

Ethnopharmacology and Species diversity of Pteridophyta in Cyathea Park, Bali: A Field study and Literature Review

Ni Ketut Ayu Juliasih

Department of Biology, Faculty of Information Technology and Science, Hindu University of Indonesia
<https://orcid.org/0000-0001-9958-2888>

I Made Dwi Mertha Adnyana (✉ i.made.dwi.mertha-2021@fk.unair.ac.id)

Tropical Medicine, Faculty of Medicine, Airlangga University <https://orcid.org/0000-0002-7167-7612>

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Abstract

Pteridophyta has been studied and conserved at the botanical garden. However, few have found and documented the medicinal properties of Pteridophyta species. The study identified species diversity and ethnopharmacology of Pteridophyta collected in Cyathea Park, Bali. Field exploration research and literature review were used in this study. The research was conducted by directly exploring the species of Pteridophyta collected in Cyathea Park, Bali and literature studies on the benefits and ethnopharmacology of Pteridophyta species are used as candidates and raw materials for traditional medicine. Data search is carried out systematically by utilizing databases and keywords. All the data is examined qualitatively and descriptively. The study's findings indicate nine species: *Cyathea contaminans* (Wall.ex Hook) Copel, *Asplenium nidus* L., *Asplenium* sp., *Selaginella* sp., *Diplazium esculentum*., *Angiopteris evecta* (G.Forst.) Hoffm, *Cyatheasp.*, *Nephrolepis hirsutula* (Forst), and *Dicksonia blumei* (Kunze) Moore. The leaves and shoots are the most frequently used raw materials in medicine. At the same time, the roots, stems, and hair are utilized in planting mediums, crafts, games, and food production. Pteridophyta species treat fever, cough, anticonvulsant, antibacterial, anti-inflammatory, antipyretic, antidiuretic, antioxidant, insecticide, larvicide, diabetes, and anti-retroviral. As many as nine identified species Pteridophyta in Cyathea Park, Bali has benefits as traditional medicinal agents and has been widely used by the people as the culture of the archipelago. Its pharmacological, phytochemical and toxicity properties need further investigations.

Introduction

Regions with high rain intensity tend to have abundant flora diversity, one of which is Indonesia (Atho et al., 2020). Tropical rain forests in the country can produce thousands of plants, including ferns (*Pteridophyta*) (Nabila et al., 2021). Pteridophyta generally lives in humid environments with temperatures ranging from 21–27°C at varying altitudes and habitats in aquatic, terrestrial, and epiphytic areas (Lestari & Nindira, 2021; Nabila et al., 2021). Pteridophyta have kormus, spore bags on parts of their bodies, and do not have seeds, so they are classified into the Cryptogamae (Silalahi, 2014; Yudianto, 1992).

The high diversity of nail plants in Indonesia has an essential role in the environment and humans (Jones et al., 2019). Pteridophyta for the environment has an ecological role, such as covering soil, protecting the soil from erosion, mixing litter for soil nutrient formation, and acting as producers in the food chain. Meanwhile, the role of Pteridophyta for humans as a source of germplasm, including for consumption needs, raw materials for traditional medicine, ornamental plants, handicrafts, and fertilizers for soil improvement (Ciawi et al., 2022; Sirichai et al., 2022; Tungmunthum et al., 2018). The existence of nail plants indicates that the environment is still in good condition (Darma et al., 2018; Taslim et al., 2019; Wu et al., 2020).

Exploration and identification of Pteridophyta in various regions of Indonesia have been widely carried out (Darma et al., 2018; Nabila et al., 2021; Nikmatullah et al., 2020). It is included in the technical implementation unit of the Eka Karya Botanical Garden Plant Conservation Center, Bali. This botanical garden has duties and functions as a cultural heritage, including a center for biodiversity research and plant conservation in eastern Indonesia. Cyathea Park covers an area of 2 ha, which is used for the conservation area of Pteridophyta and likofita plants (LIPI, 2022).

Exploration conducted by previous research is only limited to identifying the current types, quantities, identities, and conditions of Pteridophyta available to update collection data (Darma et al., 2018, 2021; Lestari & Nindira, 2021). However, not many studies have explored the benefits of Pteridophyta species in a botanical garden area being used as a traditional medicinal agent. This study seeks to bring about species diversity and the benefits of Pteridophyta Cyathea Park Collection, Eka Karya Botanical Garden, Bali as a traditional medicine agent through the study of literature on appropriate species.

Materials And Methods

Field Studies

Field exploration research and literature review were used in this study (Darwin et al., 2021). The research was conducted by directly exploring the species of Pteridophyta collected in Cyathea Park (-8.2759165, 115.1511926), Eka Karya Botanical Garden, Bali, which is located at Jalan Botanical Garden Eka Karya number 2, Candikuning, Baturiti, Tabanan Regency, Bali 82191. Cyathea Park, plot code XI.E, is located at an elevation of 1,250–1,450 meters above sea level, with temperatures ranging from 18–20°C and humidity ranging from 70–90%. Collection of Pteridophyta species identities in this study by recording based on "plaque" or board identity consisting of access number "E" and tagging number. Species validation is done through (<http://www.worldfloraonline.org/>) to determine classification, habitat data, and synonyms.

Literature studies

Literature studies on the benefits of Pteridophyta species are used as candidates and raw materials for traditional medicine. Data is collected from databases such as PubMed MeSH terms, Sciencedirect, Emerald, Nature, and Google Scholar. The keyword used is "*Cyathea contaminans* AND "*C. contaminans*", "*Asplenium nidus* L.", "*Asplenium* sp.", "*Selaginella* sp.", "*Angiopteris evecta* AND *A. evecta*", "*Dicksonia blumei* AND *D. blumei*", "*agent*", "*traditional medicine*", "*health*", "*benefits*". The instruments in this study include data recording sheets, Cyathea Park plans, stationery, and devices for documentation.

Data collection and Analysis

Data collection is carried out for one month, and all data is analyzed descriptively based on the data collected. The data is presented in narrative and table-supported documentation (Pteridophyta species image) during the study.

Results And Discussion

Species Diversity Pteridophyta Cyathea Park Collection

Nail plants (Pteridophyta) are closely related to cormofita-sporous plants and are classified as "*vascular plants*" (*Tracheophyta*) due to their true roots, stems, and leaves. They reproduce asexually by the use of spores. Nine Pteridophyta species were discovered during field searches in the Cyathea Park Collection at Bali's Eka Karya Botanical Garden. These plants are dominant and beneficial as traditional medicine agents. Fig. 1 and Table 1 list the Pteridophyta species discovered in Cyathea Park.

Characteristics of Pteridophyta species in Cyathea Park

Cyathea contaminans (Wall. ex Hook) Copel

Cyathea contaminans (Wall. ex Hook) Copel is a tribe of Cyatheaceae and has synonyms including *Polypodium contaminans* Wall. Cat., *Alsophila contaminans* Wall. ex Hook., *Alsophila acuta* Presl, *Alsophila smithiana* Presl, and *Alsophila clementis* Copel (Mustacisa-Lacaba et al., 2021; Warseno, 2015). This nail is known as a "*treenail*" by some people in Indonesia. The local names of these nails in Indonesia are *pehon nails*, *board nails*, *Tihang bodas nails* (Sunda), *Pole nails* (Bali), *Bagedor* (West Java), and *Tree ferns* (North Sumatra) (Gultoma et al., 2015). These nails' characteristics that stand out are fronds that resemble coconut trees, having a high stature, and growing in groups with other types of nails. It thrives on mountain slopes and sheltered places at 1,060–1,600 meters above sea level. Morphologically, the roots of the fibers protected by calyptra are black and slender and covered with rough roots; they are

tight and thick, and there are shallow indentations of the petiole marks attached. The height of the stem reaches 6–7 m. The location of the leaves is paired. The leaf bones are purplish and equipped with sharp spines. The leaves are 150 × 30 mm in size. These spikes are equipped with sorus near the edges of the leaves. There is no indusium. It resembles an umbrella and grows terrestrially (Ciawi et al., 2022; Wardani, 2018). The community widely uses this type of nail for crafts, ornamental plants, and raw materials for traditional medicine (Ahmad Faizal et al., 2020; Ciawi et al., 2022; Mustacisa-Lacaba et al., 2021).

***Asplenium nidus* L.**

Asplenium nidus L. It is a tribe of Aspleniaceae and has the synonym *Asplenium nidus*, syn. with *A. ficifolium* Goldm., *Thamnopteris nidus* (L.) C. Presl., *Neottopteris rigida* Feé). This nail is known as the "bird's nest nail" by the people of Bali (Lestari & Nindira, 2021). *Asplenium nidus* L. species grows in terrestrial and epiphytic areas, many of which are found in the mountains at 1,700–2,500 meters above sea level. These spikes are identical to the elongated morphology of the leaves, which are bright green and darken as they approach maturity. The length of the leaves is 150 cm long by 20 cm wide. The edges of the leaves are choppy, the leaves are lanceolate and arranged circularly, and the tips of the leaves are tapered. The petioles are sturdy, black in color, and have a length of 5 cm. The texture of the leaves resembles paper. The short rhizome is covered with smooth and dense scales. Sorus is located on the lower surface of the leaves and is arranged following the venation. The sori are narrow and located above the veins of the leaves (Nabila et al., 2021; Supiandi et al., 2019). *Asplenium nidus* L. is utilized by the community as an ornamental plant because of its unique shape and has benefits as a restorative material, especially anticonvulsant, skin disease drugs, and antichemotactics, which have been widely researched (Andrade et al., 2014; Faral et al., 2019; Heo et al., 2021; Zeng & Lai, 2019a).

***Asplenium* sp.**

Asplenium sp. is a tribe of Polypodiaceae that belongs to the herbaceous nail. The habitat is terrestrial and has the local name of a *land nail* (Bali), which helps the bird's nest. These spikes are found in moist and terrestrial areas and are classified as terrestrial. The morphology of the leaves on these spikes is single-shaped, with fine serrations on the edges of the leaves, a pinnate shape, and a dark green to dark green coloration that suggests the presence of delicate feathers above the leaf surface. There are different types of sporophylls, anglophiles, and fertile leaves. There are also spores on the enthalpy and stiff. The stem is long and slender, measuring 1-2 cm with a 60 cm–1 m. The stem is blackish-brown and has branching. The roots are fibrous, coarse, and dark brown. The sporangium is in an annulus-shaped dun of 3-5 mm, yellow in color, with fine spores and sorus surrounded by insidium (Andrade et al., 2014; Heo et al., 2021; Nabila et al., 2021). *Asplenium* sp. leaves have been known to contain essential oils used in traditional medicine (Hammami et al., 2016; Rai et al., 2017). It has analgesic benefits (Ekici & Sisman, 2020) and contains isolated chemical constituent for commercial purposes in society (Zeng & Lai, 2019b).

***Selaginella* sp.**

Selaginella sp. is known as rane nails or moss spikes. This species grows creeping, slightly erect, and herbaceous. In addition, nails of this type can grow at an altitude of 10–1,500 meters above sea level. It grows in a partially moist environment of xerophytes and epiphytes. Morphological single, squawked leaves lined up along the stem resemble a needle with a length of 1-2 mm. The dominant color of the leaves is dark green, with micropile and anisophile leaf types. On upright stems, 15–35 cm high, there are roots on branching, rounded stems, prostrate, and creeping stem types. Furthermore, the sorus in *Selaginella* sp. is heterosporous, producing microspores composed of strobilus. This species thrives under the dominance of one stem and has many branches (Baskaran et al., 2018; Rindita et al., 2020). *Selaginella* sp. is a nail rich in secondary metabolites in the form of flavonoids, phenols, and polyphenols that are beneficial for health (Reginaldo et al., 2021). Sustainable cultivation and conservation are strongly recommended to increase the number of species and cultivate plants as traditional medicinal agents (Anwar et al., 2021; Oon et al., 2021).

Diplazium esculentum

Diplazium esculentum is a tribe of Athyriaceae that is generally consumed by the community in the form of vegetables. These spikes belong to homospora, which inhabits habitats in rivers or moist soils, grow at 350–1,600 meters above sea level, and are classified as terrestrial spikes. Morphologically, the leaves of this nail are a type of compound leaf, pinnate, lanceolate shape, the presence of serrations, and pointed ends, with a length of 5–6 sm and a width of 1-2 cm. Youngs totals are generally covered with dark brown scales. Stalks and stems are green, 50–80 cm long. The roots on these spikes are fat and gathered, the rhizome is short, about 5 mm, and the rhizome propagates to the erect. The elongated sori resemble a crescent moon in the indusia vein. The sorus is ring-shaped, uneven, and follows the direction of the leaf veins. This nail is utilized because it contains various therapeutic benefits, especially in traditional medicine (Halimatussakdiah et al., 2018; Semwal et al., 2021; Zihad et al., 2019).

***Angiopteris evecta* (G.Forst.) Hoffm**

Angiopteris evecta (G.Forst.) The Hoffm is a Marattiaceae tribe synonymous with the synonyms *Polypodium evectum* G. Forst and *Angiopteris palmiformis* (Cav.). It grows terrestrially in the tropics at 950–1,200 meters above sea level. With humid soil conditions, optimal temperatures range from 19–27°C. This nail has the local name of elephant nail, "Bali and Java," and is widely found in the highlands of Bali (LIPI, 2022). This species has three variations at the base of the leaf frond stalk, namely dark green, white waxy, and brown. Leaf morphology in *Angiopteris evecta* (G.Forst.) Hoffm is a pinnate double compound, up to 6 m long, with sporophyte bone leaves and isophilic leaves with a length of 5 cm and a width of 7 cm. The leaves have a dark green color and shallow jagged edges. The stems of these spikes are erect, green, and have cavities. Part of the stem is decorated with hair thorns and rementas. Sori is a lateral annulus and forms a long line. Sori is reddish-brown, resembles a heart, and has an indusium. Sori size ± 0.5 -1.5 mm from the edges and is classified as homospora (Atho et al., 2020; Warseno, 2015). This nail has been researched and is known to have benefits as an antiretroviral, especially in HIV disease, which until now has not been found to have a cure or vaccine (Rindita et al., 2020). It is essential to encourage the use and cultivation of this nail because tropical diseases have been a problem for many people. This will aid in the quest for novel medication candidates derived from the nail *Angiopteris evecta* Hoffm (Wang et al., 2020).

***Cyathea* sp.**

Cyathea sp. It is a tribe of the Cyatheaceae, which is the most prominent family in Cyanthea Park. This nail is included in the nail of a tree with a 20 m span. These spikes grow terrestrially and include herbaceous spikes because they contain about 80% water in their bodies. It is characterized by a robust stem and rhizome (stick-like dominance). It can reach a height of 15 m and a diameter of 25–50 cm. It has 1 m long tripinnatifid leaves with an elongated form and pointy ends. On the shoots, there are serrations. The length of the leaves reaches 7–13 cm, with a width of 4 cm. The surface is paper-like, bright green to dark in color, with the presence of feathers on the fronds and leaves, including anisophiles. Next, the spore type of bean seed monolet and cup monolet is the entire sorus located at the bottom of the leaves, while the roots are all-encompassing and protected by calyptra, and there are serrations at the top (Warseno, 2015). This nail is widely used as a kicker and other nail protector underneath (LIPI, 2022). In addition, these spikes have been known to be beneficial as antiretrovirals (Larson et al., 2014) and fever drugs.

***Nephrolepis hirsutula* (Forst) C. Presl**

Nephrolepis hirsutula (Forst) C. Presl is a tribe of Davalliaceae that grows terrestrial and epiphytic at an altitude of 900–1,750 meters above sea level. This spike can grow in cuca and extreme temperatures, including deserts and open highland areas. The local name for this nail is *pedang nail* (Bali, Java, and Sumatra). A particular characteristic of this nail is that it has an elongated enthalpy resembling a sword. These nails have leaf bones that have branching; the tips of the leaves are snaking, and they include microphyl (small) and macrophiles (large). The size of the leaves is 2 cm long by 1 cm wide. The shape of the leaves is pushed with the splitting tip, and the edges of the leaves are jagged. Young leaves roll, green in color, and the leaves have three types: tropophylls, sporophylls, and brotophiles. The stems of these spikes are rounded, the height of the stem reaches 0.5 cm, they are brownish, and they have fine hairs. The sporangium is neatly arranged on the leaf vein test and grows to the height of the leaves (LIPI, 2022). This nail is also helpful as an antiviral, antimicrobial, anti-inflammatory and can treat diarrhea in both children and adults (Popovici et al., 2018; Renjana et al., 2021).

***Dicksonia blumei* (Kunze) Moore**

Dicksonia blumei (Kunze) Moore is a Cyatheaceae tribe known by the local names of *paku kidang*, *lemputu*, and *lempunah* (Bali) (LIPI, 2022). This nail belongs to the nail type of tree with a large trunk and a high stature. These spikes are found at 1.060–1.755 masl altitudes and love moist and watery areas. These plants include epiphytes and hydrophytes but are generally affected. Morphologically, the roots of these spikes are fibers protected by calyptra, and their shape is rough, black, tight, and thick with tapered aids. Slender stem stature with a height of up to 6-7 m. It has a fresh leaf, strands of inscribed leaves, and is located in pairs. The length of the petiole reaches 1 m. The bones of the primary leaves are pale, purplish, and sharply prickly. Children have a size of 34 cm and the presence of rolled veneration on young leaves. This nail has a 1 m long enthalpy, purplish brown, and a rolling enthalpy resembling a violin handle. There is a sporangium in the sorus, which is found on the lower surface of the leaves (Warseno, 2015; Zuhri et al., 2016). Feathers or hair-containing stems are widely used as planting media, and leaves and shoots are traditional medicine (Muhyi et al., 2020).

Therapeutic benefits and biological activity of Pteridophyta species in Cyathea Park

Therapeutic benefits and biological activity of Pteridophyta species in Cyathea Park, Eka Karya Botanical Garden, Bali are summarized in Table 2 based on the type of treatment, the sections used, the chemical content, and the degree of use, and other designations by the community with the ethnopharmacology approach.

Several studies have shown that ferns contain enough bioactive chemicals to be used as raw materials for traditional medicine. Ahmad Faizal et al. (2020) describe the leaf, fruit, and stem extracts of *Cyathea contaminans* (Wall ex Hook) Copel includes 2H-tetrazole, 5-(thiophene-2-yl) methyl (14.29 percent), 2-thiophene acetic acid, 2-methyl phenyl ester (14.54 percent), and phenol, 2,6-bis (1,1-dimethyl ethyl)-4-methyl (14.56 percent). The bioactive substance of *Cyathea contaminans* (Wall ex Hook) possesses moderate to strong antioxidant activity (IC_{50} 37,13–225,19 $\mu\text{g/mL}$). However, the hair of this plant includes moderate to weak antioxidant activity (IC_{50} 179,50–255,49 $\mu\text{g/mL}$). At a concentration of 250 g/mL, the hexane extract of fronds had the greatest antibacterial activity, with an inhibition percentage of 43.92 percent for *E. coli* and 46.8 percent for *S. aureus*. 2H-tetrazole, 5-(thiophene-2-yl)-methyl (14.29 percent), and 2-thiophene acetic, 2-methyl phenyl ester were shown to be the active antibacterial compounds in frond extracts (14.54 percent). *Cyathea contaminans* (Wall ex Hook) Copel extracts have the potential to serve as natural antioxidants and antibiotics.

Cyathea contaminans (Wall ex Hook) Copel contain several bioactive compounds with diverse biological activities. It is thought that its saponins, alkaloids, flavonoids, tannins, and anthraquinones are responsible for its therapeutic qualities. The content in this plant is responsible for its anti-inflammatory, analgesic, hypocholesterolemic, antioxidant, anti-seizure, and anti-diarrheal properties. Saponins from *Cyathea contaminans* (Wall ex Hook) Copel have anti-inflammatory effects because they stop releasing pro-inflammatory cytokines and reactive oxygen species from being made (Ahmad Faizal et al., 2020). Alkaloids act as analgesics, anti-inflammatory agents, and anti-tumor agents. The alkaloids in *Cyathea contaminans* (Wall ex. Hook) Copel have pain-relieving effects because they stop pain signals from being sent. Flavonoids neutralize free radicals, diminish oxidative stress, and limit the generation of pro-inflammatory cytokines. By decreasing the activity of nuclear factor-kappaB (NF- B) and reducing the production of pro-inflammatory enzymes, flavonoids in the leaves, roots, young leaves (shoots), and seeds of *Cyathea contaminans* exhibit anti-inflammatory characteristics.

Furthermore, the content of tannins has anti-diarrheal properties by inhibiting the secretion of water and electrolytes from the intestinal mucosa. Anthraquinones can stimulate the contraction of intestinal smooth muscle and inhibit the proliferation of cancer cells. Anthraquinones in leaf extract have anti-diarrheal properties by increasing the tone of the intestinal smooth muscle (Mustacisa-Lacaba et al., 2021; Wardani, 2018). Thus, the potential use as a traditional medicine tends to vary and has the potential to be developed as a candidate for traditional medicine, including the need to study active ingredients to be used as medicinal ingredients.

Asplenium nidus L., commonly known as "Bird's Nest Fern," is a plant that has historically been utilized as a medicine worldwide. It is thought to have sedative, antibacterial, immunostimulant, depurative, antimicrobial, analgesic, and other therapeutic effects (Faral et al., 2019). Kashyap et al. (2017) researched and found that the leaves of *Asplenium nidus* L. have kaempferol (3–0)-gentiobioside-7,40-diglucoside. *Asplenium nidus* L. has chemicals like flavonoids, terpenoids, and alkaloids that can relieve pain, fight infections, and kill fungi and viruses. These chemicals can reduce pain by stopping pain signals from getting through or producing cytokines that cause inflammation. They can also stop bacteria from growing and reproducing, preventing infections. Tannins and flavonoids have astringent properties. (Supiandi et al., 2019) These compounds can help reduce inflammation and speed up the healing of ulcers by clumping together proteins and creating a barrier over the ulcerated area. *Asplenium nidus* L. contains polysaccharides that can stimulate the immune system. These polysaccharides can increase the production of white blood cells, which can help to fight

infections and improve overall immune function (Nikmatullah et al., 2020; Renjana et al., 2021). Compounds like flavonoids and terpenoids have detoxifying properties (Supiandi et al., 2019). By making liver enzymes work harder and improving kidney function, these chemicals help the body eliminate toxins. They also contain flavonoids and terpenoids that make you feel sleepy. These compounds can help to reduce anxiety, promote relaxation, and improve sleep quality (Cao et al., 2017; Faral et al., 2019; Mannan et al., 2008).

Plants, including vegetables, fruits, and medicinal herbs include flavonoids such as luteolin, kaempferol, and glucopyranosyl caffeic acid (Imran et al., 2019; Taheri et al., 2021; Yu et al., 2021). Luteolin is an anticancer drug that works on breast, prostate, colon, glioblastoma, lung, and pancreas cancers in people. Additionally, it contains antiviral, anti-inflammatory, and immune-regulating properties (Imran et al., 2019). It has been demonstrated that kaempferol possesses anti-inflammatory, anticancer, and antioxidant effects. Kaempferol, another flavonoid found in *Asplenium*, has been shown to reduce inflammation and act as an antioxidant. Monoamine oxidase, an enzyme that degrades neurotransmitters, including dopamine and serotonin, has also been proven to be inhibited by it. This suggests that kaempferol may potentially act as a natural antidepressant. Glucopyranosyl caffeic acid has been found to have anti-inflammatory and antioxidant activities (Yu et al., 2021). *Asplenium nidus* L. has glucopyranosyl caffeic acid, an anti-inflammatory and antioxidant phenolic acid. It has also been shown to have anti-chemotactic properties, meaning it can prevent cells from migrating to a site of inflammation, which may be beneficial in treating conditions like arthritis. *Asplenium* sp. is a traditional medicine for treating skin diseases such as melanoma. The mechanism of action of *Asplenium* sp. is unclear. It includes anticancer, anti-inflammatory, antioxidant luteolin glycosides, kaempferol, and glucopyranosyl caffeic acid. Luteolin has been identified as having the ability to treat prostate cancer and COVID-19. (Xie et al., 2022). These flavonoids may help *Asplenium* sp. treat skin diseases like melanoma because they fight cancer, reduce inflammation, and protect cells from damage.

Selaginella sp. is a plant used as a traditional medicine by the people of Bali for centuries. It has many bioactive compounds, such as saponins, terpenoids, phenylpropanoids, steroids, quinoids, coumarins, and apigenin, which are thought to be the reason for its medicinal properties (Adnan et al., 2021). Research by Adnan et al. (2021) explains the leaf content in *Selaginella* sp. It has health benefits and is used as a medicinal agent by the public (ethnomedicine). Compounds Paucine N-(5-hydroxyselaginelllic acid), N-(5-hydroxyselaginelllic acid), and 3-D-glucopyranoside, Hordenine-O-[(6-O-cinnamoyl)-O- β -glucopyranosyl]-rhamnopyranoside, carboxylic acid of 17-cholesterol-21, 8-O-D-glucopyranoside, N1-cis-p-coumaroylagmatine, selaginelllic acid, 5-hydroxyselaginelllic acid, 5-hydroxy-N8, N8-dimethylpseudophrynaminol, N-selaginellas L-phenylalanine, glycyrrhetic acid, -sitosterol, lariciresinol On the leaves and roots, butyrolactone and selaginellin A, B, C, M, K, L, G, and H were found.

The mechanism of action of the compounds studied includes the content of saponins. It has been found to have anti-hyperuricemic, anti-inflammatory, and xanthine oxidase inhibition properties, which make it useful in treating gouty arthritis. In traditional medicine, saponins are often used for their expectorant, diuretic, and anti-inflammatory effects. Additionally, it has been demonstrated that the molecule amentoflavone exhibits AKR1B10-inhibitory activities, which suppress the proliferation of A549 human lung cancer cells both in vitro and in vivo (Bailly, 2021). Terpenoid molecules have biological effects, including the ability to influence the immune system and have antibacterial, anti-inflammatory, and antioxidant capabilities. Terpenoids are often used because they can relieve pain, reduce inflammation, and fight cancer (Setyawan, 2009; Xu et al., 2015). Phenylpropanoids are often used for their pain-relieving and anti-inflammatory effects, and steroids and quinoids are often used for their anti-inflammatory, antioxidant, and pain-relieving effects. Coumarins have anticoagulant, antimicrobial, and anticancer activities. Biapigenin is a flavonoid found in many plants with antioxidant and anti-inflammatory properties. It also has anticancer and neuroprotective activities (Reginaldo et al., 2021; Vashistha & Tejasvi, 2021).

Traditional treatments for respiratory conditions, cough, urinary tract infections (UTI), gonorrhea, topical dermatitis, larvicides, and insecticides include *Diplazium esculentum*. It has phytosterols, which have anti-inflammatory and antibacterial effects (Semwal et al., 2021; Zannah et al., 2017). Several bioactive compounds are believed to be responsible for its therapeutic effects, including phytosterols, leucoanthocyanin, glycosides, diterpenes, and triterpenes (Halimatussakdiah et al., 2020; Roy et al., 2013; Thomas & Bindu, 2021; Tongco et al., 2014). The plant contains compounds with antitussive and expectorant properties, which can help alleviate cough and promote the expulsion of mucus from the respiratory tract. Additionally, the plant components' antibacterial and anti-inflammatory characteristics can aid in treating the infection and lowering urinary tract irritation. The plant possesses anti-inflammatory and antioxidant chemicals that can help cure topical dermatitis and decrease inflammation and oxidative stress in the skin. It also has a poisonous impact on insects through contact poisoning, respiratory accretion, and acetylcholinesterase inhibition (Roy & Chaudhuri, 2020; Semwal et al., 2021).

The species *Angiopteris erecta* (G. Forst.) Hoffm is a fern species found worldwide. Traditional medicine has used it to treat various diseases, including HIV. Research Bedoya et al. (2001) discovered that fern extracts prevented HIV from replicating in vitro. The study found that the extract inhibited HIV reverse transcriptase activity, which is essential for the virus to replicate, and inhibited the replication of the virus by up to 90%. At the same time, these studies suggest that *Angiopteris erecta* may have potential as an anti-HIV agent. Furthermore, another compound reported as an antiretroviral is part of the plant extract *Cyathea* sp. It has been demonstrated that a class of substances known as naphthoflavones has antiviral action against several viruses, including HIV (Larson et al., 2014). According to another study, the antibacterial capabilities of *Cyathea* sp., a member of the *Cyathea* genus, have been investigated. The plant has been used in ethnomedicine to treat cuts and wound infections (Chaparro-Hernández et al., 2022). Gram-positive and Gram-negative bacteria may both be susceptible to the antibiotic effects of *Cyathea* sp. ethyl acetate extract. Some isolated compounds, such as 2-methyl butane-1,4-diol and 3-(1-ethoxy ethoxy), may also contribute to the antibacterial property of the plant (Baskaran et al., 2018; Silalahi et al., 2015).

Nephrolepis hirsutula (G.Forst.) C.Presl is a fern species native to the Indo-China to Pacific region (Sajeev et al., 2015). The *Nephrolepis hirsutula* (G.Forst.) C.Presl, numerous bioactive substances, including eugenol, -ionone, thymol, anethole, cinnamaldehyde, and methyl palmitate, have not yet been well researched for their impact on human health. However, some traditional medicine systems have used *Nephrolepis hirsutula* for various medicinal purposes, including treating coughs and ulcers. These uses have not been thoroughly investigated, and limited scientific evidence supports these claims. Finally, *Dicksonia blumei* (Kunze) Moore is a fern species commonly found in Southeast Asia, including countries like Indonesia and Malaysia (Muhyi et al., 2020). It has historically been used as a medicine, including an analgesic (pain reliever). Several compounds have been identified in *Dicksonia blumei* that may contribute to its analgesic effects, including flavonoids, alkaloids, and terpenoids (Suryana et al., 2018). These compounds have been shown to have anti-inflammatory and analgesic properties. The mechanism by which *Dicksonia blumei* exerts its analgesic effects is not fully understood. However, it is believed that the compounds found in the plant may inhibit the production of prostaglandins, which are molecules involved in inflammation and pain. Additionally, some of the compounds found in *Dicksonia blumei* interact with opioid receptors in the body, which could also contribute to its analgesic effects (Srithi et al., 2009). The use of *Dicksonia blumei* as an analgesic is supported by some data, but further studies are required to understand its mechanism of action and possible therapeutic applications completely.

Conclusion

As many as nine identified species has benefits as traditional medicinal agents, including *Cyathea contaminans* (Wall ex Hook) Copel., *Asplenium nidus* L., *Asplenium* sp., *Selaginella* sp., *Diplazium esculentum*, *Angiopteris evecta* (G.Forst.) Hoffm, *Cyathea* sp., *Nephrolepis hirsutula* (Forst) C. Presl and *Dicksonia blumei* (Kunze) Moore. Leaf parts and leaf

shoots (buds) are most widely used as medicinal raw materials, while roots, stems, and hairs are used as a medium for planting, crafts, games, and vegetables. In the future, study on the pharmacological, phytochemical, toxicity and efficacy of Pteridophyta components used as traditional medicinal compounds will be necessary.

Declarations

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Conflict of interests

The authors declare that there is no competing interest.

References

- Adnan, M., Siddiqui, A. J., Jamal, A., Hamadou, W. S., Awadelkareem, A. M., Sachidanandan, M., & Patel, M. (2021). Evidence-based medicinal potential and possible role of selaginella in the prevention of modern chronic diseases: Ethnopharmacological and ethnobotanical perspective. *Records of Natural Products*, 15(5), 330–355. <https://doi.org/10.25135/mp.222.20.11.1890>
- Ahmad Faizal, Intan Taufik, Anisah Firda Rachmani, & Alda Wydia Prihartini Azar. (2020). Antioxidant and antibacterial properties of tree fern *Cyathea contaminans*. *Biodiversitas Journal of Biological Diversity*, 21(5), 2201–2205. <https://doi.org/10.13057/biodiv/d210548>
- Amoroso, V. B., Antesa, D. A., Buenavista, D. P., & Coritico, F. P. (2014). Antimicrobial, Antipyretic, and Anti-Inflammatory Activities of Selected Philippine Medicinal Pteridophytes. *Asian Journal of Biodiversity*, 5(1), 18–40. <https://doi.org/10.7828/ajob.v5i1.479>
- Andrade, J. M. D. M., Passos, C. D. S., Dresch, R. R., Kielling-Rubio, M. A., Moreno, P. R. H., & Henriques, A. T. (2014). Chemical analysis, antioxidant, antichemotactic and monoamine oxidase inhibition effects of some pteridophytes from Brazil. *Pharmacognosy Magazine*, 10(37), S100–S109. <https://doi.org/10.4103/0973-1296.127354>
- Anwar, G., Oktariani, Susatya, A., BAN, P., & Wiryono. (2021). Abundance and Distribution of Medicinal Plants in Madapi Forest Kerinci Seblat National Park (KSNP) Rejang Lebong, Bengkulu. *Proceedings of the International Seminar on Promoting Local Resources for Sustainable Agriculture and Development (ISPLRSAD 2020)*, 13(Isplrsad 2020), 510–517. <https://doi.org/10.2991/absr.k.210609.077>
- Atho, M. A., Akmal, M. A. S., Riza, R. E. N., Sinta, S. D. R., Fatim, S. F., Dian, D. N. M., & Lianah, L. (2020). The diversity of ferns (Pteridophyta) and their potential use studies in the Ulolanang Kecubung Nature Reserve. *BIOEDUSCIENCE: Jurnal Pendidikan Biologi Dan Sains*, 4(1), 73–81. <https://doi.org/10.29405/j.bes/4173-814991>
- Bailly, C. (2021). The traditional and modern uses of *Selaginella tamariscina* (P.Beauv.) Spring, in medicine and cosmetic: Applications and bioactive ingredients. *Journal of Ethnopharmacology*, 280, 114444. <https://doi.org/10.1016/j.jep.2021.114444>

- Balangcod, T. D., & Balangcod, K. D. (2018). Plants and Culture: Plant utilization among the local communities in Kabayan, Benguet Province, Philippines. *Indian Journal of Traditional Knowledge*, 17(4), 609–622. <https://nopr.niscpr.res.in/handle/123456789/45073>
- Baskaran, X. ravi, Geo Vigila, A. varuvel, Zhang, S. zhou, Feng, S. xiu, & Liao, W. bo. (2018). A review of the use of pteridophytes for treating human ailments. *Journal of Zhejiang University-SCIENCE B (Biomedicine & Biotechnology)*, 19(2), 85–119. <https://doi.org/10.1631/jzus.B1600344>
- Cao, H., Chai, T. T., Wang, X., Morais-Braga, M. F. B., Yang, J. H., Wong, F. C., Wang, R., Yao, H., Cao, J., Cornara, L., Burlando, B., Wang, Y., Xiao, J., & Coutinho, H. D. M. (2017). Phytochemicals from fern species: potential for medicine applications. In *Phytochemistry Reviews* (Vol. 16, Issue 3). Springer Netherlands. <https://doi.org/10.1007/s11101-016-9488-7>
- Chaparro-Hernández, I., Rodríguez-Ramírez, J., Barriada-Bernal, L. G., & Méndez-Lagunas, L. (2022). Tree ferns (Cyatheaaceae) as a source of phenolic compounds – A review. *Journal of Herbal Medicine*, 35, 100587. <https://doi.org/10.1016/j.hermed.2022.100587>
- Ciawi, Y., Salain, I. M. A. K., & Sutapa, A. A. G. (2022). The potency of fern stem as the carbon material for clay-based ceramic filter. *IOP Conference Series: Earth and Environmental Science*, 999(1), 012020. <https://doi.org/10.1088/1755-1315/999/1/012020>
- Darma, I. D. P., Lestari, W. S., Priyadi, A., & Iryadi, R. (2018). Epiphytic Ferns and Phorophyte Trees in the Hills of Pengelengan, Tapak and Lesung, Bedugul, Bali. *Jurnal Penelitian Hutan Dan Konservasi Alam*, 15(1), 41–50. <https://doi.org/10.20886/jphka.2018.15.1.41-50>
- Darma, I. D. P., Sutomo, Hanum, S. F., Rahayu, A., & Iryadi, R. (2021). *Mengenai Koleksi Tematik Kebun Raya Eka Karya Bali dalam Sebuah Taman* (1st ed.). Lembaga Ilmu Pengetahuan Indonesia (LIPI) Press.
- Darwin, M., Mamondol, M. R., Sormin, S. A., Nurhayati, Y., Tambunan, H., Sylvia, D., Adnyana, I. M. D. M., Prasetyo, B., Vianitati, P., & Gebang, A. A. (2021). *Quantitative approach research method* (T. S. Tambunan, Ed.; 1st ed.). CV Media Sains Indonesia.
- Ekici, B., & Sisman, E. E. (2020). Using plants in hospital interior design, tekirdağ example. *Turkish Journal of Landscape Research*, 3(1), 1–9.
- El-Tantawy, M. E., Shams, M. M., & Afifi, M. S. (2016). Chemical composition and biological evaluation of the volatile constituents from the aerial parts of *Nephrolepis exaltata* (L.) and *Nephrolepis cordifolia* (L.) C. Presl grown in Egypt. *Natural Product Research*, 30(10), 1197–1201. <https://doi.org/10.1080/14786419.2015.1046070>
- Faral, H. M. B., Macaraig, R. B., PrincessMarian, B., Mojares, Caramat, R. J. D., Abando, D. D., Balangi, L. M., Aguila, S. C., & Villalobos, O. (2019). The anticonvulsant activity of *Asplenium nidus* L. (Polypodiaceae) methanolic crude leaf extract in chemically induced tonic-clonic convulsions on Swiss mice. *The Steth Archives*, 12, 18–34. <https://research.lpubatangas.edu.ph/wp-content/uploads/2019/06/Steth-2018-003.pdf>
- Gultoma, H. E. N., Patanab, P., & Yunasfic. (2015). Utilization and marketing potential of spikes (*Cyathea contaminans* Wall. Ex Hook) Case Study of Communities in Pancur Batu District and Sibolangit District Henny. *Peronema Forestry Science Journal*, 4(1), 1–11. <https://jurnal.usu.ac.id/index.php/PFSJ/article/view/577>

- Halimatussakdiah, Amna, U., & Mardina, V. (2020). Antioxidant activity of methanol extract of *Diplazium esculentum* (Retz.) Sw. leaves collected from Aceh. *IOP Conference Series: Materials Science and Engineering*, 725(012082), 1–7. <https://doi.org/10.1088/1757-899X/725/1/012082>
- Halimatussakdiah, H., Amna, U., & Wahyuningsih, P. (2018). Preliminary phytochemical analysis and larvicidal activity of edible fern (*Diplazium esculentum* (Retz.) Sw.) extract against *Culex*. *Jurnal Natural*, 18(3), 141–147. <https://doi.org/10.24815/jn.v0i0.11335>
- Hammami, S., Snène, A., El Mokni, R., Faidi, K., Falconieri, D., Dhaouadi, H., Piras, A., Mighri, Z., & Porcedda, S. (2016). Essential Oil Constituents and Antioxidant Activity of *Asplenium* Ferns. *Journal of Chromatographic Science*, 54(8), 1341–1345. <https://doi.org/10.1093/chromsci/bmw071>
- Heo, N., Yun, S., & Fernando, D. D. (2021). The complete chloroplast genome sequence of *Asplenium komarovii* Akasawa, a rare fern in South Korea. *Mitochondrial DNA Part B Resources*, 6(10), 3006–3008. <https://doi.org/10.1080/23802359.2021.1961624>
- Imran, M., Rauf, A., Abu-Izneid, T., Nadeem, M., Shariati, M. A., Khan, I. A., Imran, A., Orhan, I. E., Rizwan, M., Atif, M., Gondal, T. A., & Mubarak, M. S. (2019). Luteolin, a flavonoid, as an anticancer agent: A review. *Biomedicine & Pharmacotherapy*, 112, 108612. <https://doi.org/10.1016/j.biopha.2019.108612>
- Jones, E. J., Kraaij, T., Fritz, H., & Moodley, D. (2019). A global assessment of terrestrial alien ferns (Polypodiophyta): species' traits as drivers of naturalisation and invasion. *Biological Invasions*, 21(3), 861–873. <https://doi.org/10.1007/s10530-018-1866-1>
- Kashyap, D., Sharma, A., Tuli, H. S., Sak, K., Punia, S., & Mukherjee, T. K. (2017). Kaempferol – A dietary anticancer molecule with multiple mechanisms of action: Recent trends and advancements. *Journal of Functional Foods*, 30, 203–219. <https://doi.org/10.1016/j.jff.2017.01.022>
- Lai, H. Y., Lim, Y. Y., & Tan, S. P. (2009). Antioxidative, tyrosinase inhibiting and antibacterial activities of leaf extracts from medicinal ferns. *Bioscience, Biotechnology and Biochemistry*, 73(6), 1362–1366. <https://doi.org/10.1271/bbb.90018>
- Larson, E. C., Hathaway, L. B., Lamb, J. G., Pond, C. D., Rai, P. P., Matainaho, T. K., Piskaut, P., Barrows, L. R., & Franklin, M. R. (2014). Interactions of Papua New Guinea medicinal plant extracts with antiretroviral therapy. *Journal of Ethnopharmacology*, 155(3), 1433–1440. <https://doi.org/10.1016/j.jep.2014.07.023>
- Lestari, W. S., & Nindira, Z. (2021). Inventarisasi Dan Identifikasi Ulang Koleksi Tumbuhan Paku Kebun Raya Bali I: Suku Pteridaceae. *Jurnal Sains Dan Teknologi*, 10(2), 169–180. <https://doi.org/10.23887/jstundiksha.v10i2.34261>
- LIPI. (2022). *Kebun Raya Bali (Koleksi Tumbuhan Paku)*. Balai Konservasi Tumbuhan Eka Karya Bali. <https://krbali.lipi.go.id/tumbuhan-paku-lumut.html>
- Mannan, M. M., Maridass, M., & Victor, B. (2008). A Review on the Potential Uses of Ferns. *Ethnobotanical Leaflets*, 12(1), 281–285. <https://opensiuc.lib.siu.edu/ebf/vol2008/iss1/33>
- Menezes, J. C. J. M. D. S., & Diederich, M. F. (2021). Bioactivity of natural biflavonoids in metabolism-related disease and cancer therapies. *Pharmacological Research*, 167, 105525. <https://doi.org/10.1016/j.phrs.2021.105525>
- Muhyi, M. D., Yani, E., & Widodo, P. (2020). Diversity and Evenness of Medicinal Plants in Bantarbolang Nature Reserve Block 19-21, Pemalang, Central Java. *Bioeksakta: Jurnal Ilmiah Biologi Unsoed*, 2(1), 33–

41. <https://doi.org/10.20884/1.bioe.2020.2.1.1752>

Mustacisa-Lacaba, M. M., Dejarne, A. B., & Albina, M. B. (2021). Preparation, sensory evaluation and effectiveness of Philippine Tree Fern (*Cyathea contaminans*) as anti-spasm oil. *International Journal of Agricultural Technology*, 17(4), 1461–1470. [http://www.ijat-aatsea.com/pdf/v17_n4_2021_July/17_IJAT_17\(4\)_2021_Mustacisa-Lacaba-M.-M..pdf](http://www.ijat-aatsea.com/pdf/v17_n4_2021_July/17_IJAT_17(4)_2021_Mustacisa-Lacaba-M.-M..pdf)

Nabila, F., Sulistyowati, D., Isolina, I., Yani, R., Sigit, D. V., & Miarsyah, M. (2021). Diversity of types of pteridophyte epiphytes and spermatophyte epiphytes in the Bogor Botanical Gardens. *Proceeding of Biology Education*, 4(1), 36–50. <https://doi.org/10.21009/pbe.4-1.4>

Nikmatullah, M., Rwnjana, E., Muhaimin, M., & Rahayu, M. (2020). Potential of Cibodas Botanical Garden Fern and Lycophytes Collection as the Source of Medicine. *Al-Kauniah: Jurnal Biologi*, 13(2), 278–287. <https://doi.org/10.15408/kauniah.v13i2.16061>

Oon, Y. N., Chen, R. J., Kuan, J. M., & Sit, N. W. (2021). Bioactivity of medicinal plant extracts against human fungal pathogens and evaluation of toxicity using vero cells. *Tropical Biomedicine*, 38(3), 469–475. <https://doi.org/10.47665/tb.38.3.090>

Popovici, P. C., Ancuceanu, V. R., Olaru, T. O., Stoicescu, C.-S., & Dinu, M. (2018). Toxicity Assessment of *Nephrolepis exaltata* (L.) Schott, Fam. Nephrolepidaceae. *Acta Biologica Marisiensis*, 1(1), 27–36. <https://doi.org/10.2478/abmj-2018-0004>

Rai, S. K., Sharma, R., Kumari, A., Rasmussen, L. H., Patil, R. D., & Bhar, R. (2017). Survey of ferns and clinico-pathological studies on the field cases of Enzootic bovine haematuria in Himachal Pradesh, a north-western Himalayan state of India. *Toxicon*, 138, 31–36. <https://doi.org/10.1016/j.toxicon.2017.08.010>

Ravi, B. X., Varuvel, G. V. A., kilimas, R., & Robert, J. (2015). Apogamous sporophyte development through spore reproduction of a South Asia's critically endangered fern: *Pteris tripartita* Sw. *Asian Pacific Journal of Reproduction*, 4(2), 135–139. [https://doi.org/10.1016/S2305-0500\(15\)30010-5](https://doi.org/10.1016/S2305-0500(15)30010-5)

Reginaldo, F. P. S., Bueno, P. C. P., De, I. C. C., De, A. R., Fett-Neto, A. G., Cavaleiro, A. J., & Giordani, R. B. (2021). Molecular Networking Discloses the Chemical Diversity of Flavonoids and Selaginellins in *Selaginella convoluta*. *Planta Medica*, 87(1–2), 113–123. <https://doi.org/10.1055/a-1315-0666>

Renjana, E., Nikmatullah, M., Rifqi Firdiana, E., Wige Ningrum, L., & H. Angio, M. (2021). The Potential of *Nephrolepis* spp. as Medicinal Plant, A Collection of Purwodadi Botanical Garden, Based on Ethnomedicine and Phytochemical Studies. *Buletin Plasma Nutfah*, 27(1), 1–10. <https://doi.org/10.21082/blpn.v27n1.2021.p1-10>

Rindita, Anggia, V., Rahmaesa, E., Devi, R. K., & Alawiyah, L. F. (2020). Exploration, phenolic content determination, and antioxidant activity of dominant pteridophytes in gunung malang village, mount halimun salak national park, Indonesia. *Biodiversitas*, 21(8), 3676–3682. <https://doi.org/10.13057/biodiv/d210834>

Roy, S., & Chaudhuri, T. K. (2020). A comprehensive review on the pharmacological properties of *Diplazium esculentum*, an edible fern. *Pharmaceutics and Pharmacology Research*, 3(1), 1–9. <https://doi.org/10.31579/2693-7247/014>

Roy, S., Hazra, B., Mandal, N., & Chaudhuri, T. K. (2013). Assessment of the antioxidant and free radical scavenging activities of methanolic extract of *diplazium esculentum*. *International Journal of Food Properties*, 16(6), 1351–1370. <https://doi.org/10.1080/10942912.2011.587382>

- Sajeev, S., Pavithraraj, DB, A., & Hegde, S. (2015). Phytoconstituents of *Nephrolepis hirsutula* and *Ptygogramma calomelanos*, two medicinal ferns of the Western Ghats. *Indian Fern Journal*, 32, 244–256.
- Semwal, P., Painuli, S., Painuli, K. M., Antika, G., Tumer, T. B., Thapliyal, A., Setzer, W. N., Martorell, M., Alshehri, M. M., Taheri, Y., Daştan, S. D., Ayatollahi, S. A., Petkoska, A. T., Sharifi-Rad, J., & Cho, W. C. (2021). *Diplazium esculentum* (Retz.) Sw.: Ethnomedicinal, Phytochemical, and Pharmacological Overview of the Himalayan Ferns. *Oxidative Medicine and Cellular Longevity*, 2021(1917890), 1–15. <https://doi.org/10.1155/2021/1917890>
- Setyawan, A. D. (2009). Traditionally utilization of Selaginella: field research and literature review. *Nusantara Bioscience*, 1(3), 146–158. <https://doi.org/10.13057/nusbiosci/n010307>
- Silalahi, M. (2014). *Bahan Ajar Taksonomi Tumbuhan Rendah* (1st ed.). Universitas Kristen Indonesia.
- Silalahi, M., Supriatna, J., Walujo, E. B., & Nisyawati. (2015). Local knowledge of medicinal plants in sub-ethnic Batak Simalungun of North Sumatra, Indonesia. *Biodiversitas*, 16(1), 44–54. <https://doi.org/10.13057/biodiv/d160106>
- Sirichai, P., Kittibunchakul, S., Thangsiri, S., On-Nom, N., Chupeerach, C., Temviriyankul, P., Inthachai, W., Nuchuchua, O., Aursalong, A., Sahasakul, Y., Charoenkiatkul, S., & Suttisansanee, U. (2022). Impact of Drying Processes on Phenolics and In Vitro Health-Related Activities of Indigenous Plants in Thailand. *Plants*, 11(294), 1–19. <https://doi.org/10.3390/plants11030294>
- Srithi, K., Balslev, H., Wangpakapattanawong, P., Srisanga, P., & Trisonthi, C. (2009). Medicinal plant knowledge and its erosion among the Mien (Yao) in northern Thailand. *Journal of Ethnopharmacology*, 123(2), 335–342. <https://doi.org/10.1016/j.jep.2009.02.035>
- Supiandi, M. I., Mahanal, S., Zubaidah, S., Julung, H., & Ege, B. (2019). Ethnobotany of traditional medicinal plants used by dayak desa community in sintang, West Kalimantan, Indonesia. *Biodiversitas*, 20(5), 1264–1270. <https://doi.org/10.13057/biodiv/d200516>
- Suryana, Iskandar, J., Parikesit, & Partasasmita, R. (2018). Ethnobotany of tree ferns in pasir menyan hamlet, Sukamandi village, Subang, West Java, Indonesia. *Biodiversitas*, 19(6), 2044–2051. <https://doi.org/10.13057/biodiv/d190609>
- Taheri, Y., Sharifi-Rad, J., Antika, G., Yilmaz, Y. B., Tumer, T. B., Abuhamdah, S., Chandra, S., Saklani, S., Kılıç, C. S., Sestito, S., Daştan, S. D., Kumar, M., Alshehri, M. M., Rapposelli, S., Cruz-Martins, N., & Cho, W. C. (2021). Paving Luteolin Therapeutic Potentialities and Agro-Food-Pharma Applications: Emphasis on In Vivo Pharmacological Effects and Bioavailability Traits. *Oxidative Medicine and Cellular Longevity*, 2021, 1–20. <https://doi.org/10.1155/2021/1987588>
- Taslim, E., Ramadanil, & Sulaeman, S. M. (2019). Inventory of Terrestrial Ferns (Pteridophyta) on the Nokilalaki Hiking Trail in Lore Lindu National Park Area. *Biocolebes*, 13(2), 155–161. <https://doi.org/10.22487/25411969.2020.v9.i2.15017>
- Thomas, A., & Bindu, P. K. (2021). Assessment of nutritional relevance of *Diplazium esculentum* by qualitative phytochemical and overall protein profiling. *Plant Archives*, 21(2), 137–142. <https://doi.org/10.51470/plantarchives.2021.v21.no2.023>
- Tongco, J. V. V., Villaber, R. A. P., Aguda, R. M., & Razal, R. A. (2014). Nutritional and phytochemical screening, And total phenolic and flavonoid content of *Diplazium esculentum* (Retz.) Sw. from Philippines. *Journal of Chemical and Pharmaceutical Research*, 6(8), 238–242. <https://www.jocpr.com/articles/nutritional-and-phytochemical-screening-and-total-phenolic-and-flavonoid-content-of-diplazium-esculentum-retz-sw-from-ph.pdf>

- Tungmunnithum, D., Thongboonyou, A., Pholboon, A., & Yangsabai, A. (2018). Flavonoids and Other Phenolic Compounds from Medicinal Plants for Pharmaceutical and Medical Aspects: An Overview. *Medicines*, 5(3), 93. <https://doi.org/10.3390/medicines5030093>
- Vashistha, N., & Tejasvi, A. (2021). *Selaginella bryopteris* (L.): A Wonder Herb. *Plant Archives*, 21(1), 701–706. <https://doi.org/10.51470/PLANTARCHIVES.2021.v21.no1.097>
- Wang, T., Xiao, B., Liu, E.-D., Nguyen, K. S., Duan, J.-Q., Wang, K.-L., Yan, Y.-H., & Xiang, J.-Y. (2020). Rediscovery of *Angiopteris tonkinensis* (Marattiaceae) after 100 years, and its revision. *PhytoKeys*, 161, 1–9. <https://doi.org/10.3897/phytokeys.161.54912>
- Wardani, W. (2018). Study on production potential of adventitious root of the scaly tree fern *Cyathea contaminans* in West Java and North Sumatra. *Jurnal Ilmu-Ilmu Hayati*, 17(3). <https://doi.org/10.14203/beritabiologi.v17i3.3366>
- Warseno, T. (2015). Ex-situ conservation of some rare and critical plants species using in-vitro method in the Bali Botanic Garden. *Masyarakat Biodiversitas Indonesia.*, 1(5), 1075–1082. <https://doi.org/10.13057/psnmbi/m010518>
- Wu, D., Li, L., Ma, X., Huang, G., & Yang, C. (2020). Morphological and anatomical adaptations to dry, shady environments in *Adiantum reniforme* var. *sinense* (Pteridaceae). *PeerJ*, 8, 1–15. <https://doi.org/10.7717/peerj.9937>
- Xie, Y.-Z., Peng, C.-W., Su, Z.-Q., Huang, H.-T., Liu, X.-H., Zhan, S.-F., & Huang, X.-F. (2022). A Practical Strategy for Exploring the Pharmacological Mechanism of Luteolin Against COVID-19/Asthma Comorbidity: Findings of System Pharmacology and Bioinformatics Analysis. *Frontiers in Immunology*, 12. <https://doi.org/10.3389/fimmu.2021.769011>
- Xu, Y. M., Mafezoli, J., Oliveira, M. C. F., U'Ren, J. M., Arnold, A. E., & Gunatilaka, A. A. L. (2015). Anteaglonialides A-F and Palmarumycins CE1-CE3 from *Anteaglonium* sp. FL0768, a Fungal Endophyte of the Spikemoss *Selaginella arenicola*. *Journal of Natural Products*, 78(11), 2738–2747. <https://doi.org/10.1021/acs.jnatprod.5b00717>
- Yudianto, S. A. (1992). *Pengantar cryptogamae (sistematik tumbuhan rendah)* (2nd ed.). Tarsito.
- Yu, M., Gouvinhas, I., Rocha, J., & Barros, A. I. R. N. A. (2021). Phytochemical and antioxidant analysis of medicinal and food plants towards bioactive food and pharmaceutical resources. *Scientific Reports*, 11(1), 10041. <https://doi.org/10.1038/s41598-021-89437-4>
- Zannah, F., Amin, M., Suwono, H., & Lukiaty, B. (2017). Phytochemical screening of *Diplazium esculentum* as medicinal plant from Central Kalimantan, Indonesia. *AIP Conference Proceedings*, 1844(050001), 1–4. <https://doi.org/10.1063/1.4983439>
- Zeng, W. W., & Lai, L. S. (2019a). Anti-melanization effects and inhibitory kinetics of tyrosinase of bird's nest fern (*Asplenium australasicum*) frond extracts on melanoma and human skin. *Journal of Bioscience and Bioengineering*, 127(6), 738–743. <https://doi.org/10.1016/j.jbiosc.2018.11.005>
- Zeng, W. W., & Lai, L. S. (2019b). Multiple-physiological benefits of bird's nest fern (*Asplenium australasicum*) frond extract for dermatological applications. *Natural Product Research*, 33(5), 736–741. <https://doi.org/10.1080/14786419.2017.1405400>
- Zihad, S. M. N. K., Gupt, Y., Uddin, S. J., Islam, M. T., Alam, M. R., Aziz, S., Hossain, M., Shilpi, J. A., Nahar, L., & Sarker, S. D. (2019). Nutritional value, micronutrient and antioxidant capacity of some green leafy vegetables commonly used by southern coastal people of Bangladesh. *Heliyon*, 5(11), e02768. <https://doi.org/10.1016/j.heliyon.2019.e02768>

Tables

Table 1. Data collection on Pteridophyta species at Cyathea Park

Species	Family	Sample code	Habitus	Fig.
<i>Cyathea contaminans</i> (Wall ex Hook) Copel	Cyatheaceae	XI.E.01	Terrestrial	Fig. 1A
<i>Asplenium nidus</i> L.	Aspleniaceae	XI.E.02	Terrestrial and epiphytic,	Fig. 1B
<i>Asplenium</i> sp.	Polypodiaceae	XI.E.03	Terrestrial	Fig. 1C
<i>Selaginella</i> sp.	<i>Selaginellales</i>	XI.E.04	Xerophytes and epiphytes	Fig. 1D
<i>Diplazium esculentum</i>	Athyriaceae	XI.E.05	Terrestrial	Fig. 1E
<i>Angiopteris evecta</i> (G.Forst.) Hoffm.	Martiaceae	XI.E.06	Terrestrial	Fig. 1F
<i>Cyathea</i> sp.	Cyatheaceae	XI.E.07	Terrestrial	Fig. 1G
<i>Nephrolepis hirsutula</i> (Forst) C. Presl	Davalliaceae	XI.E.08	Terrestrial and Epiphytic,	Fig. 1H
<i>Dicksonia blumei</i> (Kunze) Moore	Cyatheaceae	XI.E.09	Epiphytes and hydrophytes	Fig. 1I

Table 2. Ethnopharmacology of Pteridophyta species collected in Cyathea Park, Bali

Species	Traditional medicine agents	Parts used	How to use	Chemical content	Other uses	Reference
<i>Cyathea contaminans</i> (Wall. ex Hook) Copel	Antimicrobials (<i>B. subtilis</i> , <i>S. aureus</i> , <i>E. coli</i> , <i>P. aeruginosa</i> , <i>C. albicans</i>) Antifungal Antiinflammatory Antioxidant Anti-seizure Cold medicine Hypocholesterolemia	Leaf Young Leaves (Shoots) Trunk Seed Stem hair Root	◦ Taped to the affected area ◦ Boiled by consuming boiled starch juice, ◦ Pounded and affixed to the wound/swelling ◦ Simple maceration	◦ Saponins ◦ Alkaloids ◦ Flavonoid ◦ Tannins ◦ Anthraquinones	◦ Ornamental plants ◦ Media planting ◦ Handcrafts ◦ Vegetables, ◦ Traditional game ◦ Carbon filters and ceramic materials ◦ Orchid support	(Ahmad Faizal et al., 2020; Amoroso et al., 2014; Ciawi et al., 2022; Gultoma et al., 2015; Mustacisa-Lacaba et al., 2021; Suryana et al., 2018; Wardani, 2018)
<i>Asplenium nidus</i> L.	◦ Fever Reliever ◦ Overcoming dandruff ◦ It relieves open wounds. ◦ Post-Delivery Tonic ◦ Analgesic ◦ Treating ulcers ◦ Antibiotics ◦ Antimicrobial ◦ Immunostimulator ◦ Depurative and sedative	◦ Leaf ◦ Leaf shoots Trunk	◦ Ground, smoothed, affixed, used on the head area ◦ Ground and pasted on the ulcer area ◦ Taped to the area experiencing swelling ◦ Boiled and consumed starch juice two times a day	◦ Saponins ◦ Alkaloids ◦ Flavonoids ◦ Tannins ◦ Polyphenols ◦ Kaempferol ◦ Quercetin	◦ Stimulate spore growth	(Amoroso et al., 2014; Faral et al., 2019; Heo et al., 2021; Lai et al., 2009; Mannan et al., 2008; Nikmatullah et al., 2020; Ravi et al., 2015; Zeng & Lai, 2019b)

<i>Asplenium</i> sp.	◦ Fever reliever ◦ Burns Medicine ◦ Skin disease ◦ Melanoma ◦ antikemotactic ◦ Antioxidant ◦ Monoamine oxidase inhibitor	◦ Leaf ◦ Root	◦ Pounded and affixed to wounds, fever sufferers, and areas of the skin	◦ Flavonoids ◦ Tannins ◦ Polyphenols ◦ Luteolin glycosides ◦ kaempferol ◦ glucopyranosyl caffeic acid	◦ Ornamental Plants ◦ Planting media	(Andrade et al., 2014; Atho et al., 2020; Ekici & Sisman, 2020; Zeng & Lai, 2019a)
<i>Selaginella</i> sp.	◦ Antidiabetic ◦ Antiinflammatory ◦ Antivirus ◦ Antimutagenic, ◦ Anti-nosyeptif ◦ Antispasmodic, ◦ Anti-cancer ◦ Anti-Alzheimer's ◦ Anti-parasite	◦ Leaf ◦ Trunk	◦ Ground, boil and drink water starch juice regularly	◦ Flavonoids ◦ Alkaloids ◦ Lignans ◦ Tannins ◦ Saponins ◦ Pigments ◦ Terpenoids ◦ Phenylpropanoids ◦ Steroids ◦ Quinoids ◦ Coumarins ◦ Biapigenin	◦ Ornamental plants	(Adnan et al., 2021; Menezes & Diederich, 2021; Rindita et al., 2020; Setyawan, 2009; Vashistha & Tejasvi, 2021; Xu et al., 2015)
<i>Diplazium esculentum</i>	◦ Respiratory diseases ◦ Cough ◦ Urinary tract infection (UTI) ◦ Gonorrhea	◦ Leaf ◦ Young Shoots ◦ Root ◦ Stem	◦ Ground, boil and drink water starch juice regularly three times a day	◦ Flavonoids ◦ Polyphenols ◦ Alkaloids ◦ Terpenoid ◦ Saponins	◦ Vegetable ◦ Ornamental plants	(Balangcod & Balangcod, 2018; Halimatussakdiah et al., 2020, 2018; Nikmatullah et al., 2020; Roy et al., 2013; Roy & Chaudhuri, 2020; Semwal et al., 2021; Sirichai et al., 2022; Thomas

	◦ Topical dermatitis ◦ Head pain ◦ Body odor ◦ Antibacterial ◦ Antifungal ◦ Immunomodulator ◦ Antioxidant ◦ Anti-inflammatory ◦ Larvicides and insecticides ◦ Antidiabetic ◦ Overcoming hematuria and dyspepsia	◦ Dried leaves and stems are burned and used as a mosquito repellent, which results from burning as a larvacide. ◦ Ground and taped to the skin that has swelling	◦ Phytosterols ◦ Leucoanthocyanins ◦ Glycosides ◦ Diterpenes ◦ Triterpenes	& Bindu, 2021; Tongco et al., 2014; Zannah et al., 2017; Zuhri et al., 2016)		
<i>Angiopteris evecta</i> (G.Forst.) Hoffm	◦ Anti-bacterial (<i>Bacillus subtilis</i>) ◦ Anti-HIV agents	◦ Leaf ◦ Leaf shoots	◦ Ground, boiled and drink water starch juice regularly	◦ Alkaloids ◦ Phenol ◦ Flavonoids ◦ Tannins ◦ Saponins ◦ Triterpene ◦ Steroids	◦ Ornamental Plants	(Rindita et al., 2020; Wang et al., 2020)
<i>Cyathea</i> sp.	◦ Antiretroviral ◦ Fever reliever ◦ Stab Wound Reliever	◦ Leaf ◦ Leaf shoots	◦ Ground, and taped to the head and legs	◦ β-naphthoflavone ◦ Phenol ◦ kaempferol ◦ Flavonoids	N/A	(Larson et al., 2014; Silalahi et al., 2015)
<i>Nephrolepis hirsutula</i> (Forst)					N/A	(El-Tantawy et al., 2016;

C. Presl	◦ Treating diarrhea ◦ Smoothing Breast Milk ◦ antimicrobial ◦ Anti-inflammation ◦ Antivirus ◦ Anticancer ◦ Healers of sores, coughs, and ulcers	◦ Leaf shoots	◦ Ground, boiled and drink water starch juice regularly ◦ Ground and taped to the area of the wound/ulcer	◦ Eugenol ◦ β-Ionone ◦ Thymol ◦ Anethole ◦ Cinnamaldehyde ◦ Methyl palmitate	Popovici et al., 2018; Renjana et al., 2021; Rindita et al., 2020; Sajeev et al., 2015)	
<i>Dicksonia blumei</i> (Kunze) Moore	◦ Fever reliever ◦ Antibacterial ◦ Analgesic	◦ Leaf shoots ◦ Trunk	◦ Pounded, boiled, and drink regularly	◦ Flavonoids ◦ Tannins ◦ Saponins	◦ Planting Media ◦ Ornamental Plants ◦ Craft	(LIPI, 2022; Muhyi et al., 2020; Suryana et al., 2018)

Figures

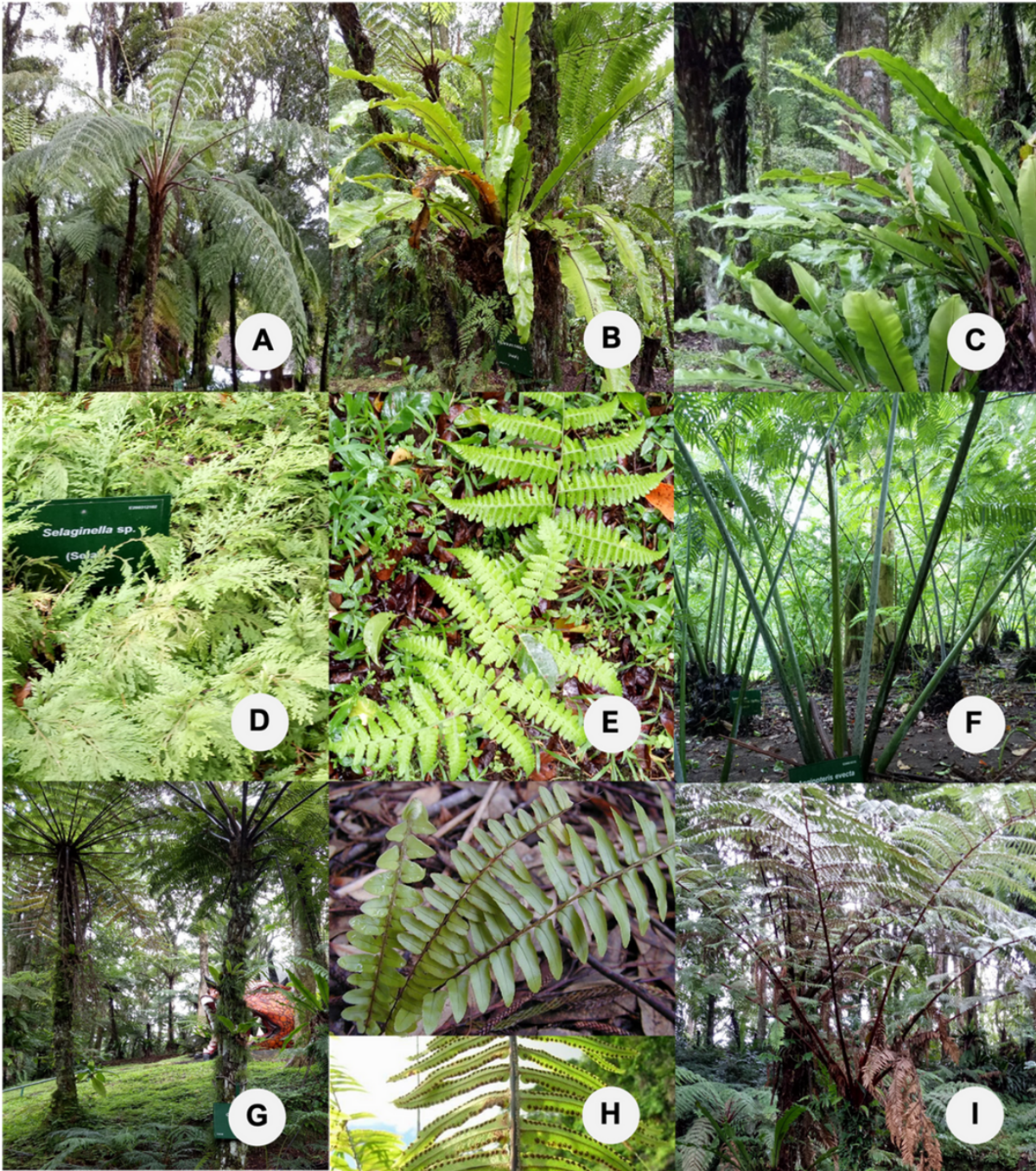


Figure 1

Pteridophyta species collection Cyathea Park, Eka Karya Botanical Garden. Information: (a) *Cyathea contaminans* (Wall ex Hook) Copel, (b) *Asplenium nidus* L., (c) *Asplenium* sp., (d) *Selaginella* sp., (e) *Diplazium esculentum*, (f) *Angiopteris evecta* (G.Forst.) Hoffm, (g) *Cyathea* sp., (h) *Nephrolepis hirsutula* (Forst) C. Presl, (i) *Dicksonia blumei* (Kunze) Moore.