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**Bryophyllum pinnatum (Lam.) Kurz.: Phytochemical and Pharmacological Profile: A Review**

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**ABSTRACT**

*Bryophyllum pinnatum* (Lam.) Kurz (Crassulaceae) is a perennial herb growing widely and used in folkloric medicine in tropical Africa, tropical America, India, China, and Australia. The divine herb contains a wide range of active compounds, including alkaloids, triterpenes, glycosides, flavonoids, steroids, bufadienolides, lipids and organic acids, have been isolated from this species. The plant is widely used in traditional medicine for the treatment of variety of ailments and well known for its haemostatic and wound healing properties. The pharmacological studies are reviewed and discussed, focussing on that different extracts from this plant have been found to possess pharmacological activities as immunomodulator, CNS depressant, analgesic, antimicrobial, antiinflammatory, antiallergic, antianaphylactic, antileishmanial, antitumorous, antiulcerous, antibacterial, antifungal, antihistamine, antiviral, febrifuge, gastroprotective, immunosuppressive, insecticidal, muscle relaxant, sedative. However, future efforts should concentrate more on in vitro and in vivo studies and also on clinical trials in order to confirm traditional wisdom in the light of a rational phytotherapy. The present review is an attempt to highlight the various ethnopharmacological and traditional uses as well as phytochemical and pharmacological aspects of *B. pinnatum* and to discuss them.

**KEYWORDS:** Alkaloids, *Bryophyllum Pinnatum*, Bufadienolides, Clinical Trials, Flavonoids.

**INTRODUCTION**

*Bryophyllum pinnatum* (Lam.) Kurz (Crassulaceae) Synonym: Kalanchoe pinnata, Pers, Bryophyllum Calycinum Salisb (1,2); Common names: Zakham-e-hyat, Life plant, air or maternity plant, love plant, Canterbury bells, Cathedral bells, parnabija etc. It is a perennial herb growing widely and used in folkloric medicine in tropical Africa, tropical America, India, China and Australia (3), classified as a weed (4). The plant flourishes throughout the Southern part of Nigeria (5). This is the only *Kalanchoe* species found in South America, however, 200 other species are found in Africa, Madagascar, China and Java. A number of species are cultivated as ornamentals and are popular tropical house plants. In Brazil, the plant goes by the common names of saíço or coirama and in Peru it is called hoja del aire (air plant) or *kalanchoe* (6).

The plant grows all over India in hot and moist areas, especially in Bengal. It is a succulent perennial plant that grows 1.0-1.5 m in height and the stem is hollow four-angled and usually branched. Leaves are opposite, decussate, succulent, 10-20 cm long. The lower leaves are simple, whereas, the upper ones 3-7 foliate and are long-petioled. They are fleshy dark green that are distinctively scalloped and trimmed in red. Leaf blade pinnately compound with 3-5 leaflets, 10-30 cm; petiolules 2-4 cm; leaflet blades oblong to elliptic, 6-8 × 3-5 cm, margin crenate with each notch bearing a dormant bud competent to develop into a healthy plantlet [7], apex obtuse. The leaves are furnished with rooting vegetative buds. Inflorescences terminal paniculate 10–40 cm. Flowers are many bell-like pendulous. Calyx tubular, 2–4 cm; Corolla reddish to purple, 5 cm, base sparsely ciliate; lobes ovate-lanceolate; stamens inserted basally on corolla; nectar scales oblong; follicles included in calyx and corolla tube. The fruit-pod with four septa and numerous, ellipsoid, smooth striate seeds within. The plant flowers in Nov-Mar and fruits in April (6, 8).

It is astringent, sour in taste, sweet in the post digestive effect and has hot potency. It is well known for its haemostatic and wound healing properties. The plant have considerable attention for their medicinal properties and find application in folk medicine, as well as in the contemporary medicine. The present review highlights the various ethnopharmacological uses, phytochemical and pharmacological studies conducted on *B. Pinnatum* and also pinpoints unexplored potential of it (8-10).

**ETHNOPHARMACOLOGY**

Various species of *B.Pinnatum* are used medicinally in Indo-China and Philippines Islands. It is naturalized throughout the hot and moist parts of India. The leaves and bark are bitter tonic, astringent to the bowels, analgesic, carminative, useful in diarrhoea and vomiting (11). It is applied externally and taken internally for all types of pains and inflammations, various bacterial, viral and fungal infections, leishmaniasis, earaches, upper respiratory infections, stomach ulcers, flu and fever (12).

In traditional medicine, the leaves of this plant have been used for antimicrobial (4,13,14), antifungal (15), antiulcer (16), anti-inflammatory, analgesic (17,18), anti hypertensive (19), potent anti-histamine and anti-allergic activity (20). The Creoles use the lightly roasted leaves for cancer, inflammations, and a leaf infusion for fevers. The Palikur mix the leaf juice with...
coconut oil or andiroba oil and then rub it on the forehead for migraines and headaches. To the Siona indigenous peoples heat the leaves and apply them topically to boils and skin ulcers. Along the Rio Pastaza in Ecuador, natives use a leaf infusion for broken bones and internal bruises. In Peru, indigenous tribes mix the leaf with aguardiente (sugar cane rum) and apply the mixture to the temples for headaches; they soak the leaves and stems overnight in cold water and then drink it for heartburn, urethritis, fevers and for all sorts of respiratory conditions. The root infusion is also used in epilepsy. Other tribes in the Amazon squeeze the juice from fresh leaves and mix it with mother's milk for earaches.

In Mexico and Nicaragua it is also used to promote menstruation and assist in childbirth. In Nigeria and other West African countries, its fleshy leaves are frequently used as herbal remedy for an array of human disorders, including: hypertension, diabetes mellitus, bruises, wounds, boils, abscesses, insect bites, arthritis, rheumatism, joint pains, headaches and body pains.

The leaves of the plant have great medicinal value and are used 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, wounds, hemorrhoids, menorrhagia, discoloration of the skin, boils, sloughing ulcers, ophthalmic, burns, scalds, corn, diarrhea, dysentery (21), headaches (22), vomiting, acute inflammations and bronchitis. It is also employed for kidney stones, gastric ulcers, skin disorders and edema of the legs. Externally, the pulp of the leaves or the juice is applied on traumatic injuries to arrest the bleeding as it contract the minute arterioles and promote the healing of wounds. It is also used for headaches, toothaches, earaches, eye infections, wounds, ulcers, boils, burns and insect bites. On traumatic wounds, the heated leaves are crushed and applied. It reduces the edema and promotes the wound healing without leaving a scar. Internally, the leaves juice and cumin seeds are given along with the double amount of ghee for its efficacy as a dietary supplement.

The plant are used by the tribes of Kerala for treating cancer symptoms (6, 23). Also plant induce the typical symptoms of cardiac poisoning, but repeated small doses also cause coryledonosis, an intoxication affecting the nervous and muscular systems of small animals, particularly sheep, in the Karoo area of South Africa (8, 10).

**Phytochemical Constituents**

*B. Pinnatum* is rich in alkaloids, triterpenes, glycosides, flavonoids, cardienolides, steroids, bufadienolides and lipids (24-27). The leaves contain a group of chemicals called bufadienolides which are very active. Bufadienolides like bryotoxin A, B, C which are very similar in structure and activity as two other cardiac glycosides, digoxin and digitoxin and possesses antibacterial, antitumorous, cancer preventative and insecticidal actions (10,28-30).

**Phenols, Phenylpropanoids and Flavonoids**

Syringic acid, caffeic acid [25], 4-hydroxy-3-methoxy-cinnamic acid, 4-hydroxybenzoic acid, p-hydroxycinnamic acid, paracoumaric acid, ferulic acid, protocatechuic acid, phosphoenolpyruvate, protocatechualic acid isolated from aerial parts of plants.

Leaves contains astragalin, 3,8-dimethoxy-4,5,7-trihydroxyflavone, friedelin, epigallocatechin-3-o-syringate, luteolin, rutin [27], kaempferol [23], quercetin [14], quercetin-3L-rhamnonsido-L-arabino furanoside (29, 39), quercetin-3-O-diariosidinose, kaempferol-3-glucoside (34), kaempferol-3-O-α-L-arabinopyranosyl (1→2)α-L-rhamno pyranoside [12], quercetin-3-O-α-L-arabino pyranosyl(1→2)α-L-rhamnoside pyranoside [13] and 4',5-dihydroxy-3,8-dimethoxy flavone-7-O-β-D-glucopyranoside [14]. Because of its restricted occurrence and its abundance in *B. Pinnatum*, flavonoid may be a chemical marker of the plant of high therapeutic potential (40, 41, 53, 54).

**Triterpenoids and Steroids**


**Fatty Acids, Minerals and Others**

Fatty acid fraction includes palmitic acid (89.3%), stearic acid (10.7%), traces of arachidic and behenic acid (30,31,42). Plant also contains HCN, oxalic acid (37), citric acid, isocitric acid (45,46), oxalacetate (42), malic acid (92) and succinic acid. The plant is rich in vitamins and aminoacids; ascorbic acid, riboflavin, thiamine, niacin, pyridoxine, glycine, cysteine, casein hydrolysate, glutamic acid, protein hydrolysate, methionine, tyrosine, phenylalanine (36, 43,45, 50).

Food contents are carbohydrates, protein, lipids, acids, iodine. The herb is good source of mineral elements such as Na, Ca, K, P, Mg, Mn, Fe, Cu, Zn. Sugar contents includes raffinose, lactose, sucrose, glucose, galactose, fructose. Plant also contains alkaloids, tannins, phenanthrene derivatives: 2(9-
1. Bryophyllin A \( R=\text{CHO} \)
2. Bryophyllin C \( R=\text{CH}_2\text{OH} \)
3. Bryophyllin B
4. Bryophollone
5. Bryophyllol
6. Bryphynol
7. Bersaldegenin-1,3,5-orthoacetate
8. Bryphollenone
9. Bryotoxin- A
10. Bryotoxin B \( R_1=\text{CH}_2\text{OH}; R_2=\text{O} \)
11. Bryotoxin C \( R_1=\text{CHO}; R_2=\text{H}_2 \)

Flavanoids

12. Kaemferol-3-O-\( \alpha \)-L-arabinosyl(1\( \rightarrow \)2) \( \alpha \)-L-rhamnopyranoside

13. Quercetin-3-O-\( \alpha \)-L-arabinosyl(1\( \rightarrow \)2) \( \alpha \)-L-rhamnopyranoside

14. 4',5-dihydroxy-3',8-dimethoxyflavone-7-O-\( \beta \)-D-glucopyranoside

15. Quercitrin

16. Stigmasterol

17. \( \beta \) -Sitosterol

18. Dihydrobrassicasterol

19. Campesterol
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20. Isofucosterol

21. 24-methyl-desmosterol

22. Codisterol

23. Kaempferol

24. Taraxasterol

25. Caffeic acid R=OH

26. Ferulic acid R= OCH₃

27. Rutin

28. Patuletin

29. Clionosterol
decenyl)-phenanthrene, 2(9-undecenyl)-phenanthrene, alkanes 
(C_{25-35}), alkanols (C_{26-34}), n-triaccontane, hentriacontane (37, 38, 43, 50).

**PHARMACOLOGICAL ACTIVITIES**

**Herbal Tonic**

The plant is good sources of ascorbic acids, riboflavin, thiamine and niacin. Natural ascorbic acid is vital for the body performance i.e. normal formation of intercellular substances throughout the body, including collagen, bone matrix and tooth dentine (47, 48). Therefore, the clinical manifestations of scurvy that is hemorrhage from mucous membrane of the mouth, gastrointestinal tract, anemia, pains in the joints can be related to the association of ascorbic acid and normal connective tissue metabolism (48). This function of ascorbic acid accounts for its normal wound healing property. As a result the plant is used in herbal medicine for the treatment of common cold and other diseases like prostate cancer (47, 49, 50). In a study an herbal composition comprised of extracts of number of herbs including *B.Pinnatum* acts as a tonic to improve respiration, aid in the elimination of toxins and improves overall vitality (51).

**Antileishmanial activity**

Infections caused by protozoa of the genus *Leishmania* are a major worldwide health problem, with high endemicity in developing countries. The incidence of the disease has increased since the emergence of AIDS. In the absence of a vaccine, there is an urgent need for effective drugs to replace/supplement those in current use. I.G. Rocha et al refered in a review on a plant extracts that a chemically defined molecules (coumarin, quercetin) of natural origin showing antileishmanial activity (52).

Quercetin, a flavonoid is responsible for the antileishmanial activity of *B.Pinnatum*. The quercetin aglycone-type structure, as well as a rhamnosyl unit linked at C-3, seem to be important for antileishmanial activity (54). Da Silva et al investigated the antileishmanial properties of three flavanoids (quercetin, quercetin and afzelin) of leaf extract in mice against *L. amazonensis* amastigotes and found oral route was more effective than other (i.v. or tropical) routes. The protective effect of plant in leishmaniasis may not be due to a direct effect on the parasite itself but rather activation of the reactive nitrogen intermediates pathway of macrophages (12, 53).

**Hepatoprotective and Nephroprotective**

Juice of the fresh leaves is used very effectively for the treatment of jaundice in Bundelkhand region of India. Yadav et al studied that the juice of leaves was found more effective than ethanolic extract as evidenced by invivo and invitro histopathological studies for hepatoprotective activity of plant and justifies the use of juice of plant leaves in folk medicine for jaundice (56). The protective effect on gentamicin-induced nephrotoxicity in rats which may involve its antioxidant and oxidative radical scavenging activities (57).

**Neuropharmacological activities**

*B. Pinnatum* has been used since 1921 in traditional medicine as an antipsychotic agent (20, 54, 55). Salahdeen et al showed that the aqueous leaf extract possesses depressant action on CNS. The animals treated with 50-200mg/Kg was found to produce quite significant decrease in locomotor’s activity in dose dependent manner, with no ptosis at these doses. Similarly in chimney, climbing and inclined screen tests, there was a significant loss of coordination and decrease muscle tone in animals treated intraperitoneally with aqueous extract in a dose dependent fashion. The result indicates significant alterations in general behaviour pattern, reduction in spontaneous mortality, potentiation of pentobarbitone-induced sleeping time in a dose dependent fashion (55-59, 65). Pal et al in his study found that the anticonvulsant effect of the aqueous leaf extract observed decrease or no effect compare to methanolic extract. The methanolic fraction possesses a potent CNS depressant action. As alcohol is known to have depressant effect on respiration related hypoglossal nerve output in humans and other mammals. It is possible therefore that the inhibitory effect of methanolic extract on CNS activities may be due to effect of methanol and partly to the constituent of *B. Pinnatum* with its attendant higher dose (59-63).

Bufadienolide has been reported to be poisonous, and it is similar to cardiac glycoside poisoning. Several studies shows that bufadienolide toxin is manifested primarily by digitalis toxicity-like cardiac effects, including Bradycardia, A-V conduction block, ventricular tachycardia, ventricular fibrillation and sudden death. Radford et al investigated that the CNS depressant activity of aqueous leaf extract could be due to the presence of bufadienolide and other water soluble constituents in the extract (64).

Yemitan et al investigated with saline leaf extract and found dose dependent CNS depressant effects (pentobarbitone-induced sleep), exploratory activity (Hole-board method, Evasion), muscle relaxant test (Chimney, Traction, Climbing, Inclined Screen tests), anticonvulsant tests (strychnine-induced convulsion, picrotoxin-induced convulsion) (66). Thus the herb possesses remarkable central depressant, skeletal muscle and minor anticonvulsant actions with an acute toxicity higher than 500mg/Kg and 2000mg/Kg when given intraperitoneally and orally (64,65).

**Antimutagenic activity**

Plant has potent antihistamine and antiallergic activity. The methanol extract of the leaves has also been reported to have histamine receptor (H1) antagonism in the ileum, peripheral vasculature and bronchial muscle (20) and protect against chemically induced anaphylactic reactions and death by selectively blocking histamine receptors in the lungs (68,69). Quercetin-3-α-L-arabinopyranosyl(1→2)-α-L-rhamnopyranosyl -side showed anti allergic activity in rats (70). Obaseiki-Ebor et al investigated that organic solvent extracts of leaves had inhibitory activity for His*- to His*+ reverse-mutations induced by ethyl methane sulfonate acting on S. typhimurium TA100 or TA1002 and were also active against reversions induced by 4- nitro-o-phenylenediamine and 2-amino fluorene in TA98. The alkaloidal/ water soluble and acid fraction had no appreciable antimutagenic activity (67).

**Anti-ulcer activity**

Flavonoids, the potent water-soluble antioxidants and free radical scavengers, which prevent oxidative cell damage, have
strong anticancer activity (16,47,71,72). Supratman et al investigated on antitumor promoting activity of bufadienolides separated from B. pinnatum and found bryophyllin A has most marked inhibition and bersaldegenin-3-acetate is less active (93). Bersaldegenin-1,3,5-orthoacetate inhibited growth of several cancer cell lines (32,33). As antioxidants, flavonoids from these plants provide anti-inflammatory activity (47) and are used for the treatment of wounds, burns and ulcers in herbal medicine. Pal et al revealed that a methanolic fraction of leaves was found to possess significant antilucre activity. 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; also significant protection for aspirin-induced ulcer in pylorus-ligated rats and for histamine-induced duodenal lesions in guinea pigs; and also significant enhancement of the healing process was also found to occur in acidic acid-induced chronic gastric lesions in rats (16). Adesanwo et al in his study showed a significant reduction in incidence of ulceration and mean basal and histamine stimulated gastric acid secretion in a dose dependent manner thus justifying its use as an anti-ulcer agent in folklore medicine (73).

**Antibacterial activity**

The presence of phenolic compounds indicate that the plant possess anti-microbial activity. Ofokansi et al. (2005) reported that plant is effective in the treatment of typhoid fever and other bacterial infections, particularly those caused by S. aureus, E. coli, B. subtilis, P. aeruginosa, K. aerogenes, K. pneumoniae and S. typhi. In his study antibacterial activities of the infusion and methanolic extracts against S. aureus ATCC 13709, E.coli ATCC 9637, Bacillus, P. aeroginosa, K. pneumonia and S. typhi using the agar diffusion method; also against S. aureus, E. coli, S.typhi, Klebsiella spp and P.aeruginosa using a modification of checkerboard method. These findings supported its use in treating the placenta and navel of newborn baby, which not only heals fast but also prevent the formation of infections (49, 74,75). Pure isolated alkaloids and their synthetic derivatives are used as basic medicinal agents for their analgesic, antispasmodic and bactericidal effects (47).

Obaseki-Ebor et al investigated the invitro antibacterial activity of leaf juice. The extract at 5% v/v was found to be bactericidal to a wide spectrum of gram-positive and gram-negative bacteria such as B. subtilis, S. aureus, S. pyogenes, S. faecalis, E. coli; Proteus spp; Klebsiella spp; Shigella spp; Salmonella spp; S. marcescens; and P. aeruginosa including the clinical isolates of these organisms possessing multiple antibiotic resistance (76). Schmitt et al showed the antimicrobial activity of decoct of leaves against gram-positive bacteria by dilution tube method (74). Akinpelu in a study found that 60% methanolic leaf extract inhibits the growth of five out of eight bacteria used, at a concentration of 25mg/ml. B. subtilis, E. coli, P. vulgaris, S. dysenteriae, S. aureus were found to inhibited, while K. pneumoniae, P.aeruginosa and C. albicans were found to resist the action of the extract (14).

**Antidiabetic Activity**

The presence of zinc in the plants could mean that the plants can play valuable roles in the management of diabetes, which result from insulin malfunction (50, 74). Ojewole evaluated the antinociceptive effect of the herb’s aqueous leaf extract by the ‘hot-plate’ and ‘acetic acid’ test models of pain in mice. The anti-inflammatory and antidiabetic effects of the plant extract were investigated in rats, using fresh egg albumin-induced pedal oedema, and streptozotocin -induced diabetes mellitus. The aqueous leaf extract produced significant (P<0.05-0.001) antinociceptive effects against thermally and chemically-induced noiceptive pain stimuli in mice. The plant extract also significantly (P<0.05-0.001) inhibited fresh egg albumin-induced acute inflammation and cause significant hypoglycaemia in rats. The different flavonoids, polyphenols, triterpenoids and phytosterols of the herb are speculated to account for the observed antinociceptive, anti-inflammatory and antidiabetic properties of the plant. It exert antinociceptive and anti-inflammatory effects probably by inhibiting the release, synthesis and /or production of inflammatory cytokines and mediators, including: prostaglandins, histamine, polypeptide kinins and so on (79).

**Immunosuppressive effect**

The fattyacids present in B. Pinnatum may be responsible atleast in part, for its immunosuppressive effect invitro (42). Rossi-Bergmann et al showed the aqueous extract of leaves cause significant inhibition of cell-mediated and humoral immune responses in mice. The spleen cells of animals pre-treated with plant extract showed a decreased ability to proliferate in response to both mitogen and antigen in vitro. Treatment with extract also impaired the ability of mice to mount a delayed-type hypersensitivity reaction (DTH) to ovalbumin. The invitro 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. Thus the aqueous extract of leaves possesses immunosuppressive activities (80). Almeida et al in an investigation also found that leaf extracts inhibited invitro lymphocyte proliferation and showed invitro immunosuppressive activity (42, 81). An attempt to identify the immunosuppressive substances present in B. Pinnatum guided by the lymphoproliferative assays. From the extract a purified fraction (KP12SA) found twenty-fold more potent to block murine lymphocyte proliferation than the crude extract. Thus provides evidence that saturated fatty acids present in herb plays an important role on lymphocyte proliferation, which explain its immunosuppressive effect in vivo (80).

**Antihypertensive activity**

Herb possesses hypotensive activity and lend credence to the folkloric use of the herb in the management of hypertension. The plant commonly used in the management of all the types and grades of hypertension by some Yorubas of Western Nigeria. Calcium was the most abundant macro element present in the plant. Normal extracellular calcium concentrations are necessary for blood coagulation and for the integrity, intracellular cement substances (78). The lower sodium content of B. Pinnatum might be an added advantage.
due to the direct relationship of sodium intake with hypertension on human (83).

Ojewole evaluated the antihypertensive efficacy of leaf extracts. The effects of aqueous and methanolic leaves extracts were examined on arterial blood pressures and heart rates of normal and spontaneously hypertensive rats, using invasive and non-invasive techniques. Both the extracts produced doserelated, significant decreases in arterial blood pressures and heart rates of anaesthetized normotensive and hypertensive rats. The hypotensive effects of the leaves extracts were more pronounced in the hypertensive than in normotensive rats. The leaves extracts also produced dose dependent, significant decreases in the rate and force of contractions of guinea-pig isolated atra, and inhibited electrical field stimulation (ES)-provoked, as well as potassium and receptor-mediated agonist drugs-induced contractions of the rat isolated thoracic aortic strips in a non-specific manner. Cardiodepression and vasodilation would appear to contribute significantly to the antihypertensive effect of the herb (19, 79).

Analgesic, Anti-inflammatory and Wound Healing activity

The high saponin content justifies the use of the extracts to stop bleeding and in treating wounds. Saponin has the property of precipitating and coagulating red blood cells. Some of the characteristics of saponins include formation of foams in aqueous solutions, hemolytic activity, cholesterol binding properties and bitterness (47, 84). These properties bestow high medicinal activities on the extracts from B. Pinnatum. Tannins have astringent properties, hasten the healing of wounds and inflamed mucous membranes. These perhaps, explain why traditional medicine healers in Southeastern Nigeria often use herb in treating wounds and burns (85). Dra Amalia et al investigated the anti-inflammatory activity of the fluid extract of the leaves against the edema caused by carrageen in rats. It was confirmed that the fluid extract with 4.5 % of total solids at doses of 100 mg/kg of weight has an anti-inflammatory effect (50, 71, 86, 87).

Aqueous extract of B. Pinnatum can demonstrate strong analgesic potency comparable in a time and dose-dependent manner to a non-steroidal anti-inflammatory drug. Igwe et al investigated that the aqueous extract was devoid of severe toxic effects, increased the pain threshold in rats using the hot plate or thermal methods, inhibited or reduced phenylbenzoquinone-induced writhing or abdominal stretches in mice in a dose-dependent manner, and produced a weak or an inferior anti-inflammatory activity than aspirin (82).

Uterine Contractility

B. Gwienenberger et al characterise the phytoterapeutic tocolytic effect of B. Pinnatum in vitro versus the conventional betamimetic, fenoterol, in human myometrium. Contractility was measured in strips of term myometrium biopsied at caesarean section in 14 women and exposed to increasing concentrations of B. Pinnatum versus +/- oxytocin 1 U/L. Result state inhibition of spontaneous contraction was concentration dependent. B. Pinnatum increased contraction frequency by 91% at constant amplitude and inhibited oxytocin stimulated contractions by 20% at constant amplitude with slightly decreased frequency. Fenoterol decreased contraction by 50% with a significant decrease in frequency (88).

B. Pinnatum is more effective and has less side effects than traditional labor inhibitors in preventing preterm delivery. In a study Plangger et al compare the tolerability and tocolytic effects between i.v. infused plant extract and beta-agonists. In a retrospective study, 67 pairs of pregnant women in preterm labor treated with i.v. 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. Results shows that pregnant women with extract and betaagonists were equal in the prolongation of pregnancy (6.2 versus 5.4 days, NS), the gestational 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). The neonatal outcome and morbidity in the B. Pinnatum group were equal or better. Therefore concluded in the management of preterm labor herb is no less effective than beta-agonists, but is significantly better tolerated (89).

The plant should not be used in pregnancy. Though not supported by clinical research, it has traditionally been used during childbirth and may stimulate the uterus. Also because of immune modulating actions, should not be used chronically for long periods of time, or by those with a lowered immune system.

Toxic to cattle

Mckenzie et al investigated that cardiac glycoside poisoning was produced in calves given flower heads of the hybrid Bryophyllum Species and found that for each plant (except B. tubiflorum), 2 calves were each given a single dose of 20 g wet weight per kg bodyweight. The results of the calf toxicity experiment with the amounts of bufadienolide measured in the plants suggests that bryotoxins A, B and C probably account for the observed disease (28, 90).

Insecticidal, Fungitoxic and Phytotoxic activity

Supratman et al isolated bufadienolides: bryophyllin A and bryophyllin C from B. Pinnatum and showed strong insecticidal activity against third instar larvae of the silkworm (93). Alabi et al studied to evaluate the fungitoxic and phytotoxic effects of extracts on the fungal pathogens inducing wilting on cowpea grown in Ago-Iwoye, South Western Nigeria. The extract reduces the Disease Infection Rate (DIR) in treated plants. Sclerotium rolfsii sac induced wilting of between 4 and 12% on cowpea seedlings treated with plant extract under field conditions while about 39.6% incidence of cowpea seedlings wilting was observed under control experiment on the same experimental plot. The extracts increased significantly the plant height, shelf life, relative water content and chlorophyll contents of the cowpea seedlings during both the wet and dry season. On the other hand, the extracts significantly reduced transpiration rate and stomata aperture of treated plant in both seasons. Furthermore, application of these extracts on the cowpea plants significantly enhanced the Leaf Area Index (LAI), number of branches and pods per plant, total dry matter per plant, weight per pod, 100 grains weight and grain.
yield in both season. The extracts also inhibited the release of current photosynthethates from treated plants thus maintaining the water status of plant and also making photosynthethates which can be oxidized to release energy needed for growth available to treated plants (91).

CONCLUSION

The B. Pinnatum is widely used divine herb. Modern pharmacological studies have generally confirmed the traditional use of B. Pinnatum and its extracts in ailments: inflammations, ulcers, fungal, viral and microbial infections, an impaired immune system, diabetes mellitus, spasms and insecticidal properties. It is believed that detailed information as presented in this review on its phytochemical constituents and various biological properties of extracts and the constituents might provide incentive for evaluation of the use of the plant in medicine and in agriculture. Extracts and fractions tested on mice and rats showed significant analgesic, anti-allergic, anti-anaphylactic, anti-inflammatory, anti-leishmanial, anti-tumorous, anti-ocularous, antibacterial, anti fungal, antihistamine, antiviral, CNS depressant, febrifuge, gastro protective, immunosuppressive, immunomodulator, insecticidal, muscle relaxant, sedative results without adverse side effects. Some small companies in India and Amazon are using B. Pinnatum as raw materials for phytochemicals.

The pharmacological studies so far have mostly been performed in vitro and in vivo with animals. In future study, the isolated principles and B. Pinnatum needs to be evaluated in scientific manner using specific animal models and clinical studies are urgently needed in order to confirm traditional wisdom in the light of a rational phytotherapy on the toxicity of plant and especially on bufadienolides and its use during pregnancy and also to understand the molecular mechanism of action, in search of lead molecule from natural resources. It could be concluded that B. Pinnatum is a rich source of compounds, interesting chemical structures and various biological active products.

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