

Review of the biological activity of plant extract of pacing (*Costus speciosus*) in Indonesia

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Abstract

Pacing, *Costus speciosus*, is a medicinal plant that grows wild in Indonesia. Pharmacological research on pacing plants in Indonesia began in the 1970s and continues until now. To find out the progress and development of research and its results, we searched for articles on the results of research on the biological activity of this plant in Indonesia that were published in the last 15 years via the internet. As a result, there were 25 articles that met the inclusion criteria reporting the results of research on the biological activity of pacing plants. There are at least 11 biological activities of the *C. speciosus* plant, namely: antibacterial, anti-fertility, anti-diabetic, antioxidant, anti-inflammatory, anti-cholesterol, anti-parasitic/anthelmintic, toxic, wounds healing, and anticancer. Thus, it can be concluded that the pacing plant has the potential to be used as a source of medicine for several diseases.

Keywords: Pacing; *Costus speciosus*; Diosgenin; Antidiabetic; Crepe Ginger

1. Introduction

Pacing is one of the vernacular names of crepe ginger (*Costus speciosus*) in Indonesia. This plant is a perennial herb native to India, Bangladesh, Cambodia, South-Central China, Myanmar, Nepal, Himalaya, Laos, Taiwan, Thailand, Vietnam, Sri Lanka, Andaman Island, Malaya, Philippines, New Guinea and Indonesia (Sumatra, Borneo, Java, Maluku, and Sulawesi) [1]. Later, this plant has spread into many regions of the world especially tropical and subtropical parts of Asia, Africa and Americas. In several countries in Africa, America, West Indies, China, Sri Lanka and India, this plant is famous for its ethnomedicinal uses [2]. Some ethnobotanical communities call the pacing plant the "insulin plant" because it contains diosgenin which has strong anti-diabetic properties [3].

In Indonesia, apart from being used as traditional medicine, *C. speciosus* has no economic value for local communities therefore the plant is not cultivated [4]. However, with the knowledge that the pacing plant contained diosgenin (a steroidal saponin) pharmacological research on this plant is increasingly widespread [5]. In this paper we present the results of research on the biological activity of pacing plant extracts which have been carried out in Indonesia in the last 15 years.

2. Methodology

2.1. Search Strategy

We used the Google search engine to search online for relevant literature. The targeted database is not limited on the reputation, but rather the open access nature of the database in question. All open access databases that allow the full text to be downloaded are used in searches including PubMed, Science Direct, Web of Science, Semantic Scholar, MDPI,

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JSTOR, Zendy, Zenodo, SCI, and Research Gate. The keyword used was as follows “pacing” AND “*Costus speciosus*” AND “bioactive substances” AND “biological activity”.

2.2. Inclusion Criteria

All papers presenting the results of study on the uses of the content extracted from pacing plants were included in our search. The main criterion for the papers collected is that they appear on a platform that can be accessed via internet search engines in Indonesia; published in the last 15 years (2010 – 2024). Language and researcher affiliation were not used as criteria.

3. Results and Discussion

In this literature study we found at least 25 articles that met the inclusion criteria. The general description of the materials and methods as well as the research results published in the articles presented in Table 1. There are at least 11 biological activities shown by the chemical compounds contained in the pacing plant namely: antibacterial, anti-fertility, anti-diabetic, antioxidant, anti-inflammatory, anti-cholesterol, anti-parasitic/anthelmintic, wounds healing, anticancer and toxic.

Table 1 Research results on the biological activity of plant extract of pacing (*Costus speciosus*) in Indonesia

Plant part used	Preparation	Experiment	Effect	Ref.
Leaves	Fractionated using ethanol, ethyl-acetate, and n-hexane	Extract exposed to bacteria and brine-shrimp (<i>Artemia salina</i>) larvae.	Extract inhibited the growth of <i>Bacillus</i> sp. and <i>S. aureus</i> . n-hexane fraction of the extract inhibited more <i>Bacillus</i> sp. and <i>E. coli</i> . Caused mortality in brine-shrimp with an LC ₅₀ of 45 - 478 ppm.	6
Rhizome	Rhizomes are macerated	Extract given to <i>Day Old Chick</i> of broiler chickens	Cell nuclei of liver pyknotic, the renal convoluted tubule cells experience karyorrhexis and karyolysis.	7
Leaves	Extraction using infusion methods	The extract was given to mice for 14 days and then the number of spermatozoa was observed	Extract reduced the number and motility of Spermatozoa.	8
Leaves	Extraction using ethanol	Extract given orally to male rats for 48 days to see its fertility parameters.	Extract make spermatozoa count reduce, sperm abnormality increase, serum testosterone increase.	9
Rhizome	Extraction using ethanol and water	Both extracts were exposed to bacteria and fungi.	Ethanol extract shows inhibition zone on <i>S. dysenteriae</i> , <i>S. typhimurium</i> , <i>Bacillus subtilis</i> and <i>S. aureus</i> . The water extract can inhibit above bacteria except for <i>S. aureus</i> .	10
Aerial parts	Ethanol extraction using Soxhlet	Extract given to alloxan-induced diabetic mice	Extract decreased the blood glucose and total serum cholesterol levels	11
Leaves	Leaves are macerated	Extract given to male rats	Leaf extract of pacing decrease sperm motility in rats	12
Rhizome	Macerated using ethanol and fractioned using n-hexane, ethyl acetic and water	Isolate identification done using UV-spectrophotometry	Isolate contain flavonoid of flavonol group.	13

Whole plant	Extracted with ethanol	The extract was given to mice to observe their body weight and blood quality.	The extract cause blood glucose levels and total cholesterol lower	14
Rhizome	Macerated using water as solvent	The extract given orally to male mice for 14 days.	Extract resulted in a significant reduction in spermatozoa level and quality.	15
Whole plant	Extracted using infusion method	The extract screened for diosgenin using HPLC with LiChrospher® 100 RP-18 as stationary phase acetonitrile as solvent	Diosgenin content of pacing extract is 0,279 %.	16
Whole plant	The extract are mad as tablet using Avicel PH 200®	The physical properties of powder included tapping index, water absorption, and moisture content are evaluated	The variation in the composition between Avicel® PH 200 as the filler-binder and amylum as the disintegration agent had a significant effect on the friability of the tablet.	17
Aerial parts	Extraction using infusion methods	Extract given to male Wistar rats for 14 days.	Administration of pacing extract can reduce total serum cholesterol equal to simvastatin 7.2 mg/kg.	18
Aerial parts	Macerated using ethanol	The extract was given to male mice to observe mating behavior, number of offspring and testosterone hormone levels.	Extract inhibit pregnancy among female rats, no obstacle of sexual behavior in male, and decreased level of male hormones	19
Aerial parts and stem	Macerated using ethanol	Extract analyzed for its antioxidant using DPPH and screened for the phytochemicals	The extract has antioxidant activity. In leaves there are flavonoids and alkaloids, in stem there are flavonoid and phenols, in flowers found flavonoid.	20
Rhizome	Ethanol extraction	Extract given orally to female mice once a day for 25 days	Tertiary follicle and De Graff follicle of mice ovary significantly decreased.	21
Rhizome	Ethanol extraction	Extract exposed to earthworms (<i>Lumbricus rubellus</i>)	Extract causing paralysis and mortality effect to the earthworms	22
Leaves	Macerated using ethanol	The extract is used to treat cuts in rabbits	The extract heals cut wounds up to 91% in days.	23
Leaves and fruits	Ethanol extraction	Extract given to bacteria isolates.	Pacing extract has antibacterial against <i>Staphylococcus aureus</i> .	24
Leaves	Extracted using hexane, ethyl acetic, and methanol	Extract were exposed to bacteria and tested for its antioxidant properties	Methanol extract has strong antioxidant activity, but ethyl acetic extract has highest antibacterial activity.	25
Flowers	Macerated using ethanol	Extracted tested for anti-inflammatory using Bovine Serum Albumin (BSA) and Tris Buffer Saline (TBS)	Flower extract of pacing contains flavonoid, phenols and saponin and has anti-inflammatory with an IC ₅₀ of 30,90 mg/L.	26
Rhizome	Macerated using ethanol	Extract injected into alloxan-induced diabetic mice	Pacing extract reduced blood glucose and enhance sexual behavior in male mice	27
Leaves	Extracted	Extract formulated into a gel and tested for organoleptic,	Ethanol extract of pacing leaves can be formulated into a physically	28

	using maceration with ethanol	homogeneity, spreadability, viscosity stability and antioxidant using DPPH method.	stable gel preparation and has antioxidant activity	
Rhizome	Ethanol extraction	Extract used to treat KOV-3 ovarian cancer cells	IC50 of cytotoxic activity was 69.143 µg/mL. and could induce apoptosis on SKOV-3 cells and can induce BAX and p53 protein expressions	29
Rhizome	Ethanol extraction	The extract was used to treat bacteria <i>Staphylococcus epidermidis</i> and fungi <i>Candida albican</i>	At the concentration of 20% the extract can kill bacteria <i>S. epidermidis</i> and fungi <i>C.albicans</i> .	30
Leaves	Water extraction	Virucidal activity of <i>C. speciosus</i> was assessed in RAW264.7 cells mixed with A (H1N1) PR8-GFP	Acids extracted from the plant revealed have antiviral effects against influenza.	31

The antibacterial properties of pacing plant extract were reported in five articles out of 25 papers obtained [6, 10, 24, 25, 30]. The anti-bacterial activity of the pacing plant was also reported by other researchers outside Indonesia, such as Shaikh *et al* (2022) that this plant extract can inhibit the bacteria *Salmonella typhi*, *Bacillus subtilis*, *Escherichia coli*, *Pseudomonas aeruginosa*, and *Staphylococcus aureus* [32]. Apart from being antibacterial, pacing plant extract was also reported by Duraipandiyan *et al.* (2012) to have anti-fungal properties against *Trichophyton mentagrophytes*, *T. simii* and *T. rubrum* [33].

There are six articles that report that pacing plant extract can be used to reduce fertility in test animals [8, 9, 12, 15, 19, 21]. According to Sari *et al.* (2018), the anti-fertility properties of pacing extract are caused by the presence of the compound diosgenin (steroidal saponin) [19]. This finding is in contrast to the findings of Khosravi *et al.* (2019) who stated that diosgenin can improve the number, motility and viability of sperm and can prevent damage to the seminiferous tubules [34]

We found studies on the anti-diabetic properties of pacing plants in three articles [11, 14, 27]. This finding is in line with the research results of Ali *et al.* (2014) pacing plant extract which states that *C. speciosus* extract reduces blood glucose levels and increases insulin levels, increases the activity of glucokinase (GK), aldolase, pyruvate kinase (PK), succinate dehydrogenase (SDH), and glycogen synthase [35].

Next, there are two articles that report the antioxidant properties of pacing plants [20, 28], The antioxidant properties of *C. speciosus* plant extract are due to the redox properties of the phenolic content of this plant [36]. Apart from having antioxidant properties, Jha *et al.* (2010) also reported that pacing plants have cytotoxic properties in Brine-shrimp [37].

Other biological activity of pacing plant is possessing anti-hyperlipidemia [11, 18]. Similar results have also been reported by Bavarva and Narasimhacharya (2008) that *C. speciosus* plant extract cures hyperlipidemia by reducing total plasma lipids cholesterol and triglycerides and improving the activity of hepatic antioxidant enzymes [38].

Apart from the above properties, several articles that we found also reported the anti-inflammatory [26], anti-parasitic/anthelmintic [22], wound healing [23], anticancer [29] and antiviral against influenza of pacing plant extract [31].

The anti-inflammatory properties of pacing plants were also discovered by other researchers outside Indonesia, such as Al Atas *et al.* (2015). The active compound which is thought to play a role in providing anti-inflammatory properties is sesquiterpene [39]. Apart from its anti-inflammatory properties, this plant is also known to have anti-analgesic and antipyretic properties [40]. The anti-parasitic properties of pacing plant extract are thought to be caused by the presence of gracillin and the new zingiberensis saponin compounds [41].

The wound healing properties of this plant, apart from being reported by Indonesian researchers, was also reported by Zishan *et al.* (2024) stating that an ointment made from *C. speciosus* plant leaf extract increases granulation formation in tissue and allows re-epithelialization to occur more quickly in wounds [42].

The finding of the anticancer properties of pacing plants was confirmed by El-Far et al. (2016) which states that the anti-cancer properties of the *C. speciosus* plant are due to the active compounds of this plant allowing for up-regulation of cellular apoptotic molecules as p53, p21, p27, caspases, reactive oxygen species (ROS) [43].

4. Conclusion

Pharmacological research on the pacing plant (*Costus speciosus*) in Indonesia in the last 15 years confirms the results of similar research in other countries. It is true that this plant is rich in bioactive which have the potential to be used as ingredients to treat various diseases or disorders because of its antidiabetic, antifertility, antipyretic, antihyperglycemic, antioxidant, anti-inflammatory, anti-parasitic/anthelmintic, wounds healing, and anticancer properties.

Compliance with ethical standards

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Disclosure of conflict of interest

Authors declare there is no conflict of interest.

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