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Hedychium Coronarium rhizomes essential oil. Main compounds and biological activity. An updated mini-review of the last 10 years.

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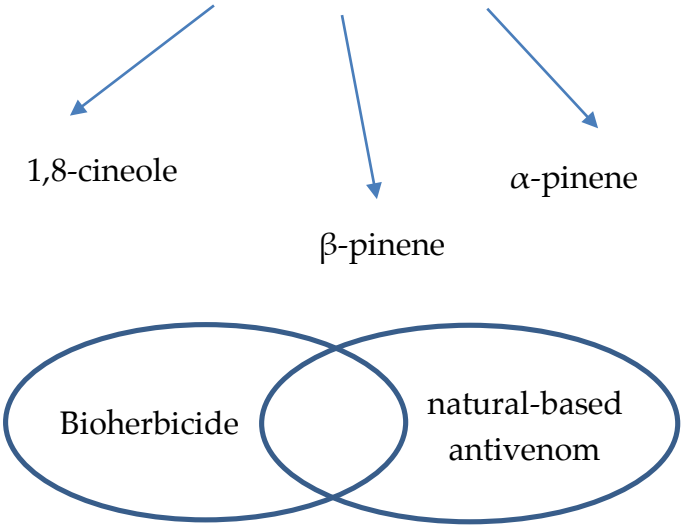
Graphical Abstract

Hedycium coronarium



Abstract.
Hedycium coronarium (Zingiberaceae) is widespread in many countries in the tropical region. The essential oil has been investigated in the last decade, and some biological activities have been performed. The chemical composition has been studied on several samples belonging to many different countries, and the main compounds of the *H. coronarium* rhizomes oil are 1,8-cineole (11-56%), β-pinene (10-39%), and α-pinene (6-13%). Several preliminary studies concerning biological activities have been performed, and some promising results have been identified regarding the antiophidian, allelopathic, antimicrobial, larvicidal, and pupicidal activities. In the present mini-review 11 articles have been selected, and analyzed in order to elucidate the chemical composition, and pharmacological data of *H. coronarium* essential oil, some trends for new researches have been also proposed. The *H. coronarium* rhyzome essential, probably due to the presence of 1,8-cineole, deserve additional investigation in order to verify its potential as bioherbicide or natural-based antivenom treatment.

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Introduction

Research trends concerning new drugs development suggest that natural products will still be for a long time an essential source of new drugs [1-3]. *Hedychium coronarium* is considered a medicinal plant which is also well known for its uses in cosmetics, and perfumes industries. The species is also cultivated for commercial purposes as a cut flower, and a garden plant. In the last 10 years *Hedychium coronarium* has been subject of new researches regarding its phytochemistry, and biological activities. *H. coronarium* belonging to the family Zingiberaceae, and it is widespread in many countries in the tropical belt, where it is commonly known as: butterfly flower, white butterfly, or Gulbakawali.

Hedychium coronarium is a perennial herb, tall about 1-2.5 m with fleshy, branched, and knotty rhizomes. Leaves are alternately disposed sharp pointed, and lance-shaped. Flowers are zygomorphic, and hermaphrodite, with glaberous calyx. Fruits are oblong, capsule contains numerous seeds [4].

Phytochemistry of *H. coronarium* has been widely investigated, especially concerning rhizomes extracts,, and several labdane-type diterpenes have been identified. Also diarylheptanoids, sesquiterpenes, phenolics compounds, and steroids have been isolated [5,6].

The essential oil obtained from *H. coronarium* rhizomes has been also investigated but it is deserve a deepener revision of the state of the art concerning its phytochemistry, and biological activities. Hence, the aim of this conference paper was to create an exhaustive, and up to date critical bibliographic investigation regarding *H. coronarium* essential oil phytochemistry, and biological activities.

Materials and Methods

The present study was performed adopting the following electronic databases: Scifinder, Pubmed, ISI-Web of Science, Google Scholar, Scielo, and ScienceDirect. Data was independently extracted from four reviewers, and the final papers selections were completed avoiding duplication of data. The following keywords were selected: Hedychium coronarium, Hedychium coronarium essential oil. Hedychium coronarium rhyzome oil.

All key words were searched individually, and in combination. The authors excluded data from patents, symposiums, and congress abstracts.

Results and Discussion

In the present conference paper 11 articles have been selected to describe the chemical composition, and biological activities. Finally, 8 additional papers have been considered in order to develop a brief discussion. Finally, 9 papers, which did not satisfy the selection methodology, were rejected because of the lack of clarity in their procedures or due to a duplicated information already reported into the selected papers.

The distribution of the scientific production on *H. coronarium* essential oil in the last decade has been reported in Figure 1.

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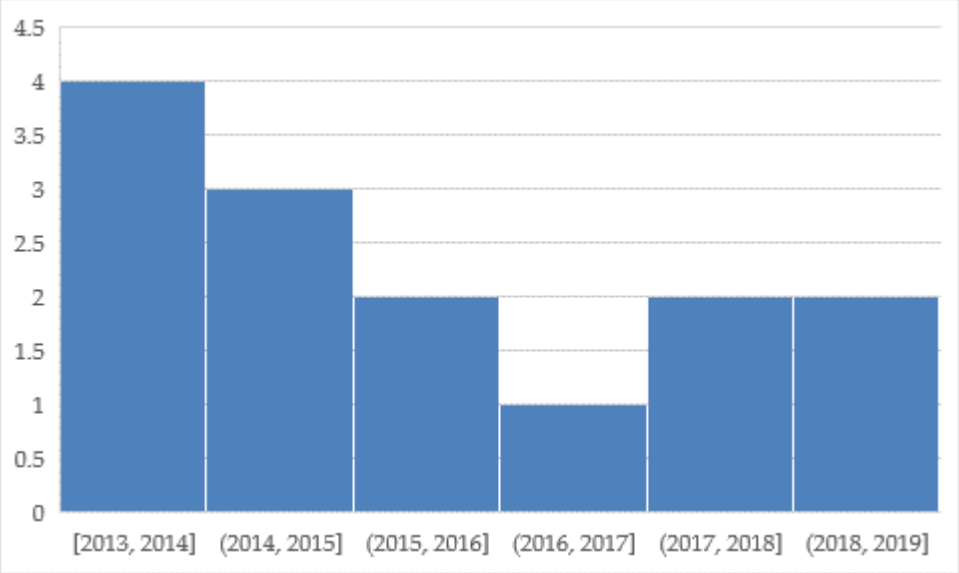

Figure 1. - Distribution of scientific production concerning *H. coronarium* essential oil in the last decade.

Chemical composition

The present conference paper allows to update two previous review articles respectively performed in 2014, and 2015 [5,6] Other studies carried out between 2016, and 2019 confirmed the preceding investigation confirming that the main compounds of the *H. coronarium* rhizomes oil are 1,8-cineole (11-56%), β-pinene (10-39%), and α-pinene (6-13%). The composition of the mayor compounds reported by cited studies is detailed in Table 1. Even if there is a remarkable difference between the data recollected in different countries, the above mentioned three compounds seem to characterize the rhizome oil composition affecting its scent, and the biological activities.

1,8-cineole has been widely investigated, and several studies focused its potential use as treatment for COPD, asthma [7,8], and wound healing [9]. α-pinene, and β-pinene are also extensively studied, and an investigation performed by Salehi, *et al.* [10] focused several promising applications for both molecules, such as antimicrobial, antimalarial, antioxidant, anti-inflammatory, analgesic, and anticoagulant.

Table 1. Mayor compounds of *H. coronarium* rhizomes essential oil.

Main compounds	Amount or range (%)	Country	Reference
β-caryophyllene	13	Vietnam	[5]
1,8-cineole	24	Brazil	[11,12]
	29	Brazil	[13]
	37	China (Taiwan)	[5]
	34	Ecuador	[14]
	56	Fiji	[5]
	41 and 37	India (Kerala)	[5]
	49	India	[15]
	33	India	[16]

	38	India	[17]
	48 and 34[a]	Eastern India	[5]
	11	Mauritius	[5]
	34	Thailand	[18]
	40	Tahiti	[5]
p-Cymene	12	India	[17]
α-humulene	17	Vietnam	[5]
Limonene	20	Himalaya (Nepal)	[5]
	20		[15]
Linalool	22	India	[6]
	22 to 29	India	[15]
	29	Himalaya (Nepal)	[5]
trans-meta-Mentha-2,8-diene	13 to 25	India	[15]
	25	India	[6]
p-Menth-1-en-8-ol	9	India	[17]
α-pinene	13	Brazil	[11,12]
	11	Brazil	[13]
	10	China (Taiwan)	[5]
	10	Ecuador	[14]
	11	Fiji	[5]
	10	India	[5]
	13	India	[16]
	6	Thailand	[18]
β-pinene	41	Brazil	[12]
	24	Brazil	[13]
	23	China (Taiwan)	[5]
	30	Ecuador	[14]
	31	Fiji	[5]
	39	India	[5]
	24	India	[15]
	30	India	[16]
	10 and 17[a]	India (Kerala)	[5]
	24	Mauritius	[5]
	14	Thailand	[18]
	25	Tahiti	[5]
	24	Vietnam	[5]
α-muurolol	17	Mauritius	[5]
α-terpineol	10	China (Taiwan)	[5]

	9 and 7[a]	India (Kerala)	[5]
	11	India	[6]
	16	Mauritius	[5]

[a] - Fresh and dried rhizomes; [b] - From micropropagated and conventional plants.

Biological activity.

Antiophidian activity.

In Miranda, Cardoso, Mansanares, Gomes and Marcussi [12]. investigated the inhibitory effects of *H. coronarium* rhyzome oil on fibrinogenolytic, and coagulant activity. The study was performed using *Lachesis muta*, *Bothrops atrox*, and *Bothrops moojen*i venoms in order to induce the fibrinogenolytic, and coagulant effect. The preincubation of snake venoms with the rhizome essential oil were able to extend the clotting time induced by all the evaluated venoms, suggesting a potential use of the oil as anticoagulant. The table 2 focused some relevant data.

Table 2. Anticoagulant activity of *H. coronarium* rhizomes essential oil.

Venom	Clotting time without oil	Clotting time with oil (0.6 µ L)	Clotting time with oil (1.2 µ L)
L. muta	52.2 ± 0.5 s	77.4 ± 07 s	76.5 ±1.8 s
B. atrox	100.8 ± 2.0 s	140.7 ± 2.2 s	147.3 ± 0.7 s
B. moojeni	108.3 ± 0.4 s	227.4 ± 1.6 s	228.3 ± 2.1 s

These findings suggested the use of *H. coronarium* rhizome oil as alternative or complementary antivenoms treatment, considering also that essential oil can be use without further formulation development. The essential oils were unable to inhibit fibrinogenolysis.

Allelopathic activity.

Allelophathic activity is a key factor to develop new bioherbicides. A research carried out by Miranda, Cardoso, Carvalho, Figueiredo and Andrade [11] investigated the effects of *H. coronarium* rhizome oil on seed germination, and seedling vigour in the lettuce seeds (Lactuca sativa, cultivar Regina SF 3500). The research focused that all the allelophathic parameter have been affected by the presence of oil, showing a clear trend in which, all parameters studied decrease. Due to the chemical composition of *H. coronarium* rhizomes essential oil, it seems that these results may be attributed to 1.8-cineole.

The allelophathic activity of *H. coronarium* rhizomes essential oil is detailed in Table 3

Table 3. Allelophathic activity of *H. coronarium* rhizomes essential oil (Miranda et al., 2015).

Allelophathic parameter	Unit	Sample without oil	Sample with oil (1% v v^{-1})
Dry matter	g	0.0365	0.0345
Germination Speed Index (GSI)	mm	76.57	36.07
Initial seed germination	%	91	77

Final Seed germination	%	95.5	84
Length of the rootlets	mm	38.5	35.7
Seedling dry weight	g	0.0373	0.0248
Shoot length	mm	15.5	9.78
Root length	mm	43.0	21.8

Another research performed by Oliveira Costa, Markowitsch, Grombone-Guaratini and Silva Matos [13] investigated the allelophathic activity of *H. coronarium* rhizomes essential oil versus four native tree from Brazil, precisely *Anadenanthera macrocarpa*, *Peltophorum dubium*, *Mimosa bimucronata*, and *Sesbania virgata*. The *H. coronarium* rhizomes essential oil at concentration of 1% was able to inhibit the germination speed index (GSI), and the germination percentage (GP) for all above mentioned species, just with the exception of the GP of S. virgate. Moreover, at 0.1% the oil also reduced the GSI, and GP of M. bimucronata. The present findings strengthen the hypothesis that *H. coronarium* rhizomes essential oil could be a potencial bioherbicide.

Antimicrobial activity.

The antimicrobial activity of *H. coronarium* rhizome oil has been extensively studied by Noriega, Guerrini, Sacchetti, Grandini, Ankuash and Manfredini [14] . Some interesting data have been obtained concerning *L. grayi*, *K. oxytoca*, and S. mutans.

Moreover, the performed antimicrobial bioautographic showed again an important role of 1,8-cineole to explain the antimicrobial activity. Also, terpinen-4-ol was considered responsible for the above mentioned results. Table 5 resumes the data concerning the MIC of H. coronarium rhizomes essential oil.

Table 5. Antimicrobial activity of *H. coronarium* rhizomes essential oil (Noriega et al., 2019).

Microorganism	MIC - Minimum Inhibitory Concentration (mg/mL)
L. grayi	0.45
K. oxytoca	0.9
S. mutans	0.18

Another investigation performed by Prakash, Chandra, Punetha, Pant and Rawat [15] focused the antimicrobial activity of *H. coronarium* rhizomes essential oil versus *Proteus vulgaris*, *Staphylococcus aureus*, *Salmonella typhi*, *Escherichia coli*, *Pseudomonas aeruginosa*. Even if the oil exhibited antifungal activity on all microorganism, the most promising result have been reported for *P. vulgaris*, *S. typhi*, and *P. aeruginosa*, a detailed information is available at Table 6

Table 6. Antimicrobial activity of *H. coronarium* rhizomes essential oil [15].

Microorganism	MICs - Minimum Inhibitory Concentrations (L/mL)
P. vulgaris	0.1953
S. typhi	0.7812
P. aeruginosa	0.1953

Larvicidal y pupicidal activities.

An investigation performed by Phukerd and Soonwera [19] focused the activity of 12 essential

oil bolonging to the Zingiberaceae genus, includis *H. coronarium*. *H. coronarium* rhyzome essential oils had activity against *Culex quinquefasciatus* larvae, with LT50 of 1.7 minutes, and 100% mortality at 15 minutes. Moreover, the oil was able to induce 100% mortality against *Ae. aegypti*, and *Cx. quinquefasciatus* larvae both at 60 minutes, and 30 minutes.

Conclusions.

H. coronarium is very common in many tropical countries, and it is recognized as a interesting species for commercial purposes. The essential oil obtained from the rhyzome has been partially investigated in the last 10 years, and some preliminary promising data have been reported in the presente conference paper. Mainly due to the presence of 1,8-cineole, the rhyzome essential oil seems to justify deepener invetigations as bioherbicide or natural-based antivenom treatment.

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