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**Review Article**

# Pharmacognostics Studies And Quality Control of Kalanchoe Pinnata

**Kauser Razzaque Naykwade*, Viraj Mahajan, Dr. Nilesh Chougule**

*Ashokrao mane institute of pharmacy, Ambap-412112.*

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## ABSTRACT

Kalanchoe pinnata, a succulent plant renowned for its medicinal properties, has garnered significant interest in pharmacognostic studies and quality control assessments.This research explores the phytochemical composition, pharmacological activities, and quality parameters of Kalanchoe pinnata to establish its efficacy and safety for therapeutic use. Standardized methods for identifying key active compounds, such as flavonoids, alkaloids, and phenolic compounds,were employed along sidemorphological and anatomical evaluations of the plant Quality control measures, including chromatographic techniques and spectrophotometric analysis, were utilized to ensure the consistency and purity of herbal preparations. The findings highlight the plant's potential in traditional medicine and underscore the importance of rigorous quality control to validate its therapeutic claims. This study contributes to the understanding of Kalanchoe pinnata's role in herbal pharmacotherapy and emphasizes the need for comprehensive quality assessment in herbal medicine.

## INTRODUCTION

Numerous plants in Latin America, and Colombia in particular, have been shown to have therapeutic qualities; these plants may contain active compounds with a range of therapeutic uses [1,2]. Among these is Kalanchoe pinnata (Lam.) Pers (syn. Bryophyllum pinnatum, (Lam.) Oken), a species that hasbeen usedin traditional medicine to treatbacterial, fungal, andviralinfections aswell as kidney stones, asthma, inflammatory issues, and ulcers. Its anti-inflammatory [3], immunosuppressive, and nephroprotective properties (4) Because of its decorative beauty and traditional medicinal qualities, this plant species has substantial economic and medicinal significance. It has been utilized in traditional medicine to treat a number of conditions, including rheumatism, inflammation, immunosuppression, hypertension, kidney stones, liver damage, and anti-tumor properties [5]. The plant can multiply through epiphyllous secondary buds, but as all biotechnological instruments [6] for conservation

***Corresponding Author:** Kauser Razzaque Naykwade
**Address** Ashokrao mane institute of pharmacy, Ambap-412112.
**Email** ✉: kausernaykwade@gmail.com

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projects require an efficient regeneration system, a technique for quick multiplication through in-vitro culture mustbe developed. Many succulent plants peciesare propagatedusingin-vitrotissue culture, which is thought to be the most effective technique [7, 8]. Alam, et al. [9]explains how K. tubi flora was successfully propagated in vitro using leaf explants, how the growth regulators in the culture media were tuned, and how high regeneration rates were attained. Sayari and associates [10]

**Taxonomical Classification**

Kingdom: Plantae(Plants)
Subkingdom: Tracheobionta(Vascularplants)
Super division : Spermatophyta (Seed plants)
Division : Magnoliophyte (Flowering plant)
Class: Magnoliopsida(Dicotyledonous)
Subclass: Rosidae
Order: Saxifragales
Family: Crassulaceae Stonecrop family
Genus: Kalanchi
Species: Kalanchoe piñata(Lam.) Per[11]

**Synonym**: Bryophyllumcalycinum, Bryophyllumpinnatum[121314]

a. Leaves b. Flowers c. Roots

Fig. 1 Depiction of *Kalanchoe pinnata* shrub

The plant isa succulent perennial that grows 1-1.5m tall and hasa hollow, four-angled, usually branched stem. The leaves are opposite, decussate, succulent, and 10-20 cm long. The lower leavesare simple, while the upper ones are 3-7 foliate and long-petioled; they are dark green, fleshy, and distinctively scalloped and trimmed in red. The leaf blades are pinnately compound with 3-5 leaflets, 10-30 cm; petiolules 2-4 cm; the leaflet blades are oblong to elliptic x 3-5 cm, margin crenate, each notch bearing a dormant bud capable of developing into a healthy plantlet apex obtuse [12]. Theleaves are equipped with rooting vegetative buds, and the inflorescences are terminal paniculate, 10- 40 cm. pendulous. Calyx tubular, 2-4 cm; Corolla reddish to purple, 5 cm base sparsely ciliate; lobesovate-lanceolate;stamensinsertedbasallyoncorolla;nectar scalesoblong;follicles included in calyx and corolla tube.[15 16 17]

**Chemical Constituents**

Aclassofveryactivecompoundsknownasbufadienolidesisfoundintheleaves. Bufadienolides, such as bryotoxins A, B, and C, haveantibacterial,antitumorous,cancer-preventive,andinsecticidalpropertiesandarestructurallyandphysiologicallysimilartotwo additional cardiacglycosides, digoxinanddigitoxin[18,19,20]. Bufadienolides-BryophyllinA(bryotoxin)[21];BryophyllinB(Fig.1); Bryophyllol(Fig. 2);Bryophollone(Fig.3);Bryophollenone(Fig.4);Bryophynol(Fig.5)[22];Bersaldegenin (fig. 6).

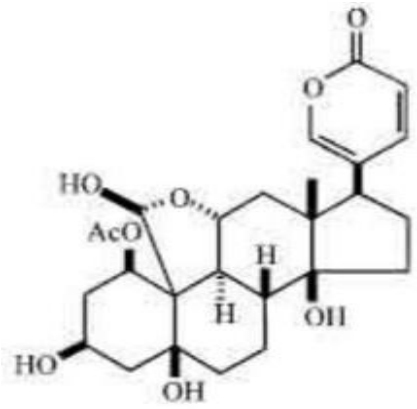


FIG. 1: BRYOPHYLLIN

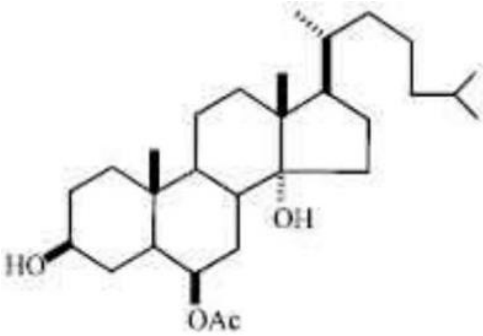


FIG. 2: BRYOPHYLLOL

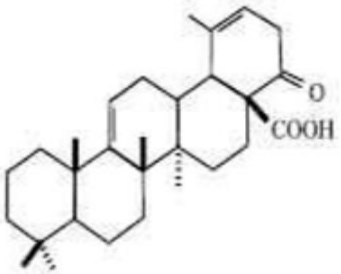


FIG. 3: BRYOPHOLLONE

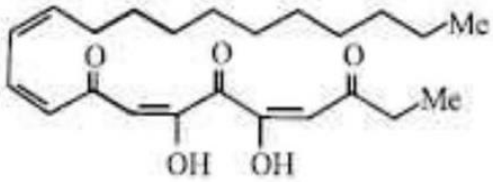


FIG. 4: BRYOPHOLLENONE

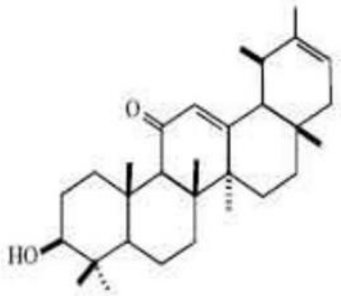


FIG. 5: BRYOPHYNOL

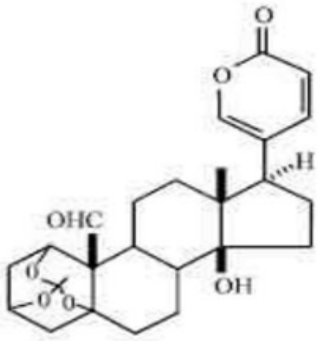


FIG. 6: BERSALDEGENIN

**Extract Ion Methods**

K.pinnata leaf extracts were produced utilizing three distinct extraction procedures. Conventional Solvent Extraction Plant samples (1 g) were immersed in threedifferent solvent combinations of methanol and waterwith differentratios (0:100 (T1CSE); 50:50 (T2CSE); 100:0 (T3CSE), volume/volume) fora duration of 24 hours at 60°C. The mixtures were then homogenized at 60°C for 4 hours using a homogenizer (HG-15D, Daihan Scientific Co., Ltd., Seoul, Korea). A basic filter paper assembly was used to remove residue material from solvent, and the samples were then concentrated using a rotary evaporator at 60°C temperature and 150 rpm (WEV-1001L, Daihan Scientific Co., Ltd., Seoul, Korea). Samples were then freeze-driedand storedat 4°Cfor additional testing as stated byTruong et al.[23].] Super Critical Fluid Extraction(SFE)

With minor adjustments, the protocol created by Lim et al. [20] for SFE was adhered to. For extraction, the Supercritical Fluid Extractor Model SFT-150 from the USAwas utilized. The specific SFE model had a syphonated carbon dioxide cylinder, a volume extractor, and a separator to produce the requiredsolventpressure forthe

process;the assemblyalsohada syringe pump.Ineverytrial,200 g of vacuum-dried K. pinnata leaf powder was put in the extractor vessel. The weight of the extract was determined at regular intervals during the extraction procedure in order to gauge the extraction rate. Operating parameters were pressure, temperature (40°C), extraction time (two hours), and pressures of 3500 psi (T4SFE), 4500 psi (T5SFE), and 5500 psi (T6SFE). Microwave-assisted extraction Following the procedure used by Ghasemzadeh et al. [24] with minor adjustments, several extracts were made by microwave heating at 700-W power for three minutes (T7MAE), six minutes(T8MAE), and nine minutes (T9MAE). Ten milliliters of methanol were mixed with two grams of K. pinnata powder. A 50 mL double-necked flask system with a cooling jacket was used to hold the mixture. After that, the mixture in the flaskwassubjectedto 700-Wof microwave radiationat various intervals to extract it. Flasks were water-cooled to room temperature once the extraction period was over. Extract filtering using a simple filtration assembly comes next. Arotary evaporator set to 40°C and 150 rpm was used to remove the solvent in order to concentrate the extract. Extracts were freeze- dried and kept for additional testing. At 20°C.

**Isolation And Identification**

**Identification Of Compound 1:3-Oxo-Olean-12-ENE**:Compound 1 (0.8g) was found to be n-hexane crystals. When vanillin-H2SO4 was sprayed over TLC employing an n-hexane: ethyl acetate (90:10) solvent solution with Rf 0.54, it produced a dark purple spot. The existence of a geminal dimethyl group at 1380 cm-1, an olefinic carbon at 1610 cm-1 (C- 12), and a carbonyl group at 1706 cm-1 were all identified by IR spectrum analysis. The presence of eight methyl groups was shown by the 8 singlet signal at δ (0.8-1.13) in the 1H-NMR spectrum. The olefinic proton at H-12 is indicated by a strong signal at δ 5.1 (1H, t). Asignal at δ217.8 in the 13C- NMR established the existence of the ketonic functional group. This data is in close accord with the data reported in the literature to be 3-oxo-olean-12-ene (Figure 4)(Lima etal., 2005; Caceres-Castillo et al., 2008). (C-3) also shows the presence of 121.5 & 145.3 ppm, indicating olefinic carbons at C12 & C13, respectively.

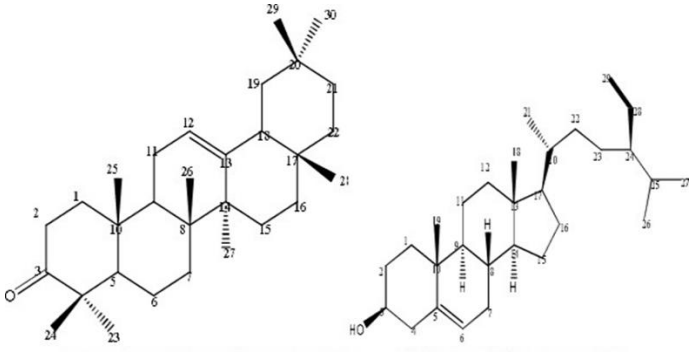


**Fig: Chemical Structure of Compound 1 and 2**

**Identification Of Compound 2:B-Sitosterol**

With Rf 0.2, Compound 2 (0.1 g) was separated asa white powder (n-Hexane: CH2CL2 70:30).After spraying with vanillin-H2SO4 using an n-hexane: ethyl acetate (90:10) solvent system, it produced a buff color under UV light that changed to a dark purple spot on TLC. The existence of a hydroxyl group and an olefinic carbon at 1645.7 cm-1 was indicated by a significant absorption band at 3377.8 cm-1 in the IR spectra of 2 (C-5). The presence of six methyl groups at δ(0.8-1.6) in the 1H-NMR spectrum indicated the presence of the C-24 ethyl sterol nucleus. Additionally, an oxygen-bearing methine

proton atδ 3.2(1H, m) andan olefinic protonatH-6 are represented bya signalat δ 5.1(1H, t). 29 carbons were identified in the 13C-NMR spectra as belonging to the six methyl groups [δ 15.7 (C-18),17.2(C-19),and17.4(C-21),18.4(C26),21.5(C-27),16.8(C-29),]vinyliccarbonatδ[124.5(C-5), 121.8(C-6)], and one oxygenated at δ 79.1 (C-3). The β-sitosterol physical and spectral data (Figure 4) were the same as those reported for compound 2 (Jayaprakasha et al., 2007; Moghaddam et al., 2007).

**Qualitative Analysis Of Phytochemical[25]**

The screening of qualitative phytochemicals was carried out as follows:

- Ferric chloride test for tannins: About 0.5gofthe extract should be boiledin 20ml of water, filtered, andafewdropsof0.1%ferricchlorideadded. Look for indications of blue-blackor greenish-brown hue.

The foaming test for saponins involves mixing 5 mg of the extract with 20 ml of distilled water, stirring for 15 minutes, and looking for the production of foam, which is a sign that saponins are present.

- Flavonoids (Leadacetate test):Adda few drops of a 10% lead acetate solution after ingesting 10 mg of the extract. When flavonoids are present, ayellowprecipitate forms.
- Terpenoids (Salkowski's test): cautiously add 3 ml of concentrated H2SO4 after mixing 5 mg of the extract with 2 ml of chloroform. H2SO4. To determine whether terpenoids are present, look for a reddish-brown interface.

According to Wagner's Test, alkaloids: Apply 1.5% v/v hydrochloric acid to 2 mg of the extract to acidify it. Add Wagner's reagent after filtering. When a brown or reddish precipitate forms, it indicates that alkaloids are present.

- Steroid (Salkowski's test):Mix 2 milliliters of chloroform with 2 milliliters of strong sulfuric acid to dissolve 5 milligrams of the extract. The presence of steroids is indicated by the emergence of a red color.
- Glycosides (sodium hydroxide test): Dissolve the extract (approximately 5 mg) in 1 ml of water and add 5–6 drops of 10% NaOH. The presence of glycosides is indicated by the formation of a yellow tint.

**Pharmacological Activities**

**Anti-inflammatory activity**

Leaf extracts of Kalanchoe pinnata were produced in methanol, acetone, chloroform and petroleum ether to investigate its effects on formaldehyde induced oedema on experimental basis. When compared to all other extracts, the methanolic extract had the strongest impact on preventing paw edema. Bradykinin, prostaglandins, serotonin, and histamine were also measured in formaldehyde-induced inflammations from injured cells that have sufficient ability to create the endogenous mediators. These experimental findings thus led to the conclusion that the presence of bufadienolides and other water-soluble extract constituents was primarily responsible for the inhibition of oedema in rats caused by formalin [26]

**Anti-microbial activity**

Kalanchoe pinnata roots were combined with methanol, chloroform, petroleum ether, and water to create extracts of varying polarity. Because of the presence of diverse flavanoids, these extracts demonstrated a multitude of potential actions when taken orally. These solvent extracts were investigated in murine models of cutaneous leishmaniasis. Quercetin-L-, 3-O-L arabinopyranosyl, 3-

O-L-rhamnopyranoside, and free quercetin dosages per day rhamno pyranoside were administered to the test animals. According to experiments, these substances were able to considerably lower the parasite load and regulate the development of lesions brought on by Leishmania amazonensis. The crude Kalanchoe pinnata aqueous extract was administered at 320

mg/kg of body weight, demonstrating the efficacy of these flavonoids. According to an HPLC-DAD-MS examination of the extract-treated mice's plasma, the primary metabolites of Kalanchoe pinnata quercetin glycosides are quercetin and quercetin glucuronides. These findings demonstrate that quercetin glycosides, which have strong oral activity against cutaneous leishmaniasis, are significant active mechanisms of the aqueous extracts [27].

**Anticancer activity**

Supert man et al. extracted bufadie no lides from Kalanchoe pinnata and tested them for their ability to suppress the early antigen activation of the Epstin Barr virus in Raji cells caused by the tumor promoter. All of the bufadie no lides exhibited good action, but the maximum activity was shown by bryophyllin A [28].

**Anticonvulsant activity**

Rats were administered Bryophyllum pinnatum leaf extract in groups at doses of 50, 100, and 200 mg/kg, and tests were conducted. Muscle tone (Chinney, inclined screen, and climbing tests), anticonvulsant (strychnin and picrotoxin-induced convulsant in mice), and head dip and evasion tests in mice. While 200 mg/kg exhibited the maximum activity, all extracts produced positive outcomes. An aqueous leaf extract of Bryophyllum pinnatum at a concentration of up to 20g/kg was found to be cytotoxic [29].

**Anti-diabetic activities**

Plant hydroalcoholic extract (500 mg/kg body weight) decreases blood glucose, lipid, and low density lipoprotein levels and increases high density lipoprotein levels in both postprandial and streptozosin- induced diabetes [30].

**Antifungal activity**

In order to assess the antifungal efficacy of Nigerian traditional plants (Vaginal Candidiasis), Adenike A. Ogunshe et al. They compared the plants to several strains of Candida albicans, Candida glabrata, Candida tropicalis, and Candida pseudotropicalis.They conclude that the ethanolic extract of Kalanchoe pinnata does not suppress any of the strains of C. pseudotropicalis. Despite having strong inhibitory effects on other species [31],]

**Antileishmanial activity**

Through the use of BALB/c mice and Leishmania amazons is (lma) to cause the disease, Da Silva et al.'s work shows that an aqueous extract of the plant, administered orally, protects mice against increasing infection with lma. 27 A 30-year-old guy who was voluntarily treated with kalanchoe pinnata after becoming naturally infected with a virulent type of Leishmania in Brazil's Amazonia. When he began eating three plant leaves per day for two weeks, the skin lesion was steadily getting bigger. The tumor stopped expanding during this time, and the diameters of the draining lymph nodes reverted to normal. The patient's serum values of urea, creatinin, TGO, and Every TGP was normal. stayed same, indicating that there was no damage to the kidneys, liver, or heart. After the kalanchoe was removed, the lesion began to recur, therefore the patient was treated with traditional pentavalent antimony.[32]

**Anti-nociceptive and anti-inflammatory activity**

Mice exposed to thermally and chemically produced nociceptive pain stimuli showed notable antinociceptive responses to Bryophyllum pinnatum leaf aqueous extracts (BPE, 25-800 mg/kg i.p.). The aqueous extract of plant leaves (BPE, 25–800 mg/kg i.p. or p.o.) dramatically reduced the acute inflammation of the rat hind paw caused by fresh egg albumin.[33]

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