Chapter Title

# PHARMACOGNOSTICAL AND PHYTOCHEMICAL POTENTIAL OF KALANCHOE PINNATA.

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# ABSTRACT

*Kalanchoe* is a type of succulent plant that can grow up to 3-5 feet in length. This chapter provides an in-depth review of the literature on pharmacogenetic and phytochemical studies of this plant. The phytochemicals that have been identified from Kalanchoe include alkaloids, diterpenoid lactones, glycosides, steroids, phenolics, and aliphatic compounds. These compounds exhibit a wide range of pharmacological properties, such as anti-diabetic, anti-neoplastic, antioxidant, immunomodulatory, anti-lipidemic, anti-allergic, and many more activities that are yet to be fully explored. Now it has become an endangered plant that needs to be conserved as well as explored for its significant green chemistry.



**KEYWORD**: *Kalanchoe pinnata*, Pharmacognostical analysis, Phytochemical studies, Pharmacological effects of the plant, Ethanomedical uses.


# INTRODUCTION

India, often regarded as the global herbal garden, has served as a rich repository of plants and their derivatives since ancient times. Humans have employed these resources in diverse ways, adapting them to various needs, notably as sustenance and medicine. Within the vast array of flora present, a staggering 35,000 to 70,000 species have found application for medicinal purposes [1]. Comprising over 100 succulent plants, the *Kalanchoe* genus typically flourishes in tropical climates. Michel Adanson, a French botanist, was the first to document this genus in the mid-1700s.

## HABITAT

The Madagascar has yielded the greatest number of species that have been identified within the genus, it is thought that the kalanchoe genus originated there. Furthermore, it has been proposed that species in this genus are native to the Americas, southern and eastern Africa, and several Asian locations, including China and Southeast Asia.[1,2]

## DESCRIPTION

- A synonymous term for this genus is Bryophyllum.
- *Kalanchoe pinnata*, is also a member of the *Crassulaceae* family.
- It is a everlasting shrub with a maximum height of 1.5 metres (Fig-1).
- This succulent plant, is native to hot and humid regions of India, particularly Bengal.
- It has hollow, four-angled stems with branching.
- It reproduces vegetatively by producing seeds and leaf buds.[3]
- The decussate, oppositely oriented succulent leaves have a length of 10 to 20 cm. The bottom leaves are plain, with noticeable red-trimmed scallops and a powerful dark green texture; the top leaves, numbered 3–7, have long petioles and a foliate structure. (Fig-1). [4]
- For ease of identification, the genus's taxonomic classification is given below (Integrated Taxonomic Information System, n.d.)..[5]

Classification *of* ***Kalanchoe pinnata*** Scientifically

| | | | |
|---|---|---|---|
| **Kingdom** | Plantae | **Class** | Magnoliopsida |
| **Sub-kingdom** | Viridiplantae | **Order** | Saxifragales |
| **Super-division** | Embryophyta | **Family** | Crassulaceae |
| **Division** | Tracheophyta | **Genus** | Kalanchoe |

(Fig.1)




**COMMON NAME**

- In English, the terms "floppers," "air plants," "best of luck leaves," "Hawaiian air plants," "life plants," and "American life plants" are frequently used to refer to it.."
- In India, particularly in Hindi, it goes by the names "Patharchur," "Patharchattam," "Pather Talk," and "Paan-futti."
- There are several references to it in Bengali, including "Kaphpat," "Patharkuchi," "Gatrapuri," "Koppat," and "Pathorkuchi."
- It is referred to as "Pattharchoor," "Zakhm-eHayaat," and "Pattharchat" in the Unani tradition.[2]

**Local *Kalanchoe pinnata* Names[6]**

| | | | |
|---|---|---|---|
| **Hindi** | Zakhm-hayat | **Tamil** | Ranakalli |
| **Arabic** | Kushnulhayat | **Kannad** | Ganduklinga |
| **Bengal** | Koppata | **Malayalam** | Elamurunga |
| **Sanskrit** | Asthi-bhaksha | **Persian & Urdu** | Chubehayat |
| **Telgue** | Simajamudu | | |

## PHARMACOGNOSTICAL ANALYSIS

Numerous investigations were carried out to identify and examine *Kalanchoe pinnata*'s macroscopic and microscopic features.

**MORPHOLOGICAL CHARACTERISTICS**

The average height of a *Kalanchoe pinnata* is 0.3 to 1.2 meters, however, there are instances when it can reach 2 meters.

**Stem** - The age of the stem affects the color it takes on. While younger stems are often reddish-pink with white specks, older stems are distinguished by their lighter tone. Additionally, the smooth, branching branches are often long and hollow.

**Flower** - The delicate, tubular blossoms of Kalanchoe pinnata are recognized by their pinkish-red hue. These are suspended on opposite sturdy stems in huge panicles. Additionally, the

corolla often has an octagonal base shape and is bloated. The flower's calyx, which can grow anywhere between 3.5 and 4 cm long, is reported to be tubular and brownish or purple. Typically, the flower's base has triangular teeth and a pale green tint [7].

**Leaves** - leaves have a serrated or crenate edge and an oblong or elliptical form. In addition, the leaves have a long petiole, an asymmetric base, and glabrous leaf surfaces. Furthermore, the color of the leaves is dependent on which side of the epidermis is exposed; that is, the lower epidermis typically has a lighter hue and the top epidermis typically has a darker green color. Additionally, the leaves are distinguished by a strong smell and a harsh flavor [8].

**Fruit** - The papery-textured calyx and corolla of the Kalanchoe pinnata plant often envelop the fruit. Additionally, the species is identified by its smooth, oblong-shaped seeds [9].

## MICROSCOPIC CHARACTERISTICS

The layer of the epidermis, hypodermis, palisade cells, and meri stele that makes up the lamina of the *Kalanchoe pinnata* leaf is exposed together with the vascular bundle, both sides of the epidermis, and the collenchymatous tissues when it passes through the midrib. It is said that this area is even and level. Both the adaxial and abaxial surfaces of the leaf lack trichomes. Additionally, it is noted that the leaves are convex on the abaxial side and shallow on the adaxial side [10].

The midrib's homogenous ground tissue is made up of parenchyma cells. The parenchymatous cells have a round shape and are compact. The vascular strand, on the other hand, is hemispherical and is made up of broad phloem bands and horizontal xylem bands. The vascular bundles, which can have a horizontal plane width of at least 170 μm, are made up of the vascular strands. In addition, the leaf petiole contains calcium oxalate crystals found in parenchymatous cells, with spiral vessels being observed in the area. Further, the stomata of the leaf of *Kalanchoe pinnata* are also observed. It was discussed that there are many stomata present in the leaf at approximately 18 to 20 mm in length. The stomata of the leaf is described as anisocytic, or structures that are uneven in size [11].

Regarding the stem, it is noted that the outer layer of the thick-walled epidermis is covered in a cuticle. Sclerenchymatous cells make up the hypodermis, which lies underneath this outermost layer. Furthermore, the parenchymatous cells that make up the cortex of the stem

are organized loosely and are distinguished by their thin walls and starch granules. The stem's xylem resembles that of herbaceous dicots, typically taking the shape of tracheids with a few parenchymal fibbers. In the meantime, the species' pith, which is made up of parenchymatous cells, is distinguished by the deposition of starch grains and crystals formed from calcium oxalate ($CaC_2O_4$). The color of the plant's flower is determined by the pigments and spongy cells that make up the epidermis on both sides of the *Kalanchoe pinnate*'s blooms [12].

## PHYTOCHEMICAL STUDIES

### PHYTO - CHEMICAL CONSTITUENTS

The plant is abundant in many different phytochemical components, including as tannins, alkaloids, flavonoids, and phenolic compounds. In addition, it has microelements like iron and zinc as well as necessary macroelements like calcium, magnesium, potassium, phosphorus, and sodium. It has been determined that vitamins such as riboflavin, niacin, thiamine, and ascorbic acid are present.[6]. More specifically, alkaloids, triterpenes, steroids glycosides, flavonoids, cardenolides, bufadienolides, and lipids are abundant in B. Pinnatum [13]. Amino acids such as thiamine, pyridoxine, ascorbic acid, glycine, cysteine, and nicotinamide are found in the plant's leaves. Carbohydrates, proteins, lipids, and other minerals including sodium, calcium, potassium, phosphorus, magnesium, ferrous, copper, and zinc are all included in the food content. Additionally, carbohydrates such raffinose, lactose, sucrose, and glucose are present [14]. Astragalin, 3, 8-dimethoxy-4, 5, 7-trihydroxyflavone, friedelin, epigallocatechin-3-o-syringate, luteolin, rutin, kaempferol, quercetin, quercetin-3-O-diarabinoside, and kaempferol-3-glucoside are among the flavonoids found in the leaves [15].

### Root

The highest concentration of elements, such as potassium, iron, calcium, phosphorus, sodium, copper, and zinc, is found in the roots [16].

### Leaves

Bryophyllum pinnatum leaves contain a variety of substances, including butyrolactone, 2, methyl, alpha-D glucopyranoside, 3,5-Dihydroxy-6-methyl-2,3-dihydro-4H-pyran-4-one

(DDMP), benzaldehyde, and n-hexadecanoic acid. These ingredients are used to treat inflammation and rheumatism. Oleic acid, which is present in the leaves, also lowers blood pressure and lowers the risk of breast cancer. The leaves also contain octadecanoic acid [16, 17].

**Stem**

Phytochemical screening of the stem of K. pinnatum has shown the presence of flavonoids, hydrogen cyanide (HCN), alkaloids, tannin, saponins, phenol, and phytate, among other chemicals. The stem of K. pinnatum has detectable levels of calcium, magnesium, phosphorus, sodium, and potassium, according to elemental analysis [16].

## PHARMACOLOGICAL EFFECTS OF THE PLANT

### WOUND-HEALING ACTIVITY

The noteworthy ability to heal wounds was shown by the ethanolic extract of *K. pinnata*, which reduced edema at the location of the wound and the size of the affected region. The extract's ability to heal wounds might be attributed to the presence of steroid glycosides [18]. Wounds may be healed by alcoholic plant extracts and petroleum ether. Additionally, the study indicated that compared to the other two extracts, the water extract exhibited greater activity [19].

### ANTIOXIDANT ACTIVITY

The harmful consequences of reactive oxygen species, including peroxyl radicals, hydroxyl radicals, singlet oxygen, superoxide, and peroxy-nitrite, are prevented by antioxidant compounds. Reducing characteristics are often linked to the existence of reductones, which have been demonstrated to break the chain of free radicals by either donating an electron or a hydrogen atom this process is how antioxidants work. It has also been observed that reductones inhibit the generation of peroxide by reacting with certain peroxide precursors. Treatment for cardiovascular diseases is well correlated with potential antioxidant activity [20].

The discovery of quercetin and kaemferol in K. pinnata leaves suggests showed quercetin significantly reduces the risk of cadmium-induced nephrotoxicity, which is caused by an increase in the expression of eNOS (endothelial nitric oxide synthase), a small cysteine-rich protein, and COX-2 (cyclooxygenase-2), as well as an inhibition of iNOS (inducible nitric

oxide synthase) and Metallothionein. The ethanolic extract had a higher total phenolic and flavonoid content than other extracts, and it was claimed that leaves exhibited greater scavenging effects than stems. The extracts' strong antioxidative action might be attributed to their high concentration of phenols and flavonoids [21].

Even in the lipid phase, the phenolic components can interact with the transition metals and chelate them by occupying their aqua-coordination sites and producing insoluble complexes with metal coordination. The capacity of phenolics to stabilize radicals by directly scavenging peroxyl radicals and producing stabilized phenoxy radicals may be the cause of the inhibition of lipid auto-oxidation. The extract's capacity to lessen metal-induced peroxidative stress (lipid phase) was revealed to be a prerequisite for its metal-chelating activity (aqueous phase). In a study using several solvent extracts to examine the plant's roots. The root methanolic extract was shown to have the highest level of activity among them [22].

**ANTITUMOR ACTIVITY**

The inhibitory effects of five bufadienolides (1–5) extracted from K. pinnata leaves on Raji cells' activation of the Epstein-Barr virus early antigen (EBV-EA) caused by the tumor promoter 12-O-tetradecanoylphorbol-13-acetate were investigated. Among the substances studied, bryophyllin A (1) had the most significant inhibition (IC50 = 0.4 microM) among all bufadienolides that showed inhibitory action. Less active compounds were bryophyllin C (2), a reduction counterpart of 1, and bersaldegenin-3-acetate (3), which lacked the orthoacetate moiety. These findings imply that bufadienolides have the potential to be used as cancer chemopreventive drugs.

DENA is regarded as a significant environmental hepatocarcinogen because of its propensity to produce free radicals during its metabolism in the liver, upsetting the antioxidant state and eventually resulting in oxidative stress and carcinogenesis. The aqueous extract prevented necrotic damage, scavenged free radicals, and shielded hepatocytes against DENA's carcinogenic effects. The aqueous extract prevented necrotic damage, scavenged free radicals, and shielded hepatocytes against DENA's carcinogenic effects [23].

**ANTIVIRAL ACTIVITY**

One of the sexually transmitted viruses that poses a serious risk to people is the human papillomavirus, or HPV. HPV is the reason of the increasing rate of cervical cancer.. When the

extract fractions were added to cancer cell lines, they inhibited both the development of the tumors and the production of viral proteins. Epstein Barr virus is a herpes virus that affects the B-lymphocytes of humans, leading to the formation of tumors [24].

## CYTOTOXICITY AND ANTIMICROBIAL ACTIVITY

The antibacterial activity of K. pinnata was demonstrated by two flavonoids and an alkaloid found in the ethanolic leaf extract of the plant. These phytocompounds prevented the development of a few gram-positive and gram-negative bacteria and fungi that are often seen. Antimicrobial potential of K. pinnata and stated that methanolic extract showed a better inhibition rate. In addition to causing skin infections, bacteria on the skin may also cause food poisoning, respiratory illnesses, wound infections, abscesses, osteomyelitis, endocarditis, pneumonia, and other issues when they enter the body. So, the prepared extract can act against such diseases, and save the lives of infected ones. The study validated the plant's historic usage in treating respiratory tract diseases, such as pneumonia [25].

## ANTILEISHMANIAL ACTIVITY

Leishmaniasis is a disease caused by protozoans belonging to the genus Leishmania. Oral administration of *K. pinnata* aqueous extract was administered to mice harboring Leishmania amazonensis infection. A few findings were recorded following the study, including the lesions' reduced size and the parasite load at the affected location. Ongoing administration of the extract not only regulated the growth but also stopped new infections from occurring. The plant extract's flavonoid glycoside content may be the cause of the antileishmanial action [26].

## ANTHELMINTIC ACTIVITY

The *K. pinnata roots* aqueous, methanolic, and chloroform extracts are anthelmintic, while the petroleum ether extract was ineffective against the worms**.** The methanolic extract was found to be most effective when compared with others. In addition to causing paralysis, the plant's root extract killed worms, especially when it was applied at greater concentrations for shorter periods. Tannins may be the culprit, since they can attach to free proteins in the host animal's digestive system or to glycoprotein on the parasite's cuticle, ultimately resulting in death [27].

## INSECTICIDAL ACTIVITY

Strong insecticidal action against silkworm larvae in their third instar was seen in isolated compounds, and this was attributed to the presence of the 1, 3, 5-orthoacetate moiety of

Bufadie-nolides [28].

## ANTI-ALLERGIC ACTIVITY

Aqueous extract of *K. pinnata* was evaluated for its protective effect in the discovery of its active component and a the-driven immunopathology that results in deadly anaphylactic shock. In vitro, K. pinnata reduced antigen-induced mast cell degranulation and histamine release. 75% of the rats were spared deadly anaphylaxis when given oral therapy with the quercitrin flavonoid that was isolated from the plant. These results suggest that K. pinnata oral therapy successfully down-modulates immune responses that induce anaphylaxis. The partial protection provided by quercitrin indicates that this flavonoid is an essential part of the K. pinnata extract against this severe allergic response. [29].

## ANTINOCICEPTIVE ACTIVITY

The methanolic extract of K. pinnata showed a significant effect on mice when compared with the standard drug aspirin. It reduced the number of acetic acid-induced writhings in a dose-dependent manner. The aqueous extract may probably have exerted its antinociceptive effects by inhibiting the release, synthesis, and/or production of inflammatory cytokines and mediators, including prostaglandins, histamine, polypeptide kinins, and so on [30].

## ANTI-INFLAMMATORY ACTIVITY

The different *Kalanchoe pinnatum* leaf extracts/fractions were studied in a rat model of chemically induced inflammation. Indomethacin inhibited edema in early, middle, and later phases in a rather homogeneous manner. Early stages of formaldehyde-induced edema were likewise somewhat inhibited by the methanolic fraction; however, later stages demonstrated considerable suppression. The methanol fraction from *K. pinnatum* leaves was more important than the other fractions in terms of % prevention of paw edema among the pet-ether, chloroform, acetone, and Methanol fractions [31].

Formaldehyde promotes inflammation from cell damage, which stimulates the creation of endogenous mediators such as histamine, serotonin, prostaglandins, and bradykinin. Additionally, since rat edema produced by formalin closely mimics human arthritis, it is recognized that screening for anti-inflammatory and anti-arthritic drugs may be done most effectively using this test protocol. The plant's anti-inflammatory properties may be related to

how its floral extract treats edema brought on by croton oil, suggesting that the plant has anti-oedematogenic properties[32].

## ANTIPYRETIC ACTIVITY

The impact of plant extract on experimental animals hyperthermic conditions. Brewer's yeast injections were used to cause pyrexia in rats. The laboratory specimens' body temperatures were lowered by the hydroalcoholic extract of *K. pinnata*, demonstrating its antipyretic action. This action could be caused by the flavonoids that are present in the extract [33].

## NEUROPHARMACOLOGICAL ACTIVITY

The mice exposed to the plant's ethanolic extract had CNS-depressant action. It was discovered that the rate of activity was almost identical to that of antidepressants used for commercial usage. The mice did not die, and the convulsions brought on by picrotoxin were postponed. The presence of bufadienolides and other water-soluble components in the extract may be the cause of its CNS-depressant action. [34].

## ANTILITHIATIC ACTIVITY

Calcium oxalate stones develop because of decreased oxalate excretion in urine. Patients with stones in their bodies were given fresh juice made from *K. pinnata* leaves as part of a medical prophylactic regimen. Regardless of the location, kind, or history of treatments, the stones were successfully eliminated with consistent juice consumption. The amount of urine expelled increased, indicating that the juice had a diuretic effect. Additionally, it promoted the increase in citrate excretion and the decrease in oxalate excretion. All the rats treated with extract had less renal injury, less epithelial lining deterioration, and less tubular dilatation when the kidneys were examined histopathologically. Prepared tablets using extracts from *K. pinnata* and stated that the medication is useful in reducing the buildup of calcium oxalate crystals and avoiding kidney stone development [35,36].

## ANTIHYPERTENSIVE ACTIVITY

The aqueous extract of *K. pinnata* prevented the rise in rats' systolic and diastolic arterial pressures, hence inhibiting salt-induced hypertension. It was suggested that the plant extract's overall antihypertensive action may be due to its antioxidant and vasculature-modifying properties. Using both invasive and non-invasive methods, the effects of the plant's aqueous and methanolic leaf extracts were investigated on the arterial blood pressures and heart rates of

normal (normotensive) and spontaneously hypertensive rats. The anesthetized rats' arterial blood pressure and heart rates were significantly reduced by both extracts in a dose-related manner. The guinea pig's isolated atria's contraction force and rate were likewise reduced by the leaf extracts [37].

As the extract dosage increased, the blood pressure dropped. However, this study also revealed the existence of bioactive substances that have harmful effects on both people and animals. Therefore, even though the plant is known to have a wide range of therapeutic benefits, the study concluded that, when testing on lab specimens, the dosage of plant extracts should be confirmed to prevent unfavorable responses [38].

**USES**

Numerous plants belonging to the genus Kalanchoe have been employed in traditional medicine in several parts of the globe. Traditional medicinal practices have employed Kalanchoe species for alleviating infections, fever, and inflammation [5,8], as well as managing illness like gastric ulcers, kidney stones, lung infections, and rheumatoid arthritis. Additionally, these plants have been utilized as remedies for respiratory and digestive illnesses, allergies [29], and nausea [39]. Furthermore, certain species of *Kalanchoe* have exhibited antimicrobial [39], wound healing [42], and anti-aging properties [22].

**ETHNOMEDICAL PURPOSES**

When consumed on an empty stomach, the leaf extract is used to treat children's fever and urinary bladder stones. Additionally, it is a treatment for diarrhoea. The juice that is taken from the leaves is used to treat diarrhoea and coughing. Leaf juice is applied externally to cure leucoderma and scabies, while a leaf decoction is applied to wounds to halt bleeding. Additionally, the plant is used for numerous purposes, including treating eye infections, headaches, inflammation, menstruation problems, pimples, wounds, aches, burns, childbirth-related concerns, colds, coughs, fever, pain, respiratory infections, earaches, eczema, and pimples. Moreover, it is useful in treating erysipelas, gas, indigestion, intestinal issues, migraines, nausea, skin issues, boils, fractured bones, bronchitis, cancer (lymphoma), conjunctivitis, epilepsy, and more. [7].

**AYURVEDA AND UNANI**

The leaves are thought to be bitter and have insecticidal qualities in Ayurveda. However, the bark is described as bitter and deadly in Unani medicine. It is recognized for its tonic, alexipharmic, astringent effects on the bowels, analgesic properties, and carminative qualities. The bark is deemed useful in treating conditions such as diarrhea, vomiting, and inflammations, as well as for managing snake bites and scorpion stings [7].

## CONCLUSION

This chapter provides in-depth information on pharmacognostic studies, phytochemical constituents, biological properties, and medicinal use of the plant. Small Indian companies and Amazon use K. Pinnata for phytochemicals. Studies done on animals but need future clinical studies. The present literature shows the pharmacological potentials of *K. pinnata* which is very helpful to researchers to explore more about this medicinal plant.

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