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Review Article

Effects of Carvacrol supplementation in human health: A narrative Review

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Abstract

Carvacrol is a natural compound, a phenolic monoterpenoid, and is found naturally in thyme, wild bergamot, black cumin, and oregano. Carvacrol has been shown in various in vivo and in vitro studies to have anticancer, anti-inflammatory, neuroprotective, antimicrobial, antibacterial, and antioxidant effects. The objective of this review is to verify the influence of carvacrol in different physiological situations. The results show the positive effects of carvacrol intake, such as: antioxidant action, anti-inflammatory activity, a preventive effect on neuronal damage, antimicrobial activity especially against fungi, the ability to induce apoptosis, and antibacterial action against different strains. In conclusion, carvacrol intake has beneficial effects in different types of physiological situations such as cancer, inflammation, bacterial and microbial infection, neuronal protection, and cellular oxidation.

Keywords: carvacrol, anticancer, neuroprotective, antioxidant and anti-inflammatory.

Introduction

Carvacrol (Figure 1) is a phenolic monoterpenoid and is found naturally in thyme, wild bergamot, black cumin, and oregano. Thyme oil contains 5% to 75% carvacrol [1].

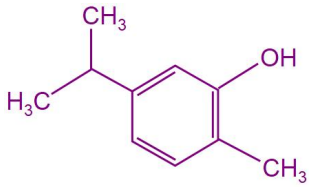

Figure 1. Carvacrol structure.

The biological activities of carvacrol (Figure 2) have been demonstrated in various in vivo and in vitro studies, including its anticancer, anti-inflammatory, neuroprotective, antimicrobial, antibacterial and antioxidant effects [1].

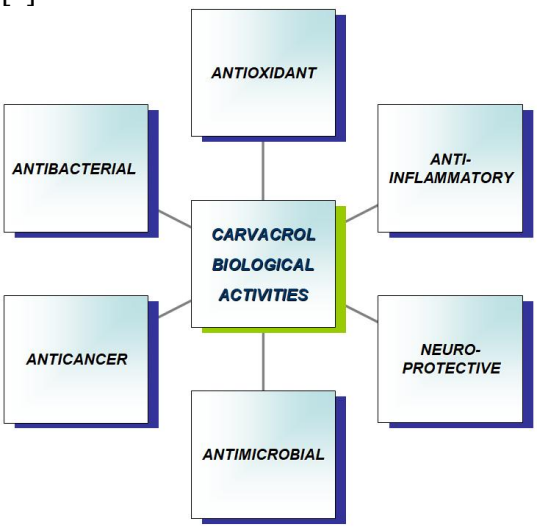

Figure 2. Biological activities of the carvacrol.

The antibacterial activity of carvacrol significantly inhibits bacterial growth, with its efficacy comparable to that of ciprofloxacin. Carvacrol acts by damaging the cell membrane, increasing its permeability, and altering the cell wall, similar to other phenolic compounds, and is effective against both gram-positive and gram-negative bacteria [2]. Recent studies have shown that carvacrol can amplify the inhibitory effects of certain conventional drugs, such as tetracycline, erythromycin, and fluconazole [3].

The antioxidant activity of carvacrol is due to its hydroxyl group (–OH), which donates hydrogen atoms to neutralize free radicals. Its ability to scavenge radicals such as superoxide and nitric oxide makes it a protective agent against oxidative stress. At the oxidative level, carvacrol has shown protective effects on the brain, liver, and kidneys. Furthermore, its hepatoprotective action against injuries such as acute pancreatitis has been investigated [1].

Prostaglandins play an important role in the inflammatory process. Cyclooxygenase (COX) is involved in the synthesis of these chemicals and has three isoforms: COX-1, COX-2, and COX-3. COX-2 is rapidly expressed by extracellular stimuli as part of the inflammatory response and is associated with inflammatory symptoms such as pain and fever. The effect of carvacrol on COX-2 gene expression was studied, and a decrease in COX-2 gene expression was observed at carvacrol concentrations of 0.008% and 0.016% [4].

The alzheimer disease accounts for 60% to 70% of dementia cases in older adults. It is characterized by neuronal loss in the hippocampus and cerebral cortex, leading to cognitive decline. Although current treatments are limited, slow-acting phytochemicals are showing therapeutic potential. Among them, carvacrol has demonstrated promising efficacy against neurological diseases due to its anti-inflammatory, antioxidant, and neuroprotective activity [5].

Antimicrobial resistance represents a growing threat to global public health. Carvacrol has demonstrated direct antimicrobial activity against human, animal, and plant pathogens, including resistant and biofilm-forming strains. Its primary mechanism involves disrupting the structural and functional integrity of the cytoplasmic membrane, leading to cell disruption and microbial death. Its efficacy makes it a promising natural candidate against antimicrobial resistance [6].

Cancer is one of the leading causes of mortality worldwide, driven by aging, population growth, and socioeconomic factors. Of the anticancer therapies approved between 1940 and 2014, approximately 50% are derived from natural products or their derivatives. Carvacrol, a natural phenolic compound, has demonstrated efficacy in cancer cell lines such as A549, DU145, HL-60, Jurkat, PC-3, and human colon, inducing apoptosis as its main mechanism of action, reinforcing its potential as a natural anticancer agent [7].

The objective of this review article is to conduct a broad and comprehensive analysis of the available scientific evidence on the role of carvacrol as an antimicrobial, antibacterial, anticancer, neuroprotective, anti-inflammatory, and antioxidant agent.

Material and Methods

A review study was conducted to answer the following research question: What effects does carvacrol administration have on human health, its mechanisms of action, and therapeutic applications?

For this review, various scientific sources were consulted, including articles and research published in medical and pharmacological journals, clinical studies, books, and scientific reviews obtained from biomedical databases such as PubMed, Scopus, and ScienceDirect in June 2025, on the use of carvacrol in various conditions affecting human

health.

The studies included in this review were selected based on the following criteria: recent publications within the last 20 years to ensure up-to-date information; studies with rigorous methodology and peer review; research analyzing the effects of carvacrol in humans and animals; and clinical trials evaluating its efficacy in various human health applications.

The analysis of the effects of carvacrol was conducted by reviewing the available scientific literature. Studies were classified according to their approach: pharmacological, clinical, or experimental. Finally, results were compared across different studies to identify common patterns.

Results

Antioxidant effects

In a study led by Canli et al. an oregano oil extract was analyzed, identifying carvacrol as its main component. Carvacrol exhibited significant antioxidant capacity, surpassing ascorbic acid. The results indicate that carvacrol has great potential as an antioxidant [8].

The authors Ebhohimen et al. compared the antioxidant capacity of carvacrol. They used in vitro methods and computational simulations to evaluate its efficacy. Carvacrol showed superior antioxidant performance and greater binding affinity to the lipoxygenase enzyme. The findings suggest that carvacrol may be an effective alternative to synthetic antioxidants for preserving lipid-rich foods [9].

Anti-inflammatory effects

Mortazavi et al. evaluated the effects of carvacrol on inflammation. Improvements in inflammatory mediators were observed. The results suggest that carvacrol has strong anti-inflammatory potential [10].

In the review study by Mączka et al. they demonstrated that carvacrol has anti-inflammatory activity. It is also effective in reducing proinflammatory cytokines [11].

A recent study by Cacciatore et al., evaluated the potential anti-inflammatory effects of carvacrol. Compounds were obtained by combining carvacrol with various anti-inflammatory drugs such as ibuprofen, flurbiprofen, and naproxen. The carvacrol and naproxen compound stood out for its stability and efficacy in vitro, making it the most promising candidate against inflammation [12].

In a study led by Marinelli et al. combined formulations of water-soluble carvacrol and hyaluronic acid were shown to improve wound repair and modulate the inflammatory response [13].

Neuroprotective effects

Azizi et al. stated in their study that they analyzed the neuroprotective potential of carvacrol in neurodegenerative diseases, highlighting its anti-inflammatory, antioxidant, and acetylcholinesterase inhibitory actions. Improvements in neurological symptoms were observed, with particular emphasis on Alzheimer's disease. Carvacrol is positioned as a promising candidate in the development of treatments for neurodegenerative disorders [14].

Azizi et al. found in their study that carvacrol could improve cognitive decline in a rat model of Alzheimer's disease. Carvacrol had a preventive effect on neuronal damage observed through histological staining. The results suggest that carvacrol may have neuroprotective effects [15].

The study by Javed et al. highlighted the therapeutic potential of carvacrol in neurodegenerative diseases such as Alzheimer's and Parkinson's. Due to its antioxidant, anti-inflammatory, and neuroprotective properties, carvacrol can modulate oxidative stress and reduce inflammation, contributing to improved memory, cognition, and motor function [16].

Wang et al. investigated the neuroprotective effects of carvacrol

against ethanol-induced neuronal damage in the hippocampus. Using in vivo and in vitro models, they found that carvacrol reduced cognitive dysfunction, oxidative stress, and apoptosis in hippocampal neurons. The results showed that carvacrol exerts its protective action through antioxidant and antiapoptotic mechanisms [17].

Antimicrobial effects

The study conducted by Al-Tawalbeh et al. evaluated the effect of carvacrol combined with antibiotics such as linezolid, minocycline, or sulfamethoxazole, significantly improving antimicrobial activity compared to monotherapy. The results indicate a synergistic action of carvacrol against resistant strains [18].

A study conducted by Soltani et al. demonstrated the antimicrobial activity of carvacrol as the main bioactive compound, showing high efficacy against multidrug-resistant bacteria and fungi, whether administered alone or in combination with antibiotics, producing enzyme inhibition and cell membrane damage [19].

Wang et al. conducted a study evaluating the effect of carvacrol on Aeromonas hydrophila, a common pathogen in aquatic environments. Carvacrol significantly reduced the virulence of the bacteria by inhibiting key factors such as biofilm and hemolysin, in addition to suppressing the expression of related genes. It showed a synergistic effect when combined with neomycin sulfate, protecting fish from infections, suggesting its potential as a therapeutic agent in aquatic systems [20].

Walasek-Janusz et al. showed in their study that carvacrol had strong antimicrobial activity, especially against fungi [21].

Anticancer effects

Machado et al. analyzed the antitumor potential of carvacrol, demonstrating significant inhibition of tumor growth both in vitro and in vivo. The mechanisms involved include apoptosis, cell cycle alterations, ROS production, and other cellular processes. They also confirmed carvacrol's anticancer properties against various types of cancer [22].

Sampaio et al. analyzed the antitumor effects of carvacrol, demonstrating its ability to induce apoptosis, arrest the cell cycle, and inhibit metastasis, highlighting its potential as a natural therapeutic agent against cancer [23].

A study by Spyridopoulou et al. evaluated the anticancer effects of carvacrol, highlighting its antiproliferative action against colorectal cancer cells and its ability to induce apoptosis [24].

Antibacterial effects

Chroho et al. found in their study that carvacrol demonstrated potent antibacterial action against six strains, even surpassing synthetic antibiotics [25].

The study by Su et al. showed that carvacrol had strong antibacterial activity against Staphylococcus aureus, inhibiting biofilms and altering cell permeability. These results support carvacrol's potential as a natural therapeutic agent [26].

Conclusions and Future Directions

The conclusions of this review highlight that carvacrol intake has beneficial effects in different physiological situations:

- Carvacrol has great potential as an antioxidant.

- Carvacrol has anti-inflammatory activity.

- Carvacrol has a preventative effect on neuronal damage.

- Carvacrol exhibits strong antimicrobial activity, especially against fungi.

- Carvacrol has demonstrated its ability to induce apoptosis, arrest the cell cycle, and inhibit metastasis, highlighting its potential as a natural therapeutic agent against cancer.

- Carvacrol exhibits potent antibacterial action against different strains, even surpassing synthetic antibiotics.

Carvacrol shows very promising results in prevention and combination treatment in different physiological situations, with anticancer, anti-inflammatory, neuroprotective, antimicrobial, antibacterial, and antioxidant effects. Therefore, it is essential to have more scientific evidence on the effects of carvacrol in these physiological situations.

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References

1) Imran M, Aslam M, Alsagaby SA, et al. Therapeutic application of carvacrol: A comprehensive review. *Food Sci Nutr*. 2022; 10(11):3544-3561. doi:10.1002/fsn3.2994

2) Bnyan, I.A.; Abid, A.T.; Obied, H.N. Antibacterial Activity of Carvacrol against Different Types of Bacteria. *J Nat Sci Res*. 2014; 4:2224–3186.

3) Marchese, A.; Arciola, C.R.; Coppo, E.; Barbieri, R.; Barreca, D.; Chebaibi, S.; Sobarzo-Sanchez, E.; Nabavi, S.F.; Nabavi, S.M.; Daglia, M. The natural plant compound carvacrol as an antimicrobial and anti-biofilm agent: Mechanisms, synergies and bio-inspired anti-infective materials. *Biofouling*. 2018;34: 630–656.

4) Mączka W, Twardawska M, Grabarczyk M, Wińska K. Carvacrol-A Natural Phenolic Compound with Antimicrobial Properties. *Antibiotics*. 2023; 12(5):824. doi:10.3390/antibiotics12050824

5) Javed H, Mohamed Fizur NM, Jha NK, Ashraf GM, Ojha S. Neuroprotective Potential and Underlying Pharmacological Mechanism of Carvacrol for Alzheimer's and Parkinson's Diseases. *Curr Neuropharmacol*. 2023; 21(6):1421-1432. doi:10.2174/1570159X21666221223120251

6) Walasek-Janusz M, Grzegorczyk A, Malm A, Nurzyńska-Wierdak R, Zalewski D. Chemical Composition, and Antioxidant and Antimicrobial Activity of Oregano Essential Oil. *Molecules*. 2024; 29(2):435. doi:10.3390/molecules29020435

7) Machado TQ, da Fonseca ACC, Duarte ABS, Robbs BK, de Sousa DP. A Narrative Review of the Antitumor Activity of Monoterpenes from Essential Oils: An Update. *Biomed Res Int*. 2022;2022:6317201. doi:10.1155/2022/6317201

8) Canli K, Bozyel ME, Turu D, Benek A, Simsek O, Altuner EM. Biochemical, Antioxidant Properties and Antimicrobial Activity of Steno-Endemic Origanum onites. *Microorganisms*. 2023; 11(8):1987. doi:10.3390/microorganisms11081987

9) Ebhohimen IE, Okolie NP, Okpeku M, Unweator M, Adeleke VT, Edemhanria L. Evaluation of the Antioxidant Properties of Carvacrol as a Prospective Replacement for Crude Essential Oils and Synthetic Antioxidants in Food Storage. *Molecules*. 2023; 28(3):1315. doi:10.3390/molecules28031315

10) Mortazavi A, Mohammad Pour Kargar H, Beheshti F, Anaeigoudari A, Vaezi G, Hosseini M. The effects of carvacrol on oxidative stress, inflammation, and liver function indicators in a systemic inflammation model induced by lipopolysaccharide in rats. *Int J Vitam Nutr Res*. 2023; 93(2):111-121. doi:10.1024/0300-9831/a000711

11) Mączka W, Twardawska M, Grabarczyk M, Wińska K. Carvacrol-A Natural Phenolic Compound with Antimicrobial Properties. *Antibiotics*.

2023; 12(5):824. doi:10.3390/antibiotics12050824

12) Cacciatore I, Spalletta S, Di Rienzo A, et al. Anti-Obesity and Anti-Inflammatory Effects of Novel Carvacrol Derivatives on 3T3-L1 and WJ-MSCs Cells. *Pharmaceuticals*. 2023; 16(3):340. doi:10.3390/ph16030340

13) Marinelli L, Cacciatore I, Costantini E, et al. Wound-Healing Promotion and Anti-Inflammatory Properties of Carvacrol Prodrugs/Hyaluronic Acid Formulations. *Pharmaceutics*. 2022; 14(7):1468. doi:10.3390/pharmaceutics14071468

14) Azizi Z, Majlessi N, Choopani S, Naghdi N. Neuroprotective effects of carvacrol against Alzheimer's disease and other neurodegenerative diseases: A review. *Avicenna J Phytomed*. 2022; 12(4):371-387. doi:10.22038/AJP.2022.19491

15) Azizi Z, Choopani S, Salimi M, Majlessi N, Naghdi N. Protein Kinase C Involvement in Neuroprotective Effects of Thymol and Carvacrol Against Toxicity Induced by Amyloid-β in Rat Hippocampal Neurons. *Basic Clin Neurosci*. 2022; 13(3):295-304. doi:10.32598/bcn.2021.666.2

16) Javed H, Mohamed Fizur NM, Jha NK, Ashraf GM, Ojha S. Neuroprotective Potential and Underlying Pharmacological Mechanism of Carvacrol for Alzheimer's and Parkinson's Diseases. *Curr Neuropharmacol*. 2023; 21(6):1421-1432. doi:10.2174/1570159X21666221223120251

17) Wang P, Luo Q, Qiao H, et al. The Neuroprotective Effects of Carvacrol on Ethanol-Induced Hippocampal Neurons Impairment via the Antioxidative and Antiapoptotic Pathways. *Oxid Med Cell Longev*. 2017; 2017:4079425. doi:10.1155/2017/4079425

18) Al-Tawalbeh D, Alkhawaldeh Y, Abu Sawan H, Al-Mamoori F, Al-Samydai A, Mayyas A. Assessment of carvacrol-antibiotic combinations' antimicrobial activity against methicillin-resistant Staphylococcus aureus. *Front Microbiol*. 2024; 14:1349550. doi:10.3389/fmicb.2023.1349550

19) Soltani S, Shakeri A, Iranshahi M, Boozari M. A Review of the Phytochemistry and Antimicrobial Properties of Origanum vulgare L. and Subspecies. *Iran J Pharm Res*. 2021; 20(2):268-285. doi:10.22037/ijpr.2020.113874.14539

20) Wang J, Qin T, Chen K, Pan L, Xie J, Xi B. Antimicrobial and Antivirulence Activities of Carvacrol against Pathogenic Aeromonas hydrophila. *Microorganisms*. 2022; 10(11):2170. doi:10.3390/microorganisms10112170

21) Walasek-Janusz M, Grzegorczyk A, Malm A, Nurzyńska-Wierdak R, Zalewski D. Chemical Composition, and Antioxidant and Antimicrobial Activity of Oregano Essential Oil. *Molecules*. 2024; 29(2):435. doi:10.3390/molecules29020435

22) Machado TQ, da Fonseca ACC, Duarte ABS, Robbs BK, de Sousa DP. A Narrative Review of the Antitumor Activity of Monoterpenes from Essential Oils: An Update. *Biomed Res Int*. 2022; 2022:6317201. doi:10.1155/2022/6317201

23) Sampaio LA, Pina LTS, Serafini MR, Tavares DDS, Guimarães AG. Antitumor Effects of Carvacrol and Thymol: A Systematic Review. *Front Pharmacol*. 2021; 12:702487. doi:10.3389/fphar.2021.702487

24) Spyridopoulou K, Fitsiou E, Bouloukosta E, et al. Extraction, Chemical Composition, and Anticancer Potential of Origanum onites L. Essential Oil. *Molecules*.

2019; 24(14):2612. doi:10.3390/molecules24142612

25) Chroho M, Rouphael Y, Petropoulos SA, Bouissane L. Carvacrol and Thymol Content Affects the Antioxidant and Antibacterial Activity of Origanum compactum and Thymus zygis Essential Oils. *Antibiotics*. 2024; 13(2):139. doi:10.3390/antibiotics13020139

26) Su F, Yang G, Hu D, et al. Chemical Composition, Antibacterial and Antioxidant Activities of Essential Oil from Centipeda minima. *Molecules*. 2023; 28(2):824. doi:10.3390/molecules28020824

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