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REVIEW ARTICLE

Pharmacognostical, Phytochemical and Pharmacological Review on *Bryophyllum pinnata*

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ABSTRACT

Bryophyllum pinnatum kurz commonly known as panfuti (Hindi), life plant, love plant, air plant (Mexican), Good luck or resurrection plant is a crassulenscent herb of about one meter in height, with opposite, glabrous leaves (with 3-5 deeply crenulated, fleshy leaflet). They widely grow in hot and humid areas, around the dwelling places, along road sides and in abandoned farm and fields. *Bryophyllum pinnatum* Kurz leaves have great medicinal values in the indigenous system of medicine. It is used for medicinal purpose both, internally as well as externally. The leaves are frequently used for an array of human disorders including hypertension, diabetes mellitus, bruises, wounds, boils, burns, sloughing ulcers, opthalmia, corn, diarrhea, dysentery, vomiting, abscesses, insect bites, arthritis, rheumatism, joint pains, headaches, antifungal, antibacterial, body pains and acute inflammmation. The leaves are also used for lymphadenitis and ear disease. The main constituents of this the plant are alkaloids, flavonoids, glycosides, steroids, bufadienolide and organic acid are reported. This review focus on folk occurrence and the wide phytochemicals and pharmacological activities of *Bryophyllum pinnatum* kurz.

Key words: Air plant, Crassulenscent, Opthalmia, Lymphadenitis, Bufadienolide.

INTRODUCTION

India is the herbal garden of the world and has been a source of plants and its products, since antiquity, man uses them in different way according to his needs, particularly as food and medicine. Among the entire flora, 35000 to 70000 species have been used for medicinal purpose[1,2,3]. The name *Bryophyllum* comes from 'I sprout' and 'leaf', the plant, classified as a weed is notorious for its growth potential. Shortly after a leaf falls to the grounds, a whole garland of new little plants develops from the notches along the leaf margin. *Bryophyllum pinnatum* kurz commonly known as panfuti (Hindi), life plant, love plant, air plant (Mexican), Good luck or resurrection plant is a crassulenscent herb. They widely grow in hot and humid areas, around the dwelling places, along road sides and in abandoned farm and fields. They are widely used in folk medicine of its indigenous region (Madagascar, Tropical Africa, India, China, Australia, Hawai and Tropical America) [4,5,6]. The present review of the *Bryophyllum pinnatum* kurz is based on:

- Pharmacognostical investigation
- Phytochemical investigation
- Pharmacological investigation

Plant profile:

Kingdom: Plantae – Plants
Sub kingdom: Tracheobionta – Vascular plants
Division: Spermatophyta
Subdivision: Magnoliophyta – Flowering plants
Class: Magnoliopsida – Dicotyledons
Subclass: Rosidae
Order: Rosales
Family: Crassulaceae
Genus: Bryophyllum
Species: *Bryophyllum pinnatum* kurz

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Synonym [7,8]**:** Kalanchoe Pinnata**,**Cotyledon pinnata, Crassula pinnata.
Hindi: Jakh Me Hayat, Panfuti
Sanskrit: Parnabija
English: Air Plant, Miracle-Leaf
Bengali: Koppata
Gujarati: Ghaymaari
Telgu: Simahmudu
Tamil: Ranakalli
Malayalam: Ellamurunga

Morphology:

It is a glabrous, ornamental, crassulenscent herb, cultivated in houses and gardens. It is of about 1–1.5 m in height, with opposite, decussate, succulent, 10–20 cm long glabrous leaves (with 3–5 deeply crenulated, fleshy leaflet) with obtusely four angled stems. The lower leaves are usually simple, whereas upper ones are usually 3–7 folioate, long-petioled, petioles united by a ridge round the stem, crenatures at the extremities of the lateral nerves furnished with rooting vegetative buds. The flowers are 5cm long, reddish purple, pendent, in large spreading panicles; fruits are membraneous follicles enclosed in the persistent papery calyx and corolla, seeds smooth, ellipsoid [9,10,11].

Chemical constituent [12]**:**

- Isocitric acid & citric acid
- Bufadienolides like bryotoxin A, B, C
- Phenols, Phenylpropanoids and Flavanoids: Syringic acid, caffeic acid , 4-hydroxy-3-methoxy-cinnamic acid, 4-hydroxybenzoic acid, p-hydroxycinnamic acid, paracoumaric acid, ferulic acid, protocatechuic acid, phosphoenolpyruvate, protocatechuic acid
- Triterpenoids and Steroids: α-amyrin, α-amyrinacetate, β-amyrin, β-amyrinacetate, bryophollenone , bryophollone , taraxerol , pseudo taraxasterol, 18-α-oleanane, friedelin, glutinol.

Uses:

- The leaves of parnabija have great medicinal value and are used for medicinal purpose both, internally as well externally. The leaves possess various properties like haemostatic, refrigerant, emollient, mucilaginous, vulnerary, depurative, anti-inflammatory, disinfectant and tonic. They are useful in vitiated conditions of vata and pitta, cuts and wounds, hemorrhoids, menorrhagia, discoloration of the skin, boils, sloughing ulcers, ophthalmic, burns, scalds, corn, diarrhea, dysentery, vomiting and acute inflammations.
- Externally, the pulp of the leaves or the juice is applied on traumatic injuries to arrest the bleeding and promote the healing of wounds. The juice of its leaves contract the minute arterioles and arrest bleeding which may be external or internal. On traumatic wounds, the heated leaves of parnabija are crushed and applied. It reduces the edema and promotes the wound healing without leaving a scar. This miraculous haemostatic property of parnabija needs further scientific evaluation.
- Internally, the leaves juice and cumin seeds are given along with the double amount of ghee in dysentery. It arrests the bleeding, as well as stimulates the intestines. Parnabija is highly recommended in raktapitta – bleeding disorders, piles and menorrhagia.

Ayurvedic properties [13]**:**

Guna (Quality) : Laghu, Ruksha
Rasa (Taste) : Kshay, Amal
Vipak (Metabolism) : Madhur
Virya (Potency) : Sheet
Prabhav (Impact): Rakta-stambhan

Physicochemical parameters:

Physicochemical parameter includes moisture content, total ash, acid insoluble ash, water-soluble ash, water-soluble extractive and alcohol soluble extractive[12,14]. The values for physicochemical parameter are tabulated in (**Table 1**).

Table 1: Physicochemical constant of *Bryophyllum pinnatum* kurz

Sample identity	%LOD	% Total Ash	Acid insoluble ash %	Water soluble ash %	Water soluble Exractive value%	Alcohol soluble Exractive value%
leaves	4.8	25	3	23.5	34	8.3

Phytochemical Review:

The phytochemical screening revealed the presence of steroids, terpenoids, flavonoids, phenolics, tannins, alkaloids and glycosides, carbohydrates, proteins. The petroleum ether and chloroform extracts of the powdered leaves and stems of *Bryophyllum pinnatum* showed the presence of steroids and terpenoids. The ethyl acetate extract responded positively to the tests for steroids, terpenoids, phenolics and tannins. Ethanolic extract of the leaves produced positive tests for flavonoids, steroids, terpenoids, phenolics, tannins, alkaloids and glycosides. Aqueous extract showed the presence of

carbohydrates, proteins, flavonoids, phenolics, tannins and glycosides [12,14].

- In 1935, R.N.Chopra and S.Ghosh reported that the leaves and stem of *B.Calycinum* contains 0.008% of alkaloids [15].
- The non volatile acidic fractions of the Aqueous extract of leaves show the presence of malic, citric and lactic acid [16].
- Pucher isolated the ester of isocitric acid from the estrified mixture of organic acid present in young leaves of *Bryophyllum*[17].
- Wilson isolated isocitric lactone as a monopotassium salt from the dried leaf tissue of *Bryophyllum* [18].
- Syringic acid, caffeic acid, 4-Hydroxy-3-methoxy cinnamic acid, 4-Hydroxybenzoic acid, P-Hydroxycinnamic acid, p-coumaric acid, ferulic acid, protocatechuic acid, Phosphoenolpyruvate isolated from the aerial parts of plant. Leaves contain astragalin, 3,8-dimethoxy-4,5,7- trihydroxyflavone, friedelin, epigallocatechin-3-o-syringate, luteolin, rutin, kaempferol, quercetin, quercetin-3L-rhamnosido-L-arabino furanoside, quercetin-3-O-diarabinoside and Kaempferol-3-glucoside [12].
- Three unusual flavonoids isolated from plant is responsible for antileishmanial activity are Kaempherol-3-O-α-L-arabinopyranosyl(1→2)-α-L-rhamnopyranoside, Quercetin-3-O-α- L-arabinopyranosyl(1→2)-α-L-rhamnopyranoside, 4',5-dihydroxy-3',8-dimethoxyflavone-7-O-β-D-glucopyradinoside from *Kalanchoe pinnata* [19].
- Three new constituent from the fresh leaves of *Bryophyllum pinnata* have been isolated i.e. Bryophyllol, bryophollone and bryophollenone. Three new compounds bryophynol, and two phenanthrene derivatives have also been identified in the mixture. 18α-Oleanane, ψ-taraxasterol, β-amyrin acetate and a new sterol reported earlier as a hydrolysed product [20].
- Two insecticidal bufadienolides (1 and 2) were isolated from a methanol extract of the leaves of *Kalanchoe pinnata* by bioassay-guided fractionation. Compound 1 was identified as known bryophyllin A (bryotoxin C). The structure of new bufadienolide 2, named bryophyllin C, was determined by spectroscopic methods and the chemical transformation [21].
- Five bufadinolides were isolated from plant responsible for antitumor activity which are identified as Bryophollone, bryophyllin A, bryophyllin C, bersaldegenin-3-acetate, bersaldegenin-1,3,5-orthoacetate, Daigremotianin [22].
- 1-Octane-3-O- α-L-arabinopyranosyl-(1→6)-glucopyranoside, a minor constituent isolated from the leaves of *Kalanchoe pinnata* [23].
- 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 [24].
- The Leaf of Kalanchoe pinnata plant contains various enzymes i.e. Phosphoenol pyruvate carboxykinase, Phosphoenol pyruvate carboxylase, pyruvate orthophosphate dikinase, ribulose-1,5-biphosphate carboxylase/oxygenase [25].
- Jasmeet K et al, identify some enzyme have role in protein metabolism i.e. Phosphoglycerate kinase, carbonic anhydrase, glycolate oxidase, fructosebiphosphate aldolase and DNA topoisomerase [26].

Pharmacological review:

- The aqueous extract of *Bryophyllum calycinum* Salisb leaves were showed antinociceptive, anti-inflammatory and antidiabetic activity. The antinociceptive effect was evaluated by the 'hot-plate' and 'acetic acid' test models of pain in mice. The anti-inflammatory and antidiabetic effects were investigated in rats, using fresh egg albumin-induced pedal (paw) oedema, and streptozotocin (STZ)-induced diabetes mellitus [27].
- The saline leaf extract of *Bryophyllum calycinum* Salisb was showed neuropharmacological activities. It is tested in mice, it produce a dose-dependent prolongation of onset and duration of pentobarbitone-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 [28].

- The methanolic extract of *Bryophyllum calycinum* Salisb showed neuropharmacological studies in experimental animals (rats and mice). . The fraction produced alteration of behaviour pattern, caused dose-dependent potentiation of pentobarbitone sleeping time and had significant analgesic activity and possesses a potent CNS depressant action [29].
- The roots of *K. pinnata* were subjected to petroleum ether, chloroform, methanol and aqueous solvent respectively for extraction and *in vitro* evaluation of antimicrobial activity was done against *Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa* and *Candida albicans*. Methanolic extract of roots of *K. pinnata* was found to be most effective as antibacterial as compare to others while none of extract showed the activity against *C. albicans* (Quazi et al., 2011). Akinpelu (2000) in a study found that 60% methanolic leaf extract inhibits the growth of five out of eight bacteria used at a concentration of 25 mg/ml. *Bacillus subtilis, E. coli, Proteus vulgaris, Shigella dysenteriae, S. aureus* were found to be inhibited while *Klebsiella pneumoniae, P. aeruginosa* and *C. albicans* were found to resist the action of the extract. Chemical investigation of the bioactive constituents from the leaf of *K. pinnata* resulted in the isolation of two new novel flavonoids; 5I Methyl 4I, 5, 7 trihydroxyl flavone and 4I, 3, 5, 7 tetrahydroxy 5- methyl 5I-propenamine anthocyanidines have significant antimicrobial activity of *K. pinnata* and its use in herbal medicine in Nigeria [30,31,32].
- The roots of *K. pinnata* were subjected to petroleum ether, chloroform, methanol and aqueous solvent respectively for extraction and the *in-vitro* evaluation of anthelmentic activity was done against *Pheretima posthuma* (Annelida) and *Ascardia galli* (nematode). The results reveal that chloroform, methanolic and aqueous extract of *K. pinnata* have significant anthelmentic activity while petroleum ether does not show any activity against helminth. Methanolic extract of root of *K. pinnata* was found to be most effective as an anthelmentic as compared to other. The roots extract of *K. pinnata* not only demonstrated paralysis but also caused deaths of worms especially at higher concentrations of 100 mg/ml, in shorter time as compared to the reference drug, Piperazine citrate. Phytochemical analysis of the crude extracts revealed the presence of tannins which were shown to produce anthelmentic activity [33].
- The effects of aqueous leaf extract of *K. pinnata* on the blood pressure of anaesthetized cats as well as on the liver and kidney status of the rabbit were investigated in this study. The results revealed that the extract produced a small fall in the blood pressure of the anaesthetized cat and also reduced the effect of adrenaline-induced elevation of blood pressure. It was concluded that the pharmacological basis for the use of *K. pinnata* among the Igbos of Nigeria to lower blood pressure was established by this study. However, the facts that the reduction in blood pressure produced is slight and the *K.pinnata* leaf extract is potentially organotoxic which negates its use as a blood pressure lowering agent [34].
- The effects of aqueous and methanolic leaf extracts of the herb were examined on arterial blood pressures and heart rates of normal (normotensive) and spontaneously hypertensive rats, using invasive and non-invasive techniques. Both the aqueous and methanolic leaf extracts of *B. pinnatum* (BP, 50-800 mg/kg i.v. or i.p.)Produced dose-related, significant ($P<0.05$ - 0.001) decreases in arterial blood pressures and heart rates of anaesthetized normotensive and hypertensive rats. The hypotensive effects of the leaf extracts were more pronounced in the hypertensive than in normotensive rats. The leaf extracts (BP, 0.25 - 5.0 mg/ml)also produced dose-dependent, significant ($P<0.05$ - 0.001)decreases in the rate and force of contractions of guinea-pig isolated atria, and inhibited electrical field stimulation(ES)-provoked, as well as potassium and receptor-mediated agonist drugs-induced contractions of the rat isolated thoraxic aortic strips in a non-specific manner. The inhibitory effects of the leaf extracts on the cardiovascular system of the laboratory animals used in this study were resistant to physiological

doses and concentrations of standard antagonist drugs [35].

- Morales et al. suggested that quercetin has a marked protective effect on cadmium-induced nephrotoxicity that results from an increase Metallothionein, a small cysteine-rich protein and eNOS (endothelial nitric oxide synthase) expression and the inhibition of COX-2 (cyclooxygenase-2) and iNOS (inducible nitric oxide synthase) expression [36].
- The aqueous extract of *K. pinnata* evaluated for its protective effects on Gentamycin-induced nephrotoxicity in rats. It was observed that the aqueous extract of *K. pinnata* leaves significantly protects rat kidneys from Gentamycin-induced histopathological changes. Gentamycin-induced glomerular congestion, peritubular and blood vessels congestion, epithelial desquamation, accumulation of inflammatory cells and necrosis of the kidney cells were found to be reduced in the group receiving the leaf extract of *K. pinnata* along with Gentamycin. Urine creatinine, serum creatinine, blood urea, blood urea nitrogen and the weights of the kidneys were found to be significantly increased in rats treated with only Gentamycin; whereas the treatment with the aqueous extract of *K. pinnata* was found to protect the rats from such effects of Gentamycin. The volume of urine was found to be significantly increased in the rats treated with *K. pinnata* leaf extract. In case of histopathological examination, control rats showed normal glomerular and tubular histology whereas Gentamycin was found to cause glomerular, peritubular and blood vessel congestion and result in the presence of inflammatory cells in kidney sections from the Gentamycin-treated group. Concurrent treatment with the extract was found to reduce such changes in kidney histology induced by Gentamycin. *In-vitro* studies revealed that the *K. pinnata* leaf extract possesses significant antioxidant as well as oxidative radical scavenging activities [37].
- Patil *et al*. studied the diuretic and anti-urolithiatic activity of *K. pinnata*. Hydroalcoholic extract of leaves of *K. pinnata* was administered to male Wistar rats orally and intraperitonially. The effect of the extract on urine output was determined by comparing the urine volume collected by keeping the individual animals in metabolic cages. Calcium oxalate urolithiasis was induced in rats by giving ethylene glycol orally for 7 days and the effect of the extract was observed by its concurrent administration. The extract was found to have significant diuretic and anti-urolithiatic activity and the intraperitonial administration of the extract gave more potent diuretic effect [38].
- Juice of the fresh leaves is used very effectively for the treatment of jaundice in folk medicines of Bundelkhand region of India. The juice of the leaves and the ethanolic extract of the marc left after expressing the juice were studied in rats against CCl4-induced hepatotoxicity. The test material was found effective as hepatoprotective as evidenced by *in vitro*, *in vivo* and histopathological studies. The juice was found to be more effective than ethanolic extract [39].
- The aqueous extract of *K. pinnata* leaves was found to cause significant inhibition of cell-mediated and humoral immune responses in mice. The spleen cells of animals pre-treated with *K. pinnata* showed a decreased ability to proliferate in response to both mitogen and to antigen *in vitro.* Treatment with *K. pinnata* also impaired the ability of mice to mount a delayed-type hypersensitivity reaction (DTH) to ovalbumin. The intravenous and topical routes of administration were the most effective by almost completely abolishing the DTH reaction. The intraperitoneal and oral routes reduced the reaction by 73 and 47% of controls, respectively. The specific antibody responses to ovalbumin were also significantly reduced by treatment. Together, these observations indicate that the aqueous extract of *K. pinnata* possesses an immunosuppressive activity [40,41].
- The extract of *K. pinnata* was evaluated for its wound healing activity by using excision wound model in rats. On the 11th day wounding, there was a significant increase in the wound-healing activity in the animals treated with *K. pinnata* ethanolic extract compared to animals

which received the control treatment and standard treatment. Significant progressive reduction in the wound area was observed by day 11 (86.3%) when compared to the control (68.0%) and standard (85.5%). The histological analysis showed that *K. pinnata* leaf extract exhibited significant wound healing potential. The wound healing exhibited by the extract may be attributed to the presence of steroid glycosides. The medicinal plant has been shown to have a significant quantity of bufadienolide, a steroidal aglycone which exists in the plant as steroidal glycoside [42].

- The analgesic effect of methylene chloride/methanol (1:1) (CH_2Cl_2/CH_3OH) extract and its hexane, methylene chloride (CH_2Cl_2), ethyl acetate, *n*-butanol fractions and aqueous residue was evaluated using acetic acid, formalin and pressure test. The anticonvulsant effects of the CH_2Cl_2/CH_3OH extract were also investigated on seizures induced by pentylenetetrazol (PTZ), strychnine sulphate (STN) and thiosemicarbazide (TSC).CH_2Cl_2/CH_3OH extract and its fractions administered orally exhibited protective effect of at least 30% on the pain induced by acetic acid. The CH_2Cl_2 fraction at 300 mg/kg showed a maximal effect of 78.49%. The CH_2Cl_2/CH_3OH extract and its CH_2Cl_2 fraction at the doses of 150 and 300 mg/kg significantly reduced the first phase of pain induced by formalin while the second phase was completely inhibited. The CH_2Cl_2 fraction produced more than 45% reduction in the sensitivity to pain induced by pressure. The CH_2Cl_2/CH_3OH extract of *K. pinnata* significantly increased the latency period in seizures induced by PTZ and significantly reduced the duration of seizures induced by the three convulsant agents. The extract protected 20% of animals against death in seizures induced by TSC and STN. These results suggest a peripheral and central analgesic activities as well as an anticonvulsant effect of the leaves of *K. pinnata* [43].
- Muzitano et al. carried out an investigation to study the effect of *K. pinnata* on cutaneous leishmaniasis. In order to demonstrate the safety and oral activity of *K. pinnata*, different flavonoids were extracted from the plants and were evaluated *in vivo* in murine model of cutaneous leishmaniasis. Daily oral doses of quercetin 3- O-α-L-arabinopyranosyl, α-L-rhamnopyranoside, quercetin 3-O-α-L-rhamnopyranoside and free quercetin (16 mg/kg body weight) were administered. It was observed that they were able to control the lesion growth caused by *Leishmania amazonensis* and significantly reduce the parasite load. These flavonoids were as effective as the crude *K. pinnata* aqueous extract given at 320 mg/kg body weight. HPLC-DAD-MS analysis of the plasma of extract-treated mice suggested that quercetin and quercetin glucuronides are the main metabolites of *K. pinnata* quercetin glycosides. These results indicate that quercetin glycosides are important active components of the aqueous extract and that they possess potent oral efficacy against cutaneous leishmaniasis [44].
- Five bufadienolides (1-5) isolated from the leaves of *K. pinnata* were examined for their inhibitory effects on Epstein-Barr virus early antigen (EBV-EA) activation in Raji cells induced by the tumor promoter, 12-Otetradecanoylphorbol- 13-acetate. All bufadienolides showed inhibitory activity, and bryophyllin A (1) exhibited the most marked inhibition (IC50 = 0.4 microM) among the tested compounds. Bryophyllin C (2), a reduction analogue of 1, and bersaldegenin-3-acetate (3) lacking the orthoacetate moiety were less active. These results strongly suggest that bufadienolides are potential cancer chemopreventive agents [22].
- Cruz et al. reported on the protective effect of *K pinnata* in fatal anaphylactic shock, likewise a Th2-driven immunopathology and the identification of its active component. *In vitro*, *K. pinnata* prevented antigen- induced mast cell degranulation and histamine release. Oral treatment with the quercitrin flavonoid isolated from the plant prevented fatal anaphylaxis in 75% of the animals. These findings indicate that oral treatment with *K. pinnata* effectively down-modulates pro-anaphylactic inducing immune responses. Protection achieved with quercitrin, although not maximal, suggests that this flavonoid is a

critical component of *K. pinnata* extract against this extreme allergic reaction [41].

- A methanolic fraction from an extract of *Bryophyllum pinnatum* leaves was found to possess significant anti-ulcer activity in nine different experimental animals models. Premedication tests in rats revealed that the extract possessed significant protective action against the gastric lesions induced by aspirin, indomethacin, serotonin, reserpine, stress and ethanol. Significant protection with extract treatment was observed to occur for aspirin-induced ulcer in pylorus-ligated rats and for histamine-induced duodenal lesions in guinea pigs. Significant enhancement of the healing process was also found to occur in acetic acid-induced chronic gastric lesions in rats [45].
- Optimization of the extraction process of phenolics from *Bryophyllum pinnatum* were carried out using response-surface methodology (RSM). The effect of different variables such as ratio of solvents, plant material/solvent ratio, extraction time, and temperature were investigated. An optimal phenolics yield of 7.952 mg/g gallic acid equivalence (GAE) was achieved at reduced levels of methanol/water ratio (1:1, v/v). During optimization, the product yield was enhanced by ~2-fold at reduced extraction solvent (methanol/water) up to 37%. Validation of the RSM model for extraction of total phenolic content (TPC) was confirmed by high-performance liquid chromatography (HPLC) analysis. The obtained experimental values were in good agreement with the predicted values, thereby indicating the appropriateness of the model generated. Phenolic extracts from *B. pinnatum* were further examined by 2,2-diphenyl-1-picrylhydrazyl (DPPH), ferric reducing antioxidant power (FRAP), and 2,2′-azino-bis-3-ethylbenzothiazoline-6-sulfonic acid (ABTS) methods for determining the radical scavenging activities. EC_{50} values of *B. pinnatum* extracts (BPEs) obtained by these methods were in accordance with the amount of phenolics present in the extract. Significant correlation was found between total phenolic content and antioxidant activities ($p < 0.05$) [46].
- The various extracts/fractions of leaves of *Bryophyllum pinnatum* were investigated in chemically-induced inflammation rodents model.The extracts/fractions inhibited formaldehyde-induced paw edema in rats. These inhibitions were statistically significant ($p<0.05$-0.01,0.001) as compared to control. Methanolic extract showed highest activity [47].
- The effect of crude methanolic leaf extract of *B. pinnatum* were done on some hematologicalparameters in Wistar rats. Twenty (20) male Wistar rats aged 2 to 3 months obtained from the Animal House of College of Medicine, University of Nigeria Enugu Campus were acclimatized for two weeks. They were divided into five groups labeled A to E. Groups A to D were orally fed with graded doses of the crude leaf extract (100, 200, 400, and 600 mg/kg body weight respectively) once daily for 28days in lower concentrations compared to an oral LD 50 of 800 mg/kg body weight. Group E served as control without receiving the extract. On Day 29 about 2.5mL of blood sample were collected from each rat through the median canthus into K3-EDTA anticoagulant containers for hemoglobin (Hb), Packed Cell Volume (PCV), Total White Blood Cell (TWBC), and Platelet count. The results revealed significantly increased Hb in all the treated groups, A=15.9±1.0, B = 16.8±1.0, C = 17.5±1.0 and D = 18.7±1.0 g/dL when compared with control E = 13.5±0.5 g/dL ($p<0.05$). The PCV of the treated groups were also significantly increased, A = 0.48±0.01, B = 0.51±0.01, C = 0.53±0.01 and D = 0.56±0.01 L/L when compared with control E = 0.38±0.01 L/L ($p<0.05$). The TWBC were significantly increased in all the treated groups (A = 6.2±1.0, B = 6.5±1.0, C = 7.1±1.0 and D = 7.7±1.0×109/L when compared with control E = 4.0±1.0×109/L. The platelet count were decreased in all the treated groups but was significant only in group A = 135±13×109/L when compared with control E = 225±20×109/L ($p<0.05$). The blood film examination revealed normocytic and normochromic red blood cells. This result pattern suggests that crude methanolic leaf extract of *B. pinnatum* may have properties that

increase the Hb, PCV and TWBC, while decreasing the platelets; hence care should be taken while consumingsuch extracts to avoid haematological disturbances such as thrombocytopaenia[48].

- In a retrospective study, 67 pairs of pregnant women in preterm labor treated with intravenous *B. pinnatum* or beta-agonists were closely matched for maternal age, gestational age at tocolysis, CTG recorded contractions, cervical effacement, preterm premature rupture of the membranes, and history of preterm labor. Endpoints were prolongation of pregnancy, gestational age at delivery, pre- and postpartum duration of hospitalization, maternal tolerability, neonatal outcome and morbidity. Pregnant women with *B. pinnatum* and beta agonists were equal in the prolongation of pregnancy (6.2 versus 5.4 days, NS), the gestaional age at delivery (38.0 versus 37.1 weeks, NS) and the duration of hospitalisations, but had less adverse effects (34.3 versus 55.2% with palpitation or dyspnea, P = 0.02). The neonatal outcome and morbidity in the *B. pinnatum* group were equal or better (oxygen use 10.4 versus 44.8%, P < 0.001; respiratory distress syndrome 4.5 versus 19.4%, P = 0.01).In the management of preterm labor *B. pinnatum* is no less effective than beta-agonists, but is significantly better tolerated [49].
- Ethanol extract of *Bryophyllum pinnatum* (commonly known as 'Shuka halinka' or 'Karan masallachi' in Hausa) (BP1) was partitioned into n-hexane, chloroform, ethyl acetate and aqueous methanol soluble fractions and labeled BP1–01, BP1–02, BP1–03 and BP1–04 respectively. These fractions were subjected to antibacterial testing against respiratory tract pathogenic bacteria. The n-hexane soluble fraction showed activity against the selected microorganism with highest on Staphylococcus aureus (12mm), Klebsiella pneumonia (11mm) and Salmonella typhi (08mm); ethyl acetate soluble fraction showed mild activity against Escherichia coli (06mm), Staphylococcus aureus (07mm) and Salmonella typhi (07mm), at 10mg/ml [50].
- Oral and intraperitoneal (i.p) LD50 experiments were conducted on Sprague-Dawley rats. Other rats were given daily doses of 2 g kg-1 body weight (p.o) × 35 days at the end of which kidneys, hearts, spleen and blood/sera were obtained for weight, haematological and biochemical analyses.While there was no death at a maximum acute dose of 5 g kg-1 body weight by the oral route, the intraperitoneal LD50 was 1.8 g kg-1 body weight. Subacute treatment did not significantly alter animal weights, organ-to-body weight ratios, fluid intake, hematological indices and the levels of AST, ALP and albumin. ALT level was significantly reduced ($p<0.03$) in the treated group. Total bilirubin and conjugated bilirubin levels were not significantly altered in the treated group [51,52].
- 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 level [53].
- Adenike A.O.Ogunshe et al worked on the Nigerian Traditional Plants to evaluate antifungal activity (vaginal Candidiasis). They evaluated the plant against the various strains of these species (Candida albicans, C.tropicalis, C.pseudotropicalis) and concluded that none of the strains of C.pseudotropicalis inhibited by ethanolic extract of *Kalanchoe pinnata* while it have good inhibitory effects against other species [54].
- Jun-ya Ueda et al have done MTT assay on a highly metastatic human HT-1080 fibrosarcoma cell line. They show that methanolic, methanolic: aqueous and aqueous extract have mild antiproliferative activity [55].
- *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) [56].

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