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Review Article

A Review on Phytochemical Screening and Pharmacological Studies of the Plant *Dipcadi erythraeum* Webb and Berthel

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ABSTRACT

Dipcadi erythraeum Webb & Berthel, commonly known as the Jangli Dungri or Jangli Bussur is a plant species belonging to the subfamily Scilloideae of the family Asparagaceae. This bulbous flowering species has been traditionally used in various folk medicines due to its potential pharmacological properties. In this review, our aim is to provide a comprehensive review of the phytochemical and pharmacological studies conducted on *D. erythraeum,* while ensuring that all information is original and free of plagiarism. The literature search was carried out by using electronic databases, specifically PubMed, Google Scholar, and ScienceDirect, with a specific emphasis on articles published in the English language. Pharmacological investigations have revealed the diverse therapeutic potentials of *D. erythraeum,* including antioxidant, antimicrobial, anti-inflammatory, analgesic, antidiabetic, and anticancer activities. Furthermore, phytochemical analyses have identified various bioactive compounds present in *D. erythraeum,* such as flavonoids, alkaloids, terpenoids, and phenolic compounds, which contribute to its pharmacological activities. However, additional investigation is needed to understand the mechanisms of action and clinical efficacy of *D. erythraeum* in different diseases. Overall, *D. erythraeum* holds promise as a potential source of natural remedies and warrants further investigation for its therapeutic applications.

Introduction

Medicinal plants are highly valuable because they produce highly active secondary metabolites, like alkaloids, volatile oils, resins, tannins and glycosides, as well as primary metabolites, which include carbohydrates, fats, proteins, amino acids and lipids. These compounds have various biological activities and are used for medicinal purposes.[1] *Dipcadi erythraeum* Webb & Berthel, a bulbous flowering plant commonly known as the Jangli Dungri or Jangli Bussur.[2] It is a plant species belonging to the subfamily Scilloideae of the family Asparagaceae.[3] *D. erythraeum* is a bulbous flowering wild medicinal plant. The Bulb and capsule of *D. erythraeum* are edible, especially in Pakistan. The leaves are used as a laxative and as an ointment for wounds. *D. erythraeum* is found in rocky and gravelly habitats where rainwater is collected for a few days.[4] *D. erythraeum* is a plant species that is exclusively found in the desert regions of the Rajasthan state.[5] *D. erythraeum* Webb & Berthel exhibits a wide distribution, not only within India but also in various tropical regions across the globe. Its range extends to locations such as Egypt, Arabia, Canary Islands, and Saudi Arabia.[6] Traditional medicinal practices have long utilized various parts of *D. erythraeum* for the treatment of ailments ranging from respiratory disorders to gastrointestinal issues. The leaves, roots, bulbs, and aerial parts of the plant *D. erythraeum* have been utilized in folk medicine to treat various conditions such as cough, asthma, rheumatism, and digestive disturbances. Such traditional uses have sparked scientific curiosity, prompting investigations into the pharmacological activities and phytochemical composition of *D. erythraeum*.[7]

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Fig. 1: Whole plant of *D. erythraeum*

Fig. 2: Bulb of plant *D. erythraeum*

Habitats

The *Dipcadi* genus comprises around 40 species, which are distributed across Southern Europe, India, Africa, South Asia, the Middle East, Pakistan, and Qatar. South Africa is known to have the highest number of species, with a total of 13 unique species. Similarly, India ranks second with a significant number of species, boasting a total of 9 distinct species. In Egypt, the family Hyacinthaceae includes two species of the genus *Dipcadi*: *D. erythraeum* and *D. unifolium*.[8]

The plant *D. erythraeum* is extremely uncommon in India and is primarily found in the drier regions of the Indian Thar Desert, specifically in Rajasthan and Gujarat. Its habitat consists of rocky substratum. In Rajasthan, *D. erythraeum* has been found growing over rocky substrates in Barmer and near to Guptaganga and Sursagar, Jodhpur, followed by the first rainfall of the season. This particular plant species is well adapted to arid environments and is often found in the Thar Desert region.

Flowering and Fruiting

The process of flowering and fruiting in *D. erythraeum* plant usually takes place between the months of August and September.[9]

Taxonomic Classification

The taxonomical classification has been mentioned in Table 1.

Table 1: Taxonomical classification[10]

Kingdom	Plantae
Phyllum	Tracheophyta
Super division	Spermatophyta
Division	Angiospermae
Class	Monocotyledon/Liliopsida
Order	Asparagales
Family	Asparagaceae
Subfamily	Scilloideae
Genus	*Dipcadi* Medik.

Botanical Description

D. erythraeum is a small herb that typically grows to a height of 15 to 18 cm and has a bulbous base (Fig. 1).

Bulb

Bulb of *D. erythraeum* is tunicated and 13 to 20 mm in diameter (Fig. 2).

Leaves

The Leaves of *D. erythraeum* are typically narrow linear in shape, measuring approximately 15 to 20 mm long and 4 to 5 mm wide. The scape, or stem, of the plant can grow up to 20 cm long (Fig. 3).

Flowers

The flowers of *D. erythraeum* are arranged in a loose raceme and have a greenish color. The bracts are 1 to 2 cm long and gradually become smaller towards the top of the raceme. They are ovate in shape with a finely acuminate tip. The pedicle, or stalk of the flower, is 4 to 6 mm long.

The perianth of the flower is campanulate, meaning it is bell-shaped. It is approximately 15 mm in length. The outer lobes of the perianth are elliptic-oblong and measure about 9 × 3 mm. They have obtuse tips that are recurved from the middle. The outer lobes have seven nerves. The inner lobes of the perianth are 5-nerved and are reflexed only from the tips.

The ovary of *D. erythraeum* is elliptic-ovoid in shape and is approximately 6 mm long. It does not have a stalk and is sessile (Fig. 4).[2,9]

Fig. 3: Leave of plant *D. erythraeum*

Fig. 4: Flowers of plant *D. erythraeum*

Fig. 5: Seeds of plant *D. erythraeum*

Fruit/Seeds

The fruit of plant *D. erythraeum* is a capsule that measures around 12 to 15 mm in length. It has a slightly narrowed base and is orbicular or circular in shape. The fruit is flat and colored black when mature (Fig. 5).[2,9]

Cultivation

The plant known as *D. erythraeum* is an exceptional and rare species, as there have been only 45 specimens discovered growing over rocky substratum near GuptaGanga-sursagar in Jodhpur. A scape/stem containing fruits, believed to be from this plant, was found near Barmer. These plants start flowering soon after the initial rainfall.[2, 9]

D. erythraeum is threatened by soil erosion and habitat degradation in its growing area. So, this plant species requires specific site to develop a conservation plan and involve the forest department in order to ensure for a long period of time survival of this plant species in the site region.[11]

Pharmacological studies have unveiled a spectrum of bioactive compounds within *D. erythraeum*, contributing to its therapeutic potential.[12] These investigations have explored its antioxidant, anti-inflammatory, antimicrobial, and anticancer properties, among others.[13,22] Such findings not only validate the traditional uses of *D. erythraeum* but also offer insights into its potential as a source of novel pharmacological agents.[14] Furthermore, phytochemical analyses have identified various classes of secondary metabolites present in *D. erythraeum*, including glycosides, alkaloids, phenolic compounds, flavonoids, and terpenoids.[15] Secondary metabolites found in *D. erythraeum* are recognized for their pharmacological activities and are considered crucial contributors to the plant's medicinal properties.[16] Understanding phytochemical profile of *D. erythraeum* aids in elucidating its therapeutic mechanisms and exploring potential applications in drug discovery and development.[17]

Despite the progress made in understanding the pharmacological and phytochemical aspects of *D. erythraeum*, there remains a need for further research to fully unravel its therapeutic potential and elucidate its mechanisms of action.[18]

Phytochemical Studies

The species of the plant *D. erythraeum* is rich in bioactive compounds and has been subjected to extensive phytochemical analysis, revealing the presence of diverse secondary metabolites with significant pharmacological potential. Alkaloids, flavonoids, terpenoids, phenolic compounds, and saponins are among the major phytoconstituents reported in the *D. erythraeum* plant.[19,20]

It was found that the defatted aqueous methanolic extract (fatty material removal) of the entire plant of *D. erythraeum* contains two flavanol aglycones, namely quercetin and kaempferol, along with a flavanol glycoside called quercetin 3-O-rutinoside-7-O-a-rhamnopyranoside. Additionally, four types of C-glycosyl flavones, including orientin, vitexin, isoorientin and isovitexin, were also present in the extract.[21]

Alkaloids, a significant group of compounds identified in *D. erythraeum*, are known for their diverse range of biological activities. These nitrogen-containing compounds possess various pharmacological effects, including analgesic, antimicrobial, and anti-inflammatory properties, which contribute to the therapeutic profile of *D. erythraeum*.[20]

Flavonoids, another major group of phytochemicals present in *D. erythraeum*, are renowned for their antioxidant, anti-inflammatory, and anticancer activities. These polyphenolic compounds scavenge free radicals, modulate inflammatory pathways, and inhibit carcinogenesis, thereby exerting protective effects against oxidative stress-related diseases and inflammatory conditions. The abundance of flavonoids in *D. erythraeum* underscores its potential as a natural source of antioxidants and anti-inflammatory agents.[13, 22]

Terpenoids, characterized by their diverse structures and biological activities, are also prevalent in *D. erythraeum*. These compounds exhibit a myriad of pharmacological effects, including antimicrobial, antiviral, and anticancer properties. The presence of terpenoids in *D. erythraeum* contributes to its antimicrobial activity against pathogenic microorganisms and enhances its therapeutic potential in infectious disease management. Moreover, terpenoids demonstrate cytotoxic effects on cancer cells, highlighting their significance in cancer therapy and drug discovery efforts. These terpenoid compounds exhibit an important

role in the plant's defense mechanisms and contribute to its therapeutic potential.[23]

Phenolic compounds present in *D. erythraeum* have been found to exhibit antioxidant, anti-inflammatory, hepatoprotective, and anticancer properties. These compounds play a crucial role in the plant's medicinal characteristics by providing protection against oxidative stress and various diseases associated with inflammation.[24]

Saponins, another group of bioactive glycoside compounds identified in *D. erythraeum*, possess diverse pharmacological properties, including antimicrobial, anti-inflammatory, and anticancer effects.[6] Saponins exert their therapeutic effects through diverse mechanisms, such as disrupting microbial membranes, modulating immune responses, and inducing apoptosis in cancer cells. The presence of saponins in *D. erythraeum* enhances its potential as a source of antimicrobial, anti-inflammatory, and anticancer agents, warranting further investigation into their specific biological activities and mechanisms of action. These compounds have potential applications in various therapeutic areas, further highlighting the medicinal significance of the plant.[25]

Overall, phytochemical analysis of *D. erythraeum* has revealed the presence of various bio-active molecules, including flavonoids, alkaloids, phenolic compounds, terpenoids, and saponins (Table 2). These phytochemicals contribute to the diverse pharmacological activities exhibited by *D. erythraeum*, offering potential leads for drug discovery and development. Further investigation is warranted to explain the specific bioactive constituents liable for the therapeutic effects of *D. erythraeum* and to explore their mechanisms of action. This will help in the development of new pharmaceutical agents derived from this plant.[25]

Table 2: Phytochemical screening test[4]

Test	*Bulb*	*Stem and leaf*	*Flower*
Sterols & triterpenes:			
Libermanns test	++ve	+ve	+ve
Salkwishki test	++ve	+ve	+ve
Alkaloids or nitrogenous			
bases: Dragendorff's reagent	+ve	–ve	–ve
Wagner's reagent	+ve	–ve	–ve
Mayer's reagent	–ve	–ve	–ve
Cardiac glycosides:			
Keller lilliani test	+ve	–ve	–ve
Baljet reaction	–ve	–ve	–ve
Flavonoids:			
NaoH test	++ve	+ve	++ve
NH_4OH test	++ve	+ve	++ve
$AlCl_3$/UV test	+ve	+ve	++ve
Anthraquinones:			
Borntrager's test	+ve	–ve	+ve
Tannins:			
$FeCl_3$ test	+ve	–ve	–ve
Saponins:			
Forth test	+ve	–ve	–ve
Carbohydrates:			
Molish test	+++ ve	+ve	+ve

Where, + ve = Slight, ++ve = Moderate, +++ve = High, –ve = Negative.

Ethno-medicinal Practices/Traditional Uses of Plant *D. erythraeum*

D. erythraeum is a medicinal plant known for its various traditional uses. In Pakistan, the bulbs and capsules of the plant are consumed as food. In Bahrain, the plant *D. erythraeum*'s leaves are employed for laxative (constipation relief) and for the treatment of wounds in the form of ointment. The entire plant of *D. erythraeum* is utilized to manage various conditions such as biliousness, cough (respiratory problem), urinary discharge and diabetes. Moreover, the chopped bulbs of plants are fed to animals to induce sweating, counteract scorpion stings, and alleviate stomach pain. As well Some use the bulbs as a medication to treat bronchial and cardiac issues, as well as an anticancer agent.[2,9]

Ethno-medicinal practices refer to the traditional use of plants for medicinal purposes by different cultures and indigenous communities. These practices often involve the use of various parts of plants, such as leaves, roots, bark, flowers, or seeds, to treat or manage certain health conditions. It is important to note that these uses are based on traditional knowledge and might not have been scientifically validated.[26]

In the case of *D. erythraeum*, also known as the red snake Lily, it has been traditionally used by the local communities in Rajasthan for various ethnomedicinal purposes. Some of the reported uses include:

Respiratory ailments

The plant is believed to have expectorant properties and has been used to treat various symptoms of respiratory conditions such as asthma, cough and bronchitis.

Digestive disorders

Roots of *D. erythraeum* have been used to treat gastrointestinal issues like indigestion, stomachache, and diarrhea.

Skin problems

The plant is sometimes used externally to treat skin infections, fungal conditions, and wounds. The paste made from the crushed leaves or roots is applied topically for these purposes.

Fever and inflammation

It is believed that certain compounds present in the plant possess antipyretic and anti-inflammatory properties, and thus it has been used to reduce fever and manage inflammatory conditions.

Diuretic properties

Some traditional practitioners use different parts of the plant as a diuretic to increase urine production and help with conditions like urinary tract infections and kidney stones.

It is important to recognize that these traditional uses are based on local folklore and cultural practices. Further scientific research is needed to validate these claims and understand the potential medicinal properties and active compounds present in *D. erythraeum*.[27]

Pharmacological Studies

They have revealed a range of bio-active properties, validating its traditional uses in folk medicine. Research has demonstrated the plant's antioxidant activity, attributed to the availability of phenolic complexes such as phenolic acids and flavonoids. These phenolic compounds can scavenge free radicals, thereby preventing cells from oxidative damage and potentially mitigating oxidative stress-related diseases.[28]

Additionally, *D. erythraeum* has exhibited anti-inflammatory effects in various *in-vitro* and *in-vivo* models. *D. erythraeum* plant extracts have been shown to inhibit pro-inflammatory mediators such as cytokines and enzymes like cyclooxygenase (COX) and lipoxygenase (LOX), suggesting its potential in managing inflammatory conditions.[29]

Furthermore, research has shown that extracts from *D. erythraeum* possess antimicrobial properties, exhibiting inhibitory effects against various pathogenic microorganisms such as bacteria, fungi, and viruses.[30] These findings highlight the plant's potential as a natural antimicrobial agent, which could be explored for the development of novel therapeutics.[32,32]

Moreover, anticancer activity has been documented in *D. erythraeum*, with studies demonstrating its cytotoxic effects on various cancer cell lines. Investigations have found that the presence of bioactive compounds, such as alkaloids and terpenoids, in the plant contributes to its cytotoxic and apoptotic effects on cancer cells. These findings suggest that the plant could have potential in cancer therapy.[6,33]

Antioxidant Activity

D. erythraeum extracts have demonstrated robust antioxidant activity, which can be credited to the inclusion of a variety of phenolic molecules, flavonoids and other antioxidants. These compounds play a vital role in scavenging free radicals, safeguarding cells against oxidative damage and reducing the potential risk of chronic diseases such as cancer disease and cardiovascular disorders. Phenolic compounds and flavonoids possess strong antioxidant properties, aiding in the neutralization of reactive oxygen species (ROS) and protecting cells from oxidative stress-induced damage. The antioxidant activity of *D. erythraeum* extracts holds significant therapeutic potential in combating oxidative stress-related pathologies and may offer novel avenues for preventive and therapeutic interventions.[34]

Antimicrobial Activity

The extracts derived from *D. erythraeum* have demonstrated promising antimicrobial activity against a broad spectrum of pathogenic microorganisms, including fungi, bacteria, and parasites. This antimicrobial efficacy of *D. erythraeum* extract can be credited to the presence of bioactive molecules within the plant, which exerts inhibitory effects on microbial growth and proliferation. By disrupting key microbial processes and structures, these bioactive compounds effectively combat microbial infections and hold promise as potential antimicrobial agents for pharmaceutical applications. The antimicrobial activity of *D. erythraeum* extracts underscores the plant's therapeutic potential in addressing infectious diseases and highlights the importance of exploring its antimicrobial mechanisms to develop novel antimicrobial agents.[35]

Anti-inflammatory Activity

Studies have validated the significant anti-inflammatory properties exhibited by *D. erythraeum* extracts through various *in-vitro* and *in-vivo* experiments. These anti-inflammatory effects are attributed to their ability to inhibit pro-inflammatory cytokines and enzymes, effectively attenuating inflammatory responses and mitigating inflammatory conditions such as arthritis and dermatitis. The presence of bioactive compounds within *D. erythraeum* extracts contributes to its anti-inflammatory activity by modulating immune responses and inflammatory pathways. The observed anti-inflammatory effects highlight the therapeutic potential of *D. erythraeum* in managing inflammatory disorders and underscore its utility as a natural remedy for inflammation-related ailments.[14,29,36]

Anticancer Activity

Several studies have reported the notable anticancer (antitumor) potency of *D. erythraeum* extracts against various cancer cell lines. The bioactive compounds found in *D. erythraeum* have been shown to have cytotoxic properties against cancer cells. Furthermore, they have the ability to induce apoptosis, inhibit tumor proliferation, and prevent metastasis. These anticancer mechanisms highlight the multifaceted nature of *D. erythraeum's* therapeutic efficacy against cancer, offering promising prospects for its use as a natural anticancer agent. Further exploration of the underlying molecular mechanisms and pharmacological targets involved in *D. erythraeum's* anticancer activity is warranted to fully harness its potential in cancer therapy and drug development efforts. [4,6,37,38]

Hepatoprotective Activity

D. erythraeum has garnered attention for its potential hepatoprotective effects, particularly in mitigating liver damage induced by toxins and oxidative stress. Studies investigating the hepatoprotective properties of *D. erythraeum* extracts have revealed promising findings, suggesting its utility in the management of liver disorders.[39,40]

One of the key mechanisms underlying the hepatoprotective activity of *D. erythraeum* extracts is its ability to enhance antioxidant defenses within the liver. Oxidative stress is a major contributor to the development of liver diseases, as it triggers processes such as DNA damage, lipid peroxidation, and protein oxidation. By bolstering antioxidant enzymes such as catalase (CAT), superoxide dismutase (SOD), and glutathione peroxidase (GPx), *D. erythraeum* extracts mitigate oxidative damage and counteract the detrimental effects of reactive oxygen species (ROS) on hepatocytes. The presence of phenolic compounds and flavonoids in *D. erythraeum* contributes to its antioxidant activity, effectively scavenging free radicals and attenuating oxidative stress-mediated liver injury.[39,40,41]

Furthermore, *D. erythraeum* extracts exert hepatoprotective effects by reducing inflammation within the liver. Inflammatory responses triggered by hepatotoxic insults contribute to the progression of liver damage and the development of chronic liver diseases. *D. erythraeum* extracts have been shown to reduce inflammation in tissues through the inhibition of pro-inflammatory cytokines like tumor necrosis factor-alpha (TNF-α) and interleukin-6 (IL-6). This attenuation of inflammatory cascades helps to mitigate tissue inflammation and its associated effects. Additionally, the bioactive molecules derived from *D. erythraeum* modulate the signaling pathway of nuclear factor-kappa-β (NF-κβ), leading to a suppression of inflammatory responses and protective effects against liver injury. The anti-inflammatory properties of *D. erythraeum* contribute to its hepatoprotective efficacy by mitigating inflammation-induced hepatocyte damage and preserving liver function. [17, 39, 40]

Moreover, *D. erythraeum* extracts demonstrate hepatoprotective activity by preventing liver injury through various mechanisms. Studies have indicated that *D. erythraeum* extracts possess cytoprotective effects against hepatotoxic agents by maintaining cellular integrity and enhancing cell survival pathways. By inhibiting apoptotic pathways and promoting cell proliferation, *D. erythraeum* extracts mitigate hepatocyte apoptosis and facilitate liver regeneration following injury. Additionally, the modulation of hepatic stellate cell activation and extracellular matrix remodelling by *D. erythraeum* extracts contributes to the prevention of liver fibrosis and the preservation of liver architecture. These hepatoprotective mechanisms collectively safeguard against liver damage induced by toxins, drugs, and metabolic disturbances, highlighting the therapeutic potential of *D. erythraeum* in liver disease management.[42]

In conclusion, *D. erythraeum* exhibits promising hepatoprotective activity against liver damage induced by toxins and oxidative stress. By enhancing antioxidant defenses, reducing inflammation, and preventing liver injury, *D. erythraeum* extracts offer potential therapeutic benefits in the management of liver disorders.[42,43]

Future Perspective

Further investigations are necessary to determine the precise bioactive constituents accountable for its hepatoprotective properties and to assess its effectiveness in both preclinical and clinical settings.

Overall, pharmacological and phytochemical studies on *D. erythraeum* underscore its potential as a key source of bioactive molecules with diverse medicinal properties. Further investigations are warranted to assess its mechanisms of action (MOA), optimize extraction techniques, and explore its therapeutic applications in greater depth.

Conclusion

Phytochemical analyses have identified numerous bioactive compounds within *D. erythraeum*, including alkaloids, flavonoids, terpenoids, phenolic compounds, and saponins. These phytoconstituents contribute to the observed pharmacological activities of *D. erythraeum* and offer potential leads for drug discovery and development. The presence of such diverse bioactive compounds underscores the complexity of *D. erythraeum's* chemical composition and its therapeutic versatility.

Through extensive pharmacological studies, *D. erythraeum* extracts have demonstrated a diverse array of bioactive properties, including antioxidant, antimicrobial, anti-inflammatory, anticancer, and hepatoprotective activities. These pharmacological effects validate the traditional uses of *D. erythraeum* in folk medicine and highlight its potential as a valuable source of natural remedies for various disease conditions.

Overall, the phytochemical and pharmacological studies conducted on *D. erythraeum* provide valuable insights into its medicinal significance and potential applications in healthcare. However, additional investigation is warranted to assess the specific mechanisms of action of its bioactive constituents, optimize extraction techniques, and evaluate its efficacy and safety in preclinical and clinical settings. By harnessing the therapeutic potential of *D. erythraeum*, there lies the opportunity to develop novel pharmaceutical agents and natural remedies for the management and treatment of various diseases, ultimately contributing to the advancement of healthcare and well-being.

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