REVIEW ARTICLE

Menthone: An Overview of their Pharmacological Importance and Novel Derivatives

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Abstract

In the world of medical herbs, a highly valued member of the Lamiaceae family, is peppermint (*Mentha piperita*),. This review aims to fill this gap by providing a comprehensive examination of peppermint, encompassing its botanical characteristics, traditional and local medicinal uses, chemical constituents, and pharmacological activities and novel derivatives of menthone. Peppermint has been revered for centuries for its wide array of medicinal properties, ranging from its ability to alleviate digestive discomfort to its antimicrobial and analgesic effects. This paper synthesizes up-to-date information on the pharmacognosy and pharmacology of *Mentha piperita*, highlighting its diverse therapeutic potentials. By consolidating research findings from various studies, this review serves as a valuable reference for researchers seeking to explore the multifaceted benefits of peppermint in pharmaceutical and nutraceutical applications. From its essential oil to its various extracts, the pharmacological activities of peppermint, including its anti-inflammatory, antioxidant, and antispasmodic properties, are thoroughly elucidated. Furthermore, this review discusses the potential mechanisms underlying peppermint's pharmacological effects, and preparation on various novel derivatives of menthone. Overall, this paper provides insights into the Pharmacognostic and pharmacological aspects of peppermint, paving the way for further research and development of novel therapeutic interventions derived from this remarkable plant.

Keywords: *Mentha piperita*, menthone, pharmacological properties, derivatives.

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Introduction

Natural products derived from plants have long been esteemed for their potential in drug development.[1] The exploration and utilization of therapeutically active compounds from plant sources remain a burgeoning field of interest. It's noteworthy that approximately 80% of the global population relies on the utilization of around 20,000 different plant species in various traditional medicinal systems, offering alternative therapeutic options with a focus on efficacy and safety.[2]

Among the myriad of natural resources with medicinal properties, the genus Mentha stands out. Widely distributed across continents including North America, Europe, Africa, Australia, and Asia, Mentha species have garnered attention for their remarkable therapeutic and economic significance.[3] Known for their aromatic properties, Mentha species have been traditionally employed in medicine, cosmetics, and pharmaceutical preparations.[4] The essential oils extracted from these species have exhibited diverse biological effects, ranging from anti-inflammatory and antimicrobial to antioxidant and antiviral activities, owing to the presence of specialized metabolites such as aromatic compounds and terpenoids. Its applications range from dental hygiene products like toothpaste and mouthwashes to aromatherapy for soothing irritation. Cultivated for over a millennium in temperate and subtropical regions, peppermint holds a prominent place in Asian traditional medicine, particularly in China. In traditional Chinese medicine (TCM), the aerial parts of peppermint, known as "Bo He" or Mint Herb, have been prescribed for ailments such as influenza, headache, red eyes, fever, and sore throat.[5]

Peppermint (*Mentha piperita*), an esteemed member of the Lamiaceae family, stands as a cornerstone in the realm of medicinal herbs. Revered for its therapeutic properties, this botanical treasure has left an indelible mark on the history of medicine, with its usage tracing back through the annals of time in both Eastern and Western civilizations. Notably, India has emerged as a leading player in the global market for mint oil and menthol, showcasing its dominance in the production and trade of these valuable substances. Successful cultivation of peppermint hinges upon adequate water supply, given its preference for moist conditions. Being a hybrid species, peppermint is sterile, necessitating its propagation through vegetative means. Planting typically occurs during the final weeks of December and January to optimize growth and yield.[7]

Peppermint manifests as a rhizomatous perennial herb, boasting a stature ranging from 30 to 90 centimeters in height. Its vigorous growth habit, coupled with its ability to spread via underground rhizomes, contributes to its resilience and widespread cultivation across diverse regions.[7-8] This robust herbaceous perennial not only endures but thrives under favorable conditions, perpetuating its legacy as a cherished botanical ally in the quest for health and well-being.[9]

Researchers have devoted significant attention to peppermint due to its multifaceted biological applications, prompting systematic investigations into its phytoconstituents and series of beneficial pharmacological effects as illustrated in figure 1. While numerous reviews on peppermint exist in the literature, none comprehensively cover all aspects of this versatile herb.[10]

This review aims to fill this gap by providing a comprehensive examination of peppermint, encompassing its botanical characteristics, traditional and local medicinal uses, chemical constituents, and pharmacological activities.[11-12] By synthesizing up-to-date information, this article serves as a valuable reference for researchers seeking to explore the traditional knowledge and pharmacological evidence surrounding peppermint for future investigations. Through a thorough analysis of the existing literature, this review seeks to shed light on the diverse therapeutic potentials of peppermint and inspire further research in this field.

Pharmacognosy of *Mentha piperita*

Mentha × piperita, commonly known as peppermint, has a rich history of cultivation and usage across diverse cultures. Egyptians have long embraced its aromatic qualities, employing it as a flavoring agent in both culinary creations and teas, as documented in the Icelandic pharmacopoeia.[13] In Chinese traditional medicine, Mentha × piperita holds therapeutic significance, with its dried leaves even discovered within Egyptian pyramids, underscoring its ancient roots and widespread use. Furthermore, in the Arab region and northern Africa, peppermint enjoys widespread popularity, often being utilized as an aromatic enhancer and flavoring ingredient in the renowned beverage known as "Touareg tea." This global recognition and utilization highlight the versatility and cultural significance of Mentha × piperita throughout history.

Mentha piperita, commonly known as peppermint, boasts a rich tapestry of traditional uses that have endured across cultures and civilizations for centuries. One of its most prominent roles lies in aiding digestion, with peppermint tea being a well-known remedy for indigestion, bloating, and gas. Its high menthol content is believed to relax the muscles of the digestive tract, providing relief from discomfort. Additionally, peppermint has been traditionally used to alleviate nausea and vomiting, making it a popular choice for addressing motion sickness, morning sickness during pregnancy, and general nausea. The cooling sensation and potential ability to improve blood flow in peppermint oil have also led to its traditional use in easing tension headaches and migraines.[14] Furthermore, peppermint's respiratory benefits have been recognized in traditional medicine, with inhalation of steam infused with peppermint oil or consumption of peppermint tea being employed to clear nasal passages and soothe irritated airways. Topically, peppermint oil has been applied for pain relief, including muscle aches, joint pain, and tension headaches, thanks to its cooling sensation and analgesic properties. Additionally, it is valued in skincare for its antibacterial and anti-inflammatory properties, aiding in the treatment of acne, eczema, and itching. In culinary realms, peppermint leaves are utilized as a flavoring agent in a variety of dishes, desserts, and beverages, while also serving as a breath freshener when chewed. Lastly, in aromatherapy, the

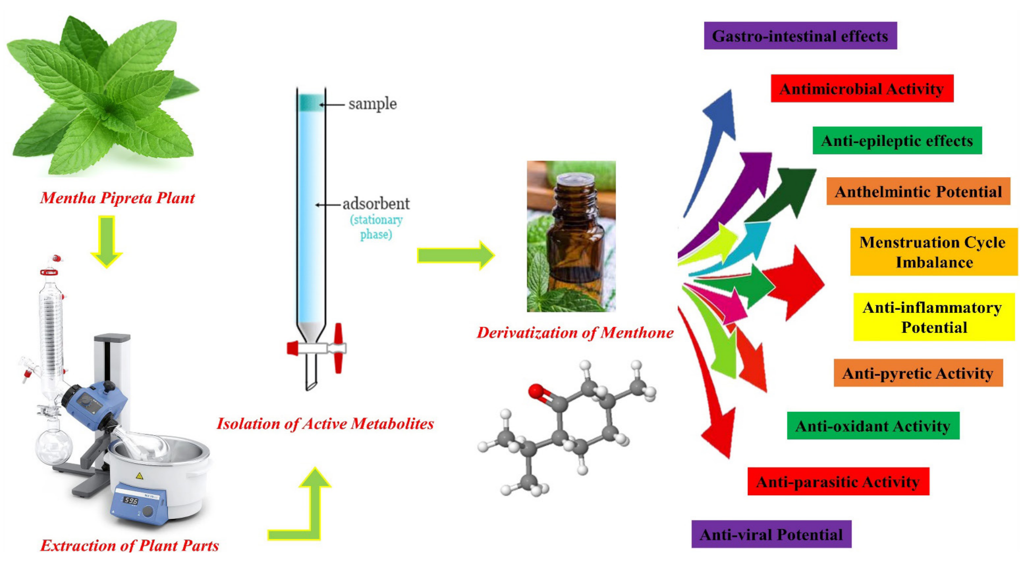

Figure 1: Different Pharmacological Activities of Mentha Pipreta Plant and its menthone derivatives

invigorating scent of peppermint oil is utilized to promote relaxation, reduce stress, and enhance mental clarity, offering a holistic approach to well-being. These myriad traditional uses underscore the versatility and efficacy of *Mentha piperita*, a cherished botanical ally with a storied history of healing and rejuvenation.[15]

Traditional Medicinal Uses

The cultural significance of Mentha × piperita, or peppermint, is widely recognized worldwide, with numerous ethnomedicinal studies shedding light on its traditional uses.[16] Across various countries, different parts of the peppermint plant have been utilized for their beneficial properties, with particular emphasis on its aerial parts and leaves.[17] In Egypt, for instance, ethnobotanical surveys have documented the use of peppermint leaf decoctions for alleviating anxiety and gastrointestinal colic. Similarly, in Brazil, group of scientists has highlighted the antiseptic, anti-infective, and wound-healing properties of peppermint leaf juice. In Italy, interviews with elderly herbal practitioners revealed the use of peppermint leaf and flower infusions or tinctures for their hepatoprotective effects and in the treatment of jaundice.[18-23] In Cyprus, peppermint leaf infusions have been traditionally employed for addressing hypotension, liver disorders, stomach issues, headaches, dyspepsia, and as a calming and nerve tonic. Additionally, peppermint leaves are commonly used as cooling and digestive agents, as observed in various ethnobotanical investigations.[24-26] These studies underscore the widespread and diverse traditional uses of peppermint across different cultures and regions, reaffirming its status as a valuable botanical resource with multifaceted medicinal properties.[27]

Phytochemical Investigation

The phytochemical exploration of *Mentha piperita*, or peppermint, involves a thorough examination of its chemical constituents present in diverse anatomical structures, notably leaves, stems, and essential oils.[28] Peppermint, belonging to the Lamiaceae family, is esteemed for its multifaceted utility in culinary, medicinal, and aromatic contexts. The phytochemical profile of *Mentha piperita* exhibits remarkable diversity, characterized by the presence of various secondary metabolites, including phenolic compounds, terpenoids, flavonoids, and volatile oils, each imparting distinctive sensory and therapeutic attributes. Notably, peppermint's essential oil is a key constituent, renowned for its abundance of menthol, menthone, and other compounds responsible for conferring the characteristic cooling sensation and minty aroma associated with the plant as depicted in figure 2. It also consists of Iso-menthone, Linalool, Limonene, Menthofuran, 1,8-cineole, β-caryophyllene, Neomenthol etc.[29-32] For instance, the presence of menthol not only contributes to its refreshing flavor but also possesses analgesic properties, making it useful in alleviating minor pains and discomforts. Furthermore, peppermint is rich in phenolic compounds such as rosmarinic acid, which exhibits potent antioxidant activity, scavenging free radicals and mitigating oxidative stress. Similarly, flavonoids like luteolin and hesperidin contribute to peppermint's anti-inflammatory and antimicrobial properties, providing potential therapeutic benefits in conditions such as inflammation and microbial infections.[33,34] Moreover, the inclusion of terpenoids and alkaloids in peppermint further broadens its pharmacological potential, with terpenoids exhibiting various biological activities such as antispasmodic and expectorant effects.[35-37] The phytochemical investigation of peppermint entails rigorous methodologies encompassing extraction, isolation, and identification techniques, including chromatography and spectrophotometry, enabling the comprehensive characterization of bioactive compounds present in peppermint extracts. This holistic understanding underscores the diverse range of biological activities exhibited by peppermint, rendering it a valuable resource in traditional medicine, pharmaceuticals, cosmetics, and food products, thereby warranting continued exploration and research endeavours.[60]

Pharmacological Evidences of *Mentha piperita*

Mentha piperita, or peppermint, has been shown to be medicinally effective through a number of investigations and clinical trials. Studies reveal that peppermint has strong anti-inflammatory, antibacterial, antioxidant, and analgesic effects, which are related to the variety of phytochemicals it contains.[61] Rich in menthol and menthone, peppermint essential oil has analgesic properties that provide pain and discomfort alleviation. Its antioxidant effect is further enhanced by phenolic components such as rosmarinic acid, which fight oxidative stress and support cellular health. Peppermint contains flavonoids, like luteolin and hesperidin, which exhibit anti-inflammatory and antibacterial properties as depicted in Table 1. This suggests that peppermint may find use in treating microbial infections and inflammation. The pharmacological evidence highlights peppermint's

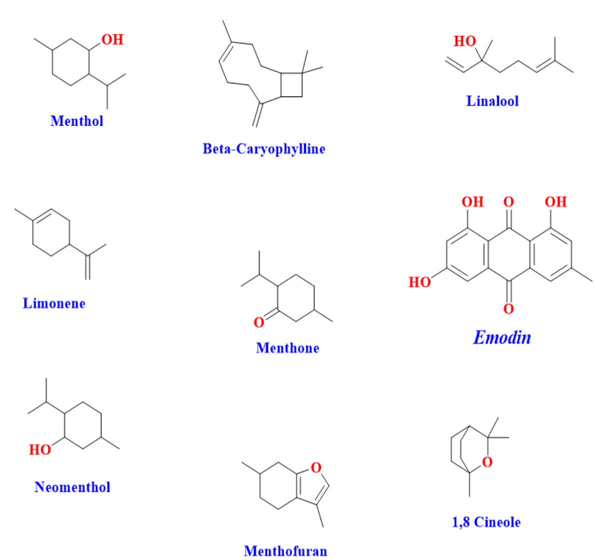

Figure 2: Different Phytochemicals present in Mentha Pipreta Plant

Table 1: Pharmacological activities of menthone and Mentha Pipreta plant extracts

Pharmacological activity	*Plant part*	*Plant extract*	*Method*	*Result*	*Active constituent*	*Ref.*
Toxicity in vivo	Leaf	Essential oil	Oral administration of the essential oil at 125, 250, 375, and 500 μ/kg doses for 14 days in rats and assessment of various biochemical and functional parameters in animal blood and various organs.	Chronic administration of the essential oil resulted in ↓ red blood cells and ↓ lymphocytes (no significant pattern on the white blood cells and mean cell vol ume), ↑ neutrophils, ↑ monocytes and ↑ liver-body weight ratio, as well as ↑ serum level of cholesterol, triglyceride, high-density lipoprotein-cholesterol and ↑ inorganic phosphate. Moreover, ↑ alkaline phosphatase activity which indicates its stimulatory effect on liver function. In 500 μL/kg concentration it showed ↑ kidney-body weight ratio, ↓ se rum urea and ↓ atherogenic index. So the oil is notcompletely safe nor apparently toxic.	-	38
Veterinary performance-in vivo	Leaf	Aqueous extract in drinking water of broiler chicks	Administration of the leaf powder to broiler chicken diet and assessment of body weight, food intake, various organ weight	The plant showed ↑ weight gain, ↑ feed intake, ↑ water intake, ↑ feed conversion productivity, ↑ dressing percentage and ↑ weight of different body organs (leg, breast and thigh), as well as ↓ mortality significantly.	-	39
Gastronomical disorder-clinical trial	Leaf	The capsule contain powder of M.longifolia and 2 other herbs	Castor oil induced diarrheal model in mice (1) and relaxant effect on isolated rabbit jejunum (2).	The extracts showed ↓gastrointestinal motility (1), inhibition of spontaneous and high concentration of K+ -induced contractions and also blocking calcium channel of jejunum (2), the petroleum spirit fraction showed highest action	-	40
Toxicity in vivo	Leaf	Aqueous extract	Intraperitoneal (i.p) and oral administration of the extract for assessment of acute toxicity in mice.	The oral and i.p administration of the extract did not showed any toxic sign and mortality up to 3200 and 1730 mg/kg, respectively.	-	41
Menstruation disorder-clinical trial	Leaf	Ethanol extract	Double-blind, randomized, placebo-controlled, multicenter study on 120 women with secondary amenorrhea and oligomenorrhea.	Administration of the plant resulted in higher number of women with bleeding during the first cycle in comparison with placebo group ($P < 0.001$) and ↑ regularity of menstruation markedly compared with placebo ($P < 0.001$), with ↓ luteinizing hormone (LH) compared with the placebo ($P < 0.002$) and no changes of total testosterone, free testosterone and follicle-stimulating hormone (FSH). The extract did not show complication or side effects.	Pipritone oxide, caryophyllene oxide and pulegone	42
Menstruation disorder-clinical trial	Leaf	Tea	Pilot clinical study on 27 patients with premature ovarian failure, M. longifolia tea (250 mL, % 8 g/L), three times a day for 2 weeks.	After 2 weeks administration of herbal medicine, 85.19 % of patient showed normal menstruation with significant decrease in FSH [(79.39 ± 19.17) to (27.83 ± 16.14) mIU/mL, $P < 0.001$].	-	43
Keratinocyte protective-in vitro	Leaf	Methanol extract and various fractions	H_2O_2-induced oxidative stress in human keratinocyte cell line using cellular viability by MTT [3-(4,5-dimethylthiazolyl) diphenyl tetrazolium bromide] assay (1), DNA and protein damage using Western Blot analyses (2), antioxidant activity using enzymatic assay (3).	The protective activity on keratinocyte against oxidative stress (1) with ↓ protein and DNA damage (2), antioxidant activity including glutathione and ↑ superoxide dismutase and↑ also inhibition of lipid peroxidation (3) which was comparable to standard compounds.	Rosmarinic acid and eriodictyol-glycopyranosy 1-rhamnopyranoside	44,45
Gastronomical in vivo and in vitro	Leaf	Methanol 30% extract	Castor oil induced diarrheal model in mice (1) and relaxant effect on isolated rabbit jejunum (2)	The extracts showed ↓gastrointestinal motility (1), inhibition of spontaneous and high concentration of K+ -induced contractions and also blocking calcium channel of jejunum (2), the petroleum spirit fraction showed highest action.	-	

Antioxidant in vitro	Leaf	methanol-water(8:2)extract	Lipid peroxidation activity determination by ferric thiocya nate method (1), xanthine-oxidase activity (2), DPPH radi cal scavenging activity (3) degradation of deoxyribose by the hydroxyl radical (deoxyribose assay) (4).	The extract showed inhibition of lipid peroxidation (1), the inhibitory action on xanthine-oxidase (2), ↑DPPH radical scavenging (3), ↓ degradation of deoxyribose by the hydroxyl radical.	-	46,47
Antioxidant in vitro	Leaf	Essential oil and methanol extract	2,2-diphenyl-1-picrylhydrazyl (DPPH) radical-scavenging (1) and β-carotene-linoleic acid assay (2).	Both essential oil and methanol extract showed DPPH radical-scavenging activity. Methanol extract had higher radical scavenging action than the oil (1). Both extract showed weak in hibit	In essential oil:cis-piperitone epoxide,piperitenoneoide & menthone	48
Anti parasitic in vitro	Leaf	Water ,ethanol and chloroform extract	The effect of plant extracts against Entamoeba histolytica and Giardia duodenalis incubated in intestinal epithelial cell culture.	Ethanol and chloroform extracts showed an ti-parasitic activity and inhibition of the growth of both protozoa, ethanol extract had higher action.	Menthol and menthone	49
Antipyrectic in vivo	Leaf	Aqueous extract	Lipopolysaccharide (LPS)-induced pyrexia in rat.	The extract showed ↓ pyrexia in animals significantly.	-	50,51
Antiviral in vitro	Leaf	Menthanol extract and ethyl acetate extract	Acute infection of human immunodeficiency virus type 1 (HIV-1) on cell culture and reverse transcriptase enzyme as sessment.	Plant extracts demonstated inhibitory action on human immunodeficiency virus type 1 (HIV-1) infection via prevention of HIV-1 reverse transcriptase enzyme	Flavones	52,53
Hepatoprotective in vivo	Leaf	Ethanol extract and various fractions	Effect of pretreatment with plant extracts on CCl4 induced oxidative stress and hepatotoxicity in mice.	The extracts showed hepatoprotective function through enhancement of antioxidant power in cluding; ↑glutathione content and ↑superox ide dismutase activity and ↓ lipid peroxida tion as well as ↓cytochrome P450.	Luteolin glycosides,apigenin glycosides and phenolic acids	54
Gastronomical disorder in vitro	Leaf	Hydroalcohalic extract	Effect of the plant extract on carbachol, KCl and BaC12 -induced contraction in ileum of Wistar rat.	The extract significantly demonstrated inhibito ry action on spasm in all experimental models. So antispasmodic effect is due to blocking calcium mobilization and potassium channels mechanisms.	-	55
Anthelmintic in vivo	Aerial part	Aqueous and ethanol extracts	Administration of plant extracts to pinworm para- sites (Syphacia obvelata and Aspiculuris tetrap- tera) infected mice	The extracts showed anthelmintic activity against both pin worm parasites in mice.		56
Anti -insect-bioassay	Leaf and flower	Essential oil	Essential oil administrated to stored product pests; the flour beetle (Tribolium castaneum) and the cowpea weevil (	The essential oil showed insecticidal action on both species; flour beetle and cowpea weevil.		57
Anti-inflammatory-in vitro	leaf	Essential oil and methanol extract	Lipopolysaccharide (LPS)-stimulated inflammato- ry assay on macrophage cell with measurement of nitric oxide (NO) production, inducible NO syn- thase (iNOS) and tumor necrosis factor (TNF-α) mRNA expression.	The plant extracts showed anti-inflammatory action via ↓NO, ↑NO scavenging and ↓ iNOS and ↓ TNF- α mRNA expression, among the fractions, only hexane fraction had anti-inflammatory activity.		58
Antimicrobial in vitro	leaf	Essential oil and menthol extract	Antimicrobial assay against 38 microbial strain in- cluding; 23 bacteria and 15 yeasts and fungi through disc-diffusion and micro-well dilution method.	The methanol extract did not show antimi-crobial activity. The essential oil demonstrat-ed antimicrobial action on 15 bacteria and all of the assessed yeast and fungi. Of thesusceptible bacteria, the highest action was observed against Bacillus macerans and Staphylococcus aureus.	In essential oil: cis-piperitone epoxide, piperitenone oxide, pulegone and menthone	59

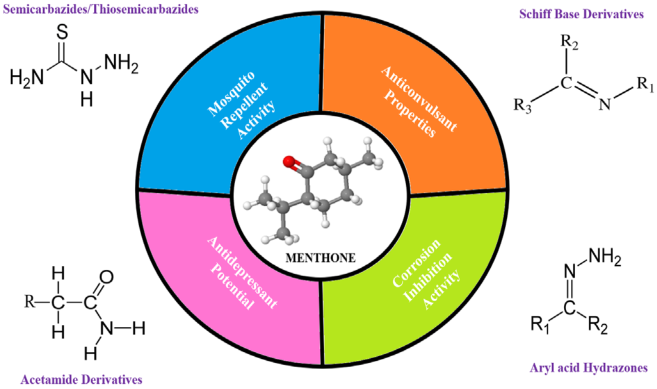

Figure 3: Different derivatives of menthone and their pharmacological importance

diverse therapeutic potential, bolstering its historic use in a range of medicinal formulations and pointing to directions for future investigation in pharmaceutical research.[62,63]

Novel Menthone Derivatives and their Pharmacological Activities

Novel menthone derivatives have emerged as promising compounds in pharmacological research, showcasing diverse activities and therapeutic potential.[64] These derivatives, synthesized through innovative chemical modifications of the menthone structure, exhibit a spectrum of pharmacological activities, ranging from analgesic and anti-inflammatory properties to antimicrobial and antioxidant effects.[65] Their intricate molecular structures offer a platform for exploring new avenues in drug development, with potential applications in various therapeutic areas. The exploration of novel menthone derivatives underscores the continuous quest for innovative pharmacological agents with enhanced efficacy and reduced side effects, promising a future of improved healthcare interventions.[66]

Jain J. et. al, 2007 have synthesized Schiff bases of menthone derived from menthol found in plant. Menthone has been reacted with hydrobromic acid in the presence of ethanol as catalyst. Further, reaction product was washed, purified and basified using sodium hydroxide solution. In another method, Menthone has been reacted with napthyl amine in the presence of zinc chloride (fused) in alcohol. Reactants were refluxed for 3 hrs. Novel derivatives were isolated and purified. They have evaluated novel derivatives of menthone for their anticonvulsant and behavioural depressant properties and found that compound 2 has been found to be more potent at 20 mg/kg dose solution.[67]

Ansari A. et al., 2020 have synthesized acetamide derivatives of menthone in the presence of DMF and potassium carbonate to yield 7-isopropyl-4 methyl-4,5,6,7-tetrahydro-1H-indazole (HMP) and 7-isopropyl-4-methyl-1-phenyl--4,5,6,7-tetrahydro-1H-indazole (PMP). HMP and PMP has been evaluated for their corrosion inhibition activity. Monte Carlo simulation studies have been used and specifically PMP have been observed with higher adsorption energy scores.[68,69]

Jain J et. al., 2010 have synthesized semicarbazides and thiosemicarbazide derivatives of menthone. They have evaluated anticonvulsant potential of novel derivatives of menthone using scPTZ model. Scientists have concluded that menthone semicarbazides could be considered as a lead compound for novel anti-convulsant discoveries.[70]

Samarasekara R. et. al., 2007 have synthesized series of menthone derivatives including menthyl chloroacetate, menthyl dichloroacetate, menthyl cinnamate, menthone glyceryl acetal, thymol and mugetanol. Derivatives have been evaluated for their mosquito repellent properties.[71]

Jain J. et. al., 2011 have syntehsized aryl acid hydrazones of menthone and further evaluated for their anticonvulsant potential. Acid hydrazone derivatives of emnthoen have been foud to enable higher protection in minimal clonic seizures as discussed in figure 3. They have concluded that menthone hydrazones are also safer molecules for anti-convulsant therapy than menthone derivatives of Schiff bases, thiosemicarbazides, semicarbazides.[72,73]

Conclusion

In conclusion, the exploration of natural products, particularly those derived from plants, continues to be a vital field in drug development, with approximately 80% of the global population utilizing around 20,000 plant species for traditional medicinal purposes. Among these, the genus Mentha, especially peppermint (*Mentha piperita*), stands out due to its extensive therapeutic applications and significant economic value. Peppermint's essential oils, rich in specialized metabolites like aromatic compounds and terpenoids, exhibit a range of biological activities, including anti-inflammatory, antimicrobial, antioxidant, and antiviral properties. Traditionally, peppermint has been employed in various cultures for treating digestive issues, headaches, respiratory conditions, and skin ailments. Phytochemical investigations reveal its rich composition of menthol, menthone, phenolic compounds, and flavonoids, contributing to its diverse pharmacological effects. Despite numerous studies, a comprehensive review of peppermint's botanical characteristics, traditional uses, chemical constituents, and pharmacological activities remains necessary. This review aims to bridge that gap, providing a thorough synthesis of existing literature and highlighting peppermint's potential in future pharmaceutical research, thereby reaffirming its role as a valuable botanical ally in the quest for health and well-being.

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Conflict of Interest

Authors declare no conflict of interest.

Animal Ethical Approval

Not Applicable.

References

1. Ahmed, N., Mahmood, A., Mahmood, A., … S. T.-J. of, & 2014, undefined. (n.d.). Relative importance of indigenous medicinal plants from Layyah district, Punjab Province, Pakistan. Elsevier. Retrieved January 3, 2024, from https://www.sciencedirect.com/science/article/pii/S0378874114004218
2. Akinmoladun, A., … E. O.-J. of M., & 2010, undefined. (n.d.). Evaluation of antioxidant and free radical scavenging capacities of some Nigerian indigenous medicinal plants. Liebertpub.Com. Retrieved January 3, 2024, from https://www.liebertpub.com/doi/abs/10.1089/jmf.2008.0292
3. Akinmoladun, A. C., Obuotor, E. M., & Farombi, E. O. (2010). Evaluation of antioxidant and free radical scavenging capacities of some Nigerian indigenous medicinal plants. Journal of Medicinal Food, 13(2), 444–451. https://doi.org/10.1089/JMF.2008.0292
4. Alam, G., Bali, S., Singh, M. P., Singh, A., & Singh, P. (2011). Wound healing potential of some medicinal plants. Researchgate.Net, 22(1). https://www.researchgate.net/profile/Dr-Alam-10/publication/258920339_Wound_healing_potential_of_some_medicinal_plants/links/0deec5296ce0f07f23000000/Wound-healing-potential-of-some-medicinal-plants.pdf
5. Al-Khattaf, F., Mani, A., Hatamleh, A., and, I. A.-J. of infection, & 2021, undefined. (n.d.). Antimicrobial and cytotoxic activities of isoniazid connected menthone derivatives and their investigation of clinical pathogens causing infectious disease. Elsevier. Retrieved May 12, 2024, from https://www.sciencedirect.com/science/article/pii/S1876034121000022
6. Al-Khattaf, F. S., Mani, A., Atef Hatamleh, A., & Akbar, I. (2021a). Antimicrobial and cytotoxic activities of isoniazid connected menthone derivatives and their investigation of clinical pathogens causing infectious disease. Journal of Infection and Public Health, 14(4), 533–542. https://doi.org/10.1016/J.JIPH.2020.12.033
7. Al-Khattaf, F. S., Mani, A., Atef Hatamleh, A., & Akbar, I. (2021b). Antimicrobial and cytotoxic activities of isoniazid connected menthone derivatives and their investigation of clinical pathogens causing infectious disease. Journal of Infection and Public Health, 14(4), 533–542. https://doi.org/10.1016/j.jiph.2020.12.033
8. Ankli, A., Heinrich, M., Bork, P., … L. W.-J. of, & 2002, undefined. (n.d.). Yucatec Mayan medicinal plants: evaluation based on indigenous uses. Elsevier. Retrieved January 3, 2024, from https://www.sciencedirect.com/science/article/pii/S0378874101003555
9. Ansari, A., Manssouri, M., Laghchimi, A., Znini, M., Lakbaibi, Z., & Azrour, M. (2020). Experimental and theoretical study on corrosion inhibition of new synthesized menthone derivatives (Menthopyrazole compounds) for mild steel in 1 M HCl solution. Medjchem-v3.Azurewebsites.Net, 2020(1), 62–76. https://doi.org/10.13171/mjc101020291189aa
10. Bouyahya, A., Abrini, J., Et-Touys, A., Medicine, Y. B.-… of I., & 2017, undefined. (n.d.). Indigenous knowledge of the use of medicinal plants in the North-West of Morocco and their biological activities. Elsevier. Retrieved January 3, 2024, from https://www.sciencedirect.com/science/article/pii/S1876382017301130
11. CHEN, G., ZHOU, D., WANG, C. M., & LI, N. (2022). Advances in the role of natural products in human gene expression. Chinese Journal of Natural Medicines, 20(1), 1–8. https://doi.org/10.1016/S1875-5364(22)60147-X
12. Chen, N. Y., Xie, Y. L., Lu, G. D., Ye, F., Li, X. Y., Huang, Y. W., Huang, M. L., Chen, T. Y., & Li, C. P. (2021). Synthesis and antitumor evaluation of (aryl)methyl-amine derivatives of dehydroabietic acid-based B ring-fused-thiazole as potential PI3K/AKT/mTOR signaling pathway inhibitors. Molecular Diversity, 25(2), 967–979. https://doi.org/10.1007/S11030-020-10081-7
13. Dahlberg, A., Ecology, S. T.-H., & 2009, undefined. (2009). Indigenous medicine and primary health care: The importance of lay knowledge and use of medicinal plants in rural South Africa. Springer, 37(1), 79–94. https://doi.org/10.1007/s10745-009-9217-6
14. Dimitrov, V., & Panev, S. (2000). First example of axial selectivity in the nucleophilic addition to (-)-menthone-addition of cyanomethyl lithium. Tetrahedron Asymmetry, 11(7), 1513–1516. https://doi.org/10.1016/S0957-4166(00)00099-9
15. Ensley, H. E., & Reale, M. J. (2012). 3.4 Terpene Derived Auxiliaries: Menthol and Pulegone Derived Auxiliaries. Comprehensive Chirality, 3, 106–152. https://doi.org/10.1016/B978-0-08-095167-6.00304-9
16. Funk, R. L., & Yang, G. (1999). C(1)-substituted menthol derivatives: Self-removing chiral auxiliaries for asymmetric conjugate additions to cycloalkenones. Tetrahedron Letters, 40(6), 1073–1074. https://doi.org/10.1016/S0040-4039(98)02627-6
17. Ghuman, S., Ncube, B., Finnie, J., … L. M.-S. A. J. of, & 2019, undefined. (n.d.). Antioxidant, anti-inflammatory and wound healing properties of medicinal plant extracts used to treat wounds and dermatological disorders. Elsevier. Retrieved January 3, 2024, from https://www.sciencedirect.com/science/article/pii/S0254629919307689
18. Giovana, C. B., Simone, N. B. de F., Priscilla, de L. S., Paula, C. A., Marcelo, F. G. B., Marcelle, M. B.-R., Janaina, P. B., Thais, R. de O., & Jose, F. H. (2016). Antifungal and cytotoxic activity of purified biocomponents as carvone, menthone, menthofuran and pulegone from Mentha spp. African Journal of Plant Science, 10(10), 203–210. https://doi.org/10.5897/AJPS2016.1454
19. Halterman, R. L., & Crow, L. D. (2003). Preparation of chiral annulated indenes derived from nopinone, verbenone

and menthone. Tetrahedron Letters, 44(14), 2907–2909. https://doi.org/10.1016/S0040-4039(03)00430-1
20. Heinrich, M., Jiang, H., Scotti, F., Booker, A., Walt, H., Weckerle, C., & Maake, C. (2021). Medicinal plants from the Himalayan region for potential novel antimicrobial and anti-inflammatory skin treatments. Academic.Oup.Com, 73, 956–967. https://doi.org/10.1093/jpp/rgab039
21. Hou, H. D., Wu, C. Y., Zhou, J., Long, F., Shen, H., Xu, J. Di, Zhou, S. S., Mao, Q., Wei, Y. J., & Li, S. L. (2023). Accumulation patterns of major bioactive components in two chemotypes of Agastache rugosa during flower development evaluated by GC-QQQ-MS/MS and UPLC-QTOF-MS/MS analyses. Industrial Crops and Products, 191. https://doi.org/10.1016/j.indcrop.2022.115942
22. Huang, M., Duan, W., Chen, N., Lin, G., Chemistry, X. W.-F. in, & 2022, undefined. (n.d.). Synthesis and antitumor evaluation of menthone-derived pyrimidine-urea compounds as potential PI3K/Akt/mTOR signaling pathway inhibitor. Frontiersin.Org. https://doi.org/10.3389/fchem.2021.815531
23. Ishtiaq, M., Mahmood, A., ethnopharmacology, M. M.-J. of, & 2015, undefined. (n.d.). Indigenous knowledge of medicinal plants from Sudhanoti district (AJK), Pakistan. Elsevier. Retrieved January 3, 2024, from https://www.sciencedirect.com/science/article/pii/S0378874115000690
24. Jain, J., Kumar, Y., Kumar, Y., Sinha, R., Kumar, R., & Stables, J. (2011). Menthone aryl acid hydrazones: a new class of anticonvulsants. Ingentaconnect.Com, 7, 56–61. https://doi.org/10.2174/157340611794072689
25. Jain, J., Kumar, Y., Stables, J., Chemistry, R. S.-M., & 2010, undefined. (2010). Menthone semicarbazides and thiosemicarbazides as anticonvulsant agents. Ingentaconnect.Com, 6, 44–50. https://doi.org/10.2174/157340610791208727
26. Kadir, M., Sayeed, M., ethnopharmacology, M. M.-J. of, & 2012, undefined. (n.d.). Ethnopharmacological survey of medicinal plants used by indigenous and tribal people in Rangamati, Bangladesh. Elsevier. Retrieved January 3, 2024, from https://www.sciencedirect.com/science/article/pii/S0378874112006745
27. Kaushik, R., Jain, J., Yadav, R., Singh, L., Gupta, D., & Gupta, A. (2017). Isolation of β-Asarone from Acorus Calamus Linn. And Evaluation of its Anticonvulsant Activity using MES and PTZ Models in Mice. Pharmacology, Toxicology and Biomedical Reports, 3(2), 21–26. https://doi.org/10.5530/ptb.2017.3.4
28. Kaushik, R., & Sharma, B. (2012). ESTABLISHMENT OF MONOGRAPH OF ACORUS CALAMUS LINN. RHIZOMES. Journal of Drug Delivery and Therapeutics, 2(3). https://doi.org/10.22270/jddt.v2i3.174
29. Keylor, M. H., Matsuura, B. S., & Stephenson, C. R. J. (2015). Chemistry and Biology of Resveratrol-Derived Natural Products. Chemical Reviews, 115(17), 8976–9027. https://doi.org/10.1021/CR500689B
30. Khan, N., Traditional, A. R.-A. J. of, & 2006, undefined. (2006). A study on the indigenous medicinal plants and healing practices in Chittagong Hill Tracts (Bangladesh). Journals.Athmsi.Org, 3(3), 37–47. https://journals.athmsi.org/index.php/ajtcam/article/view/111
31. Kunwar, R., Acharya, R., … C. C.-J. of, & 2015, undefined. (n.d.). Medicinal plant dynamics in indigenous medicines in farwest Nepal. Elsevier. Retrieved January 3, 2024, from https://www.sciencedirect.com/science/article/pii/S0378874115000501
32. Lub, J., Hoeve, W. Ten, Nijssen, W. P. M., & Wegh, R. T. (2002). The effect of substituents on the helical twisting power of aldol condensation products of menthone. Liquid Crystals, 29(1), 71–77. https://doi.org/10.1080/02678290110086541
33. Mahmood, A., Mahmood, A., … R. M.-J. of, & 2013, undefined. (n.d.). Indigenous knowledge of medicinal plants from Gujranwala district, Pakistan. Elsevier. Retrieved January 3, 2024, from https://www.sciencedirect.com/science/article/pii/S0378874113003711
34. Mason, J., Protection, T. P.-C., & 1996, undefined. (n.d.). Response of European starlings to menthone derivatives: evidence for stereochemical differences in repellency. Elsevier. Retrieved May 12, 2024, from https://www.sciencedirect.com/science/article/pii/S0261219496000464
35. Mason, J. R., & Primus, T. (1996). Response of European starlings to menthone derivatives: Evidence for stereochemical differences in repellency. Crop Protection, 15(8), 723–726. https://doi.org/10.1016/s0261-2194(96)00046-4
36. McNiven, N., (Resumed), J. R.-J. of the C. S., & 1952, undefined. (n.d.). 34. Researches in the menthone series. Part XVII. Configurations of menthols and menthylamines. Pubs.Rsc.Org. Retrieved May 12, 2024, from https://pubs.rsc.org/en/content/articlepdf/1952/jr/jr9520000153
37. Mena, E., Van De Witte, P., & Lub, J. (2000). Camphor and nopinone derivatives as new photosensitive chiral dopants. Liquid Crystals, 27(7), 929–933. https://doi.org/10.1080/02678290050043888
38. Mena, E., Witte, P. Van De, Crystals, J. L.-L., & 2000, undefined. (n.d.). Camphor and nopinone derivatives as new photosensitive chiral dopants. Taylor & Francis. Retrieved May 12, 2024, from https://www.tandfonline.com/doi/abs/10.1080/02678290050043888
39. Mishra, V., Pandeya, S., … C. P.-… der P. A., & 2002, undefined. (n.d.). Anti-HIV activity of thiosemicarbazone and semicarbazone derivatives of (±)-3-menthone. Wiley Online Library. Retrieved May 12, 2024, from https://onlinelibrary.wiley.com/doi/abs/10.1002/1521-4184(200205)335:5%3C183::AID-ARDP183%3E3.0.CO;2-U
40. Nagori, B., Plant, R. S.-R. J. of M., & 2011, undefined. (n.d.). Role of medicinal plants in wound healing. Academia.Edu. Retrieved January 3, 2024, from https://www.academia.edu/download/5344671/392-405.pdf
41. Nesterkina, M., Barbalat, D., Zheltvay, I., & Rakipov, I.

(2019). Novel menthone derivatives with anticonvulsant effect. https://www.academia.edu/download/94282048/slides.pdf
42. Odey, M., Iwara, I., Udiba, U., … J. J.-… J. of S., & 2012, undefined. (2012). Preparation of plant extracts from indigenous medicinal plants. Researchgate. Net, 1(12). https://www.researchgate.net/profile/Odey-Oko/publication/259176629_Preparation_of_Plant_Extracts_from_Indigenous_Medicinal_Plants/links/0c96052a200c6c69c1000000/Preparation-of-Plant-Extracts-from-Indigenous-Medicinal-Plants.pdf
43. Owusu, E., Mensah Ahorlu, M., Afutu, E., Akumwena, A., & Asare, G. A. (2021). Antimicrobial activity of selected medicinal plants from a sub-Saharan African country against bacterial pathogens from post-operative wound infections. Mdpi.Com. https://doi.org/10.3390/medsci9020023
44. Pan, S., Litscher, G., Gao, S., Zhou, S., medicine, Z. Y.-… alternative, & 2014, undefined. (n.d.). Historical perspective of traditional indigenous medical practices: the current renaissance and conservation of herbal resources. Hindawi.Com. Retrieved January 3, 2024, from https://www.hindawi.com/journals/ECAM/2014/525340/
45. Panev, S., Asymmetry, V. D.-T., & 2000, undefined. (n.d.). Cerium (III) chloride promoted addition of organometallic reagents to (−)-menthone—preparation of chiral neomenthyl derivatives. Elsevier. Retrieved May 12, 2024, from https://www.sciencedirect.com/science/article/pii/S0957416600000872
46. Panev, S., & Dimitrov, V. (2000). Cerium(III) chloride promoted addition of organometallic reagents to (-)-menthone-preparation of chiral neomenthyl derivatives. Tetrahedron Asymmetry, 11(7), 1517–1526. https://doi.org/10.1016/S0957-4166(00)00087-2
47. Pharmacology, A. J.-I. J. of, & 1998, undefined. (n.d.). Nature heals, a glossary of selected indigenous medicinal plants of India. Ijp-Online.Com. Retrieved January 3, 2024, from https://www.ijp-online.com/article.asp?issn=0253-7613;year=1998;volume=30;issue=2;spage=126;epage=126;aulast=Jayvir;type=0
48. Ravi, P., Ravichandran, R., A, S. D.-J. of M. C., & 1999, undefined. (n.d.). Stereoselective hydrogenation of (R)-(+)-pulegone and (2S, 5R)-(−)-menthone in presence of β-cyclodextrin and its derivatives. Elsevier. Retrieved May 12, 2024, from https://www.sciencedirect.com/science/article/pii/S1381116999000369
49. Ravi, P., Ravichandran, R., & Divakar, S. (1999). Stereoselective hydrogenation of (R)-(+)-pulegone and (2S,5R)-(-)- menthone in presence of β-cyclodextrin and its derivatives. Journal of Molecular Catalysis A: Chemical, 148(1–2), 145–155. https://doi.org/10.1016/S1381-1169(99)00036-9
50. Ravichandran, R., Chemical, S. D.-J. of M. C. A., & 1996, undefined. (n.d.). β-Cyclodextrin and its derivatives directed axial attack of hydride ion in the reduction of (R)-(+)-pulegone and (2S, 5R)-(−)-menthone. Elsevier. Retrieved May 12, 2024, from https://www.sciencedirect.com/science/article/pii/1381116996000349
51. Reviews, J. R.-C., & 1930, undefined. (n.d.). Recent Progress in the Menthone Chemistry. ACS Publications. Retrieved May 12, 2024, from https://pubs.acs.org/doi/pdf/10.1021/cr60025a001
52. Rojas, R., Bustamante, B., Bauer, J., … I. F.-J. of, & 2003, undefined. (n.d.). Antimicrobial activity of selected Peruvian medicinal plants. Elsevier. Retrieved January 3, 2024, from https://www.sciencedirect.com/science/article/pii/S0378874103002125
53. Rouzier, F., Sillé, R., Montiège, O., Tessier, A., Pipelier, M., Dujardin, G., Martel, A., Nourry, A., & Guillarme, S. (2020). Synthesis of Constrained C-Glycosyl Amino Acid Derivatives Involving 1,3-Dipolar Cycloaddition of Cyclic Nitrone as Key Step. European Journal of Organic Chemistry, 2020(43), 6749–6757. https://doi.org/10.1002/EJOC.202001162
54. Sadat-Hosseini, M., Farajpour, M., … N. B.-J. of, & 2017, undefined. (n.d.). Ethnopharmacological studies of indigenous medicinal plants in the south of Kerman, Iran. Elsevier. Retrieved January 3, 2024, from https://www.sciencedirect.com/science/article/pii/S0378874117304464
55. Sadeghi, Z., Kuhestani, K., … V. A.-J. of, & 2014, undefined. (n.d.). Ethnopharmacological studies of indigenous medicinal plants of Saravan region, Baluchistan, Iran. Elsevier. Retrieved January 3, 2024, from https://www.sciencedirect.com/science/article/pii/S037887411400035X
56. Samarasekera, R., … I. W.-P. M., & 2008, undefined. (n.d.). Insecticidal activity of menthol derivatives against mosquitoes. Wiley Online Library. Retrieved May 12, 2024, from https://onlinelibrary.wiley.com/doi/abs/10.1002/ps.1516
57. Samarasekera, R., Weerasinghe, I. S., & Hemalal, K. D. P. (2008). Insecticidal activity of menthol derivatives against mosquitoes. Pest Management Science, 64(3), 290–295. https://doi.org/10.1002/PS.1516
58. Sharif, A., Asif, H., Younis, W., Riaz, H., Ali Bukhari, I., & Mohamed Assiri, A. (2018). Indigenous medicinal plants of Pakistan used to treat skin diseases: a review. Springer, 13(1). https://doi.org/10.1186/s13020-018-0210-0
59. Sharma, A., Khanna, S., Kaur, G., Pharmaceutical, I. S.-F. J. of, & 2021, undefined. (n.d.). Medicinal plants and their components for wound healing applications. Springer. Retrieved January 3, 2024, from https://link.springer.com/article/10.1186/s43094-021-00202-w?crsi=662497082&cicada_org_src=healthwebmagazine.com&cicada_org_mdm=direct
60. Sharma, A., Khanna, S., Kaur, G., & Singh, I. (2021). Medicinal plants and their components for wound healing applications. Future Journal of Pharmaceutical Sciences, 7(1). https://doi.org/10.1186/S43094-021-00202-W

61. Shedoeva, A., Leavesley, D., Upton, Z., Medicine, C. F. A., & 2019, undefined. (n.d.). Wound healing and the use of medicinal plants. Hindawi.Com. Retrieved January 3, 2024, from https://www.hindawi.com/journals/ecam/2019/2684108/abs/
62. Sun, Y., Xun, K., Wang, Y., & Chen, X. (2009). A systematic review of the anticancer properties of berberine, a natural product from Chinese herbs. Anti-Cancer Drugs, 20(9), 757–769. https://doi.org/10.1097/CAD.0b013e328330d95b
63. Taye, B., Giday, M., Animut, A., Tropical, J. S.-A. P. J. of, & 2011, undefined. (n.d.). Antibacterial activities of selected medicinal plants in traditional treatment of human wounds in Ethiopia. Elsevier. Retrieved January 3, 2024, from https://www.sciencedirect.com/science/article/pii/S2221169111600828
64. Ullah, M., Khan, M., Mahmood, A., … R. M.-J. of, & 2013, undefined. (n.d.). An ethnobotanical survey of indigenous medicinal plants in Wana district south Waziristan agency, Pakistan. Elsevier. Retrieved January 3, 2024, from https://www.sciencedirect.com/science/article/pii/S037887411300679X
65. Umair, M., Altaf, M., one, A. A.-P., & 2017, undefined. (2017). An ethnobotanical survey of indigenous medicinal plants in Hafizabad district, Punjab-Pakistan. Journals.Plos.Org, 12(6). https://doi.org/10.1371/journal.pone.0177912
66. Uprety, Y., Asselin, H., Boon, E., … S. Y.-J. of ethnobiology, & 2010, undefined. (2010). Indigenous use and bio-efficacy of medicinal plants in the Rasuwa District, Central Nepal. Springer. https://link.springer.com/article/10.1186/1746-4269-6-3
67. Uprety, Y., Asselin, H., Boon, E. K., Yadav, S., & Shrestha, K. K. (2010). Indigenous use and bio-efficacy of medicinal plants in the Rasuwa District, Central Nepal. Journal of Ethnobiology and Ethnomedicine, 6. https://doi.org/10.1186/1746-4269-6-3
68. Verma, S., & Chauhan, N. S. (2007). Indigenous medicinal plants knowledge of Kunihar forest division, district Solan. Indian Journal of Traditional Knowledge, 6(3), 494–497. https://nopr.niscpr.res.in/handle/123456789/987
69. Witte, P., Galan, J., crystals, J. L.-L., & 1998, undefined. (n.d.). Modification of the pitch of chiral nematic liquid crystals by means of photoisomerization of chiral dopants. Taylor & Francis. Retrieved May 12, 2024, from https://www.tandfonline.com/doi/abs/10.1080/026782998206632
70. Woerpel, K. A., & Zuckerman, D. S. (2020). Synthesis of enantiopure triols from racemic Baylis–Hillman adducts using a diastereoselective peroxidation reaction. Organic Letters, 22(22), 9075–9080. https://doi.org/10.1021/ACS.ORGLETT.0C03439
71. Yakovleva, M., Denisova, K., … G. M.-C. of natural, & 2018, undefined. (n.d.). Synthesis of Optically Active Macrolides From L-Menthone Derivatives and Hydrazides of Adipic and 2, 6-Pyridinedicarboxylic Acids. Springer. Retrieved May 12, 2024, from https://link.springer.com/article/10.1007/s10600-018-2387-y
72. Yakovleva, M. P., Denisova, K. S., Mingaleeva, G. R., Gazetdinov, R. R., & Ishmuratov, G. Y. (2018). Synthesis of Optically Active Macrolides From L-Menthone Derivatives and Hydrazides of Adipic and 2,6-Pyridinedicarboxylic Acids. Chemistry of Natural Compounds, 54(3), 496–498. https://doi.org/10.1007/S10600-018-2387-Y
73. Zougagh, M., Aranda, P., Castañeda, G., & Ríos, Á. (2009). Supercritical fluid extraction-Achiral liquid chromatography with circular dichroism detection for the determination of menthone enantiomers in natural peppermint oil samples. Talanta, 79(2), 284–288. https://doi.org/10.1016/j.talanta.2009.03.047

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