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Phytochemical and Pharmacological Profile of the Magical Medicinal Herb: *Kalanchoe pinnata*

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Abstract

Kalanchoe pinnata is found mainly in the plains, tropical and subtropical regions of Africa, Australia and the United States and is widely used in medicine to treat various ailments. This includes its use in the treatment of bacterial infections in cuts and wounds and is used externally to heal wounds and reduce fever, vomiting, ear pain, smallpox, cough and headache. The genus *Kalanchoe* contains about 125 species of tropical, nutritious flowering plants of the Convolvulaceae family. In many parts of the world, the *Kalanchoe* species is primarily an ornamental and indoor plant, but some have escaped extinction and can be found in the wild and are widely known as the 'Christmas tree plant'. It is a perennial shrub that grows to a height of 1 to 1.5 m. These plants are grown as ornamental plants. In the past, the genus was divided into three categories: *Kalanchoe, Bryophyllum* and *Kitchingia*. Phytochemicals such as phenols, flavonoids, saponins, tannins, triterpenoids, glycosides, carbohydrates, sterols and amino acids are found in these extracts of plant leaves. The juice from the fresh leaves is used to treat vomiting, earache, smallpox, cough, asthma, allergies, diarrhea, blood clots, jaundice, gout, headaches, convulsions and general degeneration. A study was being conducted to investigate the mutagenic and antimutagenic activity of juice extraction from this plant. The review describes the folklore use of the plant in many disorders and discusses the various phytochemicals responsible for the pharmacological actions.

Keywords: *Kalanchoe; Bryophyllum; Plant Extract; Pharmacological; Phytochemical*

Introduction

The universal role of plants in disease treatment is illustrated by their use in all major medical systems, regardless of philosophy. The use of plants as medicine in ancient times includes their use in Mesopotamia, Egypt, Unani (Islamic) and Ayurvedic (Hindus) systems centered in western Asia and the Indian subcontinent, as well as those in the East (China, Japan, Tibet, etc). How and when used medicinal plants for the first time and, in many cases, are missing from the previous history, in fact, animals, apart from man, seem to have their medicinal properties.

After the oral transmission of medical knowledge began the use of writing (e.g. *Papyrus ebers* of Egypt, Dating back to 1600 BC), baked clay tablets (written over 660 cuneiform tablets containing approximately 650 BC records from the library of Ashurbanipal in Nineveh, now in the British Museum, refer to the drugs known today), skins and handicrafts, printed herbs (invention of the printing of 1440 advertisements), pharmacopeias and other works (first London Pharmacopoeia, 1618; first British Pharmacopoeia and later 1864), just data retention.

Alike records exist in Chinese medicinal plants (literature of the 4th century B.C) [1]. Conferring to the WHO, medicinal plants will be the best source of alternative medicine. About 80% of people from developed or developing countries use traditional medicine, which contains chemicals found in medicinal plants. Plants are a well-known source of primary and secondary metabolism where they are broken down by their chemicals and/or body structures into one or more of the following groups: fats, extracts and balsams [2].

Kalanchoe is a multi-species species most of which are used as agents for the treatment of various diseases. Plants of this type were known for their medicinal properties and have been studied by scientists for a very long time. *Pinnata* (the same name) belongs to the Crassulaceae family and can be extracted from the parent and sown separately in pots or empty countries. This plant is a water-retaining plant that grows about 1 to 1.5 m tall. The leaves of this plant are green, fleshy and brightly separated. The stems are long and have metal-like flowers (Figure 1). The plant is found in the plains and tropics of Madagascar and Southeast Africa, Australia and the Americas and is also distributed in regions of warm climates [3].

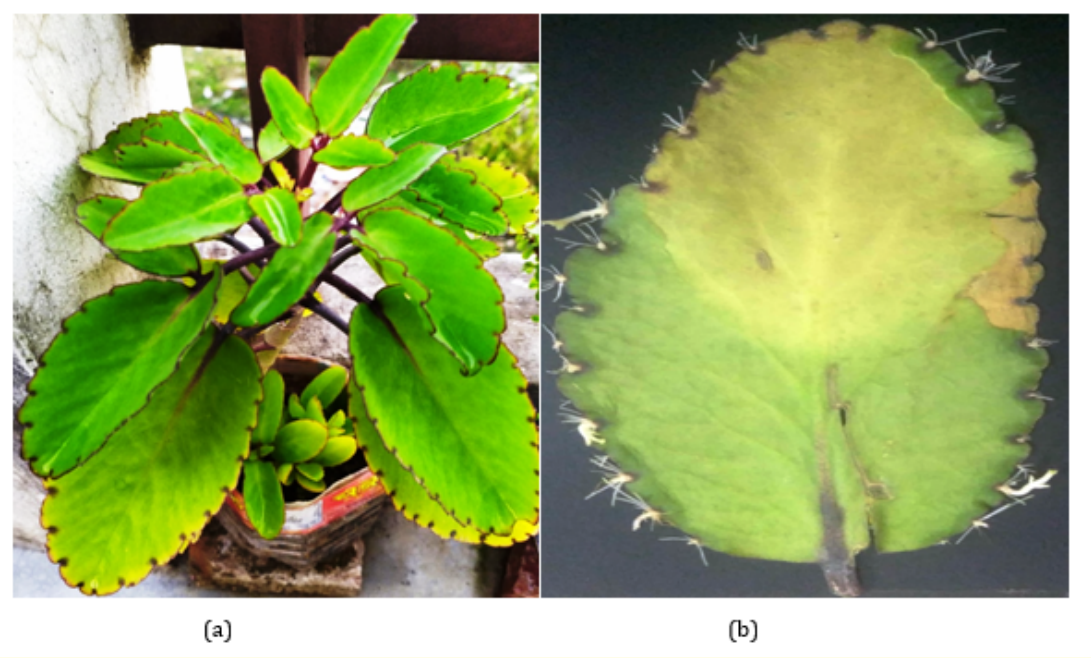


Figure 1: *(a) Kalanchoe pinnata plant (b) Vegetation on the K. pinnata leave.*

Taxonomical classification [4]:

- 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.

The leaves of this plant are medically important and many reports have described the use of this plant to treat several ailments in the traditional medical system, especially in the family. Traditionally, crushed leaves are used to make non-irritating herbs throughout Asia. Worldwide, powdered leaves are used for coughing and colds, to heal boils and wounds and to treat smallpox [5]. The crushed leaves are used to treat headaches and are used externally to reduce fever and soothe ulcers, bruises are also applied to wounds, to relieve inflammation and are taken orally to treat diabetes. The juice from the leaves is diluted to treat painful diarrhea and diarrhea [6].

It is one of the most widely used medicinal plants of ethno in Asia. In Africa, *K. pinnata* is used to help with childbirth and to treat ulcers, skin diseases and rheumatism [7]. This plant has high healing properties. It is used to treat bladder stones. *In vitro*, experimental studies have shown the antihistaminic activity of this plant and studies have also shown improved sleep quality in pregnant women, as well as tocolytic effects such as beta-agonist but with fewer side effects. The juice from the fresh leaves is used to treat vomiting, earache, smallpox, cough, asthma, diarrhea, blood clots, jaundice, gout, headache, tremors and general degeneration [7,8]. Johann Wolfgang von Goethe, who was an amateur naturalist of some repute, was ardently affectionate of this plant and gifted the baby plants to their visiting friends. He also discussed his air plant at length in an essay titled German: *Geschichte meiner botanischen Studien* («History of my botanical studies») [10].

The plant *Kalanchoe pinnata* was harvested by Pierre Sonnerat in Isle de France (Mauritius) and communicated to Lamarck who defined it in 1786 as the *Cotyledon pinnata*. Later, the Paris naturalist, Christiaan Hendrik Persoon reclassified it in the *Kalanchoe* (calling it *Calanchoe pinnata*, with an orthographic variant). At the same time, in London, the botanist Richard Anthony Salisbury designated the same plant from a sample collected from Bengal, under the name of *Bryophyllum calycinum* and at the same time, created the new genus *Bryophyllum* [11].

A study was being conducted to investigate the mutagenic and antimutagenic activity of juice extraction from this plant. Phytochemicals such as phenols, flavonoids, saponins, tannins, triterpenoids, glycosides, carbohydrates, sterols and amino acids are found in these extracts of plant leaves. These chemical components are responsible for showing the above-mentioned chemical effects. In this review, an attempt is made to confer the various functions mentioned above of *K. pinnata* and information on its therapeutic and behavioral values [12-14].

Here, we have tried to deliver a modernized summary of the traditional uses, phytochemical constituents as well as pharmacological facets of the *Kalanchoe pinnata* species which might serve the researchers to utilize the potential of this plant in its better clinical use. Along with this, we have also focussed to discuss the scrutiny of active compounds engaged in various pharmacological actions such as antimicrobial activity.

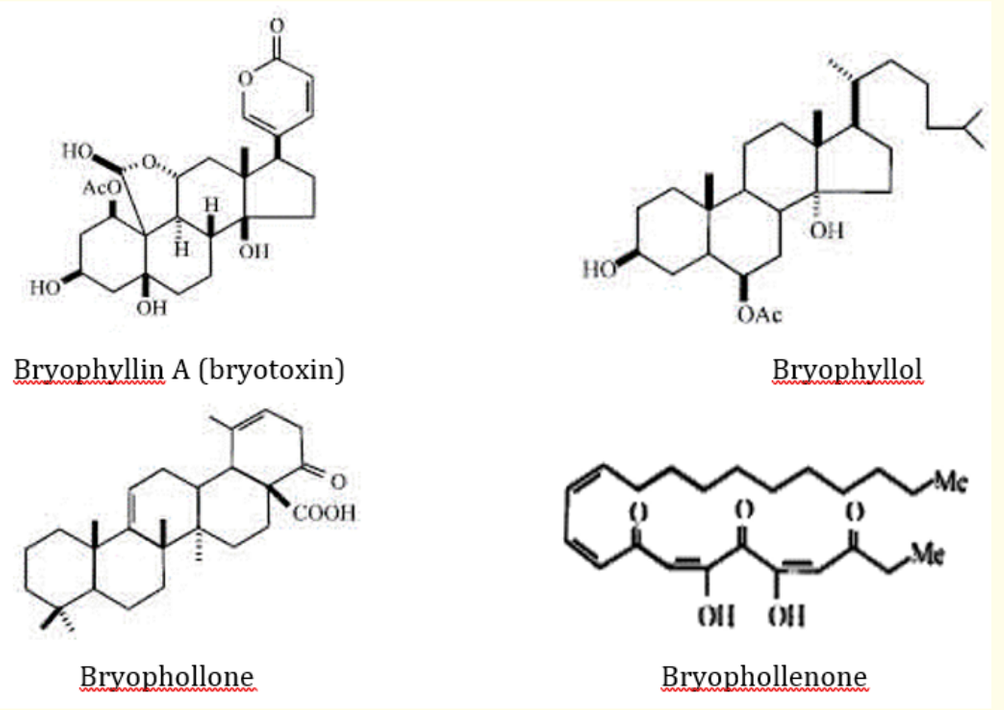
Phytochemical constituents

Many of the essential chemical elements and secondary plant metabolites are listed and the most important are bufadienolides and flavonoids. From the leaves, bryophyllin B and A have been isolated from the major components of bufadienolides like bryotoxin A, B and C which is very similar in structure and action to two other cardiac glycosides, digoxin and digitoxin and possess antibacterial, antitumoral, cancer preventative and insecticidal actions [15]. In the leaves and extracts, many flavonoids are classified, including quercitrin, kapinnatoside, 8-methoxyquercetin-3, 7-di-Orhamnopyranoside and 3', 4'-dimethoxy quercetin. Other flavonoid compounds namely Afzelin and α-rhamnoisorobin were also found [16]. In extracting ethanol from this plant, fatty acids such as stearic acid, palmitic acid and arachidic and behenic acid have been identified. The presence of alkaloids, saponins, glycosides and tannins has been confirmed in this plant [17] (Refer to table 1).

Part of the plant used	Type of extract	Phytochemical constituent	References
Leaves	Methanolic	Bufadienolides	[20]
Leaves	Ethanolic	Alkaloids, Flavonoids Glycosides, Phenolics, Steroids, Terpenoids, Tannins	[21]
Fresh leaves	Aqueous	Flavonoids	[22]
Dried leaves	Aqueous, ethanolic, diethyl ether and 20% acetic acid	Alkaloids, Flavonoids, Phenols, Tannins, Vitamins, Minerals	[23]
Powdered plant	Ethanolic	Flavonoids	[24]
Shoot	Petroleum ether	Steroid (stigmasterol)	[25]
Roots	Aqueous, chloroform, ethanol, ether	Alkaloids, Flavonoids, Glycosides, Steroids, Saponins, Tannins, Carbohydrates, Proteins, Amino acids	[26]

Table 1: *Phytochemical compounds derived using various types of extract from the different parts of the Kalanchoe pinnata species.*

It is also noticed that the accessibility of several flavonoids, polyphenols, triterpenoids and other chemicals in this plant is accountable for its many therapeutic functions such as anti-nociceptive, anti-inflammatory, anti-bacterial and anti-diabetic effects [18]. The herb is an excellent source of vitamins such as ascorbic acid, niacin and thiamine and contains the minerals Ca, Mg, Na, Fe, P, K and Zn [19].



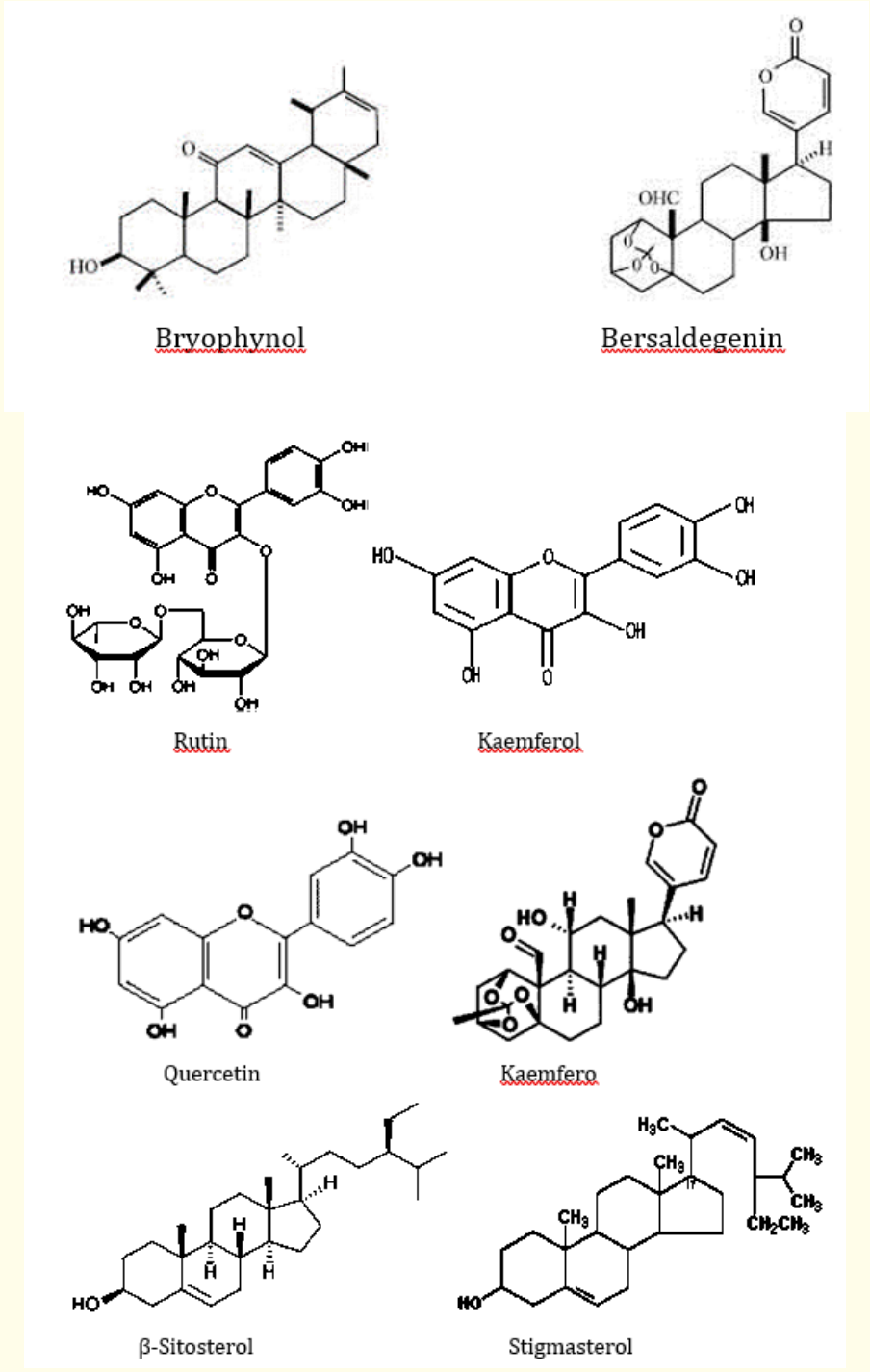


Figure 2: *Phytochemical constituents of Kalanchoe pinnata (adjusted to occupy minimum space as suggested by the honorable reviewer, images are clarified for better resolution).*

General pharmacological effects of the plant

The ongoing development of dosage forms requires the use of potential drugs that impart fewer side effects and adverse effects. In this modern era, the focus is on the use of herbal medicinal plants which has the potential pharmacological activity to subside the usage of synthetic/semisynthetic drugs to safeguard the health of the common people. A myriad of medicinal plants has been used to derive an array of potential medicinal agents based on their traditional uses that lend advantage of countless pharmacological activities and cheaper dosage form development.

Kalanchoe pinnata is one such wonder plant that possesses numerous medicinal values due to the presence of active pharmacological constituents such as alkaloids, flavonoids, glycosides, tannins, etc. Here in this section, we have focused on the potential pharmacological activity of the plant such as antimicrobial, antifungal, antibacterial, wound healing, antioxidant, antitumor, etc.

Antimicrobial activity

Kalanchoe pinnata extract has been testified for its antimicrobial activity. Mudi S and Ibrahim H in their research reported the antimicrobial potential of the *B. pinnatum* on the respiratory tract pathogenic bacteria [19]. Various extraction solvents have been utilized to determine the antimicrobial activity of the various plant parts on quite a lot of pathogens. Table 2 recapitulates the antimicrobial potential of the *Kalanchoe pinnata* plant disclosing that the methanolic extract of the leaves of the plant exhibited maximum action against most of the pathogenic test strains. Tajuddin., *et al*. in their review article, emphasized the antimicrobial functionality of *K. pinnata* extract, the bioactive compound investigation of the plant extract and their mechanism of action against pathogenic microbes [27].

Part of *Kalanchoe* plant and type of extract	Method	Pathogen	Outcomes	References
▪ Root extract ▪ Chloroform, petroleum ▪ Ether, methanol and water	*In vitro*: disk diffusion	• *E. coli* • *P. aeruginosa* • *S. aureus* • *C. albicans*	Effective antimicrobial activity was given by the methanolic extract against all pathogens excluding *C. albicans*	[28]
Ethanolic or aqueous leaf extract	*In vitro*: broth microdilution	• *β - hemolytic Streptococcus,* • *Corynebacterium diphtheriae,* • *Staphylococcus aureus,* • *Staphylococcus epidermidis,* • *Enterococcus hirae,* • *Escherichia coli* • *Candida albicans*	▪ The highest antimicrobial activity was shown by ethanolic extract against *Staphylococcus aureus, Staphylococcus epidermidis, Enterococcus hirae*	[29]

Hydroalcoholic extract	*In vitro*: agar well diffusion	• *L. monocytogenes,* • *S. typhi,* • *P. aeruginosa,* • *S. choleraesuis,* • *B. subtilis,* • *E. coli* • *S. aureus*	▪ The hydroalcoholic extract showed sufficient antimicrobial activity against L. monocytogenes, P. aeruginosa, B. subtilis and S. aureus	[30]
Leaf extract ethyl acetate and methanol	• *In vitro*: broth microdilution • *In vivo*: Swiss mice's guts	*Helicobacter pylori*	• The extract showed anti-helicobacter activity with minimum inhibition concentration (MIC) and • Minimum bactericidal concentration (MBC) values of 32 and 256 µg/ml, respectively. • The bacterial load of the gastric mucosa is reduced.	[31]
Leaf extract of wild-type and transgenic *K. pinnata*	*In vivo*: directly applied to bacteria-infected wounds	• *Pseudomonas aeruginosa* • *Staphylococcus aureus*	Both transgenic and wild-type plant extracts showed a significant anti-microbial activity	[32]
Methanolic leaf extract		• *Bacillus subtilis, E. coli, P. vulgaris, Shigella dysenteriae and S. aureus were found to be inhibited while Klebsiella pneumoniae, P. aeruginosa and C. albicans* were found to resist the action of the extract	The extract inhibited the growth of *B. subtilis, E. coli, P. vulgaris, Shigella dysenteriae and S. aureus* while *K. pneumoniae, P. aeruginosa* and *C. albicans* showed resistance to the extract.	[33]

Table 2: *Antimicrobial activity of Kalanchoe plant.*

Wound healing activity

Ethanol extraction of ethanolic *K. pinnata* has shown the important function of wound healing by reducing the size of the affected area. Studies have reported that this may be due to the presence of steroidal glycosides and phenolic antioxidants. Water, petroleum ether and alcohol particles in this plant have been reported to be more likely to heal wounds and dehydration shows more activity than the other two extracts [29].

Antibacterial activity

Investigators isolated two bufadienolides, two flavonoids and an alkaloid found in derived methane. *K pinnata* and they found it to show the strong antibacterial activity of the plant. These phytocompounds inhibit the growth of other gram-negative and positive bacteria and fungi. It has also been reported that the antimicrobial ability of the aqueous and methanolic fragments of the plant stem is of great importance. Bacteria found on the skin can cause skin infections and when they enter the body, they cause respiratory infections, food poisoning, wound infections, abscesses, osteomyelitis, endocarditis, pneumonia and other complications. Reported details can be used to prepare antibacterial and antifungal creams for commercial use. Studies have confirmed the traditional use of this plant in the treatment of respiratory diseases, including pneumonia. Petroleum ether and liquid fragments of leaves and stems of *K. pinnata* have been reported to show almost the same effect as that of an antimicrobial agent used as a standard [35]. Richwagen., *et al*. reviewed the antimicrobial activities of the Kalanchoe genus and assessed the *in vitro* antibacterial effects of two previously unexplored species against a panel of multidrug-resistant bacteria, the ESKAPE pathogens (*Enterococcus faecium, Staphylococcus aureus, Klebsiella pneumoniae, Acinetobacter baumannii, Pseudomonas aeruginosa* and *Enterobacter cloacae*) [36].

Antiviral activity

Human papillomavirus (HPV) is one of the most common sexually transmitted infections, acting as a major threat to humans. Increasing cervical cancer is instigated by HPV. This plant leaves fragments when found in cancer cell lines, suppressing the expression of viral proteins thus preventing viral growth and plant growth. Epstein Barr virus is a herpes virus that affects human lymphocytes, leading to tissue formation.

Studies conducted on the activity of chemicals isolated from the methanolic extraction of this plant have reported that plant-based compounds inhibit bacterial activity and inhibit plant growth [37].

Antioxidant activity

Antioxidants in the plant *K. pinnata* leave cells to protect against the harmful effects of active oxygen species, such as singlet oxygen, superoxide, peroxyl radicals, hydroxyl radicals and peroxynitrite. Antioxidants with reducing properties are often associated with the presence of reductones, which have been shown to act as an antioxidant by breaking a strong free chain by donating a hydrogen or electron atom. Reductones are also described to react with certain precursors of peroxide, thus preventing the formation of peroxide [38].

The potential anti-oxidant activity has a positive effect on the treatment of heart disorders and has been found that the dose of decongestant increased with increasing concentration. The leaves are reported to show more severe dehydration effects than stems and ethanolic extracts show a more complete phenolic and flavonoid content than other extracts. The high amount of phenols and flavonoids released induces high antioxidative activity. Phenolic elements can interact with flexible metals even in the lipid phase and chew them by filling their aqua bonds and forming insoluble metal-linked structures. Inhibition of lipid auto-oxidation can be caused by the ability of phenolics to stabilize radicals through the production of stable phenoxyl radicals by directly destroying peroxyl radicals and ethanolic releases K. and lipid phases [39,40].

Antitumor activity

Studies have been performed on mice by reducing tumor formation in the peritoneal region of the body. Methanolic and aqueous vegetable leaf pieces were added as drugs in certain doses. This release reduced the amount of ascetic fluid and bound tumor growth, acting as a tumor-reducing agent. Therefore, the report was reported to have antitumor activity. The ad revealed properties that reduce

apoptosis, a function of growth inhibition, in cervical cancer cells due to the presence of certain phytocompounds. The study also discussed aspects of plant antimicrobial activity. In a study, the presence of aqueous extracts of diethylnitrosamine-induced hepatocarcinogenesis in mice reduced hepatic damage. The protective effect may be due to the antioxidant and antiperoxidative effects associated with abnormal correction of lipid and lipoprotein metabolism by increasing the activity of a few lipid-binding enzymes.

Diethyl nitrosamine often produces free radicals as its metabolism occurs in the liver, disrupts the antioxidant state and ultimately leads to oxidative stress and carcinogenesis, it is considered a major natural hepatocarcinogen [41]. Milo and the group reviewed the making of antioxidants and anticancer composites from Bryophyllum spp. (Kalanchoe) using plant cell tissue culture [42].

Antileishmanial activity

Leishmania protozoans cause Leishmaniasis. The liquid discharge of *K. pinnata* was given orally to mice infected with *Leishmania amazonensis*. After the trial, several actions were performed, such as a reduction in the size of the lesion and the burden of disease on the infected area. Continuous extraction treatment not only controlled growth but also prevented further infection. It was suggested that this method could be used for visceral leishmaniasis. Antileishmanial activity can be caused by the presence of flavonoid glycosides in plant light [43].

Antihelmintic activity

A review of the various publications shows that comparative research has been conducted on the activities of various liquid chemical agents against common worms and worms. The results of their study revealed that chloroform, methanolic and aqueous extract roots of *K. pinnata* have anthelmintic activity, while petroleum ether extract does not show any anti-worm activity. Methanol extraction was found to be more effective compared to plant root not only indicating deformity but also causing worm mortality, especially at higher altitudes. The reason may be due to the discovery of tannins, as they can bind to release proteins in the intestinal tract of the host animal or glycoprotein in the parasite cuticle and cause death [39].

Insecticidal activity

Bufadienolides separated from the leaves of the *K. pinnata* plant have been reported to exhibit strong insecticidal activity against third silkworm larvae and the cause is associated with the presence of 1, 3, 5-orthoacetate moiety of bufadienolides [44].

Antinociceptive activity

Methanolic break for *K. pinnata* has been reported to show a significant anti-bacterial effect in mice compared to standard drug aspirin. Reduce the many acetic acid formulations in a dose-dependent manner. Wet extraction of plant leaves has shown antimicrobial effects in combating inflammatory and chemical pain in mice. Wet extract relieves pain and protects rats. Liquid extraction may exert its antinociceptive effects by inhibiting the secretion, binding and/or production of inflammatory cytokines by mediators, including prostaglandins, histamine, polypeptide kinins and so on [39,45,46].

Anti-inflammatory activity

An experiment to find an anti-inflammatory activity for this plant was made with petroleum ether, chloroform, acetone and methanol fractions from the leaves were given to experimental models with edema made of formaldehyde. In addition, the methanolic fraction has been reported to show more significant inhibition of paw edema than other extracts. Formaldehyde reduces inflammation in cell damage, which triggers the production of extracts that can be caused by the presence of bufadienolides and other water-soluble substances.

Chronic mediators, such as histamine, serotonin, prostaglandins and bradykinin. It is also known that the inhibition of formalin-induced edema in mice is one of the anti-inflammatory activities [26,39,47]. Sudirman and Monica in their research studied the effect of anti-inflammatory of infuse *Bryophyllum pinnatum* (*Kalanchoe pinnata*) against edema on leg thigh Swiss Webster male mice and described that the infusion of the leaves of *Bryophyllum pinnatum* has a potential anti-inflammatory effect [48].

Antidiabetic activity

Diabetes is a major risk factor for cardiovascular disease such as stroke; heart disease that affects most people in the world has been reported that the ethanolic release of *K. pinnata* lowers blood glucose levels in diabetic rats. Therefore, reduced serum glucose levels and increased glucose tolerance. Plant extraction increased pancreatic insulin secretion and researchers investigated the antidiabetic activity of ethanolic and aqueous extracts of *K. pinnata* stem against alloxan-induced diabetes in rats. They reported that both of these extracts show hypoglycemic activity, i.e. significant antihyperglycemic activity. The functions of both of these extracts were compared and it was found that ethanolic extraction showed inhibitory activity of α- amylase enzyme rather than aqueous solution, whereas aqueous extraction showed hypoglycemic activity than ethanolic extract by inducing diabetes in mice with streptozotocin treatment.

When fluid is absorbed orally, glucose levels in the blood are reduced. Also, after continuous 24-hour observation, glucose levels drop to normal levels indicating the potential for antidiabetic disease [47,49,50].

Varsha Tiwari and their group performed various pharmacological studies on the *K. pinnata* root standardized extract. They reported that the ethyl acetate extract at 300 mg/kg demonstrated significant antianxiety potential, whereas ethanol extract at 100, 200 and 300 mg/kg did not show a statistically significant antianxiety effect. The alcohol and aqueous extracts of the roots of *K. pinnata* exhibited a statistically significant ($P < 0.001$) decrease in FBG at 400 mg/kg, whereas both extracts at low doses failed to show a significant decrease in FBG on the oral glucose tolerance test.

The researchers treated STZ-induced diabetic rats with alcohol and aqueous extract (200 and 400 mg/kg) and reported a statistically significant ($P < 0.001$) reduction in FBG of the diabetic rats after the 21st day of treatment. They finally concluded that the *Kalanchoe pinnata* plant can play an effective role in the management of diabetes and anxiety [51].

Immunomodulatory activity

The liquid discharge of *K. pinnata* greatly suppressed the delayed response of mice with ovalbumin-induced allergies thus proving to be an immunosuppressive agent. Liquid excretion prevented the reduction of mast cell degranulation and histamine, due to the presence of quercitrin, flavonoid, which inhibits lethal anaphylaxis by reducing pro-anaphylactic immune responses and fluctuations in critical events related to panic leading to death (reaction) excessive excess). This immune response is particularly important in resisting the phenotype prophylactic therapy of hypersensitive individuals under the risk of anaphylactic shock [39,52].

Hepatoprotective activity

The plant is being monitored for its antimicrobial activity. In mice, carbon tetrachloride that stimulated hepatic damage was performed and found that ethanolic release of leaves reduced levels of liver enzymes, serum bilirubin, serum cholesterol and total serum protein. The results showed that the pot had a clear antibody function. Increased regeneration of hepatocytes and microsomal enzyme inhibition also protects the liver from injury [53].

Gastroprotective/Anti-ulcer activity

Bryophyllum pinnatum has gastroprotective effects and is confirmed by its reliable dose-protection effect on ethanol-induced gastrointestinal damage. Sharma., *et al*. in their study, reported that the aqueous whole plant extract of *B. pinnatum* at a dose of 750 mg/kg p.o. and MUC at a dose of 500 mg/kg p.o. distinctly lessen the occurrence of ulcers in ethanol-induced ulcer rats. They stated that the total carbohydrate content increased as equated to the control group. The aqueous whole plant extract of *B. pinnatum* at a dose of 750 mg/kg presented a substantial lessening in the above parameters that were analogous to the standard drug rabeprazole (20 mg/kg). They stated that the *B. pinnatum* extract and MUC showed a protection index of 72.69 and 69.65% respectively, whereas standard drug rabeprazole showed a protection index of 75.49%. They finally concluded that the entire plant extracts of *B. pinnatum* and MUC possess an effective gastroprotective effect [54].

Nephroprotective activity

Bryophyllum pinnatum is widely used for its nephroprotective activity in the past [55] and the concept of its use has been proven by studies. Research findings have shown that this effect depends on volume. The nephroprotective activity against nephrotoxicity induced by gentamicin in the Wistar rat kidney was tested and it is expected that this effect may be due to its antioxidant properties and radical scavenging properties. It is suggested that the juice of the leaves is more effective in the treatment of bladder dysfunction and has fewer side effects than anticholinergic drugs [39,56]. Revati and her group, in their research, reported the beneficial preventive and therapeutic nephroprotective effect of *B. pinnatum* mediated AgNPs against ethylene glycol-induced urolithiasis in rats [57].

Urolithic activity

The therapeutic drug is used in the treatment of kidney stones in traditional medicine. Leaving watery discharge significantly reduces the level of oxalate urine and, as a result, may help treat urolithiasis. In Pakistan, this medicinal herb is used to treat kidney stones in traditional medicine. *Bryophyllum pinnatum* is beneficial in reducing renal stones because it enhances the release of oxalate crystals by reducing crystal size and converting them from misleading crystals into a form of calcium oxalate monohydrate. Research has confirmed that plant extraction protects the kidney cell from the chemical calcium oxalate and oxidative stress and reduces the formation of kidney stones by increasing the melting and excretion of these stones through urine [58].

Pandhare., *et al*. in their study, stated that the oral administration of BPHE at doses of 50,100 and 200 mg/kg to rats with sodium oxalate-mediated renal calculi disclosed dose-dependent substantial ($P < 0.05$) antiurolithiatic potential, with a noteworthy setback of NaOx-induced ion excretion and urinary CaOx concentration. They concluded that their results rationalize the traditional use of *Bryophyllum pinnatum* hydroalcoholic extract (BPHE) in the treatment of renal calculi [59].

Neurosedative, muscle relaxant and psychoactive activity

Bryophyllum pinnatum has a significant effect on the CNS and it has been proven that methanolic release produced significant changes in behavioral patterns. The results of the study showed that the pot caused CNS stress and promoted the dependence on the duration of sleep pentobarbitone. Other studies have also suggested that it helps treat sleep disorders during pregnancy. The medicinal plant is helpful in the treatment and management of seizures and this was confirmed by experiments on mice. It has shown an increase in the initial dose dependence and duration of sleep induced by pentobarbitone and a decrease in experimental activity in headache testing and escape. Vascular-based muscle contraction is guaranteed on the adjacent screen, grip and elevation exercises. Both seizures caused by strychnine and picrotoxin, caused the onset of convulsions late [60]. Pereira., *et al.* and their group proposed both anxiolytic and

psychoactive effects of leaves extract of *B. pinnatum* in a dose-dependent manner in a larval zebrafish model. Their results present an understanding of the mechanisms underlying relevant behavioral effects, thus proposing the safe and effective use of leaves extract of *B. pinnatum* for the management of mood disorders [61].

Antimutagenic activity

Antihistamines and anti-viral effects are available in the plant. Methanol extract from the leaves was able to block histamine receptors (H1) in the ileum, peripheral vasculature and bronchial muscles, thus shielding against allergic reactions and chemical death by selectively blocking histamine receptors in the lungs. Quercetin-3-o-α-L-arabinopyranosyl (1→2)-α-L-rhamnopyrano - side displayed anti-allergic action in rats. The organic solvent extract of leaves imparted inhibitory activity for His- to His+ reverse mutations induced by ethyl methanesulfonate acting on the *S. typhimurium* TA100 or TA1002 and showed activity contrary to reversion induced by 4nitro-o-phenylenediamine and 2-aminofluorene in TA98. The alkaloidal/water-soluble and acid fraction had no appreciable antimutagenic activity [62].

Uterine contractility

The phytotherapeutic tocolytic action of human myometrium *in vitro* compared with standard betamimetic, fenoterol Contractility was tested with time-tested myometrium biopsied strips in the cesarean section and observed for increased *B. pinnatum* vs +/- oxytocin growth for 14 women. The pressure of the automatic crack in the emerging condition was dependent on the focus. *B. pinnatum* increased the frequency by 91% by constant size while preventing the reactivation of oxytocin by 20% by constant but low frequency. Fenoterol reduced cuts by 50% with a significant reduction in frequency [63].

Antihypertensive activity

Effects of leaf discharge *K. pinnata* in the blood pressure of untreated cats and the condition of the rabbit's liver and kidneys were investigated in this study. The results showed that the discharge produced a small fall in the cat's blood vessel that could be killed and also reduced the effect of high blood pressure caused by adrenaline. It was concluded that a medical basis for using pinnata among Nigerian Igbos to lower blood pressure was established by this study. However, the fact that the reduction in blood pressure produced is small and the extraction of *K. pinnata* leaf may be organotoxic opposes its use as an antihypertensive agent [64].

Analgesic and Anticonvulsant activity

The analgesic effect of methylene chloride/methanol (1: 1) (CH_2Cl_2/CH_3OH) extracts also hexane, methylene chloride (CH_2Cl_2), ethyl acetate, n-butanol fractions and aqueous residue were tested using acetic acid, formalin and pressure test. The anticonvulsant effects of CH_2Cl_2/CH_3OH release have also been investigated for the induction of pentylenetetrazol (PTZ), strychnine sulfate (STN) and thiosemicarbazide (TSC). CH_2Cl_2/CH_3OH extract and its oral components have shown a protective effect of at least 30% on acetic acid-induced pain. The CH_2Cl_2 fraction at 300 mg/kg showed a significant effect of 78.49%. The release of CH_2Cl_2/CH_3OH and its CH_2Cl_2 fraction at doses of 150 and 300 mg/kg significantly reduced the first phase of pain caused by formalin while the second phase was completely inhibited.

The CH_2Cl_2 fraction produced more than a 45% reduction in stress-induced pain. CH_2Cl_2/CH_3OH release of *K. pinnata* significantly increased latency time in PTZ-induced seizures and significantly reduced the duration of unconsciousness caused by three vibrations. The release protected 20% of animals from death from seizures caused by TSC and STN. These effects enhance peripheral and central analgesic activity as well as the anticonvulsant effect of leaves *K. pinnata* [65].

Anti-allergic activity

The liquid discharge of *K. pinnata* has tested the protective effect of lethal anaphylactic shock, similar to Th2 induced by immunopathology and to identify its active component. *In vitro*, *K. pinnata* protected the reduction of mast cells induced by antigen and histamine release. Oral treatment with plant-derived quercitrin flavonoid protects against lethal anaphylaxis in 75% of animals. These findings suggest that oral treatment with *K. pinnata* effectively reverses pro-anaphylactic responses that reduce immune responses. The protection obtained with quercitrin, or otherwise, suggests that this flavonoid is a critical component of *K. pinnata* extracted from this excessive response [66].

Conclusion

The current study focuses on the latest evidence-based information regarding the Phytochemical and Pharmacological profile of *Kalanchoe pinnata*. It is concluded that this deific plant encompasses many imperative therapeutic constituents that are in authority for cultivating various beneficial effects. Various studies have explicated and established the wisdom of its use in traditional medicine.

In this article, we have summarized the several pharmacological activities such as antimicrobial, analgesic and anticonvulsant, antihypertensive, uterine contractility, antimutagenic, neurosedative and muscle relaxant, urolithiatic, nephroprotective, anti-ulcer, hepatoprotective, immunomodulatory, antidiabetic, anti-inflammatory, antinociceptive, insecticidal, antihelmintic, antileishmanial, antibacterial, antiviral, antitumor, the antioxidant activity of *Kalanchoe pinnata* (Lam.). The authors hope that the information shared in this article about the *Kalanchoe* plant and its traditional use may be explored for conventional use, identification and isolation of the active compounds that are accountable for the pharmacological activities conversed in the literature so far.

The traditional and non-clinical use of the plant may well be carried forward for clinical use as an alternative treatment for several ailments discussed here.

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