Journal for Educators, Teachers and Trainers
The PROFESIOLab electronic, peer-reviewed, open-access Magazine

ISSN 1989-9572

DOI:10.47750/jett.2023.14.05.066

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Journal for Educators, Teachers and Trainers, Vol.14(5)

https://jett.labosfor.com/

Date of Reception: 12 Jun 2023

Date of Revision: 05 Jul 2023

Date of Publication : 16 Aug 2023

1 M. Sandeep Goud, 2 T. Ravi Chander, 3 Hazara Begum (2023). COMPREHENSIVE PHARMACOGNOSTIC, PHYSICOCHEMICAL, AND CHROMATOGRAPHIC CHARACTERIZATION OF POLYHERBAL CHURNA. *Journal for Educators, Teachers and Trainers*,Vol.14(5)717-730

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COMPREHENSIVE PHARMACOGNOSTIC, PHYSICOCHEMICAL, AND CHROMATOGRAPHIC CHARACTERIZATION OF POLYHERBAL CHURNA

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ABSTRACT

Polyherbal churna, a traditional herbal formulation, has gained significant attention for its therapeutic potential. This study presents a comprehensive pharmacognostic, physicochemical, and chromatographic characterization of polyherbal churna to ensure its quality, safety, and efficacy. The pharmacognostic evaluation includes the identification of plant materials, organoleptic properties, microscopic features, and standardization of the raw materials. Physicochemical parameters such as moisture content, ash values, and extractive values were assessed to determine the formulation's stability and purity. In addition, chromatographic techniques, including Thin Layer Chromatography (TLC) and High-Performance Liquid Chromatography (HPLC), were employed to profile the chemical constituents and establish a fingerprint for quality control. The study aims to provide a standardized approach for the formulation of polyherbal churna, ensuring its consistent quality and therapeutic reliability. The findings contribute valuable information on the physicochemical properties and chemical profile of polyherbal churna, which can serve as a basis for future pharmacological and clinical evaluations.

I. INTRODUCTION

Polyherbal churna, an ancient formulation in traditional medicine, is composed of multiple plant species, each contributing unique medicinal properties. These preparations are often used to treat a wide range of ailments due to their synergistic effects, offering a holistic approach to healing. The increasing interest in polyherbal formulations stems from their perceived safety, effectiveness, and ability to address multiple health concerns simultaneously, which single-drug therapies may not achieve.

In recent years, the standardization and quality control of polyherbal formulations have become essential to ensure their

efficacy and safety. However, the variability in the composition of these formulations poses challenges in their quality assurance. Pharmacognostic evaluation, which involves the study of the plant's identity, quality, and therapeutic potential, plays a critical role in establishing the authenticity of herbal products. Furthermore, physicochemical parameters such as moisture content, ash values, and extractive values are important to assess the stability, shelf-life, and potency of the formulation.

Chromatographic techniques, including Thin Layer Chromatography (TLC) and High-Performance Liquid Chromatography (HPLC), are invaluable tools in the characterization of complex herbal formulations. These methods allow for the separation, identification, and quantification of active compounds, providing a fingerprint for each formulation. By establishing chromatographic profiles, the chemical composition of polyherbal churna can be standardized, ensuring reproducibility and quality across batches.

This study aims to comprehensively evaluate polyherbal churna using pharmacognostic, physicochemical, and chromatographic methods. The goal is to establish a robust quality control framework for polyherbal formulations, contributing to their integration into modern healthcare systems and ensuring their safe and effective use.

II. LITERATURE SURVEY

Polyherbal formulations have been used for centuries in traditional medicine to manage a variety of health conditions. These formulations, which combine multiple medicinal plants, are believed to offer enhanced therapeutic effects compared to single-ingredient drugs, thanks to the synergistic interactions between the plant constituents. Polyherbal churna, in particular, is widely utilized in Ayurveda, Unani, and other traditional healing systems. However, due to the complexity of these formulations, ensuring their quality, safety, and efficacy remains a significant challenge.

Pharmacognostic Evaluation of Polyherbal Formulations: Pharmacognostic evaluation is the first step in assessing the quality of herbal medicines. According to Harborne (1998), pharmacognostic analysis involves the identification of plant materials based on their morphological, microscopic, and histological features. Gupta et al. (2015) highlighted the importance of evaluating the macroscopic and microscopic features of medicinal plants used in polyherbal preparations. They emphasized that proper identification of plant species through detailed pharmacognostic studies ensures that only the correct plant materials are used in formulation, which is essential for maintaining therapeutic efficacy.

Physicochemical Characterization: The physicochemical properties of herbal formulations are vital for understanding their stability and quality. Parameters such as moisture content, ash values, and extractive values help determine the purity and storage conditions of herbal products. Sahoo et al. (2017) discussed the significance of standardizing physicochemical tests to monitor the quality and consistency of herbal drugs. Moisture content, in particular, is an important parameter as high moisture levels can lead to microbial contamination, reducing the shelf life and quality of the product. Similarly, ash values are used to assess the inorganic content of the formulation, which can help identify adulterants or contaminants.

Chromatographic Techniques for Herbal Characterization: Chromatographic techniques are widely used for the analysis of herbal formulations due to their ability to separate and identify complex mixtures of plant constituents. Patil et al. (2018) utilized Thin Layer Chromatography (TLC) to identify the chemical markers in polyherbal formulations, revealing the potential of TLC as a qualitative and semi-quantitative method for assessing the composition of herbal drugs. Nair et al. (2019) demonstrated the efficacy of High-Performance Liquid Chromatography (HPLC) in profiling active constituents in polyherbal formulations, providing a detailed chemical fingerprint that aids in quality control. HPLC has been shown to effectively quantify bioactive compounds, such as alkaloids, flavonoids, and tannins, which are often responsible for the therapeutic actions of polyherbal preparations.

Quality Control and Standardization: Standardization is crucial for ensuring the consistency and reproducibility of polyherbal formulations. Srinivas et al. (2020) emphasized the need for developing standard protocols for polyherbal preparations, particularly in terms of their chemical composition, to avoid variations in therapeutic outcomes. The establishment of chromatographic profiles, along with physicochemical testing, can act as a benchmark for assessing the quality of each batch of polyherbal churna. This standardization process is necessary for regulatory approval and for ensuring that the formulations meet the required pharmacological standards.

Challenges and Future Directions: Despite the advantages of polyherbal churna, challenges remain in the standardization and quality control of these formulations. Variability in the plant source, environmental factors, and manufacturing processes can lead to inconsistencies in the final product. Future research needs to focus on the development of more advanced analytical methods to ensure the accurate profiling of active ingredients in polyherbal formulations. Furthermore, pharmacological studies and clinical trials are necessary to validate the efficacy and safety of these formulations.

Overall, the literature emphasizes the need for comprehensive evaluations, including pharmacognostic, physicochemical, and chromatographic assessments, to ensure the quality and effectiveness of polyherbal churna. Standardizing these processes will help integrate these traditional formulations into modern healthcare systems while preserving their therapeutic benefits.

III. MATERIALS & METHODS

3.1. Plant materials

All the ingredients of Samasharkara Churna were procured from the local market of Bhubaneswar, Odisha, India, and were authenticated by botanist Miss. Rashmibala Sahoo, Scientific officer of the Department of Botany, State Drug Testing & Research Laboratory (ISM), Bhubaneswar, Odisha, India. Voucher specimens of these ingredients have been deposited in the Department of Pharmacognosy, State drug Testing & Research Laboratory (ISM), Bhubaneswar, Odisha, India, for future reference.

3.2. Methods

3.2.1. Preparation of Samasharkara Churna

The Samasharkara Churna was prepared as per the standard method described in Ayurvedic Formulary of India. As per the

literature, all the ingredients were shade dried and powdered separately, passed through #80 sieve, and then mixed together in required proportions to get uniformly blended churna.

3.3. Pharmacognostical study

3.3.1. Determination of foreign matter

Total 100 g of the sample was spread out in a thin layer. The foreign matter was detected by inspection with the unaided eye or by the use of a lens (6), separated, weighed and the percentage foreign matter was calculated.

3.3.2. Organoleptic parameters

The organoleptic characters like colour, odour, taste, appearance and texture of the ingredients and formulation samples were evaluated based on the reported method.

3.3.3. Fluorescence analysis

Fluorescence characters of powdered materials in different standard reagent solutions towards ordinary visible light and Ultra Violet light (both long 365 nm and short 254 nm wave lengths) were observed.

3.3.4. Microscopic study of Samasharkara Churna

Five mg of the sieved (#80) powder samples (churna and ingredients) were taken and washed with plain water. Then the samples were treated separately with iodine, chloral hydrate, pholorglucinol or potassium iodide; a drop of glycerine was added and mounted. The powder sample characters were then observed by Carl Zeiss binocular microscope attached with camera according to standard method.

3.4. Physicochemical investigation

Different physicochemical investigations of churna and its raw materials were carried out using standard pharmacopoeial methods, including determination of alcohol soluble extractives, water soluble extractives, total ash, acid insoluble ash, loss on drying and pH determinations.

3.5. Determination of physical characteristics of powder

Physical characteristics like bulk density, tap density, angle of repose, Hausner's ratio and Carr's index were determined for the churna formulations.

3.6. Qualitative phytochemical investigation

Comparative qualitative chemical tests were carried out for Samasharkara Churna and its ingredients on their different extracts of various polarities. These phytochemical screening included tests for alkaloids, tannins, steroid, glycoside, flavonoids, saponins, carbohydrates, terpenoids and proteins.

3.7. Determination of toxic contaminants

3.7.1. Heavy metal determination

Heavy metal analysis was performed using PERKIN ELMER AAS200 instrument. As per protocol, sample digestion was carried out by multi-acid digestion system for Lead (Pb), Cadmium (Cd), Copper (Cu), Zinc (Zn), Nickel (Ni) and Chromium (Cr) [21]. After completion of digestion process, the filtered samples were analysed by Atomic Absorption Spectrometer (AAS). However being volatile, Mercury (Hg) and Arsenic (As) were digested using Nitric acid-Hydrochloric Acid-Potassium Permanganate system before analysis [22]. The Mercury Vapour Atomization (MVA) and Hybrid Vapour Generation (HVG) attachments were utilised for AAS analysis of Hg and As respectively. The standards of Lead (Pb), Cadmium (Cd), Arsenic

(As), Mercury (Hg), Cupper (Cu), Zinc (Zn), Nickel (Ni) and Chromium (Cr) were purchased from Merck, Germany and utilised for development of the respective calibration curves for these metals.

3.7.2. Microbial limit test

Microbial analysis was carried out as per standard procedure mentioned in Ayurvedic Pharmacopoeia of India. It included total bacterial count, total fungal count, presence of pathogens like Escherichia coli, Salmonella ebony, Pseudomonas aeruginosa, and Staphylococcus aureus.

Table 1 Fluorescence analysis of Samasharkara Churna

Powdered drug	Visible/day light	Ultra violet light	
		254 nm	366 nm
Powder as such	Crimson to dark brown	Light yellow	Light yellow
Powder + conc. HCl	Yellow	Green	Green
Powder + 10% $K_2Cr_2O_7$	Yellow	Fluorescent green	Brown
Powder + 1 M NaOH	Red brown	Deep green	Fluorescent green
Powder + $AgNO_3$	Light yellow	Yellow	Yellow
Powder + conc. HNO_3	Orange yellow	Black	Fluorescent green
Powder + conc. H_2SO_4	Dark brown	Greenish black	Black
Powder + Br_2 water	Light brown	Fluorescent green	Fluorescent green
Powder + Methanol	Light brown	Fluorescent green	Fluorescent green
Powder + CH_3COOH	Light brown	Yellow	Yellow
Powder + NH_3	Yellow	Fluorescent green	Yellow
Powder + I_2	Light purple	No colour	No colour

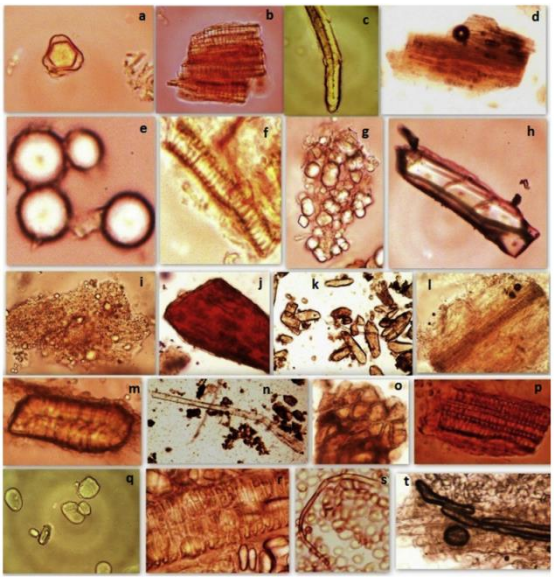

Fig. 1. Photographs of powder microscopic of Samasharkara Churna: (a) Pollen grains of Lavanga, (b) Tracheids with spiral thickenings of Lavanga, (c) Fibre of Lavanga, (d) Oil glands of Lavanga, (e) Oil globules of Jatiphala, (f) Cut fragments of scalariform tracheids and fibre oil globules of Jatiphala (g) Simple and compound starch grains oil globules of Jatiphala (h) Sclereids oil globules of Jatiphala, (i) Oil globules of Pippali, (j) Tannin content of Pippali, (k) Starch grains of Pippali, (l) Fragments of pitted vessels of Pippali, (m) Beaker-shaped stone cell of Maricha, (n) Simple fibre of Maricha, (o) Black debris along with parenchyma cells of Maricha, (p) Vessels of vascular strands of Maricha, (q) Starch grains of Shunthi, (r) Fragmented vessel elements of Shunthi, (s) Oil globule of Shunthi, (t) Fibre of Shunthi.

3.7.3. Pesticide residues study

Pesticide residues were analysed using an Agilent 7000 Triple Quad GC/MS system equipped with a multimode inlet (MMI) using a DB-5 (30 m 0.25 mm 0.25 mm) capillary column. The samples for analysis were prepared by QuEChERS method [24]. As per the standard study protocol, the GC oven temperature was programmed for linear increase from 50 C (1 min hold) to 130 C at 10 C/min, 130e250 C at 5/min and then 250e300 C, at 10 C/ min. The injector temperature was 270 C, with a split 40: 1 and Helium carrier gas at 1.1 mL/min flow. The mass spectrometric detector was operated in the GC MSMS mode with 70 eV ionization energy, ion source temperature at 230 C, and the quadrupolar mass detector at 150 C. Internal standards of pp'DDT and Chlorpyrifos were procured from sigma (Aldrich) were utilised [25]. The tested pesticides included the following:

Organochlorine pesticides: Butachlor; a-HCH; b-HCH; g-HCH (Lindane); d-HCH; O, P0 -DDT; P, P0 -DDT; O, P0 -DDE; P, P0 -DDE; O, P0 - DDD; P, P0 -DDD; a-

Endosulfan; b- Endosulfan; Endosulfan sulphate; Aldrin; Dieldrin; Endrin; Endrin aldehyde; Endrin ketone; Cis- Chlordane; Trans- Chlordane; Heptachlor; Heptachlor epoxide; Methoxychlor; Dicofol; Alachlor; Chlorthalonil; Chlorobenzilate; Dichlofluanid and Vinclozolin.

Organophosphorous pesticides: Acephate; Dichlorvos; Ethion; Fenitrothion; Methamidophos; Phosalone; Profenofos; Quinalphos; Triazophos; Chlorfenvinphos; Chlorpyriphos; Chlorpyriphos-methyl; Coumaphos; Diazinon; Dimethoate; Disulfoton;

Table 2 Phytochemical investigation of raw materials present in Samasharkara Churna

Material	Extracts	Phytoconstituents present
Lavanga	Aqueous Extract	A, T, G, F, Sa, P
	Methanolic Extract	A, T, G, F, Sa, P
	Ethyl acetate Extract	T, F, Sa, C, P
	Chloroform Extract	T, Sa, C
	Pet. Ether Extract	St
Jatiphala	Aqueous Extract	T, Sa, P
	Methanolic Extract	A, T, G, F, Sa, C
	Ethyl acetate Extract	Sa, C, P
	Chloroform Extract	A, St, G, F, C
	Pet. Ether Extract	St
Pippali	Aqueous Extract	G, Sa, C, P
	Methanolic Extract	A, Sa
	Ethyl acetate Extract	G, Sa, C
	Chloroform Extract	A, F, Sa, C
	Pet. Ether Extract	St
Maricha	Aqueous Extract	A, T, G, Sa, P
	Methanolic Extract	A, G, Sa, P
	Ethyl acetate Extract	Te, P
	Chloroform Extract	St, F, Sa, C, P
	Pet. Ether Extract	St
Shunthi	Aqueous Extract	A, T, G, Sa, P
	Methanolic Extract	G, Sa, P
	Ethyl acetate Extract	G, Sa, P
	Chloroform Extract	C
	Pet. Ether Extract	–
Samasharkara Churna	Aqueous Extract	A, T, G, F, Sa, C, P
	Methanolic Extract	A, T, G, F, Sa, P
	Ethyl acetate Extract	St, G, F, C, P
	Chloroform Extract	St, G, F, Sa, C, P
	Pet. Ether Extract	St

A: Alkaloids, T: Tannins, St: Steroid, G: Glycoside, F: Flavonoids, Sa: Saponins, C: Carbohydrates, P: Proteins, Te: Terpenoids.

Ethoprophos; Fenchlorphos; Iprobenphos; Monocrotophos; Malathion; Malaoxon; Mevinphos; Omethoate; Methyl paraoxon; Parathion-ethyl; Parathion-methyl; Prothiofos; Phorate; Phoratesulfone; Phoratesulfoxide; Phosphamidon and Triadimefon.

Table 3 Heavy metal analysis of Samasharkara Churna.

Sr. No.	Heavy metal	Standard limit* (ppm)	Observed Value (ppm)
1	Arsenic	3 ppm	1.35 ppm
2	Lead	10 ppm	3.46 ppm
3	Mercury	1 ppm	0.05 ppm
4	Cadmium	0.3 ppm	0.11 ppm
5	Nickel	NA	4.23 ppm
6	Zinc	NA	11.45 ppm
7	Copper	NA	9.51 ppm
8	Chromium	NA	8.20 ppm

3.7.4. Aflatoxin determination

Extraction and Clean-Up: The sample preparation was carried out by Immuno affinity Column Liquid Chromatography as per the reported literature HPLC Analysis: Aflatoxins were determined by a Waters Alliance 2695 HPLC instrument using a Luna C18 column (Phenomenex) of dimensions 4.6 150 mm 5 m coupled with a Waters 2475 Fluorescence detector containing Cobra cell. In this method, 40 ml of the samples were injected into the HPLC column heated at 40 C. The mobile phase was taken as water: methanol solution (60:40, v/ v) with 119 mg of potassium bromide and 350 ml of 4 M nitric acid were added to the 1 L of mobile phase for post column electrochemical derivatization of fluorescence detector. The flow rate was kept 1 ml/min with a total runtime of 20 min where the retention times were found to be 7.5 min, 9.38 min, 11.44 min and 14.5 min for Aflatoxins G2, G1, B2 and B1 respectively. The excitation wavelength and the emission wavelength for fluorescent detection were set at 362 nm and 455 nm respectively. The calibration standards were procured from Sigma Aldrich

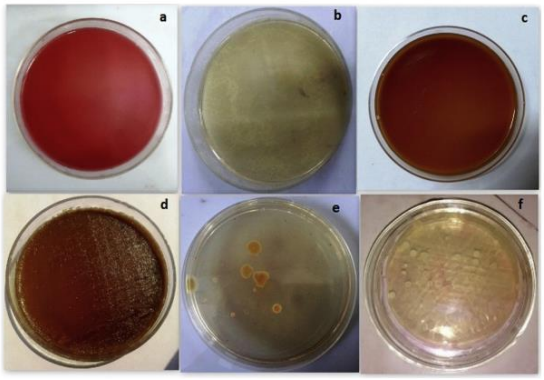

Fig. 2. Photographs of microbiological limit test in Samasharkara Churna. (a) Escherichia coli, (b) Pseudomonas aeruginosa, (c) Salmonella ebony, (d) Staphylococcus aureus, (e) Total fungal count, (f) Total bacterial count.

Table 4 TLC screening of raw materials vs. Samasharkara Churna

R_f Values					
Track A (Lavanga)	Track B (Jatiphala)	Track C (Pippali)	Track D (Maricha)	Track E (Shunthi)	Track S (Samasharkara Churna)
0.28	0.44	0.36	0.4	0.41	0.4
0.31	0.46	0.44	0.43	0.45	0.44
0.38	0.75	0.48	0.5	0.48	0.48
0.4	–	–	0.58	0.7	0.58
0.46	–	–	0.62	0.76	0.71
0.6	–	–	0.67	–	0.75
0.71	–	–	–	–	–
0.8	–	–	–	–	–
0.82	–	–	–	–	–

3.8. Chromatographically analysis

3.8.1. Thin layer chromatographic (TLC) study

Sample Preparation: Accurately weighed 1 g samples of churna and its ingredients were separately dissolved in 20 ml methanol and refluxed on water bath at 90e100 C for 15 min. They were filtered and evaporated up to 5 ml in porcelain dish and taken for TLC profiling.

3.8.2. HPTLC analysis

Stationary phase:

Silica Gel 60F254 pre-coated aluminium plates (MerckKGaA) of 10 10 cm and 0.2 mm thickness were prewashed by methanol and activated at 60 C for 5 min prior to chromatography,

Sample Preparation: Methanolic extracts were diluted in methanol up to concentration of 1 mg/ml and passed through 0.45 Millipore filters.

Development: HPTLC plates were developed in CAMAG glass twin-through chamber (20 10 cm) previously saturated with the solvent for 60 min maintained at 60 C and 40% relative humidity (RH).

The development distance was kept to be 9 cm. Mobile Phase: Toluene: Ethyl acetate: Glacial acetic acid (9:1:0.5 v/v)

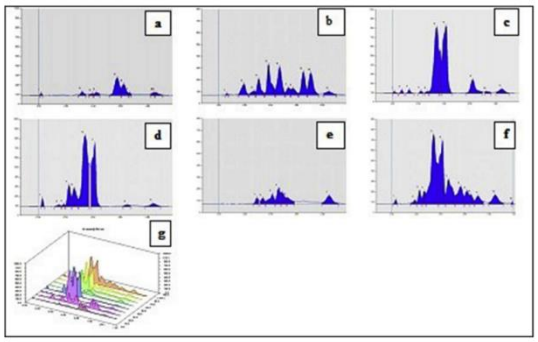

Fig. 3. HPTLC Finger prints of Samasharkara Churna and its ingredients at 254 nm before derivatization. (a) Lavanga, (b) Jatiphala, (c) Pippali, (d) Maricha, (e) Shunthi, (f) Samasharkara Churna, (g) 3D Chromatogram

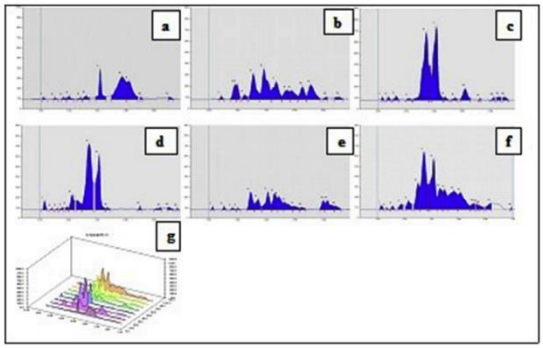

Fig. 4. HPTLC Finger prints of Samasharkara Churna and its ingredients at 254 nm after derivatization. (a) Lavanga, (b) Jatiphala, (c) Pippali, (d) Maricha, (e) Shunthi, (f) Samasharkara Churna, (g) 3D Chromatogram.

treatments. An accurately weighed quantity of sample was heated in alumina crucibles with a heating rate of 10 C/min from room temperature to 1200 C in a N2 atmosphere using a thermo gravimetric

analyzer TGA/STDTA851e (METTLER, Switzerland). The biochar yield was calculated by mass balance. The data was interpreted using STARe SW 12.10 software (METTLER) [18,29].

IV. RESULTS

4.1. Foreign matter

The tested foreign matter content in the ingredients of Samasharkara Churna was less than 0.5% (w/w). Sugar did not have any foreign matter. Limits for foreign matter of these ingredients were 0.5e2% as per Ayurvedic Pharmacopoeia of India (API).

4.2. Organoleptic parameters

In organoleptic evaluation, the prepared in-house Samasharkara Churna was found to be yellowish brown in colour with characteristic odour and tasted sweet. Organoleptic inferences of the churna along with its ingredients are given in the Supplementary Table 1.

4.3. Fluorescence analysis

In our study, the fluorescence behaviour of the powdered samples as such as well as after treatment with different reagent solutions towards ordinary light and ultraviolet light (both long 365 nm and short 254 nm wave lengths) were observed and exhibited characteristic colours as reported in Table 1.

4.4. Microscopic study of Samasharkara Churna

In the powder microscopic analysis of Samasharkara Churna (Fig. 1), the diagnostic characters such as presence of pollen grains, tracheids with spiral thickenings, simple fibre and oil glands indicated the presence of Lavanga (S. aromaticum). Simple and compound starch grains, cut fragments of scalariform tracheids and fibre, oil globule and sclereids indicated the presence of Jatiphala (M. fragrans). Starch grains, tannin content, fragment of pitted vessels and oil globule were suggestive of Pippali (P. longum). Beaker shaped stone cells, black debris along with parenchyma cells, starch grains, simple fibre, oil globules and vessels of vascular strands suggested presence of Maricha (P. nigrum). Fragmented vessel elements, oleoresin content, parenchyma cells with starch grain, fibres and oil globules observed in the sample were suggestive of Shunthi (Z. officinale).

4.5. Physicochemical investigation

Physicochemical analysis of Samasharkara Churna showed water soluble extractive 16.314% w/w, ethanol soluble extractive 20.248% w/w, total ash content 2.343% w/w, acid insoluble ash 0.441% w/w, pH of 6.697 and loss on drying of 7.97% w/w at 105 C.

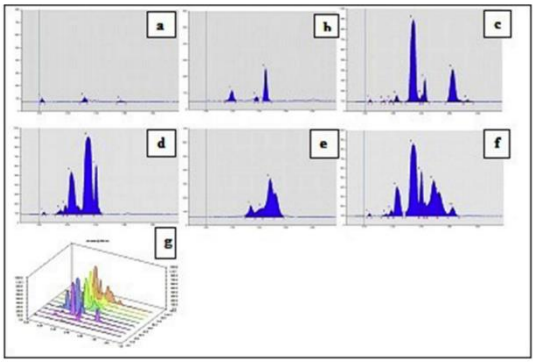

Fig. 5. HPTLC Finger prints of Samasharkara Churna and its ingredients at 366 nm before derivatization. (a) Lavanga, (b) Jatiphala, (c) Pippali, (d) Maricha, (e) Shunthi, (f) Samasharkara Churna, (g) 3D Chromatogram.

V. DISCUSSION

Samasharkara Churna was thoroughly evaluated in this work in accordance with the Ayurvedic Pharmacopoeia of India's

(API) recommendations. The United States Pharmacopoeias (USP), the European Agency for Evaluation of Medicinal Products (EMEA), and the World Health Organisation (WHO) have all offered standardisation recommendations that have been taken into consideration. Through quality control procedures, the churna was examined for pertinent physical, chemical, and analytical characteristics as part of the process to ensure its safety and reliable effectiveness [30e32].

Herbal medications should be devoid of apparent contaminants including sand and stones, toxic and dangerous foreign objects, chemical residues, moulds, insects, and other components of the same or other plants. The foreign matter level of Samasharkara Churna's components was examined in our study and confirmed to be below the API's limitations for these ingredients.

The characteristics of food or other substances as perceived by the senses—taste, sight, smell, and touch—are known as organoleptic qualities. A fundamental indicator of quality variation is provided by deviations in these qualities. Once again, fluorescence refers to the phenomenon whereby different compounds produce visible fluorescence when exposed to light. Certain components of plants exhibit fluorescence during the daylight spectrum. Additionally, many additional natural compounds exhibit fluorescence when exposed to UV light, or they may frequently be transformed into luminous derivatives by adding various.

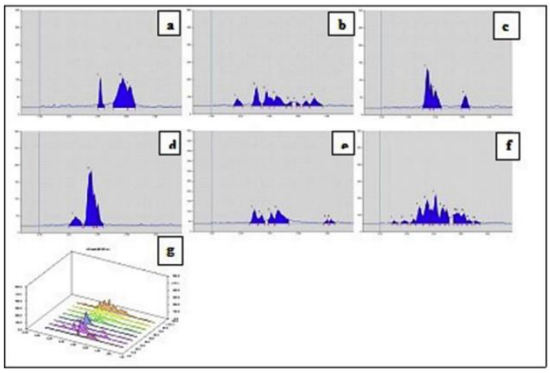

Fig. 7. HPTLC Finger prints of Samasharkara Churna and its ingredients at 540 nm after derivatization. (a) Lavanga, (b) Jatiphala, (c) Pippali, (d) Maricha, (e) Shunthi, (f) Samasharkara Churna, (g) 3D Chromatogram.

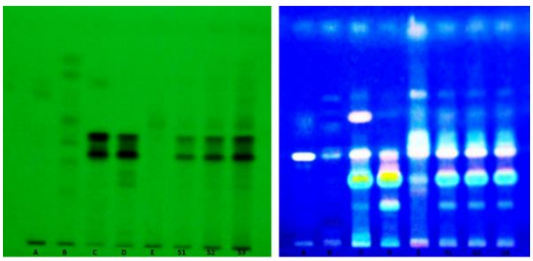

Fig. 8. (a). Photographs of HPTLC plates of Samasharkara Churna and its ingredients at 254 nm before derivatization. (A) Lavanga, (B) Jatiphala, (C) Pippali, (D) Maricha, (E) Shunthi, (S1) Samasharkara Churna (2 ml), (S2) Samasharkara Churna (4 ml), (S3) Samasharkara Churna (8 ml). (b). Photographs of HPTLC plates of Samasharkara Churna and its ingredients at 366 nm before derivatization. (A) Lavanga, (B) Jatiphala, (C) Pippali, (D) Maricha, (E) Shunthi, (S1) Samasharkara Churna (2 ml), (S2) Samasharkara Churna (4 ml), (S3) Samasharkara Churna (8 ml).

chemicals. This method of qualitative assessment is used for many crude medications and is a crucial pharmacognostical evaluation criteria. Therefore, our investigation reports on the distinctive organoleptic characteristics and

fluorescence behaviour of Samasharkara Churna.

Using various staining agents, powder microscopy is utilised to examine the distinct microscopic characteristics of medicinal plants. These investigations offer an appropriate diagnostic tool for both standardisation and adulterant detection. When confirming the presence of components in a polyherbal powder, this procedure is also extremely helpful. The microscopic characteristics found in Samasharkara Churna in our powder microscopic examination verified that all of its herbal constituents were present (Fig. 1).

The identification of formulations in normal industrial production is made easier by established preliminary and physicochemical criteria, which also provide crucial information for additional research. Both water and volatile materials are identified using the test for percentage of moisture content (loss on drying). The quantity of materials left over after ignition is measured by total ash. The quantity of silica present, particularly in sand and siliceous debris, is measured by acid insoluble ash. When assessing the uniformity and quantity of chemical components in a medication, extractive values are helpful.

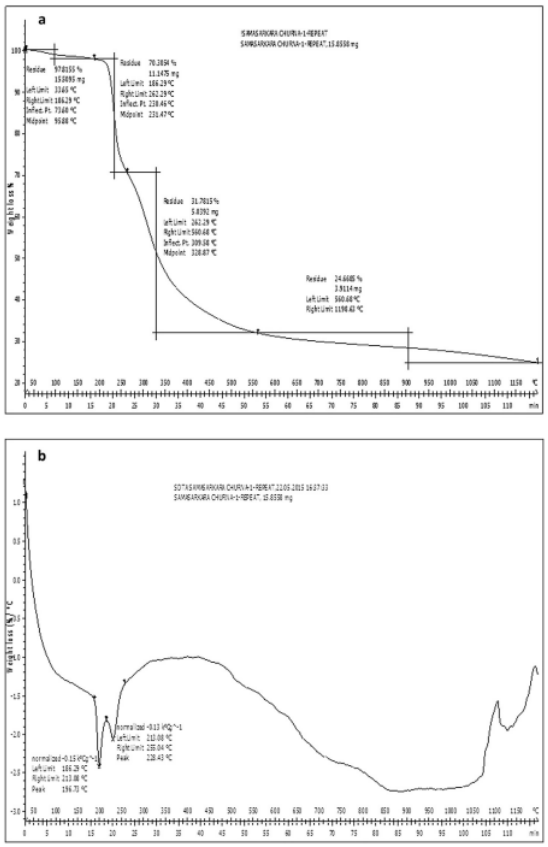

Fig. 9. (a). Thermogravimetric (TG) curve of the Samasharkara Churna. (b). Differential thermogravimetric (DTG) curve of the Samasharkara Churna. Considering the importance of these physicochemical parameters, Samasharkara Churna was characterised by evaluating water soluble extractive, ethanol soluble extractive, total ash content, acid insoluble ash, pH and loss on drying at 105 C.

Chemical substances called phytochemicals are found naturally in plants. The chemical makeup of the crude material extracted from the plant is influenced by several factors, including the location, time of harvest, part utilised, and isolation technique. Samasharkara Churna and its constituent constituents are subjected to a comparative phytochemical assessment in solvents with varying polarities in this regard. Alkaloids, flavonoids, terpenoids, and other

phytoconstituents have been reported to be helpful in the treatment of asthma in the past [33, 34]. According to its phytochemical examination, Samasharkara Churna has the aforementioned ingredients, which may account for its effectiveness in treating asthma (Shwasa Roga).

One essential component of the pharmaceutical production process is powder flow. It is essential to comprehend powder movement during combining, packing, and shipping. The powder flow may be measured using a variety of compendia techniques, including Hausner's ratio, Carr's compressibility index, bulk density, tapped density, and angle of repose. The mass of an untapped powder sample divided by its volume, including the contribution of the inter-particulate void volume, is the bulk density of the powder. As a result, the bulk density is influenced by the powder particle density as well as the particle arrangement in the powder bed. The increased bulk density that results from physically tapping a container holding the powder sample is known as the "tapped density." Flowability is influenced by particle size. Larger, denser particles tend to flow freely, while finer particles with lower bulk/tapped densities do not. Once more, a Hausner ratio of 1.25 denotes inadequate flow capacity. Once more, the better the flow characteristics, the lower the Carr's Index. Excellent flow is indicated by 5e15, good flow by 12e16, fair flow by 18e21, and bad flow by >23. In our study, Samasharkara Churna's poor flow ability was indicated by low tap and bulk densities, as well as high Hausner's ratio and Carr's index.

TGA is a quick, accurate, and repeatable method used in pharmaceutical applications to characterise materials. Weight loss over a given temperature reveals the sample's composition and thermal stability. Information on the volatile and heat-liable chemicals found in medicinal plant materials can be obtained by thermocharacterization. The examination of plant materials during standardisation may benefit greatly from this. The Samasharkara Churna TG curve (Fig. 9a) may be divided into four phases. Up to around 186 C, the first stage of decomposition occurs, with a minimal mass loss of 2.2%, suggesting that the product is not hygroscopic. The loss of volatile oils, particularly monoterpenes, may be the cause of the weight loss at this point. However, the primary weight loss, which is ascribed to both the generation of turbostratic crystallites during pyrolysis and the breakdown of plant components, mostly took place in the temperature range of 196Ce560 C, including the second and third decomposition phases [41]. The second step was the breakdown of both macro and micro compounds between 186 and 262 C, which corresponded to 27.5% mass losses. The nondegradable residues, primarily mineral residues, associated with mass losses of 38.5% during the third mass loss stage, which occurred between 262 and 560 degrees Celsius. The breakdown of more heat-resistant components, such as lignin, resulted in weight stabilisation of the biochar with mass losses of just 7.1% during the last (fourth) degradation stage at 560–1200 C. Approximately 75.3% of the total mass was lost across the four phases. Two endothermic peaks at 196 C and 228 C within the second breakdown stage of 186e262 C of the TG curve have been corroborated by the DTG curve (Fig. 9b), which is used to assess the thermal instability of Samasharkara Churna. These two peaks show that Samasharkara Churna's mass loss rate from decomposition reaches its highest at these

two temperatures. Nevertheless, the full DTG curve showed no more peaks.

VI. CONCLUSION

The comprehensive pharmacognostic, physicochemical, and chromatographic characterization of polyherbal churna is essential for ensuring the quality, safety, and efficacy of these traditional formulations. Pharmacognostic evaluation serves as the foundation for identifying plant materials and ensuring the authenticity of the raw ingredients. By examining the macroscopic, microscopic, and histological features of the plants, we can confirm that only the correct species are used, thus maintaining therapeutic integrity.

Physicochemical characterization, including tests for moisture content, ash values, and extractive values, provides essential data regarding the formulation's stability, purity, and shelf life. Standardization of these parameters ensures that the formulation remains consistent across batches and minimizes the risk of contamination or degradation.

Chromatographic techniques such as Thin Layer Chromatography (TLC) and High-Performance Liquid Chromatography (HPLC) are powerful tools for profiling the chemical constituents in polyherbal churna. These techniques not only allow for the identification and quantification of bioactive compounds but also aid in creating a chemical fingerprint for quality control. Establishing a chromatographic profile ensures that the formulation contains the expected levels of active ingredients and supports the reproducibility of the product.

Overall, this study highlights the importance of standardizing polyherbal formulations to guarantee their therapeutic efficacy and safety. By employing comprehensive pharmacognostic, physicochemical, and chromatographic evaluations, we can develop robust quality control protocols that will facilitate the integration of polyherbal churna into modern healthcare systems. Furthermore, these standardized procedures will support the regulatory approval of polyherbal products, allowing them to be widely used in clinical settings with confidence. Future research and clinical trials are necessary to fully validate the clinical efficacy and safety of polyherbal churna, ensuring that it continues to meet the demands of both traditional and modern medicine.

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