A phyto-pharmacological overview on Jewel Weed

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ABSTRACT

Jewel weed is a common name of Impatiens balsamina Linn. (Family, Balsaminaceae). It is often grown as garden plant due to its attractive foliage and flowers. It is traditionally used as diuretic, emetic, laxative, demulcent and tonic. It is reported to possess beneficial effects in lumbago, intercostal neuralgia and in burns. Studies have revealed presence of various phytoconstituents like flavanoids, triterpenoids, glycosides, fatty acids and alkaloids. The present review is an attempt to summarize traditional values, pharmacognostical and phytopharmacological reports of Jewel weed.

INTRODUCTION

Jewel weed, scientifically known as Impatiens balsamina Linn. (Syn. Balsamina hortensis) belonging to family Balsaminaceae, is an annual, erect herb having 30-90 cm height (Herber, 1864) (Fig. 1). It is distributed throughout India, Ceylon (up to 3000 ft height), China and Malaya. In India it is commonly cultivated as garden plant throughout tropical and sub-tropical parts, grows gregariously as forest under growth and commonly seen on the boarders of rice fields (Chatterjee and Pakrashi, 1997; Collett, 1921). It may be found in large patches on damp ground and also in small clumps along the road sides (Madhav, 1959). Whole plants and flowers are used for medicinal and cosmetic purpose. In India it is known by various vernacular names: Dushpatrijati (Sanskrit); Gulmendhi (Hindi); Dupati (Bengali); Kasittumbai (Tamil); Jewel Weed, Garden Balsam, Balsam Weed, Touch-me-not (English); Terada (Marathi); Gulmendi, Tanmania (Gujarati); Tambol, Bontil (Punjabi); Haragaura (Oriya) and Mecchingom (Malayalam). (Anonymous, 1959; Kirtikar and Basu, 1933; Nadkarni, 1989; Chopra et al., 1969).

TAXONOMICAL CLASSIFICATION

Kingdom : Plantae
Division : Spermatophyta
Subdivision : Angiospermae
Class : Dicotyledonae
Subclass : Asteridae
Order : Ericales
Family : Balsaminaceae
Genus : Impatiens
Species : balsamina
Botanical Description

It is a pubescent or glabrate, erect, branched succulent annual herb. Young shoots are hairy. Stem bears alternate, up to 15 cm long, narrowly lanceolate, acuminate, deeply serrate, glabrous leaves which bear decurrent, shot, pubescent petiole. Flowers are rose coloured or nearly white, axillary, pubescent, slender and shorter than the leaves. Fruits are capsular, tomentose and hairy, with rigid yellow bristles, ellipsoid and narrowed at both ends. Seeds are globose, tubercled, 0.5 cm in diameter, reticulate and having black testa. Flowers and fruits appear during rainy season (Chatterjee and Pakrashi, 1997; Kirtikar and Basu, 1933).

Traditional Uses

The plant and its parts are widely used by tribal people for curing variety of ailments. The medicinal uses of I. balsamina are also mentioned in ancient books. Whole plant is having emetic, diuretic and laxative properties when taken internally and externally it is used for pains in joints (Chopra et al., 1956; Jaykrishna, 1998).

The flowers are having cooling, demulcent and tonic effect and applied in case of burns and scalds. They are also used for lumbago and intercostals neuralgia (where they are reported to relieve stasis and improve circulation). Leaves are used in poultices in Philippines and seeds are said to be beneficial for difficult labour in China. In Bali, leaves are eaten and flowers and leaves are used for dyeing finger nails (as substitute of henna i.e. Lawsonia inermis Linn.) (Anonymous, 1959).

In Madhya Pradesh, ethnomedicinally the plant is used for the treatment of inflammation, burns, ulcers, constipation, arthritis and urinary retention (by tribal people) in Amarkantak region and root extract is used for treatment of irritation of gastrointestinal canal in Pachmarhi region (Srivastava et al., 2012;
Mishra et al., 2012). In Garhwal Himalaya, Uttarakhand, leaf paste is externally applied in burns, where the plant is known as Balsam o Majethi in local regions (Uniyal and Shiva, 2005). Leaves of I. balsamina (Local name: Keembung) are pounded and applied topically to treat split nails in some villages of Malaysia (Ong et al., 2011). It is also believed to be a useful cosmetic herb (Sanghi and Tiwle, 2013). Ethnomedically the flowers are utilized in cases of snake bites (Binorkar and Jani, 2012). The aerial parts of plant are used for treatment of articular rheumatism, bruises and beriberi in Chinese herbal medicine. In some areas of Japan several types of dermatitis, including urticaria, is treated by topical application of squeezed juice of the petals (Chang S, 1977).

PHYTOCHEMISTRY

Various phytoconstituents have been identified and isolated from various parts of plant including fatty acids, flavanoids, triterpenoids and glycosides.

Flowers of Impatiens balsamina shows presence of flavanol, kaempferol (4’,5,7-trihydroxyflavonol), quercetin (3’,4’,5,7-tetrahydroxyflavonol) and myricetin (3’,4’,5,7-penta hydroxyflavonol). Kaempferol and myricetin is found in petals and sepals while quercetin is found in sepals only (Clevenger S, 1958). Kaempferol 3-rhamnosyl diglucoside was isolated from white petals of plant and based on spectroscopic techniques its structure was determined to be kaempferol-3-O-[2”-O-α-L-rhamnopyranosyl-3”O-β-D-glucopyranosyl]-β-D-glucopyranoside (Fukumoto et al., 1994).

Kaempferol, kaempferol 3-glucoside, kaempferol 3-glu cosylrhamnoside, kaempferol 3-rutinoside and kaempferol 3-(p-coumaroyl) glucoside was reported to be present in the plant (Calderon JM, 2011). These naturally occurring structurally similar kaempferol and its derivatives were detected and quantified using capillary electrophoresis with electrochemical detection (Hua et al., 2001).

Determination of total flavonoid and total phenolic content of stem and leaf of Impatiens balsamina, harvested at different time interval (March, May and July) revel that the leaf extracts have higher total flavonoids and total phenolic content than those of stem extracts. More over as the harvest time delayed phenolic contents of stems were significantly decreased but the total phenolic and total flavonoid contents of leaves were significantly increased (Kang et al., 2013).

2-Methoxynaphthalene-1,4-dione(C$_7$H$_4$O$_2$) (Jin et al., 2011) and 2-Methoxy-1,4-naphthoquinone was isolated from leaves of Impatiens balsamina (Kang and Moon, 1992). A Reversed-phase High-performance Liquid Chromatography method has been developed and validated for simultaneous determination of three Naphthoquinones i.e. lawson, lawson methyl ether and methylene-3,3’-bilawsone; the main active compounds of Impatiens balsamina leaves (Sakunphueak and Panichayupakaranant, 2010). High-Performance Thin-Layer Chromatography method has been developed and validated for quantification of same three naphthoquinones using N-butyl acetate-

chloroform-glacial acetic acid (6:4:0.1) as mobile phase (Abhijeet et al., 2014).

Two new tetrahydrnaphthalenes 1α, 2α-diol-4α-ethoxy-1, 2, 3, 4-tetrahydrnaphthalene and 1α, 2α, 4β-triol-1, 2, 3, 4-tetrahydrnaphthalene were isolated from the stem of Impatiens balsamina and their structures were elucidated by various spectroscopic methods (Chen et al., 2010).

Ethanolic extract of dried seeds shows presence of alkaloids, flavanoids, terpenoids, saponins and tannins. The first baccharane triterpenoid from natural source, Hosenkol-A, was isolated from the seeds of Impatiens balsamina and characterized as (3S,4R,17R,20S,24S,25S)-3,17,26,28-tetrahydroxy-21,24-epoxybaccharane (Shoji et al., 1983). New baccharane glycosides-Hosenkosides A-E and L-O were isolated from seed and their structures were determined using 2D NMR technique and chemical derivatization (Shoji et al., 1994(a); Shoji et al., 1994(b)). A new monoglyceride = (–)(R,Z)glycerol-1-octadec-9-enoate – isolated and characterised from seeds (Patra and Chaudhari, 1988). Seeds also contain β-sitosterol, a new antraquinone and palmitic acid, stearic acid, oleic acids as well as their ethyl ester (Rastogi, 1970; Rastogi, 1985; Rastogi, 1990).

From the seeds of Impatiens balsamina two flavones glycosides i. e. quercetin-3-O-[α-L-rhamnopyranosyl(1→2)]-β-D-glucopyranosyl]-5-O-β-D-glucopyranoside and quercetin-3-O-[6””-O-cafeoyl]-α-L-rhamnopyranosyl(1→2)]-β-D-glucopyranosyl]-5-O-β-D-glucopyranoside were isolated and identified based on various spectral studies (Jing et al., 2010).

Balsaminones A and B (Dinaphofuran-7,12-dione derivatives) were isolated from the pericarp of Impatiens balsamina, together with 2-methoxy-1,4-naphthoquinone, compounds having significant antipruritic activity (Ishiguro et al., 1998).

p-Hydroxybenzoic acid was identified as a precursor of 2-Hydroxy 1,4-Naphthoquinone in Impatiens balsamina (Bohm BA, 1967).

A novel natural bisnaphthoquinone, methylene-3,3’-bilawsone was isolated from root culture of Impatiens balsamina along with lawson and 2-methoxy-1,4-naphthoquinone (naphthoquinones); scopoletin and isofraxidin (coumarin) and spinasterol (sterol) (Panichayupakaranant et al., 1995). A new biscomarin, 4,4’-bisofraxidin has been isolated from the root cultures of Impatiens balsamina, whose structure was elucidated by 1D and 2D NMR techniques (Panichayupakaranant et al., 1998).

PHARMACOLOGICAL ACTIVITIES

Antibacterial and antifungal

Various extracts from the plant Impatiens balsamina were screened for the antibacterial activity against bacterial pathogen like Shigella boydii, Salmonella paratyphi, Proteus vulgaris, Staphylococcus aureus and Cryptococcus neoformans and fungal pathogen like Candida albicans. High zone of inhibition was observed in all tested pathogen except Salmonella
paratyphi and Proteus vulgaris. These two pathogen shows moderate zone of inhibition (John et al., 2013).

Antimicrobial activity of ethanolic extract of stem and leaf of the plant, harvested at different time interval (March, May and July), on various pathogen revealed that leaf extracts shows marked higher antimicrobial activity than the stem extracts at the same concentration. Ethanol leaf extract, regardless of harvest time, showed strong activity against Candida albicans and Clostridium perfringens; clear activity against Vibrio parahaemolyticus and Bacillus cereus and moderate activity against Salmonella typhimurium and Escherichia coli; slight activity against Staphylococcus aureus and Listeria monocytogenes. Stem ethanolic extract did not show any activity except stem of july harvested sample which is active against Candida albicans and Escherichia coli (Kang et al., 2013).

The three naphthoquinones from the leaf extract of Impatiens balsamina i.e. lawson, lawson methyl ether and methylene-3,3'-bilawson were evaluated for antimicrobial activity against dermatophyte fungi, yeast, aerobic bacteria and facultative anaerobic bacteria. Out of three lawsone methyl ether was found to be the most potent and broad spectrum antimicrobial agent (Sakunphueak et al., 2012).

Impatiens balsamina leaves extract in 100%, 50% and 25% concentration are as effective as 2% Ketoconazole to inhibit the growth of Candida. Various extracts (alcohol, benzene, chloroform, methane, petroleum ether, cool water and hot water) from the leaf and root of Impatiens balsamina were studied for in vitro antimicrobial activity against 7 bacterial species and 5 fungal species. Excellent antimicrobial activity was found in ethanolic and chloroform extracts against all test microorganism (Rajendra et al., 2014).

A single bioactive compound was isolated from 95% ethanolic extract of the dried aerial parts of Impatiens balsamina, and identified as 2-methoxy-1,4-naphthoquinone, whose structure was confirmed by various spectroscopic methods. Out of 12 bacterial and 8 fungal strains tested, it was found to have antimicrobial activity against 5 gram-positive and 2 gram-negative strains and all fungi (including multi-drug resistant strains) (Yang et al., 2001).

Isolated kaempferol and quercetin from the flowers of Impatiens balsamina showed antibacterial activity against Propionibacterium acnes and Minimum Inhibitory Concentration (MICs) for both compounds were ≤32 µg/ml and ≤64 µg/ml for clindamycin-sensitive and resistant P. acnes, respectively. Further kaempferol and quercetin separately in combination with clindamycin showed a greater synergic effect than their combination with erythromycin (Lim et al., 2007).

Various extracts of seed of the plant screened by Disc diffusion method showed potential antibacterial action against Bacillus anthracis and Escherichia coli and antifungal action against Aspergillus niger and Fusarium sp. (Jain B, 2011).

The four closely related, plant derived, smallest (20 amino acids long), antimicrobial peptides were isolated from seeds of Impatiens balsamina, designated Ib-AMP1, Ib-AMP2, Ib-AMP3 and Ib-AMP4. Peptides were inhibitory to the fungal and bacterial growth and were no cytotoxic to cultured human cells (Tailor et al., 1997). Further synthetic variant of Ib-AMP1 was found to be fully active on yeast and fungal strains. Replacement of amino acid residues by arginine or tryptophan, the fungal growth inhibition nor salt-dependency of Ib-AMP4 could be improved by more than two fold (Theyissen et al., 2005). The non-essentialness of disulfide bonds of Ib-AMP1 was proved by synthesizing a disulfide-removed linear analog of Ib-AMP1 which showed 3.7-4.8 fold higher antimicrobial specificity than wild-type Ib-AMP1 (Wang et al., 2009).

**Antiinflammatory, analgesic and antidiabetic activity**

The aqueous extract of Impatiens balsamina leaves has been reported to posses analgesic and anti-inflammatory activities (Debashree et al., 2013). The two new 1,4-naphthoquinone sodium salts isolated from the corolla of Impatiens balsamina showed significant selective cyclooxygenase-2 inhibitory activities, which supports the drug to be used to treat articular rheumatism, pain and swelling (Oku and Ishiguro, 2002). Methanol extract of Impatiens balsamina flowers showed strong and dose-dependent antinociceptive activity in chemical and heat induced mice models (Imam et al., 2012).

In vitro antiinflammatory and anti-inflammatory activities of ethanolic seed extract were performed by inhibition of alpha amylose enzyme and bovilne serum albumin (BSA) denaturation assay respectively. The results showed that the seeds of the plant have antidiabetic and anti-inflammatory activity which supports the traditional use of the plant (Shivaji et al., 2013).

**Anti-anaphylactic activity**

Study of 35% ethanolic extract of white petals of Impatiens balsamina showed it had a significant anti-anaphylactic activity (Ishiguro et al., 1992). In another study anti-anaphylactic effects of an ethanol extract of Impatiens balsamina, kaempferol 3-rutinoside and lawson are from Impatiens balsamina significantly inhibited the decrease of blood flow (Ishiguro et al., 2002).

Due to presence of platelet activating factor antagonist and compound with weak antihistamine effect, in flower extract of Impatiens balsamina, it shows protective effect against severe hypotension resulting from simulated anaphylaxis in mice. (Oku and Ishiguro, 1999; Ishiguro and Fukumoto, 1997).

**Antipruritic/Antidermatitic activity**

The balsaminones A and B from the pericarp of the Impatiens balsamina have significant antipruritic activity (Ishiguro et al., 1998).

100 mg/kg, 35% ethanol extract from petals of Impatiens balsamina was studied in atopic dermatitis model NC mice and found to be effective for the prevention and treatment of atopic dermatitis. Kaempferol 3-rutinoside and 2-hydroxy-1,4-naphthoquinone (lawson) isolated from the extract suppressed scratching behaviour and dermatitis at 10 microg/kg dose (Oku
and Ishiguro, 2001). The isolated Kaempferol from the flowers of *Impatiens balsamina* showed inhibitory activity against mushroom tyrosinase. It also strongly inhibit melanin production by Streptomyces bikiniensis in a dose dependent manner, without inhibiting cell growth (Lim, 2006).

**Anti H-Pylori activity**

Extracts of all parts of *Impatiens balsamina* (including root, stem, leaf, seed and pod) shows bactericidal activity against *Helicobacter pylori*. The pod extract was more effective, showing lower MIC and MBC (1.25-2.5 and 1.25-5.0 µg/ml, respectively). The acetone and ethyl acetate pod extracts indicate significant activity. This activity exceeded that of metronidazole and approximated to that of amoxicillin (Wang, 2009). Compounds isolated from *Impatiens balsamina* (2-methoxy-1, 4-naphthoquinone (1) and stigmastera-7,22-diene-3β-ol (2)) were evaluated for their anti- *H. pylori* activity. The MICs and MBCs for (1) were 0.156-0.625 and 0.313-0.625 µg/ml, respectively, and they were 20-80 µg/ml for both of MICs and MBCs for (2) against *H. pylori* resistant to antibiotics (clarithromycin, metronidazole and levofloxacin). The activity of compound (1) was equivalent to that of amoxicillin (Wang et al., 2009).

**Anti-androgen effect**

The bisnaphthaquinone derivative named impatienol (1), 3-hydroxy-2-[3-hydroxy-1,4-dioxo (2-naphthyl)] ethyl naphthahene-1,4-dione in the active fraction of 35% ethanol extract of *I. balsamina* aerial parts, showed remarkable testosterone 5-alpha-reductase inhibitory activity (Ishiguro et al., 2000).

**Antioxidant activity**

The antioxidant activities of ethanolic seed extract was determined by reducing power assay (Iron (III) to iron (II) reduction), Phospho molybdenum assay and DPPH free radical scavenging assay. The extract exhibited a high level of free radical scavenging activity (Shiaji et al., 2013). The ethanolic extract of whole plant of *Impatiens balsamina* showed invivo antioxidant activity, at a concentration of 200 mg/kg body wt, evaluated by chromium induced oxidative stress in male albino rats (Baskar et al., 2012a). The infusion of plant was evaluated for determination of antioxidant capacities using ferric-reducing antioxidant power (49.23 ± 1.07 µmol Fe(II)/g) and Trolox equivalent antioxidant capacity (47.36 ± 2.55 µmol Trolox(II)/g) assays, and total phenolic content was measured by Folin-Ciocalteu method (4.47 ± 0.11 mg GAE/g) (Sha et al., 2013). In another study the aqueous extract of flower of *Impatiens balsamina* was evaluated for antioxidant capacity by 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging property and total antioxidant capacity (TAC) and results were obtained 1140.36 (µg/ml) and 13.04 (AAE) respectively (Archana and Bratati, 2014).

**Anthelmintic activity**

Seed oil of *Impatiens balsamina* (10.50 and 100 mg/ml), exhibit significant anthelmintic activity in terms of time of paralysis and time of death of *Pheritima posthuma* (Jalalpure et al., 2007).

**Anti tumor activity**

The ethanol and chloroform extracts of *Impatiens balsamina* leaves have shown *in vitro* anti-tumor activity against the human hepatocellular carcinoma cell line HepG2. Further separation and purification leads to the isolation of active component which was identified as 2-methoxy-1,4-naphthoquinone (Ding et al., 2008). Crude leaf extract of *Impatiens balsamina* leaves and isolated 2-methoxy-1,4-naphthoquinone showed histoprotective effects on the pancreas, stomach, duodenum and spleen of tumor-induced mice (Herrera et al., 2013). In another study the ethanol extract of *Impatiens balsamina* was investigated for *in vitro* cytotoxicity and *in vivo* antitumor activity by Hela and NIH3T3 cells by MTT assay and Dalton’s ascites lymphoma tumor bearing mice respectively, where by at 200 and 400 mg/kg dose, it significantly increase the life span, decrease in the cancer cell number and exert protective effect on the hemopoietic system. The results clearly indicate significant antitumor and cytotoxic effects, which supports ethno-medical use of *Impatiens balsamina* in cancer therapy (Baskar et al., 2012b). A new dinaphtho-furan-7,12-dione derivative named Balsaminone C, isolated from seeds of *Impatiens balsamina* exhibit cytotoxicity against cancer cell lines A549, Bel-7402 and Hela (Pei et al., 2012). The study was conducted to investigate the cytotoxicity of 2-methoxy-1,4-naphthoquinone against gastric adenocarcinoma (MKN45 cell line). The compound resulted in serious necrosis at dose higher than 50 µM, via superoxide anion catastrophe (Wang and Lin, 2012).

**CONCLUSION**

Plants are being used as curative agents for variety of ailments. Detailed literature survey of the *Impatiens balsamina* revealed its traditional and medicinal usefulness. Various pharmacological studies reports are available which validate its traditional uses. A number of photochemicals isolated from various parts of plants have shown a variety of activities. However to explore full therapeutic potential of plant, further phytochemical, pharmacological and clinical research is required.

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