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RESEARCH ARTICLE

Standardisation and Antimicrobial Activity of *Hedychium spicatum* (*Shati*)

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Abstract

Background: *Hedychium spicatum* Buch. Ham. (*Zingiberaceae*), also known as the spiked ginger lily, is a versatile herbal medicine used in traditional systems of medicine for its therapeutic properties. It has been used as an analgesic, antifungal, anti-inflammatory, antimicrobial, antioxidant, antispasmodic, Central Nerves System (CNS) depressant and for cytotoxic activities, fevers, pediculicidal and respiratory disorders. **Aim:** To standardise and evaluate the antimicrobial activity of *H. spicatum* (*Shati*). **Method:** A study was conducted to standardise the anti-microbial activity of *H. spicatum* (*Shati*). An extract was prepared using hydroalcoholic and organoleptic methods and physico-chemical analyses were performed. **Results:** It was discovered that High-Performance Thin Layer Chromatography (HPTLC) was more flexible than traditional Thin Layer Chromatography (TLC) methods. The hydroalcoholic extracts inhibited good antimicrobial activity against all tested fungi and bacteria. The study concludes that the standardisation and potential antimicrobial activity of *H. spicatum* extracts against tested bacteria and fungi have been evaluated. **Conclusion:** Further investigation is needed to explore polyherbal formulations for infectious skin disorders.

Keywords: Anti-microbial Activity, Inflammation, Physiochemical, Phytochemicals

1. Introduction

For many years, native traditional medicine has been based mostly on plants with medicinal qualities. Herbal plant extracts and by-products are employed globally as botanical pharmaceuticals, herbal medications and treatments, traditional remedies, plant food supplements and other applications because of their unique multi-target therapeutic activity and ability[1-4]. These herbs greatly impact the creation of new medications because they contain a range of naturally occurring phytochemicals that are essential for medicine[5,6]. Most pharmacological drugs on the market today are sourced from plants[7]. Anti-inflammatory, antioxidant and antimicrobial drugs are incredibly abundant in many of the plants that make up Mother Nature. *H. spicatum* Buch. Ham and the extract is a significant medicinal herb that belongs to the *Zingiberaceae* family of plants. This plant is named differently in different parts of India (Table 1). The scientific classification of the plant is given in Table 2.

Hedychium spicatum Buch. Ham., originates in the Himalayan region[8,9]. The rhizomes are traditionally used as herbal medicine and have been treasured in the traditional system of medicine for being versatile in therapeutic properties as the treatment of analgesic, antifungal, anti-inflammatory, antimicrobial, antioxidant, antispasmodic, CNS depressant, cytotoxic activities, fevers, pediculicidal and respiratory disorders[10-13].

The plant is a perennial rhizomes herb in use for decades in India as a traditional medicine. It originated in the Central and Western Himalayas at altitudes of 3500-7500 feet. The rhizomes, known as *Kapur kachari* are an article of commerce in the Indian bazaar.

The classical names are *Shati*, *Suvrata*, *Gandhamulika*, *Gandharika*, *Gandhavadhu*, *Prithu palashika* and *Gandhapalashi*[10].

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Table 1. Vernacular names[13]

English	Spiked Ginger Lily
Hindi	*Kapur Kachari*
Bengali	*Shati, Kachri, Kapura Kachari*
Gujarati	*Kapur Kachali, Kapur Kachari, Kapur*
Kannada	*Seena Kachora, Goul Kachora, Gandha Shati. Kachori*
Malayalam	*Katchooram, Katcholam*
Marathi	*Gabla Kachari. Kapura Kachari*
Punjabi	*Bankela, Banhali, Shalwi, Kachoor, Kachur, Sheduri*
Tamil	*Kichili Kizongu, Poolan Kizangu*
Telugu	*Gandhakachuralu*
Oriya	*Gandhasunthi*

This plant is used in numerous *Ayurvedic* herbal compositions for the treatment of various illnesses. The rhizome of *H. spicatum* is well-recognised in Ayurvedic literature for treating hair loss as well as hiccups, joint discomfort, digestive problems and respiratory problems. Rhizomes from plants are commonly used as a powder, syrup or tablet in *Ayurveda*[14]. The diverse range of essential oils found in *H. spicatum*, which include sedative, anti-diabetic, anti-helminthic, anti-inflammatory, anti-microbial and antioxidant qualities, all contribute to its exceptional performance and health benefits.

Rhizomes are used as a carminative, appetiser and stimulant. In addition, rhizomes are used to make a popular tonic and dietary supplement called *Chayawanprash*. Both the leaves and the roots of the plant are used in Tibetan medicine. It is well recognised for its sweet-smelling, fragrant blossoms, which can be used both medicinally and aesthetically. Dried and powdered rhizomes are used as natural colours in the Indian festival of Holi. Enhancing tobacco scent is one of the rhizomes' other well-known advantages. The plant's leaves have insecticidal qualities that make them useful for making floor mats[15-19]. *H. spicatum* is one of the plant species listed as near-threatened and vulnerable by the International Union for Conservation of Nature and Natural Resources[20-22]. It also works well for rheumatoid arthritis, diarrhoea, piles, ulcers, dyspepsia, skin disorders, liver problems and hair issues. The roots are used by people all over the world as a snakebite treatment. TB23 is treated with both the rhizome decoction and deodar sawdust[23].

Table 2. Scientific classification

Kingdom	Plantae
Division	*Magnoliophyta*
Class	*Liliopsida*
Order	*Zingiberales*
Family	*Zingiberaceae*
Genus	*Hedychium*
Species	*spicatum*

2. Materials and Methods

2.1 Collection of Plants

Hedychium spicatum (*Shati*), plant was harvested from India's Uttarakhand region for research study (Figures 1A and 1B).

2.2 Extraction

A test solution was extracted out of a *Shati* sample in this investigation using a hydroalcoholic method. After mixing the sample with 50 millilitres of methanol, it was refluxed for one hour. After that, the mixture was filtered via a filter membrane with a 0.45-micron pore size. Plant determinations, both qualitative and quantitative were made using this extract.

2.3 Organoleptic Study

The study of objects that can be experienced by the senses, including sight, sound, taste and touch, is known as organoleptic study[24] and several methods, such as direct perception through smell as well as chemical or microscopic analysis, can be used to evaluate the organoleptic qualities of dried materials[25]. Thus, the dried plant powder's condition, colour, nature, odour, texture and taste were ascertained through sensory analysis of the organoleptic tests.

2.4 Physico-chemical Analysis

In the current investigation, the subsequent physicochemical parameters were determined using the hydroalcoholic plant extract.

2.5 Loss on Drying (LOD)

To determine the percentage of LOD, 1.0g of plant extract was added to a glass stopper weighing container, which was subsequently dried for an hour in a hot air oven and repeatedly weighed.

Figure 1. *Hedychium spicatum* **(A)** plant; **(B)** powder extract.

$$\% \text{ loss of drying} = \frac{(B - A)}{\text{Wt of Taken}} x100$$

2.6 pH Value

A pH meter electrode was used to measure the pH of 1.0g of plant extract and 100mL of water. The mixture was stirred for one minute. Three measurements were taken, and the average was calculated.

2.7 Water Soluble Extractive for Extract and Powder

After mixing, shaking, filtering and storing the water, the sample was used. A formula was used to calculate the percentage of water-soluble extractives in the filtrate after it was dried at 105°C.

Wt. taken (A): a g in 100 mL, 25 mL, taken i.e., $\frac{25xa}{100}$

$$\% \ of \ \ water - soluble \ extractive = \frac{\text{Wt. of residue}}{Wt.of \ sample(A)} x100$$

2.8 Alcohol Soluble Extractive

The mixture of plant extract and 100mL alcohol was agitated for six hours and then filtered for eighteen hours. After drying the filtrate at 105°C, the extractive proportion soluble in alcohol was calculated.

Wt. taken (A): a g in 100 mL, 25 mL, taken i.e., $\frac{25xa}{100}$

$$\% \ of \ \ alcohol - soluble \ extractive = \frac{\text{Wt. of residue}}{Wt.of \ sample(A)} x100$$

2.9 Total Ash

After the sample was heated to 450°C and burned until it was carbon-free, it was weighed and proportioned according to a formula.

$$\% \ of \ \ Total \ Ash \ = \frac{\text{Wt. of Ash}}{Wt.of \ sample} x100$$

2.10 Acidic Insoluble Ash

After extracting all of the ash, adding 10% HCl, heating, filtering, and washing away any soluble material, the amount of acid-insoluble ash was calculated by filling an ash crucible using insoluble ash, igniting it at 800°C and weighing it. It was established how much acidic insoluble ash there was.

$$\% \ of \ \ Acidic \ Insoluble \ Ash = \frac{\text{Wt. of acidic insoluble ash}}{Wt.of \ sample} x100$$

2.11 HPTLC Fingerprinting

After diluting the extract in alcohol, it was filtered and put into 60F254 aluminium sheets for MERCK-TLC/

HPTLC. Several solvent systems, such as glacial acetic acid and methanol, were prepared with the solvent chloroform and 10ul of the extract was sprayed with the anisaldehyde-sulphuric acid reagent. Using the CAMAG Linomat 5 applicator, which was attached to the CAMAG HPTLC apparatus, the sample was applied in triplicate. A TLC plate heater was used to dry the chromatograms after they were produced in the CAMAG TLC twin chamber. Densitometers were scanned at 254, 366 and 540nm. R_f values and fingerprint data were recorded using the WIN CATS software.

2.12 Heavy Metal Analysis By ICP-MS Method

The 10-ppm working standard solution was created by adding one millilitre each of Type-1 water and the standard stock solution. Various amounts of the standard solution were added to produce standard solutions with concentrations of 2 ppb, 5 ppb and 10 ppb (Table 3).

Table 3. Instrument parameters for heavy metal analysis

Power		Ramp (Min)	°C (Control)	Hold Time (min)
MAX	%			
800 W	100	30	180	10

Following digestion, the containers were fumigated, distilled water was added to a 50mL jar and the mixture was filtered through 0.22u filter paper. ICP-MS was used to find metals.

2.13 Anti-microbial Activity

A slant comprising *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Escherichia coli*, *Bacillus subtilis*, *Candida albicans* and *Aspergillus brasiliensis* was prepared as part of the investigation. Mulller Hinton Agar, Potato Dextrose Agar and Sabroud Dextrose Agar were used in the manufacture of the media. To check for antimicrobial activity, test materials were weighed, sonicated, refluxed and filtered. The zone of inhibition was evaluated after the extract was tested against gram-positive, gram-negative and fungal bacteria.

2.14 Microbial Limit Test (TAMC, TYMC and Pathogen Test)

Sterile soybean casein digest broth was used to prepare and combine the samples. The microbiological limit was ascertained using the pour-plate method. After labelling two petri dishes, 25mL of the medium was applied. After the plates were incubated for three to five days, the colonies were tallied, and the mean was determined.

$$Colony\ forming\ unit\ (cfu): \frac{No.\ of\ colonies\ x\ dilution\ factor}{Weight\ of\ sample}$$

Using a variety of identification tests, the study involved detecting *Salmonella typhi*, *P. aeruginosa*, *S. aureus* and *E. coli*. On MacConkey Broth, pink colonies of E. Coli, metallic colonies of *S. typhi*, greenish colonies of *P. aeruginosa* and yellow zones of *S. aureus* were found. While negative controls looked at medium and diluent sterility, positive controls assessed viability and growth parameters.

2.15 Total Antioxidant Study by DPPH Method

After being extracted with 20mL of 50% methanol, the material was filtered and made diluted. For antioxidant research, working solutions containing 160µg, 320µg, 480µg and 640µg were prepared in various volumetric flasks.

2.16 Total Phytochemicals

Methanol and gallic acid were combined to create the standard solution, which was then followed by a 50% methanol solution. Methanol was added to the extract to make the sample. As part of the experiment, Demineralised (DM) water solutions were made, absorbance was measured and the percentage of total polyphenols was computed.

$$\%of\ Total\ Polyphenol = \frac{T}{S} x \frac{Cs}{Ct} x \frac{P}{(100 - LOD)} x100$$

Where: T = absorbance of test solution; S = absorbance of standard solution; Cs = concentration of standard solution; Ct = concentration of test solution; P = Purity of standard; LOD = loss on drying of extract.

Total Flavonoids: A weighted sample was mixed with methanol, stirred and then dried. To determine the total flavonoid proportion, the resultant methanolic filtrate was concentrated, evaporated and filtered.

$$\%\ Of\ \ Total\ Flavonoids = \frac{\text{Weight of residue}}{Wt.of\ sample taken} x100$$

3. Results and Discussions

3.1 Organoleptic Analysis

The powder had a light brown hue and a unique taste and smell, as determined by the organoleptic examination. Research indicates that the most important stage in determining the sample's quality and purity is to evaluate its ash value[26]. Biologically active molecules are chemicals that may be used to cure a variety of illnesses[27]. Plants include a variety of phytochemicals that have a wide range of biological and therapeutic uses. The identification of other classes of phytoconstituents in various medicinal plant sections forms the basis for the discovery of drugs, medicines and antibiotics[28,29].

Table 4. Results of physicochemical analysis

Parameters	Result
Loss on Drying	9.98%
pH (1%)	6.84
Water Soluble Extractive	14.00%
Alcohol Soluble Extractive	6.78%
Total Ash	4.75%
Acid Insoluble Ash	0.93%

3.2 Physio-chemical Analysis

The *Shati* extract's physicochemical properties are given below in Table 4. It shows that the solution's pH was 6.84 and that 9.98% of the material remained wet due to drying loss. In the interim, low moisture content might have stopped microbiological growth in the sample. The values for total ash and acid insoluble ash have been determined to be 4.75% and 0.93%, respectively, for the ash content. Additionally, the solubility percentages for alcohol and water were found to be 6.78% and 14.00, respectively.

3.3 HPTLC Results

By comparing the Rf values determined for the phytoconstituents in the tested sample to reference standards, it would be possible to identify any unknown substances. The chemical concentrations may also be ascertained using the peak area values. An essential technique for assessing the calibre of botanical materials is HPTLC. It makes it possible to analyse a variety of substances effectively and economically. Because the zones remained distinct, studies on HPTLC have shown that it is more adaptable than traditional TLC procedures. Although additional quantitative measurement using marker chemicals and

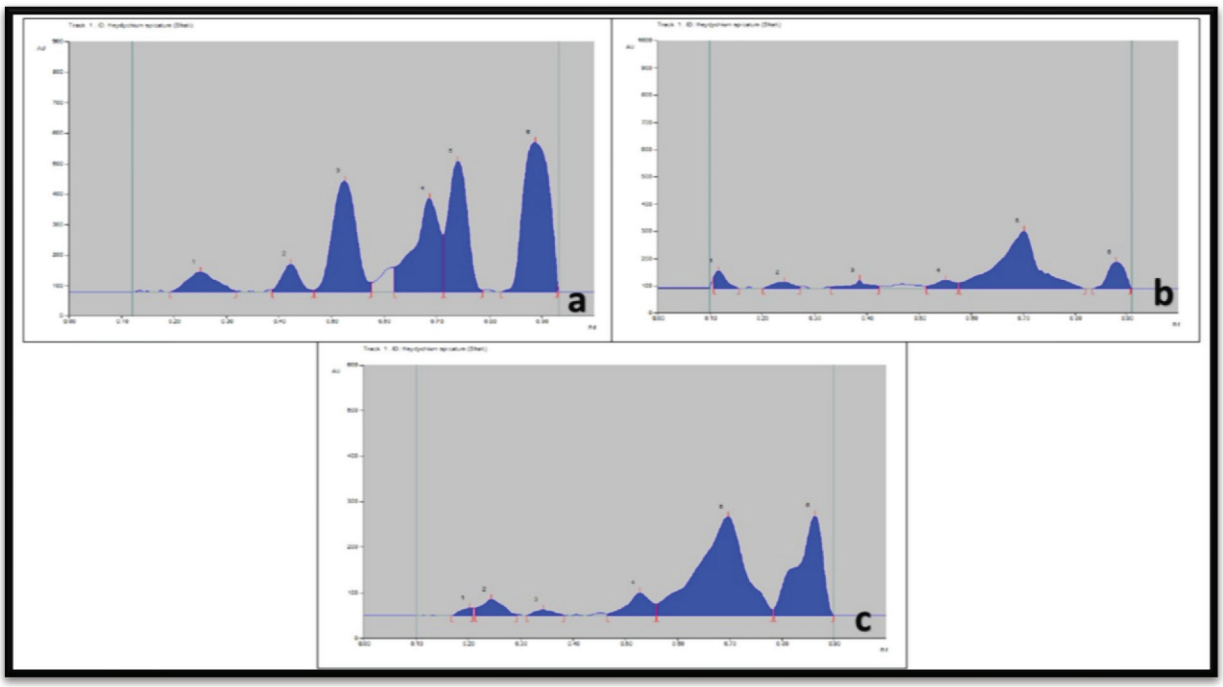

Figure 2. Hydroalcoholic extract HPTLC chromatogram with distinct phytoconstituent peaks (bands) at 254nm, 366nm and 540nm. **(A)** 250nm; **(B)** 366nm; **(C)** 540nm.

investigation of the other chemical components may be required, these data can be utilised in conjunction with the other values to establish standards for this plant. Flavonoids and polyphenols were discovered by the most recent investigation.

Six spots with the following R_f values were discovered on the HPTLC Chromatogram at 254 nm in the current study's HPTLC fingerprinting of the hydroalcoholic extract: 0.25, 0.42, 0.53, 0.69, 0.74 and 0.89. Six spots with the following R_f values were found on an HPTLC chromatogram at 366nm: 0.12, 0.25, 0.42, 0.53, 0.74 and 0.89.

By analysing the absorption spectra at the beginning, middle, and end of the band, the material's purity was confirmed. Six more spots with R_f values of 0.20, 0.25, 0.34, 0.53, 0.69 and 0.89 were seen at 540nm. Different phytoconstituent peaks (bands) are visible in the hydroalcoholic extract HPTLC chromatogram at 254nm (Figure 2A), 366nm (Figure 2B) and 540nm (Figure 2C).

3.4 Heavy Metal Analysis (ICP-MS)

The heavy metal analysis is tabulated in Table 5.

3.5 Anti-microbial Activity

Two gram-positive, two gram-negative and two fungal were compared to the extracts from *Shati*. The results showed that every type of fungus and bacterial that was studied had strong levels of action against the HCl extracts (Table 6). *Aspergillus brasiliensis* and *S. aureus*, both of which had inhibition zones of 20mm, were the microorganisms most responsive to extracts. It was discovered that some microbes, such as *P. aeruginosa* had inhibition zones for 15mm. *Escherichia coli*, *B. subtilis* and *C. albicans* had only a slight susceptibility to the inhibition zones in the extracts.

Table 5. Results of heavy metal analysis

Parameters	Result	Limit as per Ayurvedic pharmacopeia
Lead	0.007ppm	NMT 10ppm
Cadmium	0.001ppm	NMT 0.3ppm
Mercury	0.002ppm	NMT 1ppm
Arsenic	0.001ppm	NMT 3ppm

3.6 Microbial Limit Test (TAMC TYMC and Pathogen Test)

The *Shati* extracts were evaluated using the plate-pour method for their microbiological activity against four different bacteria. The results include the examined bacteria, *S. typhi*, *P. aeruginosa*, *E. coli* and *S. aureus* (Table 7). Yeast and mould were absent from the sample and the overall microbial count was Nil cfu/g.

The plant extract's antibacterial qualities have been confirmed by a plethora of additional studies, and the microbial test indicated the extract's anti-microbial activity. *Hedychium spicatum* extracts in petroleum ether and chloroform were demonstrated to be effective against a variety of gram-positive and gram-negative bacteria, including *E. coli* (MTCC 1687), *Alkaligens faecalis* and *Klebsiella pneumonia*. Two gram-positive bacteria, *Bacillus cereus* and *S. aureus* (KI-1A)[30]. In the antibacterial activity of the *Shati* plant flower, essential oils against a gram-negative bacterium, *Borrelia burgdorferi* were eradicated at 0.1% (v/v) flower concentration[31]. Arora *et al.*'s study on the methanol extract of *Shati* against specific bacterial strains, such as *B. cereus*, *E. coli*, *P. Aeruginosa*, *K. pneumonia*, *Shigella boydii*, *Shigella flexneri*, *Shigella soneii* and *V. cholera*, revealed inhibitory effects of ciprofloxacin and methanolic extract[32]. Strong antibacterial and antifungal qualities have been found in rhizome essential oils, according to studies[33-35]. The essential oil was found to have a mild antibacterial effect against *Salmonella enterica* and to form inhibitory zones with a diameter of 9 to 16 mm[35]. A range of methicillin- and vancomycin-resistant *S. aureus* strains

Table 6. Anti-microbial and anti-fungal activity of *Shati* DE extraction

Name of Sample	Zone of Inhibition (mm)					
	***S. aureus* (ATCC6538)**	***P. aeruginosa* (ATCC9027)**	***E. coli* (ATCC8739)**	***B. subtilis* (ATCC6633)**	***C. albicans* (ATCC10231)**	***A. brasiliensis* (ATCC16404)**
Blank	*NZI	*NZI	*NZI	*NZI	*NZI	*NZI
***Shati* Dry Extract**	20mm	15mm	10mm	11mm	15mm	20mm
* - No zone of inhibition						

Table 7. Microbial analysis of *Shati* dry extract

Sr No.	Parameters	Results	Limit as per Ayurvedic Pharmacopeia
1	Total Microbial Plate Count (TAMC)	Nil	10^5cfu/g
2	Total Yeast and Mould Count (TYMC)	Nil	10^3 cfu/g
Pathogen Test Results			
1	*Staphylococcus aureus*	Absent	Absent/g
2	*Salmonella* sp.	Absent	Absent/g
3	*Pseudomonas aeruginosa*	Absent	Absent/g
4	*Escherichia coli*	Absent	Absent/g

were among the bacterial and fungal strains that the extract of different solvents inhibited[30]. Furthermore, research has demonstrated that essential oils may be fungi toxic[36]. The essential oil of the species prevented the pregerminated spores of *Aspergillus flavus* and *Fusarium verticillioides*, which are responsible for the production of aflatoxin and fumonisin, two significant families of mycotoxins, from developing at all[37]. Many studies have been conducted on the *in-vitro* activity of crude solvent extract; however, none of them have particularly addressed the solvent fraction or separated components of the species.

3.7 DPPH Scavenging Effect (%)

The findings of the DPPH at various concentrations are tabulated and shown below (Table 8).

One example of a free radical is DPPH, which is stable at ambient temperature and precipitates a violet solution in ethanol. The DPPH is lowered by an antioxidant molecule, which alters the violet precipitate's colour in ethanol. Analysing DPPH makes antioxidant evaluation easier and faster. The results of the investigation indicate that the plant extracts possess strong antioxidant properties. Strong antioxidant capabilities, including metal ion chelating, radical scavenging, and minimising properties, have also been associated with essential oils extracted from *H. spicatum* rhizomes[35,38]. Furthermore, the antioxidant activities of the rhizome methanolic extract were inhibited, which were associated with the presence of phenolic components[39-42], even though previous research found variations in the antioxidant activity of

Table 8. Findings on the DPPH scavenging effect at various concentrations

Concentration (µg)	DPPH Scavenging effect (%)
160	15.51
320	37.14
480	55.91
640	71.83
Results of the test sample	
Regression Equation	Y=0.1173X – 1.8367
IC_{50}	441.91ug/ml concentration of sample required to inhibit 50% of DPPH free radical

methanolic extracts and essential oils obtained from different Himalayan locations[35,38,42]. Nonphenolic antioxidants such as xanthophylls, a- and b-carotene, and DL-a-tocopherol have also been noted in other investigations[35,38,42-44].

3.8 Total Phytochemicals

A UV spectrophotometer was used to quantify the total phenols and flavonoids. Phenols are believed to possess significant antioxidant properties in addition to their antibacterial, anticancer, and antiallergic properties. Flavonoids are plant-based substances that are thought to make up the majority of polyphenolic compounds found in the diets of humans. A quantitative analysis of these elements is essential to determining the medicine's quality. 2.1% flavonoids and 1.98% phenols, respectively, are included in the extract. Numerous phytochemicals, including alkaloids, albumin saccharine, carbohydrates, flavonoids, glycosides, proteins, phytosterols, resins, saponins, starch, steroids and tannin, were identified in the plant extract based on previous research[45,46]. Research indicates that the overall phenol content of a plant indicates the presence of antioxidant phytochemicals including beta-carotene, xanthophyll, and DL-tocopherol[42]. Resins, starch, organic acids, ethyl esters of para-methoxy-cinnamic acid and d-sabinene sesquiterpenes are found in the rhizome of the species[13,47,48].

Tinea capitis, tinea corporis, tinea barbae, tinea unguium and tinea pedis were among the tinea infections. *Hedychium spicatum* contains ethyl p-methoxycinnamate as an active ingredient. A cream that contains *H. spicatum* oil which inhibits melanogenesis and is anti-dermatophytic is applied.

Tumor Necrosis Factor-alpha (TNF-alpha) suppression could be the cause of the anti-melanogenesis effect. The mixture also has deodorising properties[49].

Research has even proven the plant's anti-inflammatory properties and patented the recipes. Research on essential oils revealed that a blend of 0.5 to 6% by weight of essential oils, including *Cymbopogon citratus*, *Zanthoxylum armatum* and *H. spicatum*, had a synergistic anti-inflammatory and analgesic impact on the skin. When applied at varying concentrations, the same formulation was beneficial in reducing pain associated with fibromyalgia, rheumatoid arthritis and other ailments[49].

The plant has a significant flavonoid content, as the current study shows. A comprehensive study on flavonoids indicates that these molecules have several applications and properties, such as anti-inflammatory, anti-microbial, and treatment of skin disorders[50].

Plant extracts called flavonoids have long been utilised in cosmetics and dermatology. However, the mechanisms underlying their impacts have just lately become known to the public. Although the effectiveness of flavonoids in crossing the skin barrier has not been extensively studied, existing research suggests that these compounds can penetrate the stratum corneum and reach beneficial levels in the dermis and epidermis[51,52]. The makeup of the flavonoid and the properties of the vehicle affect the penetration rate[53].

The benefits of the plant on dermatology have been thoroughly studied and it has been demonstrated that a formulation derived from n-hexane extracts through the soxhlations process has a cinnabloc component that functions as both a sunscreen and a skin-lightening substance[49,54,55]. Further research indicates that the plant extract (0.001% to 20%) acts as a natural sunscreen formula to protect skin from UV radiation with both long- and short-wavelengths[49,55,56]. The study found that applying hexane methyl acetate extract topically assisted in the removal of corns as well as in preventing the growth of new corns and itchy, cracked and hardened skin. It was found that the *H. spicatum* cream formulation, containing 0.8 to 1.08% [w/w] alcoholic extract, reduced frostbite, dry skin and sunburn. In the past, the *H. spectrum* was thought to be the active component in cosmetics. To improve the quality of the skin, minimise wrinkles and stop UV rays from penetrating the skin, 0.2% to 6% of the extract was utilised in this composition. This was done to halt the synthesis of nitric oxide and the depletion of thiols like glutathione. The IC_{50} for NO inhibition was around 69.97 g/ml.

4. Conclusion

Hedychium spicatum is a highly significant plant in medicine, according to the study's findings. Alcoholic extracts of *H. spicatum* rhizomes exhibit antibacterial activity, indicating a wide spectrum of pharmacological actions. Because of this species' substantial research on photochemistry and pharmacological properties, ethnomedicine studies are extremely important. Studying its primary flavonoid properties is essential since flavonoids have several therapeutic applications, such as anti-inflammatory, anti-microbial and therapies for skin disorders. Its clinical profile will also need to be thoroughly investigated for its involvement in a variety of microbiological illnesses. The natural plantation of this species has disappeared as a result of illicit harvesting and the careless use of its rhizome extract in the manufacture of numerous medications. Reestablishing this plant in its native environment is required. Planning for appropriate proliferation and large-scale cultivation of this species is therefore necessary. The development of polyherbal formulations for infectious skin problems or diseases will be the main focus of future research.

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