



Book of Abstracts

5th International Congress & 6th National Conference on
Biotechnology of Medicinal Plants & Mushrooms
October, 7 & 8 - 2025
Rasht - Iran

Co-rganizers: University of Zanjan and University of Guilan,



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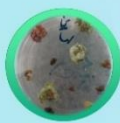
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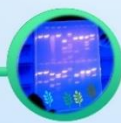
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دانشگاه گیلان



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جمهوری اسلامی ایران
وزارت علوم، تحقیقات و فناوری



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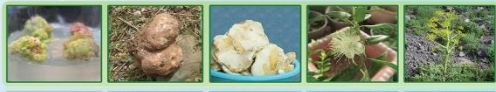


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خلاصه مقالات علمی پنجمین گنگره بین المللی و ششمین همایش ملی

زیست فناوری گیاهان دارویی و قارچهای کوبی

تاریخ برگزاری: 15 و 16 مهر ماه ۱۴۰۴

محل برگزاری: دانشگاه کیلان

برگزارکنندگان مشترک: دانشگاه زنجان و دانشگاه کیلان

پاییز ۱۴۰۴

پیش‌گفتار

خداوند منان را بسیار شکر گزاریم که در تداوم برگزاری دوره‌های منظم قلمی گنگره، توفیقان بخشید که با همه تکنها و ناملایات، شاهد برپایی پنجمین گنگره بین المللی و ششمین همایش ملی زیست فناوری گیاهان دارویی و قارچهای کوبی بصورت حضوری و مجازی (ترکیبی) در 15 و 16 مهرماه 1404 به میزبانی دانشگاه کیلان باشیم. اینک در جمع بندی و گردآوری و انتشار خلاصه مقالات این رویداد مهم، ذکر این نکته را یادآور می‌شویم که مسوولیت صحت و دقت و درستی نتایج و مطالب ارایه شده، اختصاصاً و انحصاراً بر عهده نویسندگان مقالات بوده و دبیرخانه گنگره جهت حفظ امانت از هرگونه دخل و تصرف علمی در مقالات ارسالی خودداری نموده است. با توجه به تاکیدات متمادی و بسایت گنگره و نیز در ارتباطات مجازی با ارسال کنندگان مقالات، دال بر رعایت الگو و ادبیات نگارشی و املائی و کنترل دقیق موازین علمی در بیان یافته‌ها در متون انگلیسی مقالات، فایل‌های ارسالی چکیده مقالات پوست، با این پیش فرض موکد، مورد گردآوری و تنظیم و صفحه بندی و انتشار قرار میگیرد. ضمن شکر قلبی از همه همکاران و دانشجویان و انجمن‌های تخصصی داخلی و بین المللی همراه گنگره که ذکر نام و همت بلندشان در این اختصار نمیگنجد، بویژه اعضا محترم کمیته‌های سیاست گذاری، کمیته علمی و داوران ارجمند و نیز اعضا محترم کمیته اجرایی در دانشگاه زنجان و بطور خاص از زحمات میزبانی شایسته دانشگاه کیلان بویژه زحمات و پیکیرهای جناب آقای دکتر سمیع زاده لایچی، رئیس محترم دانشکده کشاورزی / دکتر محمد حسین رضا دوست مدیر محترم گروه بیوتکنولوژی دانشکده، دکتر سالار منجم مدیر اجرایی گنگره...، توفیق همه محققین و پژوهشگران عرصه زیست فناوری گیاهان دارویی و قارچهای کوبی را در گستره گیتی، در ارتقا و بهبود این بخش از علوم زینتی بارویکرد استفاده بهینه از فناوریهای سازگار با طبیعت، از خداوند بزرگ و منان خواستاریم.

دبیرخانه دایمی گنگره ادواری بین المللی زیست فناوری گیاهان دارویی و قارچهای کوبی

علی عارلو - بهرام ملکی زنجان

پاییز 1404



5th International Congress and 6th National Conference on
**Biotechnology of Medicinal Plants
and Mushrooms**



Congress Time and Place:
October 7 and 8, 2025 - University of Guilan

Co-organizers:
University of Zanjan and University of Guilan



The congress will provide an opportunity for students, entrepreneurs and technologists around the world to have a constructive dialog and share their ideas about the scientific innovations in fields of biotechnology on medicinal plants and mushrooms. We invite papers with all topics in biotechnology related with medicinal plants and mushrooms. Please submit your abstracts to be selected for oral or poster presentation.

Deadline for Submission:
14 September 2025



The congress topics

Genetic engineering

Genetic diversity

Tissue culture

Gene expression

Secondary metabolites

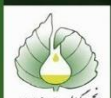
Mushrooms biology

Other related subjects



Congress website :
<https://ic-bmpm.znu.ac.ir/2025/en>





پنجمین کنگره بین‌المللی و شصتینمین همایش ملی زیست فناوری گیاهان دارویی و قارچهای کوهسار

زمان برگزاری: ۱۵ و ۱۶ مهرماه ۱۴۰۴
محل برگزاری: دانشگاه گیلان

برگزارکنندگان مشترک:
دانشگاه زنجان و دانشگاه گیلان

5th International Congress and 6th National Conference on

Biotechnology of Medicinal Plants and Mushrooms

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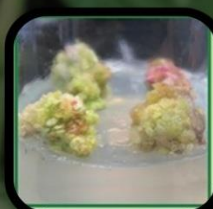
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مهلت ارسال مقالات:

۲۰ شهریور ۱۴۰۴



محورهای اصلی

- ۱- مهندسی ژنتیک، تنوع ژنتیکی، کشت بافت، بیان ژن، متابولیت های ثانویه و فیزیولوژی گیاهی
- ۲- داروهای گیاهی و طبیعی مبتنی بر زیست فناوری
- ۳- زیست فناوری و زیست شناسی قارچ های کوهی، سمی، خوراکی و صنعتی
- ۴- تجارت فناوری های نوین زیستی در حوزه گیاهان دارویی، داروهای گیاهی، قارچ های کوهی و صنعتی
- ۵- صنایع مرتبط با زیست فناوری، گیاهان دارویی و قارچ های کوهی
- ۶- گیاهان دارویی، حفاظت از مراتع و محیط زیست
- ۷- سایر پژوهش های مرتبط با گیاهان دارویی، قارچ های دارویی و مشتقات دارویی



آدرس سایت کنگره:

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Revealing Potential Effects of *Punica granatum* Seed-derived Compounds in Prevention of Cancer Metastasis by Network Pharmacology and Molecular Docking

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Abstract

Cancer metastasis remains one of the major challenges in oncology, leading to high mortality and limited therapeutic success. Natural bioactive compounds derived from medicinal plants and agricultural by-products have attracted considerable attention for their potential to modulate multiple molecular targets simultaneously. Pomegranate (*Punica granatum*) seeds are particularly rich in polyphenols, flavonoids, punicic acid, and sterols, which have been reported to exert antioxidant, anti-inflammatory, and anticancer effects. This study aimed to elucidate the potential mechanisms of pomegranate seed-derived compounds in preventing cancer metastasis through an integrative in silico approach involving network pharmacology and molecular docking. The active compounds were identified through TCMSP and SwissTargetPrediction databases, while metastasis-related targets were retrieved from GeneCards and DisGeNET. Intersection targets were visualized by Venn diagram analysis using R software. A protein–protein interaction (PPI) network was constructed with STRING and analyzed using Cytoscape. Hub targets were identified through the MCODE plug-in. Gene Ontology (GO) and Kyoto Encyclopedia of Genes and Genomes (KEGG) enrichment analyses were performed using the clusterProfiler package with an adjusted p-value <0.05 . The bioinformatics analysis revealed that pomegranate seed-derived compounds interact with a wide range of metastasis-associated targets. Venn analysis identified over 120 overlapping targets between the compounds and cancer metastasis-related genes. Construction of the PPI network highlighted several central hub proteins, including MMP9, VEGFA, EGFR, AKT1, and MAPK1, which play crucial roles in extracellular matrix remodeling, angiogenesis, and cell migration. GO enrichment analysis demonstrated that these targets are primarily involved in biological processes such as regulation of cell adhesion, apoptotic signaling, oxidative stress response, and epithelial–mesenchymal transition. KEGG pathway analysis further revealed significant enrichment in the PI3K/Akt, MAPK, HIF-1, and NF-κB signaling pathways, all of which are key regulators of tumor progression and metastatic potential. Molecular docking analysis provided additional evidence for the strong binding affinity of major pomegranate seed bioactives. Punicic acid exhibited stable interactions with MMP9 and VEGFA active sites,

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potentially blocking matrix degradation and angiogenic signaling. Ellagic acid and flavonoid derivatives showed high docking scores with EGFR and AKT1, suggesting a role in modulating growth factor signaling and inhibiting downstream pathways associated with tumor invasion. Moreover, sterol constituents of pomegranate seed extracts demonstrated favorable binding to MAPK1, which may contribute to the suppression of proliferative signaling cascades. In summary, the results indicate that pomegranate seed-derived compounds possess multi-target anticancer properties that may contribute to metastasis suppression. The integration of network pharmacology and molecular docking highlights the therapeutic promise of these natural bioactives in the development of functional medicine strategies against cancer .

Keywords: Pomegranate seed, *Punica granatum*, punicic acid, metastasis, network pharmacology, molecular docking, functional medicine

Mushroom proteins and its nutraceutical perspective

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Sher-E-Kashmir University of Agricultural Sciences and Technology of Jammu (J&K)-India

Abstract

Edible mushrooms are increasingly recognized as safe and dependable sources of high-quality protein, on account of their low fat and high fiber content, along with beneficial compounds like phenolics and flavonoids. With an average protein content of 23.80g per 100g of dry weight, they provide a cost-effective option that is easily accessible and aligns with environmental and social standards, making them an excellent sustainable alternative protein source. Their significant protein content also makes them attractive for producing protein hydrolysates for various food applications. These hydrolysates, which include low molecular weight peptides—particularly di- and tri-peptides with minimal free amino acids, enhance dietary versatility and offer therapeutic benefits. Mushroom proteins and peptides are seen as alternative to animal protein product worldwide. Nutraceutical products based on hydrolyzed proteins or BPs of mushroom can be the future of food and pharma industries. These peptides can regulate important bodily functions through their myriad activities including antihypertensive, antimicrobial, antithrombotic, immunomodulatory, opioid, antioxidant and mineral binding functions .

Keywords: Mushrooms, Protein, Hydrolysates, Peptides.

Mushroom Cultivation in India: The Road Ahead

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Sachin Gupta, Moni Gupta, Upma Dutta, Megha Abrol and Ranbir Singh
Sher-E-Kashmir University of Agricultural Sciences and Technology of Jammu (J&K)-India

Abstract

In India, there has been significant increase in production of mushrooms in the last few years. The country's production in 2010 was 1.00 lakh metric tons, of which button mushroom accounted for 89% of the total production, followed by oyster (6%), milky (1%) and others (4%). Punjab, Himachal Pradesh, Haryana, Odisha were the leading producers of the mushroom in the country as on 2010. By 2017, the production of mushrooms in India has reached to a level of 1,30,000 MT. During this period, the productivity has raised from 20% to 24.5% owing to the release of 10 improved strains in different commercially grown mushrooms. From 2010-2017, the mushroom industry in India has registered an average growth rate of 4.3% per annum. In India, there are five mushroom species viz., white button mushroom (*Agaricus bisporus*), oyster (*Pleurotus* spp.), paddy straw (*Volvariella volvacea*), milky (*Calocybe indica*) and shiitake (*Lentinula edodes*) which are in under commercial cultivation. The commercial markets are dominated by *Agaricus bisporus*, *Pleurotus* spp. and *Volvariella volvacea*. These three mushrooms are contributing about 96% of total mushroom produced in India. Milky mushroom (*Calocybe indica*) is indigenous tropical mushroom of the country. However, the commercial cultivation is restricted to South Indian states only and contributing up to 3% to the total mushroom production. Mushroom Industry is flourishing in India and has a very bright future ,

Keywords: Button mushroom, Oyster mushroom, Milky mushroom, Paddy straw mushroom.



The Effects of Edible Mushrooms on the Immune System

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³ Yüzüncü Yıl University, Department of Pharmaceutical Microbiology, Van, Turkey

Abstract

Edible mushrooms, widely consumed globally, have been recognized for their health benefits, particularly in immune system modulation. This study reviews the positive and negative effects of mushrooms on the immune system, highlighting compounds like β -glucans, found in varieties such as shiitake, maitake, and reishi. These mushrooms activate immune cells, like macrophages and natural killer (NK) cells, enhancing immune responses and regulating inflammation. Additionally, mushrooms contain antioxidant properties, which reduce oxidative stress and strengthen immune cell function. Some species, such as oyster mushrooms, also modulate gut microbiota by increasing short-chain fatty acids (SCFAs), further boosting immune system efficiency. However, there are negative effects, including allergic reactions such as "shiitake dermatitis" caused by consuming raw or undercooked mushrooms, and potential risks from mycotoxins in improperly stored mushrooms. These risks can reduce immune cell function, especially in individuals with weakened immune systems. Moreover, the relationship between edible mushrooms and autism spectrum disorder (ASD) is explored. Imbalances in gut microbiota, associated with ASD, may be improved by mushrooms like *Ganoderma lucidum*, which can help balance the immune system. Although promising, research in this area is still in its early stages and requires further clinical studies.

Keywords: Edible mushrooms, immune system, β -Glucans, autism spectrum disorder



Conversion and development of *Prunus armeniaca* L. oil into value-added products for use in the food, cosmetics and health industries

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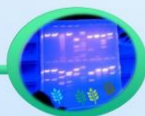
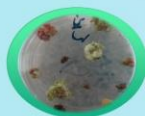
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Abstract

The apricot (*Prunus armeniaca* L.) is an economically important fruit species that is widely cultivated in Asia and the Mediterranean basin. As well as fresh and processed fruit products, apricot kernels and their derivatives are attracting more and more attention as valuable by-products in the context of sustainability and the circular economy. GC-FID analysis revealed the presence of high levels of various fatty acids, including palmitic acid (4.54222%), palmitoleic acid (0.54765%), stearic acid (1.28074%), cis-oleic acid (71.85505%), cis-linoleic acid (21.60338%), γ -linolenic acid (0.08944%), docosadienoic acid (0.05517%) and docosaheptaenoic acid (DHA) (0.02635%). Apricot kernel oil contains high levels of monounsaturated and polyunsaturated fatty acids (particularly oleic and linoleic acids), as well as tocopherols, phytosterols, and phenolic compounds. It exhibits significant antioxidant, anti-inflammatory, and emollient properties. These properties support its use as a functional ingredient in cosmetic formulations, food products and phytopharmaceutical applications. Additionally, extracts obtained from the pulp, peel and kernels of the fruit exhibit antioxidant and antimicrobial activities, thereby increasing their industrial importance. However, the presence of cyanogenic glycosides, such as amygdalin, poses a significant toxicological risk. Therefore, strict compliance with safety regulations and the implementation of effective detoxification and bitter removal methods are mandatory. Current studies suggest that apricot kernels could be used as a source of bioactive compounds and as a sustainable raw material for creating valuable products. This review summarises the current knowledge on the chemical composition, biological activities and industrial applications of apricot kernel oil and extracts, and discusses the toxicological limitations, regulatory framework and research gaps that need to be addressed for its safe use.

Keywords: *Prunus armeniaca*, apricot kernel oil, amygdalin, antioxidant, cosmetics, functional food, sustainability



Pharmaceutical applications of immobilized enzymes and polymers produced by probiotics

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Abstract

Enzyme immobilization is a widely used technology in various fields and industries such as bioremediation, environmental monitoring, biotransformation, food industry, textile industry, detergent industry, pharmaceutical industry and diagnostics etc. This technology has economical and technical advantages. Immobilization of enzyme can lower the cost and also provide operational stability to enzymes. There are many methods of immobilization that are used. Unfortunately, there is no a universal material or method that can be used as support material; i.e. the carrier and also immobilization method might differ from enzyme to enzyme and also according to application. Immobilization technique is useful for these applications: acting as a support for enzymes, enhancing the catalytic properties and stabilities of enzymes, easy recovery from the reaction mixture, reusability of enzymes for many cycles, decreasing operational cost, The immobilized enzymes are suitable for various industrial applications.

Keywords: Enzyme immobilization, pharmaceutical industry, bioremediation.



Enhancing the Biosynthesis of Cinnamyl Alcohol Glycosides by In Vitro Biotransformation of Precursor Compounds

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³Department of Plant Biotechnology, Group of Horticultural Plant Genetics, Institute of Genetics and Biotechnology, Hungarian University of Agriculture and Life Sciences, Budapest, Hungary

Abstract

Cinnamyl alcohol glycosides (CAGs) represent the characteristic bioactive compounds of *Rhodiola rosea* (roseroot) preparations and products. The rapid expansion of the market for roseroot-based products, along with increasing demand for raw plant materials, has placed significant pressure on wild populations worldwide, underscoring the need for alternative production strategies. In this research, the potential of roseroot callus cultures to enhance selected precursors molecules into CAGs—namely rosin, rosavin, and rosarin—was investigated. Proposed CAG precursors, including phenylalanine, trans-cinnamic acid, cinnamaldehyde, and cinnamyl alcohol, were individually supplied to liquid callus cultures at a concentration of 2 mM. Samples were collected in different intervals and analyzed by HPLC to be compared with untreated controls. All tested precursors, with the exception of phenylalanine, significantly enhanced CAG biosynthesis. The efficiency of biotransformation increased with the proximity of the precursor to the final products within the biosynthetic pathway, both in terms of conversion rate and final CAG yield. Supplementation with trans-cinnamic acid and cinnamyl alcohol resulted in significant increases in CAG accumulation after 24 h and 96 h, respectively. Among the analyzed compounds, rosin was uniquely detected in the culture medium, and only in callus cultures supplemented with cinnamyl alcohol. Overall, these findings demonstrate that roseroot callus cultures possess a strong capacity to biotransform selected cinnamyl alcohol glycoside precursors, highlighting their potential as a sustainable platform for the production of pharmaceutically valuable CAGs.

Keywords: Bioactive compounds, Cinnamyl alcohol glycosides, Biotransformation



Exploring *Salvia verticillata* (Lamiaceae): From Bioactive Compounds to Practical Solutions

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Abstract

Salvia verticillata L. (Lamiaceae), commonly known as lilac sage, represents an underexplored medicinal plant with significant therapeutic potential. This presentation integrates findings from comprehensive phytochemical characterization, biological activity assessments, nanotechnology applications, and emerging in vivo evidence for polycystic ovary syndrome (PCOS) management. Our previous phytochemical profiling of methanolic extracts from *S. verticillata* aerial parts revealed exceptional richness in phenolic compounds, particularly rosmarinic acid and its derivatives, salvianolic acids, and luteolin-O-glycosides. These extracts demonstrated strong antioxidant potential, moderate antimicrobial activity against *Escherichia coli* and *Staphylococcus aureus*, and good biocompatibility with normal cell lines while showing selective cytotoxicity toward cancer cells. Building upon these findings, we successfully developed green-synthesized silver nanoparticles using aqueous *S. verticillata* extracts. Optimization studies yielded crystalline nanoparticles (40-70 nm) with enhanced antibacterial and cytotoxic properties, particularly against colon cancer cells, while maintaining biocompatibility with human fibroblasts. These nanoparticles also exhibited significant catalytic activity in organic pollutant degradation, highlighting their environmental applications. Most recently, our unpublished in vivo PCOS studies reveal promising therapeutic effects of *S. verticillata* root extract in animal model, demonstrating improvements in hormonal balance, ovarian morphology, and metabolic parameters. These findings suggest potential mechanisms involving antioxidant and anti-inflammatory pathways. Our research trajectory illustrates how traditional knowledge can guide contemporary scientific applications, from phytochemical characterization to nanomedicine and evidence-based therapeutics. Future directions include clinical translation of PCOS findings, further exploration of anti-inflammatory mechanisms, and development of standardized extracts for pharmaceutical and nutraceutical applications. *S. verticillata* emerges as a valuable bioresource bridging ethnopharmacology and modern biomedicine.



Lavandula species - Nutritional profile and metabolites with pharmacological relevance

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Abstract

Native to the Mediterranean region, *Lavandula* species are widely distributed and cultivated across Europe, North Africa, Southwest Asia, and the Americas. Valued for centuries for their aromatic and medicinal properties (Latin *lavare* – “to wash”), lavender is today cultivated on more than 200,000 hectares worldwide, with France, Spain, Italy, Bulgaria, and China among the leading producers. *Lavandula* is a perennial genus adapted to sunny, warm, and dry habitats, thriving on well-drained, calcareous soils (pH 6.0–7.5). Cultivation practices, including pruning, irrigation management, and weed control, are essential for maintaining plant growth and essential oil yield and quality. Traditionally used in medicine, aromatherapy, and culinary practices, lavender has evolved into a plant of significant industrial and pharmacological interest. Aside from its well-known essential oil profile, lavender also possesses noteworthy nutritional value. Reported compositions include proteins (6.34–23.43%), carbohydrates (40.53–71.05%), lipids (1.29–8.16%), and nutritionally significant elements, supporting its potential as a functional food ingredient. The major commercial species for essential oil production are *L. angustifolia*, *L. × intermedia*, and *L. latifolia*. Essential oils are rich in linalool and linalyl acetate, while species-specific compounds such as camphor, trans-carveol, and carvacrol further define their chemical variability. In addition to volatile constituents, a broad spectrum of phenolic compounds has been identified using LC/MS, HPLC, and UPLC techniques. Detected phenolic acids include protocatechuic, chlorogenic, caffeic, ferulic, and rosmarinic acids, alongside flavonoids such as apigenin, luteolin-7-O-glucoside, quercetin, rutin, kaempferol, and isorhamnetin. Novel metabolites, including lavandupyrone, lavandudiphenyls, and lavandufluoren derivatives, further expand the phytochemical diversity. Flowers generally contain higher concentrations of phenolics compared to leaves. These metabolites contribute to multiple biological activities such as antioxidant, anti-inflammatory, antimicrobial, antiviral, neuroprotective and antiacetylcholinesterase activity. Based on nutritional value, chemical diversity, and significant therapeutic potential, the increasing global demand reflects importance of *Lavandula* species in pharmaceutical, cosmetic, food, and wellness industries.

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Identification of microRNA targeting Chalcone synthase genes in *Cynara Cardunculus* and *Silybum marianum*

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Abstract

Milk thistle (*Silybum marianum*) belongs to the Asteraceae family and is a medicinal plant containing silymarin. Artichoke (*Cynara Cardunculus* var. *scolymus*) is rich in polyphenolic compounds, inulin, fiber, minerals, and antioxidant compounds. Chalcone synthase (CHS) is a key enzyme for the biosynthesis of flavonoids and anthocyanin pigments in plants. MicroRNAs (miRNAs) play a key role in regulating gene expression in plants. In this study, miRNAs affecting CHS family genes in artichoke, including six genes (CcCHS1, CcCHS3, CcCHS4, CcCHS5, CcCHS6), and milk thistle, including two genes (Smchs2, Smchs3), were identified bioinformatically using the NCBI database and the psRNATarget web-based software. Finally, the relationships between target genes and their associated miRNAs were mapped in Cytoscape software. Based on the results obtained in this study, six target genes and seven types of microRNA were identified for artichoke. In milk thistle, two target genes and two microRNAs were identified.

Keywords: Chalcone synthase, Asteraceae, flavonoids, CHS family



Application of Medicinal Plants as Natural Preservatives in the Food Industry

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Abstract

Growing consumer concerns regarding the adverse effects of synthetic preservatives, such as benzoates and nitrites, have led to a significant surge in interest towards natural and safe alternatives. Medicinal plants, owing to their diverse range of bioactive compounds—including phenols, terpenoids, alkaloids, and sulfur compounds—have demonstrated considerable potential for application as natural preservatives in food products. These compounds exert their preservative effects through multiple mechanisms, such as inhibiting the growth of microorganisms (bacteria, fungi, and yeast), preventing lipid oxidation, and preserving the sensory quality of food. The objective of this review article is to systematically evaluate recent studies on the application of extracts and essential oils from medicinal plants in preserving various food categories, including meat, dairy, cereal, and oil products. Findings clearly indicate that plants such as thyme, eucalyptus, clove, cinnamon, rosemary, and mint possess potent antimicrobial and antioxidant properties, attributable to their high content of phenolic compounds (e.g., carvacrol, thymol, eugenol, and cinnamaldehyde). For instance, incorporating thyme essential oil into sausages and deli meats has been shown to significantly enhance their shelf life against pathogens like *Listeria monocytogenes* and *E. coli*. Although challenges such as impact on flavor and aroma, determination of effective dosage, and stabilization within the food matrix persist, emerging technologies like microencapsulation, nanoemulsification, and combination with other preservation methods (e.g., active packaging) appear promising for facilitating the broader application of these natural preservatives in the food industry. This review concludes that medicinal plants represent not only a safe and environmentally friendly alternative to synthetic preservatives but may also enhance the nutritional value of food products.

Keywords: Medicinal Plants, Natural Preservatives, Bioactive Compounds, Antimicrobial, Antioxidant, Food Industry.

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The pivotal role of secondary metabolites in enhancing heavy metal tolerance in plants inoculated with symbiotic fungi

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Abstract

Soil contamination by heavy metals such as cadmium, lead, nickel, and zinc has emerged as a significant environmental and agricultural challenge in recent years. These metals disrupt cellular structures and induce oxidative stress, negatively affecting plant growth and fertility, thereby reducing crop yield and quality. Plants respond to these stresses by activating defensive pathways, notably through the production of secondary metabolites. Compounds such as flavonoids, alkaloids, glucosinolates, and terpenoids enhance plant tolerance to heavy metals via metal ion chelation, reactive oxygen species scavenging, and modulation of hormonal signaling pathways. Additionally, symbiotic fungi, particularly arbuscular mycorrhizal fungi and endophytes, can stimulate or enhance secondary metabolite biosynthesis pathways in host plants. These fungi significantly bolster plant defenses by improving nutrient uptake, reducing metal translocation to aerial organs, and activating antioxidant systems. This paper comprehensively reviews the physiological, biochemical, and molecular mechanisms underlying the interactions between symbiotic fungi and secondary metabolite biosynthetic pathways in plants exposed to heavy metal stress, outlining novel opportunities for phytoremediation, sustainable agriculture, and biotechnological applications.

Keywords: Endophyte, antioxidant, abiotic stress, heavy metals, secondary metabolites,



MicroRNA–Gene Interaction Network Analysis in the Tanshinone Biosynthetic Pathway of Chinese Sage (*Salvia miltiorrhiza*)

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Abstract

Salvia miltiorrhiza (Danshen) is one of the most important medicinal plants in Traditional Chinese Medicine, renowned for producing valuable bioactive compounds known as tanshinones. These diterpenoid compounds possess numerous pharmacological properties, including antioxidant, anti-inflammatory, and anticancer activities. Understanding the regulatory mechanisms governing the tanshinone biosynthetic pathway, particularly at the post-transcriptional level, is crucial for optimizing the production of these metabolites. This study employed a bioinformatics approach to analyze the microRNA–gene interaction network within the tanshinone biosynthetic pathway. The mRNA sequences of three key genes in this pathway—CPS1, KSL1, and CYP—were retrieved from the NCBI database. Using the psRNATarget software (with an Expectation parameter = 5), these sequences were analyzed against a microRNA database (miRBase) to predict targeting microRNAs. The results identified a total of 252 microRNAs, belonging to 28 families, that potentially target these three key genes. The CPS1 gene was found to be primarily regulated by microRNAs from the miR781, miR319, and miR482 families. The KSL1 gene was predominantly targeted by members of the miR156 and miR902 families, whereas the CYP gene was mainly influenced by microRNAs from the miR2630 and miR399 families. Network analysis using Cytoscape software revealed complex regulatory patterns, indicating that certain microRNAs, such as miR7492 and miR482, can simultaneously target two genes (CPS1 and CYP, and CYP and KSL1, respectively). This observation suggests the phenomenon of “microRNA cooperativity,” where multiple microRNAs act additively or synergistically to repress the expression of a common target gene. The findings of this study highlight the pivotal role of microRNAs in the fine-tuning of the tanshinone biosynthetic pathway. The identification of these regulatory microRNAs provides valuable molecular insights for metabolic engineering objectives. Targeted manipulation of their expression levels holds promise for enhancing tanshinone production yield in *Salvia miltiorrhiza*. Future studies utilizing techniques such as CRISPR or RNAi can further validate the functional roles of these predicted microRNAs.

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Keywords: *Salvia miltiorrhiza*, Tanshinone biosynthesis, microRNA, medicinal plants

Identification of Key Genes in Breast Cancer Cells Treated with Withaferin A Derived from *Withania somnifera* Using Microarray Data Analysis

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Abstract

To identify key genes involved in breast cancer cells treated with Withaferin A, relevant microarray data were collected from the Gene Expression Omnibus (GEO) database and analyzed using RStudio software. Gene ontology (GO) and KEGG pathway enrichment analyses were conducted using the DAVID online tool. The protein-protein interaction (PPI) network was constructed using the STRING database, and the differentially expressed genes (DEGs) were imported into Cytoscape software for further analysis. Based on the results, 42 DEGs were identified in the comparison between control group samples and MCF-7 cells, using $|\log FC| \geq 2$ as the threshold. According to the KEGG pathway enrichment analysis, mineral absorption (hsa04978) was the most significantly enriched pathway. Additionally, based on the gene network reconstruction results using the gene connectivity degree algorithm, four key hub genes (ATF3, DDIT3, IFIT1, and HMOX1) were identified as the most significant hub genes. These hub genes may serve as potential biomarkers for therapeutic targets in breast cancer.

Keywords: biological process, hub gene, gene ontology.



Seed priming and its effects on physiological and biochemical changes influencing germination in Iranian borage (*Echium amoenum* Fisch & Mey.)"

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Iranian Borage (*Echium amoenum* Fisch & Mey.) is an important medicinal plant of the Boraginaceae family, which poor seed germination has limited the expansion of its cultivation. This research was conducted to investigate the effect of priming with potassium nitrate (KNO_3) at concentrations of 20 and 30 mMol on the physiological germination indices and biochemical changes of Iranian borage seeds. The experiment was carried out in a completely randomized design with four replications in 2024. After treatment with KNO_3 for 24 hours, the seeds were placed under controlled conditions (temperature 25°C, relative humidity 70%). The results revealed that the 30 mMol KNO_3 treatment significantly increased germination percentage (89.8%), germination rate (0.016), seedling length (16.21 cm), and seedling vigor index (0.33). Furthermore, the activity of alpha-amylase, catalase, and peroxidase enzymes was markedly enhanced in this treatment, indicating the stimulation of seed reserve metabolism and reduction of oxidative stress. In contrast, the 20 mMol treatment had no significant effect on germination rate and alpha-amylase activity. Therefore, priming with KNO_3 at a concentration of 30 mMol, by improving physiological and biochemical traits, is an effective strategy for enhancing the germination efficiency and establishment of Iranian borage. This technic can be used in the cultivation management of this medicinal plant in the highland regions of Iran.

Keywords: Iranian Borage, Priming, Potassium Nitrate, Germination Physiology, Antioxidant Enzymes



Bioactive compounds and therapeutic properties of Iranian borage (*Echium amoenum* Fisch & Mey.) and breeding methods to enhance desirable compounds

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Abstract

Iranian Borage (*Echium amoenum* Fisch & Mey.) is recognized as one of the most important medicinal plants in Iranian traditional medicine. Recent studies have shown that this plant contains numerous bioactive compounds, including unsaturated fatty acids, phenolic compounds, alkaloids, and mucilage, each possessing unique therapeutic properties. In recent years, multiple research efforts have investigated various breeding and plant improvement methods aimed at enhancing its active compounds and reducing undesirable constituents. Results from studies conducted in recent years (2020-2023) indicate that, despite the significant therapeutic potential of Iranian borage, there is a need for more clinical trials with larger sample sizes, standardization of extraction methods, and the development of protocols for reducing toxic alkaloids. Furthermore, in the field of breeding, integrating classical and modern breeding approaches could offer more effective strategies for improving the quality of Iranian borage.

Keywords: Iranian Borage, Breeding, Phenolic Compounds, Alkaloids



Phytochemical Characterization of sage (*Salvia officinalis* L.) Essential Oil Grown in Zanjan's Climatic Region

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Abstract

This study examines the phytochemical properties of essential oil extracted from *Salvia officinalis* L. (sage) cultivated in the unique climatic conditions of Zanjan, Iran. The aerial parts of the plant were harvested at full flowering stage, and the essential oil was obtained through hydrodistillation using a Clevenger apparatus. Chemical analysis was performed via gas chromatography (GC) and gas chromatography-mass spectrometry (GC/MS). The essential oil yield was found to be 2.1% (v/w), with 32 compounds identified, representing 96.8% of the total oil composition. The major constituents included α -thujone and β -thujone (28.5% combined), 1,8-cineole (19.3%), camphor (14.7%), α -humulene (6.2%), and borneol (4.9%). Oxygenated monoterpenes, particularly thujones and 1,8-cineole, were the dominant chemical class, defining the essential oil's characteristic profile. Zanjan's semi-arid climate, calcareous soils, high solar exposure, and notable diurnal temperature shifts appear to significantly influence the biosynthesis of key phytochemicals, especially monoterpenes. These findings highlight the region's potential for producing high-quality sage essential oil rich in bioactive compounds suitable for pharmaceutical, aromatherapy, and industrial applications.

Keywords: 1,8-Cineole, Borneol, Gas Chromatography, sage, Thujone



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The role of miRNAs in medicinal plants in controlling the severity of COVID-19 disease

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Abstract

Studies show that some medicinal plants may contain miRNAs that can reduce the severity of the disease. In this study, the history of the use of medicinal plants in traditional medicine and their role in the treatment of coronavirus disease was reviewed. Plants that may have antiviral potential in controlling the severity of coronavirus disease were studied, and the chemical and biological properties of these plants were investigated. Genetic information related to the viruses of Iranian coronavirus patients was extracted, and it was shown that certain miRNAs are present in patients with low disease severity and that these miRNAs can help regulate the activity of viral genes and reduce the severity of the disease. Then, computer prediction models were used to investigate the interactions of miRNAs from different medicinal plants with the virus. Conclusions show that miRNAs from the medicinal plant cinnamon have the most interactions with target sequences in the coronavirus.

Keywords: medicinal plants, traditional medicine, disease severity reduction, miRNAs,

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A Novel Approach to Inducing Bioactive Compounds in Greenhouse Plants Using Abiotic Stress Factors

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Abstract

Bioactive compounds are recognized as natural chemicals with positive effects on human health and have garnered significant attention in scientific research and agriculture. These compounds include flavonoids, phenols, antioxidants, and other secondary metabolites that play a crucial role in enhancing the quality and nutritional value of plants. For instance, flavonoids are known as powerful antioxidants that can prevent oxidative damage to cells, thereby reducing the risk of cardiovascular diseases, diabetes, and certain types of cancer. Phenols are also recognized as anti-inflammatory and anti-bacterial compounds that can help improve the immune system. Given the increasing demand for natural and healthy products, researchers are striving to develop effective methods for enhancing the production of these compounds in plants. One of the innovative and effective methods for increasing the production of bioactive compounds is the use of abiotic stress factors. Abiotic stresses such as drought, salinity, and unsuitable temperatures can act as stimuli for the production of secondary metabolites. In fact, in response to these stresses, plants produce compounds that not only assist them in coping with environmental conditions but also enhance the quality and nutritional value of the products. In this context, researchers have been investigating and analyzing various methods for inducing bioactive compounds through the application of abiotic stresses in greenhouse plants. This article examines the effects of abiotic stresses on the physiology and metabolism of plants and emphasizes the importance of understanding the molecular and biochemical mechanisms associated with the production of bioactive compounds. Ultimately, the findings of this study can assist farmers and researchers in making informed decisions to increase the production and quality of crops and can lead to the development of more effective methods in sustainable agriculture.

Keywords: bioactive compounds, metabolic pathways, nanoparticles, plant physiology, sustainable agriculture



Natural Insecticides Derived from Medicinal Plants: A Systematic Review of Applications and Mechanisms of Action

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Abstract

The increasing incidence of insect resistance to synthetic insecticides, coupled with growing concerns about their adverse effects on human health and the environment, has intensified the search for safe and eco-compatible alternatives. Medicinal plants, which produce a wide array of defensive secondary metabolites, represent a rich and promising resource for the development of natural insecticides. These bioactive compounds—including alkaloids, terpenoids, phenols, flavonoids, and essential oils—act upon insects through various mechanisms such as contact and gastric toxicity, repellency, feeding deterrence, disruption of growth and development, and reduction of fecundity. The objective of this review article is to systematically evaluate contemporary studies on the efficacy of medicinal plant extracts and essential oils against major agricultural and public health pests. Findings clearly demonstrate that plants such as pyrethrum (*Tanacetum cinerariifolium*), neem (*Azadirachta indica*), eucalyptus, garlic, lavender, and thyme possess significant insecticidal potential. For instance, azadirachtin, derived from the neem tree, is recognized as a potent growth regulator. Although challenges such as extract standardization, stability in open-field conditions, and determination of effective large-scale dosing persist, potential solutions include novel formulation strategies (e.g., microencapsulation, nanoemulsions) and integration into Integrated Pest Management (IPM) frameworks. This review concludes that medicinal plants not only offer safe and biodegradable alternatives to synthetic insecticides but also pave the way for the development of sustainable pest control strategies.

Keywords: Medicinal Plants, Natural Insecticide, Secondary Metabolites, Plant Extract and Essential Oil, Integrated Pest Management (IPM).



The Prospective Use of *Stachys lavandulifolia* in Food Technology

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Abstract

The *Stachys lavandulifolia*, commonly known as mountain tea, belongs to the Lamiaceae family. It is native to Iran, Iraq, Turkey, and Turkmenistan. *S. lavandulifolia* is a perennial plant with a woody base, hairy stems, greenish-gray leaves, and pink, purple, and rarely white, cluster-like flowers. The leaves reach 15–25 cm high with simple branches. The cluster inflorescences are pinkish-purple, rarely white or yellowish. *S. lavandulifolia* is used in traditional medicine to treat digestive and respiratory disorders, headache, dizziness, joint pain, rheumatism, and nerve pain. *S. lavandulifolia* has various bioactive compounds, including polyphenols, tannins, flavonoids, iridoids, loganic acid, and phenylethanoid glycosides. Since *S. lavandulifolia* is rich in bioactive compounds that possess antioxidant, antimicrobial, and potential health-promoting properties, it could be considered as a natural preservative to extend shelf-life and improve the safety of food products. As a result, in this study, the potential usage of *S. lavandulifolia* as a food additive is discussed to explore its application in the food industry.

Keywords: *Stachys lavandulifolia*, bioactive compounds, food processing, food products



A Systematic Review of the Application of Medicinal Plants as Thickening and Gelling Agents in the Food and Pharmaceutical Industries

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Abstract

Thickeners are essential additives in the food and pharmaceutical industries, enhancing product quality and consumer satisfaction by improving rheological properties, stability, and texture. With a growing inclination towards natural compounds, medicinal plants have garnered significant attention as rich sources of natural hydrocolloids, such as polysaccharides, mucilages, and gums. These compounds not only offer desirable technological functionality but also often possess health-beneficial properties, including the prevention of digestive diseases, cholesterol reduction, and antioxidant activity. The objective of this review article is to systematically evaluate the potential of specific polysaccharide-containing medicinal plants as natural alternatives to synthetic and semi-synthetic thickeners. Findings indicate that the mucilage from seeds of psyllium, basil, and balangu, as well as gum tragacanth, exhibit exceptional viscosity and water-holding capacity due to their high soluble fiber content. Similarly, polysaccharides extracted from the roots of medicinal plants like licorice and ginseng demonstrate significant thickening and emulsifying properties. Although challenges such as variability in composition based on geographical source, cultivation conditions, and extraction methods persist, advancements in extraction technologies and bio-modification are paving the way for the standardization and broader application of these natural resources. This article concludes that utilizing medicinal plants as thickeners represents a promising approach for developing "clean-label," healthy, and consumer-friendly products in the food and pharmaceutical industries.

Keywords: Medicinal Plants, Natural Thickener, Hydrocolloid, Polysaccharide, Mucilage, Gum, Rheology.



Evaluating callus formation of *Cynara scolymus* L. under the influence of growth regulators including NAA and 2,4-D

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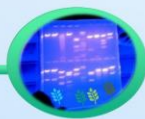
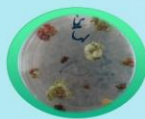
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Abstract

Medicinal plants are used in various cosmetic, food, pharmaceutical, and medical industries. Artichoke (*Cynara scolymus* L.) is a perennial medicinal plant that has antioxidant, anticancer, antiinflammatory, antimicrobial, lipid-lowering, and heart and liver-protecting properties due to its phenolic compounds (such as cynarin and caffeoylquinic), flavonoids, inulin, and volatile organic compounds (e.g., methyl salicylate, camphene, and alpha-terpinene). Tissue culture of medicinal plants is widely used to produce secondary metabolites. This study investigated the callus formation of artichoke from explants (leaflet, crown, and rootlet) in culture medium containing NAA (0, 3, and 6 mg L⁻¹) and 2,4-D (0, 0.5, and 1 mg L⁻¹) hormones. The results showed that callus formation occurred in all cultured explants. According to the results of callus weight and dimensions, the best explant for producing callus was the rootlet, and the leaflet had the weakest callus formation. Considering the largest callus dimensions (average 3cm) in rootlet explants cultured in medium containing 6 mg L⁻¹ NAA, rootlet explants and NAA hormone can be suggested for optimizing artichoke tissue culture and callus formation.

Keywords: Artichoke, hormone, explant, medicinal plant



Quantitative and Qualitative Analysis of Phenolic Content in Walnut Septum Extract with Different Solvents

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Abstract

In the last few decades, scientific evidence has highlighted the importance of plants in the prevention and/or supportive treatment of a variety of diseases. Plants contain a significant amount of phenols, which are distributed throughout different parts of the plant and give the plants antioxidant properties. Walnut Septum (WS), a by-product frequently discarded during Walnut processing, contains a phytochemical profile that demonstrates its therapeutic potential. It is Walnut's main source of polyphenols with powerful antioxidant and anti-inflammatory capacities. However, the detailed information on the compositional profile of phenolics in the Septum remains limited. Thus, to explore the nutraceutical values of the materials, the phenolic profiles of the Walnut Septum must first be identified. To address this question, Walnut Septum extracts were prepared using four different solvents—aqueous, acidic, ethanolic, and methanolic—to assess their efficiency in phenolic compound extraction. The selection of these solvents was based on their distinct chemical properties, influencing solubility and extraction efficiency. Qualitative analyses were conducted, followed by quantitative assessment utilizing the Folin-Ciocalteu reagent and spectrophotometry at 765 nm, referencing a standard Gallic acid Calibration curve. The results demonstrated that methanolic and ethanolic solvents yielded the highest phenol extraction, suggesting their superior efficiency in polyphenol extraction. These findings highlight the potential of Walnut Septum as a valuable source of polyphenols, with promising applications in pharmaceutical and nutraceutical formulations. Further studies should explore the bioavailability and therapeutic efficacy of these extracts.

Keywords: phenol, septum, solvent, walnut



Biotic Elicitation with Yeast Extract Enhances Phytochemical and Antioxidant Profiles of *Calendula officinalis* L. Grown in Vitro

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Abstract

Elicitors are effective tools in in vitro culture technology that stimulate plant defense responses, leading to increased production of secondary metabolites. These compounds, whether biotic or abiotic in origin, can activate biochemical pathways and significantly enhance the yield of medicinal compounds. Their use, especially in medicinal plants, represents a novel approach to increase valuable phytochemicals under controlled laboratory conditions. One important medicinal plant in this context is *Calendula officinalis* L., which is rich in bioactive phytochemicals such as flavonoids, terpenoids, and phenolic compounds. Besides its broad medicinal properties, this plant is widely used in cosmetic, pharmaceutical, and food industries. Due to its high demand and pharmaceutical importance, propagation and metabolite production through in vitro culture have gained considerable attention. In this regard, the application of elicitors like yeast extract can optimize metabolite production in these systems. The objective of this study was to investigate the effect of biotic elicitation using yeast extract at different concentrations on the phytochemical profile, antioxidant activity, and defense-related enzyme activities (catalase and peroxidase) of *Calendula officinalis* L. callus cultured in vitro. After sterilization and seed germination, callus induction was performed on a hormone-supplemented medium containing NAA and BAP. Yeast extract at concentrations of 1000, 1200, and 1400 mg/L was applied in a completely randomized design to the callus. Total phenolic content was measured using the Folin–Ciocalteu method at 735 nm and expressed as mg gallic acid per gram fresh weight. Total flavonoid content was determined by the aluminum chloride colorimetric assay at 510 nm and reported as mg quercetin equivalents. Antioxidant activity was evaluated by the DPPH assay at 517 nm and expressed as a percentage of radical scavenging. Catalase activity was assessed by monitoring hydrogen peroxide decomposition at 240 nm, and peroxidase activity was measured at 470 nm following a reaction with guaiacol and H₂O₂. Analysis of variance revealed that yeast extract, as a biotic elicitor, significantly enhanced total phenolics, total flavonoids, antioxidant activity, and the activities of catalase and peroxidase enzymes compared to the control. Increasing yeast extract concentrations resulted in significant improvements in these parameters, demonstrating the concentration-dependent efficacy of the elicitor in enhancing medicinal compound production and strengthening defense mechanisms in *Calendula officinalis* L. callus under in vitro conditions.

Keywords: phenolic compounds, flavonoids, catalase and peroxidase activity

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Investigation of Physicochemical Properties and Bioactive Compounds of Fermented Ganoderma (*Ganoderma lucidum*) Based Kombucha Compared to Green Tea and Coffee Kombucha

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Abstract

Kombucha is a fermented tea beverage produced by the symbiosis of bacterial cultures and yeasts called (SCOBY). Kombucha is characterized by its rich chemical content and health benefits, including organic acids, minerals, and vitamins that mainly originate from the tea used in it. Kombucha is mainly prepared in the form of black tea, but other types of tea are also increasingly used, which can have a significant impact on its content and health benefits. The type of tea has an important effect on the parameters related to antioxidant potential and polyphenolic compounds. Therefore, this experiment was designed and conducted as a factorial in a completely randomized design in the tissue culture laboratory of the Horticulture Department of the University of Zanjan to compare three types of kombucha obtained from Ganoderma, green tea, and coffee. After preparing the three types of kombucha, polyphenolic, antioxidant, alcohol, sucrose, and acidity indices were measured at time points of 0, 5, 10, and 15 days. The results showed that the fermentation time and tea type had a significant effect on the anti-radical property of kombucha. In terms of tea type, kombucha prepared from green tea had the highest antioxidant potential (94.61%) and the highest levels of phenol (320.1 mg/L) and flavonoid (254.1 mg/L) and reached its highest value on the first day of fermentation. Ganoderma ranked second and coffee ranked third. However, the stability of these compounds in the Ganoderma kombucha was higher than in the others. The drink containing Ganoderma, compared to green tea, had better performance in maintaining safety and in increasing total phenol, but its phenol content was lower than that of green tea. However, due to the innovation and special medicinal benefits of Ganoderma, it has high potential for the development of functional drinks.

Keywords: antioxidant, fermented tea, flavonoid, medicinal mushroom



Effect of Gamma Irradiation on Key Quality and Safety Parameters of Iranian Black Tea

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Abstract

This study comprehensively evaluated the effects of gamma irradiation on the microbial safety, antioxidant activity, and phenolic compound content of Iranian dry black tea to determine an optimal treatment dose for shelf-life extension. Packaged tea samples (metallized foil and nylon) were irradiated at doses of 5, 10, and 15 kGy and compared with non-irradiated controls during storage. Microbiological analysis demonstrated that gamma irradiation significantly ($p < 0.05$) reduced the microbial load at all applied doses. A dose of 5 kGy was sufficient for the complete elimination of moulds, yeasts, and Enterobacteriaceae, including *Escherichia coli* and *Klebsiella*. However, a dose of 10 kGy was required to fully eliminate aerobic bacteria from the initial contamination. The type of packaging did not influence the microbial stability during storage. Regarding tea quality traits, irradiation at 5 kGy did not induce significant changes in the content of key phenolic pigments (theaflavin and thearubigin) or in the tea's antioxidant activity, as measured by the DPPH method. Doses of 10 and 15 kGy caused a slight but statistically significant ($p < 0.05$) decrease in these phenolic compounds. Notably, the antioxidant activity in samples treated with 10 kGy was higher than in both the control and the 5 kGy samples. In conclusion, a gamma irradiation dose of 10 kGy is proposed as the optimal treatment. It ensures complete microbial decontamination, including aerobic bacteria, while causing only minimal, acceptable changes to the tea's bioactive phenolic compounds and even enhancing its antioxidant activity, without adversely affecting its sensory attributes. This dose presents a viable method for significantly extending the shelf life of dry black tea.

Keywords: Antioxidant activity, Black tea, Gamma irradiation, Microbial decontamination, Shelf-life



Study of the efficiency of different strains of *Agrobacterium* (*A. rhizogenes* and various microprobes on the transformation efficiency of hairy roots of the medicinal plant Valerian (*Valeriana officinalis* L.)

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Abstract

Valerian (*Valeriana officinalis* L.) is a medicinal plant whose root is effective in treating depression and Alzheimer's. The aim of this study was to optimize the production of hairy roots in this plant using different strains of *Agrobacterium rhizogenes* and various microprobes with the aim of producing secondary metabolites under in vitro conditions. This experiment was carried out as a factorial experiment in a completely randomized design with three replications. The factors studied included explants with three levels (leaf, stem and root) and the bacterial strain with four levels (A4 and A13, MSU440 and ATCC15834). The results showed that the interaction of the factors studied on the traits of days until hairy root induction, percentage of hairy root induction, number and dry weight of hairy roots after two months was significant. The highest induction percentage (99.3%), number of days to hairy root emergence (4 days) and the highest number of roots (7) occurred in the treatment combination of root explants inoculated with the MSU440 strain. The highest root dry weight was observed in the treatment combination of leaf microsample and ATCC15834 strain and was 0.2 g. The lowest value (0.02) occurred in the stem microsample and A13 strain. The transgenic nature of hairy roots was confirmed by PCR detection of a part of the rolB gene, while it was not amplified for the natural and non-transgenic roots of the relevant product. In general, the results of this study showed that hairy root induction in Valerian was affected by the explant and bacterial strain, and these results are an important prerequisite for experiments related to hairy root culture with the aim of producing secondary metabolites.

Keywords: molecular analysis, transformation, tissue culture, valerian



Evaluation of the Apoptotic and Cytotoxic Effects of Selected Methanolic and Ethanolic Medicinal Plant Extracts on Cancer Cells

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Abstract

This study evaluates the cytotoxic effects of plant-derived extracts as potential alternatives to conventional cancer therapies. Methanolic and ethanolic extracts from *Catharanthus roseus*, *Melia azedarach*, *Berberis integerrima*, *Mahonia fortunei*, and *Betula pendula* were tested on cell lines of KB, HeLa, G292, U87-MG, A431, and MCF-7 and a normal line of HGF-1 using MTT assay and flow cytometry. The non-liposomal methanolic extract of *C. roseus* showed the highest cytotoxicity (~96%) against MCF-7 cells. Liposomal *M. azedarach* extract demonstrated over 80% cell death in cancer cells, primarily inducing apoptosis and causing G0/G1 cell cycle arrest. Extracts from *B. integerrima* and *M. fortunei* also promoted apoptosis but exhibited significant toxicity toward normal HGF-1 cells. In contrast, *B. pendula* extract effectively induced apoptosis in KB cells with minimal toxicity to normal cells. Results suggest that plant extracts, especially in liposomal form, have significant potential to selectively induce apoptosis in cancer cells, with liposomal *M. azedarach* emerging as a promising candidate for further development in combination cancer therapies. Selectivity and low toxicity toward normal cells are critical for their therapeutic potential.

Keywords: Cancer, medicinal plants, apoptosis, encapsulation, liposome, cytotoxicity.



Biotechnological Enhancement of Medicinal Properties in *Chrysanthemum* sp. Callus Through Salicylic Acid Elicitation

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Abstract

Elicitors are biological or chemical compounds that stimulate plant defense responses and significantly enhance the production of secondary metabolites. Salicylic acid (SA) is one of the important elicitors that activates defense pathways, leading to increased synthesis of bioactive compounds such as phenolics, flavonoids, and antioxidants. *Chrysanthemum* sp., as an important ornamental and medicinal plant, contains valuable antioxidant compounds. Plant tissue culture provides a suitable platform to study the effects of SA on the production of these compounds. In this study, chrysanthemum seeds were sterilized and cultured on MS medium. After growth, leaf explants were used for callus induction on a medium containing 2 mg/L BAP and 2 mg/L 2,4-D under light conditions. Salicylic acid elicitor was added to the medium at concentrations of 0, 50, 100, and 150 μ M. Total phenolic content, flavonoid content, antioxidant capacity, and anthocyanin levels of callus tissues were measured. Results showed that increasing SA concentration significantly enhanced the production of total phenolics, flavonoids, antioxidants, and anthocyanins. The highest amounts were observed at 150 μ M SA. These increases indicate the regulatory role of SA in activating metabolic and genetic pathways related to bioactive compound synthesis. The findings suggest that salicylic acid as an elicitor can improve the medicinal quality of chrysanthemum by boosting secondary metabolite production and antioxidant activity. This study provides an effective strategy to enhance bioactive compound production in *Chrysanthemum* sp. tissue culture.

Keywords: medicinal plant, secondary metabolite, callus culture, plant tissue culture technology



بررسی اثر دارویی منتول روغن نعناع بر سرطان پروستات و شناسایی ژن-های کلیدی موثر در درمان

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چکیده

سرطان پروستات در حال حاضر شایع‌ترین سرطان و دومین علت مرگ ناشی از سرطان است. شناسایی ژن‌های دخیل در پیشرفت بیماری و بهره‌گیری از درمان‌های هدفمند ژنتیکی در نمونه‌های تیمار شده توسط گیاهان دارویی همچون منتول روغن نعناع در سرطان پروستات با استفاده از آنالیزهای بیوانفورماتیکی، افق‌های جدیدی را در جهت ژن درمانی و بهبود داروهای مورد استفاده بیماران گشوده است. از این رو در این مطالعه داده‌های میکروآرایه مربوط به اثر درمانی منتول روغن نعناع حل شده در اتانول بر سرطان پروستات در غلظت 0/1 درصد با استفاده از کشت سلول‌های PC-3 و تیمار آن‌ها در 3 تکرار و با استفاده از ابزار GEO2R آنالیز شدند. تحلیل شبکه پروتئینی ژن‌ها و تجزیه و تحلیل مسیرهای عملکردی با استفاده از ابزارهای بیوانفورماتیکی انجام شد. آنالیز داده‌های میکروآرایه نشان داد که منتول روغن نعناع تغییرات قابل توجهی در بیان ژن‌های مرتبط با التهاب، مهاجرت سلولی و مسیرهای بقاء ایجاد می‌کند. شناسایی ژن‌های کلیدی افزایش بیان یافته همچون PTGS2، IL6 و SERPINE1 به عنوان نقاط اتصال مشترک بین مسیرهای التهابی و تهاجمی، این فرضیه را تقویت می‌کند که منتول می‌تواند به عنوان یک ترکیب دارویی مؤثر در کنار سایر عوامل، در طراحی درمان‌های هدفمند برای سرطان پروستات مورد استفاده قرار گیرد. همچنین دو ژن IL1A و PTGS2 به عنوان ژن‌های کلیدی کاهش بیان یافته با پاسخ التهابی مرتبط بوده و می‌تواند نقش مهمی در مهار مسیرهای بقاء سلولی داشته باشد و فرصت مناسبی برای توسعه درمان‌های ژنتیکی نوین فراهم کند.



Application of plant secondary metabolites in nanobiotechnology: Synthesis of green nanoparticles with multifunctional anticancer and antibacterial properties

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Abstract:

Plant secondary metabolites have attracted the attention of researchers as natural reducing and stabilizing agents in the synthesis of metal nanoparticles. This review article systematically reviews the latest advances in the synthesis of green nanoparticles using plant secondary metabolites and their multiple applications in the medical field. Studies show that compounds such as alkaloids, flavonoids, terpenoids, and polyphenols found in plant extracts are able to convert metal ions into stable nanoparticles. This green synthesis method has significant advantages over conventional chemical methods, including biocompatibility, low cost, and the absence of toxic substances. Investigation of the biological properties of these nanoparticles has shown that they have anticancer effects through various mechanisms, such as induction of apoptosis, inhibition of angiogenesis, and production of reactive oxygen species. They also exhibit significant antibacterial activity against antibiotic-resistant pathogens. Challenges in this field include precise control of the size and morphology of nanoparticles, increasing their stability under physiological conditions, and a better understanding of their mechanisms of action. However, the high potential of these nanoparticles in the development of multifunctional drugs and targeted drug delivery systems makes them a promising option in medical nanobiotechnology. This systematic review emphasizes the importance of using plant secondary metabolites in the development of smart nanomaterials with medical applications and discusses the future prospects of this research area.

Keywords: Secondary metabolites, nanobiotechnology, drug delivery



بررسی ویژگی‌های ساختاری و عملکردی پلی‌ساکاریدهای زیست فعال برخی از گیاهان دارویی ایران

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چکیده

پلی‌ساکاریدها به عنوان اجزای کلیدی گیاهان دارویی، نقش مهمی در سلامت انسان و درمان بیماری‌ها ایفاء می‌کنند. این ترکیبات ساختار پیچیده‌ای دارند که عملکردهای بیولوژیکی متنوعی از جمله فعالیت ضد التهابی، ضد اکسایشی، تنظیم متابولیسم و تقویت سیستم ایمنی را شامل می‌شود. ایران به دلیل تنوع بالای گیاهان دارویی، منبع غنی پلی‌ساکاریدهایی با ویژگی‌های ساختاری و عملکردی منحصر به فرد است. در این مقاله، مروری جامع بر ویژگی‌های ساختاری پلی‌ساکاریدهای استخراج شده از گیاهان دارویی مهم ایران ارائه شده است. نتایج این مطالعه می‌تواند راهنمایی ارزشمند برای تحقیقات آینده و توسعه فرآورده‌های دارویی طبیعی مبتنی بر پلی‌ساکاریدهای گیاهی باشد.

کلمات کلیدی: پلی‌ساکاریدها، گیاهان دارویی، ایران، ترکیبات ضد اکسایش، ضد التهاب



Effects of Hydroalcoholic Extract of *Nigella sativa* on the Fertility indicators of Type 1 Diabetic Mice

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Abstract

Studies have shown that the function of the reproductive system is impaired under the influence of diabetes. In this study, the effect of hydroalcoholic extract of *Nigella sativa* (black seed) on sperm quality and fertility indices in male mice with type 1 diabetes was investigated. In this experimental study, 25 male mice with an average weight of 26 ± 2 g were randomly divided into five groups of five mice each: Group 1 received normal saline and served as the control group. Group 2 was the diabetic control group and received normal saline as well. Groups 3, 4, and 5 were diabetic mice treated with hydroalcoholic extract of *Nigella sativa* at doses of 50, 100, and 200 mg/kg, respectively. Key sperm health parameters were then evaluated. Administration of the hydroalcoholic extract of *Nigella sativa* at doses of 100 and 200 mg/kg significantly increased the sperm count and the percentage of live sperm in the cauda epididymis. A significant reduction was also observed in sperm DNA damage, sperm immaturity, and malondialdehyde (MDA) levels, along with an increase in serum testosterone levels ($P < 0.05$). The findings indicate that the hydroalcoholic extract of *Nigella sativa* improves sperm fertility parameters and fertility potential in diabetic male mice.

Keywords: Diabetes, *Nigella sativa*, NMRI mice, Fertility indices, Oxidative stress



بررسی اثرات فارماکولوژیکی گیاهان دارویی بر بیماری های التهابی مزمن

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چکیده

زمینه: بیماری های التهابی مزمن، نظیر آرتریت روماتوئید، بیماری های التهابی روده و پسوریازیس، از مهم ترین علل ناتوانی و کاهش کیفیت زندگی در سطح جهان هستند. مکانیسم های پاتوفیزیولوژیک این بیماری ها اغلب با فعال سازی مسیرهای التهابی، ترشح بیش از حد سیتوکین ها و استرس اکسیداتیو همراه است. در دهه های اخیر، استفاده از گیاهان دارویی به دلیل دارا بودن ترکیبات فعال زیستی نظیر فلاونوئیدها، فنولیک ها، تریپن ها و آلکالوئیدها، به عنوان گزینه ای مکمل یا جایگزین در مدیریت این بیماری ها مورد توجه پژوهشگران قرار گرفته است.

هدف: این مطالعه با هدف مرور و تحلیل شواهد موجود در مورد اثرات فارماکولوژیکی گیاهان دارویی و ترکیبات فعال آن ها بر مکانیسم های التهابی مرتبط با بیماری های التهابی مزمن انجام شد.

روش: جستجوی نظام مند در پایگاه های بین المللی (PubMed)، (Web of Science)، (Scopus)، (ScienceDirect) و پایگاه های فارسی (SID)، (Magiran) با کلیدواژه های فارسی و انگلیسی مرتبط با "گیاهان دارویی"، "التهاب مزمن" و "اثرات فارماکولوژیک" انجام گرفت. مقالات منتشر شده بین سال های ۲۰۱۰ تا ۲۰۲۵ که به بررسی اثرات ضدالتهابی گیاهان دارویی در مدل های سلولی، حیوانی یا کارآزمایی های بالینی پرداخته بودند، وارد مطالعه شدند.

یافته ها: نتایج مرور نشان داد که گیاهانی همچون *Curcuma longa* (کورکومین)، *Zingiber officinale* (زنجبیل)، *Rosmarinus officinalis* (روزمری) و *Camellia sinensis* (چای سبز) با مهار مسیرهای NF- κ B و MAPK، کاهش بیان COX-2 و iNOS، و تعدیل ترشح سیتوکین های التهابی نظیر TNF- α و IL-6، اثرات ضدالتهابی قابل توجهی نشان می دهند. شواهد بالینی نیز اثرات بهبوددهنده در علائم بیماران مبتلا به آرتریت روماتوئید، کولیت اولسراتیو و پسوریازیس را تأیید کرده اند، هرچند محدودیت هایی از جمله تنوع دوز و فرمولاسیون و کمبود کارآزمایی های بالینی با کیفیت بالا مشاهده شد.

نتیجه گیری: گیاهان دارویی و ترکیبات فعال آن ها با مکانیسم های چندگانه، پتانسیل بالایی در تعدیل فرآیندهای التهابی مزمن دارند و می توانند به عنوان مکملی ایمن و مؤثر در کنار درمان های رایج استفاده شوند. با این حال، نیاز به مطالعات بالینی تصادفی شده با طراحی دقیق برای تعیین دوز بهینه، ایمنی بلندمدت و اثربخشی بالینی ضروری است.

واژگان کلیدی: گیاهان دارویی، التهاب مزمن، اثرات فارماکولوژیک، ترکیبات فعال زیستی، مکانیسم ضدالتهاب، بیماری های التهابی.



Biochemical Behavior of Peroxidase in Different Physiological Growth Conditions of *Solanum lycopersicum* in Response to Cysteine and Glycine

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Abstract

Tomato (*Solanum lycopersicum*), as a model plant in the Solanaceae family, is highly valued for its nutritional, genetic, and physiological traits. Under biotic and abiotic stress conditions, reactive oxygen species (ROS), such as hydrogen peroxide (H_2O_2), accumulate and damage cellular structures. Ascorbate peroxidase (APX) plays a crucial role in maintaining redox balance by converting H_2O_2 into water through the ascorbate-glutathione cycle. This study aimed to investigate the kinetic behavior and thermal stability of APX in three developmental stages of tomato (immature, ripe, and post-storage) and to evaluate the effects of two inhibitors, cysteine and glycine. Samples were prepared, homogenized, and centrifuged, and the crude extract was used to measure enzyme activity. APX activity was assessed by monitoring the decrease in absorbance at 290 nm, and data were analyzed using statistical tests. Results showed that the maximum reaction rate (V_{max}) increased progressively from the immature to the ripe and post-storage stages, indicating the plant's response to elevated oxidative stress during development. The decrease in Michaelis constant (K_m) reflected enhanced substrate affinity and catalytic efficiency under stress conditions. The type of inhibition varied with developmental stage; cysteine exhibited stronger inhibition due to its thiol group, suggesting a regulatory role in redox balance, while glycine showed milder effects. The optimal temperature for APX activity also shifted depending on growth stage and inhibitor presence, indicating structural adaptation of the enzyme to environmental conditions. These findings highlight the regulatory role of APX in antioxidant defense and its potential application in postharvest stress management.

Keywords: *Solanum lycopersicum*, Kinetics, peroxidase, Cysteine, Glycine



Evaluation of the antimicrobial properties of ethanolic extracts of plant wastes (black tea leaves, orange peel, and green walnut husk) on pathogenic bacteria in-vitro

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Abstract

Nowadays, due to the preference of consumers for organic products free of chemical additives, natural antibacterial compounds have received more attention. The increasing awareness of the negative effects of chemical preservatives has led to more research on the antimicrobial effect of plant essential oils and their potential for use as preservatives. The aim of this study was to investigate the antimicrobial effects of extracts from black tea leaves, orange peel and green walnut husk extracts on two pathogenic bacteria, *Pseudomonas aeruginosa* and *Escherichia coli*. This study was conducted on a total of 20 strains of pathogenic bacteria, *E. coli* (10) and *P. aeruginosa* (10), with diverse clinical origins. After drying and powder preparation, ethanolic extracts (70%) were prepared from plant wastes (black tea leaves, orange peel, and green walnut husk) by maceration method. To measure the antimicrobial effects of the extracts (at a concentration of 50 mg/mL), the Kirby-Bauer disk diffusion method was used in Mueller-Hinton agar medium and MIC and MBC were determined in Mueller-Hinton broth and Mueller-Hinton agar medium, respectively. The maximum and minimum diameters of the inhibition zones for black tea leaves, orange peel, and green walnut husk at a concentration of 50 mg/ml were 5-19, 6-17 and 8-15 mm for *P. aeruginosa* strains, and 10-19, 6-15, and 8-16 mm for *E. coli* strains, respectively. The results obtained from the MIC and MBC assays showed that, after 24 h of treatment of the strains, the minimum growth inhibitory concentration (MIC) for both bacteria was 12.5 mg/mL, and the minimum bactericidal concentration (MBC) of the extracts in both bacteria was 25 mg/mL. The results report the significant antibacterial effect of the investigated plant extracts against the infection-causing bacteria, *E. coli* and *P. aeruginosa*. These extracts, after conducting standard clinical tests, can be candidates for the production of pharmaceutical supplements.

Keywords: black tea leaves, orange peel, green walnut shell, medicinal plants, antimicrobial



Sustainable Conservation of Genetic Diversity and Medicinal Plant Species through Gene Bank: An Evaluation of Natural Ecosystems in Bushehr Province

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Abstract

The accelerating degradation of natural resources, including water, soil, and native or endemic plant species, poses a serious threat to biodiversity and ecological security. The conservation of medicinal plant genetic resources, particularly those at risk of extinction, remains one of the major challenges in sustainable natural resource management. This study aimed to evaluate the effectiveness of a gene bank in conserving the genetic resources of medicinal plants within the natural ecosystems of Bushehr Province, Iran. Seed samples were obtained from natural habitats in accordance with the standards of the International Seed Testing Association (ISTA) and the International Plant Genetic Resources Institute (IPGRI). Following the assessment of germination capacity, physical purity, seed moisture content, and thousand-seed weight, the samples were stored in the gene bank under controlled conditions. The results revealed that the highest species diversity was found in the families Apiaceae, Poaceae, Asteraceae, Brassicaceae, Papilionaceae, and Lamiaceae. The main threats identified were land-use change and habitat destruction (such as road construction and the expansion of oil and gas industries), unauthorized and unsustainable harvesting, as well as intentional and unintentional wildfires. Overall, the findings confirm the effectiveness of gene banks as a scientific and practical approach for conserving the genetic resources of medicinal plants and threatened species and they highlight the need to expand such programs to other regions of the country.

Keywords: gene bank, genetic resources, medicinal plants, plant biodiversity, sustainable natural resource management



Biotechnological Assessment of *Malva sylvestris* in hydroponic Systems: Insights into Medicinal Plant Resilience

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Abstract

Malva sylvestris L. is a medicinal and rangeland species widely distributed across semi-arid ecosystems, known for its pharmacological properties and ecological resilience. As a perennial herbaceous plant, it plays a vital role in maintaining biodiversity and soil stability in degraded rangelands. Given its inherent plasticity in developmental pathways and stress tolerance, *M. sylvestris* serves as a promising model for exploring morphogenetic and cytological responses under abiotic stress. Hydroponic cultivation systems offer a controlled environment to investigate the plant's cellular and developmental dynamics under drought conditions, minimizing external variables and enhancing reproducibility. This promotional study aims to highlight the adaptive morpho-anatomical traits and developmental plasticity of *M. sylvestris* when exposed to water deficit in hydroponic systems. Observations suggest alterations in meristematic activity, modulation of cell cycle progression, increased cuticular deposition, and reduced parenchymal cell volume—indicative of drought-induced developmental reprogramming. The integration of hydroponics with developmental biology not only facilitates sustainable production of medicinal plants but also reduces anthropogenic pressure on natural rangelands. Furthermore, the ability of *M. sylvestris* to maintain cellular integrity and functional morphology under stress underscores its potential for biotechnological applications and climate-resilient agriculture. Promoting hydroponic cultivation of rangeland medicinal species like *M. sylvestris* can bridge the gap between ecological conservation and modern phytopharmaceutical production. This approach aligns with sustainable resource management and offers a viable pathway for enhancing medicinal plant yield, quality, and resilience in water-limited environments.

Keywords: Sustainable development, Plant biotechnology, Biological resource management, Rangeland ecology, Controlled-environment production

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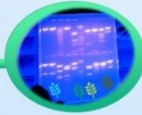
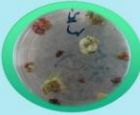
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Medicinal Plants: A Scientific Odyssey from Traditional Remedies to 21st-Century Therapeutics

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Abstract

Medicinal plants have underpinned traditional healthcare systems worldwide for millennia (Julián-Flores et al., 2025). Recent comprehensive reviews highlight the ability of plant metabolites to act against gastrointestinal disorders and to modulate host inflammatory responses (Julián-Flores et al., 2025). Plant-derived compounds are also being revisited as solutions to antimicrobial resistance because of their multi-target mechanisms and synergy with conventional drugs (El-Saadony et al., 2025). Contemporary systems and synthetic biology approaches permit detailed mapping and heterologous production of plant natural-product pathways, improving supply and enabling pathway optimization (Qin et al., 2025). Artificial intelligence and computational chemistry accelerate metabolome annotation, activity prediction, and *in silico* prioritization of phytochemical leads (Varghese et al., 2025). Targeted experimental studies demonstrate that seeds and leaves of long-used species yield peptide and small-molecule leads with antimicrobial, anti-inflammatory, and anticancer potential (Ismoil et al., 2025; Saha et al., 2025). Integrating ethnobotanical knowledge with omics, AI, and synthetic biology creates an efficient pipeline for turning traditional remedies into 21st-century therapeutics (Varghese et al., 2025; Qin et al., 2025).

Keywords: medicinal plants, phytochemicals, antimicrobial resistance, gastrointestinal



Early Growth Response of (*Artemisia dracunculus* L.) to Methanol Application and Growing Medium under Drought Stress

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Abstract

To evaluate the effects of wood alcohol application and planting substrate on the early growth of tarragon (*Artemisia dracunculus* L.) under different drought stress conditions, a greenhouse experiment was conducted at Torbat Heydarieh University during 2024–2025. The study was arranged as a three-factor factorial experiment based on a completely randomized design with three replications. Treatments included wood alcohol application at two levels (no application and application), planting substrate at two levels (sandy–light soil and clay–heavy soil), and drought stress at three irrigation intervals (every 2, 4, and 6 days). Results indicated that drought stress significantly reduced germination traits and early growth parameters. Wood alcohol improved most germination and growth characteristics, although it had no significant effect on germination percentage. The best growth performance was observed in light soil with irrigation every 2 and 4 days, with no significant difference between them. The highest leaf number, shoot fresh and dry weight, and plant height were obtained from wood alcohol application combined with irrigation every 2 days in loamy soil. Furthermore, wood alcohol application in heavy soil alleviated the negative impacts of drought stress. Overall, the findings suggest that wood alcohol can be recommended as a management strategy to mitigate drought stress and enhance the early growth of tarragon in arid and semi-arid regions.

Keywords: early growth, germination, wood alcohol, planting substrate



Effect of Wood Alcohol on Germination and Growth Parameters of Lemon Balm (*Melissa officinalis*) under Drought Stress and Different Soil Textures

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Abstract

Drought stress is one of the main limiting factors for growth and yield of medicinal plants, and the use of natural compounds to enhance plant resistance is essential. This study evaluated the effect of wood alcohol application on seed germination and early growth of lemon balm (*Melissa officinalis*) under different soil textures and irrigation regimes in 2025. The experiment was conducted as a three-factor factorial design including wood alcohol application (absence and presence), soil type (light/sandy and heavy/clay), and irrigation interval (every 2, 4, and 6 days) with three replicates. Results showed that drought significantly reduced germination and early growth parameters. Application of wood alcohol improved germination rate, shoot length, leaf number, and fresh and dry biomass. The highest growth was observed in light soil with 2- and 4-day irrigation intervals, with no significant difference between them. In heavy soil, wood alcohol mitigated the negative effects of drought and enhanced early plant growth. The findings indicate that wood alcohol can increase plant resistance under drought stress conditions. In addition to improving early growth, it may also enhance the final yield of lemon balm. This study confirms the effectiveness of wood alcohol as a useful tool in sustainable cultivation of medicinal plants.

Keywords: drought stress, light soil, heavy soil



Evolution and Disjunction of Species in the Genus *Pterocarya* in Iran and the World

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Abstract

The Hyrcanian Forests in northern Iran, remnants from the Tertiary geological period, are recognized as one of the most significant biological regions in Iran and the world. The genus *Pterocarya*, belonging to the Juglandaceae family, reproduces sexually through *P. rhoifolia* and asexually via *P. fraxinifolia*. *Pterocarya fraxinifolia* (Poir.) Spach, known scientifically, is a deciduous, light-loving species that primarily grows at elevations ranging from 20 to 1200 meters along riverbanks. This species is found in regions such as the Caucasus, Turkey, Georgia, Azerbaijan, and Iran. To date, 15 species of the genus *Pterocarya* have been documented globally, with five out of six species present in East Asia (Vietnam, China, Korea, and Japan). In Iran, only *P. fraxinifolia* grows naturally in three northern provinces: Gilan, Mazandaran, and Golestan, with a small population also found in the western provinces of Lorestan and Ilam. The most stable habitats for this species are located in the Caucasus, while the highest genetic diversity is observed in the Hyrcanian region. Research indicates that this genus became extinct in Europe during the mid-Miocene due to climatic and geological conditions but expanded into the Caucasus region thereafter. The leaf extract of the wingnut has antimicrobial, antifungal, and therapeutic properties for breast cancer, stomach diseases, intestinal worms, skin and hair problems, and hair dyeing.

Keywords: Caucasus, Genetics, Hyrcanian Forest, Wingnut



The Study of Genetic Diversity and Haplotype Network of *Dionysia cespitosa* Using ITS sequencing and Morphological Traits

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Abstract

Dionysia cespitosa (Primulaceae), one of the endemic species of the Zagros Mountain, Iran, is classified into three subspecies (ssp. *bolivari*, ssp. *cespitosa*, ssp. *isophylla*). Internal Transcribed Spacer sequences (ITS) were used to assess the genetic diversity and haplotype network among 7 populations of *D. cespitosa*. The results showed an average haplotype diversity (0.93) and nucleotide diversity (0.00923) with 25 unique haplotypes. Additionally, haplotype network showed that population 1 (Hap_1) likely represents an ancestral lineage shared among populations. Morphological results illustrated that in principal component analysis (PCA), the first four components had eigenvalues greater than one (4.5, 2.1, 1.5, and 1.3, respectively), explaining a total of 68.80% of the diversity among the quantitative traits, with plant height, bract width, and corolla length being the most significant.

Keywords: *Dionysia*, Genetic diversity, ITS sequencing, Morphology



Multi-Omics Modeling of Immune Pathways Induced by Shiitake Mushroom AHCC in the Sustained Clearance of HPV Using the Nucleotide Transformer

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Abstract:

Human papillomavirus (HPV) persistence is linked to dysregulation of interferon (IFN) pathways, where IFN- γ plays a key role in antiviral and antitumor immunity by coordinating NK cells, T cells, and antigen-presenting cells (Barrat et al., 2019; Bhat et al., 2018; Castro et al., 2018). Clinical studies show that Active Hexose Correlated Compound (AHCC), a shiitake mushroom extract, supports HPV clearance by enhancing both innate and adaptive immunity (Smith et al., 2022), modulating dendritic and regulatory T cell function (Chowdhury et al., 2019), and promoting Th1-biased, IFN- γ -driven responses (Dea-Ayuela et al., 2020). Additionally, AHCC's effects may extend to PD-1/PD-L1 checkpoint regulation, influencing viral clearance versus immune evasion (Gao et al., 2018; Sun et al., 2018). Collectively, evidence suggests that AHCC fosters a favorable immune environment for HPV elimination. In this study, we employed an advanced bioinformatics pipeline integrating transcriptomics, metabolomics, and immunomics datasets to construct a predictive framework for identifying key immune pathways activated in response to AHCC. Promoter sequences of immune-related genes were extracted and analyzed using the Nucleotide Transformer genomic language model to uncover structural and regulatory features influencing gene expression under treatment versus control conditions. Subsequently, deep learning algorithms and network-based pathway analyses were applied to integrate multi-omics data, revealing candidate genes and central hubs within IFN- γ signaling, NK cell activation, and PD-1/PD-L1 immune checkpoint pathways. Our modeling results suggest that AHCC enhances antiviral immunity against HPV by modulating the expression of critical genes associated with Th1-biased immune responses. This work not only provides novel insights into the molecular immunomodulatory mechanisms of shiitake-derived AHCC in HPV clearance but also establishes a data-driven framework for developing next-generation adjuvant therapies based on medicinal mushrooms.

Keywords: HPV, Shiitake, AHCC, Bioinformatics, Nucleotide Transformer, Antiviral Immunity, Deep Learning

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شناسایی و بررسی غلظت عناصر موجود در گیاه دارویی مارچوبه (*Asparagus officinalis*) با استفاده از آزمون ICP

-پویا طاهرخانی

گروه ژنتیک و به نژادی گیاهی ، واحد تاکستان ، دانشگاه آزاد اسلامی ، تاکستان ، ایران

2-فرزان طاهری

گروه ژنتیک و به نژادی گیاهی ، واحد تاکستان ، دانشگاه آزاد اسلامی ، تاکستان ، ایران

3-علی عمارلو

پژوهشکده فناوری های نوین زیستی دانشگاه زنجان ، زنجان ، ایران

چکیده:

مارچوبه با نام علمی *Asparagus officinalis* L. var. *altilis* از خانواده Asparagaceae می باشد. گیاه مارچوبه هم به صورت تازه و یا خشک در انواع غذاها و هم به عنوان یک داروی گیاهی مفید در طب آسیایی و اروپایی استفاده می شود. یونانی ها در قدیم به عنوان سبزی از آن استفاده می کردند ، اما در واقع رومی ها اولین افرادی بودند که عملیات زراعی برای کشت مارچوبه را توسعه دادند و دستورالعمل کاشت آن را نوشتند. مارچوبه دو نوع ساقه هوایی دارد ، یکی ساقه هایی است که مصرف خوراکی داشته و برگ ندارد و دوم ساقه هوایی است که دارای برگ بوده و غیر خوراکی است. نام اسید آمینه آسپاراژین از آسپاراگس، نام لاتین مارچوبه گرفته شده است زیرا مارچوبه از نظر این اسید آمینه بسیار غنی است. مارچوبه بومی نواحی معتدل بوده و یک گیاه فصل خنک می باشد. مارچوبه یکی از گیاهان دارویی و خوراکی ارزشمند است که به دلیل دارا بودن ترکیبات فعال و عناصر معدنی مختلف، توجه پژوهشگران بسیاری را به خود جلب کرده است. در این پژوهش، غلظت عناصر معدنی در بخش های مختلف گیاه مارچوبه (ریشه، ساقه، میوه نارس و میوه رسیده) با استفاده از آزمون طیفسنجی پلاسمای جفت شده القایی (ICP) مورد بررسی قرار گرفت. نتایج نشان داد که عناصر پرمصرف مانند سیلیسیم (Si) ، پتاسیم (K) ، منیزیم (Mg) ، سدیم (Na) و فسفر (P) در غلظت های بالا در اندام های مختلف تجمع یافته اند. همچنین ریزمغذی هایی مانند آهن (Fe) ، روی (Zn) ، منگنز (Mn) و مس (Cu) نیز در مقادیر قابل توجهی وجود داشتند. در مقابل، عناصر سنگین و بالقوه سمی نظیر سرب (Pb) ، کادمیم (Cd) و جیوه (Hg) در غلظت های بسیار پایین حضور داشتند. نتایج نشان داد که ریشه گیاه بیشترین توانایی تجمع عناصر را دارد، در حالی که میوه ها غنی از عناصر با ارزش تغذیه ای مانند Mg و Zn هستند. این یافته ها می تواند در توسعه کشت و کاربرد دارویی و تغذیه ای مارچوبه مؤثر باشد .

کلمات کلیدی: مارچوبه ، طیفسنجی پلاسمای جفت شده القایی (ICP) ، امنیت غذایی-دارویی ، عناصر گیاهی.



A review of research related to secondary metabolites in the medicinal plant asparagus

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Abstract :

Medicinal plants, as rich natural sources of bioactive compounds, hold a prominent place in both traditional and modern medicine. Secondary metabolites are compounds that do not play a direct role in plant growth but provide diverse medicinal properties for humans. Asparagus (*Asparagus officinalis*), due to its content of flavonoids, steroidal saponins, sulfur compounds, and phenolic acids, has attracted the attention of researchers. These compounds are distributed in different parts of the plant and exhibit antioxidant, anticancer, anti-inflammatory, and antimicrobial effects. The aim of this article is to provide a comprehensive review of the studies conducted on the secondary metabolites of asparagus and to examine their role in the medicinal effects and potential applications of this plant.

Keywords: Asparagus, Secondary metabolites, Flavonoids, Saponins, Phenolic compounds, Pharmacy



A review of the medicinal properties of purple violet and white violet: chemistry, pharmacology, clinical evidence, and research perspectives

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Abstract

The genus *Viola*, with more than 500 species, is rich in valuable secondary metabolites such as flavonoids, anthocyanins, coumarins, saponins, alkaloids, mucilage, and cyclotides (highly stable cyclic peptides). *Viola odorata* (purple violet) is one of the best-known medicinal plants of this genus and has been used in traditional Iranian medicine and other traditional systems for respiratory, skin, fever, headache, and insomnia diseases, and a significant portion of these uses are now supported by laboratory and clinical data. In contrast, there is less direct pharmacological evidence for *Viola alba* (white violet), but phytochemical data and measurements of its antioxidant and phenolic capacity, including reports from Iranian populations, point to its therapeutic potential. This article systematically reviews the literature, compares the two species, and summarizes the possible mechanisms of action, pharmaceutical forms, safety considerations, and knowledge gaps.

Keywords: Violet purple, Violet white, Medicinal properties, Plant compounds, Secondary metabolite



Analysis of the Elements Present in Purple Violet and White Violet Medicinal Plants Using ICP Testing

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Abstract

The demand for herbal medicines is increasing. Mineral elements play an important role in the formation of active substances in medicinal plants. The aim of the present study is to investigate the elements present in two medicinal plant species, purple and white violet. In this study, 28 mineral elements were quantitatively determined by atomic absorption spectrometry from the roots, stems, and flowers of purple and white violet. The distribution of mineral elements among different organs was analyzed using one-way analysis of variance. The results show that the total content of Al, Fe, K, Mg, Mn, Na, P elements in all parts of purple violet and the elements Mg, K, Al, Si, Na, and Mn in all parts of white violet has the highest values. Analysis of variance showed significant changes in the content of mineral elements in different organs of violet species ($P < 0.05$). According to the analysis of variance, the concentration of each element varied significantly among different plant parts ($P < 0.05$). These results showed that there are large differences in the use of elements between different tissues of violet. The detection and analysis of characteristic elements, as a scientific basis, provides the possibility of quality control for medicinal violet. Considering the ease of growth of medicinal violet in different regions and the diversity in the type of secondary metabolites and active ingredients, this potential can be effectively exploited in the pharmaceutical industry.

Keywords: medicinal plants, mineral elements, purple violet, white violet.



Identification and investigation of the concentration of elements in the medicinal plant asparagus using ICP testing

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Abstract

Asparagus, scientifically known as *Asparagus officinalis* L. var. *altilis*, is a member of the Asparagaceae family. The asparagus plant is used both fresh and dried in a variety of dishes and as a useful herbal medicine in Asian and European medicine. The Greeks used it as a vegetable in ancient times, but in fact the Romans were the first to develop agricultural practices for asparagus cultivation and write instructions for its cultivation. Asparagus has two types of aerial stems, one is the edible stems that do not have leaves, and the second is the aerial stem that has leaves and is inedible. The name of the amino acid asparagine is taken from asparagus, the Latin name for asparagus, because asparagus is very rich in this amino acid. Asparagus is native to temperate regions and is a cool-season plant. Asparagus is one of the valuable medicinal and edible plants that has attracted the attention of many researchers due to its active compounds and various mineral elements. In this study, the concentration of mineral elements in different parts of the asparagus plant (root, stem, unripe fruit and ripe fruit) was investigated using inductively coupled plasma (ICP) spectroscopy. The results showed that essential elements such as silicon (Si), potassium (K), magnesium (Mg), sodium (Na) and phosphorus (P) accumulated in high concentrations in different organs. Also, micronutrients such as iron (Fe), zinc (Zn), manganese (Mn) and copper (Cu) were present in significant amounts. In contrast, heavy and potentially toxic elements such as lead (Pb), cadmium (Cd) and mercury (Hg) were present in very low concentrations. The results showed that the plant root has the greatest ability to accumulate elements, while the fruits are rich in nutritionally valuable elements such as Mg and Zn. These findings can be effective in developing the cultivation and medicinal and nutritional applications of asparagus.

Keywords: asparagus, inductively coupled plasma (ICP) spectroscopy, food-pharmaceutical safety, plant elements



Comparative Analysis of Phenolic Profiles and Biological Activities in Three Lamiaceae Species (*Rosmarinus officinalis* L., *Mentha piperita* L. and *Ocimum basilicum* L.) Using HPLC and HPTLC

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Abstract

The Lamiaceae family includes numerous aromatic herbs with significant ethnomedicinal value, largely due to their rich phenolic and flavonoid composition. In this study, the phenolic profiles and biological properties of *Rosmarinus officinalis* L., *Mentha piperita* L., and *Ocimum basilicum* L. were systematically compared. Botanical authentication was conducted through macroscopic and microscopic analyses and confirmed by herbarium registration. Spectrophotometric assays confirmed the presence of high levels of phenolic and flavonoid compounds. Advanced chromatographic techniques, including High-Performance Liquid Chromatography (HPLC) and High-Performance Thin-Layer Chromatography (HPTLC), were applied to characterize phytochemical markers. Rosmarinic acid was identified as a major constituent in all three species, while menthol and rutin were prominent in *M. piperita*, and *O. basilicum* was particularly enriched in eugenol and other phenolic derivatives. These compounds are recognized for their potent antioxidant, antimicrobial, and antifungal properties. Biological activity screening revealed that all three herbs exhibited strong antioxidant potential as demonstrated by free radical scavenging assays. Furthermore, antimicrobial and antifungal evaluations highlighted the effectiveness of *R. officinalis* L. and *O. basilicum* L. against bacterial and fungal strains, while *M. piperita* L. displayed moderate inhibitory activity. Safety evaluations based on heavy metal and pesticide residue analyses confirmed compliance with international standards. This comparative investigation emphasizes the importance of phytochemical profiling and bioactivity assessment in Lamiaceae plants, supporting their integration into standardized phytopharmaceuticals for antioxidant and antimicrobial applications.

Keywords: Medicinal plants, Comparative analysis, HPLC.



Antifungal Potential of Olive Leaf Extract (*Olea europaea* L.): Natural Compounds Against Pathogenic Fungi

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Abstract

Olive (*Olea europaea* L.) leaf is a promising reservoir of secondary metabolites, particularly polyphenols and flavonoids—well-known for their antioxidant and therapeutic properties. The alarming rise in fungal infections and the limited efficacy of existing antifungal drugs, intensified by increasing resistance, pose a serious threat to global health. These challenges have intensified interest in natural products, particularly those derived from medicinal plants, as safer and more sustainable therapeutic alternatives. Olive leaves, a commonly discarded by-product of the olive industry, are rich in polyphenolic compounds with documented antioxidant, anti-inflammatory, and antimicrobial properties (Markhali et al., 2020; Borjan et al., 2020). This study presents a preliminary investigation into the antifungal efficacy of olive leaf extract, with the aim of assessing its potential for use against pathogenic fungi. Dried olive leaves were subjected to ethanolic extraction using 80% ethanol at room temperature, followed by phytochemical screening. The total phenolic content was determined using the Folin–Ciocalteu assay, confirming a high abundance of phenolic constituents (Borjan et al., 2020). Antifungal activity was evaluated using the agar well diffusion method, targeting clinically relevant fungal strains such as *Fusarium oxysporum* and *Aspergillus niger*. Early observations suggest that the extract can inhibit fungal growth, as indicated by visible inhibition zones around the wells.

Keywords: Olive leaf, Phenolic compounds, Antifungal activity, Natural product



Natural antimicrobial compounds of plant origin (Case study of phytochemical investigation and antimicrobial activity of *Cinnamomum verum* on common pathogenic bacteria in-vitro)

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Abstract

Infectious diseases have always been a major concern for humanity and have continuously attracted the attention of many medical and laboratory professionals. On the other hand, antibiotic treatment leads to other problems such as drug resistance and side effects. The use of new herbal medicines with fewer side effects can be of great help in treating infections. *Cinnamomum verum* is a small, evergreen tree, the bark of which is used as a spice. The aim of this study was to investigate the antimicrobial properties of *C. verum* extract against 4 strains of pathogenic bacteria: *Escherichia coli*, *Klebsiella pneumoniae*, *Staphylococcus aureus*, and *Pseudomonas aeruginosa*. In this study, a hydroalcoholic extract (70% ethanol) was prepared from cinnamon powder at a concentration of 50 mg/mL by maceration. The composition of the active ingredients of the extract was analyzed using gas chromatography-mass spectrometry (GC-MS). The antibacterial effect of the extract and antibiotics gentamicin and tetracycline was investigated by the disk diffusion method (three replicates for each test), and then the average diameter of the growth inhibition zone of the substances released from the disk against the bacteria under study was measured and recorded with a millimeter ruler. The minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) of the extract were calculated by the dilution method. The presence of thymol, naphthalene, and styrene in the *C. verum* extract as the dominant active ingredients was confirmed using GC-MS. The growth inhibition zones of the extract at a concentration of 50 mg/mL against *E. coli*, *K. pneumoniae*, *S. aureus*, and *P. aeruginosa* bacteria in the disk method were measured to be 13, 15, 21, and 16 mm, respectively. *S. aureus* treated with the extract showed the highest inhibition zone with a diameter of 21 mm. *E. coli* strain showed resistance to tetracycline antibiotic; *S. aureus* treated with gentamicin and tetracycline was the most sensitive bacterium to treatment with the antibiotics studied, with the highest inhibition zone diameters, 30 and 35 mm, respectively. In the dilution method, the extract also showed an acceptable growth inhibitory and lethal effect on the tested bacteria. The minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) of cinnamon extract were 6.25 and 12.5 mg/mL, respectively, against *E. coli*, *K. pneumoniae*, and *P. aeruginosa*, and the lowest MIC and MBC were 3.12 and 6.25 mg/mL for *S. aureus*. Based on the results, *C. verum* extract has significant antibacterial properties in vitro, but for clinical applications and prescription as an alternative to synthetic antibiotics, clinical studies are necessary to confirm the antibacterial effects of the extract in vivo.

Keywords: Biological antibiotics, medicinal plants, MIC, MBC



Herbal-Based Nanopharmaceuticals in Cancer Therapy: Innovations and Challenges

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Abstract

Herbal-based nanopharmaceuticals represent a transformative approach in cancer therapy, combining the therapeutic potential of natural compounds with the precision of nanotechnology. This report explores the advancements, challenges, and future directions of these formulations in oncology. Herbal compounds, such as curcumin, quercetin, and resveratrol, exhibit significant anticancer properties but face limitations like poor bioavailability and instability. Nanotechnology addresses these issues by enhancing solubility, stability, and targeted delivery, thereby improving therapeutic efficacy and minimizing systemic toxicity. Key innovations include the development of nanocarriers such as liposomes, nanoparticles, and micelles, which enable controlled drug release and site-specific action. These systems not only improve drug accumulation at tumor sites but also reduce adverse effects on healthy tissues. Furthermore, the integration of diagnostic and therapeutic functions into single nanoscale platforms, known as theranostics, offers promising avenues for personalized cancer treatment. Despite these advancements, challenges such as large-scale production, regulatory hurdles, and potential nanoparticle toxicity remain significant barriers. This report underscores the need for continued research and standardization to fully realize the potential of herbal-based nanopharmaceuticals in revolutionizing cancer therapy.

Keywords: Herbal-based nanopharmaceuticals, nanocarriers, theranostics, cancer therapy



Nanobiotechnology and Plant-Derived Compounds: Advances in Nanoformulations for Therapeutic Applications

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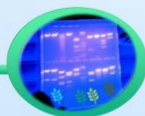
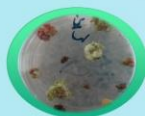
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Abstract

Nanobiotechnology has emerged as a transformative field in drug delivery and therapeutic innovations. The integration of plant-derived phytochemicals with nanocarriers offers a promising approach to enhance bioavailability, stability, and targeted delivery of therapeutic molecules. Herbal extracts and phytochemicals have long been used in traditional medicine, but their poor solubility and rapid metabolism limit their efficacy. Nanocarrier systems, including liposomes, polymeric nanoparticles, and lipid-based nanoparticles, have shown significant potential in overcoming these limitations. This review highlights recent advances (2024–2025) in the application of nanobiotechnology to plant-derived compounds, emphasizing green synthesis approaches, nanoformulations for cancer and chronic diseases, and future prospects in translational medicine. Challenges, including regulatory issues, safety, and large-scale production, are also discussed.

Keywords: Nanobiotechnology; Phytochemicals; Herbal extracts; Nanoformulations; Green synthesis; Drug delivery



A Phytochemical Investigation of *Rydingia persica* Root Extract

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Abstract

Rydingia persica (Lamiaceae) is widely distributed in southern and southeastern Iran. This medicinal plant, which is called Golder in Persian, is traditionally used for its remedial properties, and its aerial parts have been investigated for their phytochemical composition and antidiabetic potential. A literature survey showed that there has been limited phytochemical study on the roots of *R. persica*. This study aimed to extract and identify bioactive compounds from Golder roots through the use of high-performance equipment. A phytochemical investigation of the acetone extract from the roots of this species was undertaken, resulting in the isolation and identification of five natural compounds: beta-sitosterol (1), betulinic acid (2), bongardol (3), daucosterol (4), and its derivative (5). Structural elucidation of these compounds was established by their spectral data, including 1D and 2D NMR experiments.

Keywords: Antidiabetic, Natural compounds, NMR, *Rydingia persica*.



Deep Learning and Multi-Omics Integration for Plant Secondary Metabolic Pathway Prediction

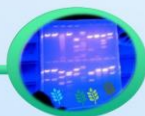
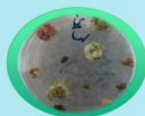
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Abstract

Phytochemical pathway discovery is challenged by the complexity of plant metabolic networks, hindering the development of new natural products. To address this, we comprehensively reviewed databases like PubMed, Google Scholar, and Scopus to examine computational frameworks that integrate deep learning with multi-omics data. The results identified three primary strategies for data integration. Early integration combines all data into a single matrix, which is effective for straightforward prediction but can be challenged by high dimensionality. Intermediate integration seeks a shared, lower-dimensional representation of the data, making it a powerful tool for biological discovery by revealing latent relationships. Late integration analyzes each data type separately before merging the results, a method particularly useful in clinical applications where interpretability is crucial. While these approaches offer a more holistic understanding, they face challenges such as high data dimensionality and heterogeneity, with the most effective strategy ultimately depending on the specific research objective.

Keywords: Bioinformatics, Metabolomics, Natural Product Discovery, Pathway Engineering



The effect of some plant hormones on saffron tissue culture and micro corm production

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Abstract

Saffron (*Crocus sativus* L.) is a triploid and sterile plant that can only be propagated through mother corms. Due to the limitations of natural propagation, the application of tissue culture techniques can provide an effective approach to enhance the multiplication rate of this valuable medicinal plant. In this study, to evaluate the effect of growth regulators on micro corm induction and organogenesis, healthy corms were surface-sterilized and cultured on half-strength MS medium supplemented with 6% sucrose. Hormonal treatments included BAP at concentrations of 0, 2, and 4 mg L⁻¹ and NAA at concentrations of 0 and 1 mg L⁻¹, arranged in a completely randomized design with five replications. The results showed that the treatment containing BAP (4 mg L⁻¹) + NAA (1 mg L⁻¹) produced the highest rate of micro corm formation and sprouting, while the control (hormone-free) treatment exhibited the lowest effect. Furthermore, BAP alone significantly increased the number of shoots, but the combination of BAP and NAA not only enhanced the number of shoots but also significantly improved the diameter and weight of micro corms. Overall, the findings suggest that the combination of BAP (4 mg L⁻¹) and NAA (1 mg L⁻¹) can be considered an effective strategy for in vitro propagation of saffron and the production of vigorous micro corms.

Keywords: Saffron, plant hormone, tissue culture, micro corm.



Comparison of Herbal and Chemical Mouthwashes in Terms of Side Effects and Patient Compliance

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Abstract

Mouthwashes have long been used as adjuncts to toothbrushing and dental flossing for maintaining oral hygiene. The primary objectives of these products are to reduce oral microbial load, prevent dental caries, control gingival inflammation, and prevent periodontal diseases. Chemical mouthwashes, particularly chlorhexidine, are recognized as the gold standard due to their strong antiplaque and antimicrobial effects. However, they have notable limitations, including tooth staining, taste disturbances, dry mouth, and oral mucosal irritation. These adverse effects can lead to reduced patient acceptance, incomplete use, or discontinuation.

Herbal mouthwashes contain compounds derived from various plants, such as green tea, aloe vera, turmeric, clove, and tea tree oil. These compounds possess natural antibacterial, anti-inflammatory, and antioxidant properties, while producing substantially fewer side effects. Additionally, their mild and natural taste enhances patient acceptance and encourages continued use. Studies have demonstrated that regular use of herbal mouthwashes can result in significant reductions in dental plaque and gingival inflammation, with their efficacy in many parameters approaching that of chlorhexidine. A systematic review published in 2024 in the Journal of Clinical Periodontology evaluated 18 randomized clinical trials. The results indicated that herbal mouthwashes can exert effects comparable to chlorhexidine in reducing plaque and gingival inflammation. In some studies, chlorhexidine was slightly more effective, but the difference was not statistically significant. Beyond their antiplaque effects, assessment of gingival inflammation revealed that plant extracts can effectively reduce inflammation and improve clinical indices. Regarding side effects, herbal mouthwashes outperform chemical ones. The most common adverse effects of chlorhexidine include tooth discoloration, bitter or unpleasant taste, and oral mucosal irritation. In contrast, herbal mouthwashes typically report only mild and transient effects, such as slight burning sensations. This contributes to higher patient adherence to herbal products and improved long-term therapeutic outcomes.

Key words: Medicinal plants, Mouthwash, Oral diseases



Investigating the antioxidant and antibacterial properties of orange blossom (*Citrus aurantium*) extract

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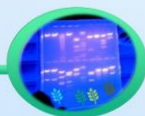
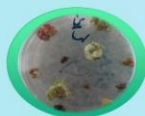
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Abstract

The escalating prevalence of antimicrobial resistance necessitates the exploration of phytochemical alternatives, particularly from *Citrus* species renowned for their bioactive secondary metabolites. *Citrus aurantium* L. flowers represent a valuable botanical resource harboring diverse phenolic compounds with significant biotechnological potential for pharmaceutical applications. This investigation elucidated the antimicrobial and antioxidant efficacies of ethanolic orange blossom (*C. aurantium* flower) extracts through comprehensive in vitro bioassays. Antimicrobial susceptibility was evaluated via well diffusion methodology against five clinically relevant bacterial pathogens: *Escherichia coli*, *Staphylococcus aureus*, *Listeria monocytogenes*, *Streptococcus salivarius*, and *Acinetobacter* spp., with minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) determinations established at 12.5 mg/mL and 25 mg/mL, respectively. Inhibition zone diameters ranged from 10 mm (*E. coli*) to 15 mm (*L. monocytogenes* and *S. salivarius*), demonstrating differential species-specific susceptibility patterns. Radical scavenging capacity was quantified through 2,2-diphenyl-1-picrylhydrazyl (DPPH) assay, yielding an IC₅₀ value of 5.8 mg/mL compared to butylated hydroxytoluene (BHT) standard (0.4 mg/mL), while ferric reducing antioxidant power exhibited 40.67 µmol/L equivalency. The observed bioactivities corroborate the phytochemical complexity inherent to *C. aurantium* floral tissues, attributable to flavonoid glycosides, phenolic acids, and terpenoid constituents that collectively confer antimicrobial and antioxidant properties through multiple mechanistic pathways, including free radical neutralization and membrane integrity disruption. These findings substantiate the biotechnological valorization of *C. aurantium* flowers as a promising source for developing novel antimicrobial and antioxidant formulations, warranting further investigation into bioactive compound isolation, structural elucidation, and mechanistic studies to advance translational applications in pharmaceutical biotechnology.

Keywords: *Citrus aurantium*, orange blossom, antimicrobial resistance, phytochemical bioactivity, secondary metabolites, DPPH radical scavenging, minimum inhibitory concentration, minimum bactericidal concentration



The effect of some plant hormones on lemon tissue culture and micro propagation

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Abstract

Lippia citriodora (lemon verbena) is a medicinal and aromatic plant from the Verbenaceae family, valued for its essential compounds such as citral and limonene, widely used in pharmaceutical, food, and cosmetic industries. Conventional propagation of this plant through seeds and cuttings is limited due to poor rooting and genetic variability; therefore, tissue culture provides an efficient alternative for mass and uniform propagation. In this study, leaf and nodal explants were surface-sterilized and cultured on MS basal medium. For callus induction, treatments containing 2,4-D ($1.0\text{--}2.0\text{ mg L}^{-1}$) combined with BAP (0.5 mg L^{-1}) resulted in vigorous green callus formation. Shoot organogenesis was optimized on MS medium supplemented with BAP ($1.0\text{--}1.5\text{ mg L}^{-1}$) plus NAA (0.1 mg L^{-1}), producing the highest number of shoots (an average of 6.2 shoots per explant). For rooting, IBA ($0.5\text{--}1.0\text{ mg L}^{-1}$) was the most effective treatment, achieving over 80% rooting frequency. Acclimatized plantlets showed a survival rate of more than 70% after transfer to sterile soil under greenhouse conditions. Overall, the results indicate that the combination of BAP and NAA for shoot induction and IBA for rooting are the most effective treatments for in vitro propagation of *Lippia citriodora*, providing a reliable strategy for large-scale and uniform production of this valuable medicinal plant.

Keywords: Lemon, plant hormone, tissue culture, micro propagation



Nanotechnology-Based Formulations of Herbal Products for Improved Oral Health

Samin Amarloo

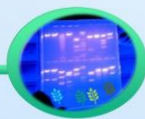
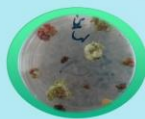
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Abstract

Nanotechnology, as an advanced tool in the development of oral care products, offers new opportunities to enhance the effectiveness of herbal formulations. One of the main challenges in using plant extracts in the oral cavity is their low stability and rapid clearance from the tooth and gingival surfaces. Nanoparticles can protect active phytochemicals, improve their absorption, and provide controlled release, thereby enhancing their antibacterial and anti-inflammatory effects. The use of nanoliposomes and nanoemulsions is considered an effective approach due to their ability to maintain prolonged contact of active compounds with the oral surface. These delivery systems increase the solubility of plant-derived compounds and reduce the need for high doses of active ingredients. Lower dosages minimize potential side effects and improve patient compliance. A 2023 study published in Dental Materials demonstrated that a formulation containing chitosan nanoparticles and green tea extract inhibited the growth of *Streptococcus mutans* by 70% more than a conventional solution. Nanoliposomes have also been employed for the delivery of plant-based antioxidants, resulting in improved antiplaque and anti-inflammatory effects. Beyond enhancing therapeutic efficacy, nanotechnology provides additional advantages, such as improved product stability, better taste and odor, and reduced oral mucosal irritation. Collectively, these benefits lead to higher patient adherence to regular use, ultimately resulting in improved clinical outcomes and greater treatment success.

Key words: Medicinal plants, Oral health, Nano technology.



Micropropagation of the medicinal plant peppermint

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Abstract

Mentha piperita L. (peppermint) is an important aromatic and medicinal plant valued for its essential oils, especially menthol and menthone, which are widely used in pharmaceutical, cosmetic, and food industries. Conventional propagation of peppermint through stolons is limited due to low multiplication rates and risk of disease transmission. Tissue culture techniques provide a reliable alternative for the rapid and large-scale production of healthy and genetically uniform plants. In this study, nodal explants of *M. piperita* were cultured on Murashige and Skoog (MS) medium supplemented with different concentrations of plant growth regulators. Among the tested combinations, MS medium containing 1.0–2.0 mg/L BAP (6-benzylaminopurine) in combination with 0.5 mg/L NAA (α -naphthalene acetic acid) showed the highest shoot induction and multiplication rate. Rooting was achieved on half-strength MS medium supplemented with 0.5 mg/L IBA (indole-3-butyric acid), resulting in a high frequency of root formation. The regenerated plantlets were successfully acclimatized in greenhouse conditions with a survival rate exceeding 85%. The results confirm that in vitro culture of peppermint is an efficient method for mass propagation, germplasm conservation, and future genetic improvement programs.

Keywords: *Mentha piperita*, micropropagation, tissue culture



The Pharmacology and Therapeutic Potential of *Salvia* Species: Phytochemical and Clinical Evidence

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Abstract

The genus *Salvia* (sage) has transitioned from a traditional remedy to a focus of systematic pharmacological research. This review integrates current knowledge of its chemistry, dominated by terpenoids and phenolics, and the pharmacology attributable to those constituents. Across diverse experimental systems, *Salvia* extracts most consistently attenuate inflammation and oxidative stress, often by modulating NF- κ B-driven signaling and activating the Nrf2 axis to strengthen endogenous defenses. These same pathways plausibly underlie preclinical signals of neuroprotection, anticancer activity, and metabolic regulation. By contrast, the clinical literature remains limited and methodologically heterogeneous, with small samples and nonstandardized extracts. Progress now depends on rigor: chemically characterized products, harmonized dosing, and adequately powered, preregistered trials to enable a fair test of *Salvia*'s therapeutic value rather than an assumption of benefit.

Keywords: *Salvia*; phytochemistry; terpenoids; phenolics; NF- κ B; Nrf2; pharmacology; clinical trials; standardization



Enhancing spearmint (*Mentha spicata* L.) Essential Oil Quality: Role of Drought Stress and Harvest Time in Secondary Metabolite Modification

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Abstract

Environmental management plays a key role in optimizing the production of phytochemical compounds, especially essential oils. This study investigated the effects of drought stress and harvest time (I and II) on the concentration of secondary metabolite compounds in spearmint (*Mentha spicata* L.). The results showed that, in comparison between harvest times, compounds such as β -pinene (53.85% decrease) and limonene (10.76% decrease) declined in harvest II, while sabinene increased by 25.93%. Under drought stress, the concentrations of 1,8-cineole (110.20% increase) and germacrene-D (187.61% increase) rose significantly under severe stress, indicating a plant defense response. However, carvone decreased by 17.09% under severe stress, likely due to limited energy resources. The interaction between stress and harvest time revealed that germacrene-D increased more in harvest I under severe stress (360.53%) compared to harvest II (100%), whereas β -pinene sharply declined in harvest II under severe stress (89% decrease). The findings suggest that optimal stress management (moderate level) and proper harvest timing can enhance essential oil quality and the production of valuable compounds, which is important for industrial and agricultural applications.

Keywords: Carvone, GC-MS analysis, Metabolic profiling, Monoterpenes, Sesquiterpenes



بررسی خواص دارویی و زیست فناوریانه ترافل سیاه ایرانی: ظرفیت های ناشناخته قارچ های دنبل کوهی

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چکیده:

قارچ های دنبل کوهی (Tuber spp.) به عنوان منابع طبیعی غنی از ترکیبات زیست فعال، توجه فزاینده ای در پژوهش های زیست فناوریانه به خود جلب کرده اند. گونه بومی Tuber brumale در ایران، علی رغم پراکندگی جغرافیایی و پتانسیل زیستی بالا، نسبت به گونه های شناخته شده اروپایی مانند T. melanosporum، T. magnatum و T. aestivum کمتر مورد بررسی قرار گرفته است. در این مطالعه مروری ساختاریافته، اطلاعات مرتبط با ترکیبات شیمیایی و فعالیت های زیستی گونه های مذکور، با تمرکز بر مطالعات منتشر شده از سال ۲۰۰۰ تا ۲۰۲۴، از پایگاه های PubMed، Scopus، Web of Science و ScienceDirect گردآوری و تحلیل شدند. استخراج ترکیبات عمدتاً از طریق تکنیک هایی مانند GC-MS، HPLC و FTIR صورت گرفته و آزمون های زیستی همچون مهار رادیکال DPPH، مهار نیتریک اکسید و بررسی های ضد میکروبی مبنای ارزیابی قرار گرفتند. نتایج نشان داد T. brumale حاوی مقادیر قابل توجهی از ترکیباتی نظیر اسکوالن، فنول ها، اسیدهای چرب غیر اشباع و مولکول های فرار بوده و در برخی سنجش های زیستی، عملکردی برابر یا حتی فراتر از گونه های اروپایی داشته است. این یافته ها نشان دهنده ظرفیت بالقوه این گونه در توسعه فرآورده های دارویی، مکمل های طبیعی و سامانه های زیست فناوریانه است. با این حال، نیاز به مطالعات تکمیلی با روش شناسی پیشرفته، آنالیز دقیق تر ترکیبات منفرد، بررسی سمیت و زیست دسترس پذیری، و ارزیابی صنعتی شدن کاربردهای این گونه، همچنان احساس می شود.

واژه های کلیدی: Tuber brumale، قارچ دنبل کوهی، ترکیبات زیست فعال، فعالیت زیستی، فرآورده طبیعی، GC-MS



Valorization of olive oil processing by-products through the recovery of bioactive phenolic compounds: Evaluation and comparative analysis of antioxidant assays (DPPH, ABTS, and FRAP)

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Abstract

Extraction and purification of polyphenolic compounds from agricultural wastes, especially olive pomace, have been the subject of increasing scientific interest owing to the potent antioxidant, anti-inflammatory, and antimicrobial activities of these compounds. The overall health-promoting activity of olive phenolic components is well established. Over the past few years, the biological activities of two compounds isolated, namely oleuropein and hydroxytyrosol, have been defined with particular emphasis on their antioxidant activity (1). Of the several methods available, resin-based separation—more specifically, with macroporous resins—has been shown to be a very efficient methodology for selective adsorption, enrichment, and purification of polyphenols owing to their large surface area, chemical inertness, and preference for phenolic moieties (2). Molecularly imprinted resins display a high selectivity in separating target phenolic compounds like hydroxytyrosol and oleuropein, enhancing their bioavailability for food and pharmaceutical applications (3). In this study, the extract from olive oil waste was enriched for major phytochemical constituents by using macroporous resins. One of the resins was selected for its optimum efficiency in the enrichment and purification process, and adsorption–desorption of polyphenols was then optimized both under static and dynamic conditions. In the subsequent steps, crucial parameters like type of resin, concentration of sample loading, adsorption/desorption times, and solvent conditions were systematically optimized. These optimizations led to a reproducible and highly efficient protocol for the recovery of polyphenols, in consonance with earlier reports on the effectiveness of macroporous resin-based separation techniques. The antioxidant activity of the crude extract and the enriched fraction was determined using DPPH, ABTS, and FRAP assays. The results indicated that both fractions had a significant free radical scavenging capacity, with the enriched fraction showing higher activity. Furthermore, based on the lipophilic nature of certain antioxidant constituents present in olive fruit, it was observed that the DPPH assay showed higher sensitivity and effectiveness in detecting antioxidant activity compared to the other methods employed.

Keywords: Polyphenols, Olive pomace, Resin-based extraction, Sustainable valorization
Natural antioxidants

Address of the secretariat: Research Institute of Modern Biological Techniques
University of Zanjan, Iran- Postal code: 4537138791
<http://ic-bmpm.znu.ac.ir/2025>



بررسی ویرایش ژنوم گوجه فرنگی (*Solanum lycopersicum*) با استفاده از فناوری CRISPR و تأثیر آن بر بهبود طعم و اندازه میوه

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چکیده

ویرایش ژنوم گوجه‌فرنگی با استفاده از فناوری CRISPR/Cas9 امکان اصلاح دقیق ژن‌های مرتبط با کیفیت، طعم و اندازه میوه را فراهم کرده است. این فناوری بهبود مسیرهای بیوشیمیایی مرتبط با ترکیبات طعم‌دهنده مانند لیکوپن و کاروتنوئیدها را امکان‌پذیر می‌کند. همچنین، اصلاح ژنتیکی برای افزایش اندازه و عملکرد محصول از طریق بهینه‌سازی رشد و توسعه میوه مورد بررسی قرار گرفته است. علاوه بر این، CRISPR/Cas9 در بهبود مقاومت گوجه‌فرنگی در برابر تنش‌های محیطی مانند خشکی، شوری و بیماری‌ها نقش دارد. روش‌های نوین مانند ویرایش پایه‌ای و پرایم ادیتینگ دقت اصلاح ژنتیکی را افزایش داده‌اند. این فناوری نه تنها موجب افزایش بهره‌وری کشاورزی می‌شود، بلکه امکان اصلاح سریع و دقیق صفات مطلوب را فراهم می‌کند. استفاده از CRISPR/Cas9 در اصلاح ژنتیکی گوجه‌فرنگی می‌تواند تأثیر قابل توجهی بر بهبود کیفیت و پایداری محصولات کشاورزی داشته باشد. مطالعات نشان داده‌اند که تغییرات در مسیرهای بیوشیمیایی مرتبط با میزان قند و اسیدهای آلی می‌تواند منجر به تولید گوجه‌فرنگی‌هایی با طعم شیرین‌تر و مطلوب‌تر شود. همچنین، ویرایش ژن‌های تنظیم‌کننده رشد، مانند *KNL2*، تأثیر قابل توجهی بر اندازه و وزن میوه داشته است.

واژه‌های کلیدی: CRISPR/Cas9، اصلاح ژنتیکی، بهره‌وری کشاورزی، افزایش اندازه، ویرایش ژنوم



کشت گیاهان دارویی در استان گیلان: مروری بر وضعیت، گونه‌ها، توسعه و برنامه‌های آموزشی

Cultivation of medicinal plants in Guilan Province: A review of the status, species, development and educational programs

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چکیده

گیاهان دارویی، به عنوان یکی از مهم‌ترین منابع تأمین مواد اولیه صنایع داروسازی، غذایی، آرایشی و بهداشتی، جایگاهی ویژه در کشاورزی پایدار و اقتصاد مقاومتی دارند. این گیاهان، به واسطه خواص درمانی و دارویی منحصر به فرد، نه تنها در ارتقای سلامت جامعه مؤثرند، بلکه با ایجاد فرصت‌های شغلی و افزایش درآمد کشاورزان، سهم قابل توجهی در توسعه مناطق روستایی و تحقق اهداف اقتصادی ایفا می‌کنند. استان گیلان، واقع در شمال کشور، به دلیل موقعیت جغرافیایی ممتاز، تنوع اقلیمی و خاک حاصلخیز، از ظرفیت بالایی برای کشت، پرورش و بهره‌برداری از گونه‌های بومی و وارداتی گیاهان دارویی برخوردار است. این مقاله مروری با هدف ارائه تحلیلی جامع از وضعیت کشت گیاهان دارویی در گیلان، به بررسی پیشینه تاریخی استفاده از این گیاهان، معرفی مهم‌ترین گونه‌های دارویی کشت‌شده یا خودرو، تحلیل شرایط اکولوژیک و زیست‌محیطی مؤثر بر رشد و تولید آن‌ها، بررسی روندها و راهبردهای توسعه کشت و فرآوری محصولات، و ارزیابی برنامه‌های آموزشی و ترویجی اجرا شده برای توانمندسازی کشاورزان و فعالان این حوزه می‌پردازد. در پایان، با جمع‌بندی یافته‌ها، چالش‌ها و فرصت‌های پیش‌رو به منظور ارتقای جایگاه استان گیلان در صنعت گیاهان دارویی مورد بحث و بررسی قرار می‌گیرد.



Quantitative and Qualitative Analysis of Tannin Content in Leaf Extracts of a Native *Campanula* Species from the Eskou Region Using Different Solvents

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Abstract

Campanula species, commonly known as bellflowers, are recognized for their rich phytochemical profile and traditional medicinal applications. This study investigates the total tannin content of leaf extracts from a native *Campanula* species collected in the Eskou region of East Azerbaijan, Iran. Four solvents—distilled water, 1% hydrochloric acid, 80% ethanol, and 80% methanol—were used for extraction, employing both soaking and boiling methods. Qualitative tests (Ferric chloride and 10% sodium hydroxide) confirmed the presence of tannins, particularly hydrolyzable forms in acidic and alcoholic extracts. Quantitative analysis using the Folin–Ciocalteu method revealed significant variation in tannin yield across solvents, with acidic and methanolic extracts showing the highest concentrations. These findings highlight the influence of solvent type on tannin extraction efficiency and suggest potential applications of *Campanula* leaf tannins in pharmaceutical and cosmetic formulations.

Keywords: Tannin, *Campanula*, Solvent, Phytochemical analysis



Prediction of the effect of thidiazuron, kinetin and BAP on callus induction, somatic embryogenesis and regeneration of *Hyoscyamus niger* by Box-Behnken design

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Abstract

Hyoscyamus niger, a notable medicinal plant from the Solanaceae family, serves as a valuable source of the alkaloids hyoscyamine and scopolamine. This research utilized the Box-Behnken design within the response surface methodology to determine and forecast the ideal concentrations of TDZ, BAP, and kinetin for achieving callus formation and regeneration through somatic embryogenesis using leaf and petiole explants. The petiole explant was selected for the percentage of callusing and number of shoots, and the leaf explant was selected for callus fresh weight and percentage of shooting prediction. The callusing percentage varied between 20.00% and 100%, while the fresh weight of callus ranged from 70.08 mg per explant to 1287.08 mg per explant. The somatic embryogenesis percentage spanned from 40.00% to 100%, with the shooting percentage falling between 50.00% and 100%. Additionally, the number of shoots per callus ranged from 1.00 to 8.50. The R² values were as follows: 86.80% for the callusing percentage, 74.47% for the fresh weight of callus, 79.20% for the somatic embryogenesis percentage, 78.40% for the shooting percentage, and 97.01% for the number of shoots. The best conditions for maximizing the percentage of callusing (100%) were predicted by culturing the petiole explant on the MS medium containing 0.11 mg/L TDZ and 1.253 mg/L BAP. The highest callus fresh weight (3273.64 mg/explant) was predicted by culturing the leaf explant on MS medium containing 0.52 mg/L TDZ. The highest percentage of somatic embryogenesis (100%) was predicted by culturing the petiole explant on MS medium supplemented with 0.533 mg/L TDZ and 1 mg/L BAP or MS medium containing 1.159 mg/L TDZ and 3 mg/L BAP. The best conditions for maximizing the percentage of shooting (100%) were predicted by culturing of leaf explant on MS medium with 0.18 mg/L TDZ and 2.89 mg/L BAP. It is predicted that the highest number of shoots was obtained by culturing the petiole explant on MS medium with 0.1 mg/L TDZ and 3 mg/L BAP (8.61 shoots per callus).

Keywords: Callusing, Henbane, Regeneration, Response surface methodology, TDZ

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Bioinformatics analysis of cis-regulatory elements in the promoter of the Geranyl Pyrophosphate: olivetolate geranyltransferase (GOT) gene and its relationship with the regulation of the cannabinoid biosynthesis pathway in cannabis (*Cannabis sativa* L.)

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Abstract

The cannabis plant (*Cannabis sativa* L.) has attracted research attention due to its potential to produce valuable secondary metabolites, such as cannabinoids. The gene Geranyl Pyrophosphate: olivetolate geranyltransferase (GOT) encodes a key enzyme in the biosynthesis pathway of these compounds. In this study, the GOT gene was retrieved from the UniProt database and aligned to the cannabis genome using BLASTP (E-value $\leq 1e-5$, coverage $\geq 80\%$). A 2000-bp upstream region of the transcription start site (TSS) for each variant was extracted using the BioMart tool in Ensembl Plants and analyzed in the PlantCARE database to identify cis-regulatory elements. In total, 14 regulatory elements were identified and classified into four groups: 1) hormone-responsive elements (ABA, SA, auxin, and gibberellin), 2) abiotic stress-responsive elements (drought, light, and wounding), 3) function-specific elements (seed regulation, defense, and stress), and 4) structural elements (core promoter, MYBHv1 binding, and protein binding). The results revealed that GOT1, dominated by core promoter elements, plays a fundamental role in transcription initiation, whereas the variants GOT2, GOT3.1, and GOT3.2 exhibit more dynamic expression in response to stimuli due to the abundance of promoter/enhancer elements. The co-occurrence of hormone- and abiotic stress-responsive elements confirms the role of these genes in environmental adaptation and growth regulation. The identification of seed-specific elements also suggests their involvement in critical developmental stages. These findings were visualized using TBtools software and represent a key step toward understanding the regulatory mechanisms underlying the biosynthesis of secondary metabolites such as THCV and CBDV, which hold significant potential for medical applications.

Keywords: Cannabis sativa, cis-regulatory elements, GOT gene, cannabinoids, PlantCARE

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بررسی تنوع ژنتیکی در برخی از ژنوتیپ های جنس کاسنی (Cichorium spp.) با استفاده از نشانگرهای مولکولی ISSR

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چکیده

کاسنی گیاهی چند ساله و علفی و یکی از مهمترین گیاهان خانواده Asteraceae با خواص دارویی متعدد می-باشد. بنابراین مطالعات تنوع ژنتیکی روی گیاه دارویی کاسنی به منظور شناسایی هرچه بیشتر ژرم پلاسما این گونه و همچنین بهره‌برداری از تنوع ژنتیکی آن در برنامه‌های به نژادی و اصلاح نباتات یک ضرورت است. مطالعه حاضر جهت بررسی تنوع ژنتیکی ژنوتیپ های مختلف کاسنی با استفاده از نشانگر ISSR در گلخانه و آزمایشگاه بیوتکنولوژی دانشگاه شهرکرد انجام شد. در این مطالعه در مجموع 26 ژنوتیپ ایرانی و خارجی (24 خارجی و 2 ایرانی) از کاسنی Cichorium که شامل 14 ژنوتیپ از گونه C.intybus و 12 ژنوتیپ از گونه C.indivia می باشند استفاده شد. بذور از بانک ژن IPK کشور آلمان و شرکت پاکان بذر اصفهان تهیه شدند. آزمایش در دو مرحله ی عملیات کشت در گلخانه جهت نمونه برداری از برگ-های جوان برای استخراج DNA و آزمایش های مولکولی در آزمایشگاه صورت گرفت. در تحقیق حاضر 10 آغازگر ISSR در مجموع 193 باند تولید کردند که همگی چند شکل بودند. محدود PIC بین 0/43 (UBC809) تا 0/49 (UBC880) با مقدار میانگین 0/45 متغیر بود. در بررسی کلی آماره های تنوع ژنتیکی از جمله تعداد آل موثر و مشاهده شده، هتروزیگوسیتی مورد انتظار و مشاهده شده و تنوع ژنی نی مشخص شد که از بین 10 آغازگر مورد بررسی آغازگرهای UBC880 و ISSR1 مقادیر بالاتری را به خود اختصاص دادند و در تمایز ژنوتیپ ها نقش بارزتری را ایفا نمودند. مطالعه گروه بندی جمعیت ها نشان داد که با توجه به آماره های ارزیابی شده از بین دو جمعیت مورد بررسی جمعیت اول مقادیر بالاتری را برای PPL، NPL، He، I، Na، به خود اختصاص داد. ضریب همبستگی تشابه تطابق ساده بین ژنوتیپ ها در محدود 0/42 تا 0/67 مشاهده شد. تجزیه خوشه ای صفات مولکولی با استفاده از الگوریتم COMPLETE انجام شد و ژنوتیپ های کاسنی در دو گروه اصلی توزیع شدند و هر خوشه نیز به دو زیرگروه تقسیم شد و تفکیک ژنوتیپ ها از نظر نوع گونه کامل بود اما از نظر منشاء جغرافیایی کامل نبود. تجزیه به مولفه های اصلی سه گروه را مشخص نمود به طوری که سه مولفه اول در مجموع 86/24 درصد از واریانس کل را توجیه نمودند که نتایج خوشه ای را تایید کرد. نتایج تجزیه واریانس مولکولی (AMOVA) نشان داد که تنوع افراد درون جمعیت ها بیشتر از تنوع بین جمعیت ها می باشد و بنابراین بهتر است در برنامه های اصلاحی کاسنی به منظور انتخاب والدین مناسب انتخاب درون جمعیت ها صورت پذیرد.

کلمات کلیدی: آستراسه، گیاه دارویی، نشانگر مولکولی



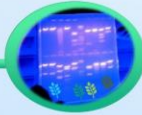
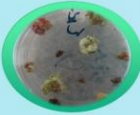
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ارزیابی صفات مرتبط با جوانه زنی در برخی ژنوتیپ-های کاسنی در شرایط تنش خشکی

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چکیده

کاسنی از گیاهان دارویی محسوب می-شود که دارای کاربردهای پزشکی بسیاری می باشد. به نظر می رسد مطالعات جامعی بر روی تنوع ژنتیکی و واکنش به انواع تنش-ها در ژنوتیپ های کاسنی صورت نگرفته است. مطالعه حاضر به منظور بررسی صفات مرتبط با جوانه زنی 26 ژنوتیپ کاسنی در شرایط تنش خشکی انجام شده است. نتایج تجزیه واریانس صفات مربوط به جوانه زنی نشان داد که اثر تنش خشکی روی تمام صفات مورد ارزیابی در سطح احتمال 0/01 معنی دار بود. طبق نتایج حاصل از مقایسه میانگین سطوح مختلف خشکی و ژنوتیپ های مورد بررسی، صفات درصد جوانه زنی، وزن ریشه چه، وزن ساقه چه، طول ریشه چه، طول ساقه چه و شاخص بنیه بذر در همه سطوح خشکی نسبت به شاهد به طور معنی-داری کاهش یافتند و ژنوتیپ های CICH503 و CICH IR2 بیشترین مقدار درصد جوانه زنی را به خود اختصاص دادند. تجزیه همبستگی در مطالعه حاضر با استفاده از ضریب پیرسون انجام شد و طبق آن در شرایط نرمال تمام صفات محاسبه شده با هم همبستگی معنی داری در سطح احتمال 0/01 داشتند و در این شرایط بیشترین همبستگی (98٪) بین صفت طول ریشه چه با درصد جوانه زنی و وزن ریشه چه و صفت شاخص بنیه بذر با درصد جوانه زنی و طول ساقه چه مشاهده شد اما در شرایط تنش خشکی بیشترین همبستگی (98٪) بین صفت وزن ریشه چه با درصد جوانه زنی و کمترین (61٪) آن بین طول ساقه چه با طول ریشه چه مشاهده شد. با توجه به نتایج تجزیه به مولفه های اصلی در شرایط نرمال سه مولفه اول توانستند 98٪ از تغییرات کل واریانس را توجیه کنند و در شرایط تنش خشکی تجزیه به مولفه های اصلی 8 صفت مورد ارزیابی را به 3 مولفه تقلیل و بر اساس آن 97٪ از تغییر کل داده ها را توجیه کرد. مقایسه بای پلات در شرایط نرمال و تنش خشکی نشان داد که ژنوتیپ های CICH IR2 و CICH28, CICH462, CICH104, CICH57 از نظر تحمل به خشکی برتر از سایر ژنوتیپ ها می باشند. همچنین مولفه اول دارای حساسیت پایین به تنش خشکی می باشد و مولفه دوم حساس به تنش خشکی است. تجزیه خوشه ای به روش ward انجام شد و طبق آن در هر دو شرایط نرمال و تنش ژنوتیپ ها به سه خوشه تقسیم شدند و ژنوتیپ های خوشه سوم نسبت به سایر خوشه ها در برابر خشکی مقاوم تر هستند. با توجه به تنوع بالا از نظر تحمل به تنش خشکی در ژنوتیپ-های مورد بررسی می توان از این ژرم پلاسما جهت انتخاب ژنوتیپ-های برتر و همچنین انتخاب ژنوتیپ-ها با حداکثر فاصله ژنتیکی جهت استفاده در برنامه-های به-نژادی استفاده کرد.

کلمات کلیدی: کاسنی، تنش غیر زیستی، ریشه-چه، ساقه-چه، تنوع ژنتیکی



Evaluation of Genetic Variation in Some Genotypes of *Foeniculum vulgare* Using ISSR and IRAP Molecular Markers

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Abstract

Fennel (*Foeniculum vulgare* L.) is one of the oldest and most important medicinal plants belonging to the Apiaceae family, widely used in traditional medicine. The present study was carried out to identify genetic diversity in 20 different genotypes of *F. vulgare* L. using 5 inter-simple sequence repeat (ISSR) molecular markers and 5 inter-retrotransposon amplified polymorphism (IRAP), collected from different geographical regions of the world. The exotic genotypes were obtained from the Leibniz Institute of Plant Genetics and Crop Plant Research (IPK). Native landraces were purchased from Pakan Bazr Com., Isfahan, Iran. Leaf DNA was extracted and purified, and the quality and quantity of the samples were confirmed using gel electrophoresis and spectrophotometry. PCR amplification of DNA fragments with ISSR and IRAP primers was performed, and the products were separated by agarose gel electrophoresis. The results showed that the average number of observed alleles (N_a) for both ISSR and IRAP markers was 2. The maximum number of effective alleles in ISSR markers (1.69) was obtained with the UBC808 primer, while the maximum in IRAP markers (1.69) was related to the NIKITA primer. The mean Shannon index was estimated as 0.50 for ISSR and 0.51 for IRAP, indicating that IRAP markers had slightly higher discriminatory power for fennel genotypes. The highest observed heterozygosity (H_o) in ISSR (0.40) was related to the UBC808 primer, while in IRAP (0.42) it was obtained with the K001 primer. The polymorphic information content (PIC) for ISSR loci ranged from 0.26 to 0.42 (mean = 0.37), with the highest value related to ISSR2 (0.42). For IRAP loci, PIC values ranged from 0.28 to 0.41 (mean = 0.32), with the maximum related to the SUKKULA primer (0.41). The mean PIC values for ISSR and IRAP markers were 0.37 and 0.32, respectively, confirming the higher efficiency of ISSR. The effective multiplex ratio (EMR) averaged 16 for ISSR and 9.80 for IRAP. The marker index (MI), calculated based on polymorphic bands, averaged 5.89 for ISSR and 3.17 for IRAP, with the maximum MI recorded for ISSR11 and K001 primers, respectively. Cluster analysis grouped the fennel genotypes into seven clusters based on ISSR and IRAP data, which were partially confirmed by principal coordinate analysis (PCoA). Overall, these findings demonstrate the presence of substantial genetic diversity among fennel genotypes worldwide and suggest that both ISSR and IRAP markers are effective tools for studying genetic variability in this species.

Keywords: Cluster analysis, Fennel, Genetic variation, Molecular markers



ارتباط قارچ دارویی *Ganoderma lucidum* با ارتفاع از سطح دریا در جنگل خیرود نوشهر

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چکیده

قارچ گانودرما لوسیدوم با نام علمی *Ganoderma lucidum* معروف به قارچ جاودانگی یا لینگ-ژی است. اکولوژی این قارچ بصورت پارازیت بر روی درختان سرپا و ساپروفیت بر روی خشک-دار و شاخه-های افتاده می-باشد. قارچ جاودانگی یکی از شناخته-شده-ترین قارچ-های دارویی در جهان می-باشد. ترکیبات دارویی اغلب از پلی-ساکاریدهایی از *Ganoderma* در درمان دیابت نوع 2 و هیپاتیت ثابت شده است. شناسایی قارچ-های دارویی که نقش مهمی در تامین نیازهای غذایی جامعه دارند و می-توانند در حفظ سلامت و درمان بسیاری از بیماری-ها متاثر باشند. هدف از این پژوهش شناسایی قارچ-*Ganoderma lucidum* دارویی در جنگل-های خیرود نوشهر و ارتباط آن با عامل اکولوژیک ارتفاع از سطح دریا می-باشد. این بررسی در سه طبقه ارتفاعی 0 تا 400 متر، 400 تا 800 و 800 تا 1200 متر از سطح دریا انجام شد و شناسایی قارچ-های گانودرما از طریق مرفولوژی انجام شد. نتایج نشان داد که بیشترین پراکنش در ارتفاعات 800 تا 1200 متر از سطح دریا بوده است که به ترتیب از طبقه ارتفاعی 0 تا 400 متر 12 درصد، در طبقه ارتفاعی 400 تا 800 متر 38 درصد و در طبقه ارتفاعی 800 تا 1200 متر از سطح دریا 50٪ پراکنش داشته است. همچنین وضعیت درختان نشان داد که 62 درصد قارچ های گانودرما لوسیدوم بر روی درختان سرپا و 38 درصد بر روی درختان افتاده زیست می-کردند که نشان می-دهد از لحاظ اکولوژی، بیشتر پارازیت است. بررسی اکولوژی قارچ-ها ما را در شناخت بهتر بوم سازگان جنگل کمک می-کند.

واژه های کلیدی: قارچ جاودانگی، دارو، بوم شناسی، اکولوژی



Regression relationship between saffron safranal content with soil parameters and planting management along with the use of bacterial biofertilizers

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Abstract

Saffron stigma (*Crocus sativus* L.) contains an important metabolite called safranal, which plays an important role in its marketability and medicinal properties. The level of this metabolite can be influenced by ecological conditions and farm management. This study investigates how bacterial biofertilizer composition and soil physicochemical parameters jointly affect safranal content in saffron. In this research, various scientific studies on the effect of different types of bacteria on saffron safranal content were collected and reviewed from 2000 onward, and data on biofertilizer characteristics (genus, number of species, bacterial concentration), soil properties (pH, electrical conductivity, organic matter), fertilization regimes (animal and chemical), and year of cultivation after treatment were extracted. Multiple regression analysis was performed using SAS software to quantify the relationships between these factors and stigma safranal level. The regression results showed that the most effective factors in increasing safranal content when using bacterial biofertilizers were the number of bacterial species in the biofertilizer and the percentage of organic matter, whose regression coefficients were 0.41 and 0.38, respectively. Among the soil parameters and management factors, manure application and pH had the least effect and a negative relationship with stigma safranal content, with coefficients of -0.57 and -0.45, respectively. Overall, the results of this study showed that increasing microbial diversity in bacterial biofertilizers and organic matter in the soil can increase safranal production, while alkaline conditions and excessive manure inhibit the biosynthesis of terpenoids such as safranal.

Keywords: Saffron, Safranal, Bacterial biofertilizer, Regression, Meta-analysis



Regression relationship between saffron crocin content with soil parameters and planting management along with the use of bacterial biofertilizers

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Abstract

Saffron (*Crocus sativus* L.) is a high-value crop whose commercial and medicinal quality is largely determined by its apocarotenoid composition, especially crocin. The use of sustainable agricultural practices, such as the use of bacterial biofertilizers, can be effective and helpful in increasing the crocin content of saffron. In this study, data from several studies since 2000 on the effects of bacterial biofertilizers on saffron crocin, such as bacterial genus and species, soil type, electrical conductivity, pH, organic matter content, number of years after treatment, use of animal and chemical fertilizers, application rate, and concentration of bacterial inoculum were obtained. Regression analysis was performed using SAS software to quantify the relative effect of these factors on crocin content. The results showed that the percentage of soil organic matter was the most effective factor in increasing crocin content (regression coefficient = 0.39), along with the use of bacterial biofertilizers, such that each 1% increase in organic matter was associated with an 11% increase in crocin content. Bacterial species diversity (0.37) and manure application (0.35) also significantly increased crocin levels. In contrast, the number of years after treatment showed a negative relationship (-0.49), indicating a 7% annual decrease in the effectiveness of the biofertilizer. These results emphasize the importance of enriching soil organic matter, using a diverse bacterial population, and judicious use of manure, along with the renewal of biofertilizers and organic fertilizers in consecutive years after cultivation, to maintain the qualitative yield of saffron, especially the amount of the important and valuable metabolite crocin.

Keywords: Saffron, Crocin, Bacterial biofertilizer, Regression, Meta-analysis



ترجیح میزبانی قارچ *Fomes fomentarius* و ارتباط با قطر برابر سینه درختان

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چکیده

قارچ *Fomes fomentarius* معروف به قارچ سم‌آسبی یا آتش‌زنه می‌باشد و کلاهک آن تا قطر 52 سانتی‌متر رشد می‌کند و بسیار ضخیم و سخت است و در زیستگاه خود به صورت تک یا چندتایی بر روی تنه درختان سرپا و افتاده زیست می‌کند. در برخی منابع این قارچ، برای بند آوردن خون، مورد استفاده دندان‌پزشکان و جراحان در گذشته استفاده شده است. هدف از این پژوهش شناسایی قارچ *Fomes* در جنگل‌های خیرود نوشهر و ارتباط آن با فاکتورهای قطر برابر سینه و وضعیت درخت می‌باشد. نتایج نشان داد این قارچ، از قطر برابر سینه 14 سانتی‌متر تا قطر برابر سینه 180 سانتی‌متر پراکنش داشته است. همچنین نتایج نشان داد این قارچ در تمام فصول سال در جنگل‌های شمال مشاهده می‌گردد و بیشتر بر روی درختان ممرز، بلندمازو و راش رشد می‌نماید. نکته مهم این پژوهش نشان داد بیش از 90 درصد قارچ *Fomes* بر روی درختان سرپا پراکنش داشته است که نقش پارازیتی آن را نشان می‌دهد.

واژه های کلیدی: قارچ آتش‌زنه، قطر برابر سینه، پاییز



The effect of *Plantago major* extract on the inhibition of tet A and tet B gene expression in multidrug-resistant *Escherichia coli*

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Abstract

Today, drugs processed from medicinal plants are a worthy alternative to chemical drugs as biological innovations in the field of medicine. Plantain or greater plantain with the scientific name *Plantago major* L. is from the Plantaginaceae family, which has about 265 species worldwide. About 60 secondary metabolites have been identified from plantain, including flavonoids, alkaloids, terpenoids, phenolic compounds (caffeic acid derivatives), iridoid glycosides, fatty acids, polysaccharides, and vitamins. In this study, the effect of its hydroalcoholic extract under drought stress on the inhibition and expression of resistance-related genes in multidrug-resistant *Escherichia coli* (MDR) was investigated using different concentrations of plantain extract. The bacteria collected were Bacillus and Gram-negative. Disk diffusion data showed that 10 out of 12 bacterial samples showed resistance to the clindamycin and vancomycin antibiotics used. Based on the results obtained from PCR of the samples and gel electrophoresis, tet(A) genes were expressed in 4 samples and tet(B) in 7 out of 10 samples. According to the findings of this study, plantain extract was able to effectively affect two genes associated with resistance in multidrug-resistant (MDR) *Escherichia coli*, including tetA and tetB genes, and by reducing the expression of some of these genes, it prevented the growth of multidrug-resistant *Escherichia coli*.

Keywords: Plantain major extract, Multidrug Resistance, *Escherichia coli*, tet(A) and tet(B) genes



Evaluation of the Anticancer Effects of Aqueous Extract of *Stachys schtschegleevii* Sosn and its Biosynthesized Magnetic Nanoparticles on AGS Gastric Cancer Cell Line

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Abstract

Gastric cancer is among the most prevalent malignancies in Iran and worldwide. Due to its high mortality rate, metastatic potential, and the severe side effects of chemotherapy, researchers are seeking alternative compounds with reduced toxicity and enhanced efficacy. *Stachys schtschegleevii* Sosn, a member of the Labiatae family, is an herbaceous to semi-shrubby annual or perennial plant. It possesses notable anti-inflammatory and antimicrobial properties and has been traditionally used to treat conditions such as sinusitis, asthma, rheumatism, colds, urinary tract infections, and dysuria. It is also employed for disinfecting the respiratory, urinary, and female reproductive systems. Furthermore, this plant exhibits strong antioxidant activity, and its effects on apoptosis induction and cell cycle inhibition in various cancer cell lines have been reported. In this study, we investigated the inhibitory effects of the aqueous extract of *Stachys schtschegleevii* and its biosynthesized magnetic nanoparticles on the proliferation of AGS gastric cancer cells. The cytotoxicity was assessed using the MTT assay. Initially, the concentration and number of AGS cells, along with various concentrations of the plant extract and green-synthesized magnetic nanoparticles (confirmed via physicochemical tests), were determined for treatment. Concentrations of 10, 20, 40, 60, 80, and 100 mg/mL of the extract and nanoparticles were applied to 96-well plates containing 50,000 cells per well for 24, 48, and 72 hours. The results demonstrated that both treatments induced cell death in AGS cells, with the calculated IC₅₀ values indicating a stronger inhibitory effect of the magnetic nanoparticles compared to the plant extract alone. These findings suggest a promising anticancer potential of *Stachys schtschegleevii* against gastric cancer cells, which is further enhanced at the nanoscale, thus introducing a viable candidate for future therapeutic studies.

Keywords: *Stachys schtschegleevii* Sosn, AGS cell line, Gastric Cancer, Magnetic Nanoparticles

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Salinity stress modulates secondary metabolism and antioxidant responses in *Dracocephalum moldavica*: The synergistic mitigation role of titanium dioxide nanoparticles and arbuscular mycorrhizal fungi

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Abstract

Nowadays, the application of nanoparticles and mycorrhizal fungi has been considered as a strategy to increase plant resistance to environmental stresses. Moldavian balm (*Dracocephalum moldavica* L.) is an important medicinal plant with significant antioxidant properties. In this study, the effects of salinity, titanium dioxide nanoparticles (TiO₂ NPs), and arbuscular mycorrhizal fungi (AMF) on the defense system of Moldavian balm were investigated using a factorial experiment based on a randomized complete block design. The treatments included salinity at three levels (0, 100, and 150 mM NaCl), TiO₂ nanoparticles at two concentrations (0 and 50 ppm), and mycorrhizal inoculation at two levels (non-inoculated and inoculated with *Funneliformis mosseae*), with three replications. The results showed that the effects of salinity, TiO₂ NPs application, and AMF on the activity of antioxidant enzymes (ascorbate peroxidase and guaiacol peroxidase) and the concentration of compatible osmolytes (proline and soluble sugars) were significant. The foliar application of TiO₂ NPs and inoculation with AMF increased the activity of antioxidant enzymes at both the 100 and 150 mM salinity levels. The content of soluble sugars and proline increased following the application of 50 ppm TiO₂ NPs, either alone or in combination with *F. mosseae*, under salinity stress. Moreover, HPLC analysis showed that salinity increased the levels of secondary metabolites, including phenolic compounds (such as *p*-coumaric acid and caffeic acid) and flavonoids (e.g., quercetin). It appears that the combination of TiO₂ NPs and AMF enhanced stress tolerance in the Moldavian balm plant by stimulating both enzymatic and non-enzymatic antioxidant defense systems.



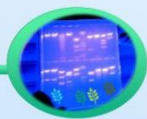
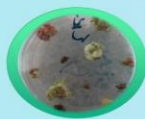
5th International Congress and 6th National Conference on

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Congress Time
October 7 and 8, 2025 University of Guilan

Co-organizers :
University of Zanjan and University of Guilan



Key words: Phenolic compounds, Stress tolerance, Secondary metabolites, Nanotechnology, Symbiosis

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The Effect of Drought Stress on the Quantity and Quality of Essential Oil in the Medicinal Plant Sage (*Salvia officinalis* L.)

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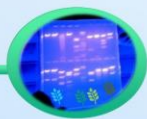
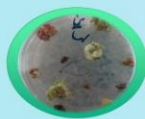
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Abstract

Sage (*Salvia officinalis* L.), a member of the Lamiaceae family, is one of the most important medicinal plants with anti-inflammatory, antioxidant, and antimicrobial properties. Its essential oil has wide applications in the pharmaceutical, food, and cosmetic industries. This research was conducted using a completely randomized design with four irrigation treatments (full irrigation as control, mild stress at 75%, moderate stress at 50%, and severe stress at 25% of field capacity) and three replications. Essential oil extraction from the aerial parts of the plant at full flowering stage was carried out using hydrodistillation with a Clevenger apparatus for 3 hours. The results showed that moderate drought stress (50% field capacity) significantly increased the essential oil yield to 2.8%. Chemical analysis using GC/MS revealed significant changes in secondary metabolite content: the percentage of major compounds, including thujone (from 24.5% to 31.2%) and camphor (from 12.3% to 16.5%), increased under mild and moderate stress conditions, while severe stress caused a significant reduction in 1,8-cineole. This study demonstrates that controlled drought stress not only enhances the quantity of essential oil by stimulating monoterpene biosynthetic pathways but also improves its quality by increasing key bioactive compounds. Therefore, optimized irrigation management can be employed as an effective and sustainable strategy for the industrial production of sage with higher essential oil content and added pharmaceutical value.

Keywords: Drought stress, Field capacity, Medicinal plants, Monoterpenes, Thujone



Identification of Chemical Compounds and Phytochemistry of Spearmint (*Mentha spicata*) Essential Oil under Cultivation Conditions in Zanjan

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Abstract

Spearmint (*Mentha spicata*) is a perennial, aromatic herbaceous plant belonging to the Lamiaceae family. Due to its bioactive compounds, it has wide applications in the food industry (as a flavoring agent and natural preservative), pharmaceutical industry (as an antispasmodic, antiflatulent, antimicrobial, and antioxidant), cosmetics, and perfumery. This study aimed to analyze the chemical composition and phytochemical properties of spearmint essential oil cultivated under the climatic conditions of Zanjan. The research was conducted at the field site and the laboratory of the Institute of Modern Biological Technologies at the University of Zanjan. The aerial parts of the plant were harvested at the full flowering stage, and the essential oil was extracted using hydrodistillation with a Clevenger apparatus. Chemical analysis was performed using gas chromatography-mass spectrometry (GC/MS). The results showed an essential oil yield of 2.1% (v/w), with 32 compounds identified, accounting for 98.5% of the total essential oil content. The major compounds included carvone (58.3%), limonene (18.7%), 1,8-cineole (6.5%), β -myrcene (4.2%), and α -pinene (2.8%). The high abundance of oxygenated monoterpenes, particularly carvone, was notable. The semi-arid climate, calcareous soil, and high solar radiation in Zanjan significantly influenced the biosynthesis of these compounds. These findings highlight the potential of spearmint cultivated in Zanjan as a rich source of bioactive compounds for pharmaceutical, food, and cosmetic industries.

Keywords: Gas chromatography, Carvone, limonene, 1,8-cineole, Oxygenated monoterpenes



The effect of the growth stage of *Amaranthus retroflexus* on the quantity and quality of its secondary metabolites

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Abstract

The Amaranthaceae family, a large and cosmopolitan group, encompasses a vast array of over 175 genera and 2,000 species. Beyond their ecological presence, numerous members of this family hold substantial economic and ethnopharmacological value, being cultivated worldwide as nutritious vegetables and utilized in traditional herbal medicine systems. A key aspect of their bioactivity is attributed to their rich and diverse phytochemical composition. Among the most therapeutically relevant secondary metabolites are terpenoids, a large class of compounds renowned for their wide-ranging pharmacological effects. This study investigated the effect of vegetative, maturity, and flowering growth stages on the quality and quantity of secondary compounds in amaranth. Amaranth plants (redroot pigweed) were harvested at three growth stages from a wheat field, and their compounds were analyzed using GC-MS. The harvest at different times was associated with changes in the quantity and quality of secondary compounds in the wild amaranth plant. The majority of these compounds belonged to the groups of terpenoids, esters, and alkanes. In both the vegetative and mature plant stages, terpenes and esters were among the most abundant compounds. According to the results, the plant during the flowering and seed stage showed the highest number of compounds compared to the two previous growth stages. In this growth stage as well, terpenes were the most abundant group of compounds. The monoterpenoid eucalyptol was identified in all three growth stages. The monoterpenoids borneol, linalool, and terpinen-4-ol were common to the plants in the vegetative stage and the flowering and seed stage. The monoterpenoid thymol, TMS derivative, was identified in the vegetative stage and the mature plant. Other terpene compounds were different in the mature plant and the flowering and seed stage plant. The area under the curve (% Peak Area) was collectively higher during the mature plant and initial flowering stages. Terpenes (26.06%), esters (7.96%), and alkanes (2.36%) showed the highest percentage of index compounds. Different growth stages throughout the plant's life cycle influence its secondary metabolite content. The concentration of secondary compounds in plants is not constant throughout their life; rather, plants alter them based on their needs under different environmental conditions.

Keywords: Medicinal plants, Secondary metabolites, Alkanes, GC/MS, redroot pigweed



Medicinal and Pharmacological Properties of *Eryngium caucasicum* Trautv.

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Abstract

Eryngium caucasicum Trautv., belonging to the Apiaceae family, is an aromatic herbaceous species native to the northern regions of Iran. Due to its richness in phenolic compounds and high antioxidant activity, it has attracted considerable attention in pharmacological research. Active compounds in this plant, such as limonene, flavonoids, and folic acid, play a significant role in modulating biological processes, including the reduction of oxidative stress and chronic inflammation. These mechanisms are effective in the prevention and management of chronic diseases, such as iron-deficiency anemia, inflammatory joint diseases, and cancer. The root of *Eryngium caucasicum*, mainly harvested in autumn, contains sugars and sucrose and possesses antifungal, antibacterial, and antispasmodic properties. It is used in the treatment of urinary tract infections, pertussis (whooping cough), liver disorders, and kidney stone elimination. Multiple studies have demonstrated the efficacy of methanolic extract of *Eryngium caucasicum* against antibiotic-resistant bacterial strains such as *Staphylococcus aureus* and *Escherichia coli*, indicating its considerable potential as a natural source of antimicrobial compounds. Furthermore, the plant's diuretic and immune-boosting effects contribute to improved digestive function and toxin elimination, thereby expanding its therapeutic applications. These findings highlight the high potential of *Eryngium caucasicum* in complementary medicine and the development of herbal drugs, which warrants further clinical and pharmacological investigations.

Keywords: Caucasian eryngo, *Eryngium caucasicum*, Phenolic compounds, Antioxidant



Evaluation of the Effects of Aqueous Extract of *Cymbopogon citratus* and its Silver Nanoparticles on Cell Viability Reduction and Apoptosis Induction in the Acute Lymphoblastic Leukemia Cell Line (Molt-4)

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Abstract

Acute lymphoblastic leukemia (ALL) is a malignancy of lymphoid lineage blood cells, characterized by the proliferation of numerous lymphocytes involved in the immune system, with higher incidence in children. This study investigates the cytotoxic and apoptotic effects of *Cymbopogon citratus* (lemongrass) aqueous extract—a plant known for its potent antioxidant properties and traditional medicinal use—on the Molt-4 leukemia cell line. The MTT assay was employed to assess the impact of the extract and its biosynthesized silver nanoparticles, determining IC₅₀ values of 172 and 60 µg/mL at 24 and 48 hours, respectively. To evaluate early and late apoptosis as well as necrosis, Molt-4 cells were treated with ½IC₅₀ for 48 hours and analyzed using acridine orange/ethidium bromide staining to observe cellular morphology. The results demonstrated significant inhibition of cell viability and induction of apoptosis in Molt-4 cells treated with both the extract and its silver nanoparticles. Given the antioxidant nature of *Cymbopogon citratus* and the oxidative stress associated with conventional ALL therapies, apoptosis induction via antioxidant-rich botanicals may represent a promising therapeutic strategy for this leukemia.

Keywords: Acute lymphoblastic leukemia, *Cymbopogon citratus* extract, Silver nanoparticles



In vitro embryo culture in *Canna indica* L. a method to eliminate long seed dormancy

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Abstract

The search for new medicinal and therapeutic resources is a targeted approach by various researchers in biological sciences worldwide, aimed at preventing and combating numerous human diseases. *Canna indica* L. is a tropical plant belonging to the Cannaceae family, which is sometimes called Indian shot. Although *Canna* is more commonly known as an ornamental plant, several reports indicate the medicinal properties of its various parts, which can be promising in programs to introduce new medicinal plants. The seed dormancy period in this plant is very long, and in some reports it is stated to be up to 4 years. For this reason, seed cultivation is justified only for breeding and producing diverse colors of the plant. Effective breeding programs for this plant, aimed at introducing new varieties and enhancing genetic diversity, require strategies to reduce germination time and overcome its prolonged seed dormancy. In this study, mature and immature seed embryos of *Canna* (Gol Akhtar – Persian) were sown and evaluated in two cultivation media: full Skoog (MS) and one-half (1/2 MS) in the form of factorial experiments based on a completely randomized design with 5 replications in the summer of 2025. The results indicated that the planting of immature seed embryos was successful in breaking seed dormancy and producing in vitro seedlings within 25 days at 22°C in a photoperiod of 8 hours of light and 16 hours of darkness compared to fully mature seed embryos. No significant difference was observed between the two cultivation media tested, and the use of a cheaper medium (1/2 MS) is recommended to reduce costs.

Keywords: Medicinal plants, Tissue culture, *Canna indica* L.



Effects of Mycorrhizal and Rhizobium Inoculation on Phenolic Compounds of Soybean (*Glycine max* L.) under Copper Toxicity

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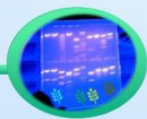
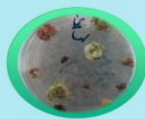
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Abstract

Heavy metals such as copper negatively affect plant growth, photosynthesis, and nutrient uptake by inducing oxidative stress. This study investigated the effects of mycorrhizal fungi and Rhizobium inoculation on the phenolic compounds of soybeans under copper toxicity. A factorial experiment was conducted in a greenhouse using a randomized complete block design with three replications. Treatments included four copper levels (0, 50, 100, and 200 mg/kg soil) and four inoculation types (control, mycorrhiza, rhizobium, and mycorrhiza + rhizobium). Results showed that copper stress significantly increased phenolic compounds, especially in inoculated plants compared to non-inoculated ones. Mycorrhizal and rhizobium symbiosis alleviated copper stress by enhancing antioxidant activity, improving phosphorus uptake, supporting nitrogen fixation, and maintaining plant metabolism. Overall, the findings suggest that inoculation with mycorrhiza and rhizobium can mitigate the harmful effects of copper stress on soybean.

Keywords: Copper stress, Mycorrhizal fungi, Phenolic compounds, Rhizobium japonicum, Soybean



Investigation of the Export and Import of Major Iranian Medicinal Plants

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Abstract

Iran, with 11 of the world's 13 distinct climate zones, possesses remarkable richness in the genetic diversity of its plant cover. The number of plant species in Iran is estimated at between 8,000 and 12,000 out of the world's roughly 420,000 plant species, more than 2,300 of which have medicinal, aromatic, culinary-spice, or cosmetic-hygienic properties. Around 1,700 species are unique to Iran and thus considered endemic. According to available statistics, Iran ranks first globally in the export of various medicinal plants, including saffron, damask rose, asafetida, galbanum, gum tragacanth, etc. Other export plants from Iran include cumin, chamomile, yarrow, black pepper, hollyhock, anise, thyme, asparagus, hyssop, turmeric, licorice and bitter licorice, mastic gum, shir-e-tiqal (*Eremurus*), henna, green cumin, psyllium, lemon balm, sidr leaves (*Jujube* leaves), sage, wild celery (*kelus*), maidenhair fern, Khansar manna (Persian manna), chicory flower, borage, mastic resin, lavender, bay leaves, and more. Major buyers of Iranian medicinal plants include Turkey, Russia, the United Arab Emirates, Oman, Japan, Germany, and China. While Iran is a major exporter of medicinal plants, it is also a selective, limited importer of these products. Saffron, barberry, and licorice account for the largest share of exports, whereas the small flow of imports mainly consists of plant extracts and raw materials for processing. According to Iran Customs data and the UN Comtrade database, the total value of the country's medicinal plant exports in 2023 was about USD 550 million, with the largest share attributed to saffron. Imports were limited—around USD 40 million in 2023—and comprised plant extracts, seeds, and raw processing materials, sourced mainly from India, China, and Turkey. Statistics for 2023 show that the value of Iran's saffron exports exceeded USD 300 million, barberry around USD 50 million, and licorice (including roots and extract) nearly USD 30 million. The primary destinations for saffron were China, the United Arab Emirates, Spain, and Italy, while barberry was exported mainly to the European Union and Persian Gulf countries. Licorice was exported mostly to Germany, Japan, and South Korea. Key imported items included concentrated herbal extracts such as ginseng, chamomile, and licorice derivatives, as well as essential oils and high-purity pharmaceutical ingredients, primarily supplied by India (about 25 percent), China (about 20 percent), Turkey, and Germany. These imports are intended to compensate for shortages of pharmaceutical raw materials and to secure high-quality extracts not widely produced domestically. Given climate change, recurring droughts, shifting government support policies, and the political conditions affecting international interactions, annual data on the export and import of medicinal plants—as well as the quantity and quality of traded items—are subject to change and must be updated regularly. Clearly, continuous monitoring of the factors influencing exports and imports can help mitigate potential challenges in this health-oriented market. This article examines and discusses the aforementioned issues in detail, based on the most recent available information.

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Keywords: Medicinal plants, Imports, Exports, Trade balance

Recent Advances in the Extraction and Purification of Phycocyanin from *Arthrospira platensis* (Spirulina)

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Abstract

Given growing concerns regarding the use of synthetic preservatives in various food products, there is a clear need to focus on natural compounds with preservative properties. Phycocyanin, which is extracted from the microalga *Spirulina platensis* (also known as *Arthrospira platensis*), is one such compound. Despite advancements in the cultivation of *Spirulina*, the study of phycocyanin extraction remains a key challenge. Various factors, such as cell disruption methods, solvent type, biomass-to-solvent ratio, temperature, and mixing speed, can significantly affect the yield and purity of phycocyanin. After selecting the appropriate cyanobacterium and cultivating the microalgae, the extraction method is one of the most important factors for recovering the maximum amount of phycobiliproteins (PBPs) from microalgae, with key determinants including the cell disruption method, solvent type, and solvent-to-biomass ratio. Various methods are used for harvesting microalgae, including flocculation, centrifugation, and membrane filtration. Osmotic shock is a direct extraction method that releases PBPs by manipulating internal or external osmotic pressure after immersing microalgae in an extraction buffer for an extended period in the absence of light or by mixing them with distilled water. However, the main limitations of conventional extraction methods are their moderate extraction efficiency, long extraction times, and the potential for disruption or denaturation of phycobiliproteins. Modern green extraction techniques, such as ultrasound-assisted extraction (UAE), high-pressure homogenization (HPH), pressurized water extraction (PWE), and supercritical carbon dioxide extraction, overcome these issues. They are becoming popular alternatives due to their environmental compatibility and higher extraction efficiency.

Keywords: *Spirulina platensis*, Phycocyanin, Phycobiliproteins



Introduction to drought-tolerant medicinal plants cultivation

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Abstract

People living in arid regions have long been in harmony with the desert and its phenomena, and have coexisted with its difficulties and limitations. For a long time, a balance has been maintained between human exploitation and the carrying capacity of the ecosystem, and desertification has not occurred. With the emergence of droughts and specific climatic changes on the one hand, and the sudden increase in population and the greedy and unwise exploitation of water, soil, and plant resources on the other, the phenomenon of desertification began and also affected areas with high potential for producing medicinal plants. This issue has been considered one of the most important problems of human societies. One of the biological methods for stabilizing quicksand and rehabilitating desert lands is planting seedlings in bare and uncovered areas (sandbanks and desert lands) with suitable medicinal species that are resistant to dry conditions. A medicinal plant species suitable for planting should have certain characteristics, including adaptability and easy establishment, resistance to livestock grazing, the ability to repair and regrow after harvesting plant parts, biomass production in the desired season, a long growing season, and the possibility of natural regeneration after initial establishment. Similarly, resistant and water-efficient medicinal plants in arid and semi-arid lands can provide food, pharmaceutical, industrial, and fiber materials for humans. Also, cultivating drought-resistant species in urban green parks and gardens brings vitality and freshness and is effective in preserving biodiversity. This article introduces dryland medicinal plant species.

Keywords: Drought, Medicinal plant, Biodiversity



Evaluation of cold tolerance in cultivated genotypes of *Lallemantia iberica* (Bieb.) collection of National Plant Gene Bank of Iran in autumn cultivation

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Abstract

One of the important goals and challenges in cold and dry regions is to identify and introduce genotypes tolerant to cold stress. This project aimed to identify genotypes tolerant to cold stress in autumn rain-fed and irrigated cultivation from among 100 selected genetic samples during three crop years: 2010, 2011, and 2012. In the first year, 100 selected dragonhead seed samples were cultivated in Urmia under irrigated conditions and were studied based on desired traits such as uniformity, growth rate, cold tolerance, and grain yield. The promising samples were selected based on the above traits using appropriate statistical analysis methods. In the second and third years, a supplementary evaluation was carried out on 49 selected populations from the first year in the form of a 7×7 lattice design with two replications in the regions of Urmia and Karaj over 2 years. The results showed that there was a very significant difference among the populations in terms of all the characteristics studied. Finally, after combined analysis and examination of agronomic characteristics, 25 lines and populations were selected for advanced studies and adaptation in cold and cold-temperate regions.

Keywords: Autumn cultivation, Grain yield, 1000-grain weight, *Lallemantia*



Natural insecticides derived from medicinal plants: A systematic review of applications and mechanisms of action

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Abstract

The increasing incidence of insect resistance to synthetic insecticides, coupled with growing concerns about their adverse effects on human health and the environment, has intensified the search for safe and eco-compatible alternatives. Medicinal plants, which produce a wide array of defensive secondary metabolites, represent a rich and promising resource for the development of natural insecticides. These bioactive compounds—including alkaloids, terpenoids, phenols, flavonoids, and essential oils—act upon insects through various mechanisms such as contact and gastric toxicity, repellency, feeding deterrence, disruption of growth and development, and reduction of fecundity. The objective of this review article is to systematically evaluate contemporary studies on the efficacy of medicinal plant extracts and essential oils against major agricultural and public health pests. Findings clearly demonstrate that plants such as pyrethrum (*Tanacetum cinerariifolium*), neem (*Azadirachta indica*), eucalyptus, garlic, lavender, and thyme possess significant insecticidal potential. For instance, azadirachtin, derived from the neem tree, is recognized as a potent growth regulator. Although challenges such as extract standardization, stability in open-field conditions, and determination of effective large-scale dosing persist, potential solutions include novel formulation strategies (e.g., microencapsulation, nanoemulsions) and integration into Integrated Pest Management (IPM) frameworks. This review concludes that medicinal plants not only offer safe and biodegradable alternatives to synthetic insecticides but also pave the way for the development of sustainable pest control strategies.

Keywords: medicinal plants, natural insecticide, secondary metabolites, plant extract and essential oil, Integrated Pest Management (IPM)



Combined Influence of Phosphorus Stress and Gibberellic Acid on the Secondary Metabolites of *Mentha longifolia* L.

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Abstract

This study was conducted to evaluate the individual and interactive effects of phosphorus (P) stress and gibberellic acid (GA) application on the phytochemical composition of essential oil in *Mentha longifolia* L. The experiment was carried out under pot conditions in an open field using a randomized complete block design with four replications. Treatments included four P levels (100%, 75%, 50%, and 25% of the recommended P fertilizer rate) and two foliar spray regimes (with or without 100 mg L⁻¹ GA), arranged factorially. Aerial parts were harvested at full flowering, and essential oil constituents were extracted via hydro-distillation and analyzed by GC-MS. Results revealed that both P stress and GA significantly influenced the accumulation of key phytochemicals. Phosphorus deficiency generally increased monoterpene ketones, menthone, menthol, and pulegone, while decreasing oxygenated compounds such as 1,8-cineole and piperitenone oxide. GA application suppressed menthone and linalool but enhanced menthol and piperitenone oxide. Significant interaction effects ($p < 0.01$) were observed for several compounds, including α -pinene, limonene, linalool, menthol, terpinen-4-ol, α -terpineol, piperitone, thymol, and piperitenone oxide, indicating that the response to GA was modulated by P availability. For instance, thymol accumulation was promoted by GA under P sufficiency but induced only under severe P stress (25% P) in the absence of GA. Correlation analysis further revealed strong positive associations among piperitenone, piperitenone oxide, and terpinen-4-ol, and negative links between menthone and β -pinene derivatives, suggesting coordinated or competing biosynthetic pathways. These findings demonstrate that the phytochemical profile of *M. longifolia* is highly responsive to combined hormonal and nutritional signals, highlighting the potential for integrated P and GA management to tailor essential oil composition for specific industrial or medicinal applications.

Keywords: antioxidant compounds, monoterpenes, nutrient deficiency, secondary metabolism, terpenoid biosynthesis



The Situation of Traditional Medicine in the Outlook of Modern Healthcare

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Abstract

Traditional, Complementary, and Integrative Medicine (TCIM) refers to a set of therapeutic approaches that lie outside the boundaries of conventional medicine but can be applied alongside it to promote health or manage diseases. This field includes methods such as regional traditional medicine (e.g., Chinese medicine or Ayurveda), herbal medicine, acupuncture, homeopathy, and mind–body practices. In developed countries, engagement with TCIM is mostly characterized by a scientific integration approach and complementary application, rather than complete substitution. Population-based studies in Germany, the United States, and other European countries have shown that over 70% of individuals have used TCIM methods at least once, and about one-third have benefited from them in the past year. Common reasons for TCIM use include controlling chronic pain and musculoskeletal disorders, managing stress, improving sleep quality, and enhancing overall health. Furthermore, about 40% of the population consider TCIM an important part of their personal health. TCIM users often suffer from a greater burden of disease and have lower health-related quality of life. This highlights the need to develop integrated care models in which evidence-based modern medicine remains the main foundation, while TCIM serves as a complementary tool to improve quality of life, manage symptoms, and address patients' complex needs. This study examines how different countries approach the existence of TCIM.

Keywords: TCIM, health, traditional medicine, modern medicine



Investigation of Interaction between Medicinal Plants and Synthetic Drugs

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Abstract

Concurrent use of conventional drugs and herbal preparations is a highly prevalent phenomenon worldwide. Many patients, particularly those with chronic conditions, consume herbal medicines or dietary supplements without informing their physicians. Systematic reviews have demonstrated that such co-administration can lead to clinically significant outcomes, ranging from reduced therapeutic efficacy to increased adverse effects. This issue becomes especially critical when drugs with a narrow therapeutic index—such as cardiovascular agents, anticoagulants, or immunosuppressants—are involved, since even minor fluctuations in plasma concentration may result in serious consequences. Among the most frequently implicated herbs are *Ginkgo biloba*, *Panax ginseng*, and garlic, for which substantial clinical evidence of interactions with conventional medications has been reported. The mechanisms underlying these interactions are primarily twofold: pharmacokinetic—alterations in drug absorption, metabolism, or excretion through induction or inhibition of drug-metabolizing enzymes (notably the CYP450 family) or modulation of transporters such as P-glycoprotein; and pharmacodynamic—direct or additive effects on physiological pathways (e.g., increased bleeding risk or potentiation of central nervous system depression). Recent literature emphasizes the need for human pharmacokinetic/pharmacodynamic (PK/PD) studies to validate the clinical relevance of mechanisms initially observed in vitro. A major challenge in interpreting and managing herb–drug interactions arises from fragmented evidence. Lack of standardization in herbal preparations, reliance on case reports and in vitro studies, and the scarcity of well-designed clinical PK/PD trials with chemically defined extracts all contribute to uncertainty. Emerging scholarship highlights the necessity for rigorous standardization of herbal products, targeted PK/PD investigations, and stronger pharmacovigilance systems to quantify risks and provide evidence-based guidance for clinical practice.

Keywords: medicinal plants, drug interaction, synthetic drugs

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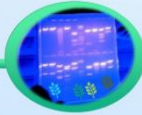
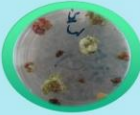
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AI-Powered Bioinformatics in Exploring Secondary Metabolite Key Genes

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Abstract

Secondary metabolites are a principal source of pharmaceuticals, agrochemicals, and ecological signals. Recent advances in artificial intelligence (AI) and machine learning (ML), combined with the explosion of multi-omics datasets, are now fundamentally transforming how researchers identify key genes that drive secondary metabolite biosynthesis. This paper reviews leading computational strategies, ranging from profile-HMM and rule-based BGC detectors to modern deep learning—including protein language models and multi-omics integrative ML—and synthesizes best practices for prioritizing candidate genes for experimental validation. We highlight representative tools (antiSMASH, DeepBGC/e-DeepBGC, multi-omics ML pipelines) and recent studies that illustrate improved sensitivity and deeper functional insight. Finally, we outline gaps (interpretability, cryptic clusters, cross-taxon generalization) and propose future directions, including explainable AI (XAI), self-supervised pretraining, and stronger integration of metabolomics to close the genotype–chemotype gap.

Keywords: secondary metabolites, bioinformatics, Artificial Intelligence, key gene



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Shaping Cognitive Geometry of Healthy Living with Medicinal Plants Through a Strategic Approach

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Abstract

How can we continuously redesign the healthy lifestyle of 90 million Iranian citizens - and hundreds of millions of citizens of other countries - by drawing strategic cognitive geometry based on the medicinal plants industry?. This paper, by reinterpreting three seven-dimensional strategic analysis models in accordance with the context of Iranian culture, has explained the answers to this question from the perspective of shaping a healthy lifestyle strategy centered on medicinal plants. Management is the science and skill of applying other sciences to achieve life goals. Strategic management is the most comprehensive management approach to realize life visions. This paper examines from a cognitive perspective how to realize the common vision of all experts, activists, and those interested in realizing the role of medicinal plants in shaping healthy lifestyle, and presents a model for implementing the cognitive geometry of healthy living through medicinal plants.

Keywords: Lifestyle, Strategic analysis models, Shaping cognitive geometry.

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Effect of foliar application of macro and micronutrients (nano and conventional) in magnetic and normal forms on the quantitative and qualitative traits of Camelina (*Camelina sativa* L.) under rain-fed conditions

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Abstract

Camelina (*Camelina sativa* L.) is a common oilseed plant in Asia and Europe, belonging to the Brassicaceae family, about which little is known, particularly in Iran. It has been proposed as a viable option for diversifying traditional Mediterranean cropping systems, thus holding significant importance. In the present study, the effect of foliar application of macro-elements (N–P–K) and micronutrients (Zn–Mn–Fe) in both nano and conventional forms at five levels (control, conventional macro-elements, nano macro-elements, conventional macro-elements + conventional micro-nutrients, nano macro-elements + nano micro-nutrients) and type of application at two levels (magnetic and conventional) was evaluated on camelina under rain-fed conditions in West Azerbaijan province, Iran. For this purpose, a factorial experiment based on a randomized complete block design (RCBD) with three replications was used. The results of the analysis of variance (ANOVA) indicated that the studied factors and their interactions significantly influenced multiple quantitative and qualitative traits of camelina. These traits included plant height, the number of secondary branches, the number of siliques, fresh and dry leaf weight, silique weight, the number of seeds per silique, thousand-seed weight, seed yield, oil content, oil yield, and harvest index. Overall, foliar application of macro- and micronutrients in nano form enhanced drought stress tolerance in camelina plants, and magnetic treatment improved micronutrient uptake efficiency compared to conventional methods. The improvement of the traits was influenced more profoundly by macro-elements than by microelements. Our findings can be utilized to develop an optimal fertilizer regimen to mitigate the adverse effects of drought in camelina cultivation, reduce chemical fertilizer application, and enhance both seed and oil yield.

Keywords: magnetic nutrition, drought stress, element absorption, *Camelina sativa*, nano-fertilizers