

Rosemary: A Journey of Exploration

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Abstract

Rosemary is a perennial plant that belongs to Lamiaceae family. This herb which is native to Mediterranean region, and also in countries like Spain and Portugal is a rich source of volatile compounds like flavonoids, terpenes and essential oils. The richness of these components makes Rosemary an excellent antioxidant, anti-inflammatory and anti-microbial agent. Despite possessing an array of beneficial properties, rosemary's consumption remains relatively low in India, primarily due to its limited availability and lack of widespread cultivation in the country. This article will help to pursue knowledge regarding the physico-chemical and engineering properties of the Chinna Coonoor (Ooty) Variety of Rosemary and also understand the effect of different drying and oil extraction methods used.

Introduction

Rosemary (*Salvia Rosmarinus*) is an aromatic perennial plant which requires cool winter and mild summer below 30° C for its growth. It is usually planted during the months of June-July and September - October under rain fed conditions. The genus name Rosmarinus is developed from the Latin words "ros" (dew) and "marinus" (sea), resulting in the name "dew of the sea," which likely refers to the plant's ability to thrive in coastal areas and withstand ocean mists.

Rosemary belongs to the class of aromatic and therapeutic plants, that are differentiated by their high essential oil production. These plants are rich in terpenes, phenolic compounds, terpenoids, and other phytochemicals, which are bioactive substances with specific Anti-bacterial and Anti-oxidant effects. The most common phenolic compounds in rosemary are flavonoids such as naringenin, eriodictiol, hesperidin, vicenin-2, luteolin-7-glucuronide, apigenin, and luteolin; diterpenes such as carnosol and carnosic acid; and phenyl propanoic acids such as caffeic acid, rosmarinic acid, and salvianolic acids (Peng et al., 2022)

Drying Methods

Drying is a crucial pre-treatment step in the extraction of essential oil from aromatic herbs like rosemary. It helps in reducing moisture content,

enhancing shelf life, and often improving oil yield by facilitating the rupture of oil glands. The method of drying significantly influences the quantity and quality of the essential oil extracted. In this study, several drying methods were employed to prepare rosemary leaves prior to hydro-distillation, each offering distinct thermal and structural impacts on the plant material.

1. Tray Drying (Hot Air Drying)

Tray drying is a conventional and widely used method where rosemary leaves are spread in thin layers on perforated trays and exposed to a controlled stream of hot air at set temperatures. In general, drying can be performed at temperatures such as 50°C, 60°C, and 70°C. The process ensures uniform drying and is relatively gentle, preserving many of the volatile compounds in rosemary. Higher drying temperatures (e.g., 70°C) may enhance essential oil yield by facilitating better rupture of oil glands, but excessive heat can also degrade thermally sensitive components.

2. Vacuum Drying

Vacuum drying under reduced pressure, which lowers the boiling point of water and allows drying at lower temperatures. This method is suitable for heat-sensitive materials like medicinal and aromatic herbs. In the case of rosemary, vacuum drying is performed in the range of 45°C to 70°C. Although it offers gentle drying and retains colour and aroma well, oil yield may be lower compared to higher-temperature methods due to less mechanical rupture of oil-containing structures.

3. Microwave Drying

Microwave drying uses electromagnetic radiation to heat the moisture inside the plant cells directly. This leads to rapid drying, typically reducing drying time from hours to minutes. While this method is fast and energy-efficient, it may cause uneven heating or localized overheating, which can result in degradation or loss of volatile compounds. This method may give the lowest essential oil yield due to potential thermal damage.

4. Shade Drying (Optional Traditional Method)

Shade drying is a traditional method wherein leaves are dried naturally in ambient air, away from direct sunlight. It preserves the aroma and sensitive

compounds well but takes longer and is less controllable. It is more prone to microbial contamination and quality variability.

5. Freeze Drying (Lyophilization) – Advanced Method

Freeze drying is an advanced technique where the water content is removed by sublimation under vacuum after freezing the plant material. This method best preserves the structure, aroma, and phytochemical profile but is expensive and less commonly used for bulk essential oil processing.

Essential Oil Extraction

Rosemary essential oil is rich in bioactive compounds, making it valuable for several medicinal uses. To obtain this essential oil from rosemary leaves, several traditional and modern extraction techniques are used. Among the traditional methods, the most commonly employed include steam distillation or hydro-distillation, cold pressing, solvent extraction, enfleurage, and maceration. Each method has its own advantages, limitations, and suitability depending on the nature of the plant material and the intended application of the oil.

Hydro-distillation

This is one of the oldest and most widely adopted techniques for essential oil extraction. In this method, the plant material is submerged in water and brought to a boil. As the water heats up, steam carries the volatile essential oil from the plant, and the vapor mixture is then condensed back into liquid form. The essential oil, being lighter than water, separates and floats on the surface, from where it is collected. A Clevenger apparatus, a laboratory glass setup designed for hydro-distillation, was used for this process in the present study. This method is particularly suitable for rosemary, as it ensures a clean extraction without chemical solvents and can be applied to both fresh and dried leaves.

Cold pressing

This method commonly used for essential oil extraction, particularly from citrus fruits like oranges and lemons. In this mechanical process, the plant material is crushed to squeeze out the oil without applying heat. However, this technique is not effective for rosemary, as its fibrous leaves do not yield oil easily through mechanical pressing.

Solvent extraction

It involves the use of chemical solvents such as hexane or ethanol to dissolve the essential oils from the

plant material. After soaking, the solvent is evaporated, leaving behind a concentrated form of the oil known as an "absolute." This method is useful for heat-sensitive compounds and offers higher yields but has limitations due to potential solvent residues in the final product and the higher cost of processing. Although suitable for delicate flowers or low-yield plants, it is less preferred for rosemary essential oil extraction when purer and more natural methods are available.

Enfleurage

It is an old and gentle method used traditionally for extracting oils from delicate flowers like jasmine. In this method, the plant material is placed on glass plates coated with odorless fat, which absorbs the aromatic compounds over time. The fat is then washed with alcohol to separate the essential oil. While effective for fragile flowers, this method is time-consuming, expensive, and not suitable for hardy, fibrous plants like rosemary.

Maceration method

It is also called as the macerator technique, involves soaking crushed rosemary leaves in a carrier oil, such as olive or sunflower oil, at a warm temperature. Over time, the active components from the plant are transferred into the oil, creating a herbal-infused oil. This method does not yield pure essential oil but is widely used in preparing therapeutic or cosmetic oils. It is simple and low-cost but less potent in comparison to distilled oils.

Modern Trends in Extraction

The traditional methods of extraction are now being developed and replaced by different modern methods. This helps to enhance the quality and the yield of the essential oil obtained in a much efficient manner. Some of the modern methods utilised are:

1. Supercritical Fluid Extraction Method [Using CO₂]
2. Microwave Assisted Hydro distillation.
3. Ultrasonic Extraction

As per a study, it is found that microwave-assisted hydro distillation makes it possible to minimize the extraction time of the essential oils in comparison with conventional hydro distillation. Thus, the same yield of essential oils is obtained for 20 minutes only with MAH while it takes 180 minutes with CH. In addition, the quality of the essential oil is improved to a 1.14% increase in oxygenates. In conclusion, the MAH method offers significant advantages over conventional

hydro distillation and can therefore replace it on a pilot and industrial scale.

The Supercritical Fluid Extraction Method is also a significant method of extraction which produces a high quality essential oil. However, the high cost of the extraction medium makes it unsuitable for use to farmers and also for large scale production.

Ultrasound-assisted extraction (UAE), also termed sonication, is one of non-thermal treatment technologies that has been extensively used for extracting bioactive compounds from medicinal plants. This treatment has been reported to be simple, inexpensive, reliable, along with enhancing the extract yield and quality and inhibiting bioactive substances damage. Furthermore, sonication is considered advantageous because of its short processing time with reduced energy consumption. For the above-mentioned benefits, this technique is considered an environment-friendly and effective alternative to conventional extraction methods.

Benefits Of Rosemary Essential Oil

- Rosemary has significant antimicrobial, anti-inflammatory, anti-oxidant, anti-apoptotic, anti-tumorigenic, antinociceptive, and neuroprotective properties.
- It is a natural medicine in the treatment of the nervous system pathological conditions including anxiety, depression, Alzheimer's disease, epilepsy, Parkinson's disease, and withdrawal syndrome.
- Alleviation of Metabolic Disorders like Obesity and Diabetes
- Effective food preservative due to its high anti-oxidant and anti-microbial activities.
- Rosemary administration has a positive impact on gastrointestinal (GI) health through decreased oxidative stress and inflammation in the GI tract.
- Treatment for hair loss, dermatitis, anxiety, cognitive improvement, constipation, joint and muscle pain, and improvement of circulation.

Scope In Food Industry

This herb is used extensively as a condiment or culinary spice due to its richness of bioactive and volatile compounds like eugenol, rosmarinic acid,

naringenin etc. It is used in a variety of contexts mainly in Middle East and European cuisines. In Mexico, it is used in the tea preparations and also as seasonings over the meat. This enhances the flavour profile and overall palatability of the food. It is also included in the marinades of lamb, pork, and chicken dishes. Minced leaves are added as toppings in dishes like stews, pastas, salads, fish and different types of breads. Due to the herb's significant medicinal value, researches are carried out exploring ways to maximize its use in food products. In India, it is usually used to flavour soups and beverages.

Conclusion

Rosemary is a highly valuable medicinal herb which is yet to be explored and utilised in the field of food and pharmaceutical industry. The abundance of bioactive compounds like flavonoids, terpenes, phenolic compounds make it effective against several ailments. The impact of different drying methods was studied and the most suitable method can be found. The yield and quality of the essential oils extracted were also evaluated by this study. The application of rosemary in different areas were also discussed in this article.

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