



VERBESINA ENCELIOIDES: AN INVASIVE SPECIES WITH SIGNIFICANT THERAPEUTIC AND AGROECOLOGICAL POTENTIAL

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Abstract: *Verbesina encelioides* (wild sunflower or golden crownbeard), a member of the Asteraceae family, is a rapidly spreading invasive annual herb native to the United States and Mexico. Over recent decades, it has expanded across Asia, Africa, Europe, and India, particularly dominating arid and semi-arid regions. Its strong invasive capacity is largely attributed to its high reproductive efficiency, with seed germination rates reaching approximately 80%. Despite its ecological impact and competition with native flora, the species has gained scientific interest due to its rich phytochemical composition and diverse biological activities. Phytochemical investigations have revealed the presence of alkaloids, flavonoids, phenolics, terpenoids, tannins, saponins, and glycosides, contributing to antioxidant, antimicrobial, antiprotozoal, nematocidal, and anticancer properties. Furthermore, its allelopathic and phytotoxic potential suggests promising applications in the development of eco-friendly bioherbicides. This article summarizes current knowledge regarding the distribution, phytochemistry, pharmacology, and agroecological relevance of *V. encelioides*, highlighting its dual role as both an ecological threat and a valuable bioresource.

Key words: *Verbesina encelioides*; invasive species; phytochemistry; allelopathy; medicinal plants; bioherbicides; antioxidant activity; germination rate; Asteraceae.

Verbesina encelioides is an annual herb widely recognized for its invasive behavior and remarkable adaptability to diverse environmental conditions. Originally native to North America, it has successfully colonized multiple continents, including Asia, Africa, and Europe. In India, the species has been present since the



1960s–1970s and has rapidly expanded in northwestern and dry regions over the last two decades. Its ecological success is strongly associated with its high reproductive capacity, particularly its seed germination rate, which reaches up to 80%, allowing efficient establishment and rapid spread in disturbed habitats such as agricultural lands and roadsides.

Invasive alien plant species are considered among the leading causes of biodiversity loss worldwide. They disrupt ecosystem balance, compete with native plants for nutrients, water, and sunlight, and may alter soil chemistry and microbial communities. However, while invasive species pose ecological threats, they may also represent underexplored sources of valuable bioactive compounds. Historically, medicinal plants have formed the foundation of traditional healthcare systems, and more than 80% of the global population still relies on plant-based remedies for primary healthcare. Nearly half of modern pharmaceutical drugs are derived directly or indirectly from natural products, emphasizing the importance of phytochemical research.

Traditionally, *V. encelioides* has been used to treat gastrointestinal disorders, skin infections, inflammatory conditions, and snake bites. These ethnomedicinal applications suggest the presence of biologically active constituents. Phytochemical analyses confirm that different parts of the plant contain diverse secondary metabolites, including alkaloids, flavonoids, phenolic compounds, terpenoids, tannins, saponins, and glycosides. Such compounds are widely recognized for their therapeutic potential and biological activity.

Experimental investigations have demonstrated that extracts of *V. encelioides* exhibit antioxidant, antimicrobial, antiprotozoal, nematocidal, and anticancer properties. Antioxidant effects are primarily linked to phenolic and flavonoid constituents capable of neutralizing reactive oxygen species and reducing oxidative stress. Antimicrobial activity suggests potential applications against pathogenic bacteria and fungi, while preliminary anticancer studies indicate cytotoxic effects against certain cancer cell lines. Nevertheless, comprehensive studies on molecular mechanisms of action, pharmacodynamics, toxicity, and



clinical efficacy are still insufficient. Rigorous pharmacological and clinical investigations are necessary before therapeutic applications can be fully validated.

In addition to its medicinal relevance, *V. encelioides* demonstrates strong allelopathic and phytotoxic properties. Allelopathy refers to the release of chemical



compounds that inhibit the growth and germination of neighboring plant species. This characteristic contributes significantly to its invasiveness and ecological dominance. At the same time, these allelochemicals may offer promising opportunities for developing environmentally friendly bioherbicides. The growing problem of herbicide-resistant weeds and environmental concerns associated with synthetic herbicides have intensified the search for natural alternatives. Plant-derived allelochemicals with multiple mechanisms of

action may provide sustainable solutions for weed management. However, further research is required to isolate and characterize these phytotoxic compounds and to evaluate their safety and effectiveness under field conditions.

Conclusion

Verbesina encelioides represents a complex and multifaceted species with both ecological risks and significant biomedical and agricultural potential. Its high germination rate of approximately 80% enhances its invasiveness and competitive advantage, yet its rich phytochemical composition provides promising therapeutic and agrochemical prospects. While current studies highlight its antioxidant, antimicrobial, anticancer, and allelopathic activities, detailed mechanistic, toxicological, and clinical evaluations remain necessary. Transforming invasive species into valuable biological resources may provide innovative strategies for sustainable ecosystem management and drug discovery. With systematic scientific validation, *V. encelioides* has the potential to shift from being primarily an ecological

concern to becoming an important natural source for pharmaceutical and agricultural applications.



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