



Review Article

MEDICINAL IMPORTANCE OF *MOLLUGO VERTICILLATA* (MOLLUGINACEAE): A REVIEW

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ABSTRACT

Over the years, the world has become common to pandemic diseases in humans with lot of ailments and untreated infectious disorders. Most of the laboratories across the globe run in with under developed vaccines and drugs for many diseases for its procurement and prevention. But the bioavailability of the drug in the market is less reached due to high cost and etc. In the current situation, plant saps and its extracts are used to counteract with the pathogens based on the information in traditional medicine. Most of the phytochemical enriched herb, weed or plants available commonly are used for treatments of various diseases. One of the herbs found is *Mollugo verticillata* (commonly known as 'green carpet weed'). It is commonly used in treating fever, aches and other various ailments and it shows promising activity in pharmacological properties due to the presence of phytoconstituents like terpenoids, saponins and flavonoids. Finally, the plant extract has enormous medicinal importance. This review is a collection of overall research work on *Mollugo verticillata* plant and their medicinal compounds present.

KEYWORDS: Pandemic, Prevention, Traditional, *Mollugo verticillata*, Phytochemicals, and Pharmacological.

INTRODUCTION

Medicinal plants research is one and remains to be the best area of research in development of newer and effective drugs^[1,2]. It has been reported that extracts of plant are common in ancient medicine and their contribution with respect to health benefit was estimated over 80% of the world's total population^[3,4]. Bioactive compounds are by-products of the plant species and are therefore regarded as an invaluable repository of unusual chemical compounds since these secondary metabolites are like chemical fingerprints of each plant species^[5]. According to the history, plants used in ancient medicine are used to treat various diseases and are a rich source of antioxidants^[6]. In most of the cases, the research has confirmed by discovering the hypothesis on mechanism and mode of action of the plants through use of traditional medicine.

Importance of medicinal plants in development of drugs is well known and humans have used and been using them for treatment of different ailments from the ancient days. The search for new pharmacologically active agents from natural resources such as plants, microbes, animals have led to the discovery of newer drugs which are effective, potent and are used clinically^[7]. A herbal weed

belonging to the family of *Molluginaceae* is used in traditional medicine in many Indian villages due to its various beneficial effects^[8]. In general, several species belonging to *Mollugo* genus include, *M. cerviana* (thread stem), *M. pentaphylla* (African), *M. nudicaulis* (naked stem), *M. verticillata* (green) and *M. oppositifolia* (slender).

Mollugo verticillata L. (Family: *Molluginaceae*) is an annual herb commonly grown in warm and wet regions of the American continent^[9]. The chemistry of these medicinal plants is differentiated by the production of triterpenesaponins and flavonoid compounds^[10]. Ferreira *et al.* (2003) reported that triterpenesaponins and flavonoids derivatives possess a significant effect on the immune system^[11]. Earlier, the immunomodulatory activity of triterpenesaponins has been stated in previous report^[12]. In all of the *Mollugo* species C-glycosylflavonoid compounds are present^[13].

Apart from *M. verticillata*, other species of *Mollugo* are reported with high therapeutic activity. *Mollugo cerviana* (thread stem carpet weed) is used to treat jaundice^[14], suppressor for stomach ache and vaginal discharge after child birth^[15,16] and increases

eyesight^[17] where roots are used in treating rheumatism^[18].

Different extracts (polar to non-polar) show distinct biological activities based on diverse chemical compounds present in them when extracted. The current review is described based on the literature collected and organized as growth and habitat of the plant, morphology, chemical composition and the medicinal properties of *Mollugo verticillata*.

Mollugo Verticillata

Mollugo verticillata (Fig. 1) belongs to family of *Molluginaceae* is an annual herb with prostrate growth habit^[11]. It is a common weedy plant grown in disturbed areas like fields, gardens, road sides and parking lots^[19]. The plant is native to tropical America^[20] and forms a prostrate circular mat that climbs rapidly on nearby plants. This plant is also known to be edible.

Taxonomical Classification

Kingdom: Plantae

Clade: Tracheophytes

Clade: Angiosperms

Clade: Eudicots

Order: Caryophyllales

Family: Molluginaceae

Genus: *Mollugo*

Species: *M. Verticillata*

Morphology

The leaves are narrowly, whorled with 3-8 at each node. The length is 4-25mm long, 0.5-3mm wide, smooth and possess an obovate or spatulate shape. Leaves are mostly light-green in color with a reddish tinge at late phonological stage^[21]. It grows and sprawl across the soil due to its habitat of prostrate growth and forms mats^[11]. The flowers are formed in clusters 2-5 blooming from July to September. Color of the flower is white or greenish white with tiny 5-15mm stalks. Flowers turn into fruit which is egg shaped and 1.5-4mm in length and the seeds are 0.5 m long and are red to rusty brown in color^[22-24].



Fig. 1 *Mollugo verticillata*- Plant^[11]

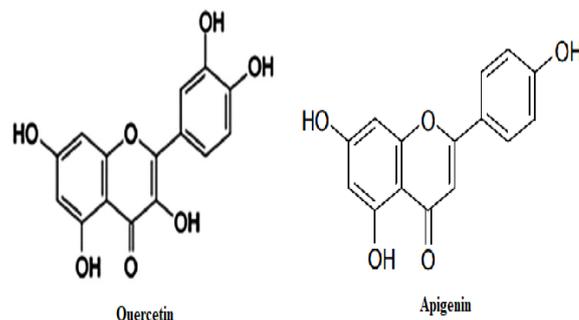


Fig. 2 Structures of flavonoid compounds^[25]

Chemical Composition

However, Flavonoid aglycones, such as quercetin and apigenin (Fig. 2) are the effective inhibitors of nitric oxide production^[25]. Ferreira et al. (2003) reported that compounds like quercetin and other flavonoid glycoside and triterpenoid glycoside showed immunomodulatory effects in *Bacillus Calmette Guerin* (BCG) antigen and *Mycobacterium tuberculosis* whole antigen induced mice peritoneal cell cultures^[11]. Antonio and Vivit (2017) stated that only few reports show their phytochemistry, and among *Mollugo* species, *M. oppositifolia*, *M. pentaphylla* and *M. nudicaulis* had similar phytochemicals as *M. verticillata*^[26]. The plant *M. pentaphylla* is reported to contain flavonoid compounds such as apigenin, mollupentin, mollugogenol A, B and D, along with triterpenoid, oleanolic acid and β -sitosterol^[27].

Traditional Uses

The ethnomedicinal value of *M. verticillata* revealed to possess anti-anemic and anti-hyperglycemic properties^[26]. It is used as tops for salads and good for anaemic. It's utilized as demulcent and poultice^[28].

Pharmacological Activities

The medicinal plant indicates different pharmacological activity like anti-oxidant^[29], anti-microbial, anti-inflammatory, anti-tumour^[30], anti-hyperglycemic^[31].

Antioxidant Activity

The antioxidants are found abundantly in fruits and vegetables and protect the human body from oxidative stresses leading to damage of cells, diseases and other severe disorders^[32]. According to the report, in comparison with *Mollugo* species, *M. pentaphylla* and *M. cerviana* are more promising antioxidants than *M. verticillata*^[26]. *M. cerviana* significantly inhibited free radicals by $84.12 \pm 1.06\%$ at $400 \mu\text{g/mL}$ ^[33]. In addition, *M. pentaphylla* and *M. cerviana* require IC_{50} levels of $16 \mu\text{g/mL}$ ^[34] and $99 \mu\text{g/mL}$ ^[35] respectively, when compared to *M. verticillata*

at 405.86µg/mL^[26]. However, *M. verticillata* is more potent than *M. nudicaulis* (IC₅₀ 1, 350µg/mL)^[29].

Antimicrobial Activity

With the increase of interest in antibiotics came an increase of interest in plants as a potential source of antimicrobial substances^[36]. According to the literature searched, anti- microbial activity of *M. verticillata* (pH- 5.47) showed active against gram negative bacteria (*Escherichia coli*) using saline extract than gram positive bacteria (*Staphylococcus aureus*)^[37].

Antihyperglycemic Activity

With respect to multidrug resistance of *Mycobacterium tuberculosis* and active infection in people accompanied with HIV infection, there is a need for discovery and production of novel effective drugs against TB is felt^[38]. Though the plant is responsible for the hyperglycemic effects more research has to be carried out due to the fact that the plant possess phytoconstituents that are capable of reducing blood glucose levels. However, additional investigations are required to address the exact mechanism by *M. verticillata* lowering blood glucose levels using *in vivo* studies.

Immunomodulatory Effect

The only research work carried out in immunomodulatory effect of *M. verticillata* in *in vivo* revealed to be promising and showed that ethanolic extracts (EE) could directly increase NO (Nitric Oxide) release by peritoneal cells, but reduces the immune response of these cells when treated with BCG antigen and *Mycobacterium tuberculosis* whole antigen (TB)^[11]. Ferreira et al.(2003) reported that NO production by cells treated with BCG and EE was similar to that observed in control cells (BCG= 8.30µM and BCG + *Mollugo*= 5.09µM)^[11]. Though the extract could not reverse the effect of TB it showed effective in reducing the stimulus. Decrease in NO production was about 35 % (TB= 12.37µM and TB + *Mollugo*= 8.01µM). The immuno stimulatory effects obtained using *in vitro* studies were confirmed in *in vivo* studies for some of the plant species such as *Mollugo verticillata*, *Phoradendron serotinum* and *Petiveria alliacea*^[39]. Immunomodulatory effect using *in vitro* studies of *M. verticillata* revealed NO production (1.6 fold) at 25µg/mL using murine peritoneal primary macrophages co-cultures with *Mycobacterium tuberculosis* [48 h] and H₂O₂ production (0.4 fold) at 2.9µg/mL with murine primary peritoneal macrophages [24 h] compared to control cells^[40].

Importance of *In vitro* Studies

Efforts were made to optimize the concentrations of various plant growth regulators

(PGRs) for *in vitro* growth of plant regeneration. A lot of research works were reported for *Mollugo* species, especially in *M. nudicaulis* Lam plant. The highest regeneration induction of about 88% of friable callus was observed on MS medium containing 4.44µM 6-BAP (Benzylaminopurine), 4.65µM kinetin, 2.69µM NAA (Naphthaleneacetic acid) and 0.91µM thidiazuron^[41]. This plant can be used for *in vitro* growth responses and can be proved that hypocotyl explants can be best for callus induction. To date, only two C₃-C₄ intermediate species with a cosmopolitan distribution in warm climates, *M. nudicaulis* L and *M. verticillata* L., have been reported^[42].

Additionally, *M. verticillata* plant extract possesses therapeutic activities which are used in traditional medicine that can be used for enhancing the medicinal importance. This tissue culture could be used for year-round availability of the plant as well as allowing for comparative analysis of the functional anatomy of the *in vitro* grown plants and parent plant.

CONCLUSION

Mollugo verticillata (L.) is a medicinal herb used in traditional medicine which possess to be effective as antimicrobial, antioxidant and immunomodulatory activity. The exact bioactive compound and their mode of action is to be clearly studied and identified. Most of the researches on this plant extracts are not sufficient enough to clearly show any pharmacological activity like anti-inflammatory and anti-tumour activity. In the drug improvement process, identification and characterization of bioactive compounds are necessary with current research.

These metabolites can be produced from plants and *in vitro* developed cultures which could be the source for an alternative one. Production of useful metabolites can be achieved which underlie the role and importance along with exact mechanism from the plant using elicitation method. Reports suggest that *in vitro* developed cultures have the potential to accumulate greater amount of secondary metabolites compared to field grown plant. In the current study, literature on *M. verticillata* and its compounds will help the researchers for further studies.

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