

THE MIRACLE PLANT (*KALANCHOE PINNATA*): A PHYTOCHEMICAL AND PHARMACOLOGICAL REVIEW

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ABSTRACT

Kalanchoe is a succulent perennial plant that grows 3-5 feet tall. Commonly known as 'air plant,' it has tall hollow stems, fleshy dark green leaves that are distinctively scalloped and trimmed in red, and bell-like pendulous flowers. Kalanchoe is botanically classified with two main Latin names which refer to the same plant: Bryophyllum pinnatum and Kalanchoe pinnatum (as well as various synonyms of both). This review presents detailed survey of literature on phytochemical and medicinal properties of the plant. The chemicals reported from the plant belong to different classes such as alkaloid, diterpenoidal lactones, glycosides, steroids, phenolics, aliphatic compounds, etc. The notable pharmacological properties include anti-diabetic, anti-neoplastic, antioxidant, immunomodulation, anti-lipidaemic, anti-allergic and many more activities which are yet to be explored.

KEYWORD: *Kalanchoe pinnata*, Phytoconstituent, Pharmacological activity.

INTRODUCTION

Kalanchoe is a medicinal plant largely used in folk medicine for the treatment of kidney stones, gastric ulcer, pulmonary infection, rheumatoid arthritis etc. *Kalanchoe pinnata* has become naturalized in temperate regions of Asia, Australia, New Zealand, West Indies, Macaronesia, Mascarenes, Galapagos, Melanesia, Polynesia, and Hawaii. In many of these, such as Hawaii, it is regarded as an invasive species. In French Polynesia, *Kalanchoe pinnata* has been declared a threat to biodiversity. It is also widely distributed in the Philippines and it is known as katakataka or kataka-taka which is also an adjective meaning astonishing or remarkable. In India it is cultivated in gardens and wild on the hills of North-Western India, Deccan and Bengal.

Taxonomy

- Kingdom** : Plantae (Plants)
Subkingdom : Tracheobionta (Vascular plants)
Super division : Spermatophyta (Seed plants)
Division : Magnoliophyta (Flowering plant)
Class : Magnoliopsida (Dicotyledonous)
Subclass : Rosidae
Order : Saxifragales
Family : Crassulaceae Stonecrop family
Genus : *Kalanchoe*
Species : *Kalanchoe pinnata* (Lam.) Per³



Fig 1 *Kalanchoe pinnata* Plant



Fig 2 Leaf of *Kalanchoe pinnata*

Synonyms

Bryophyllum calycinum, *B. germinans*, *B. pinnatum*, *Cotyledon calycina*, *C. calyculata*, *C. pinnata*, *C. rhizophilla*, *Crassuvia floripendia*, *Crassula pinnata*, *Sedum madagascariense*, *Verea pinnata*⁴

Regional Names

- Hindi: zakhm-hayat
 Arabic: kushnulhayat
 Bengal: koppata
 Sanskrit: asthi-bhaksha
 Telgu: simajamudu
 Tamil: ranakalli
 Kannad: ganduklinga
 Malayalam: elamurunga
 Persian & Urdu: Chubehayat^{1,2}

Description

It is a glabrous herb 0.3-1.2m. High;

Stems obtusely four angled the older light colored, younger parts reddish speckled with white.

leaves variable decussate, the lower usually simple or occasionally compound, 8-12 and 6-8cm in size, the upper usually 3-5or sometimes 7- folio late, long pointed, the petioles united by a ridge round the stem. Leaflets ovate or elliptic, crenate or serrate. The leaves often produce, on their crenature at the extremities of the lateral nerves, buds furnished with root, stems and leaves, which drop off and at once become new plants¹.

Flowers reddish purple, pendent in large spreading panicles with opposite stout branches; pedicle slender. Calyx red and green at the base, striated, pale green above, teeth triangular. The corolla swollen and octagonal at the base, reddish purple, constricted in the middle. Filaments green at the base, pinkish below the anther. Anther hastate and black.

Fruits enclosed in the persistent papery calyx and corolla.

Seeds small smooth oblong –ellipsoid, scarcely striate, smooth. The leaves often produce, on their crenature at the extremities of the lateral nerves, buds furnished with root, stems and leaves, which drop off and at once become new plants.

Distribution

Kalanchoe is a medicinal plant largely used in folk medicine for various treatments; it is distributed through out India and cultivated in gardens and wild on the hills of North-Western India, Deccan and Bengal⁵.

Traditional Uses

WORLDWIDE ETHNOMEDICAL USES	
Brazil	for abscesses, adenoids(infected), arthritis, athlete's foot, boils, bronchitis, bubos, burns, calluses, conjunctivitis, corns, coughs, dermatitis, dermatosis, earaches, eczema, edema, erysipelas, fever, glaucoma, headache, infections, inflammation, insect stings, intestinal problems, itch, kidney stones, lymphatic disorders, mouth sores, nervousness, respiratory infections, rheumatism, scurvy, skin problems, toothache, tuberculosis, tumor, ulcers, urinary insufficiency, wart, whooping cough, wounds, and as a sedative. ⁴
Ecuador	for bruises, broken bones ⁴
Guatemala	for aches, diarrhea, pain, skin problems ⁴
India	for abdominal discomfort, boils, bruises, cholera, cuts, diabetes, diarrhea, dysentery, flatulence, headaches, kidney stones, indigestion, insect bites, scabies, sores, urinary insufficiency, wounds ^{6,4}
In Himalaya	Leaves are applied on wound, bruises, swelling and insect bite ⁷
Arunachal pardesh	Leaf extract is taken in empty stomach is used in the treatment of urinary bladder stones and fever in children's. ⁸
Orisa	For diarrhea ⁹
Maharashtra	The leaves juice is used against cough, dysentery ¹
Karnataka	Leaf juice externally applied to scabies and leucoderma and leaf decoction applied over cuts to stop bleeding. ^{11,4}
Mexico	for eye infections, headaches, inflammation, menstrual disorders, pimples, wounds ⁴
Nicaragua	for aches, burns, childbirth, colds, coughs, fever, headache, pain, respiratory infections ⁴
Nigeria	for coughs, earaches, eczema, inflammation, pimples ⁴
Peru	for bacterial infections, boils, broken bones, bronchitis, cancer (lymphoma), conjunctivitis, coughs, earaches, eye infections, epilepsy, erysipelas, fever, gas, headache, heartburn, inflammation, intestinal problems, migraine, nausea, skin problems, sores, ulcers, urethritis ⁴
Bangladesh	for coughs, mucus, fever, epilepsy, constipation, piles etc ¹⁴
South America	for asthma, chest colds, earaches, headaches, sores, strains, tumors ⁴
USA	for chicken pox, fevers, stomachache ⁴
West Indies	for menstrual disorders, ulcers, hypertension, urinary disorder ¹⁰
Vietnam	for antibacterial and anti-inflammatory ¹²
Elsewhere	for arthritis, asthma, bruises, burns, constipation, diabetes, earaches, headaches, malnutrition, migraines, nephritis, paralysis, respiratory infections, rheumatism, sprains, swelling, ulcers, wound ⁴ , and to induce vomiting of blood , cut umbilical cord in new born baby, expel worms. ¹⁵

Unani and ayurveda

In ayurveda the leaves are bitter poisonous to insects. While in unani the bark is bitter and poisonous; tonic, alexipharmic, astringents to the bowels, analgesic, carminatives; useful in diarrhea and vomiting, inflammations; in snake-bite and scorpion sting.⁴

Pharmacognostical Studies

The macroscopic studied showed that leaves are opposite, simple or compound, 12-18cm and 6-8cm in size, apex is obtuse, ovate or elliptic in shape, crenate or serrate margin, asymmetric base, reticulate venation, petiole is long, surface is glabrous, upper epidermis dark green in color and lower epidermis lighter in color and with a characteristic odors and bitter test .

The microscopic studies of leaves of plant showed xylem, phloem, mesophyll tissue, midrib, while the trichomes absent both side i.e. adaxial side and abaxial side. It is broadly shallow on the adaxial side and convex on the abaxial side. It has thin adaxial epidermal layer of small, less prominent cells. The abaxial epidermis is also nary thin and less distinct. The ground tissue of midrib is parenchymatous and homogenous. The cells are circular or angular and compact. The vascular strand is single, collateral, small and hemispherical in shape. It consists of thick horizontal band of xylem and fairly wide band of phloem. The vascular bundle is 100µm in vertical plane and 170 µm in horizontal plane. The lamina is uniformly flat with even surface. The mesophyll tissue is not differentiated into palisade and spongy parenchyma. The stomata are abundant, these are 18-20 stomata per mm², having anisocytic in nature¹⁶.

Phytochemical Review

➤ The plant contain alkaloids , flavonoids, phenolic compound, tannins, macro elements ;magnesium, calcium, potassium,

phosphorus, sodium , microelements; iron, zinc, vitamins ; ascorbic acid, riboflavin, thiamine, niacin.¹⁷

- Syringic acid, caffeic acid, 4-hydroxy-3-methoxy-cinnamic acid, 4-hydroxybenzoic acid, p-hydroxycinnamic acid, para-coumaric acid, ferulic acid, protocatechuic acid, phosphoenolpyruvate, protocatechuic acid isolated from aerial parts of plants. Leaves contain astragalin, 3, 8-dimethoxy-4, 5, 7- trihydroxyflavone, friedelin, epigallocatechin-3-o-syringate, luteolin, rutin, kaempferol, quercetin, quercetin- 3L-rhamonsido-L-arabino furanoside, quercetin-3-O-diarabinoside, and kaempferol-3-glucoside.¹⁸
- three unusual flavonoids isolated from plant responsible for antileishmanial activity are Kaempferol 3-O-α-Larabinopyranosyl(1→2) α-L-rhamnopyranoside, Quercetin 3-O- α-Larabinopyranosyl(1→2) α-L-rhamnopyranoside, 4',5-dihydroxy-3',8-dimethoxyflavone 7-O-β-D-glucopyradinoside and quercetin from *Kalanchoe pinnata*¹⁹
- From fresh leaves of *Bryophyllum pinnatum* three new constituents, bryophyllol, bryophollone and bryophollenone have been isolated .Three new compounds, bryophynol and two phenanthrene derivatives have also been identified in the mixture. 18α-Oleanane, ψ-taraxasterol, β-amyryn acetate and a new sterol, reported earlier as a hydrolysed product, have also been obtained, along with a mixture of α- and β-amyrins and their acetates.²⁰
- Two insecticidal bufadienolides were isolated from methanolic extract of leaves of *kalanchoe pinnata* and identified as bryophyllin A and bryophyllin C.²²
- Five bufadienolides were isolated from plant responsible for anti tumor activity which are bryophollone, bryophyllin A,

bryophyllin C, bersaldegenin-3-acetate, bersaldegenin1,3,5-orthoacetate, daigremotianin²¹

- 1-octane3-O- α -L-arabinopyranosyl-(1 \rightarrow 6)-glucopyranoside, a minor constituent isolated from leaves.⁴²
- The cardenolide and steroidal contents includes β -sitosterol, bryophyllol, bryophynol, bryotoxin A, bryotoxin B, campesterol, 24-ethyl-25-hydroxycholesterol, isofucosterol, clionasterol, codisterol, peposterol, 22-dihydrobrassicasterol, clerosterol, 24-epiclerosterol, 24-ethyl-desmosterol, stigmasterol are isolated from aerial parts.¹⁸
- Leaf contains amino acids i.e. thiamine, pyridoxine, ascorbic acid, glycine, cysteine, casein hydrlysate, nicotinamide, Food content i.e. carbohydrate, protein, lipids, Minerals; sodium, calcium, potassium, phosphorus, magnesium, ferrous, copper, zinc, and sugars; raffinose, lactose, sucrose, glucose etc²³
- The plant content various enzymes i.e. Phosphoenolpyruate carboxykinase (PCK), Phosphoenolpyruate carboxylase (PEPC), Pyruate orthophosphate dikinase (PPDK), ribulose-1, 5-biphosphate carboxylase/oxygenase (Rubisco) etc enzymes presents in leaf of plant *Kalanchoe pinnata*.²⁴
- Phosphoglycerate kinase, Carbonic anhydrase, Glycolate oxidase, Fructosebiphosphate aldolase, DNA topoisomerase etc protein were identified by Jasmeet K et al, in which most of having role in metabolism.²⁵

Pharmacological Review

Anticancer activity

Supertman and et al isolated Bufadienolides from *Kalanchoe pinnata* and were examined for their inhibitory effects on Epstein Barr virus early antigen activation in Raji cells induced by the tumor promoter, all bufadienolides shows good activity, while Bryophyllin A shows highest activity²².

Anticonvulsant activity

Bryophyllum pinnatum leaf extract (50,100,200mg/kg) given to the rats in groups and various test were performed Head dip and evasion test in mice, muscle tone (Chinney test, inclined screen test and climbing test) and anticonvulsant test (strychnin and picrotoxin induced convulsant in mice). The all extracts showed positive results while 200mg/kg shows highest activity. Cytotoxic study revealed that the aqueous leaf extract of Bryophyllum pinnatum in dosage up to 20g/kg³¹.

Anti-diabetic activities

Hydroalcoholic extract of plant (500mg/kg body wt.) shows reduction in both postprandial and streptozosin induced diabetes blood glucose levels, triglyceride levels, low density lipoprotein level, and increase in high density lipoprotein level⁴⁰.

Antifungal activity

Adenike A. O. Ogunshe et al worked on the Nigerian Traditional plants to evaluate antifungal activity (Vaginal Candidiasis). They evaluated the plants against the various strains of these species (*Candida albicans*, *C.glabrata*, *C. tropicalis*, *C. pseudotropicalis*). They conclude that none off the strains of *C. pseudotropicalis* inhibited by ethanolic extract of *Kalanchoe pinnata*. While it have good inhibitory effects against other species³⁵.

Antileishmanial activity

Da Silva et al used BALB/c mice for the experiment and Leishmania amazonensis (lma) used to induce the disease, the work demonstrate that the aqueous extract of plant protects mice against progressive infection with lma by oral route of administration.²⁷

A case of a 30-yr old man who was naturally infected in the Amazonian region of

Brazil with a virulent species of Leishmania, and was voluntary treated with *kalanchoe pinnata*. The skin lesion was steadily growing when he started ingesting three leaves of plant a day for 2 weeks. Throughout this period of time the lesion stopped growing and the draining lymph nodes returned to normal sizes. The patient did not notice any side effect and the urea, creatinin, TGO and TGP serum levels remained unaltered suggesting absence of liver, heart or kidney toxicity. Upon *kalanchoe* withdrawal the lesion started growing again and the patient was then submitted to the classical pentavalent antimony therapy.²⁸

Antimicrobial activity

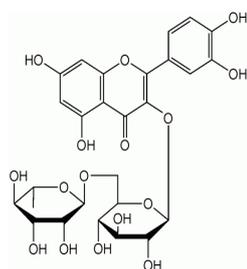
Kalanchoe pinnata leaf extract (60% methanolic extract) was found to inhibit the growth of five out of eight microorganism used, at a concentration of 25mg/ml. *klebsiella pneumoniae*, *pseudomonas aeruginosa* and *candida albicans* showed resistance.³²

Anti-nociceptive and anti-inflammatory activity

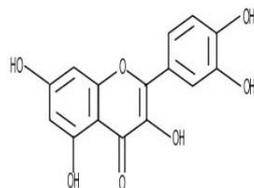
Bryophyllum pinnatum leaf aqueous extracts (BPE, 25-800mg/kg i.p.) Produced significant antinociceptive effects against thermally and chemically induced nociceptive pain stimuli in mice. The plant leaf aqueous extract (BPE, 25-800mg/kg i.p. or p.o) significantly inhibited fresh egg albumin induced acute inflammation of the rat hind paw²⁹.

Antiproliferative activity

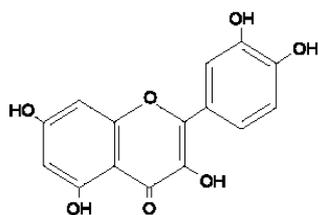
Jun-ya Ueda et al. have done MTT assay on a highly metastatic human HT-1080 fibrosarcoma cell line. The shows that methanolic, methanolic: aqueous and aqueous extract have mild antiproliferative activity³⁶.



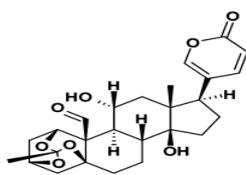
Rutin



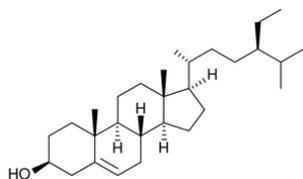
kaempferol



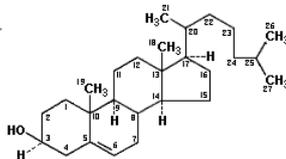
Quercetin



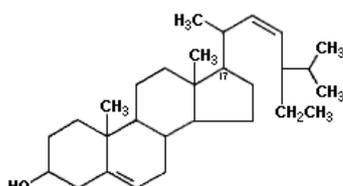
bryophyllin A



β - Sitosterol



cholesterol



Stigmasterol

Anti ulcer activity

The ethanolic extract shows activity against acute ulcers, while aqueous extract did not prevent the formation of gastric mucosal lesions induced by indomethacin⁴¹.

Diuretic and antiurolithic activity

Hydroalcoholic extract of leaves of *Kalanchoe pinnata* (Crassulaceae) was administered to male wistar rats by oral and intraperitoneal route at the doses of 100,300,500 and 800 mg/kg. The effect of urine out put was determined by comparing the urine volume collected by keeping individual animal in metabolic cages. Antiurolithic effect was determined by comparing urinary electrolyte levels, biochemical parameters and kidney histology with control and standard drug treated animals. Plant extract was found to exert significant diuretic and antiurolithic activity.³⁹

Hepatoprotective activity

The leaf juice (concentrated) and the ethanolic fraction of the juice (EX) was taken for the activity. Both in vitro and in vivo model were taken for assessment of activity.

Hepatotoxicity was induced by chloroform is due to its metabolite ccl3· a free radical that binds to lipoprotein and leads to per oxidation of lipids of endoplasmic reticulum. The result of this experiment are the decrease of bilirubin level by the plant concentrate up to 105.50% and decrease of SGPT level by concentrate and EX up to 92.47 and 87.43% respectively. These data along with histopathological studies clearly show the Hepatoprotective activity of *kalanchoe pinnata*³³.

Immunomodulatory effect

male BALB/c mice and Lou-M rats were used for the experiments and Eosinophil counts, OVA specific IgE, T cell proliferation, Cytokine production, Histamine release assay etc parameters were considered, the results shows that plant extract and its Quercetin flavonoids effectively protects mice against anaphylactic shock³⁴.

Nephroprotective activity

Harlalka et al report that the aqueous extract of leaves of *Kalanchoe pinnata* possesses potent nephroprotective against gentamicin induced nephrotoxicity in rats and in vitro anti oxidant activity³⁷.

Neurosedative and muscle relaxant activity

The saline leaf extract of plant was investigated on neuropharmacological activity to ascertain claims of local use. When tested in mice, it produced a dose-dependent prolongation of onset and duration of pentobarbital- induced hypnosis, reduction of exploratory activities in the head-dip and evasion tests. Moreover a dose dependent muscle in coordination was observed in the inclined screen, traction and climbing tests. It delayed onset to convulsion in both strychnine and picrotoxin induced seizures in addition to minimal protection against picrotoxin seizures³⁰.

Uterine relaxant

Bryophyllum pinnatum shows relaxant effect in vitro on the contractility of human myometrium and reinforcing against fenoterol induced uterine contractility (Spontaneous contraction, Oxytocin stimulated contraction).³⁸

Wound healing activity

The effect of *kalanchoe pinnata* leaf extract viz. petroleum ether (PE), alcoholic extract (AE), and water extract (WE) on healing, excision, incision and dead space wound in albino rat has been investigated. All the three extract showed significant increase in the breaking strength of incision wound. Cotton pellet dry weight and hydroxy prolin content of granulation tissue, when compared to control groups, and they showed significant increase in wound contraction and formation of scars on 17th post wounding day. The result reveal that WE hastened the healing process in open wounds, but all the extract administered systematically promoted the healing of incision wounds.²⁶

MARKETED PREPARATION

1 Amantol – cream

Upper respiratory disorders, sinusitis, bronchitis, allergic reactions, conditions related to blockages in nasal passage. Ingredients: Mentha viridist extract (mint.), Iresine difusa (escanel) extract, Lippia alba extract (yantria), Zingiber officinalis extract (ginger), *Kalanchoe pinnata* extract (Pakipanga), *Mansia alliacea* extract (ajo de monte), mentol, alcanfor, water, cream base. External usage only⁴³

2 Parnabija svarasa -anti obesity⁴⁴

CONCLUSION

The plant *kalanchoe pinnata* is a succulent plant which has been introduced to many temperate and tropical regions of the world as an ornamental. In several of these regions, the species is widely naturalised and regarded as invasive. It forms dense stands in dry and disturbed areas. *Kalanchoe* is rich in alkaloids, triterpenes, glycosides, flavonoids, steroids and lipids. The leaves contain a group of chemicals called bufadienolides which are very active and have sparked the interest of scientists. They are very similar in structure and activity as two other cardiac glycosides, digoxin and digitoxin (drugs used for the clinical treatment of congestive heart failure and related conditions). *Kalanchoe's* bufadienolides have demonstrated in clinical research to possess antibacterial, anti-tumor, cancer preventative, and insecticidal actions. Generally leaf, leaf juice and whole plant is used the root part is not yet explored hence the further studied should be done to evaluate its chemical and pharmacological activity. As we find that clinical trial on the plant yet not done hence the plant can be explored for clinical study.

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