A Review on Pandanus Tectorius (Keya) and its Major Pharmacological Activites

By
Shamik Rehan
17146004

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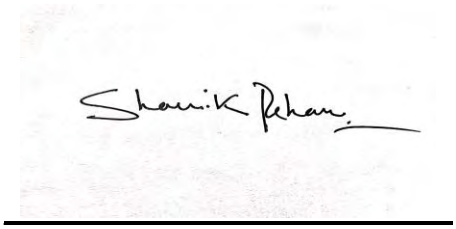

Shamik Rehan- 17146004

Approval

The project/thesis titled "A REVIEW ON *PANDANUS TECTORIUS* (Keya): and its Major Pharmacological Activities" submitted by Shamik Rehan(1716004) of Spring, 2022 has been recognized as acceptable in fulfilment of the requirements for the degree of Bachelor of Pharmacy(Hons.) on the basis of the work submitted on this date [Date-of-Defense].

Examining Committee:

Supervisor:
(Member)

_____
Dr.Farhana Alam Ripa
Assistant Professor, School of Pharmacy
Brac University

Program Coordinator:
(Member)

_____
Namara Mariam Chowdhury
Lecturer, School of Pharmacy
Brac University

Deputy Chair:
(Member)

_____
Hasina Yasmin,PhD
Professor and Deputy Chairperson,School of Pharmacy
Brac University

Dean:
(Chair)

_____
Eva Rahman Kabir,PhD
Professor and Dean, School of Pharmacy
Brac University

Ethics Statement

There are no trials on either humans or animals involved in this study.

Abstract

The value of medicinal plants as a source of treatment has been recognized since the dawn of mankind. This review research focused on the little tree Pandanus tectorius (*P. tectorius*), which is used in traditional medicine to cure a number of diseases.Other body and organ functions, such as renal function and lipid metabolism, may be affected by diabetes. Pandanus tectorius has promising pharmacological properties against diabetes mellitus, owing to its extraordinary behavior. This study discovered that this plant not only enhances biological function but also reduces the severity of many drugs' side effects.

Keywords: Pandanus Tectorius; anti-diabetic; pharmacological activites.

Dedication

I want to dedicate my work to all of God's exceptional and unique children who have the potential for artistic beauty!

Acknowledgement

Firstly, I want to express my gratitude to Almighty Allah for giving me traits like patience, courage, and confidence, all of which have been extremely helpful to me in completing this thesis.Next, I would like to acknowledge my parents for encouraging me to pursue my academic goals.My project is being supervised by Dr. Farhana Alam Ripa (Assistant Professor, School of Pharmacy, Brac University), and I am incredibly appreciative of all of her kind support, dedication, supervision, motivation, and constructive assistance.

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List of Acronyms

PT	*P.tectorius*
WHO	World Health Organization
CQAs	Caffeoylquinic Acids
AMP	Activated protein kinase
GLUT	Glucose transporter
AHPND	Acute Hepatopancreas Nercosis Disease
HSP	Heat shock protein
LDL	Low density lipoprotein
HDL	High density lipoprotein
HMGCR	Hydroxy methylglutory coenzyme
SGOT	Serum glutamic- oxaloacetic transminase
SGPT	Serum glutamic- pyruvic transminase
PTM	*P.tectorius* methanolic
PTA	*P.tectorius* aqueous
COX	Cyclooxygenase
DPPH	2,2 – diphenyl -1- picryhydrazyl
HCV	Hepatitis C virus
apoB100	Apolipoprotein B100
SARS	Severe acute respiratory syndrome

Chapter 1

Introduction

1.1 Medicinal Plants

Recuperating with the assistance of healing plants is practically pretty much as old as humanity itself. The connection among man and his experiences into nature for restorative purposes dates from the earliest past, and there is adequate proof of this from different sources, including delivered reports, recorded achievements, and inconceivably huge plant cures. Utilizing strong plants happened because of man's disclosure of powerful methods for searching for meds in the barks, seeds, common thing bodies, and different pieces of the plants during different significant times of the battle against sicknesses. Present day science has seen their fast advancement and associated a few plant-determined meds that are many times utilized in old city establishments with current pharmacotherapy. The information about the movement of issues connected with the utilization of accommodative plants, tantamount to the headway of care, has pressed clinical experts and specialists to resolve the issues that have emerged with the development of expert relationship on the side of man's life (Petrovska, 2012).

A report of World Wellbeing Association indentifies that around 80 % of individuals relies upon standard medications. Alongside, at current circumstance several remedies owe their initiation to useful plants. Standard substances have since a shockingly lengthy timespan refilled in as wellsprings of strong medications, where drugs including salicylates, quinine, ergotamine and

digitalis can be implied as a few old models. The revelation of medications through traditional means incorporates a different way of thinking joining native, phytochemical, normal, and atomic technique. Moreover, the divulgence of supportive plant-based remedies stays a critical region that has been neglected up until now,where an arranged solicitation can produce essential data with respect to various drug targets.Unexpectedly, the potential advantages of spices have ignited easygoing maltreatment of the normal assets, a peculiarity that is being seen from one side of the planet to the other. This reduction in biodiversity is all around the result of the ascending in the general individuals, expedient and now and again spur of the moment industrialization, irregular deforestation, overexploitation of typical assets, contamination, at last by and large natural change. Consequently, of most ridiculous significance plant biodiversity is gotten, to give future essential combination and lead compounds for the valuable improvement of human progression running wildThis turns out to be much more urgent for less created countries where composed bioprospecting related to non-disastrous commercialization could assist with guaranteeing biodiversity and ultimately gainful for human in the long haul. (Sen and Samanta, 2014).

1.2 Pandanus Tectorius

From West Africa to the Pacific, there is a group of plant and animal species known as the pandanaceae, which is only found in the subtropics and rainforests. More than 750 species of the monocot family Pandanaceae (screwpines) are widely dispersed throughout the Paleotropics. It has been proposed that the Gondwanan origin of the family, with its uninterrupted Paleotropical flow, is related to the division of that supercontinent. However, recently, fossils that supported that theory were transferred to different families, and fresh fossil discoveries support a different theory. The Pandanaceae dates as far back as feasible to the Late Cretaceous, and genera on

previous Gondwanan landmasses started to travel in the Late Eocene, a genuinely long time after endless the southern side of the equator focus regions moved somewhere new. The best subset of the family, the Pandanus tectorius species complex, originated in Eastern Queensland a very long time ago and has since spread to almost the entire family's area, from Africa to Polynesia. That gathering's global spread via hydrochory may be explained by a variety of features, such as anemophily, multi-created propagules, and agamospermy, which can aid in the improvement of new masses in distant locations (Gallaher et al., 2015).

Table 1: Taxonomy of family Pandanaceae (*ITIS - Report: Pandanaceae*, n.d.)

Kingdom	**Plantae**
Division	Tracheophyta
Class	Magnoiliopsida
Order	Pandanales
Family	Pandanaceae

The pandanus tree is otherwise called the screw pine which is quite possibly of the most fundamental and valuable tree in the Pacific region of the planet, coming.In expansion, they are associated with their supportive roots, astonishing blooms, and tremendously scrumptious regular items, and they are referenced in neighborhood folklore and legends. Notwithstanding the way that P. tectorius is unmistakable close to the beach front part and around the Pacific locale also. Also, it is as often as possible depicted as being seen somewhere else because of mentioned disturbance. Despite the fact that P. tectorius has been perceived to major areas of strength for have in the Hawaii district where it is found, reports of it from Asia are irrefutably misidentifications of other, comparatively related species. Troublesome sea shores are colonized

by Pandanus species. Pandanus species, especially P. tectorius, can attack and extend in waterfront plant networks, shaping thick timberlands that stretch over the Pacific. They are additionally popular for the a wide range of items and administrations they offer, including food from their copious products of the soil from their leaves. Considering that there are scarcely any occasions of splendid naturalization, P. tectorius is ensured to have a for the most part safeguarded likelihood of spreading past its nearby reach (Pandanus Tectorius (Screw Pine), n.d.- a).

Chapter 2

2.1 Plant Description and history

P. tectorius is a little tree that grows to a height of 14 m, or 18 m in more prepared areas, and has a shadow spread that is typically around the same size (other than in taller plants). The majority of substantial regions of strength for have been covered by broader plants with various flying and prop roots and thick, frequently prickly trunks, but trees with an undoubted bole of 4–8 m have also been present. Only under exceptional circumstances might the capacity compartment's expansiveness ever exceed 12 to 25 cm. The bark features lines of prickles and undulating leaf scars, and it can be smooth or flaky, grey or reddish brown.However there are contrasts between the toward the sea and leeward faces. P. tectorius has two sexual directions. Male plants are ordinarily more fanned, with up to 30 (generally outrageous 60) branches, stood out from female plants, which have up to 15 branches (most noteworthy 30). Blooms are conveyed at the tip of the shoot.Female blossoms resemble pineapples, whereas male blooms are fragrant, little, white, hanging, packed in racemes or spread out in gatherings, with big white magnificent bracts, and only last for about a day. Even though there are large variations in leaf size and shape both within and between trees, they are always spirally arranged in three sections and tightly packed at branch apices. The leaves are a pale green color, 1-3 m long, and 11–16 cm broad. They are M-shaped in cross section, and have short, 2.5 mm length spiky or prickly midribs and edges, with smooth edges on some varieties. The upper portion of the leaf hangs down and the midrib curves in fully grown leaves, giving plants their distinctive hanging appearance (Pandanus Tectorius (Screw Pine), n.d.- a).

Figure 1 : *P.tectorius* (*Pandanus Tectorius : Beach Pandan | Atlas of Living Australia*, n.d.)

The Paleotropics are home to more than 750 different species of the monocot family Pandanaceae, also known as screwpine plants. According to some theories, the family's origins occurred during the Gondwanan period, and the division of the supercontinent led to a careful Paleotropical spread. However, fresh fossil discoveries offer a different explanation, and the fossils that previously supported that theory have been transferred to different families.In this study, relationships between Pandanaceae genera were interpreted using nuclear and chloroplast sequencing. In order to assess whether the date of major intra-familial parentages and the split of Gondwana are connected, a chronogram was constructed using two meticulously preserved fossils. Long after several southern equator-side central regions had already started to divide, the Pandanaceae family first formed in the Late Cretaceous, and genera on former Gondwanan lands began to separate in the Late Eocene. A continuous dispersal that is controlled by a crucial distance vanishes is among the disclosures.The largest member of the family which is The Pandanus tectorius species is originated in Eastern Queensland in the distant past and has since expanded to nearly every region within the family's range, from Africa to Polynesia. It is

confirmed that hydrochoric dispersal and a confluence of elements, including agamospermy, anemophily, and multi-developed propagules, have aided in the growth of new masses in remote areas. (Gallaher et al., 2015)

2.2 Taxonomic Tree

Table 2: Taxonomy of P.tectorius(*ITIS - Report: Pandanus Tectorius*, n.d.)

Kingdom	**Plantae**
Subkingdom	Viridiplantae
Superdivision	Embryophyta
Division	Tracheophyta
Class	Magnoliopsida
Order	Pandanales
Family	Pandanaceae
Genus	Pandanus
Species	Pandanus tectorius

2.3 Morphology and anatomy

Characteristics of the leaves of *P.tectorius* are described below:

Figure 2: *P.tectorius* leaves(*NParks | Pandanus Tectorius*, n.d.)

The 1-3m (3.3-10ft) long by 11-16 cm (4.3-6.3 in) wide, spirally arranged leaves are gathered at the branch apices. V- to Y-shaped in section, with spiky midribs. Typically, marginal prickles are 0.8 to 2.5 mm (0.0 to 0.1) long. The upper third of fully formed leaves hangs downward and the midrib is twisted, giving pandanus plants their recognizable droopy appearance (Thomson et al., 2006a).

Characteristics of the flowers of *P.tectorius* are described below:

Figure 3: *P.tectorius* flower (Pandanus Tectorius - Hala, Tahitian Screwpine, Pu Hala, Screw Pine, Textile Screwpine, Thatch Screwpine, Pandanus, Pandan, Tourist Pineapple, Pineapple Tree - Hawaiian Plants and Tropical Flowers, n.d.)

At the tip of the shoot, heads of flowers are produced. The fragrant male flowers are small, white, pendant-shaped, and placed in branches with sizable, ornamental bracts. The inflorescence of male flowers only lasted for about a day before it started to rot. The female flowers resemble pineapples(Thomson et al., 2006a).

Characteristics of the fruits of *P.tectorius* are described below:

Figure 4: *P.tectorius* fruit riped(*File:Pandanus Tectorius Fruit (Riped).JPG - Wikimedia Commons*, n.d.)

Fruit heads can range in shape from ovoid to ellipsoid to subglobose to globose, with total measurements of 8 to 30 cm (3 to 12 in) long by 4 to 20 cm (1.6 to 8 in). The fruit's head is made up of several closely clustered, wedge-shaped, meaty drupes, commonly referred to as keys. Each phalange is long by wide and narrowly oblong to ovoid. The endocarp is 15–35 mm long, firm, and dark reddish-brown in color. The mesocarp is made up of the apical and basal parts. The apical mesocarp of each carpel is a long cavern containing an aerenchyma composed of a few longitudinal fibers and white membranes. The basal mesocarp measures 10–30 mm in length and is fleshy and fibrous.When a fruit is edible, this is the area that is chewed and consumed. When fully developed, the phalanges' basal part can range in hue from light yellow to dark yellow, orange, and orange or red (Thomson et al., 2006a).

Table 3 : Nutrient content of fruits(Englberger et al., 2006)

Water	80%

Protein	1.3g
Carbohydrate	17g
Dietary fiber	3.5g
Sodium	70mg
Magnesium	17mg
Potassium	236mg
Calcium	88mg
Carotene	60g
Vitamin A	5.0g
Vitamin C	5.2mg

2.4 Geographical distribution

Micronesia, Philippines, New Caledonia, the Solomon Islands, Vanuatu, French Polynesia, Papua New Guinea, some of Indonesia, Queensland in Australia, and Papua New Guinea are home to P. tectorius and embrace the likelihood that it is local to northern Australia and besides has a widely greater ordinary arrive at in the Pacific islands, including Hawaii. It is recorded as existing in all of shoreline Queensland, northern New South Grains, Expert Howe Island, and East Timor by the Leading group of Heads of Australasian Herbaria (2014). Regardless, perhaps later appearances make it trying to choose the specific furthest reaches of its extraordinary area(Pandanus Tectorius (Screw Pine), n.d.- b).Although P. tectorius is said to have been acquainted with Puerto Rico (USDA-NRCS, 2015), more data in regards to the species' exact personality is by all accounts required. P. tectorius was not referenced in Kairo et al(2003) .'s exhaustive exploration of obtrusive species in the Caribbean; the main Pandanus they referenced

was P. utilis in Bermuda. The San Juan Greenhouse in Puerto Rico has Pandanus species, but the exact species has not yet been affirmed by an expert considering late ordered changes. Leading more examination on P is vital. tectorius' status beyond its regular living space (Field Foundation in Tropical Brushland by Flying Herbicide and Cultivating Medicines on Kaunai., n.d).

Figure 5: Geographical distribution of *P.tectorius* (*Pandanus Tectorius Parkinson Ex Du Roi | Plants of the World Online | Kew Science*, n.d.)

This species' natural range extends from the Philippines to the Pacific. It is a tree that mainly inhabits the wet tropical environment (s). It can be used as food, medicine, and for both social and environmental purposes(Pandanus Tectorius Parkinson Ex Du Roi | Plants of the World Online | Kew Sciencce, n.d.).

Native to (Green) : Caroline Island, Cocos (Keeling) Island, Cook Island, Fiji, Gilbert Island,

Hawaii, Jawa, Lesser Sunda Island, Line Island, Maluku, Marianas, Marquesas, Marshall Is, New Caledonia, New Guinea, New South Wales, Niue, Philippines, Pitcairn Island, Queensland, Samoa, Santa Cruz Island, Society Island, Solomon Island, Tokelau-Manihiki, Tonga, Tuamotu(*Pandanus Tectorius Parkinson Ex Du Roi | Plants of the World Online | Kew Science*, n.d.).

Introduced into (Purple): Mexico Central, Mexico Gulf, Mexico Southeast, Phoenix Is., Puerto Rico, Seychelles, Thailand, Windward Is., Bangladesh, Andaman Is., Chagos Archipelago, Costa Rica, Laccadive Is(*Pandanus Tectorius Parkinson Ex Du Roi | Plants of the World Online | Kew Science*, n.d.).

2.5 Cultivation and micropropagation

P.tectorius, a plant native to lowland humid and subhumid tropical regions, is farmed at heights of up to 600 meters but is rarely seen above an elevation of 20 meters in the wild. It can be found in regions with mean annual temperatures of 24 to 28 °C, with the hottest month having a mean of 28 to 36 °C and the coldest month having a mean of 17 to 25 °C. Its native range's lowest temperature is 12°C, but according to one study, it may occasionally withstand temperatures as low as almost freezing. With no dry season or only a brief dry season lasting 2 to 3 months, the average annual rainfall ranges from 1,500 to 4,000 mm(Elevitch, 2007). Thrives in sunlight or light shade, and favors wet but well-drained soil in a sunny location. It is capable of growing in a surprisingly wide variety of light- to heavy-textured soil types, including brackish/saline soils, light-colored, infertile coralline atoll sands, alkaline sands, thin soils on top of limestone, and peaty swamps that thrive in sandy soils and performs well in rocky or very alkaline soil(*Trade Winds Fruit | Rare and Heirloom Seeds*, n.d.). Tolerant of pH levels between 6 and 10. Plants can withstand a lot of exposure to the sea, including buffeting from mild to strong tropical

storms. Established plants can endure 3 to 6 month droughts and continue to bear fruit. They can also withstand prolonged soil waterlogging. It can take 20 years for plants produced from seeds to attain sexual maturity. They go through a juvenile, semi-prostrate phase for the first 4 to 9 years, followed by 5 to 12 years of erect trunk growth before flowering starts. Plants can continue to produce for an additional 40 to 60 years or beyond(Elevitch, 2007).

The drupes should be soaked for five days in cool tap water, with daily water changes, to hasten germination. Dried fruit that is still viable will float, so keep them. As an alternative, cut off the drupe's fleshy portion, set it on the planting media, and bury it halfway. Keep the potting soil damp. About two months pass before germination. During the growth season, suckers. lateral shoot cuttings. Large cuttings can be used to propagate plants. Selected stems have aerial or prop roots, roughly two-thirds of the leaves are removed to lessen water loss, and the stems are rooted in sandy soil(*Useful Tropical Plants*, n.d.).

2.6 Botany and Uses

The geographic distribution of P. tectorius includes tropical northern Australia, Papua New Guinea, and the Pacific islands of Oceania, as well as the coastlines of South and Southeast Asia (Lim, 2012). P. tectorius is an essential organic product crop in Oceania, with populations in the Marshall Islands, Kiribati, Papua New Guinea, New Caledonia, Fiji, and the rest of Polynesia (Pacific Food sources, n.d.). People consume the meaty natural product keys of P. tectorius either raw or cooked into a variety of safe food variations all around the Pacific. Natural items change color from green to yellow to orange or orange-red as they mature. Pandanus natural products are produced when the green tops of the keys separate to reveal a vibrant orange tone and a notably delicious aroma.. The portion of the key that is chewed into and consumed is the stringy, meaty

basal mesocarp. In Micronesia, adults devour more than 20 new keys every day throughout the fruiting season. A fantastic and incredibly nice activity to do in between feasts is to bite on fresh keys (Thomson et al., 2006b).

Chapter 3

Active Constituents

Since the dawn of time, simple techniques have been used to harness the healing potential of substances originating from plants and animals without the need for the isolation of pure compounds. How a crude drug will act pharmacologically is determined by the composition of its constituent parts. The physiological effects of a wide variety of synthetic compounds, including alkaloids, terpenoids, flavonoids, glycosides, and phenolics, can therefore be attributed to specific plant species. Plants are a well-known source of optional metabolites with a variety of underlying plans and features as well as interesting natural activities, making them principally responsible for the most beneficial effects. Plants are still a major source of medicine today as they have been throughout human history. The odd composite edible fruits are made up of distinct parts known as "keys" that are attached to a fibrous core in Figure 6a (Fig. 6c). The word "bunch" is used to describe the entire composite fruit (including keys and the core). The interiors of the keys are chewed and licked for their delectable pulp (Andriani et al., 2019).

Figure 6: *P.Tectorius fruits (a), its keys (b) and core parts (c)(Pandanus Tectorius Fruits (a), Its Keys (b) and Core Parts (c).... | Download Scientific Diagram, n.d.)*

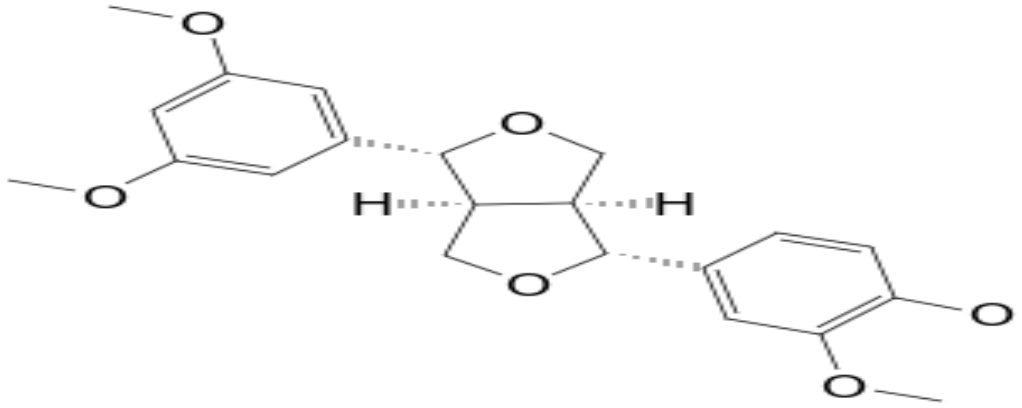
P. tectorius, especially its leaves, have long been recommended by Indian Ayurvedic medicine for the treatment of a variety of illnesses. The therapeutic properties of natural substances are directly influenced by their chemical composition. Pandanus oils have been used for centuries to treat a variety of ailments, including earaches, headaches, arthritis, giddiness, debility, rheumatism, small pox, and spams. Among the reviving creams discovered in the plant's leaves are ether (37.2%), terpene-4-old (18.6%), -terpineol (8.3%), 2-phenylethyl liquor (7.5%), benzyl benzoate (11%), viridine (8.8%), and germacrene (8.3%). Additionally, there are trace amounts of benzyl salicylate, benzyl acetic acid derivative, and benzyl liquor. Additionally, cavitation, hepatitis, illness, and dysuria are all treated using P. tectorius leaves. The abundant phenolic synthetic compounds discovered in the plant included alkaloids, flavonoids, saponins, phenols (vanillin, benzoic acid corrosive methyl ester, and an original benzofuran subordinate), terpenes (phytosteroid mix), eudesmin, kobusin, desmin, and hydrofuran. The organic P. tectorius product separation contains caffeoylquinic acids, vitamins C, E, and -carotene, as well as isopentenyl, dimethylallyl acetic acid derivatives, and cinnamates, all of which may be directly or indirectly related to the concentrate's natural efficacy (Andriani et al., 2019).

According to the writing, the most typical ingredients collected from the Pandanus family were alkaloids, terpenoids, natural aicds, and lignans. Only a few studies have focused on the compound structures of the products of the Pandanus family; the majority of studies have focused on the synthetic components generated from the leaves and roots. The 15 combinations from P. tectorius were strangely unrelated to one another and had never been found in other organic products from the Pandanus genus. Trans-ethyl acetic acid, which made up about 0.1% of the dry material, was the source of the most of these chemicals. Like P. tectorius fruits, the majority of these compounds contain anti-oxidant and some mitigating activities (Zhang et al., 2012a).The organic exercises of a few secluded compounds were recorded in Table.

Name of the Coumpounds	Activities reported
Vanillin	Inhibition of tryosinase(Wang et al., 2014); Anti-oxidant(Kamiloğlu et al., 2006)
Tangeretin	Cholesterol-lowering activity(Kurowska & Manthey, 2004); Anti-tumor(Lee et al., 2008)
Naringenin	Anti-viral(Tutunchi et al., 2020)
Chrysin	Aromatase inhibitor(van Meeuwen et al., 2008)
trans-ethyl caffeate	Anti-inflammatory(Chiang et al., 2005)

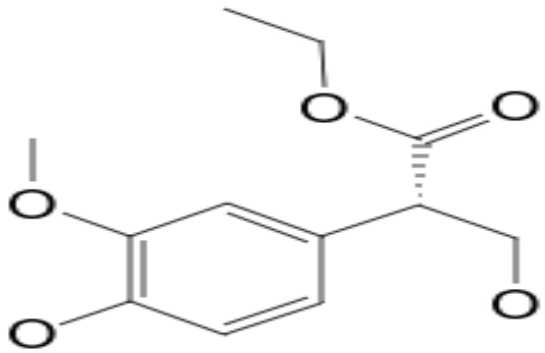
Table 4: Reported biological activites of some isolated compounds(Zhang et al., 2012a)

The findings showed that the phenolic content of P. tectorius organic products was high and that it was powerful as a cell-reinforcing and antibacterial specialist for both the keys and the center parts. Two new phenolic compounds, pandanusphenol A (1) and B (2), were separated from the organic byproducts of pandanus tectorius. Their designs, including entire setups, were chosen using a broad spectroscopic analysis that included 2D NMR experiments (1H-1H Comfortable, HMBC, and NOESY), HRESIMS findings, and Cd information. Rarely do typical furofuran lignans exhibit Pandanusphenol A's two methoxy bunches on the phenyl ring as a substituted example (1). (Zhang et al., 2013).



Mol Weight – 372.42g/mol	Molecular formula- C21H24O6

Figure 7: PANDANUSPHENOL-A(*PANDANUSPHENOL-A - SpectraBase*, n.d.)



Mol weight – 240.25g/mol	Molecular formula- C12H16O5

Figure 8: PANDANUSPHENOL-B(*PANDANUSPHENOL-B - SpectraBase*, n.d.)

Chapter 4

4.1 Antidiabetic activity

Because glucose is essential for human health due to its crucial role as an energy source and the fact that brain tissues cannot produce it, glucose homeostasis is important. In this way, maintaining healthy blood glucose levels is crucial for endurance. However, abnormally high blood glucose levels are the way that diabetes, a prominent degenerative disease in the public eye, is portrayed. Insulin and glucagon play a vital role in maintaining normal glucose homeostasis. Therefore, in contrast to insulin, glucagon affects blood glucose levels; it is vital to comprehend what the linked bioactivities of these two substances signify for glucose homeostasis in both healthy and diabetic conditions (Hruby, 1997).

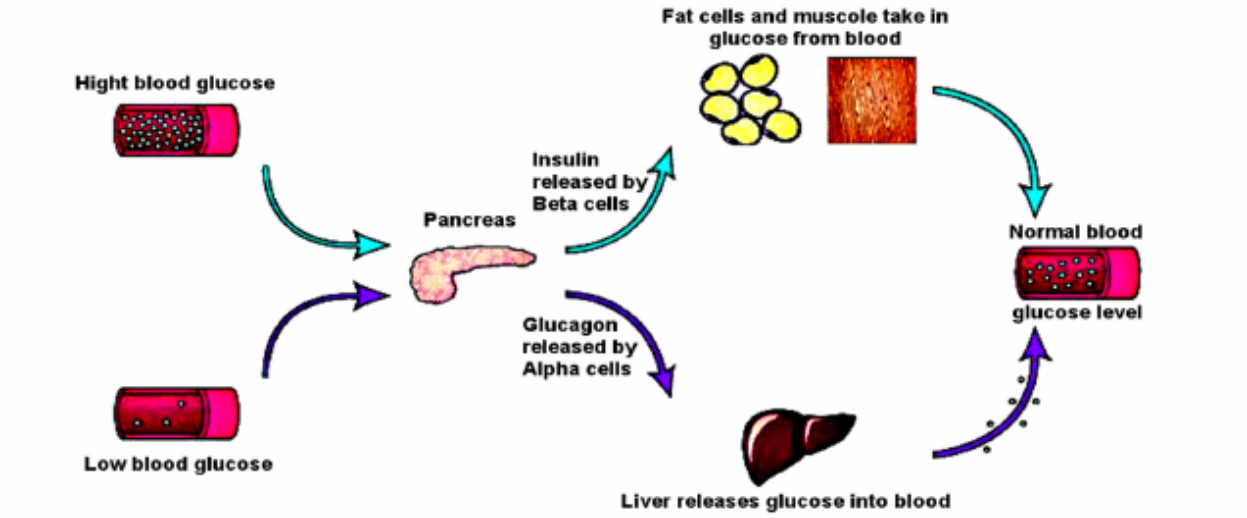


Figure 9 : Homeostatsis of blood glucose(*The Glucose Homeostasis. | Download Scientific Diagram*, n.d.)

The severe oral cytotoxicity and hypoglycemic efficacy of P. tectorius natural product ethanol extract in the treatment of diabetes mellitus in pale skinned mice were assessed. The results demonstrated that Pandanus tectorius natural product extricate had no significant oral side effects and that Pandanus tectorius natural product separate in ethanol at a dose of 1.6g/kg body weight after 14 days significantly reduced blood glucose levels and was comparable to the effects of the over-the-counter diabetic type 2 medication Glibenclamide (Nga, n.d.). A variety of caffeoylquinic acids are present in different food types (CQAs). Although some CQAs have been shown to have antihyperglycemic effects, it is still unknown if eating foods high in CQAs is advantageous for people with diabetes. PTF (200 mg/kg) treatment significantly reduced body weight, fasting glucose levels, hyperinsulinism, hyperlipidemia, and the area under the glucose resilience test and insulin resistance test curves for glucose. In db/db mice, PTF therapy significantly reduced islet hypertrophy and increased blood proinflammatory cytokine levels. According to biochemical analysis, PTF therapy significantly increased AMP-activated protein kinase (AMPK) and Akt substract of 160 kDa phosphorylation as well as the articulation and movement of glucose carrier type 4 (GLUT4) in skeletal muscles (AS160). Additionally, it affected the hepatic glucose and lipid not fully fixed by atomic attractive reverberation based metabolomics, decreased the statement of glucose 6-phosphatase and phosphoenolpyruvate carboxykinase, increased the activity of hexokinase, and altered the record of a few significant lipid metabolic properties in the liver. The PTF that is high in CQA is advantageous for managing diabetes in general. It may reduce hyperglycemia and dyslipidemia by activating the AMPK-AS160-GLUT4 pathway in skeletal muscles and blocking gluconeogenesis and lipogenesis in the liver (Wu et al., 2014).

4.2 Immunomodulatory Activity

Infectious disorders in particular are on the rise globally, and they require effective body defense mechanisms to be kept under control through the immunomodulation process. Malnutrition and infectious diseases continue to be problems, especially in underdeveloped countries where they seriously impair the immune system responses of those who are afflicted. Stress, infectious disorders like acute respiratory tract infections, diarrheal illnesses, yellow fever, hepatitis A and E, tuberculosis, and HIV/AIDS are the main causes of immunodeficiency(Kasper et al., 2015). The immune system is modulated using a variety of allopathic medications. However, these medications are prohibitively expensive for the poor, difficult to obtain, and frequently linked to negative drug reactions. As a result, most people, particularly in rural parts of developing countries, turn to alternative herbal remedies made from medicinal plants like *P. tectorius* because they are generally accepted, available, less expensive, and thought to have less negative effects(Chan, n.d.). For preventing the spread of pathogenic microorganisms, especially those that affect aquaculture-used aquatic creatures, plants and herbal extracts are essential. The usage of plant or herbal extract is anticipated to be safer for aquatic creatures and less damaging to the environment than standard treatment alternatives like antibiotics, which, when administered incorrectly, encourage the growth of potentially antibiotic-resistant bacteria(Anirudhan et al., 2021).

The resistance of shrimp to Vibrio parahaemolyticus, a pathogenic microbe that causes Intense Hepatopancreas Putrefaction Infection, is based on middle fatal part challenge endurance (LD50 = 106 cells/ml), but this is not conclusively established. No passings occurred 24 hours after exposure to 0.5–6 g/L of the organic product extract openness, proving that P. tectorius was not harmful to shrimp at these concentrations. After a 24-h

brooding of 2–6 g/L of the organic product removal, shrimp endurance was increased by 50%, increasing shrimp resistance to V. parahaemolyticus. Along with an increase in endurance rates, Hsp70, ProPO, peroxinectin, penaeidin, crustin, and transglutaminase all individually expanded at 10, 11, 11, 0.4, 8, and 13-overlap. The development of Hsp70, a sub-atomic chaperone essential for cell protein collapsing, tissue fix, and safe reaction in living organisms, may have resulted in less obvious signs of histopathological degeneration in the hepatopancreas and muscle tissues of Vibrio-contaminated shrimp prepared with P. tectorius remove (Anirudhan et al., 2021).

4.3 Antihypercholesterolemic and Antiatherosclerotic potencies

Atherosclerosis is one of the main causes of death worldwide. Due to the side effects of the currently available medications, more potent and secure fixes are needed. Regular asset selections are essential to the development of innovative prescriptions. P. tectorius (Pandanaceae) has traditionally been used in Ayurvedic medicine to treat a variety of illnesses. By adjusting the quality articulation of the HDL receptor (SR-B1) and 3-hydroxy-3-methylglutaryl coenzyme A reductase (HMGCR) in vitro, separately, a review demonstrated the viability of P. tectorius organic product as hostile to atherosclerotic and hostile to hypercholesterolemic specialists. The P. tectorius organic product was shown to be noncytotoxic to the HepG2 cell line by the 3-(4,5-dimethylthiazol-2-yl) 2,5-diphenyl tetrazolium bromide examination. P. tectorius organic product significantly upregulates the SR-B1 quality while effectively downregulates the HMGCR quality. Additionally, an in vivo investigation revealed that P. tectorius is effective at increasing HDL and, consequently, lowering absolute cholesterol levels. Additionally, P. tectorius organic product had no effect on the in vivo toxicity markers

serum glutamate pyruvate transaminase and serum glutamic oxaloacetic transaminase. All P. tectorius natural product examples inhibited HMGCR movement and increased SR-B1 quality articulation in in vitro studies, and similarly decreased total cholesterol levels in in vivo studies. Additionally, the cytotoxicity test revealed that the organic P. tectorius product had no negative effects on HepG2 cells. The degrees of SGOT and SGPT were accurate after PEK treatment, and PMK demonstrated the harmless movement of P. tectorius natural products. By having an administrative impact on SR-B1 and HMGCR activities, the review demonstrated that P. tectorius (organic goods) is an unequalled source of regular phytochemicals for potential specialists against hypercholesterolemia and against atherosclerosis (Andriani et al., 2020).

4.4 Anti-inflammatory Activity

Irritation is a creature's nebulous immunological response meant to protect and heal against the impacts of harmful enhancements. Persistent irritation is linked to several major causes of mortality in the Philippines and around the world, including vascular disorders, cancerous growths, chronic lower respiratory problems, and diabetes mellitus. Using carrageenan-induced mouse paw edema, the predicted in vivo mitigation viability of the Pandanus tectorius methanolic (PTM) and P. tectorius watery (PTA) extracts was examined. Paw thickness, histological, and immunohistochemical analyses of cyclooxygenase (COX)-2 articulation were estimated and evaluated parameters. PTA at 500 mg/kg significantly reduced irritation following the addition of carrageenan (Carr), with a mean paw thickness change of 0.110 0.024 mm at six hours after the addition and a histological mean fiery grade of 1.80 0.20. The reduced immunohistochemical COX-2 articulation with PTA at 500 mg/kg was analyzed with a mean final 3,3′-diaminobenzidine (Touch) power of 63.70 2.08. Ethyl caffeate and dihydroconiferyl alcohol were the dominant peaks in the liquids chromatography-mass spectrometry (LC-MS)-

based identification of possible auxiliary metabolites of PTA, which have been claimed to have calming effects. This investigation has advanced the rational understanding of using P. tectorius as a potential sedative with optional metabolites that might be relevant to pharmacology. This study has explained the logic behind P. tectorius's in vivo COX-2 balance-based ability to be effective against discomfort. Untargeted LC-MS metabolite profiling was used to locate a putatively discovered particle with realized reducing mobility in the P. tectorius extricates, suggesting that the substance's synergistic effects may have increased the plant's impact. Further research on the mitigating characteristics of P. tectorius, both synthetically and pharmacologically, is currently required to create more secure plant-based specialists (del Mundo et al., 2020).

4.5 Antioxidant and Antibacterial activity

The phytochemical components, various organic components, and butanol divisions from Pandanus tectorius stem barks, leaves, and organic products were taken into consideration. The concentrations of phenolics in natural product separates were the highest among the concentrates, especially in the ethyl acetic acid derivation division (278.33-3.93 mg gallic corrosive reciprocals/g extricate). All concentrations had very minimal flavonoid content. The ethyl acetic acid derivation division from P. tectorius organic products demonstrated the most notable cell reinforcement action, according to portion-subordinate DPPH, 1,1-diphenyl-2-picryl hydrazyl, revolutionary seeking activity (IC 50 = 0.2800.06 mg/ml). Additionally, P. tectorius extracts, particularly the fraction that derives ethyl acetic acid from soil-derived compounds, demonstrated potent antibacterial activity against Staphylococcus aureus, Bacillus subtilis, and Salmonella typhimurium.The L-DOPA (L-3,4-dihydroxyphenylalanine) oxidase action of tyrosinase in the melanin creation pathway was essentially hindered by organic product removes,

particularly the ethyl aceate portion(Phuong Hoa and Nhu, 2015).

The high total phenol content and synthetic components (phenolic, flavonoid, steroid, triterpenoid, saponin, and glycosides) of P. tectorius natural products, according to discoveries, give them their limited ability to prevent cancer as well as their antibacterial action against B. subtilis, S. aureus, E. coli, and P. aeruginosa. Given that P. tectorius natural compounds had no harmful effect on Crude at low fixation (for mitigating study), L-6 (for antagonistic to diabetic review), or HepG2 cell lines, more research on its robotic path toward identifying various ailments may be focused (for antiatherosclerosis study). Additionally, it showed that it was non-cytotoxic to the HeLa and MCF-7 cell lines (Andriani et al., 2019).

4.6 Antiviral Activity

Naringenin is present in P. tectorius, which is known to be rich in phenolic compounds. Naringenin, also known as 4′ 5 7-trihydroxyflavanone, is one of the most important flavonoids because of its potential biological activities, such as antioxidant, anti-inflammatory, and antiviral properties (Hartogh & Tsiani, 2019a).

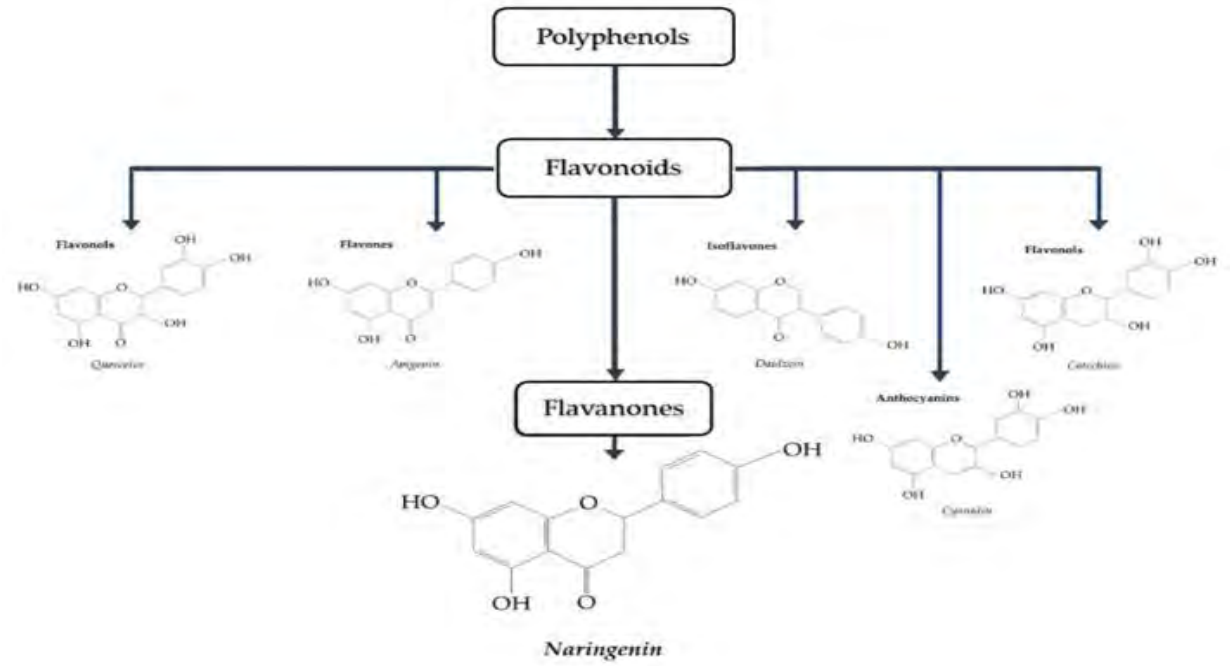


Figure 10 : Classification of polyphenols.Naringenin belongs to the class known as flavanones(Hartogh & Tsiani, 2019b)

Several investigations claim that flavonoids have some natural effects against different types of illnesses. The results of tests to determine whether the flavanone naringenin possesses any antiviral activities against infections like HCV, CHIKV (Chikungunya virus), DENV (Dengu infection), and ZIKV have been completed. Additionally, it was demonstrated that human hepatocytes must express apoB100 and accumulate very low-density lipoprotein in order to convey HCV (VLDL). Given 200 M naringenin, the HCV-infected Huh7.5.1 human hepatoma cell was unable to produce apoB100-subordinate HCV. According to the study, naringenin also suppressed the apoB mRNA in the infected cells and reduced the arrival of both apoB100 and HCV by 70%.The Huh7.5.1 human hepatoma cell that had been contaminated with HCV was given 200 M naringenin, which repressed apoB100-subordinate HCV creation. According to the study, naringenin also suppressed the apoB mRNA in the infected cells and reduced the arrival of

both apoB100 and HCV by 70%. In a different study, the use of naringenin reduced HCV production without changing intracellular viral RNA or protein levels. Additionally, naringenin prevented the aggregation of infectious virus particles. By activating the peroxisome proliferator-enacted receptor (PPAR), naringenin also reduced the accumulation of VLDL, which is anticipated for the entry of HCV particles. According to Gonçalves et al. (2017), oxidative pressure develops as a result of the feeling of cell disintegration caused by HCV contamination, with cancer prevention agent protein movement falling and the liver catalysts alanine transaminase (ALT) and aspartate transaminase action raising (AST).

In human A549 cells, naringenin administration prevented ZIKV infection in a fixation-dependent manner. Naringenin was also proven to have antiviral effects after treating the crucial human monocyte-determined dendritic cells for contamination. This information demonstrates that naringenin has the ability to prevent the collecting or production of viral particles. Additionally, a contact between the protease space of the NS2B-NS3 protein of ZIKV and naringenin can explain the counter ZIKV movement of naringenin.

Chapter 5 : Discussion

The production of pharmacopoeial, non-pharmacopoeial, or synthetic pharmaceuticals is thought to have access to a variety of chemicals from medicinal plants. Even when a nation or culture is very affluent in complementary and synthetic therapeutics, neither can ignore the potential of medicinal plants. Additionally, these plants have been important in the development of human civilizations all over the world, where a number of plants are seen as essential sources of nutrition and are consequently recommended for their therapeutic capabilities. Phenols, flavonoids, alkaloids, terpenoids, and glycosides are present in *P. tectorius*. This review demonstrates that these active substances exhibit numerous requirements for biological activities. These plants are a treasure trove of diverse pharmacological traits and outstanding anti-diabetic potential. Diabetes is becoming more prevalent in our society and is predicted to pose a severe threat to public health in the not too distant future. In these circumstances, the use of a wide variety of pharmacological elements has been shown to be a successful treatment for diabetes.There have been claims that medicinal herbs contain hypoglycemic potential and can be utilized to treat diabetes mellitus. Apart from this Its roots were discovered to be useful in treating digestive and respiratory diseases, while its leaves have been used to treat hepatitis, asthma, colds, and cancer. Vanillin was one of ten phenolic compounds identified from *P. tectorius* that had significant antioxidant action. It has been noted that this plant may have immunomodulatory and anti-inflammatory properties. Due in large part to this plant's anti-diabetic qualities, interest in its therapeutic potential has increased. I believe that “chapter 4” of this review contains a lot of evidence to support this declaration. As a result, this plant may be an effective alternative for a variety of illnesses and ailments.

Chapter 6: Future Perspective

Humans use every component of the living plant known as sea pandanus (Pandanus tectorius Park). Future development of this plant has a lot of exciting potential. Due to the secondary metabolites they contain, pandan fruit and leaves can be used as a therapeutic element, and even the leaves can be used in the textile industry.One of the plants with considerable physiologically important chemicals is pandanus tectorius, which is crucial for therapeutic purposes. Chemicals present in plants such as flavonoids, alkaloids, terpenoids, and glycosides have curative and life-saving effects. The plant is known for having anti-diabetic, anti-hypercholesterolemic, anti-bacterial, anti-viral, anti-inflammation, and anti-oxidant properties. In addition to this, fruit extract from Pandanus tectorius supports Hsp70. Pandan has a number of significant vitamins, minerals, and antioxidants that are known to improve health, according to preliminary study. For instance, vitamin A, which is crucial for eye health and may potentially aid to prevent cancer, is abundant in pandan. Pandan is highly regarded in traditional medicine for its ability to relieve pain, particularly joint and arthritic pain. According to research, pandan extract-derived oils are full of phytochemicals that can help with arthritis symptoms. Additionally, they can aid in the relief of earaches and headaches. In addition, it cures wounds, smallpox, and leprosy. In order to prevent this plant from going to waste, it must be properly produced into therapeutic formulations, and its long-term use must be strictly controlled. In addition to this, individuals should be taught how to use the plant correctly in order to get the most out of it.

Chapter 7 : Conclusion

The growing trend's rising prevalence of disease and its associated effects with commercial medications represent a serious threat to humanity. Naturopathic therapy is a reliable, cost-effective, and generally safe alternative to conventional medicine that can help to prevent this. One of these vital medicinal plants, Pandanus tectorius, is responsible for several pharmacological characteristics and substantial physiologically relevant chemicals. In order to assess this plant's potential as an anti-diabetic, anti-hypercholesterolemic, antioxidant, antibacterial, anti-inflammatory, and also as an immunomodulatory agent, numerous assays are carried out on it. Regrettably, however, the inspections are carried out with a higher number of in-vivo assays in only animals. There are very few human trials for these numerous vital biological activities. I want to advise upcoming researchers to screen this plant more as a foundation for creating cutting-edge and successful remedies that the plant may be able to produce. Additionally, there are currently no established procedures in place to guarantee the effectiveness and quality of its product. Pharmacologically speaking, safety is a relative phrase that requires clarification through additional research. The absence of standards for herbal mixtures is a severe constraint. The main objective of this study is to emphasize the significance of this plant in light of the assay results, which were highly encouraging..

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