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Fumaria officinalis: Phytochemical complexity and its medicinal significance

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Abstract

Fumaria officinalis L. has long been valued in traditional medicine across Europe and Asia, where it has played a significant role in indigenous herbal practices. This review aims to provide a comprehensive examination of the phytochemical composition, pharmacological properties, and potential therapeutic applications of *F. officinalis* through a modern phytochemistry perspective. Advanced chromatographic and spectroscopic techniques – such as HPLC, GC–MS, and LC-MS/MS – have enabled detailed analysis of its complex chemical profile, with a particular focus on isoquinoline alkaloids and phenolic compounds. Protopine, identified as the predominant alkaloid, together with several phenolic constituents, is implicated in the plant's reported anti-inflammatory, hepatoprotective, and antioxidant activities.

A systematic review of literature sourced from major databases including Scopus, PubMed, and ScienceDirect (with an emphasis on studies published within the last decade) was conducted to correlate the chemical composition with pharmacological outcomes. This integration of traditional ethnobotanical knowledge with contemporary analytical methods not only highlights the structural diversity of *F. officinalis* but also reinforces its potential as a natural source for drug development. The review discusses the quantitative and qualitative aspects of the bioactive compounds, shedding light on their mechanisms of action and potential synergistic effects. Ultimately, these findings support the notion that *F. officinalis* is a promising candidate for the development of novel natural therapeutics. Further research should prioritize the isolation of additional bioactive constituents, detailed structure elucidation, and clinical validation to fully exploit its pharmacological potential.

Graphical abstract

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Introduction

Fumaria officinalis L. (common fumitory) is one of the most extensively studied species within the genus *Fumaria* (family Fumariaceae) and has long been used in traditional medicine across Europe and Asia. It was traditionally employed as a remedy for liver ailments, skin conditions, and inflammatory disorders due to its detoxifying, anti-inflammatory, and antiseptic properties [1,2]. The plant's therapeutic effects are attributed to its diverse chemical constituents, including isoquinoline alkaloids, flavonoids, and phenolic compounds, making *F. officinalis* a promising candidate for the development of herbal medicines [[3], [4], [5]].

Pharmacological studies indicate a broad spectrum of biological effects for *F. officinalis*. In addition to its anti-inflammatory properties, the plant also possesses antioxidant, antibacterial, antiviral, and hepatoprotective effects [[6], [7], [8]]. Due to these properties, the mentioned herb is a promising candidate for the development of new pharmaceutical products that could improve the treatment of various chronic diseases [9].

An overview of scientific research examining the chemical composition and pharmacological activity of *F. officinalis* remains highly relevant, particularly amid the growing interest in plant-based therapies and natural remedies. *F. officinalis* continues to attract attention due to its diverse range of bioactive compounds and promising therapeutic potential.

The purpose of this article is to review and study available scientific literature on *F. officinalis*, with a focus on its phytochemical profile, pharmacological mechanisms of action, and potential medical applications. Special attention is given to its anti-inflammatory properties, which are central to both its traditional use and modern pharmacological interest. Additionally, the article highlights advanced analytical techniques used to characterize the plant's biological activity.

Literature sources from major scientific databases were analyzed, *e.g.*, Scopus, PubMed, Wiley, ScienceDirect, ResearchGate, NCBI, Web of Science, EBSCO, Ovid Medline. To optimize the search, the following keywords or their combinations were used: *F. officinalis*, pharmacological activity, isoquinoline alkaloids, chromatographic methods, molecular docking, *etc.* Special attention was paid to literature sources published in the last ten years.

For the graphical representation of the article materials, the Canva (online tool, automatically updated) software was utilized. The diagram was created using Python (Matplotlib 3.6.3). The online platform ChemSpider was used to search for the chemical formulas of compounds.

The plant names were checked with the “World Flora Online” website on December 11, 2025.

Section snippets

The genus *Fumaria*: a multifaceted plant with ecological and medicinal significance

The genus *Fumaria* (Fumariaceae) includes approximately 46 species worldwide, with some sources listing over 380 names for different species [[10], [11], [12]]. It was first described by Linnaeus in his work “Species Plantarum”, published in 1753. The name is believed to originate from the Latin phrase *fumus terrae*, meaning “smoke of the earth”. This name likely refers to the smoky scent of the plant and its morphological features, including the translucent colors of the flowers, which give them …

History and modern uses of *F. officinalis* in medicine

Among the numerous members of the Fumariaceae family, the greatest attention is given to *F. officinalis* [3], see Fig. 3. Due to its wide range of pharmacological properties, this herb is used in both traditional and official medicine [11]. Its properties, including anti-inflammatory, antimicrobial, and antioxidant effects, make it rather promising for the development of new herbal remedies [6,14,24]. One of the key advantages of *F. officinalis* compared to other members of the genus is the …

Chemical compounds of *F. officinalis*

Phytochemical studies of *Fumaria* species described in the literature have revealed a wide range of chemical components, including alkaloids, flavonoids, saponins, steroids, triterpenoids, anthraquinones, tannins, glycosides, and amino acids. The primary group of alkaloids in Fumariaceae family consists of benzylisoquinolines. Previous phytochemical studies on *F. officinalis* confirm the presence of isoquinoline alkaloids and a high content of polyphenols [3,5,21,57], see Table 1. …

Conclusions

1. Pharmacological Potential. *F. officinalis* demonstrates significant pharmacological potential, particularly due to its anti-inflammatory, antioxidant, antibacterial, and hepatoprotective properties. These effects, supported by both *in vitro* and *in vivo* studies, position the plant as a promising candidate for the development of natural therapeutic agents aimed at managing inflammation-driven and chronic diseases. Importantly, the multi-target action of its alkaloids reflects a holistic …

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CRediT authorship contribution statement

Yuliya Prokopenko: Writing – review & editing, Writing – original draft, Visualization, Software, Resources. **Ivan Surzhykov:** Writing – original draft, Software, Methodology, Data curation. **Olha Golovchenko:** Writing – review & editing, Visualization, Resources, Project administration, Data curation. **Volodymyr Mishchenko:** Writing – review & editing, Resources, Methodology, Formal analysis. **Victoriya Georgiyants:** Writing – review & editing, Resources, Project administration, Methodology, Data …

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. …

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References (75)

X. Yang *et al.*
Isolation, biological activity, and synthesis of isoquinoline alkaloids
Nat. Prod. Rep. (2024)

S. Khamtache-Abderrahim *et al.*
Isoquinoline alkaloid fractions of *Fumaria officinalis*: characterization and evaluation of their antioxidant and antibacterial activities
Ind. Crop. Prod. (2016)

N. Bribi *et al.*
Intestinal anti-inflammatory activity of the total alkaloid fraction from *Fumaria capreolata* in the DSS model of colitis in mice
Bioorg. Med. Chem. Lett. (2020)

P.C. Gupta *et al.*
A review on ethnobotany, phytochemistry and pharmacology of *Fumaria indica* (fumitory)
Asian Pac. J. Trop. Biomed. (2012)

Z.H. Mardirossian *et al.*
Alkaloids of *Fumaria officinalis*
Phytochemistry (1983)

I.E. Orhan *et al.*

Antioxidant and hepatoprotective activity appraisal of four selected *Fumaria* species and their total phenol and flavonoid quantities
Exp. Toxicol. Pathol. (2012)

C.H. Chen *et al.*
Protopine, a novel microtubule-stabilizing agent, causes mitotic arrest and apoptotic cell death in human hormone-refractory prostate cancer cell lines
Cancer Lett. (2012)

Y. Wang *et al.*
Exploration of isoquinoline alkaloids as potential inhibitors against human islet amyloid polypeptide
ACS Chem. Neurosci. (2022)

R. Bai *et al.*
Discovery of natural anti-inflammatory alkaloids: potential leads for the drug discovery for the treatment of inflammation
Eur. J. Med. Chem. (2021)

R. Zhang *et al.*
Diverse alkaloids and biological activities of *Fumaria* (Papaveraceae): an ethnomedicinal group
Fitoterapia (2020)

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