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"A Review on Rosemary Herbs"

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ABSTRACT
Rosemary (Rosmarinus officinalis) is recognized for its extensive pharmacological activities, notably its potent antioxidant and anti-inflammatory effects.Its active constituents, including carnosol and Rosmarinus acid, assist in mitigating oxidative stress and inflammation, rendering rosemary a potential therapeutic option for conditions associated with oxidative damage, such as ischemic stroke.Current studies suggest that rosemary possesses the capacity to enhance cognitive performance, safeguard against conditions associated with oxidative stress, and contribute to improved metabolic and cardiovascular function. Owing to its wide spectrum of bioactive properties and favorable safety profile, rosemary remains an important subject of research for the development of new therapeutic agents and nutraceutical products.

Keywords: photochemistry, essential oils, rosmarinic acid, antioxidant, anti-inflammatory, and antimicrobial.

I. INTRODUCTION

Herbal medicines and natural products have been employed in traditional medical practices since ancient times. Corresponding to this increasing demand, global research into the medicinal and pharmacological properties of plant-derived compounds has expanded significantly. Among these medicinal plants, Rosmarinus officinalis L., commonly known as rosemary, has received considerable scientific attention. Rosemary, a perennial evergreen shrub within the family Alliaceae, is esteemed both as a source of essential oils and as a culinary herb. Archaeological and anthropological evidence indicates that rosemary has historically been utilized in traditional medicine, gastronomy, and cosmetic formulations. Recent scientific studies have increasingly focused on the therapeutic potential of various rosemary extracts and their bioactive constituents. Morphologically, the plant exhibits a well-developed root and stem system with numerous branches. Its linear, needle-like leaves are bright green, approximately 3 cm in length, and borne on short petioles. The abaxial (lower) surface of the leaves contains glandular trichomes that secrete essential oils. The plant produces blue flowers towards the apices of its stems and bears dark-colored, smooth, rounded fruits. The parts of the plant most used for economic and medicinal purposes are the leaves and flowers. Rosemary leaves typically contain between 0.3% and 2.5% essential oil. Moreover, rosemary juice has demonstrated antiseptic properties and has been reported to enhance blood circulation in the skin. For these reasons, fresh or dried rosemary leaves are frequently used as a culinary additive, not only for flavor enhancement but also for their reported antidepressant and antiviral activities.[1]

1: Rosmarinus officinalis

Botanical Classification of Rosemary

- **Common Name:** Rosemary
- **Hindi Name:** Gulmehandi [1]
- **Species:** S. Rosmarinus
- **Biological Name:** Salvia Rosmarinus. [2]

Historical Uses and Therapeutic Uses

Rosemary has historically been employed for a variety of therapeutic purposes, including the alleviation of muscular pain, stimulation of hair growth, enhancement of memory, immune system support, and promotion of circulatory and anti-inflammatory functions. Furthermore, a molecular docking study conducted by Estela Fernandes-e-research Silva in 2020 suggested that rosemary's antiviral potential may be associated with its ability to bind to the spike protein, indicating its possible role as a protective agent against the novel

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coronavirus. This review aims to consolidate comprehensive information on Rosmarinus officinalis, encompassing its botanical characteristics, geographical distribution, phytochemical constituents, and traditional medicinal applications. [3]

2. Health Benefits of Rosemary

Therapeutic Parameter

Antioxidant Activity:

Detrimental effects of reactive oxygen species (ROS), which might be produced by daily environmental stresses or physical exertion, are greatly reduced by antioxidants. A compound that suppresses oxidation, especially the deterioration of things that have been stored, is called an antioxidant. One such plant known for its antioxidant action is rosemary (Rosmarinus officinalis), which aids in shielding cells from oxidative damage brought on by free radicals. Previous research has linked this function to the polyphenolic chemicals found in rosemary leaves, including rosmarinic acid, carnosol, and carnosic acid. These molecules tend to build up in cell lipid membranes, where they exhibit antioxidant properties. A study conducted by a research group demonstrated that exposing dried rosemary leaves to gamma radiation generally enhanced their antioxidant activity compared to untreated samples. However, the extent of this enhancement varied depending on the extraction solvent used. Methanol extracts showed minimal change in activity post-irradiation, while ethanol and water extracts exhibited a significant increase in antioxidant capacity. Interestingly, methanol extracts consistently showed higher total phenolic content and antioxidant activity regardless of irradiation. These results highlight how important the extraction solvent is in affecting the phenolic concentration and antioxidant potential. [1]

Anti-infectious action:

Most plants produce antimicrobial secondary metabolites in response to pathogenic attacks and environmental stressors or as part of their regular growth and developmental processes. The application of essential oils has emerged as a novel strategy to inhibit microbial proliferation. These substances interact with microbial cell membranes, changing the composition of fatty acids, disrupting electron transport, changing genetic material and nutrition pathways, and causing cellular contents to seep out. They also disrupt membrane-associated proteins, which causes the integrity and functionality of the membrane to be lost. [2]

3: Pharmacological value of R. officinalis [4]

Sl. No.	Tissue	Extract	Activity
1	Leaves	Super critical CO2	Anti-tumours activity
2	Leaves	Methanol extract	Anti-inflammatory effect
3	Leaf	aqueous extract	Anti-pyretic, improve circulation
4	Whole plant	Methanol extracts	Anti-microbial activity
5	leaves	acetone extract	Food additive
6	Whole plant	Aqueous Extract	Choleretic and hepatoprotective activities
7	Leaf	Ethanol extract	Anti-cancer activity
8	Whole plants	n-hexane extract	Anti-oxidative activity

Antibacterial-Antimicrobial-Antifungal Activity:

The use of aromatic and therapeutic plants in the culinary, pharmaceutical, and agricultural industries has significantly increased in recent years. These plants' secondary metabolites, which give them antifungal, antibacterial, and antioxidant qualities, are primarily responsible for this

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increased interest. Among these, rosemary (Rosmarinus officinalis) has been widely studied for its potent antibacterial activity, which is closely linked to its unique chemical constituents. Numerous investigations have assessed the antimicrobial potential of plant-derived extracts. Additionally, research has indicated that oil-based formulations of rosemary exhibit pronounced antimicrobial effects. The increasing prevalence of health complications, including various forms of cancer, liver diseases, and hormonal imbalances associated with chemical residues in agricultural products, has prompted interest in essential oils as natural, eco-friendly alternatives to synthetic fungicides. The polymorphic fungus Candida albicans can cause a wide range of infections, from minor skin disorders to serious systemic illnesses. Studies have shown that rosemary essential oil possesses inhibitory effects against C. albicans, a common human pathogen. Furthermore, rosemary oil has demonstrated antifungal activity against Aspergillus Niger, a significant pathogen affecting humans, plants, and animals alike. [1]

Activities of the CNS and endocrine system:

One of the most common metabolic diseases in the world is diabetes mellitus. Insulin and oral hypoglycaemic medications are frequently used to treat it, although they don't provide a cure and frequently have significant side effects. Several in vivo studies have demonstrated that rosemary may contribute to reductions in blood glucose levels. Additionally, both in vitro and in vivo research has indicated that carnosic acid, a major constituent of rosemary, can inhibit gastric lipase activity in Zucker rats. Improved triglyceride profiles have been associated with this inhibition. Carnosic acid and carnosol seem to be key players in glycaemic control modulation. This has led to intensified research into the therapeutic potential of Rosmarinus officinalis. In relation to depression, multiple studies have reported reduced immobility time in animal models, along with modulation of key neurotransmitters, namely dopamine, norepinephrine, serotonin, and acetylcholine. Rosmarinus acid, another bioactive compound in rosemary, has shown potential in the context of neurodegenerative diseases. It has exhibited cholinergic and neuroprotective properties, including the inhibition of acetylcholinesterase, suggesting possible therapeutic applications in conditions such as Alzheimer's disease. The findings revealed a significant enhancement in memory speed a parameter considered predictive of cognitive performance during aging when using culinary doses of rosemary. These findings reinforce the need for more research on the effects of low-dose rosemary supplementation on cognition. The additional tables that go with the original publication contain more detailed information from in vitro and in vivo investigations. [5]

Migraine

Migraine is characterized by a range of symptoms, with the most prominent being a unilateral, throbbing or pulsating headache. The pain may initially present as a mild, dull ache that progressively intensifies into a pulsing sensation of varying severity ranging from mild to severe. According to a study by BK Gökçe et al., rosemary has demonstrated potential as a CAM, or complementary and alternative medicine, is used to treat main headache conditions. [6]

Phytochemical Profile and Bioactive Compounds

Primary Active Constituents

The therapeutic potential of rosemary is attributed to its diverse phytochemical composition, particularly its abundance of phenolic diterpenes and volatile constituents. Compounds exhibit synergistic interactions that underpin the herb's notable antioxidant, anti-inflammatory, and neuroprotective effects. [7] & [8]

Carnosic Acid and Carnosol

Carnosic acid is recognized as the most prevalent and pharmacologically potent constituent in rosemary, comprising up to 30% of certain extracts. As a phenolic diterpene, it serves as a key antioxidant by scavenging reactive oxygen species (ROS), during which it is oxidized to form carnosol and other related metabolites. Empirical evidence indicates a direct association between carnosic acid intake and ROS neutralization within plant tissues, thereby establishing its function as an effective free radical quencher. Carnosol, the principal oxidation product of carnosic acid, contributes to antioxidant defense through distinct mechanisms, primarily by inhibiting lipid peroxidation rather than engaging in direct ROS scavenging. Together, these complementary pathways constitute what has been described as a 'unique and highly effective antioxidant system,' affording robust protection against oxidative damage. [8]

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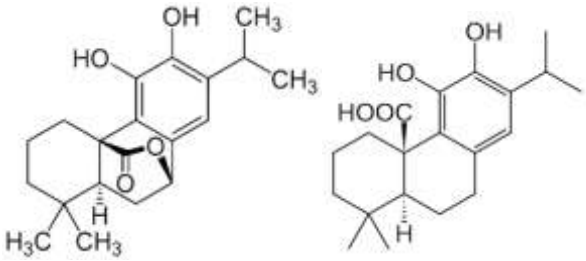
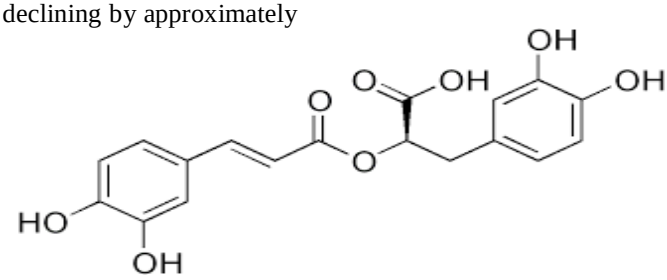


CARNOSOL CARNOSIC ACID

Rosmarinic Acid

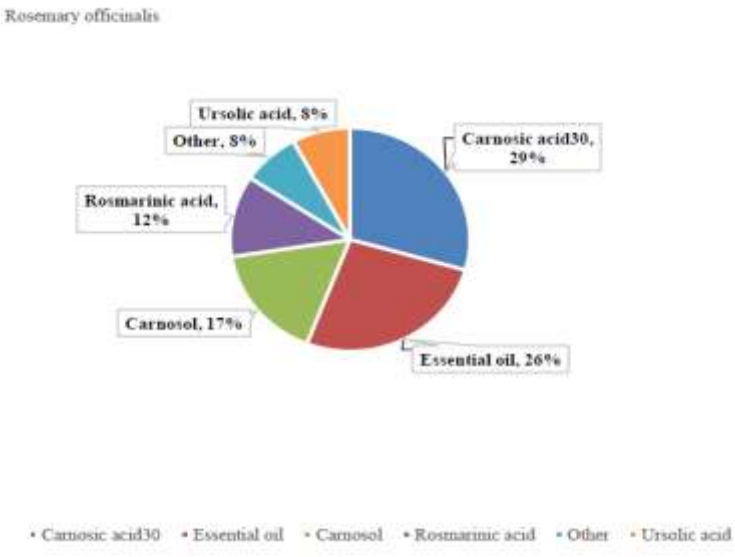
Rosmarinic acid, a phenolic chemical found in many Lamiaceae family members, exhibits significant anti-inflammatory and antimicrobial activities. Unlike carnosic acid which shows marked seasonal variability, reaching peak levels in December and declining by approximately 50% during the summer, rosmarinic acid maintains relatively stable concentrations throughout the year. This temporal consistency supports its use as a dependable marker compound for the quality assessment of rosemary-based formulations [7] & [9]



ROSMARINIC ACID

Essential Oil Components

Rosemary essential oil contains over 18 identified compounds, representing 97.42% of the total oil composition.These compounds contribute to rosemary's characteristic aroma and provide additional therapeutic benefits, including antimicrobial and cognitive-enhancing properties. [10]



4. Chemical substances of Rosemary officinal [11]

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Mechanism of rosemary metabolites in enzyme regulation

5. Mechanism of rosemary metabolites in enzyme regulation [3]

Inhibited	Reduced	Suppressed	Ameliorated	Stimulated
hepatic stellate cells (HSCs)	mRNA Level	Nitrosative Liver Damage	Biochemical Indicator	Antioxidant Defense system
Transforming Growth Factor Beta 1	Hepatic NO Content	P65 Nuclear Translocation	Formation of 3NT	Hepatic TLR4 signaling
connective tissue growth factor	Total Collagen Content	Accumulation of Phagocytosis	TNF-α CoX-2	NrF2/Ho-1 pathway
anti soft muscles Antibody (ASMA)	Lipid Hyperoxide	Liver inflammation		PCNA protein Expression

Cultivation of Rosemary

Climatic Requirements

Rosemary (Salvia Rosmarinus) flourishes in climates that resemble the Mediterranean region, which are typified by arid summers and mild winters. Optimal growth occurs within a temperature range of 15 °C to 25 °C; however, the species can with stand temperatures as low as -6 °C under certain conditions.

Light Requirements

Low light levels sometimes lead to weak, extended stems and decreased essential oil production, which lowers the plant's medicinal and culinary effectiveness.

Soil Requirements

Rosemary thrives in sandy or loamy, one of main causes cultivation failure in this plant is still root rot, which is greatly increased by excessive wetness or inadequate drainage.

Propagation Methods

Seed Propagation:

Although rosemary (Salvia Rosmarinus) can be propagated from seed, this method is generally considered inefficient due to its slow germination rate and the need for optimal environmental conditions. Seedlings typically require up to three weeks to germinate, and even then, success rates are often low.

Cuttings for Propagation:

The most reliable and popular technique for growing rosemary is vegetative propagation via stem cuttings. This technique not only accelerates plant establishment but also ensures the preservation of desirable traits from the parent plant.

Layering Technique:

Layering, which entails bending a low-growing stem into the soil and securing it while it is still linked to the parent plant, is an alternate and efficient propagation technique. Over, time, the buried portion of the stem develops roots and can subsequently be detached and transplanted as a new, independent plant.

6: Rosemary under Drip irrigation

Cultivation Practices

Irrigation Requirements:

Once established, rosemary exhibits significant drought tolerance and does not require frequent irrigation.

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7: Nursery raising and Seedlings of Rosemary.

Nutrient Management:

Although not a heavy feeder, rosemary benefits from periodic fertilization, especially in nutrient-poor soils or when grown in containers. Vigorous growth can also be encouraged by organic substitutes like compost, seaweed extract, or diluted fish emulsion.

Pruning Practices:

Regular pruning is critical for maintaining plant health, enhancing bushiness, and preventing excessive elongation. The optimal time for pruning is during the active growth phase in spring or early summer. For shaping purposes, approximately one-third of the plant's height can be trimmed back, ensuring cuts are made just above leaf nodes to stimulate new growth. Caution should be taken to avoid cutting into older, woody stems, as these areas regenerate slowly and may not recover well.

8: Rosemary under Mulching.

Mulching:

Applying mulch around rosemary plants contributes to soil moisture retention, temperature regulation, and weed suppression. In warmer climates, mulch helps retain moisture and prevents soil overheating, while in colder regions, it provides insulation to protect the root system. The mulch layer should be monitored regularly and replenished as needed to maintain its effectiveness and to keep the planting area weed-free.

Harvesting and Postharvest Handling

Harvesting:

Rosemary may be harvested throughout the year, though the optimal time is immediately prior to the flowering stage, when the concentration of essential oils is at its peak.

Drying and Storage:

To preserve rosemary for future use, harvested sprigs should be bundled and hung upside down in a dry, warm, and well-ventilated environment. Once fully dried, the leaves can be removed from the stems and stored in airtight containers, away from direct sunlight. Alternatively, rosemary may be frozen or used fresh for culinary and medicinal purposes. [12]

Rosemary Uses

Rosemary (Rosmarinus officinalis) is extensively utilized across various industries due to its multifunctional properties. The incorporation of aqueous rosemary extracts has been shown to enhance the sensory attributes of yogurt, including flavour, texture, appearance, and overall acceptability. It possesses preservative and pesticidal properties, making it valuable in agricultural and food applications. According to Waithaka et al., rosemary essential oil extracts effectively control fungal diseases in maize. Furthermore, its efficacy as a fumigant against bruchid pests under storage conditions has been documented. Additionally, components of rosemary essential oil exhibit notable antimicrobial properties, including antibacterial and antiviral activities. [13]

II. CONCLUSION

Rosemary (Salvia Rosmarinus, formerly Rosmarinus officinalis) is a multifunctional medicinal and aromatic plant with significant pharmacological, nutritional, and industrial relevance. compounds contribute therapeutic potential in managing oxidative stress-related disorders, neurodegenerative diseases, metabolic syndromes, and infections. Because of its essential oils and inherent preserving properties, rosemary is used not just in medicine but also in food preservation, cosmetics, and agriculture. Overall, the diverse pharmacological profile and wide-ranging applications of rosemary highlight its value

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as a promising natural resource for future pharmaceutical and nutraceutical developments.

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