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A COMPREHENSIVE UPDATED REVIEW ON PHYTOCHEMICAL AND PHARMACOLOGICAL PROFILE OF KALANCHOE PINNATA

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ABSTRACT

Known by most as Panphuti, *Kalanchoe pinnata* is a member of the Crassulaceae family and is extensively distributed in tropical Africa, tropical America, India, China, and Australia. This perennial plant has bell-shaped pendulous blooms, thick dark green leaves that are distinctly scalloped and trimmed in red, and grows to a height of three to five feet. Numerous active substances, including steroids, alkaloids, triterpenes, glycosides, flavonoids, bufadienolides, lipids, and organic acids, are present in the plant. The various extracts from this plant have anti-inflammatory, antianaphylactic, antileishmanial, antitumorous, antibacterial, gastroprotective, antiallergic, immunosuppressive, insecticidal, muscle relaxant, sedative, antiulcerous, central nervous system depressant, and analgesic properties. These properties are reviewed and discussed along with the pharmacological studies. Traditionally, it has been used to cure leucorrhea, digestive disorders,

fever, constipation, and to nourish hair and treat gray hair. The goal of the current review is to highlight *Kalanchoe pinnata*'s phytochemistry, traditional uses, and pharmacological report.

KEYWORDS: *Kalanchoe pinnata*, Phytochemicals, Inflammation, Extraction, Convulsion.

INTRODUCTION

Medicinal plants are well-known and highly esteemed around the world for their abundance of beneficial compounds that can prevent and treat ailments.[1] Madagascar is the natural home of Kalanchoe pinnata. Wonder plant or Divine plant is the name given to this.[2] The chemical composition of the leaf, stem, and root sections has a significant therapeutic index.[3] It is a continuous, straight, juicy shrub that grows to a height of approximately 1.5 meters. It resurface via spores and also vegetatively from leaf bubils. It has tall, slender stems, freshly-fallen, shaded olive green leaves with separate scallops and pares, and shady, bell-shaped, swinging flora. This plant's tough leaves or stems can be readily dispersed. An eye-catching plant that is already spreading like a wildfire anywhere plantations produce.[4] Kalanchoe pinnata varieties have been utilized in traditional medicine to treat inflammation, infections, rheumatism, hypertension, and kidney stones.[5] Hominids can be protected from a variety of disorders by phytochemicals. Non-nutritive plant mixes known as phytochemicals guarantee protective, therapeutic, or illness-fighting properties. These compounds are produced by plants to protect themselves, but new research shows that other phytochemicals can protect animals in addition to diseases. Pods and sages contain a variety of phytochemicals, each with a different method.[6] Modern pioneers are more intrigued by plant-based remedies than synthetic ones since they are highly biocompatible and have less adverse effects. Because of overexploitation, delayed development, and environmental destruction—possibly the main causes of the market's constant demand—the average yield and class are not fair. Further cultivation of these rugged, medically important plants is not feasible because to the crop's high susceptibility to rhizome rot, leaf spot, and microbial wilt.[7] As a result, few disease-free Elite implanting materials are available.

Synonyms[8]

Bryophyllum calycinum Salisb., *Kalanchoe pinnata* (Lam.) Pers., *Cotyledon pinnata* Lam., and *Sedum madagascaricum* Clus.

Vernacular name[9,10]

Table 1: Vernacular name of *kalanchoe pinnata.*

Sanskrit:	Parnabeeja, Asthibhaksha
English	Air plant
Hindi:	Zakhmhaiyat, Pathharchoor
Kannada	Gandukalinga, Kadu basale
Malayalam	Elamarunga
Tamil	Malaikalli, Ranakalli
Telugu	Ranapala
Marathi	Gayamari
Bengali	Koppatha, Pathar kuchi.
Persian & Urdu	Chubehayat

Taxonomical classification[11]

Table 2: Taxonomical classification of *kalanchoe pinnata.*

Kingdom	Plantae - Plants
Subkingdom	Tracheobionta - Vascular plants
Division	Spermatophyta - Seed plants
Subdivision	Magnoliophyta - Flowering plants
Class	Magnoliopsida - Dicotyledons
Subclass	Rosidae
Order	Rosales
Family	Crassulaceae - Stonecrop
Genus	*Bryophyllum*
Species	*B. pinnatum* (Lam.) Oken

Macroscopic characters[12,13]

Attractive and glabrous, *Kalanchoe pinnata* grows to a height of 0.3 to 1.2 meters. Obtusely four slanting twigs: the older ones are brightly colored, while the younger ones have rose-colored specks of snow. Variable and decussate, superior leaves are usually three to seven foliate with long petioles, whilst lower leaves are usually modest or complicated. An edge that is close to the stalk unites the petioles. Oval or elliptic flyers have a crenate or notch border. Plants are hanging in large dispersion panicles with opposing divisions and willowy pedicels. Sepals are pale green above, green at the edges, and striated red. The petals have three corners on the inner lobes and are octagonal, puffy, and ruddy-floral. Rose-pink monofilaments lower the anthers, green at the base. Shadowy and hasty anthers. flutters in green. Fruitlet is surrounded by a persistently fluttery corolla and calyx. The smaller, oblong-ellipsoid planes are called stones.

Microscopic characters[14-16]

The little character has a curve on the adaxial side and a thin sheet on the abaxial side. Its adaxial epidermal coating is shrill and composed of small, less protruding compartments. The midrib's stranded tissue is parenchymatous. The cells are compressed, round, and pointed. The vascular strand has a small, semicircular shape and is single. It has a broad band of phloem and a dense parallel symphony of xylem. The xylem component has a tiny wall, tapering to a point. The vascular packs are parallel and erect in the plane. The mesophyll is separated into palisade and mushy parenchyma, whereas the lamina is smooth. The rich form of anisocytic type stomata is formed. The greenery's longitudinal section demonstrates the presence of coiled arteries. There are no trichomes on the abaxial.

Phytochemical constituents

The fragrant plant known as *Kalanchoe pinnata* has a sour and sweet scent. Numerous *Kalanchoe pinnata* species have been recognized based on their taste. The plant may grow up to 1.5 meters tall. Green plants with a sour taste are called Sweet *Kalanchoe pinnata*.

This plant is rich in lipids, alkaloids, bufadienolides, steroids, glycosides, cardenolides, and flavonoids. "Bufadienolides," which include bryotoxin-C, bryotoxin-B, and bryotoxin-A, are abundant in its leaves and possess potent chemo-preventive, anti-tumor, anti-bacterial, and insecticidal qualities.[17] This plant's bitter-tasting leaves and bark have anti-emetic and diarrhoeic properties due to its carminative, analgesic, and astringent properties for the intestines.[18]

Syringic acid, caffeic acid, 4-hydroxy-3-methoxycinnamic acid, 4-hydroxybenzoic acid, p-hydroxycinnamic acid, p-coumaric acid, ferulic acid, and protocatechuic acid have all been isolated from plant aerial parts. Astragalin, quercetin, quercetin-3-L-rhamonsido-Larabino gluconoside,[19] quercetin-3-O-diarbinoside, friedelin, epigallocatechin-3-osyrigate, rutin, kaempferol, and astragalin There are three distinct flavonoids in plantare. 3-O-α-Larabinopyranosyl Kaempferol 3-O-α-Larabinopyranosyl quercetin.

From fresh Bryophyllum pinnatum leaves, three new components have been identified: bryophyllol, bryphollone, and bryophollenone. In addition, the combination contains two derivatives of phenanthrene and bryophynol, three unique compounds. 18 1-octane3-O—L-arabinopyranosyl-(16)-glucopyranoside, a minor component isolated from leaves, was

identified as bryophyllin C and bryophyllin A, two insecticidal bufadienolides derived from *Kalanchoe pinnata* leaves.[20,21]

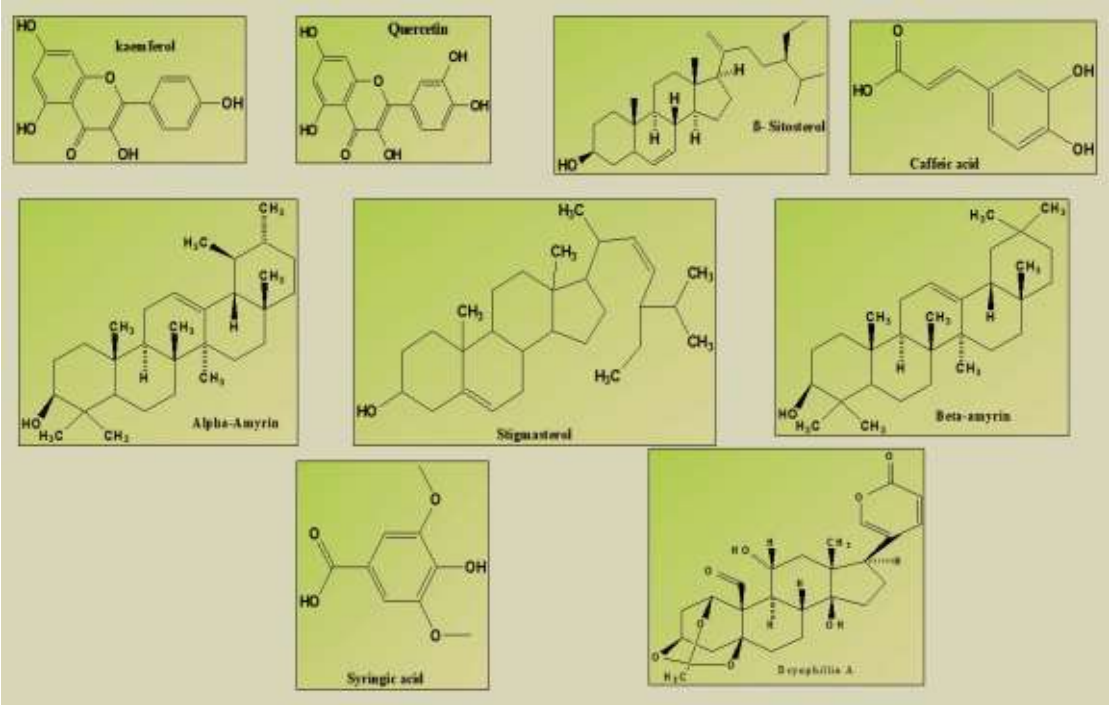

Fig. 1: Phytoconstituents present in *kalanchoe pinnata.*

Geographical distribution

Most temperate regions of Hawaii, Polynesia, Melanesia, Galapagos, Mascarenes, Macaronesia, West Indies, New Zealand, Asia, and Australia are home to the plant known as *Kalanchoe pinnata*. Due to its widespread distribution throughout the Philippines and colloquial names, kataka-taka and katakataka, which translate to "remarkable and astounding," this plant is considered invasive. It is also clear that *Kalanchoe pinnata* is indigenous to Madagascar, where it grows in large quantities on granitic and sandy soils along the shore. This plant grows in the central highlands of Madagascar, which have a sub-humid to moderate humid environment with around 1000–2000 millimeters of rainfall annually. It is occasionally seen at low elevations in dry to mesic regions in the United States and Hawaii.[22]

Pharmacological actions

1. Anticancer activity

All of the bufadienolides that were isolated from *Kalanchoe pinnata* were shown to have good efficacy, with bryophyllin exhibiting the greatest level of activity, when it came to their

ability to prevent the early antigen activation of the Epstin Barr virus in Raji cells caused by the tumor promoter.[23]

2. Antifungal activity

Researchers evaluated the antifungal efficacy of traditional Nigerian herbs (Vaginal Candidiasis). The plants were assessed in comparison to the several strains of Candida albicans, Candida glabrata, Candida tropicalis, and Candida pseudotropicalis. They come to the conclusion that *Kalanchoe pinnata* ethanolic extract did not suppress any of the C. pseudotropicalis strains. Even so, it effectively inhibits the growth of other species.[24]

3. Anti-Ulcer Activity

A *Kalanchoe pinnata* leaf extract in methanolic fraction was reported to have potent anti-ulcer properties in nine different experimental animal models. The extract showed a strong protective effect against stomach lesions caused by aspirin, indomethacin, serotonin, reserpine, stress, and ethanol in pre-medication experiments conducted on rats. Extract treatment effectively protected pylorus-ligated rats and guinea pigs from developing duodenal ulcers caused by aspirin and histamine. Additionally, there was a notable improvement in the healing process in rats who had chronic stomach ulcers caused by acetic acid.[25]

4. Anticonvulsant activity

Rats were administered groups of *Kalanchoe pinnata* leaf extract (50, 100, and 200 mg/kg), and several tests were conducted. Mice are tested for muscular tone (Chinney test, inclined screen test, climbing test, and head dip and evasion test), anticonvulsant (strychnin and picrotoxin produced convulsant in mice), and muscle tone. While all extracts had favorable outcomes, the maximum activity was shown at 200 mg/kg. According to a cytotoxic research, Bryophyllum pinnatum leaf extract in aqueous form can be taken up to 20g/kg.[26]

5. Antimicrobial Activity

An ethanolic extract of the leaves and stem of K. pinnata was tested for cytotoxicity using the brine shrimp lethality assay. The ethanolic extract destroyed the brine shrimp nauplii. At different dosages, it had a varied death rate. The disc diffusion method was used for the antibacterial test. At a dosage of 0.5 grams per disc, the extract's antibacterial activity was assessed against eight different bacterial strains and contrasted with that of amoxycillin, the standard therapy. An ethanolic extract of *Kalanchoe pinnata* Linn. was used in this investigation. All of the examined bacteria showed significant sensitivity to each of the five

test species, with the exception of B. megaterium, S. typhi, and Vibrio cholerae. The range of the inhibition zone is 6.355 to 8.2±0.22 mm.

The zone of inhibition against E. coli was the greatest (8.2±0.22 mm).[27]

6. Hepatoprotective activity

For the activities, concentrated leaf juice and the juice's ethanolic fraction (EX) were used. An in vivo and an in vitro model were used to evaluate the activity.

Chloroform causes hepatotoxicity because of its metabolite, ccl3·, a free radical that attaches to lipoprotein and causes the endoplasmic reticulum's lipids to peroxide. The experiment's findings show that the plant concentrate may lower bilirubin levels up to 105.50% and that concentrate and EX can lower SGPT levels up to 92.47 and 87.43%, respectively. These findings unambiguously demonstrate the hepatoprotective properties of *Kalanchoe pinnata*, as do histological investigations.[28,17]

7. Hypoglycemic activity

The hypoglycemic effect of *Kalanchoe pinnata* plant stem extract is demonstrated. The goal of the study was to lower the blood glucose level in normally fasting rats.[29] Because of its zinc content, the plant *Kalanchoe pinnata* is used to treat diabetes that results from insulin failure. Rats with diabetes mellitus and fresh egg albumin-induced pedal edema were utilized to assess the anti-inflammatory and anti-diabetic effects of plant extract.[30] The herb's many phytochemicals, including flavonoids, phytosterols, and triterpenoids, are thought to be responsible for the anti-inflammatory, anti-nociceptive, and anti-diabetic effects that have been seen.[31]

8. Immunomodulatory effect

Eosinophil counts, OVA-specific IgE, T cell proliferation, cytokine production, histamine release assay, and other parameters were taken into consideration during the experiments, which were conducted on male BALB/c mice and Lou-M rats. The results indicate that the plant extract and its Quercetin flavonoids effectively protect mice against anaphylactic shock.[32]

9. Antihypertensive activity

The herb's hypotensive properties support the folklore usage of the plant in the treatment of hypertension. Some Yorubas in Western Nigeria frequently use this herb to treat hypertension

of all kinds and grades. It has been documented that *Kalanchoe pinnata* is a traditional therapy for hypertension in Trinidad and Tobago.[33]

10. Anti-allergic activity

According to several recent scientific studies, oral medicines containing quercitrin that has been discovered and extracted from plants can up to 75% avoid animal deadly anaphylaxis. These findings demonstrate that pro-anaphylactic generated immune response modules may be effectively slowed down by oral administration of different forms of *Kalanchoe pinnata*. Quercitin-assisted protection revealed that flavonoids are *Kalanchoe pinnata*'s most important component and the one that protects against severe allergic responses.[34,8]

11. Antioxidant activity

The potential preventive benefits of *Kalanchoe pinnata* water extract against gentamicin-induced nephrotoxicity in rats was assessed. Studies conducted in vitro have demonstrated the significant antioxidant activity and oxidative radical scavenging capabilities of *Kalanchoe pinnata* leaf extract. Additionally, in the event that testing animals experience gentamicin-induced nephrotoxicity, water-based leaf extracts of *Kalanchoe pinnata* may potentially exhibit nephroprotective properties.[30]

12. Wound healing property

Owing to the presence of ethanolic extract, K. pinnata exhibits wound healing activity. Similar to the oedema at the wound site, it is reducing the size of the afflicted region. Additionally, phenolic antioxidants and steroidal glycosides are to blame. Recent research indicates that plant petroleum ether, water, and alcoholic extracts can all help heal wounds. Additionally, the study demonstrated that the water extract exhibited higher activity than the other two extracts.[35,30] The *Kalanchoe pinnata* plant contains a high concentration of saponins, which are useful for treating wounds and stopping bleeding. Moreover, saponins can cause red blood cells (RBCs) to coagulate and precipitate. Other essential characteristics of saponins include hemolytic activity, formation of foams in aq. solution, bitterness and binding of cholesterol properties.[36]

13. Anti-inflammatory activity

To investigate the effects of *Kalanchoe pinnata* leaf extracts on formaldehyde-induced oedema in an experimental setting, leaf extracts were produced in methanol, acetone, chloroform, and petroleum ether. Out of all the extracts, the methanolic extract had the

strongest efficacy in preventing paw oedema.[13] Furthermore, bradykinin, prostaglandins, serotonin, and histamine were measured in formaldehyde-induced inflammations from injured cells that had the capacity to create the endogenous mediators. Therefore, based on these experimental findings, it was determined that the presence of bufadienolides and other water-soluble extract ingredients was primarily responsible for the suppression of formalin-induced oedema in rats.[37]

14. Antipyretic activity

It was demonstrated how plant extract affected the hyperthermic circumstances in the test animals. Rats were given brewer's yeast to induce pyrexia. Laboratory specimens were administered K. pinnata hydroalcoholic extract, which demonstrated its antipyretic efficacy by lowering body temperature. Flavonoids, which are present in the extract, could be the cause of this activity.[38]

15. Anti-depressant activity

In animal experiments, *Kalanchoe pinnata* has also been shown to have strong sedative and central nervous system (CNS) depressing properties. The plant K. pinnata leaf extract has the power to raise a neurotransmitter's concentration in the brain. GABA stands for gamma amino butyric acid.[39]

16. CNS depressant activities

Kalanchoe pinnata leaf methanolic fractions significantly altered behavioral patterns, causing dose-dependent potentiation of pentobarbitone sleeping duration and a notable impact on analgesic efficacy. Conversely, there was a noticeable decline in exploratory performance as well as a lack of lingering curiosity.[40]

17. Anti-histamine activity

Previous research revealed that pre-treating mice's cells with an aqueous extract of K. pinnata reduced the amount of histamine released by the cells. Additionally, a flavonoid fraction derived from the plant's juice that contains a compound that is both water- and n-butanol-soluble is what gives it its antihistamine, anti-inflammatory, and, most importantly, immunosuppressive properties.[41]

SUMMARY

Typically, tropical and temperate parts of the earth are home to *Kalanchoe pinnata*. It is well acknowledged to possess an extensive array of possible pharmacological properties, encompassing the management of several severe illnesses mostly associated with humans. A common usage for *Kalanchoe pinnata* is as a wonderful herb. The traditional uses of *Kalanchoe pinnata* and its extracts for severe illnesses, inflammations, painful ulcers, fungal infections, viral diseases, microbial attacks, impaired immune systems, diabetes mellitus, spasms, and insecticidal properties have been largely confirmed by modern pharmacological investigations. It is thought that comprehensive data, such as that provided in this study, about the phytochemical elements of the plant and the different biological characteristics of its extracts and constituents may encourage further research into the plant's potential use in agriculture and medicine. In tests conducted on mice and rats, extracts and fractions demonstrated noteworthy effects in terms of analgesia, allergy relief, anti-inflammatory, anti-tumorous, anti-leishmanial, anti-ulcerous, anti-fungal, antibacterial, anti-histamine, CNS depressant, antiviral, febrifuge, immunosuppressive, gastro-protective, immunemodulator, muscle-relaxant, insecticidal, and sedation without causing side effects. Some Indian businesses, including Amazon, use it as a source of raw materials for phytochemicals. The majority of pharmacological research done on animals thus far has been done both in vitro and in vivo. It is urgently necessary to conduct scientific evaluations of the separated principles of *Kalanchoe pinnata* in the future utilizing particular animal models and clinical research. Furthermore, it is critically necessary to understand the molecular mechanism of action in order to predict the chemical structures of molecules and various biologically active byproducts that accompany them, as well as to validate the value of conventional wisdom in the context of a reasonable phytotherapy regarding the toxicity of plants, particularly bufadienolides and their use during pregnancy.

Conflict of interest

The authors declare that the review was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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