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Review Article

HEDYCHIUM SPICATUM BUCH-HAM. (KUCHRI), A TREASURE HOUSE OF ESSENTIAL OILS

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ABSTRACT

Medicinal plants have a very significant role in the health care system. They are served as the primary source of modern drugs. One of such important medicinal plant is *Hedychium spicatum* Buch-ham. which belongs to the Zingiberaceae family (ginger family). The plant is commonly known as the spiked ginger lily in English and Kuchri in Hindi and Shati in Sanskrit. It is a commercially valuable plant due to its rhizomes. This rhizomatous plant holds a significant place in Ayurveda due to its extraordinary disease-curing properties. It is mentioned as Shwasahara mahakashaya dravya in Ayurveda. It is used in many folk cultures around the world as a remedy against many diseases like diarrhoea, liver-related problems, pain, vomiting, stomachache, inflammation, nausea, headache, fever etc. It is a therapeutically important plant due to the presence of numerous important essential oils as major phytochemical constituents like 1,8-Cineole, camphene, sabinene, β-pinene, myrcene, α-phellandrene, etc. The main therapeutic properties of the plant are anti-inflammatory, anti-microbial, hepatoprotective, tranquilizer, antipyretic, anti-diabetic, pediculicidal, anti-helminthic etc. The aim of the present review is to provide information related to phytochemistry, therapeutic properties, traditional uses of *Hedychium spicatum* in Ayurveda and folk medicinal system.

Keywords: Kuchri, Rasapanchak, Camphene, Pediculicidal, Anti-inflammatory

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INTRODUCTION

Medicinal plants are the major segment of native traditional systems of medicine for years. Herbal products are used in almost each and every corner of the world (Intentional as well as domestic markets) under various categories such as herbal drugs, botanical drugs, botanicals, phytomedicines, traditional medicines, herbal medicines, traditional Chinese medicines (TCMs), traditional herbal medicinal products, natural health products, or plant food supplements, because of their remarkable multi-target therapeutic actions, safety and easily availability [1-4]. Medicinal herbs play a critical role in the manufacturing of new drugs because they contain phytochemicals of diverse nature which are medically important [5, 6]. In the modern era, half of the drugs which are used clinically, have been developed primarily from plant sources [7]. There are numerous plants exist in mother nature which are extremely valuable as they are the rich source of anti-microbial, anti-inflammatory, anti-oxidant drugs. *Hedychium spicatum* Buch-ham. (fig. 1) is one of such important medicinal plants which belongs to the zinger family Zingiberaceae. The plant is commonly known as spiked ginger lily, garland flower in English. Whereas it got its trade name Kapurakachari due to its commercially valuable rhizomes [8]. Locally the plant is known as ban haldi or kuchri. Zingiberaceae family is commonly known for its extraordinary therapeutic properties. This family is found growing wild in the tropical areas of the world like Southeast Asia. Gingers are served as an important ingredient in food, spices, medicines, dyes and perfume etc. There are approximately 53 genera having 1200 different variety of species present in Zingiberaceae family. 20 genera and almost 200 different species of Zingiberaceae family have been reported from various regions of India [9-11]. The genus name *Hedychium* is derived from 'hedys' a greek word which means sweet and 'chion' means snow [12]. It is a well-recognized genus for its specific aroma, beautiful foliage and attractive, diverse and showy nature of flowers and comprises of almost 50 different species [13]. Almost each species of this genus is native to central and Southeastern Asia and more specifically found in southern China and some Himalayan regions except H. peregrinum, which is a native plant of Madagascar [14]. *Hedychium spicatum* has a very rich history of its utilization in traditional medication systems and is commonly known as an anti-diabetic plant [15]. It has a significant position in World's most traditional medicine system i.e. Ayurveda. It is used in many Ayurvedic herbal formulations to treat a variety of ailments. The use of *Hedychium spicatum* rhizome has been mentioned in Ayurvedic literature for treating hair loss, digestion and problems related to the respiratory system, joint pain, and hiccups and to maintain cardiac health. In Ayurveda the plant rhizomes are usually consumed in powder, syrup or tablet form [16]. *Hedychium spicatum* is a rich source of various kind of essential oils which are responsible for its extraordinary therapeutic properties like anti-microbial, tranquilizing, anti-oxidant, anti-inflammatory, pediculicidal, hepatoprotective, anti-diabetic and anti-helminthic etc. The essential oils are used in manufacturing of soap, hair oil, face powder and incense. *Hedychium spicatum* is utilized by many different cultures and tribes of the world as remedy to treat many diseases like asthma, piles, diarrhoea, liver-related problems, constipation, dysentery, stomachache, bronchitis, cough, headache, pain, inflammation and as an anti-venom against snakebites, skin disorders, dropsy and hair fall. Rhizomes are used as an appetizer, carminative and stimulant. Rhizomes are used for making well-known tonic as well as food supplement called Chayawanprash. The roots and leaves of this plant are used in Tibetan medicines. Apart from its clinical and therapeutic use, it is famous for its sweet-scented flowers which are used for ornamental purposes. The powdered form of dried rhizomes is used as herbal holi color (an Indian festival of colors). The rhizomes are used to provide aroma to tobacco. Due to the insecticidal properties of its foliage, it is being used to make floor mats [17-26]. As per the International Union for Conservation of Nature and Natural resources (IUCN) report, H. spicatum has now listed under vulnerable species and near threatened plant species containing essential oils. The main reason behind it overexploitation and habitat degradation of the plant [27-29]. Vernacular names and taxonomic classification of *Hedychium spicatum* is given in table 1 and 2 respectively.

Fig. 1: *Hedychium spicatum* plant

Table 1: Vernacular names of *Hedychium spicatum* [30, 31]

English	Spiked ginger lily, Perfume ginger, Zedoaery
Hindi	Kapur kachri, Sitruti, Kachoor, Van haldi
Sanskrit	Palashi, Shatgrantha Subratha, Gandhmulika, Gandharika, Gandhvadhu and Prathupalashika, Shati, Gandhpalassi
Bengali	Kapurakachri, Shati, Kachri
Gujrati	Kapurkachli, Kapurkachari, Kapur krachari
Kannada	Gandhasati, Seenakachora, Kachora, Kacchura
Malayalam	Katcholam
Oriya	Gandha sunthi
Punjabi	Khor, Kachoor, Kachur
Tamil	Poolakizhangu, Kichilikizhangu
Telugu	Gandha Kachurala
Kashmir	Kapurkachara
Marathi	Kapurkachri, Gabla kachari
Assamese	Katuri, Sati
Arabic	Jaramdada

Table 2: Taxonomy of *Hedychium Spicatum*

Taxonomic rank	Taxon
Kingdom	Plantae
Division	Magnoliphyta
Class	Liliopsida
Order	Zingiberales
Family	Zingiberaceae
Genus	Hedychium
Species	spicatum
Common Name	Kuchri

Morphological features of *Hedychium spicatum*

Hedychium spicatum is a perennial rhizomatous medicinal herb with an erect leafy stem and reaches up to the height of about 5-150 cm. The leaves are long, broad, sessile, glabrous and ovate-lanceolate with clasping sheaths and are about 30 cm in size. There is the presence of a densely flowered spike of 30 cm. The bracts are large, oblong and green. Flowers are hermaphrodite, fragrant and white-colored with the base of orange-yellow or red color. The floral spikes are dense, terminal and 15-25 cm long. Floral bracts are singled flowered and large, oblong and green colored. The flowers bear 3-lobbed calyx which is usually shorter than the bract and white ascending and of closely imbricate type. Corolla is about 5-6.3 cm in size which is larger than the calyx. The floral petals are white and are linearly spread. White curate lip having 2 elliptical lobes with orange or yellow base is present. The stamens are shorter than the lip and have red filaments. Flowers bear linear anther of size 6-8.5 mm. The fruit capsules are globular having a lining of orange-red color. Numerous seeds of black and white color with arils are present. The rhizomes are 15–20 cm long, 2.0–2.5 cm in diameter and are fleshy and horizontal. Externally the rhizome is yellowish-brown in appearance but on storage, they turn dark brown. Rough reddish brown layer is present over the one edge of each piece having numerous scars and circular rings and rudiments of rootlets [32-34].

Geographical distribution of *Hedychium spicatum*

H. spicatum is a native plant of south-eastern Asian countries. It is found more commonly in the subtropical Himalayas. In India it is primarily found in Assam, Arunachal Pradesh and Uttarakhand at an elevation of 1800-3000 m. Whereas it is also found in Jammu and Kashmir, Thiruvananthapuram hills of Kerala. It is also found widely growing in the Malysia, Nepal, Bhutan, Myanmar, Northern Thailand and China [35,36]. The plant impressively tolerates wide range of climatic conditions of forest margins from 1500 to 2800m asl. *H. spicatum* grows well in light (sandy), medium (loamy) and heavy (clay) soils. It prefers acid, neutral and basic (alkaline) soils [37].

Phytochemical constituents of *Hedychium spicatum*

Hedychium spicatum contains phytochemical compounds like alkaloids, carbohydrate, protein, resins, saponins, steroid, tannin, starch and glycosides, flavonoids and tritepenoids, albumin saccharine and phytosterols [38, 39]. This medicinal plant is well recognized for its wide range of essential oils which are the major phytochemical constituents of this medicinal herb. The major compound classes of essential oils present in the plant are monoterpene hydrocarbons, oxygenated monoterpenes, sesquiterpene hydrocarbons and oxygenated sesquiterpenes. 1,8-Cineole is the major constituent of essential oil. Other essential oils such as camphene, sabinene, β-pinene, myrcene, α-phellandrene, δ-2-carene, α-terpinene, p-cymene, limonene (z)-β-ocimene, γ-terpinene, trans-linalool oxide (furanoid), cis-linalool oxide (furanoid), linalool, camphor, δ-terpineol, α-terpineol, β-caryophyllene, α-humulene, allo-aromadendrene, 9-epi-β-caryophyllene, epi-cubebol, α-muurolene, γ-cadinene, β-himachalene, δ-cadinene, hedycaryol, cis-sesquisabinene hydrate (e)-nerolidol, spathulenol, caryophyllene oxide, epi-cubenol, eremoligenol, α-cadinol, β-eudesmol, α-eudesmol, τ-muurolol, agarospirol, epi-β-bisabolol, eicosane, ethyl p-methoxycinnamate, ethyl cinnamate, eucalyptol, endo-borneol, 3-carene, camphene, α-gurjunene, β-copaene, p-cymen-8-ol, α-pinene, verbenone, limonene oxide, isobornylformate, eucarvone, thymol, o-cymene, longipinocarvone, β-pinene, α-acorenol, camphor, caryophyllene oxide, d-limonene, (1r)-(-) myrcenol, cubenol, (z)-pinocarveol, p-cymene, trans-α-bergamottin, alpha-ylangene, linalyl anthranilate, pinocarvone, (-)-spathulenol, α-calacorene, cis-verbenol, 3-nitro propionic acid, linalool oxide, rotundene, (R)-lavandulyl acetate are primarily present in the rhizomes of the plant [40-45]. The rhizomes also contain sitosterol and its glucosides, furanoid diterpene-hedychenone and 7-hydroxyhedychenone. Total phenolic content of the plant indicates the presence of phytochemicals like xanthophyll, α-carotene, β-carotene, DL-α-tocopherol. These phenolic compounds are known to be associated with antioxidant activity [46, 47]. Reddy *et al.*, the study discovered two novel labdane-type diterpene (1, 2), along with compounds like yunnacoranarin D, coronarin-E, drimene, 4-methoxy ethyl cinnamate, ethyl cinnamate, chrymsin [48]. Chemical structures of phytochemicals are shown are fig. 2.

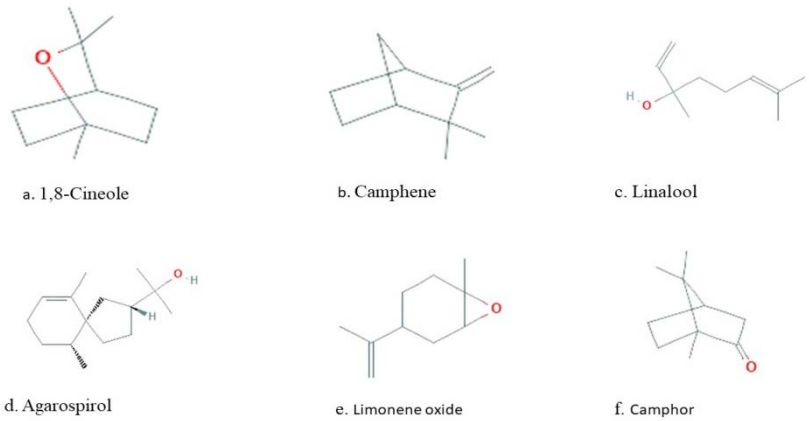

Fig. 2: Chemical structures of some of the phytochemicals of *Hedychium spicatum*

Traditional and modern view of *Hedychium spicatum*

Ayurvedic view of *Hedychium spicatum*

The origin of Ayurveda is almost 2500 and 500 BC old. The word Ayurveda depicts the meaning "science of life". Its treats the diseases by balancing the three body components/doshas of the body i.e. kapha (water and earth), pitta (fire) and vata (space and air) [49-51]. *Hedychium spicatum* is a popular medicinal plant Ayurveda science of life. It is commonly known as Shati in Ayurveda. It consists of Kaphavataghna properties i.e. it balances the kapha and vata Doshas. In Charak Samhita, *Hedychium spicatum* is mentioned under Shwasahara mahakashaya dravya i.e. drugs having the potential to treat cough and other problems related to the respiratory system. It is mainly used to treat cough, wound ulcer, fever, respiratory problems and hiccough, respiratory tract issues, dermatological diseases, and tropical pulmonary eosinophilia [52-55]. Rasapanchak of *Hedychium spicatum* is given in table 3.

Table 3: Rasapanchak of *Hedychium spicatum* as per ayurveda [56]

Sanskrit/English	Sanskrit/English
Virya/Potency	Ushna/Hot
Vipak/Metabolic property	Katu/Pungent
Guna/Physical property	Laghu/light, Teekshna/Pungent
Rasa/Taste	Katu/Pungent, Tikta/Bitter, Kashaya/Astringent

Properties of *Hedychium spicatum* as per Ayurveda [57]

Hedychium spicatum has "Rogaghnata" i.e. diseases curing properties such as it is used to treat swelling (sandhishotha), pain (shoola), toothache (dantashoola), halitosis (mukhadurgandha), wound (vrana), apoplectic convulsions (apatantraka), rheumatoid arthritis (amavata), tastelessness (aruchi), poor digestion (agnimandhya), flatulence (adhamana), colic pain (udarashoola), diarrhoea (atisara), piles (arsha), blood related isssues (raktavikara), allergic rhinitis (pratishyaya) and cough (Kasa),

Actions of *Hedychium spicatum* as per Ayurveda [58, 59]

Vedansthapana (pain-killer), dur-gandhanashana (odour repellent), deepana (appetizer), shoolaprashamana (pain-reliever), Hikkanigrahana (treats hiccups), rakthashodhaka (blood purifier), jwaraghna (anti-pyretic), uttejaka (stimulant) and keshya (good for hair).

Ayurvedic formulations of *Hedychium spicatum* [60, 61]

The most famous Ayurvedic formulation of of Hedychium spicatum is "Bharangyadi" is well known polyherbal Ayurvedic formulation which is made up of Clerodendrum serratum, Hedychium spicatum and Inula racemosa. In Ayurveda, it is used for treating allergic rhinitis and allergic asthma. In vitro analysis of this polyherbal formulation done by Kajaria D et al., suggested its use as a significant immunomodulatory as well as an anti-microbial and anti-inflammatory drug.

Folk view of *Hedychium spicatum*

Some plants are used in many medicinal folk practices which represent their rich ethnobotanical significance [62]. Ethnobotany not only promotes the value of cultural beliefs but also plays a vital role in the health care system and drug development [63]. *Hedychium spicatum* is associated with many ethnobotanical uses. For instance, the root powder of this plant is used traditionally as a remedy to asthma [64]. Kurumba tribal people of Chemmankarai, Nilgiri use leaves to get relief from headache. They use preparation made up of rhizome powder and goat milk as a cure to asthma [65]. In Western Mizoram, rhizome is traditionally used for many medicinal purposes like, liver-related problems, pain, vomiting, stomachache, inflammation and snakebite. The rhizome is used as an expectorant, tonic, carminative and stimulant [66]. Some local communities of Rudraprayag District, Uttarakhand apply the root paste topically in swelling [67]. In the Jaunsar-Bawar Hills of Uttra Pradesh, people treat diarrhoea with the paste made up of *Hedychium spicatum* rhizome [68]. In Darjeeling and Sikkim, rhizome is used against stomach and liver-related issues and vomiting whereas in some other regions it is used to cure asthma, cough, diarrhoea, vomiting and headache [69, 70]. People from Dhwaj sacred grove from the Central region of Indian Himalayas traditionally treat cold, cough, tonic, asthma, gastric problem, liver diseases, fever with the *Hedychium spicatum* rhizome [71]. Traditional healers of Bhubaneshwar, Odisha use rhizome powder of *H. spicatum* to treat bronchial asthma, also used as an appetite enhancer. They also treat local inflammation, nausea, hiccups, halitosis and vomiting with the plant rhizome [72]. Tribes of Koraput Odisha, use tuber paste externally as a remedy for rheumatism and loose motion [73]. People use rhizome of this plant in folk medicinal practices to treat asthma, piles, bronchitis, snake bite and nausea in the Bageshwar valley of Uttarakhand [74]. In Marginal hill community, Uttrarakhand, people use *Hedychium spicatum* rhizome in gastrointestinal (problems related to the intestine and used as a purgative, laxative and carminative) respiratory (it is used to treat cough), dermatological problems (cosmetics and used against lice) [75]. In Kumaun, Himalaya, people use root against problems related to liver, fever, vomiting, diarrhoea, inflammation, pains [76]. Traditional healers of Nanda Devi Biosphere Reserve, Uttarakhand use this plant against asthma, piles and liver related problems [77]. People in Siwalik region of Uttarakhand treats dysentery traditionally with the plant rhizome [78]. Women from Garhwali region use rhizome as a blood purifier and in treating rheumatic pain [79]. In some areas of Uttarakhand root powder is used to treat neuromuscular disorders and body pain, asthma and also used as an anti-cancer and antimicrobial [80, 81]. The Migratory Shepherds in Summer Hill of District Shimla use the plant rhizome against asthma and cough [82]. In some areas of kullu, rhizomes are used against asthma, bronchitis and as a blood purifier [83]. The Kanwar tribe of Chhattisgarh, use *Hedychium spicatum* tuber in sexual enforcement [84]. In many districts of Nagaland, plant is used to treat diseases like fever, headache, vomiting, diarrhoea, inflammation [85]. Some indigenous groups of Northern Chin State, Myanmar use rhizome of the plant to get relief from menstrual bleeding, wound bleeding, asthma, and kidney problems. They also use it as a tonic [86]. Some ethnic groups of Parbat district, Western Nepal use the rhizome decoction against indigestion and high fever [87]. A Nepalese tribe named Raji, use plant rhizome to enhance digestion, loss of appetite and to treat constipation, stomachache [88]. Some native groups of Lore Lindu National Park, Central Sulawesi, Indonesia, use the rhizome in cosmetics and as a spice [89]. The rhizome paste of this plant is used around many parts of the world as a traditional remedy for abscesses (dermatological disorder) [90, 91].

Modern view of *Hedychium spicatum*

Herbal medicinal products are preferred more because these have negligible adverse impacts and toxicity associated with them. But concerns regarding the safety of these products are raising due to the practice of adulteration and contamination [92-96,]. Adulteration always leads to the degradation of herbal products which may cause severe health risks [97]. Common adulterants of herbal products are orthodox drugs and fake or inferior plant materials and foreign materials. Species misidentification in the Global market of herbal products is a very common type of adulteration. Misidentification of plant species induces undesirable, unrelated species which may have the potential to cause severe impacts on consumer health. This can be intentional or unintentional. Intentional adulteration is carried out to derive maximum profit by cleverly increasing the weight or quantity of the herbal product [98, 99]. For instance, Kaempferia galanga Linn is a plant species whose rhizomes are sold out in the market as the same name as that of *Hedychium spicatum* i. e Shati. This may happen due to morphological similarity [100]. Improper packaging and storage are also associated with contamination [101]. The quality of herbal products can only be assured if proper standardization tools and techniques are set up from the beginning of the process to the ending i.e. from the collection of raw material to the production of end product [102]. For the detection of adulteration, the most preferred technique which is used nowadays is DNA barcoding. Its molecular-based technique which has a great potential to identify the species and detect out the adulterant and contaminants in the herbal products [103].

Therapeutic properties of *Hedychium Spicatum*

Hedychium spicatum has extraordinary therapeutic properties due to its wide range of phytochemical constituents. Some of the therapeutic properties of *Hedychium spicatum* are discussed below.

Anti-inflammatory activity

Chachad *et al.*, conducted a comparative study to evaluate the anti-inflammatory potential of *Hedychium spicatum* Buch-Ham ex Smith, *Kaempferia galanga* Linn. and *Curcuma zedoaria* Rosc. The study was conducted out on carrageenan-induced rat paw edema models. The ethanolic extract of *Hedychium spicatum* rhizome showed the maximum anti-inflammatory behavior. The study confirms that the plant is associated with anti-inflammatory activity [104].

Anti-microbial

As per the reports of Bisht *et al.*, essential oil, petroleum ether and chloroform extracts of *Hedychium spicatum* have anti-microbial potential. They use gram-positive bacterial strains (*Bacillus cereus, Staphylococcus aureus, Staphylococcus aureus* (KI-1A)**,** *Staphylococcus aureus*) and gram-negative strains **(***Alkaligens faecalis, Escherichia coli, Escherichia coli* (MTCC 1687), *Klebsiella pneumoneae, Pseudomonas aureginosa* (MTCC 424), *Salmonella typhi, Shigella dysenterae*) to evaluate the anti-microbial potential of *Hedychium spicatum*. The fungal strains used were *Alternaria saloni, Aspergilus fummigatus, Aspergilus flavus, Aspergilus niger, Candida albicans* (MTCC 227), *Fusarium oxysporum, Mucar racemosus, Penicilium monotricales, Penicilium spp., Rhizopus stolonifer, Trichoderma viride,* and *Trichoderma lignorum*. The extracts showed potent activity against the used microbial strains suggesting the anti-microbial behavior of the plant [105]. Feng *et al.*, conducted a study to evaluate the anti-microbial behavior of flowers essential oil against *Borrelia burgdorferi* (a gram-negative bacteria). The bacteria used in the study was in stationary phase cycle. It was observed that essential oil at 0.1% (v/v) concentration effectively eradicated *B. burgdorferi* and left with negligible chances of the regrowth of the bacteria [106]. Arora *et al.* also conducted a comparative study to evaluate the antimicrobial potential of methanolic extract of *Hedychium spicatum* rhizome and the antibiotic ciprofloxacin at 200 to 1200 µg/ml concentrations against bacterial strains namely *Shigella boydii, Shigella soneii, Shigella flexneri, B. cereus, V. cholerae, E. coli, S. aureus, Ps. aeruginosa* and *K. pneumonia.* A similar inhibitory effect was noticed for both methanolic extract and ciprofloxacin [107].

Hepatoprotective activity

Hepatoprotective activity of *Hedychium spicatum* was studied by Joshi Uttara in an *in vitro* study. The study was conducted on primary rat hepatocytes in which hepatotoxicity was induced by paracetamol. Dietrpene isolated from methanol extracts significantly worked on hepatocytes viability and other associated parameters like glutamic transaminase, glutamic pyruvic transaminase and total protein by restoring them. The study suggested that *Hedychium spicatum* has potent hepatoprotective activity [108].

Anti-diabetic

Kaur *et al.*, conducted an *in vivo* study to evaluate the anti-diabetic potential of *Hedychium spicatum* in rat models in which diabetes was induced artificially by intraperitoneal injecting alloxan monohydrate solution. The treatment of models by orally administering rhizome essential oil at 0.3 Ml dose for 14 d, resulted in reduced levels of blood glucose and urea. It was also observed that essential oil helped Islets of Langerhans in regaining the original shape [109].

Tranquilizing activity

Chopra *et al.*, evaluated the tranquilizing activity of *Hedychium spicatum* in rat models and the results showed that rhizome essential oil is associated with the tranquilizing activity. It significantly worked on avoidance response caused by the depressed condition, performance of rota-rod and hypnosis induced by phenobarbitone and analgesia induced by morphine in rats [110].

Ameliorative efficacy

Chaudhary *et al.*, conducted an *in vivo* study on eight weeks old, white leghorn male chicks which were intoxicated with indoxacarb to evaluate the ameliorative actions of *Hedychium spicatum*. Root powder of the plant showed its ameliorative actions by normalizing the levels of total erythrocyte count (TEC), total leukocyte count (TLC), haemoglobin (Hb), packed cell volume (PCV), absolute lymphocyte count (ALC), absolute heterophill count (AHC) and lymphocyte and by reducing the value of differential leucocyte count (DLC %) to normal. The study concluded that the plant has ameliorative actions [111].

Pediculicidal

Jhadav *et al.*, studied the pediculicidal activity of *Hedychium spicatum* in an *in vitro* study. The study was conducted out on *Pediculus humanus capitis* (head louse). It was observed that essential oil extracted from rhizomes of the plant at the concentration of 5%, 2% and 1% caused 95-100% mortality rate in the models after the interval of 2 h of treatment with the extract. The study confirms that the essential oil showed better results than the 1% permethrin-based products available in the market [112].

Anti-helminthic

Sravani *et al.*, analyzed the anti-helminthic potential of *Hedychium spicatum* in *in vitro* using adult Indian earthworms named *Pheretima posthuma* and *in silico* study. It was found from the results of *in vitro* study that beta-sitosterol extracted from the rhizomes showed potent inhibitory actions than the standard drug called Piperazine citrate. The time taken by beta-sitosterol for paralysis and death was less than that of Piperazine citrate. Whereas no significant findings were obtained from the *in silico* study [113].

Anti-pyretic

Arora *et al.*, investigated the antipyretic activity of *Hedychium spicatum* in an *in vivo* study on Wister strain albino rat models. The models were induced with pyrexia artificially by Brewer's yeast. Methanolic extract of the plant was found to be an effective measure against pyrexia as it significantly elevated the body temperature of models at the dosage of 100 mg/kg and 200 mg/kg. Thus, the study suggested the use of *Hedychium spicatum* as an antipyretic agent [114].

CONCLUSION

The present study is an attempt to provide detailed information about an important medicinal plant species *Hedychium spicatum*. Modern pharmacological studies indicated that this plant has extraordinary biological potential. It is strongly believed that the data presented in this review on the utilization of *Hedychium spicatum* plant in Ayurveda and folk cultures might draw the attention of researchers to use this plant in modern medicines. The diverse kind of phytochemicals present in this plant can be the promising source of anti-microbial, hepatoprotective, immunomodulatory, pediculicidal drugs.

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AUTHORS CONTRIBUTIONS

All the authors have contributed equally.

CONFLICT OF INTERESTS

The authors declared no conflict of interest.

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