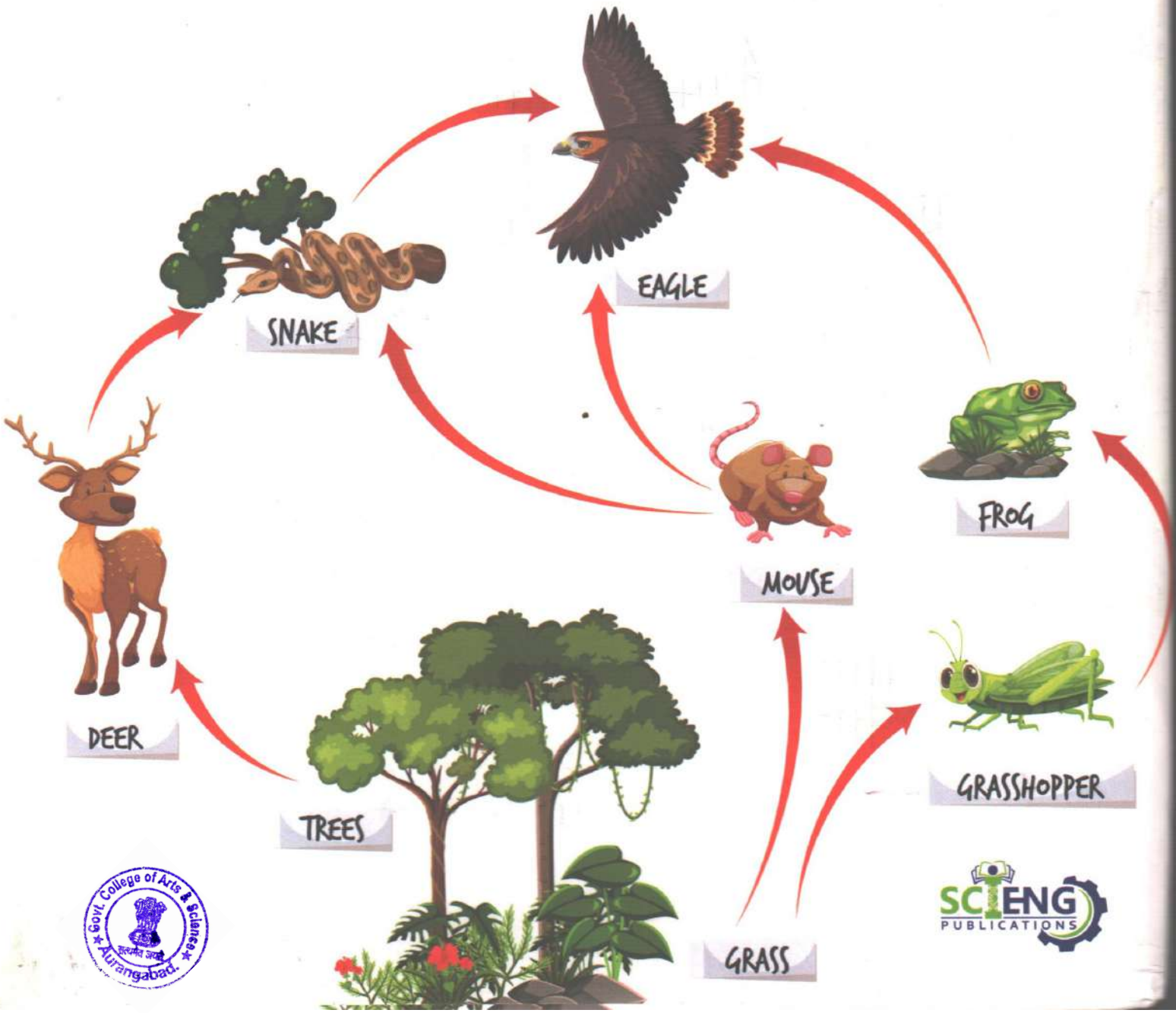
ZOOLOGY
BIO-UMBRELLA

(Volume - I)

DR. SANGEETA. B. DONGRE



CONTENTS

SCIENG PUBLICATIONS

Chapter
1

BRIEF REVIEW ON PHYTOCHEMISTRY AND PHARMACOLOGY OF *IMPATIENS BALSAMINA* L.

BAPU R THORAT [1] & ARCHANA CHAPOLIKAR[2]

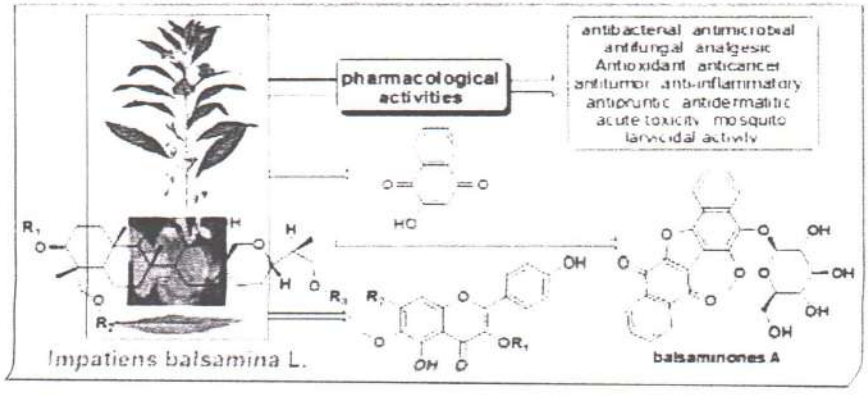
Department of Chemistry, Government College of Arts and Science,
Aurangabad, (M.S.) India – 431004.
*Corresponding Author: Bapu R. Thorat, Email: iycbrthorat@gmail.com.

ABSTRACT

Impatiens balsamina Linn was the annual traditional herbaceous medicinal plant belonging to Balsaminaceae Family; commonly known as garden balsam or rose balsam or Jewel weed. This herb was basically found in Asia, Africa and Madagascar, temperate Europe and America. It was rich sources of napthoquinones, flavonoids, glycosides and sapogenins along with various phytoconstituents like flavanoids, triterpenoids, glycosides, fatty acids and alkaloids therefore it is traditionally used as diuretic, emetic, laxative, demulcent and tonic. It was reported to possess antimicrobial activity, antipruritic activity, antidermatitic activity, transcriptional activity, antioxidant activity, antiallergic activity, anti-rheumatoid arthritis activity, anti-histamine activity, testosterone 5α-reductase inhibitory activity, cyclooxygenase-2 inhibitory activity and anti platelet activating activity. The present review summarizes all the research work carried out of this herb belong to traditional uses, pharmacological uses, phytochemical constituents, etc.

KEYWORDS: *Impatiens balsamina*, garden balsam, pharmacological uses, napthoquinones, Balsaminaceae.

GRAPHICAL ABSTRACT



INTRODUCTION

Traditional medicine also known as folk medicine was the system that developed from generation to generation within various societies, it was known as Ayurveda, Unani, Siddha, etc. All over the world, India has a rich flora that is widely distributed throughout the country. In the Balsaminaceae family, the Impatiens genus name is derived from the fact that the seed capsule ejected from a flower when ripe. The Impatiens are also called balsam, touch me not, etc. Today this genus has more than 1000 species all over the world but only two genera are recognized. J Steven; et al 2006 First monograph on the Impatiens genus was published in 1859 by British botanist Josheph Daltons Hooker. In 1874 and 1875, Hooker described 120 species of Impatiens genus native to India. These genus species do not tolerate dry conditions. Impatiens has two types of flowering pattern, flat and pouched. The Impatiens is native to temperate, subtropical, and tropical Africa, Asia and Madagascar, temperate Europe, and America. Many of the species were found in the subtropical and tropical belt so it was easy to mistake Impatiens as a warm weather plant. The Impatiens have both annual and perennial species, the annual species colonize were found in the Himalayas, northern India, and Nepal while perennial species are found in Africa, southern India, China, and the East Indies. Christopher Cumo 2013. The balsams (Impatiens) have a short life cycle, large flowers, and rather precise differentiation of color classes. The genus Impatiens (Compositae) has been known for its different biological activities in Asian and American Medicines include - antimicrobial activity, antipruritic activity, antidermatitic activity, transcriptional activity, antioxidant activity, antiallergic activity, anti-rheumatoid arthritis activity, anti-histamine activity, testosterone 5α-reductase inhibitory activity, cyclooxygenase-2 inhibitory activity and anti-platelet activating activity, etc. Most of the herbaceous plants of this genus were rich sources of naphthoquinones, flavonoids, glycosides, and sapogenins. In traditional therapeutic systems or reported applications, *I. balsamina L.* has been the most popular species among the reported genus *Impatiens*. Some other species of the same genus reported for their therapeutic applications such as Flowers of *I. glandulifera* are recommended for psychological problems and pain and are used in Bach flower remedies, which cause sedation, relax, and help to balance the emotional state Thaler, K. 2009. *Impatiens sulcata* Wallich in Roxb. (Balsaminaceae) was reported as a medicinal plant different from folk medicine for the treatment of several ailments. The rhizomes of *Impatiens pritzellii* Hook. f. var. hupehensis Hook. f. Zhou, X 2007 and the whole plant of *Impatiens textori* MIQ have been reported in different in Chinese medicine. Rhizomes of *Impatiens pritzellii* were used as a traditional treatment for rheumatoid arthritis, diarrhea, and acute abdominal pain. *Impatiens parviflora* has been widely used in traditional medicine in Asia to treat rheumatism, fractures, and infection, and in some areas of China people ingest this plant as a vegetable or use it as an anti-cancer herb. The extracts from species of *Impatiens*, especially *I. balfourii* Hook. f., *I. glandulifera*, and *I. parviflora*, were contained significant amounts of phenols and flavonoids and showed interesting multidirectional biological activity, such as antimicrobial and antioxidant abilities Szewczyk, K.; 2016. Ayurvedic system of medicines describes the oil of the plant *Impatiens scabrida* to be used as semi-drying oil Yadawa R. N., 1992; the whole plant of *Impatiens textori* has been used for detoxication and treatment of carbuncle and contusion in Chinese medicine Chang S. 1977. It is also used for decreasing blood pressure and inflammation

Ueda Y., 2003. Aerial parts of *Impatiens emirnensis* Bak are used as an antimalarial remedy in Madagascar Rasoanaivo P., 1992. *Impatiens siculifer* was used in traditional Chinese medicine in the treatment of rheumatoid pain and paralysis, burns, scalds, and fractures (State Administration of Traditional Chinese Medicine, 1999). In America, *Impatiens capensis* has been used to treat hives, and rashes caused by other plants Henn R. L., 2008. It is also used to prevent poison ivy rash by rubbing it on the skin before known exposure or immediately after coming in contact with poison ivy Foster S., 1990.

Impatiens balsamina L. is a species of *Impatiens* genus native to southern Asia in India Myanmar, Malaya, Bangladesh, and Burma and now cultivated in China for ornamental and medicinal purposes. In India, it is used in traditional methods such as Ayurveda, Unani, and Siddha for various diseases and physiological conditions. It belongs to the family of Balsaminaceae which consists of more than 1000 species. In India, this species was commonly cultivated as a garden plant throughout tropical and sub-tropical parts, grows gregariously as forest undergrowth, and is commonly seen on the borders of rice fields, Chatterjee A, 1997damp ground and roadsides, Madhav R.1959 and in heavy clay soil. The ripe seed capsules undergo explosive dehiscence Synonyms of *Impatiens balsamina* is *Impatiens coccinea, Impatiens corneta, Balsamina hortensis*. The balsams have a short life cycle, large flowers, and rather precise differentiation of color classes.

1. PLANT PROFILE

Family	: Balsaminaceae
Botanical Name	: Impatiens balsamina L.

2. TAXONOMICAL CLASSIFICATION[3]

Kingdom	: Plantae – Plants
Subkingdom	: Viridiplantae
Infrakingdom	: Streptophyta – land plants
Superdivision	: Embryophyta
Division	: Tracheophyta/Magnoliophyta/Spermatophyta - vascular plants
Subdivision	: Spermatophytina/Angiospermae – seed plants, spermatophytes, phanérogames
Class	: Magnoliopsida/Dicotyledonae
Subclass	: Asteridae
Superorder	: Asteranae
Order	: Ericales
Genus	: *Impatiens* L.
Species	: *Impatiens balsamina* L. – spotted snapweed

3. DIFFERENT NAMES OF THE PLANT[6]

English	: Garden balsam, Garden jewelweed, Rose balsam, Spotted snapweed, Touch-me-not, Jewel weed, Balsam weed
Hindi	: Gul-mehndi, Gul-mendi, Gulmehndi, Gulmendi, Manjrya, Mehndi, Phyaktuli, Timadia
Kannada	: Basavana paadadagida, Basavanapaada, Gowri hoo gida, Gowri hoovina Gida, Gowri hoovu, Karna kundala, Karnakundala
Malayalam	: Tilo-onapu, Mecchingom
Marathi	: Chirdo, Terada
Oriya	: Haragaura
Panjabi	: Tambol, Bontil
Sanskrit	: Tairini, Dushpatrijati
Tamil	: Aivartenkittumpai, Aivartyenki, Kacit-Tumpai, Kasittumpai, Kopurattumpai, Kulin, Tucapattiri, Uropantikai, Uropantikaicceti, Utakatacceti, Utakatam
Telugu	: Chilaka mukka puvvu, Kaasithummi, Kasi tummi, Mudda gorinta
Urdu	: Gulemendi
Bengali	: Dupati
Gujarati	: Gulmendi, Tanmania

4. PLANT MORPHOLOGY

Impatiens balsamina L. is a sparsely-branched, pubescent or glabrate, annual erect herbaceous plant with a stick but a soft stem and grows about 0.3 to 1 m in height (Herber 1864). The leaves of the herb are alternately or spirally arranged along the succulent stems, lanceolate-elliptic, and have serrate margins. They are about 4 to 10 cm long and 1.5 to 3 cm broad with a deeply toothed margin. Steams of the herb bear alternate, up to 15 cm long, narrowly lanceolate, acuminate, deeply serrate, glabrous leaves which bear decurrent, shot, pubescent petiole. Flowers are showy and come in many colors (rose-colored - red, pink, purple, lilac, mauve, white), axillar, pubescent, slender, shorter than the leaves i.e. 2.5 to 5 cm long, produced in stalkless clusters in leaf axils. Flowers are hermaphrodites (having both organs) and are easily pollinated by bees and other insects, as also nectar-feeding birds. The spurs are incurved and about 1 to 2.5 cm long. Fruits are fuzzy capsular, tomentose and hairy, ellipsoid and narrowed at both ends, green turning to brown when mature with rigid yellow bristles, and split open easily to scatter small seeds. Seeds are globose, tubercled, reticulate, 0.5 cm in diameter, and have black testa. Both flowers and fruits appeared during rainy seasons (Thaler et al 2003) and Anonymous 1959). The colchicines treatment increases the herb height, stem circumference, leaf length, and several branches.

5. TRADITIONAL USES

1. Whole *Impatiens balsamina* L. herb was used for medicinal and cosmetic purposes. Different parts of the herbaceous plant were used in different traditional remedies and

for skin afflictions. Ethanolic juice from the leaves and flowers is used to treat warts and snakebite (Binorkar et al 2008) and applied to burn (Yuan-Chuen Wang et al 2009). The aerial part of the herb was used in Chinese medicine for the treatment of articular rheumatism, bruises, and beriberi (Chang Su 1977).

2. *Impatiens balsamina* L. herb has been used as indigenous traditional medicine in Asia for rheumatism, fractures, swelling, fingernail inflammation, and other ailments (Debashree et al 2013).
3. In Korean folk medicine, this *Impatiens* species was used as a medicine called *bongseonhwa dae* for the treatment of constipation and gastritis (*Park et al 2003*).
4. Chinese uses *I. balsamina* L. as counteracting snakebite or ingested poisonous fish. Juice extracted from the stem and rice liquor mixture was used to reduce swelling and heal bruises. The dried pulverized stem ointment was used to reduce pain. The paste of flowers was used to treat back pain and neuralgia (Chinese Pharmacopoeia Commission 2010). The aerial parts including leaf and steam have been used locally for the treatment of inflammatory, rheumatic and pruritic diseases (The Committee of Chinese Materia Medica 1996). Well-dried ripe seeds have been reported in Chinese herbal medicines for the treatment of amenorrhea, abdominal mass, bone choking throat, and sores (Chinese Pharmacopoeia Commission 2010).
5. The Vietnamese wash their hair with an herb extract to stimulate hair growth i.e. to stimulate the follicles to grow hair (Christopher Cumo 2003).
6. The hydroalcoholic extract of the aerial part of *Impatiens balsamina* L. herb was used as an inhibitor of 5α-reductases, enzymes that reduce testosterone levels (*Ishiguro et al 2000*). The basic active non-steroidal compound showing inhibition activity was isolated - impatienol, 3-hydroxy-2-[[3-hydroxy-1, 4-dioxo (2-naphthyl)] ethyl] naphthalene-1, 4-dione. This study supports the use of the herb in folk medicine against male pattern baldness.
7. In Korea and Bali, the juice of red petals of flowers and leaves (garden blossoms) was used to produce an orange nail varnish
8. The seeds of the plant have been used to promote blood flow such as for the suppression of post-childbirth pain.
9. In Thailand, *I. balsamina* L. has been traditionally used for the treatment of thorn or glass-puncture wounds, abscesses, ingrown nails, and chronic ulcers caused by an allergic reaction to detergents (Farnsworth and Bunyapraphatsara 1992).
10. In some villages in Malaysia, leaves of *I. balsamina* L. have been pounded and applied topically to treat split nails (Ong et al 2011).
11. Flowers have a cooling, demulcent, and tonic effect and are used in the case of burns and scalds, lumbago, and intercostals.
12. In Japan, squeezed juice of petals (white corolla) is used to treat several types of dermatitis, including urticaria, and anti-anaphylactic (Chang Su1 1977).

13. Tribal of Amarkantak, Madhya Pradesh of India, the herb is used for the treatment of inflammation, burns, ulcers, constipation, arthritis, and urinary retention; in the Pachmarhi region, roots extract is used for the treatment of irritation of gastro-intestinal canal (Mishra et al 2012 and Srivastava et al 2012).
14. *I balsamina* extracts show a long-lasting skin moisturizing effect and prevent dryness, rough skin chap, dandruff, and splitting hair ends, hence are used to prepare lotions, creams, hair tonics, cosmetics, bath preparations, and detergents (Baskar et al 2012).
15. In China, to control the post-harvest decay and maintain the quality of the Newhall navel orange (*Citrus sinensis* L.,), it was dipped into the extract of *Impatiens balsamina* L. stems. After 100 days of cold storage, it reduced the decay rate and weight loss of the fruit from 10.2% to 6% and from 6.33% to 2.91%, with no deleterious effect on the quality of fruits (Rong Zeng et al 2013).
16. The dried herb is boiled in water to make tea which was used to treat systemic bacterial and fungal infections or applied directly on the skin or nails in a plaster form to treat local infections Yang et al 2001).
17. Regular ingestion of large quantities of this herb can be dangerous due to its high mineral content.

6. ETHNOBOTANICAL USES

Leaves and young shoots are cooked and eaten as a vegetable. Raw or cooked Seeds of this herb are edible. The plant has been reported to have different pharmacological activities such as antibacterial (Ahmed John, Koperuncholan 2012 and Xiaobo and Jürgen 2013) antimicrobial (Jain 2011 and Kang et al 2013). antifungal (Thevissen et al 2005), analgesic (Debashree et al 2013). Antioxidant (Kang et al 2013), anticancer (Baskar et al 2012), antitumor (Baskar et al 2012 and Ding et al 2008), anti-inflammatory, antipruritic (Hisae Oku, Kyoko Ishiguro 2011), antidermatitic (Hisae Oku, Kyoko Ishiguro 2011), acute toxicity (Takeshi et al 2013 and Benny et al 2014), mosquito larvicidal activity (Marimuthu and Mohan 2014).

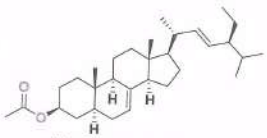
The chemical and pharmacological studies have identified different flavonol and naphthoquinone derivatives; some of them are showing strong antimicrobial, anti-anaphylaxis, anti-inflammatory, itch alleviating, and anti-dermatitis activities (Ding et al 2008). Mucilaginous flowers have cooled, antifungal and antibacterial properties, anti-tumor, antipruritic, anti-anaphylactic activity, treat pains in the joints, used to treat burns, warts, scalds, and snakebites. Powdered seeds were given to women during labor to provide strength. A dye can be obtained from flowers and leaves, and used for dyeing fingernails and toenails.

A. BACTERICIDAL AND ANTIMICROBIAL ACTIVITY

Several bacterial strains show resistance to antibiotics; one of them was *Helicobacter pylori*. *H. pylori* strains have resistance to antibiotics such as larithromycin (CLR), metronidazole (MTZ), and levofloxacin (LVX). The extracts of different parts and whole herb along with seeds and pods of *Impatiens balsamina* L. 95% ethanol and study their activity against *H. pylori*. The MICs values of 95% ethanol extract of the pod were relatively low therefore the

pods were further extracted by using different solvents such as water, acetone, or ethyl acetate were tested against *H. pylori*. The MICs and MBCs value of ethyl acetate extract were the lowest among all the solvent extracts; the value of MICs of water extract was even higher than 95% ethanol extract. All the data and literature studies suggested that *I. balsamina* L. extract was more efficient bactericidal against *H. pylori* than any other reported crude extract of natural product n(Yuan-Chuen et al 2009). Infection with *Helicobacter pylori* bacteria is strongly associated with gastric cancer and gastric adenocarcinoma. The isolated compounds, 2-methoxy-1, 4- naphthoquinone (MeONQ) and stigmasta-7, 22- diene-3β-ol (spinasterol, **1**, **2**) from the pods and roots/ stems/ leaves of Impatiens *balsamina*. The bactericidal activity of MeONQ was dose-dependent which is not affected by the environment such as pH (Yuan-Chuen Wang et al 2011).

alpha-Spinasterol
1



alpha-Spinasterol acetate
2

The higher activity was due to different compounds isolated from *Impatiens balsamina* L. including peptides, phenolics, quinines, and flavonols (Ishiguro and Oku 1997and Oku and Ishiguro 2011). The antibacterial activities of the extracts in different solvents such as Hexane, Petroleum ether, Acetone, Methanol, and water of the plant "*Impatiens balsamina*" were screened against selective bacterial strains. The bacterial pathogens *Shigella boydii*, *Candida albicans*, and *Cryptococcus neoformans* showed good positive results in all extracts, methanol and aqueous extracts are more active (Ahmed John and Koperuncholan 2012). The *in vitro* antimicrobial activity of leaf and root extracts of *Impatiens balsamina* were studied against selected microbial pathogens; ethanol extracts were more active against bacterial than the fungal strains while the chloroform extract showed moderate antimicrobial activity against the bacterial and fungal pathogens.

Various extracts of seeds of *I. balsamina* L. showed potential antibacterial action against *Bacillus anthracis* and *Escherichia coli* and antifungal action against *Aspergillus niger* and *Fusarium* sp (Jain 2011). . The hexane extracts containing flavonoids, alkaloids, phenol, tannin, alkaloids, steroid, saponin, phenol, flavonoids, triterpenes glycosides, etc showing strong activity against *S. aureus*, *K. pneumonia*, *P. vulgaris*, and *S. marcescens* microorganisms (Manikandan et al 2016) The peptides known as Ib-AMP1-4 isolated from seeds of *I. balsamina* L. showing activity against different gram positive and gram negative bacterial strains and fungi (Tailor et al 1997 and Trevisan et al 2007). Flavonoids and naphthoquinones (**3**, **4**) such as quinone (2-methoxy-1,4-naphthoquinone, **3**) isolated from the aerial part of the herb were found to have activity against fungi and food-borne pathogenic bacteria (Yang et al 2001). In the screening of various extracts of *I. balsamina* L. against different bacterial strains, the results of all tested bacteria show higher activity

except *Salmonella paratyphii* and *Proteus vulgaris* (John and Koperuncholan 2013). The ethanolic extract of leaves was containing a higher amount of flavanoids and phenolic shows stronger antibacterial activity than the stem extract at the same concentration. The leaf extract was moderate activity against *Salmonella typhimurium* and *Escherichia coli*; slight activity against *Staphylococcus aureus* and *Listeria monocytogenes* (Kang et al 2013). The in-vitro antimicrobial activity of various extracts of leaf and roots in different solvents were studied; excellent results were found for ethanolic and chloroform extracts against all test microorganism (Rajendra et al 204).

Lawsone and lawsone methyl ether extracted from leaves has been reported as the active constituents exhibiting antifungal and antibacterial activities (Farnsworth et al 11976 and Tripathi et al 1978); lawsone methyl ether was found to be the most potent and broad-spectrum antimicrobial agent (Sakunphueak et al 2012). There are many research articles on the antimicrobial activity of naphthoquinones, the Methylene-3,3'-bilawsone extracted from root culture showing antimicrobial and antipruritic activity (Ishiguro et al 1994). The isolated flavonoids and naphthoquinones extracted and isolated from leaves of *Impatiens balsamina* L. also show anti-anaphylaxis (Ishiguro et al 1994), and anti-allergic (Oku et al 2002 and Ueda et al 2015)and anti-inflammatory (Oku et al 2002)activities. The lawsone methyl ether extracted from leaves exhibited an intensive anti-tumor activity against HepG2 cells (Ding et al 2001).

The crude leaves extract in different solvents such as benzene, chloroform, ethyl acetate, and methanol showed larvicidal activity against the larvae of three important vector mosquitoes, *viz*, *An. stephensi*, *Ae. aegypti* and *Cx. quinquefasciatus*. Among all tested extracts, methanol extract was showing the highest larvicidal activity (Marimuthu and Mohan 2014. Antiacne effect of cream of leaves extract in methanol of *Impatiens balsamina* L. towards *Propionibacterium acnes* and *Staphylococcus epidermidis* was studied. Among all the extracts, 15% extract showed the most effective inhibition of the growth of bacteria (Abdurraafi et al 2015).

B. ANTI-INFLAMMATORY AND ANALGESIC ACTIVITY

Aqueous leaves extracts of *Impatiens balsamina* L. has possesses analgesic and anti-inflammatory activities (Debashree et al 2013). The analgesic activity of the aqueous extract of leaves of *Impatiens balsamina* L. was studied in a suitable animal model by using the tail-flick method; the results show a significant analgesic without any adverse effects (Debashree et al 2013).

The analgesic and anti-inflammatory activities are studied by using the tail-flick method and the carrageenan-induced paw edema method in albino rats respectively. The aqueous extract of leaves contains anthocyanins, Cox-2 inhibitory naphthoquinones (lawsone, lawsone methyl ether, methylene-3,3'-bilawsone), kaempferol glucosides, and flavonoids such as quercetin; the higher amount of flavonoids possess analgesic activity. The methanol extract of flowers of *Impatiens balsamina* L. showed strong and dose-dependent antinociceptive and CNS depressant activities in chemical and heat-induced mice models (Imam et al 2012) which justifies the use of the plant in folk medicine to treat lumbago, neuralgia, burns, and scalds. The *in-vitro* anti-inflammatory, antioxidant and antidiabetic

activity of ethanolic seed extract of *Impatiens balsamina* L. was studied by different methods or assays (Shivaji et al 2013). The results showed that the seeds of the plant have anti-diabetic and anti-inflammatory activity and it was dose-dependent (Shivakumara et al 2014).

C. ANTI-DIABETIC ACTIVITY

Different phytochemicals were used to manage post-prandial hyper-glycemia at the digestive level or used as glucosidase inhibitors. The antidiabetic activity of compounds separated from hydroalcoholic extract of flowers of *Impatiens balsamina* L. was studied against α-glucosidase i.e. α-glucosidase inhibitory assay. Some of the isolated polyphenols, glycosides, and flavonoids were shown excellent α-glucosidase inhibitory activity (Qian et al 2015). The α-Amylase is the enzyme that hydrolyses alpha-bonds of large alpha-linked polysaccharides such as glycogen and starch to yield glucose and maltose; if the activity of enzymes amylase decreases or suppressed would delay the degradation of starch and oligosaccharides. The ethanolic extracts of the seed of *Impatiens balsamina* L. showed strong *in-vitro* anti-diabetic activity (Shivakumara et al 2014).

D. ANTIPRURITIC/ANTIDERMATITIC ACTIVITY

The balsamin ones A and B separated from the extract of the pericarp of the *Impatiens balsamina* have significant antipruritic activity (Ishiguro et al 1998). 35% Hydroalcoholic extract of petals of *Impatiens balsamina* L. was studied in atopic dermatitis model NC mice; it was found to be effective for the prevention and treatment of atopic dermatitis. Kaempferol 3-rutinoside and 2-hydroxy-1,4-naphthoquinone (lawsone) were effective phytochemicals, present in extract suppressed scratching behavior and dermatitis at a 10 micron/kg dose (Oku and Ishiguro 2001). The Kaempferol isolated from the flowers of *Impatiens balsamina* showed inhibitory activity against mushroom tyrosinase. It also strongly inhibits melanin production by *Streptomyces bikiniensis* in a dose-dependent manner, without inhibiting cell growth (Squadriato et al 1998 and Duh 1998).

E. ANTIOXIDANT PROPERTY

Oxygen is a highly reactive atom that can be becoming part of potentially damaging molecules commonly known as "free radicals." Free radicals are capable attacking of healthy cells of the body and causing them to lose their structure and function. Such kind of cell damage caused by free radicals makes a major contribution to aging and to degenerative diseases of aging such as cancer, cataracts, immune system decline, cardiovascular disease, and brain dysfunction. Generally, free radicals have been responsible for at least 50 diseases (fortunately; free radical formation was controlled naturally by various beneficial compounds known as antioxidants which are primary or secondary phytochemicals.

The antioxidant activities of ethanolic extract of air-dried seeds were determined by reducing power assay (Fe(III) to Fe(II) reduction), Phospho-molybdenum assay, and DPPH free radical scavenging assay. The extract shows a high level of free radical scavenging activity (Shivaji et al 2013). The ethanolic extract of the whole plant of *Impatiens balsamina* showed *in vivo* antioxidant activity (induced by chromium in male albino rats), at 200 mg/kg of body weight which was evaluated by chromium-induced oxidative stress in male

albino rats (Baskar et al 2012). The antioxidant property of infusion of the plant was evaluated by 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 determined by Folin-Ciocalteu method (4.47 ± 0.11 mg GAE/g) (Sha et al 2013). The antioxidant capacity of aqueous extract of flower of *Impatiens balsamina* was evaluated by DPPH free radical scavenging assay and total antioxidant capacity (TAC), the results (1140.36 (µg/ml) and 13.04 AAE) showing good activity (Archana and Bratati 2014). The antimicrobial and antioxidant properties of various extracts of the stem in different were studied by DPPH free radical scavenging and reducing power assay, all extracts showed moderate antioxidant and good antimicrobial activity especially antifungal properties (Bu-Li Su et al 2012). The antioxidant properties of ethanolic extract of stem and leaves were studied by DPPH assay; the leaf extract shows higher antioxidant activity than those of stem because of higher total phenolic and flavonoid contents (Kang et al 2013).

F. ANTI-TUMOR ACTIVITY

The *Impatiens balsamina* has an extensive range of phytochemicals like naphthoquinones, phenolic acids, anthocyanidins, flavonoids, coumarins, glycosides, and steroids which have effective bioactivity. The two types of cancer inhibitors such as flavonoids and naphthoquinones were extracted from different parts of the herb. The lawsone, lawsone methyl ester, and methylene-3,3'-bilawsone were proven to possess an intensive antitumor activity. The major constituent quercetin inhibited the proliferation of human MDA-MB-435 breast cancer cells in-vitro and in-vivo, associated with down-regulation of signal transductions in the cells (Bu-Li Su et al 2012).

The ethanol and chloroform extracts of leaves of *Impatiens balsamina* have shown *in vitro* anti-tumor activity against the human hepatocellular carcinoma cell line HepG2. Further separation and purification led to the isolation of 2-methoxy-1,4-naphthoquinone as an active component (Ding et al 2003). The chloroform extract shows strong tumor inhibition than curcumin. Crude leaf extract of *Impatiens balsamina* leaves and isolated 2-methoxy-1,4-naphthoquinone showed significant histoprotective effects on the pancreas, stomach, duodenum, and spleen of tumor-induced mice (Herrera et al 2013). Methanol extract of *Impatiens balsamina* L. decreases the cell viability of HSC-2 human oral cancer cells and induced apoptosis. The results suggested that methanol extracts may be used to treat oral cancer (Shin et al 2015). The methanol extract also may serve as a potential candidate for the treatment of human oral squamous cell carcinoma cells; the extract decreases the cell viability and induced apoptosis (Shin et al 2015). In another study, the ethanol extract of *Impatiens balsamina* was investigated for *in vitro* cytotoxicity against transplantable and antitumor activity by using human cell lines such as Hela and NIH3T3 cells by MTT assay and Dalton's ascites lymphoma tumor-bearing mice respectively. The extract at 200 and 400 mg/kg dose significantly increases the life span, decreases the cancer cell number, and exerts a protective effect on the hemopoietic system. The extract showed strong *in-vitro* cytotoxicity against the HeLa cell line without affecting normal cells. The results clearly show significant antitumor and cytotoxic effects, which supports the ethnomedical use of *Impatiens balsamina* in cancer therapy (Baskar et al 2012). A new dinaphthofuran-7,12-dione derivative named Balsaminone A, B, and C, separated from seeds of *Impatiens balsamina* exhibits moderate cytotoxicity against cancer cell lines A549 (lung), Bel-7402 (liver), and Hela (cervix) human neoplastic cell lines (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 showing a good potential candidate agent for helicobacter pylori infection-related diseases at a dose higher than 50 µM, via superoxide anion catastrophe (Wang and Li 2012).

The phenolic compounds (two containing nitrile group) isolated and characterized from white flowers of *Impatiens balsamina* were subjected to cytotoxic studies by determining their inhibitory effects on human tumor cell lines (A549, SK-OV-3, SK-MEL-2, and HCT15) in vitro using the sulforhodamine B (SRB) assay, their neuroprotective activity by determining their effects on nerve growth factor (NGF) secretion in C6 cells, and their anti-neuro-inflammatory activity by measuring nitric oxide (NO) production in lipopolysaccharide (LPS)-stimulated BV-2 cells (Chung Sub Kim et al 2015). The phenolic compounds showed cytotoxic activities against the SK-MEL-2 cell line.

7. CULTIVATION

It is commonly grown in gardens but has also naturalized in many countries around the world, appearing mostly in disturbed areas. It is suitable for flower beds and containers. Propagate by seeds.

8. ETYMOLOGY

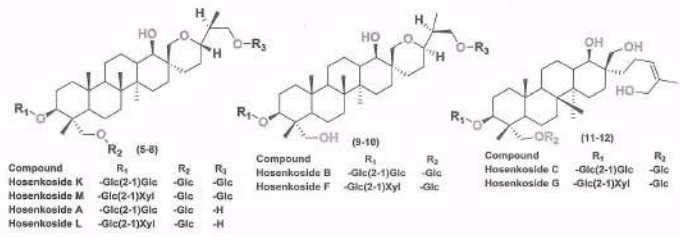
The Genus name means impatient, referring to the exploding seed pods.

9. SECONDARY METABOLITES:

The major secondary phytochemicals were commonly identified and isolated from the different parts of the herb including fatty acids, naphthoquinones, coumarins, phenolic acids, quinones, flavonoids, triterpenoids, glycosides (*Li et al 2011*), peptides, leucocyanidins, anthocyanidins, tannins, saponins, alkaloids, essential oils, and steroids, etc (Bohm et al 1962). The *Impatiens* genus was a rich source of organic acids, anthraquinones, and flavonoids.

A quinone (2-methoxy-1,4-naphthoquinone) and bisnaphthoquinone derivative isolated from the aerial part of the herb (Yang et al 2003), other quinones such as lawsone, balsaquinone, 2-methoxy-1,4-naphthoquinone (MeONQ), naphthalene-1,4-dione and impatienol (*Ishiguro et al 2011)* have been isolated from the petals, pericarp, and aerial parts of the plant (Fukumoto et al 1996).

Alcoholic extracts of dried seeds show the presence of alkaloids, flavonoids, terpenoids, saponins, and tannins. Peptides, known as Ib-AMP1 (a highly basic small antimicrobial peptide with 20 residues) (Sunil et al 1998, Yuan-Chuen Wang et al 2011) baccharane triterpenoid, Hosenkol-A, and baccharane glycoside (Shoji et al 1994), namely hosenkosides A, B, C, F, G, K, L, and M (*Li* et al 2011) (5-12) extracted in aqueous methanol and ethanol by ultrasonic extraction from *I. balsamina* L. seeds and separated by using HPLC electrospray ionization mass spectrometric detection and evaporative light scattering detection.



Compound	R_1	R_2	R_3
Hosenkoside K	-Glc(2-1)Glc	-Glc	-Glc
Hosenkoside M	-Glc(2-1)Xyl	-Glc	-Glc
Hosenkoside A	-Glc(2-1)Glc	-Glc	-H
Hosenkoside L	-Glc(2-1)Xyl	-Glc	-H

Compound	R_1	R_2
Hosenkoside B	-Glc(2-1)Glc	-Glc
Hosenkoside F	-Glc(2-1)Xyl	-Glc

Compound	R_1	R_2
Hosenkoside C	-Glc(2-1)Glc	-Glc
Hosenkoside G	-Glc(2-1)Xyl	-Glc

Fig. 1: Hosenkoides Isolated from the Alcoholic Extract of Dry Seeds of *I. Balsamina*.

A new monoglycerides such as (-) (R, Z) glycerol-1-octadec-9-enoate was isolated from seeds and characterized (Patra and Chaudhari 1988). Two flavones glycosides such as quercetin-3-*O*-[α-]-rhamnose-(1→2)-β-d-glucopyranosyl]-5-*O*-β-d-glucopyranoside, quercetin-3-*O*-[(6‴-*O*-caffeoyl)-α-]-rhamnose-(1→2)-β-d-glucopyranosyl]-5-*O*-β-d-glucopyranoside (**14**), a viscous oil, alpha-amyrin (**13**), beta-sitosterol (**16**), alpha-spinasterol (1), balsaminasterol and an anthraquinone glycoside were isolated from seeds and characterized by different spectral studies (Shoji et al 1983 and Patra and Chaudhari 1988).

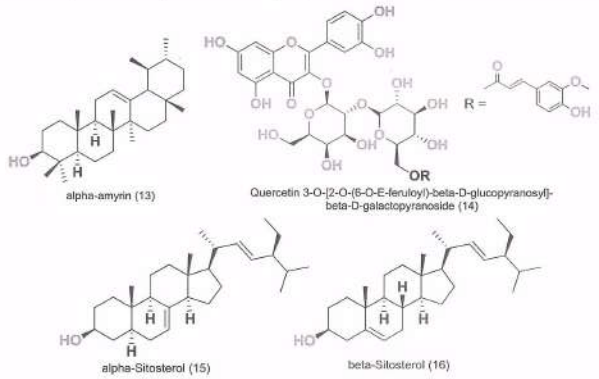
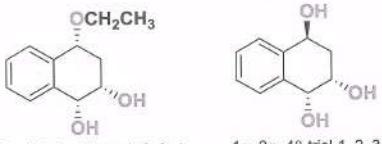


Fig. 2: Monoglyceride and Sitosterol Isolated from Seeds of *I. Balsamina*.

A new HPLC method has been developed and validated for three main bioactive naphthoquinones i.e. lawsone, lawsone methyl ether, and methylene-3,3′-bilawsone (*Sakunphueak et al 2010*), and two new tetrahydronaphthalenes (**17-18**) as 1α, 2α-diol-4α-ethoxy-1, 2, 3, 4-tetrahydronaphthalene and 1α, 2α, 4β-triol-1, 2, 3, 4-tetrahydronaphthalene were isolated from stem and elucidated their structures (Chen et al 2010).



1α, 2α-diol-4α-ethoxy-1, 2, 3, 4-tetrahydronaphthalene (17)

1α, 2α, 4β-triol-1, 2, 3, 4-tetrahydronaphthalene (18)

Fig. 3: Compounds Separated from Hydroalcoholic Extract of Stem of *I. Balsamina*.

Flavonoids (Ding et al 2008, Ishiguro et al 1997, Oku et al 2001, Ishiguro et al 1994, *Sakunphueak et al 2010*, Lee et al 1994) such as kaempferol, quercetin, rutin, astragalin, nicotiflorin, naringenin, and their derivatives; lawsone, hennotannic acid, lawsone methyl ether, methylene-3,3′-bilawsone (*Sakunphueak* et al 2010) were isolated from petals and leaves of *I. balsamina* L.

The flowers of the herb containing flavanol, kaempferol (4′,5,7-trihydroxyflavonol), quercetin (3′,4′,5,7-tetrahydroxyflavonol), and myricetin (3′,4′,5′,5,7-pentahydroxyflavonol); kaempferol (**39**) and myricetin (**38**) was found in petals and sepals while quercetin was isolated from sepals only (Clevenger 1958). Kaempferol and its derivatives such as kaempferol 3-glucoside, kaempferol 3-glucosylrhamnoside, kaempferol 3-rutinoside and kaempferol 3-(p-coumaroyl) glucoside was reported and quantified present in the *I. balsamin* (*Hua eta al 2001 and* Calderon-Montano et al 2011). The structure of kaempferol which was isolated from white petals was determined by spectroscopic techniques and is kaempferol-3-O-[2″- O- α - L- rhamno pyranosyl - 3″ O-β-D- glucopyranosyl] -β- D-glucopyranoside (Fukumoto et al 1994). Some polyphenols, glycosides, and flavonoids were separated from the hydroalcoholic extract and studied their antidiabetic activity (Qian Li et al 2015). Various flower colors exhibited in this species were due to the presence of glycosides of three anthocyanidins: pelargonidin (**25**), peonidin (**26**), and malvidin (Raliph et al 1956).

The white flower of *I. balsamin* used in Korean medicine was investigated for its phytochemicals; the phenolic compounds (**19-42**), phenolic containing nitrile groups (**19**), and Lawson methyl ether were extracted and isolated from methanol extract Chung Sub Kim et al 2015.

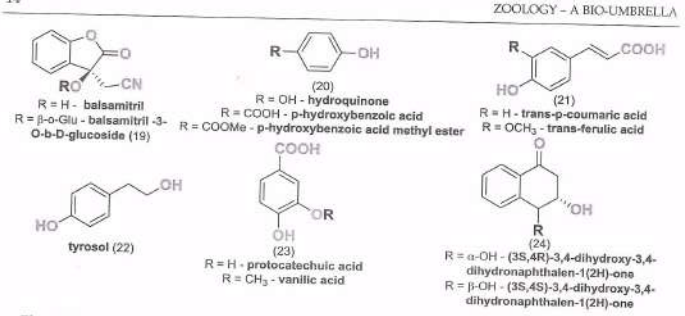
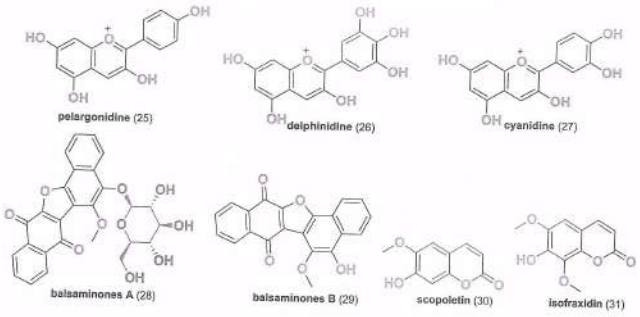


Fig. 4: Phenolic Compound Isolated from Methanolic Extract of White Flowers of *I. Balsamin*

The phytochemical investigation of flowers afforded four new triterpene saponins (Balsaminside A-D **28**, **29**, **45**), glycosides, autantiamide acetate (**36**), and glycerol 9(E),11(Z),13(E)-octadecatrienoyl ester (**47**). The bioassay of all investigated compounds showed that all the compounds had significant cytotoxic activity against t-HSC/Cl-6 cells. Therefore, triterpene saponins are potential functional food ingredients that can be used as new anti-hepatic fibrosis agents (QianLi et al 2017).

Balsaminones A (**28**) and B (**29**) (Dinapthofuran-7,12-dione derivatives) were isolated from the pericarp of *Impatiens balsamina*, along with 2-methoxy-1,4-naphthoquinone, compounds having significant antipruritic activity (Ishiguro et al 1998).



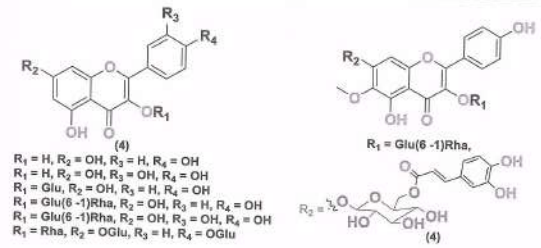


Fig. 5: Kaempferol and its Derivatives Separated from Hydroalcoholic Extract of Flowers of *I. Balsamina*.

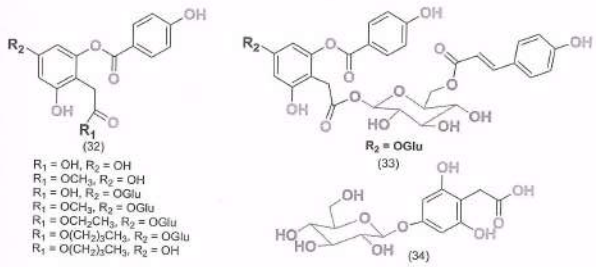
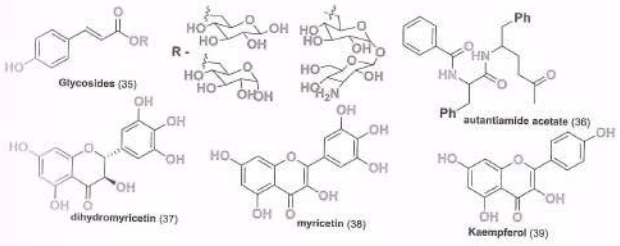


Fig. 6: Compounds Separated from Hydroalcoholic Extract of Flowers of *I. Balsamina*.



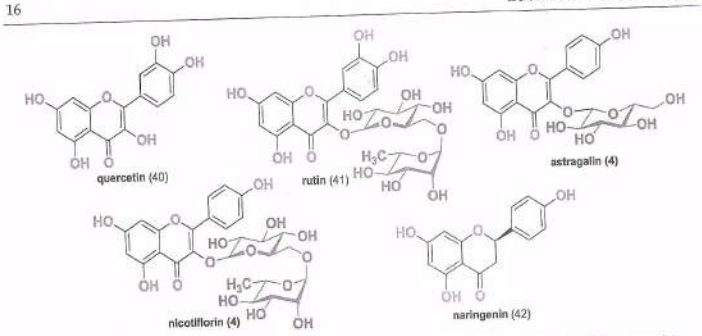
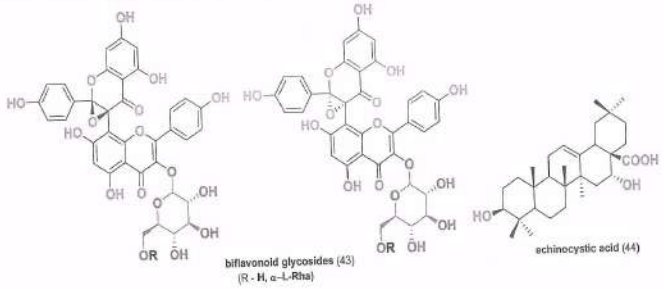


Fig. 7: Compounds Separated from Hydroalcoholic Extract of Flower Parts and Leaves of *I. Balsamina*.

Four biflavonoid glycosides (**43**) along with several known compounds such as echinocystic acid (**44**) were obtained from the white petals of *Impatiens balsamina* and investigated for potential neuroprotective activity using C6 cells and cytotoxicity against some human tumor cell lines, but they are inactive against all the tested cell lines[9].



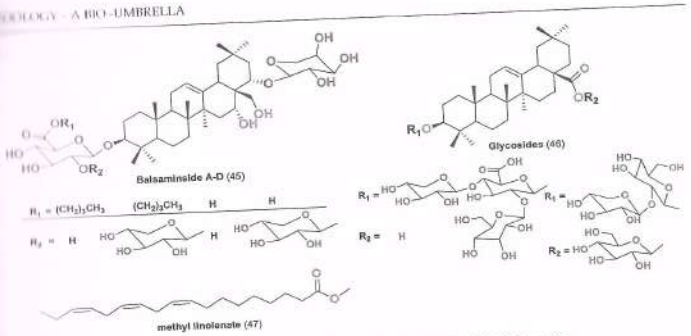


Fig. 8: Compounds Separated from White Petals of *I. Balsamina*.

The total flavonoid and total phenolic content were higher in leaf extract than those of steam extracts, 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 by Kang et al (2003).

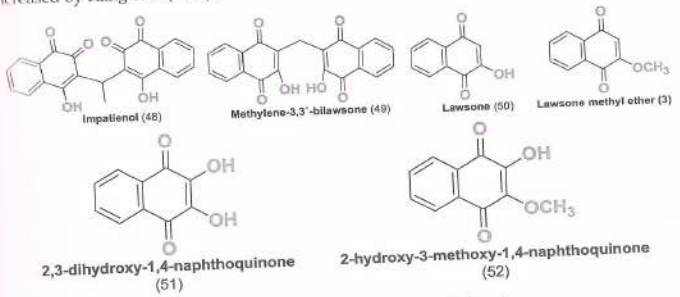


Fig. 9: Flavonoids Present in Leaves of *I. Balsamina*.

The flavonoid, methylene-3,3'-bilawsone Oku et al (2002, 2003) has been reported as a naphthoquinone (Imam et al 2012 Shivaji et al 2013) and extracted from the roots culture of *I. balsamina* Panichayupakaranant et al (995). Different phytochemicals such as salicylic acid, sinnapic acid, cafeic acid, scopoletin (7-hydroxy-6-methoxycoumarin), 2-hydroxy, 1,4-naphthoquinone, and 2-methoxy-1,4-naphthoquinone were extracted and purified from the

leaves (Kang et al 1942) and stem of *I. balsamin*. A new biscoumarin, 4,40-biisofraxidin was isolated from the roots of *I. balsamina*. (Baskar et al 2012).

Financial support and sponsorship: Nil.

Conflict of Interests: There are no conflicts of interest.

REFERENCES

1. J Steven; et al, *Systematic Botany.*, 2006; 31(1):171-180.
2. Christopher Cumo. Impatiens. *Encyclopedia of Cultivated Plants: From Acacia to Zinnia*. Christopher Cumo, ed. ABC-CLIO, 2013. p. 523. ISBN 9781598847758.
3. (a) Thaler, K.; Kaminski, A.; Chapman, A.; Langley, T.; Gartlehner, G. Bach Flower Remedies for psychological problems and pain: A systematic review. *BMC Complement. Altern. Med.* **2009**, 9; (b) Zhou, X.; Zhao, X.; Tang, L.; Zhang, Y.; Ruan, H.; Pi, H.; Qiu, J.; Wu, J. Immunomodulatory activity of the rhizomes of *Impatiens pritzellii* var. hupehensis on collagen-induced arthritis mice. *J. Ethnopharmacol.* **2007**, 109, 505–509; Wan R. D., Li J. A., Fang L. F., *Journal of Chinese Medicine Material*, **1989**, 12, 18-20; (c) Szewczyk, K.; Zidorn, C.; Biernasiuk, A.; Komsta, Ł.; Granica, S. Polyphenols from Impatiens (Balsaminaceae) and their antioxidant and antimicrobial activities. *Ind. Crop. Prod.* **2016**, 86, 262–272; Ding Z. S., Jiang F. S., Chen N. P., Lv G. Y., Zhu C. G., *Molecules*, **2008**, 13, 220-229; (d) Yadawa R. N., Jain B., *Asian J. Chem.*, **1992**, 4, 936-938; (e) Chang S., New Medical College, *"Dictionary of Chinese Crude Drugs"*, Shanghai Scientific Technological Publishers, Shanghai, **1977**; (f) Ueda Y., Oku H., Iinuma M., Ishiguro K., *Biol. Pharma. Bull.*, **2003**, 26, 10, 1505-1507; (g) Rasoanaivo P., Petitjean A., Ratsimamanga SU., Rakoto Ratsimamanga A., *J. Ethnopharmacol.*, **1992**, 37, 117-127; (h) Henn R. L., *"Wildflowers of Ohio,"* Indiana University Press, Bloomington, IN, **2008**; (i) Foster S., Duke JA., *"Peterson Field Guide to Eastern/Central Medicinal Plants,"* Houghton Mifflin, New York, **1990**.
4. (a) Chatterjee A, Chandra Pakrashi S, The Treatise on Indian Medicinal Plants. National Institute of Science Communication, New Delhi 1997; 3:134-135; Collett H. Flora Simlensis. Thacker, Spink & Co. 2nd Impression, **1921**, 72-73; (b) Madhav R. Glimpses of Nature, Our Monsoon Plants. Bombay Natural History Society. Series no. 4, 7; **1959**.
5. Khyati Narendrakumar Shah, Preeti Verma, Bhanubhai Suhagia, A phyto-pharmacological overview on Jewel Weed, *Journal of Applied Pharmaceutical Science***2017**; 7 (08):246-252.
6. Anonymous, The Wealth Of India, Raw Materials. Council of Scientific & Industrial Research, New Delhi, Vol. V, **1959**, 168; Chopra R N, Chopra I C, Varma B S, Supplement To Glossary of Indian Medicinal Plants. Publications & Information Directorate: New Delhi **1969**, 45-46; Kirtikar K R, Basu B D, Indian Medicinal Plants. New Cinnaught Place, Dehra Dun, Vol. I, **1933**, 445-446; Nadkarni K M, Indian Materia Medica. 3rd Edition. Popular Prakashan: Bombay, Vol. I, **1989**, 676.
7. Herber D, *Hand Book of The Indian Flora*. Crabancore Sircar Press, **1864**, Vol. I, 185-186.
8. Binorkar S V, Jani D K, Profile of medicinal plants with Anti-ophidian property, *Journal of Pharmaceutical and Scientific Innovation*, **2012**; 1(5):13-20.

9. Yuan-Chuen Wang, Deng-Chang Wu, Jyun-Ji Liao, Cheng-Hsun Wu, Wan-Yu Li, and Bi-Chuang Weng, *In vitro activity of Impatiens balsamina L. against multiple antibiotic-resistant Helicobacter pylori". Am. J. Chin. Med.* **2009**; *37(4):713–22.*
10. Chang Su. Dictionary of Chinese Crude Drugs, New Medical College Shanghai Scientific Technological Publishers, Shanghai. **1977**.
11. N Debashree, A Subhalakshmi, S Rita, A Pfuzia, Study of Analgesic and anti-Inflammatory Effects of *Impatiens balsamina* leaves in albino rats, *Int J Pharm.Bio Sci.*, **2013**; 4(2):581-87.
12. *Park J H, Kim J M, Do W I, Pharmacognostical studies on the folk medicine bong seon wha dae, Korean Journal of Pharmacognosy* **2003**; *34(3):193–96.*
13. The Committee of Chinese Materia Medica, Chinese Materia Medica, Shanghai Scientific and Technological Press, Shanghai, **1996**, pp. 1120–1121.
14. Chinese Pharmacopoeia Commission, Chinese Pharmacopoeia, vol. I, 2010 ed., China Medical Scientific and Technological Press, Beijing, **2010**, p. 247.
15. *Ishiguro K, Oku H, and Kato T, Testosterone 5α-reductase inhibitor bisnaphthoquinone derivative from Impatiens balsamina, Phytother Res.* **2000**; *14(1):54-60.*
16. *"Summer, the Way It Used to Be..." The Korea Times. 06 January* **2018**.
17. Farnsworth N R, Bunyapraphatsara N, *Thai Medicinal Plants: Recommended for Primary Health Care System*. Prachachon: Bangkok; **1992**, 167–168.
18. Ong H C, Zuki R M, Milow P, Traditional knowledge of medicinal plants among the Malay villagers in Kampung Mak Kemas, Terengganu, Malaysia, *Ethno Med*, **2011**; 5(3):175-185.
19. Mishra R K, Patel S P, Srivastava A, Vashistha R K, Singh A, Puskar A K, Ethnomedicinally important plants of Panchmarhi region, Madhya Pradesh, India. *Nature and Science*, **2012**; 10(4):22-26.
20. Srivastava A, Patel S P, Mishra R K, Vashistha R K, Singh A, Puskar A K, Ethnomedicinal importance of the plants of Amarkantak region, Madhya Pradesh, India. *Int. J. Med. Arom. Plants*, **2012**; 2(1):53-59.
21. Baskar N, Devi B P and Jayakar B, Evaluation of antioxidant activity of ethanol extract of *Erythrina variegata and Impatiens balsamina* on chromium (VI) induced oxidative stress in albino rats. *International Journal of Research In Pharmacology and Pharmacotherapeutics* **2012**; 1(1):30-33.
22. Rong Zeng, Ashan Zhang, Jinyin Chen, Yongqi Fu, Impact of carboxymethyl cellulose coating enriched with extract of *Impatiens balsamina* stems on the preservation of 'Newhall' navel orange, *Scientia Horticulturae***2013**; 160:44 – 48.
23. Yang X, D K Summerhurst, S F Koval, C Ficker, M L Smith, and M A Bernards. Isolation of an antimicrobial compound from *Impatiens balsamina* L. using bioassay-guided fractionation. *Phytother. Res.*, **2001**; 15:676–680.
24. S Ahmed John, M Koperuncholan, Antibacterial Activities of Various Solvent Extracts from Impatiens Balsamina, *IJPBS*, **2012**; 3(2):401-406.