry for various applications, including:
1. Identification of Active Pharmaceutical Ingredients (APIs)
- FTIR helps identify and characterise APIs, ensuring their quality and purity.
2. Analysis of Excipients
- FTIR is used to analyse excipients, such as polymers, binders, and fillers, in pharmaceutical formulations.
3. Quality Control
- FTIR is used to monitor the quality of pharmaceutical products during manufacturing, ensuring they meet predefined standards.
4. Detection of Impurities
- FTIR can detect impurities or contaminants in pharmaceutical products, helping to ensure their safety and efficacy.
5. Polymorph Identification
- FTIR is used to identify and characterise different polymorphic forms of APIs, which can affect their bioavailability and efficacy.
6. Stability Studies
- FTIR is used to study the stability of pharmaceutical products, helping to identify potential degradation products or changes in their chemical structure.

Benefits of FTIR in Pharmaceuticals

1. Rapid analysis: FTIR analysis is typically fast and efficient.
2. High sensitivity: FTIR can detect small changes in molecular structure.
3. Non-destructive: FTIR is a non-destructive technique, meaning it doesn't damage the sample.

FTIR spectroscopy is a valuable tool in the pharmaceutical industry, providing a rapid and non-destructive means of analysing the chemical structure of pharmaceutical products. Its applications range from identification and characterisation of APIs to quality control and stability studies.

4. RESULTS AND DISCUSSION

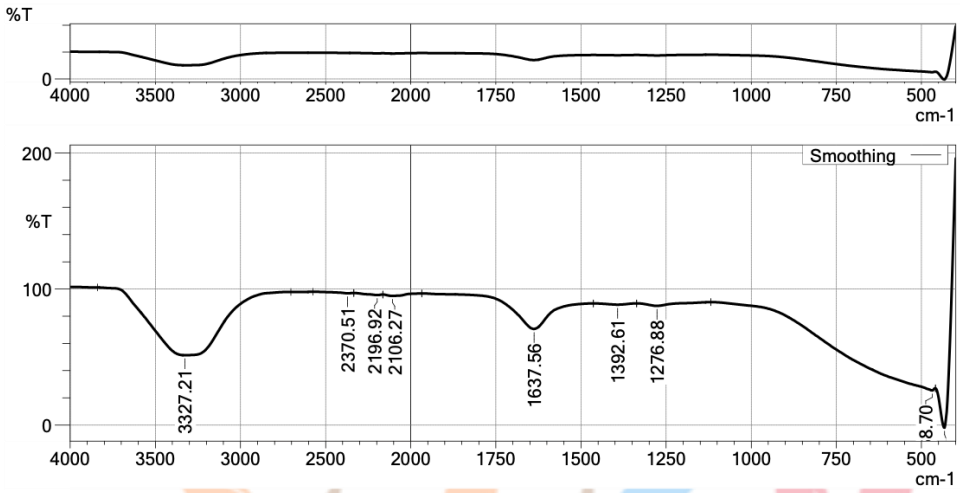

Fig1: Image of the FTIR spectrum of *Sanjeevi Theeneer*

	Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area
1	432.05	-1.94	105.32	459.06	399.26	3077.440	3767.889
2	468.70	25.44	2.56	1118.71	459.06	25621.056	-1619.387
3	1276.88	87.63	2.05	1336.67	1118.71	2360.087	155.610
4	1392.61	88.51	0.91	1463.97	1336.67	1403.017	55.623
5	1637.56	70.67	21.27	1967.39	1463.97	5640.166	2157.761
6	2106.27	94.95	1.22	2164.13	1967.39	849.174	130.699
7	2196.92	95.56	0.59	2333.87	2164.13	646.591	52.509
8	2370.51	96.86	0.35	2574.97	2333.87	605.051	7.747
9	3327.21	51.30	48.37	3838.34	2704.20	22799.209	22249.294

Table1: FTIR data of *Sanjeevi Theeneer*

Observed Peak (cm^{-1})	Probable Functional Group(s)	Group Type	Interpretation
3327.21	O–H / N–H stretching	Hydroxyl / Amino group	Broad peak indicating phenols, alcohols, or amines (polyphenolic compounds)
2370.51 – 2196.92	C≡C or C≡N triple bond stretching (weak zone)	Alkynes / Nitriles (less likely)	Possibly from trace alkyne/nitrile-containing phytochemicals
2106.27	C≡C (internal alkyne) or allene-like stretching	Unsaturated compounds	Could represent specific plant-derived lipophilic actives
1637.56	C=C stretching / N–H bending	Aromatic / Amide I	Aromatic ring systems, flavonoids, proteins
1392.61	C–H bending or symmetric COO^- stretching	Alkyl / Carboxylate	Indicates CH_3/CH_2 groups or carboxylic acids
1276.88	C–O / C–N stretching	Ether / Alcohol / Amine	Suggests glycosidic bonds, polysaccharides, alkaloids
468.70 – 432.05	Fingerprint region, possibly M–O / C–X bonds	Metal-ligand / Halogenated groups	Might be from mineral components or natural inorganic content

Table2: FTIR Data interpretation of Sanjeevi theneer

CONCLUSION

In this study we have investigated fingerprinting properties and metabolite profiling of the complex mixtures of the herbo mineral distiilate medicine *Sanjeevi Theneer* using FTIR based metabolomics approach. Various functional groups, The FTIR analysis of the ST poly herbo mineral formulation reveals the presence of diverse functional groups typically associated with bioactive plant metabolites.

The prominent broad O–H/N–H band at 3327 cm^{-1} suggests the abundance of hydroxyl-rich compounds such as flavonoids and polyphenols.

Distinct peaks between 2100–2300 cm^{-1} and around 1637 cm^{-1} support the presence of unsaturated bonds and aromatic systems, indicative of phenolic cores and proteinaceous elements. The fingerprint region (1276–1392 cm^{-1} and below 500 cm^{-1}) reveals complex vibrations arising from glycosidic linkages, amines, and possibly metal-associated components, which may be reflective of mineral-rich herbal ingredients. Overall, the spectrum underscores the chemically diverse nature of the formulation, contributing to its potential pharmacological effect. The application of FTIR analyses was successful in analysis and identification of various secondary metabolites present in the Trial drug *Sanjeevi theeneer(5)*. FTIR was found to be a simple, easy to use, rapid and inexpensive method for identification and for checking in any variation in herbal raw material. So it can be a very useful and supportive tool in the quality control and standardisation of the herbal raw materials that are useful for phytopharmaceuticals and nutraceuticals industries.

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