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Ethnomedicinal uses, phytochemical analysis and antibacterial activity of *Hedychium coronarium* J. Koenig rhizome

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Abstract
Zingiberaceae is the largest family of the order Zingiberales containing more than 1600 species and 200 genera among which *Hedychium* is the medium sized ornamental genus containing near about 40-50 speciesmostly distributed throughout the tropics and sub tropics of the world. Being aromatic and rich in diverse bioactive compounds plants of this family are economically, ethnomedicinally and pharmaceutically very important. Apart from their traditional use as spices, food, ethnomedicine, dyes, perfume etc., they have got a huge future potential in new drug development due to their antimicrobial, anti-inflammatory, anti-diabetic, anti-cancer and antioxidant characteristics. In the present study, the ethnomedicinal uses of *Hedychium coronarium* has been documented. In addition to this the antimicrobial properties of this plant have been examined by disc diffusion method. It has been concluded that *H. coronarium* exhibited remarkable anti-bacterial property against the gram-positive bacteria *Staphylococcus aureus* than gram-negative bacteria *Escherichia coli*. The GCMS analysis reveals the presence of 18 compounds which are responsible for the medicinal properties of this plant.

Keywords: Ethnomedicinal uses**,** herbal medicine, antimicrobial property, bioactive compounds, Kuldiha wild life sanctuary

1. Introduction
Gingers are the medicinal herbs containing the aromatic rhizomes used as spices, medicines, dyes, a useful raw material in pharmaceutical, cosmetic, food industry and widely distributed throughout the world. Zingiberaceae is the largest family of the order Zingiberales containing near about 50 genera and approximately 1600 species [1-2]. The genus *Hedychium* belong to the subfamily Hedycheae contains about fifty species [3]. *Hedychium coronarium* an endangered species is commonly known as the “white ginger lily” or “butterfly ginger” and known as gandasuli in India a Sanskrit word meaning “the fragrance of princes” and locally known as Torani or Gadain Odisha is native to Myanmar and North east India [4-5]. The plant parts of the *H. coronarium* commonly used as spices, medicines, dyes, condiments and ornamental plants. Leaves are taken with betel nut to ease abdominal pain and boiled leaves are applied to relieve stiff and sore joints in Thailand, Leaves are boiled and administered orally to treat indigestion in Malaysia, a hot water infusion of the leaves is consumed to treat hypertension or as a diuretic in Brazil [5-7]. Rhizomes are consumed as stimulant and carminative. A decoction of the stem is gargled for tonsillitis. In Vietnam, rhizomes are used for the treatment of inflammation, skin diseases, headache and rheumatic pain. Rhizomes of *H. coronarium* are used for the treatment of headache, diabetes, inflammation and rheumatic pain in traditional Chinese medicine [8-9]. In India the rhizome is used to treat fever, rheumatism and throat-associated problems by some tribal community in Bihar and Manipur [10-12]. The rhizome powder is used to cure diarrhoea by tribal groups of Uttar Pradesh and rhizome paste is applied against snake bite [13-14]. The rhizome of the plant is used in the treatment of diabetes, headache, cancer, inflammation, apoptosis and invasion [10, 15]. It is also used as anti-rheumatic, excitant, febrifuge and tonic. Young buds and flowers are edible and are used in food flavouring agent and flowers are eaten as vegetable [16-17] flowers are used by local people in fever, arthritis and eye disease [18]. Flower extract is marketed as eye drop in Amarkantak region of Madhya Pradesh, India [19]. Rhizome is used in the preparation of traditional delicacy called as 'eronba' in Manipur. The stems of the plant contain high amount of cellulose (43–48%) and are therefore used in making paper. The rhizomes of *H. coronarium* have been used for isolation of several diterpenes having several biological efficacies such as anti-inflammatory, anti-tumour, antiallergic, anti-malarial, leishmanicidal, analgesic and cytotoxic activities [20-23].

The pharmacologically bioactive compound of *H. coronarium* is coronarin D, a labdane diterpenoid which exhibits several biological properties such as antimicrobial, anti-inflammatory and anticancer activity [8, 24-25]. It inhibits nuclear factor kappa β pathway thereby inducing apoptosis and suppressing osteoclastogenesis [10]. Coronarin D exhibits excellent antifungal activity against *Candida albicans in vitro* [26]. Terpenes constitute the major portion of *H. coronarium* essential oil with eucalyptol and β-pinene as the major constituents [27]. Labdane diterpenes from its rhizome essential oil constituents have shown antimalarial, antihypertensive and anti-inflammatory properties. The medicinal value of this plant lies in its chemical active substances like coronarin D which produces a definite physiological action on humans. The rhizome part only contains coronarin D as its constitutive against cancer by suppression of osteoclast genesis. Coronarin D has been reported to inhibit NF-κB activation pathway induced by different carcinogens and pro-inflammatory molecules 3, 6-7. Terpenoids from *H. coronarium* oil has also been reported to have antioxidant and antimicrobial properties. The plant rhizome extract is used for the preparation of several cosmetic products. In spite of its huge demand, the plant availability in wilds is increasing the cost of the plant [28].

2. Methodology

2.1. Collection of plant specimen

Healthy rhizomes of *H. coronarium* were collected from the natural wild habitats of Chandabali (21.450, 86.815) block of Bhadrak district in Odisha (Fig-1). Field surveys in the region were conducted during the flowering season of the plant i.e., during the month of July to October to know the natural habitat and distribution pattern of this plant. The local Vaidyas / Kavirajs (traditional medicinal practitioners) and other knowledgeable persons of the tribal villages in and around the Kuldiha wild life sanctuary of Balasore district of Odisha were interviewed during the field visits about the uses of this plant and the plant species was identified with the help of regional flora books [29-30].

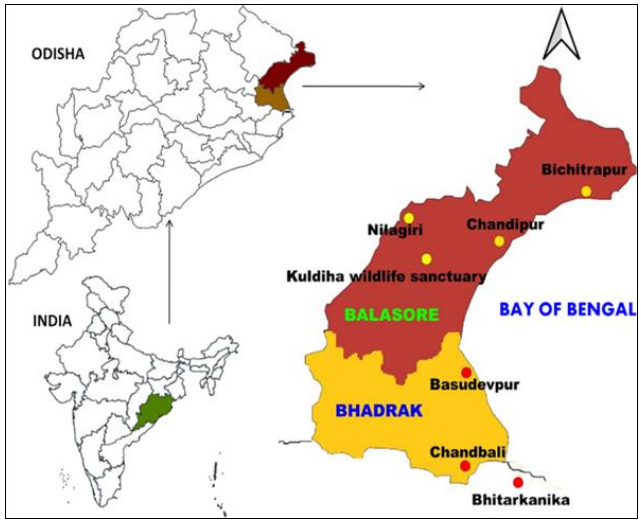

Fig 1: Northern coastal region of Odisha including two districts of Balasore and Bhadrak with important eco sensitive sites.

Fig 2(a): *Hedychium coronarium* (b) Rhizome of *H. coronarium*.

2.2. Plant processing

The rhizomes of the plant species (Fig-2b) were collected from the planted plants in the Department of Environmental science Fakir Mohan University, Balasore, Odisha. The rhizomes were washed properly and then washed in distilled water and cut into slices and air dried in room temperature for 3 to 4 months. Then the completely dried rhizomes were powered manually. Then the compounds were extracted from the rhizome powder by the Soxhlet apparatus method. 10gram sample powder were packed by filter paper, tied and soaked in ethanol at 70 ˚C for 4-8 hr. The ethanol extract was totally evaporated by rotary evaporator to the compounds (10.23±1.02) %. Each weighed dry sample was then reconstituted in 10 ml of ethanol and was stored in the dark at low temperature (4 ˚C) for qualitative analysis by GCMS and antimicrobial assay.

2.3 Field survey

For documentation of the traditional ethnomedicinal knowledge of local communities of the study region, questionnaire was held which mainly aimed to record the plant parts used, modes of drug preparation and their doses with respect to any disease. During the field visits questionnaire programmes were held among the experienced persons and local healers (*Kaviraj* and *Vaidyas*) among which more than 60% were above 50 years old and 40% were between 30 to 50 years old.

2.4 GCMS Analysis

GCMS analysis was carried out using Shimadzu GCMS-QP-2020 system equipped with flame ionization detector using SH-Rxi-5 MS capillary column having dimensions 30m (L)x 0.25 mm(dm)x 0.2 µm df (film thickness). The sample (0.1 µl) was injected to the column with the split ratio 1:5. The temperature of the injector and detector was maintained in GC was 260 ˚C. The oven temperature was initially set at 50 ˚C with the hold time 1 min then increased to 230 ˚C at the rate of 5 ˚C/min with the hold time 5 min then increased to 260 ˚C at the rate of 15 ˚C/min with the hold time 10 min. The flow rate of the carrier gas (Helium) adjusted to 1 ml/min.

GCMS analysis was performed using GCMS-QP 2020,

Shimadzu system equipped with mass selective detector having ion source temp 200 ˚C, interface temp 270 ˚C, solvent cut time 3min threshold 70 ev with the mass range from 50-600 m/z in 54 min.
The compounds were identified by comparison of retention indices (RIs) with those reported in the literature and also by comparison of mass spectra with data in NIST library.

2.5 Antimicrobial assay
Antibacterial activity of essential oil was assayed by the agar disc diffusion method against the gram-positive bacteria *Staphylococcus aureus* and gram-negative bacteria *Escherichia coli*. These bacterial strains were procured from the Microbial Type Culture Collection and Gene Bank (MTCC) of CSIR Institute of Microbial Technology, Chandigarh.
The selected bacteria cultured in 100 ml nutrient broth culture. In the disc diffusion method nutrient agar was used as culture media and the sterilised discs were placed aseptically over the bacterial culture on nutrient agar plates and incubated 37 ˚C for 24 hours. After incubation for 24 hr the zone of inhibition around the disc were measured by centimetre scale. The antibacterial activities were determined by measuring the diameter of zone in cm. This experiment was replicated 3 times to confirm the reproducible result. Sterile blank paper discs were impregnated with essential oil of *H. coronarium*, only sterile solvent methanol as solvent control, the sterile distilled water was taken as -ve control and amoxicillin was used as +ve control for comparison of antibacterial activity.

3. Result and Discussion
3.1. Ethnomedicinal uses
The ethnomedicinal uses of *H. coronarium* which is locally known as *Torani* or *Gada* has been documented. Though mostly used as ornamental species, few respondents revealed their ethno-medicinal use in the study region. The fresh rhizome paste is used in the treatment of rheumatism. The rhizome extract is taken to cure diarrhoea and paediatric abdominal pains. Decoction of fresh rhizome or leaves is used for gargling to treat oral infection, tonsillitis and bad breath. Tribal people of Koraput district of Odisha use the rhizomes as vegetable during food scarcity and also use to treat rheumatism and loose motion [31]. The rhizome paste is applied to cure body ache in Arunachal Pradesh [32]. In Arunachal Pradesh and Mizoram local people use the extracts and paste of flower, rhizome and leaf as tonic, febrifuge, mild tranquiliser [33]. In Manipur local people use this rhizome as anti-vomiting ingredient [34].

3.2. Chemical composition of essential oil
Biochemical analysis has been carried out by Gas chromatography and Mass spectrometry (GC-MS) to identify the total chemical composition of the rhizomes of *H. coronarium*. A total of 18 compounds has been analysed and identified by NIST library and literature(Table-1).Among these compounds the Benzene, 4-(1E)-1,3-butadien-1-yl-1,2-dimeth exhibited the major area of percentage (20.78%) followed by3-Cyclohexen-1-ol, 4-methyl-1-(1-methylethy (20.70%), beta.-Myrcene (15.76%), (E)-1-(2, 4, 5-Trimethoxyphenyl)buta-1, 3-diene (14.39%), Bicyclo [3.1.0] hexane, 4-methylene-1-(1-methyle (4.68%), Cyclohexene, 3-(1,5-dimethyl-4-hexenyl)-6-m (4.33%), m-Camphorene (3.10%), gamma.-Terpinene (2.24%) and p-Camphorene (1.01%) are the major representative compounds. The major compounds present in the fresh and dried rhizomes *H. coronarium* are 1, 8-cineole (41% and 37%), β-pinene (10% and 17%), and α-terpineol (9% and 7%) [34]. Another report indicates that the main component present in *H. coronarium* is found to be linalool (29.3%), limonene (20.3%), trans-meta-mentha, 2, 8- diene (12.9%), γ-terpinene (8.9%) and 10-epi-γ-eudismol (3.8%) [35].

Table 1: Chemical constituents of ethanolic extract of *Hedychium coronarium* rhizome detected by GC-MS

Sl. No.	Compound Name	Real Time	Area %
1	Bicyclo [3.1.0] hexane, 4-methylene-1-(1-methy	8.175	4.68
2	beta-Myrcene	8.624	15.76
3	1, 3, 6-Octatriene, 3, 7-dimethyl-, (Z)-	10.264	0.84
4	gamma-Terpinene	10.602	2.24
5	Undecane	11.759	1.18
6	3-Cyclohexen-1-ol, 4-methyl-1-(1-methylethyl	14.083	20.70
7	1, 3-Cyclohexadiene, 5-(1, 5-dimethyl-4-hexenyl)	22.628	3.30
8	alpha-Farnesene	22.875	0.94
9	beta-Bisabolene	22.959	0.59
10	Cyclohexene, 3-(1, 5-dimethyl-4-hexenyl)-6-me	23.342	4.33
11	(E)-4-(But-1-en-1-yl)-1, 2- dimethoxybenzene	24.920	0.55
12	Benzene, 4-(1E)-1, 3-butadien-1-yl-1, 2-dimetho	25.790	20.78
13	(E)-1-(2, 4, 5-Trimethoxyphenyl)buta-1, 3-diene	28.146	15.36
14	(E)-1-(2, 4, 5-Trimethoxyphenyl)but-1-ene	28.813	1.27
15	(E)-4-(3, 4-Dimethoxyphenyl)but-3-en-1-ol	30.924	2.69
16	Hexadecanoic acid, methyl ester	32.041	0.71
17	m-Camphorene	32.663	3.10
18	p-Camphorene	33.339	1.01

3.3. Antibacterial assay
The essential oil of *H. coronarium* exhibited remarked anti-bacterial against the gram-positive bacteria *Staphylococcus aureus* and gram- negative bacteria *Escherichia coli*. The EO of *H. coronarium* exhibited more antibacterial activity on *Staphylococcus aureus* than the gram-negative bacteria *Escherichia coli*. Coronarin D is an important bioactive compound found in *H. coronarium* and is known for anti-allergy, antimicrobial, anti-inflammatory and anticancer properties and also exhibited the antibacterial activities *against Escherichia coli, Staphylococcus aureus, Salmonella typhi, Pseudomonas aeruginosa and Proteus vulgaris* [36-37].

4. Conclusion
In the present study the ethnomedicinal uses of *H. coronarium* has been documented**.** It has been observed that the rhizome

extracts are much effective to cure diarrhoea and paediatric abdominal pains. In addition to this the antimicrobial properties of this plant have been examined by disc diffusion method. It has been concluded that *H. coronarium* exhibited remarkable anti-bacterial property against the gram-positive bacteria *Staphylococcus aureus* than gram-negative bacteria *Escherichia coli*. The GCMS analysis its rhizome reveals the presence of 19 compounds which are responsible for the medicinal properties of this plant. Among these compounds m-Camphorene is one of the important compounds possessing many biological properties like antibacterial, anti-cancer, anti-monoamine and anti-inflammation activities.

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References

1. Kress WJ, Prince LM, Williams KJ. The phylogeny and a new classification of the gingers (Zingiberaceae): evidence from molecular data. American Journal of Botany. 2002;89:1682-1696. https://doi.org/10.3732/ajb.89.10.1682
2. Jena S, Ray A, Sahoo A, Panda PC, Nayak S. Deeper insight into the volatile profile of essential oil of two *Curcuma* species and their antioxidant and antimicrobial activities Industrial crops and products 2020;155:(112830).1-11. https://doi.org/10.1016/j.indcrop.2020.112830
3. Hartati R, Suganda AG, Fidrianny I. Botanical, phytochemical and pharmacological properties of *Hedychium* (Zingiberaceae)–A review Procedia Chemistry. 2014;13:150-163. https://doi.org/10.1016/j.proche.2014.12.020
4. Chan EWC, Wong SK. Phytochemistry and pharmacology of ornamental gingers, *Hedychium coronarium* and *Alpinia purpurata*: A review. Journal of Integrative Medicine. 2015;13(6):368-379.
5. Singh NR, Singh S. Wild medicinal plants of Manipur included in the red list. Asian Agri History Foundation. 2009;13(3):221-225.
6. Ribeiro RA, Fiuza de Melo MM, De Barros F, Gomes C, Trolin G. Acute anti-hypertensive effect in conscious rats produced by some medicinal plants used in the state of São Paulo. Journal of Ethnopharmacology. 1986;15(3):261-269.
7. Ibrahim H. *Hedychium*. In: van Valkenburg JLCH, Bunyapraphatsara N (eds) Plant resources of South-East Asia, medicinal and poisonous plants. Backhuys Publisher, Leiden, 2001, p 290-295.
8. Van Kiem P, Thuy NTK, Anh HLT, Nhiem NX, Van Minh C, Yen PH. Chemical constituents of the rhizomes of *Hedychium coronarium* and their inhibitory effect on the pro-inflammatory cytokines production LPS-stimulated in bone marrow-derived dendritic cells. Bioorganic & medicinal chemistry letters. 2011;21(24):7460-7465.
9. Lu Y, Zhong CX, Wang L, Lu C, Li XL, Wang PJ. Anti-inflammation activity and chemical composition of flower essential oil from *Hedychium coronarium*. African Journal of Biotechnology, 2009, 8(20).
10. Kunnumakkara AB, Ichikawa H, Anand P, Mohankumar CJ, Hema PS, Nair MS. A labdane diterpene, inhibits both constitutive and inducible nuclear factor-kappa B pathway activation, leading to potentiation of apoptosis, inhibition of invasion, and suppression of osteoclastogenesis. Molecular cancer therapeutics. 2008;7:3306-3317.
11. Singh R, Dwivedi PK, Mishra D. Ethnobotanical uses of *Hedychium coronarium* (J.) Koenig in Vidhya region (MP) India. International Journal of Environmental Research and Public Health. 2014;12:47-48.
12. Devi TI, Devi KU, Singh EJ. Wild medicinal plants in the hill of Manipur, India: A traditional therapeutic potential. International Journal of Scientific and Research Publication. 2015;5:1-9.
13. Shukla AN, Srivastava S, Rawat AKS. A survey of traditional medicinal plants of Uttar Pradesh (India)-used in treatment of infectious diseases. Natural Science. 2013;11:24–36.
14. Ray S, Sheikh M, Mishra S. Ethnomedicinal plants used by tribal of East Nimar region, Madhya Pradesh. Indian Journal of Traditional Knowledge. 2011;10:367-371.
15. Bhandary MJ, Chandrashekar KR, Kaveriappa KM. Medical ethnobotany of the Siddis of Uttara Kannada district (Karnataka), India. Journal of. Ethnopharmacology. 1995;47(3):149-158.
16. Kunkel G. In: Plants for Human Consumption, G. Kunkel (ed), Koeltz Scientific Books, West Germany, 1984, 393.
17. Facciola S. Cornucopia - A Source Book of Edible Plants. Kampong Publications. 1990, 166-167.
18. Jain Li J, Vunsh MR. Callus induction and regeneration in *Spirodela*and *Lemna*. Plant Cell Reports. 2004;22:457-464.
19. Mishra M. Current status of endangered medicinal plant *Hedychium coronarium* and causes of population decline in the natural forests of Anuppur and Dindori districts of Madhya Pradesh, India. International Journal of Biological Sciences. 2013;2:1-6.
20. Matsuda H, Morikawa T, Sakamoto Y, Toguchida I, Yoshikawa M. Labdane-type diterpenes with inhibitory effects on increase in vascular permeability and nitric oxide production from *Hedychium coronarium*. Bioorganic & medicinal chemistry. 2002;10(8):2527-2534.
21. Oh S, Jeong IH, Shin WS, Wang Q, Lee S. Synthesis and biological activity of (+)-hedychilactone A and its analogs from (+)-sclareolide. Bioorganic & medicinal chemistry letters. 2006;16(6):1656-1659.
22. Céline V, Adriana P, Eric D, Joaquina AC, Yannick E, Augusto LF. Medicinal plants from the Yanesha (Peru): Evaluation of the leishmanicidal and antimalarial activity of selected extracts. Journal of ethnopharmacology. 2009;123(3):413-422.
23. Chimnoi N, Sarasuk C, Khunnawutmanotham N, Intachote P, Seangsai S, Saimanee B. Phytochemical reinvestigation of labdane-type diterpenes and their cytotoxicity from the rhizomes of *Hedychium coronarium*. Phytochemistry Letters. 2009;2(4):184-187.
24. Chen JJ, Ting CW, Wu YC, Hwang TL, Cheng MJ, Sung PJ. New labdane-type diterpenoids and anti-inflammatory constituents from *Hedychium coronarium*. International Journal of Molecular Sciences. 2013;14(7):13063-13077.
25. Reuk-ngam N, Chimnoi N, Khunnawutmanotham N, Techasakul S. Antimicrobial activity of coronarin D and its synergistic potential with antibiotics. BioMed research

international, 2014.
26. Ray A, Halder T, Jena S, Sahoo A, Ghosh B, Mohanty S. Application of artificial neural network (ANN) model for prediction and optimization of coronarin D content in *Hedychium coronarium*. Industrial Crops and Products. 2020;146:112186.
27. Ray A, Dash B, Sahoo A, Nasim N, Panda PC, Patnaik J. Assessment of the terpenic composition of *Hedychium coronarium* oil from Eastern India. Industrial Crops and Products. 2017;97:49-55.
28. Parida R. Coronarin-D production from tissue cultured plantlets of *Hedychium coronarium*. Journal of Biologically Active Products from Nature. 2018;8(3):162-170.
29. Haines HH. The Botany of Bihar and Orissa 1921-1925;6:Parts, London.
30. Saxena HO, Brahmam M. The Flora of Orissa. Regional Research Laboratory and Orissa Forest Development corporation, Bhubaneswar.1994-1996, 1-4.
31. Pradhan B, Panda D. Wild tuber species diversity and its ethno-medicinal use by tribal people of Koraput district of Odisha, India. Indian journal of natural products and Resources. 2016;2:33–36.
32. Kala CP. Ethnomedicinal botany of the Apatani in the Eastern Himalayan region of India. J. Ethnobiology and Ethnomedicine. 2005;1:1-8. https://doi.org/10.1186/1746-4269-1-11
33. Basak S, Sarma GC, Rangan L. Ethnomedical uses of Zingiberaceous plants of Northeast India. Journal of Ethnopharmacology. 2010;132:286-296. https://doi.org/10.1016/j.jep.2010.08.032.
34. Joy B Rajan, Abraham E. Antimicrobial activity and chemical composition of essential oil from *Hedychium coronarium*. Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives. 2007;21(5):439-443.
35. Prakash O, Rajput M, Kumar M, Pant AK. Chemical Composition and Antibacterial Activity of Rhizome Oils from *Hedychium coronarium* Koenig and *Hedychium spicatum* Buch-Ham. Journal of essential oil-bearing plants. 2010;13(2):250-259.
36. Chen JC, Hsieh MC, Lin SH, Lin CC, His YT, Lo YS. Coronarin D induces reactive oxygen species-mediated cell death in human nasopharyngeal cancer cells through inhibition of p38 MAPK and activation of JNK. Oncotarget. 2017;8:108006. Doi:10.18632/oncotarget.22444.
37. Behera S, Kamila PK, Rout, KK, Barik, DP, Panda PC, Naik SK. An efficient plant regeneration protocol of an industrially important plant, *Hedychium coronarium* J. Koenig and establishment of genetic & biochemical fidelity of the regenerants. Industrial Crops and Products. 2018;126:58-68. https://doi.org/10.10s16/j.indcrop.2018.09.058.