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An overview about *Hedychium spicatum*: a review

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ABSTRACT

The Indian Himalayan Region (IHR) serves as tremendous repository of plant biodiversity which is derived from extreme altitudinal gradients and phenomenal geographic provinces and has been proved as the richest reservoir of medicinal plants and aromatic plants. The lavish range of plant biodiversity in IHR is supported by various landscape features that provide myriad of habitats. *Hedychium spicatum* Buch-Ham (Zingiberaceae), commonly known as spiked ginger lily, is found in the entire Himalayan region. Rhizome contains about 4% of essential oil and its phytochemical investigations have shown the presence of a variety of terpenoids (monoterpenoids, sesquiterpenoids and diterpenoids).Traditionally, the rhizomes are used in the treatment of respiratory disorders, fevers, tranquilizer, hypotensive, antispasmodic, CNS depressant, analgesic, anti-inflammatory, antimicrobial, antioxidant, antifungal, pediculicidal and cytotoxic activities. The family Zingiberaceae well known for its immense medicinal values is distributed widely throughout the tropics, particularly in Southeast Asia. Zingiberaceae family is an important natural resource that provides many useful products for food, spices, medicines, dyes, perfume and aesthetics. Ethnobiologically, H. spicatum is not commonly popular throughout the Indian Himalayan region, but multifarious uses are practised specifically in different regions. In this review, we will briefly explain about the various multi-faceted aspects about H*edychium spicatum*.

Keywords: *Hedychium spicatum*, Chemical composition, Rhizomes, Zingiberaceae.

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INTRODUCTION

The Indian Himalayan Region (IHR) serves as tremendous repository of plant biodiversity which is derived from extreme altitudinal gradients and phenomenal geographic provinces and has been proved as the richest reservoir of medicinal plants and aromatic plants. The lavish range of plant biodiversity in IHR is supported by various landscape features that provide myriad of habitats [1]. IHR is expanded up to approximately an area of 5, 91,000 km^2 and constitute five biogeographic zones with altitude ranging from 200–8000 m [2]. Out of these geographic regions Western Himalayas are the store house of medicinal and aromatic plant diversities. IHR gives shelter to 18,440 plants species out of which 8,000 are angiosperms, 44 are gymnosperms and 6001, 736, 1159 and 6900 Spp. of pteridophytes, bryophytes, lichens and fungi, respectively. Most of these plant species are used by the inhabitants of the IHR in for medicine, food, fuel, fodder, timber. Out of the total species of vascular plants, 1,748 species are medicinal and are used in different systems of medicine [3]. Two out of eighteen hot spots bio diversities of the world are located in India. India is also one of twelve mega biodiversity countries in the world. India contributes about 45,000 plant species (the total number may be even close to 60,000, as several parts of India are yet to be botanically explored) to the world biodiversity. Of these, seed bearing plants account for nearly 15,000-18,000 species. Varied climatic conditions (such as, alpine in the Himalaya to tropical wet in the south and arid in Rajasthan) have given rise to rich and varied flora in the Indian subcontinent. In order to promote Indian herbal drugs, there is an urgent need to evaluate the therapeutic potentials of the drugs as per WHO guidelines [4]. Ironically, not many Indian products are available in standardized form, which is the minimum requirement for introducing a product in the Western market [5]. Zingiberaceae is the largest family in the order Zingiberales with 53 genera and over 1200 species [6]. Based on morphological features i.e., number of locules and placentation in the ovary, development of staminodia, modifications of the fertile anther and rhizome-shoot-leaf orientation, so far four tribes (Alpinieae, Globbeae, Hedychieae and Zingibereae) have been recognized within the Zingiberaceae [7, 8].

BOTANICAL DESCRIPTION OF PLANT

Hedychium Spicatum (Ham-ex-Smith), family *Zingiberaceae*, is a small hardy rhizomatous perennial herb that grows to around 1-2m, with green leaves, and large orange whitish flowers. It is also known as Shati in Ayurvedic classics,

Kapoor Katcheri in Hindi and commonly known as "Spiked Ginger lily". Leaves are about 30 cm in length, oblong, lanceolate , variable in breadth, glabrous. Spike is 30 cm, densely flowered; bracts large, oblong and green. Flowers are hermaphrodite, ascending and closely imbricate. Corolla tubes are 5-6.3 cm; segments 2.5 cm; lanceolate , lip cuneate, deeply bifid, broad, not at all clawed; filaments are pale red; anther linear 6-8.5mm. Fruit is capsule type; glabrous and globose, when ripe the three valves are reflexed exposing numerous small black seeds embedded in a red aril. Rhizomes are 15-20 cm long; 2.0-2.5 cm in diameter, externally yellowish brown, which changes to dark brown on storage [9-13].

NATIVITY, ENDEMICS AND DISTRIBUTION OF *H. SPICATUM*

Hedychium spicatum is a native herb of South-East Asian countries [14, 15] and near endemic to the Himalayan Region [16] with its diverse growth habitats in sub-tropical to temperate zones [9-10, 16-18]. It has a wide distribution in Bhutan [19]; Nepal [20, 21]; Japan [22]; Thailand [23, 24]; Pakistan [25] and China [12]. In India, it has been found in Andhra Pradesh [26, 27]; Arunanchal Pradesh [28, 29]; Darjeeling [30]; Himachal Pradesh [31-33]; Karnataka [34]; Manipur [35, 29]; Meghalaya; Mizoram [29]; Nagaland [37]; Orissa [38] and Sikkim [39, 40]. This plant is grown as a sub-tropical bedding plant in a rich and moist soil. It cannot grow in shade. It requires sunny weather but can tolerate temperature down to -2°C. This plant has been known to withstand temperature as low as -16°C in Germany. Flowering occurs in the months of July-August and seed formation occurs in September – October. Its easy availability and several natural populations in shady moist and rocky habitats, near water courses and in open or dense oak dominated or mixed forest regions of Indian Central Himalayan Region from 1200- to 2400 m have been well documented [41-49].

CHEMICAL COMPOSITION OF *H. SPICATUM*

The rhizome extract has been reported to contain essential oil, starch, resins, organic acids, glycosides, albumen and saccharides, which has been advocated for treatments of bronchitis, indigestion, eye disease and inflammations. It is also used as a laxative, stomachic, carminative, and stimulant, tonic to the brain and in diarrhea. The essential oil is reported to have anti-microbial activity against bacteria and fungi [50, 51]. Rhizome contains about 4% of essential oil and its phytochemical investigations have shown the presence of a variety of terpenoids (monoterpenoids, sesquiterpenoids and diterpenoids) [52]. Various chemical constituents reported in Hedychium spicatum essential oil are α-pinene, β-pinene, limonene, 1,8 - cineole, 2-alkanones, linalool, camphor, linalyl acetate, β-terpineol, borneol, β-caryophyllene, γ-cadinene, humulene, terpinolene, p-cymene, benzyl cinnamate, benzyl acetate, lindylacteate, γ-terpinene, β-phellandrene, methyl paracumarin acetate, cinnamic ethyl acetate, ethyl-pmethoxycinnamate, ethyl cinnamate, d-sabinene, sesquiterpene-cadinene, sesquiterpene alcohols, sesquiterpene hydrocarbons, drimane and labdane derivatives, hedychenone, 7–hydroxyhedychenone, spicatanoic acid, spicatanol and spicatanolmethyl ether [53]. The essential oil from rhizomes are used in the treatment of respiratory disorders, fevers, tranquilizer [54], hypotensive, anti-spasmodic, CNS depressant, analgesic [55], anti-inflammatory [56], antimicrobial , antioxidant , antifungal, pediculicidal and cytotoxic activities [50, 57-59]. The rootstocks of the herb have bitter camphor like taste and strong aromatic odor. Therefore, it is widely used in incense and fragrant preparations. Rootstock is carminative, emenagogue, expectorant, stimulant, stomachic and tonic. It is also useful in the treatment of liver diseases and poor circulation due to thickening of blood [60].

Table 1: Carotenoids and vitamin content in *Hedychium spicatum* [61]

Antioxidants (mg/100 g)	Planted	Wild
Total phenolics	218.00	181.00
Xanthophyll	0.23	1.65
-Carotene	6.90	20.50
ß-Carotene	19.30	61.80
DL- -tocopherol	4.90	1.10

PHARMACOLOGICAL ACTIONS

The following are the pharmacological actions of Hedychium spicatum reported till date:

Antidiabetic activity:

The essential oil obtained from the rhizomes of Hedychium spicatum possesses significant antidiabetic activity. The main compound responsible for antidiabetic activity was found to be 1, 8 cineole. The oral doses of 0.3 ml/rat of Hedychium spicatum essential oil administered for 14 days reduced the blood glucose and urea level significantly as compared to the normal control [62].

Tranquilizing activity:

Essential oil of rhizomes of H. spicatum was reported to possess mild tranquilizing action of short duration. It depressed conditioned avoidance response, rota-rod performance and potentiated the phenobarbitone induced hypnosis and morphine analgesia in rats [63].

Antihistaminic, anti-inflammatory and ulcer protective activity:

Aqueous and ethanolic extracts of the dried rhizome of H. spicatum were evaluated for anti-histaminic and ulcer-protective activities in guinea pig (GP), anti-inflammatory and analgesic activities in rat and acute toxicity in mouse. Treatment with aqueous and ethanolic extracts of Hedychium spicatum showed significant gastric ulcer protection against histamine-induced gastric ulcer in GPs. Anti-inflammatory effect was also produced by both the extracts against carrageenan-induced paw edema in rats from 1h onwards, and this was greatest at 3h. The benzene extract of rhizome of H. spicatum possessed significant analgesic activity in acetic acid induced writhing in mice. Both the extracts did not show any toxic effect like increased motor activity, salivation, clonic convulsion, coma and death in mice even at the 2000 mg/kg dose (nearly 10 times of the optimal effective dose), indicating the safety of the extracts [64].

Pediculicidal activity:

The rhizome essential oil extracted from H.spicatum showed significant high in vitro pediculicidal activity at 5 %, 2 %, 1 % concentration, than 1 % permethrin based product [65].

Antimicrobial activity:

Essential oil, petroleum ether and chloroform extracts of Hedychium spicatum showed inhibitory activity against Gram (+) and Gram (−) bacterial cultures, including a strain of Dimethylsulfoxide methicillin and vancomycin resistant Staphylococcus aureus and fungal cultures. Rhizome terpenoid component of Hedychium spicatum was reported to possess antimicrobial activity against Staphylococcus aureus, Shigella flexneri, Pasteurella multocida and Escherichia coli, whereas, ethanol fruit extract of H. spicatum showed antibacterial and antifungal properties against Salmonella sps., Escherichia coli and filamentous fungi [66, 67, 68].

Antioxidant and hepatoprotective activity:

The study of antioxidant and hepatoprotective activity of methanolic extract of rhizomes of Hedychium Spicatum (MEHS) in CCl_4-induced hepatotoxicity model in rats revealed significant activities on substantially elevated serum enzymatic levels of AST, ALT, and ALP. Total bilirubin was found to be restored towards normalization significantly by the MEHS in a dose dependent manner with maximum hepatoprotection at 400 mg/kg dose level. The histopathological results also supported the biochemical evidences of hepatoprotection. Elevated level of superoxide dismutase (SOD) and decreased level of malondialdehyde (MDA) further strengthen the hepatoprotective observations. The results of the study revealed that MEHS have potent antioxidant activity and hepatoprotective activity against CCl_4-induced hepatic damage in experimental animals.

Terpenoid compositions of rhizome of Hedychium Spicatum were found to possess antioxidant activity. The rhizome essential oil exhibit moderate to good Fe^{2+} chelating activity whereas the essential oil a completely different DPPH radical scavenging profile [67].

Antimalarial activity:

The 50 % extract of the rhizome of H. spicatum showed antimalarial activity against Plasmodium berghei strain (NK 65) [69].

Cytotoxic activity:

Phytochemical investigation of chloroform extract from rhizomes of Hedychium Spicatum led to the isolation of two new labdane type diterpenes. All the isolates and its derivatives were tested for in vitro cytotoxicity on different cancer cell lines by MTT assay. The cell lines used in this study were HELA (cervical cancer), MCF-7 (breast cancer), HEP G2 (liver cancer) and HT-29, COLO-205 (colon cancer). From the results of the cytotoxicity evaluation of these constituents H. spicatum, it appeared that compound $C_{15}H_{22}O_2$ 275.1623 displayed potent activity against Hela cell line with the IC_{50} 0.30 µg/mL, which was more potent than the standard doxorubicin.

Results indicated that compounds $C_{15}H_{22}O_3$ 235.1692 and $C_{15}H_{22}O_2$ 275.1618 may serve as an important natural lead compounds for future development as they showed potent cytotoxic activity against Hela cell lines with an IC_{50} value of 0.3 µg/mL and 1.80 µg/mL, respectively [70].

Hypocholesterolemic Activity:

Chronic administration of β-sitosterol subcutaneously to rats for 60 days was well tolerated and there was no clear cut evidence of any gross or microscopic lesions either in the liver or kidney. Liver and kidney function tests were assessed by determining the blood/serum parameters like hemoglobin, blood glucose, serum protein, serum bilirubin, serum cholesterol, serum GPT and serum GOT. All the parameters were in the normal range except serum proteins and serum cholesterol. Serum cholesterol was the only variable which depleted markedly in both the sexes in a dose dependent manner suggesting intrinsic hypocholesterolemic effect of sterol [71].

Anthelmintic activity:

The anthelmintic activity of rhizomes of H. spicatum against adult Indian earthworms, Pheretima posthuma was evaluated. The time taken for each worm for paralysis and death was determined. The results were compared with that of standard i.e., piperazine citrate. Methanol extract of H. spicatum produced dose dependent anthelmintic activity whereas aqueous extract was not all effective. Methanol extract showed better anthelmintic activity when compared with the standard drug piperazine citrate [72].

INDUSTRIAL USE OF H. SPICATUM

Its powdered rhizome, extract and essential oil are mixed in several herbal formulations. Rhizome of H. spicatum is source of essential oil [41, 49] and several natural secondary metabolites viz., terpenes, alcohols, aldehydes and phenols [49, 51, 59]. Its essential oils have many medicinal efficacies, including anti-inflammatory and analgesic effects. Its use as a mild tranquillizer and Central Nervous System depressant [54], antibiotic and antimicrobial [50]; in-vitro pediculicidal [64]; in-vitro Hepatoprotective and application in cosmetic products creates a high industrial demand for raw material [73].

CONCLUSION

On the basis of the present review, it has been concluded that Hedychium spicatum is medicinally very important plant. Aqueous and ethanolic extracts of rhizomes of H.spicatum was found to have wide range of pharmacological activities. Moreover its clinical profile is being studied for its activity in Bronchial asthma and pulmonary eosinophilia. Due to illegal harvesting and indiscriminate exploitation of its rhizome extract in making various types of drugs, the natural plantation of this species has become extinct. There is need to re-establish this plant in its natural habitat. Therefore, there is need to plan out proper propagation and cultivation of this species at large scale.

REFERENCES

1. Samant SS, Dhar U, Palni LMS, Medicinal plants of Indian Himalaya: Diversity, Distribution, Potential Values. Nainital: Gyanodaya Prakashan. 1998.
2. Rodgers WA, Panwar HS, 1988. Planning a wildlife protected area network in India. Report. Wildlife Institute of India, Dehradun.1988
3. Samant SS, Joshi HC. Plant diversity and conservation status of Nanda Devi National Park and comparisons with highland National Parks of Indian Himalayan Region. International Journal Biodiversity Science Management. 2005; 1(1):65-73.
4. WHO, 2004. Quality Control Methods for Medicinal Plants. WHO, Geneva.
5. Dubey NK, Kumar R, Tripathi P.. Global promotion of herbal medicine:India's opportunity. Curr. Sci. 2004; 86(1):37-41.
6. Kress WJ. The phylogeny and classification of the Zingiberales. Annal.Missouri Bot. Garden 1990; 77:698–721.
7. Petersen OG. Musaceae, Zingiberaceae, Cannaceae, Marantaceae. In: Engler, A. and Prantl, K. (eds.), Die Naturlichen

Pflanzenfamilien. Verlagvon Wilhelm Engelmann, Leipzig, Germany. 1889; 2(6): 1–43.
8. Schumann K, Zingibaraceae. In: Engl r, A. (ed.) Hedychium coronarium and allied species. K w Bull. 1904; 368–372.
9. Negi KS. Spiked ginger lily, Hedychium spicatum Buch.-Ham.(Zingiberaceae). Indian Perfumer. 2001; 45(1):1-2.
10. Gaur RD. Flora of the District Garhwal North West Himalaya (with ethno botanical notes). Transmedia, Srinagar (Garhwal), India. 1999.
11. Garg SN, Shawl AS, Gulati, BC. Sesquiterpene alcohols from Hedychium spicatum var. acuminatum. Indian Perfum. 1977; 21:79.
12. Wang YQ, Zhang DX, Chen ZY. Pollen histochemistry and pollen: ovule ratios in Zingiberaceae. Annal. Bot. 2004; 94(4):583-591.
13. Csurhes S, Jones HM. Pest Plant Risk Assessment. Dense waterweed Egeria densa Biosecuirty Queensland 2008. (http: //www.dpi.qld.gov.au).
14. Pushpangadan P, Nair NK, Ahmad MR. Biodiversity and Medicinal Plant Wealth of South Asian Countries. National Botanical Research Institute, (Council of Scientific & Industrial Research), Lucknow, India 2001.
15. Reddy PP, Rao RR, Rekha K,. Two new cytotoxic diterpenes from the rhizomes of Hedychium spicatum. Bioorganic Med. Chem Let. 2009 a; 19(1):192-195.
16. Samant SS, Butola JS, Sharma A. Assessment of diversity, distribution, conservation status and preparation of management plan for medicinal plants in the catchment area of Parbati Hydroelectric Project Stage-III in Northwestern Himalaya. J. Mount. Sci. 2007; 4(1):34-56.
17. Jain SK. Ethnobotanical diversity in Zingibers of India. Ethnobot. 1995; 7 (1-2):83-88.
18. Koranga SS, Ojha SN, Negi KS, Tiwari LM, Rawat AKS. Bold seeded Spiked Zinger Lily (Hedychium spicatum Buch.-Ham. ex J.E. Smith). Seed Res. 2011; 39(2):203-208.
19. Chettri N, Shakya B, Sharma E. Biodiversity Conservation in the Kangchenjunga Landscape. International Centre for Integrated Mountain Development, Kathmandu, Nepal 2008.
20. Balami NP. Ethnobotanical use of plants among Newar community of Pharping village of Kathmandu district, Nepal. Tribhuvan University J. 2004; 24(1):13-19
21. Kumar KCS, Muller K. Medicinal plants from Nepal; II. Evaluation as inhibitors of lipid peroxidation in biological membranes. J. Ethnopharmacol. 1999; 64 (2):135-139.
22. Mukherjee I. Chromosome studies of some species of Hedychium. Botanical Magazine Tokyo 1970; 83:237-41.
23. Picheansoonthon C, Wongsuwan P. Notes on the genus Hedychium J. Koenig (Zingiberaceae) known for Thailand. J. Royal Inst. Thailand 2008; 33(3):119–131.
24. Sirirugsa P. Thai Zingiberaceae: species diversity and their uses. Invited lecture presented at the International Conference on Biodiversity and Bioresources: Conservation and Utilization, Phuket, Thailand. Pure Appl. Chem. 1999; 70(11):1-8.
25. Siddiqui BS, Choudhary MI, Medicinal Plant Biodiversity in Pakistan - Opportunities and Threats. In: Pushpangadan, P., Nair, K.N. and Ahmad, M.R. (eds.). Biodiversity and Medicinal Plant Wealth of South Asian Countries, Country Reports of Bangladesh, Bhutan, India, Iran, Maldives, Nepal, Pakistan and Sri Lanka. National Botanical Research Institute, Council of Scientific & Industrial Research, Rana Pratap Marg, Lucknow, India 2001.
26. Rao VLN, Busi BR, Rao BD, Rao CS, Bharathi K, Venkaish M. Ethnomedicinal practices among Khonds of Visakhapatnam district, Andhra Pradesh. Indian J. Trad. Knowled. 2006; 5(2):217-219.
27. Savithramma N, Sulochana C , Rao KN. Ethnobotanical survey of plants used to treat asthma in Andhra Pradesh, India. J. Ethnopharmac. 2007; 113(1): 54-61.
28. Srivastava RC, Choudhary RK. Floristic scenario of Itanagar Wildlife Sanctuary-a case study. Bul. Arunachal For. Res. 2006; 22 (1-2):17-21.
29. Tushar BS, Sarmab GC, Rangana L. Ethnomedical uses of Zingiberaceous plants of Northeast India. J. Ethnopharmac. 2010; 132(1): 286-296.
30. Chhetri DR, Basnet D, Chiu PF, Kalikotay S, Chhetri G, Parajuli S. Current status of ethnomedicinal plants in the Darjeeling Himalaya. Curr. Sci. 2005; 89 (2):264-268.
31. Chawla A, Yadav PK, Uniyal SK, Kumar A, Vats SK, Kumar S, Ahuja PSLong-term ecological and biodiversity monitoring in the western Himalaya using satellite remote sensing. Curr. Sci. 2012; 102(8):1143-1156.
32. Rana MS, Samant SS. Threat categorization and conservation prioritization of floristic diversity in the Indian Himalayan region: A state of art approach from Manali Wildlife Sanctuary. J. Nature Conserve. 2010; 18(3):159-168.
33. Bhasin V. Gaddis' Folk Medicine: A Source of Healing. Ethno-Med. 2008; 2(1):1-27.
34. Bhandary MJ, Chandrashekar KR, Kaveriappa KM. Medical ethnobotany of the Siddis of Uttara Kannada district, Karnataka, India. J. Ethnopharmac. 1995; 47(3):149-158.
35. Singh A, Lal M, Samant SS. Diversity, indigenous uses and conservation prioritization of medicinal plants in Lahaul valley, proposed Cold Desert Biosphere Reserve, India. International J. Biodiversity Science & Management 2009; 5(3):132-154.
36. Shankar R, Devalla RB. Conservation of folk healing practices and commercial medicinal plants with special reference to Nagaland. International J. Biodiversity and Conservation 2012; 4(3):155-163.
37. Behera KK, Sahoo S, Patra S. Floristic and medicinal uses of some plants of chandaka denudated forest patches of Bhubaneswar, Orissa, India. Ethnobot. Leaflets 2008; 12:1043-1053.
38. Hussain S, Hore DK. Collection and conservation of major medicinal plants of Darjeeling and Sikkim Himalayas. Indian J. Tradnl. Knowl. 2007; 6(2):352-357.
39. Badola HK, Pradhan BK 2010. Population exploration of Rhododendron maddenii in Sikkim, bordering Khangchendzonga Biosphere Reserve questioning rarity and endangerment. Ne. Biol. 2010; 1 (1):1-9.
40. Bottini AT, Garfagnoli DJ, Delgado LS, Dev V, Duong ST, Kelley CG, Keyer R, Raffel R, Joshi P, Mathela CS 1987. Sesquiterpene alcohol from Hedychium spicatum var. acuminatum. J. Nat. Prod. 1987; 50(4):732-734.
41. Joshi M, Singh SP, Rawat YS. Plant forms and sesonality of leaves in herb layer of sites with varying lavel of deforestation. J. Trop. For. Sci. 1992; 6(4):508-522.
42. Mehrotra P, Kharakw IG, Pangety YPS. Ecological implication of plant traits, strategies and competitive abilities of herbs. App. Ecol. Env Res. 2004; 2(2):1-13.
43. Ram J. Biodiversity and conservation of high altitude meadows of Uttaranchal Himalaya. Bullet. National Inst. Ecol. 2005; 15:11-17.
44. Bahuguna A, Phondani PC, Negi VS, Rawat LS, Maikhuri RK, Joshi PC and Bisht NS. Floristic diversity and indigenous uses of forest vegetation of Dabka watershed in Indian Central Himalaya. Ethnobot. Leaflets 2010; 14(4):491-510.
45. Verma RS, Padaliya RC. Comparative essential oil composition of different vegetative parts of Hedychium spicatum Smith from Uttarakhand, India. International J. Green Pharmacy 2010; 4(4):292-295.
46. Rawat R, Vashistha DP. Common herbal plant in Uttarakhand, used in the popular medicinal preparation in Ayurveda. International J. Pharmacogn. Phytochem. Res. 2011; 3(3):64-73.
47. Ghildiyal S, Gautam MK, Joshi VK, Goel RK. Pharmacognostical Study of Hedychium spicatum (Ham-ex-Smith) Rhizome. A.P.J. Trop. Dise. 2012; 2(1): 148-153.
48. Lohani N, Tewari LM, Joshi GC, Kumar R, Kishor K. Ex-situ conservation of Hedychium spicatum Buch.-Ham. using different types of nursery beds. Afr. J. Ag. Res. 2013; 8(27):3580-3589.
49. Negi KS, Koranga SS, Ojha SN, Pandey MM, Rawat AKS, Raina AP, Rayal A. Spiked Zinger Lily (Hedychium spicatum): Identification of superior genotypes from Indian Himalayan region. Indian For. 2014; 140(4): 363-367.
50. Bisht GS, Awasthi AK, Dhole TN. Antimicrobial activity of Hedychium spicatum. Fitoterapia. 2006; 77:240-242.
51. Joshi S, Chanotiya CS, Agarwal G, Prakash O, Pant AK, Methela CS. Terpenoids compositions and antioxidant and antimicrobial properties of the rhizome essential oil of different Hedychium species. Chemistry and Biodiversity. 2008; 5:299-309.
52. Chopra RN, Nayar SL, Chopra LC. Glossary of Indian medicinal plants. Council of Scientific and Industrial Research New Delhi. 1986; 130-131.
53. Sravani T, Padmaa MP. Evaluation of anthelmintic activity of rhizomes of Hedychium spicatum Buch. Ham. International Journal of Research and Pharmaceutical Science. 2011; 2(1):66-68.

54. Dixit VK, Varma KC. Effect of essential oils of rhizomes of Hedychium spicatum on central nervous system. Indian Journal of Pharmacology. 1979; 1(2):147-149.
55. Rastogi RP, Mehrotra BN. Compendium of Indian Medicinal Plants, New Delhi, Central Drug Research Institute, Lucknow and National Institute of Science Communication, 1984; 3:332-333.
56. Tandon SK, Chandra S, Gupta S, Lal J. Analgesic and anti-inflammatory effects of Hedychium spicatum. Indian Journal of Pharmaceutical Sciences. 1997; 59(3):148-150.
57. Aqil F, Ahmad I. Broad spectrum antibacterial and antifungal properties of certain traditionally used Indian medicinal plants, World Journal of Microbiology and Biotechnology. 2003; 19(6):653-657.
58. Jadhav V, Kore A, Kadam VJ. In vitro Pediculicidal activity of Hedychium spicatum essential oil, Fitoterepia. 2007; 78(7-8):470-473.
59. Reddy PP, Rao RR, Rekha K, Babu KS, Shashidhar J, Shashikiran G, Lakshmi VV, Rao JM. Two new cytotoxic diterpenes from the rhizomes of Hedychium spicatum. Bioorganic & medicinal chemistry letters. 2009; 19(1):192-195.
60. Chauhan NS. Medicinal and aromatic plants of Himachal Pradesh. Indus Publishing; 1999.
61. Bhatt ID, Prasad K, Rawat S, Rawal RS. Evaluation of antioxidant phytochemical diversity in Hedychium spicatum: A high value medicinal plant of Himalaya. Phog mag. 2008; 4(16):202-205.
62. Kaur H, Richa.R. Antidiabetic Activity of Essential Oil of Hedychium spicatum. International Journal of Pharmacognosy and Phytochemical Research 2017; 9(6).
63. Chopra N. Tranquilising action of essential oils of Hedychium spicatum. Indian J Pharmacol 1979; 11:147.
64. Tandon SK, Chandra S, Gupta S, Lal J. Analgesic and anti-inflammatory effects of Hedychium spicatum. Indian J Pharma Sci 1997; 59(3):148-50.
65. Jadhav V, Kore A, Kadam VJ. In vitro pediculicidal activity of Hedychium spicatum essential oil. Fitoterpia 2007; 78(7-8):470-73.
66. Bishit GS, Awasthi AK, Dhole TN. Antimicrobial activity of Hedychium spicatum. Fitoterpia 2006; 77(3):240-42.
67. Joshi S, Chanotiva CS, Agarwal G, Prakash O. Terpenoid compositions and antioxidant and antimicrobial properties of the rhizome essential oils of Hedychium spicatum. Chem Biodivers 2008; 5(2):299-309.
68. Ray PG, Majumdar SK. Antimicrobial activity of some Indian plants. Economic Botany 1976; 30:317-320.
69. Misra SB. Antimalarial activity of Traditional plants against erythrocytic stages of Plasmodium berghei. Int J Pharmacog 1991; 29:19-23.
70. Reddy PP, Rao RR, Rekha K. Two new cytotoxic diterpenes from the rhizomes of Hedychium spicatum. Bio Org Med Chem Let 2009; 19(21):192-95.
71. Malini T, Vanithakumari G. Rat toxicity studies with β-sitosterol. J Ethnopharmacol 1990; 28(2):221-34.
72. Sravani T, Padmaa MP.Evaluation of anthelmintic activity of rhizomes of Hedychium spicatum Buch. Ham. Int. J. Res. Pharm. Sci., 2011; 2(1):66-68.
73. Joshi UP, Mishra SH. In-vitro hepatoprotective activity of isolated diterpene from Hedychium spicatum. Pharmacologyonline 2011; 1:990-997