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Pharmacological Activities of Extracts and Isolated Phytochemical Constituents of Pandanus Odorifer (Forssk.) Kuntze

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ABSTRACT

Pandanus odorifer (Forssk.) Kuntze belongs to the Pandanaceae family. P. odorifer is used in traditional medicines to treat diabetes, jaundice, skin diseases, brain disorders, and urinary tract illnesses. This work aims to present a comprehensive review to analyze, summarize, and document the reported pharmacological activities of this plant species. Compounds such as eugenol, capric acid, germacrene B, camphor, and linalool have been discovered in this plant species. The major electronic databases (Web of Science, PubMed, ScienceDirect, and Scopus) were applied to identify the relevant published studies from 1900 to June 2021. In vitro and in vivo level of scientific evidence of pharmacological activities of various extracts and active compounds of this plant species is available at the moment. Pharmacological investigations show that P. odorifer possesses such as antioxidant, chemoprotective, antidepressant, antidiabetic, anti-inflammatory, and hepatoprotective activities. This work provides a basis for further pharmacological and phytochemical researches using P. odorifer.

Keywords: Pandanaceae, Pandanus odorifer, Pharmacological activities, Siddha Medicine, Sri Lanka

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INTRODUCTION

Pandanus odorifer (Forssk.) Kuntze [synonym: *Pandanus odoratissimus* L.f.] is a small tree that belongs to the *Pandanaceae* family. It is called (Thaalai) in Tamil. This plant species usually grows on sandy coasts and it is distributed in Sri Lanka, India, China, Myanmar, Cambodia, Thailand, Vietnam, Malaysia, Laos, Philippines, and Indonesia. [1,2]

Figure 1. A *Pandanus odorifer* (Forssk.) Kuntze tree (Source: Kew Science, 2021)

P. odorifer is used to prepare food, medicine, essential oil, fragrance, ornaments, and weaving materials.[1-3] Its leaves and fruits are used to flavor the foods.[1,4]

P. odorifer is used to treat various diseases in traditional medicines like Siddha Medicine and Ayurveda in Sri Lanka, Taiwan, and India. The traditional medicinal uses including part used, disorder treated, traditional medicine, country, and reference are presented in Table 1. Flower of this plant species is used to treat diseases such as diabetes, skin diseases, asthma, urinary tract illnesses, and syphilis in Siddha Medicine and Ayurveda in Sri Lanka and India.[5-14] Whereas its leaf is utilized to treat including heart diseases, leprosy, tumor, brain diseases, and smallpox in Ayurveda in India.[9,14] Furthermore, *P. odorifer* root is used to treat constipation, urinary tract illnesses, diabetes, fever, and thyroid disorders in Ayurveda in India.[5,7] The flower has more traditional medicinal uses than the other parts like root, tender leaf, and leaf.

Table 1. Traditional Medicinal Uses of *P. odorifer*

Part used	Disorder treated	Traditional medicine	Country	Reference
Flower	Syphilis, tumor, skin diseases, leukoderma, leprosy, generating perspiration, earache, bronchitis, blood diseases, asthma, urinary tract illnesses, headache, rheumatism, constipation, diabetes	Siddha Medicine, Ayurveda	Sri Lanka, India	5 - 14
Leaf	Brain diseases, heart diseases, leukoderma, scabies, skin diseases, smallpox, tumor, leprosy, syphilis, headache, rheumatism	Ayurveda	Sri Lanka, India	9, 14, 15
NS	Backache	Ayurveda	India	5, 7
Root	Constipation, urinary tract illnesses, diabetes, syphilis, fever, thyroid disorders	Ayurveda	India, Taiwan	5-7, 16, 17

Abbreviations NS: Not stated.

Several natural compounds have been identified in flower and root parts of *P. odorifer*. Compounds such as eugenol, capric acid, germacrene B, camphor, dodecane, geranial, and linalool have been discovered in the flowers.[9,18] Moreover, compounds including pinoresinol, kobusin, eudesmin, epipinoresinol, and vanillin have been found in the roots of this plant species.[17] On the other hand, vanillin has been identified in both flowers and roots of *P. odorifer*. [9, 17, 18] So far, only two parts of this plant species have been

investigated to identify the compounds present in them. Anyhow, leaves, flowers, and root are used in traditional medicine to treat various illnesses (see Table 1). Thus, it is recommended that to study the chemistry of various extracts of these parts to identify the compounds which might be novel and might have several pharmacological activities.[19]

As stated above, *P. odorifer* is used to cure several ailments in traditional medicines. However, there are only a few scientific pieces of evidence currently available for its traditional medicinal uses. So far, there is no comprehensive review available to analyze, summarize, and document the reported pharmacological activities of this plant species. Therefore, the aim of this work to present a comprehensive review to provide a basis to conduct more phytochemical and pharmacological investigations using *P. odorifer* in the future.

MATERIALS AND METHODS

The major electronic databases (Web of Science, PubMed, ScienceDirect, and Scopus) were applied to identify the relevant published studies of *P. odorifer* from 1900 to June 2021. "*Pandanus odorifer"* and "*Pandanus odoratissimus"* were utilized as search terms in this work. Only researches related to pharmacological activities of this plant species were taken in account in this work.

RESULTS AND DISCUSSION

Pharmacological Activities of *P. odorifer*

So far, *in vitro* and *in vivo* level of scientific evidence of pharmacological activities of various extracts and active compounds of this plant species is available. More information like level of scientific evidence, pharmacological activity, part used, extract/compound, bioassay/model, dose/concentration, duration, and reference are presented in Table 2. Pharmacological investigations show that *P. odorifer* possesses activities such as the antioxidant, chemoprotective, antidepressant, antidiabetic, anti-inflammatory, and hepatoprotective.[17,20-26] More studies have been carried out to investigate the antioxidant activity of this plant species and the majority of studies have been conducted in *in vivo* models. Also, methanol extract is explored in more pharmacological activities such as antioxidant, antidepressant, anti-inflammatory, and hepatoprotective activities. To date, plant parts namely root, flower, and leaf have exhibited various pharmacological activities. Remarkably, all these parts are used to treat various disorders in traditional medicines too. Hence, all the parts used in traditional medicines have demonstrated a pharmacological activity. Traditional medicinal uses including rheumatism, diabetes, brain diseases, and jaundice have been validated by revealing by reported antidiabetic, anti-inflammatory, antidepressant, and hepatoprotective activities.[21,23-26] Still, there is no scientific evidence available for treating such as skin diseases, urinary tract illnesses, asthma, and tumors in traditional medicines. Hence, it is worth studying these pharmacological activities for creating more scientific evidence for the traditional medicinal uses. Only reported pharmacological activities which have the highest level of scientific evidence at the moment and used the lowest dose or concentration are discussed below.

In Vivo Pharmacological Activities

Antidepressant Activity

Raju et al. (2011) investigated the antidepressant potential of methanol leaf extract, and the extract at the concentration of 50 mg/kg was administered to mice for 30 minutes period. The results revealed that the extract has exhibited potential antidepressant activity.[23]

Antidiabetic Activity

An ethanolic extract from the root was orally administered to an alloxan-induced diabetic rat at the concentration of 150 mg/kg to investigate antidiabetic activity for ten days continuously and the extract unveiled a significant reduction in blood glucose levels.[21]

Antiinflammatory Activity

An extract prepared using methanol was applied on Carrageenan-induced acute paw edema in rat for three hours. The extract (100 mg/kg) inhibited the inflammation and the authors have not mentioned the part used to prepare the extract.[24]

Hepatoprotective Activity

El-Shaibany et al. (2016) studied the hepatoprotective potential of flower extract prepared using methanol. The extract at the concentration of 500 mg/kg was administered to an acetaminophen-induced hepatotoxic guinea pig for ten days. The results revealed that the extract unveiled a significant hepatoprotective activity at the stated dose.[25]

In Vitro Pharmacological Activities

Antioxidant Activity

An extract of root prepared using ethanol was investigated to study the antioxidant activity using lipid peroxidation inhibitory potential assay. The extract exhibited a significant antioxidant effect at IC_{50} of 8 µg/ml.[21]

Chemoprotective Activity

Kaewklom and Vejaratpimol (2011) investigated the chemoprotective activity of flower extract (0.015 mg/ml) using human keratinocyte stem cell lines. The authors discovered that the extract has a significant chemoprotective activity against stem cell lines. In this study, the authors did not state the solvent used to prepare the extract.[22]

Toxicity Studies

There are a few toxicity investigations have been carried out for the safety and efficacy purposes of *P. odorifer* extracts. More details such as part used, extract, model, dose, duration, and reference are listed in Table 3. Root ethanol extract (3000 mg/kg) was orally administered to rats for 7 days showed no adverse effects or mortality.[26] Furthermore, another study carried out by Raju et al. (2011) states that leaf methanol extract (2000 mg/kg) orally administered to mice for 14 days is also safe and produced neither mortality nor adverse effects.[23] Thus, further *in vivo* studies should be conducted to have more scientific evidence to provide more information for safety and efficacy purposes.

Table 2. Reported Pharmacological Activities of P. Odorifer

Level of evidence	Pharmacological activity	Part used	Extract / compound	Bioassay / model	Dose / concentration	Duration	Reference
In vitro	Antioxidant	NS	Methanol	DPPH radical scavenging assay	NS	NA	20
In vitro	Antioxidant	Root	Ethanol (80%)	DPPH radical scavenging assay	10 µg/ml (IC_{50})	NA	21
In vitro	Antioxidant	Root	3,4-bis(4-hydroxy-3-methoxybenzyl) tetrahydrofuran	Ferric thiocyanate assay	NS	NA	17
In vitro	Antioxidant	Root	Pinoresinol	Ferric thiocyanate assay	NS	NA	17
In vitro	Antioxidant	NS	Methanol	Hydroxyl radical scavenging assay	NS	NA	20
In vitro	Antioxidant	Root	Ethanol (80%)	Lipid peroxidation inhibitory potential assay	8 µg/ml (IC_{50})	NA	21
In vitro	Antioxidant	NS	Methanol	Nitric oxide radical scavenging assay	NS	NA	20
In vitro	Antioxidant	NS	Methanol	Superoxide radical scavenging assay	NS	NA	20
In vitro	Chemoprotective	Flower	NS	Human keratinocyte stem cell	0.015 mg/ml	NA	20
In vivo	Antidepressant (Motor coordination)	Leaf	Methanol	Mouse	50 mg/kg	30 min	23
In vivo	Antidepressant (Sodium pentobarbital induced sleeping time)	Leaf	Methanol	Mouse	50 mg/kg	30 min	23
In vivo	Antidepressant (Spontaneous motor activity)	Leaf	Methanol	Mouse	50 mg/kg	120 min	23
In vivo	Antidiabetic	Root	Ethanol (80%)	Alloxan-induced diabetic rat	150 mg/kg	10 d	21
In vivo	Anti-inflammatory	NS	Methanol	Carrageenan-induced acute paw edema rat	100 mg/kg	3 h	24
In vivo	Anti-inflammatory	NS	Methanol	Formalin-induced chronic paw edema rat	100 mg/kg	3 h	24
In vivo	Hepatoprotective	Flower	Methanol (85%)	Acetaminophen-induced hepatotoxic guinea pig	500 mg/kg	10 d	25
In vivo	Hepatoprotective	Root	Ethanol	Paracetamol-induced hepatotoxic rat	200 mg/kg	7 d	26

Abbreviations: NS: Not Stated; NA: Not Applicable; IC_{50}: Half-maximal inhibitory concentration; DPPH: 2,2-diphenyl-1-picrylhydrazyl

Table 3. Reported Toxicity Studies of P. Odorifer

Part used	Extract	Model	Dose (mg/kg)	Duration	Reference
Leaf	Methanol	Mouse	2000	14 d	23
Root	Ethanol (80%)	Rat	3000	4 h	21
Root	Ethanol	Rat	3000	7 d	26

CONCLUSION AND RECOMMENDATIONS

This work evaluated, summarized, and documented the reported relevant pharmacological and phytochemical studies of *P. odorifer*. Several compounds have been discovered in *P. odorifer* fruit and root. Also, antioxidant compounds have been isolated from roots. *P. odorifer* has several traditional medicinal uses. However, there are only a few scientific pieces of evidence available for these claims. Therefore, it is advised that to conduct more *in vitro*, *in vivo*, and clinical pharmacological and phytochemical investigations for various parts of this plant species. This work provides a basis for further pharmacological and phytochemical researches of *P. odorifer.*

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