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EXTRACTION OF OIL FROM ORANGE PEEL BY STEAM DISTILATION

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Abstract :
This project focuses on the sustainable extraction of essential oil from orange peel utilizing steam distillation. Orange peel, a byproduct of the citrus industry, contains valuable essential oils known for their aromatic and functional properties. Steam distillation, a widely employed technique in essential oil extraction, offers an environmentally friendly and efficient method for obtaining these oils. This study aims to optimize the steam distillation process parameters such as temperature, pressure, and extraction time to enhance the yield and quality of the extracted oil. Additionally, the project explores the potential applications of the extracted orange peel oil in industries such as food, cosmetics, and aromatherapy, highlighting its economic and environmental significance. Through experimental investigation and analysis, this research contributes to the development of sustainable practices in the utilization of agricultural byproducts and the extraction of value-added products.

Key Words: essential oil orange peel, steam Distillation, Extraction.

1.INTRODUCTION

The extraction of essential oils from natural sources has garnered significant attention in recent years due to their diverse applications in various industries such as food, cosmetics, pharmaceuticals, and aromatherapy. Among these natural sources, citrus fruits, including oranges, stand out for their rich content of essential oils found primarily in their peels. Orange peel, a byproduct of the citrus industry, is abundant and possesses valuable aromatic compounds that contribute to its distinct fragrance and therapeutic properties. One of the most common methods employed for the extraction of essential oils from plant materials is steam distillation. This technique involves the use of steam to rupture the oil glands within the plant material, releasing the essential oils, which are then carried along with the steam and subsequently condensed into a liquid form. Steam distillation offers several advantages, including high extraction efficiency, minimal degradation of heat-sensitive compounds, and environmental friendliness, making it a preferred method for obtaining essential oils from botanical sources. In this project, the focus lies on the extraction of oil from orange peel using steam distillation. The utilization of orange peel for oil extraction not only provides a sustainable solution for managing agricultural waste but also presents an opportunity to obtain value-added products with numerous potential applications. By optimizing the steam distillation process parameters such as temperature, pressure, and extraction time, it is possible to enhance the yield and quality of the extracted orange peel oil. Furthermore, the extracted orange peel oil holds promise for diverse industrial applications. Its aromatic profile makes it a desirable ingredient in the formulation of perfumes, cosmetics, and household cleaners. Additionally, the oil's antimicrobial and antioxidant properties render it suitable for use in food preservation and flavoring. Moreover, the therapeutic benefits of orange peel oil, including its mood-enhancing and stress-relieving properties, make it a popular choice in aromatherapy products. Through this project, we aim to contribute to the advancement of sustainable practices in both agriculture and industry. By exploring the extraction of oil from orange peel using steam distillation, we seek to harness the potential of agricultural byproducts while promoting eco-friendly methods for obtaining valuable essential oils. This research endeavors to bridge the gap between agriculture and industry by offering a viable solution for waste management while generating value from underutilized resources.

2. ESSENTIAL OILS

1. **Aromatic Qualities:** The oil possesses a refreshing, tangy aroma that is both invigorating and uplifting. Its bright citrus fragrance is often used in aromatherapy to promote a positive mood, reduce stress, and create an energizing atmosphere.
2. **Therapeutic Benefits**: Rich in compounds such as limonene and citral, orange peel oil offers a wide range of therapeutic benefits. It is known for its antimicrobial properties, which can help inhibit the growth of bacteria, viruses, and fungi, making it useful in natural cleaning and disinfecting applications.
3. **Digestive Support:** Orange peel oil has long been used to support digestive health. It may aid in relieving symptoms of indigestion, bloating, and nausea by promoting healthy digestion and soothing the gastrointestinal tract.
4. **Skin Care:** In skincare, orange peel oil is valued for its astringent and antioxidant properties. It can help tone and rejuvenate the skin, reduce the appearance of acne and blemishes, and improve overall skin texture and appearance.

3. PHYSICAL PROPERTIES OF ESSENTIAL OIL

1. **Color:** Essential oils come in a wide range of colors, from clear to pale yellow, green, or even deep blue or amber, depending on the specific oil. For example, lavender essential oil is typically colorless to pale yellow, while peppermint oil is often pale yellow with a slight green tint.

2. **Viscosity:** Essential oils generally have a low viscosity, meaning they are thin and flow easily. However, some oils may be slightly more viscous than others due to differences in their chemical composition. For example, patchouli essential oil is thicker and more viscous than oils like lemon or tea tree.

3. **Odor:** The aroma of essential oils is one of their most distinctive characteristics. Each oil has its own unique scent profile, ranging from floral and fruity to spicy, woody, or herbaceous. The intensity of the aroma can vary, with some oils being very potent and others more subtle.

4. **Volatility:** Essential oils are highly volatile, meaning they evaporate readily at room temperature. This volatility contributes to their aromatic properties and makes them easily dispersible in the air when diffused or applied topically.

5. **Solubility:** Essential oils are not soluble in water but are soluble in other oils, alcohols, and solvents. This property makes them ideal for use in carrier oils, lotions, and other oil-based formulations. However, essential oils should be properly diluted before direct application to the skin to prevent irritation or sensitization.

6. **Density:** The density of essential oils can vary, but most are less dense than water. This means that they will float on the surface of water if added undiluted, though they can be dispersed in water using emulsifiers or solvents.

7. **Refractive Index:** Essential oils have a refractive index, which is a measure of how much light is bent, or refracted, as it passes through the oil. This property can be used to identify and authenticate essential oils, as different oils have distinct refractive indices.

4. CHEMICAL CONSTITUENTS OF ESSENTIAL OIL

1. **Monoterpenes:** These are simple hydrocarbons with the molecular formula C10H16. Examples include compounds like limonene (found in citrus oils), pinene (found in pine and fir oils), and myrcene (found in hops and lemongrass oils).
2. **Sesquiterpenes:** These are larger terpenes with the molecular formula C15H24. They often have more complex structures and can exhibit a wide range of biological activities. Examples include compounds like β-caryophyllene (found in black pepper and clove oils) and farnesene (found in chamomile and ylang-ylang oils).
3. **Oxygenated Monoterpenes**: These are monoterpenes that have undergone oxidation reactions, resulting in the addition of oxygen atoms to the molecule. Examples include alcohols like linalool (found in lavender and coriander oils), aldehydes like citral (found in lemon and lemongrass oils), and ketones like camphor (found in rosemary and eucalyptus oils).
4. **Oxygenated Sesquiterpenes:** Similar to oxygenated monoterpenes, these are sesquiterpenes that have undergone oxidation reactions. Examples include compounds like nerolidol (found in neroli and ginger oils) and farnesol (found in rose and jasmine oils).
5. **Phenols:** These are aromatic compounds that contain a hydroxyl group (OH) attached to an aromatic ring. Examples include compounds like thymol (found in thyme and oregano oils) and eugenol (found in clove and cinnamon oils). Phenols often exhibit strong antimicrobial properties.
6. **Esters:** These are compounds formed by the reaction of an alcohol with an organic acid. Examples include compounds like linalyl acetate (found in lavender and bergamot oils) and geranyl acetate (found in rose and geranium oils). Esters contribute to the fruity and floral notes of many essential oils.
7. **Alcohols:** These are organic compounds containing a hydroxyl group (OH) attached to a saturated carbon atom. Examples include compounds like geraniol (found in rose and geranium oils) and terpineol (found in pine and cajuput oils). Alcohols often have pleasant, floral aromas and can exhibit antimicrobial properties.
8. **Ketones:** These are compounds containing a carbonyl group (C=O) attached to two alkyl groups. Examples include compounds like camphor (found in rosemary and eucalyptus oils) and menthone (found in peppermint and spearmint oils). Ketones can have cooling, minty aromas and may exhibit analgesic properties.

5. DIFFERENT EXTRACTION METHODS FOR OF EXTRACTION OF OIL FROM ORANGE PEEL

1. **Cold Pressing:** Cold pressing, also known as expression or mechanical pressing, is a simple and traditional method for extracting oil from citrus peels. In this method, the orange peel is mechanically pressed to release the oil, which is then collected. Cold pressing preserves the natural aroma and flavor of the oil but may yield lower quantities compared to other extraction methods.

2. **Steam Distillation:** Steam distillation is a widely used method for extracting essential oils from plant materials, including orange peel. In this method, steam is passed through the orange peel, causing the oil glands to rupture and release the essential oil. The steam and oil vapor are then condensed and collected, with the oil separating from the water. Steam distillation allows for efficient extraction of oil while preserving its aromatic and therapeutic properties.

3. **Solvent Extraction:** Solvent extraction involves using a solvent, such as hexane or ethanol, to extract oil from orange peel. The solvent dissolves the oil from the peel, forming a solution that is then separated from the solid plant material. The solvent is then evaporated to recover the oil. Solvent extraction can yield high quantities of oil but may require additional processing to remove traces of solvent from the final product.

4. **Microwave Assisted Extraction (SFE):** Microwave-assisted extraction (MAE) is a technique that uses microwave radiation to speed up the extraction of compounds from various materials, like plants or foods. It's faster than traditional methods, enhances extraction efficiency, and allows for selective extraction. MAE finds applications in extracting bioactive compounds, analyzing food and environmental samples, and in pharmaceutical and nutraceutical industries. Optimization of parameters like microwave power and extraction time is crucial, along with safety precautions due to exposure to high temperatures and microwave radiation.

5. **Ultrasound Extraction :** Ultrasound extraction utilizes high-frequency sound waves to enhance the extraction of compounds from materials like plants or foods. It's a rapid and efficient method, often used in extracting bioactive compounds and essential oils. Ultrasound creates cavitation bubbles in the solvent, which implode near the sample surface, enhancing mass transfer and extraction efficiency. It's applicable in various industries, including pharmaceuticals, food, and environmental analysis. Optimization of parameters like frequency and power is essential for maximizing extraction yield. Ultrasound extraction offers advantages like reduced extraction time, improved selectivity, and lower solvent consumption.

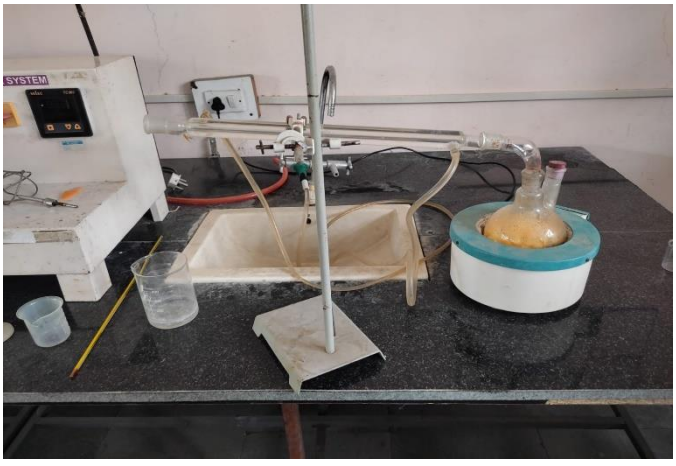
6. COMPARISON OF DIFFERENT EXTRACTION METHODS

From above comparison we found that distillation is most suitable path

1. Efficient Process: Steam distillation is an efficient method as it can extract oils from the peels in a fast and effective way.
2. Less Harmful to Environment: Steam distillation is a green method and not harmful to the environment compared to other methods that use chemical solvents.
3. Produces High-Quality Oil: Steam distillation produces pure and high-quality orange peel oil by separating the oil from water and impurities.

Methods	Solvent	Temperature	Pressure	Time	Cost
1) Steam Distilation	Water	Room temperature	Atmospheric	Long	Low
2)Solvent Extraction	Methanol,Ethanol,or mixture of Alcohol and Water	Under heat depending on Solvent used	Atmospheric	Long	Moderate
3) Microwave Assisted Extraction	Water,Aqueous and non-aqueous Solvents	Room temperature occasionally under heat	Atmospheric	Short	Moderate
4) Ultrasound Extraction	Methanol,Ethanol,or mixture of Alcohol and Water	Room temperature occasionally under heat	Atmospheric	Short	Moderate
5) Cold Pressing	-	-	Atmospheric		Moderate

Research Methodology



Plant Material: orange peel

Material And Instruments:

Boiler or steam generator (to produce steam), Steam inlet tube (to direct steam into the distillation flask),Distillation flask (where the orange peel and water are placed),Condenser (to condense the steam into liquid),Receiver flask (to collect the condensed liquid),Cooling water inlet and outlet (for circulating cold water through the condenser),Vacuum pump (optional, for reducing pressure in the system),Heat source (e.g., hot plate or gas burner) for heating the distillation flask,Thermometer (to monitor the temperature of the distillation process),Clamps and stands (for supporting and securing glassware),

Collection And Identification Of Orange Peel:

Examine the orange peel visually. It should have a bright orange color and a rough, dimpled texture. Look for small oil glands visible as tiny dots on the outer surface. Gently crush or tear a small piece of the orange peel and smell it. Orange peel typically has a strong, citrusy aroma, characteristic of oranges. Feel the texture of the orange peel. It should feel slightly rough and textured, with small oil glands releasing a slight oiliness when rubbed between your fingers. Obtain fresh oranges from a reliable source. Ensure they are organic if possible, to avoid pesticide residue. Carefully separate the orange peels from the fruit. Try to avoid including too much of the white pith beneath the peel, as it can affect the quality of the oil.

Orange peel sample

Extraction Of Oil From Orange Peel By Steam

Distilation: We have taken 150gm of sample of orange peel

Step 1: Harvesting - Orange peels are carefully harvested from ripe oranges.

Step 2: Grinding - The peels are finely ground to increase the surface area for effective extraction.

Step 3: Boiling Water - Water is first boiled in a large boiler to generate steam.

Step 4: Steam Flow - The steam flows through the orange peels in the extraction chamber, which releases the oil from the peels.

Step 5: Condensation - The steam containing the oil vapor is cooled and condensed in a separate chamber, which results in pure orange peel oil.

Step 6: Separation - The essential oil is separated from the distillate and collected for further processing.

Calculation Of Oil Yield:

The calculation of oil yield typically depends on several factors such as the type of oilseed, the extraction method used, and the efficiency of the extraction process. However, a general formula to calculate oil yield from oilseeds can be expressed as:

$$\text{Oil Yield (\%)} = \frac{\text{weight of oil used}}{\text{weight of sample used}}$$

Here's a breakdown of the components:

1. **Weight of Oil Obtained:** This refers to the weight of oil extracted from the oilseed after the extraction process. This can be measured using a scale that is sensitive enough to measure small quantities accurately.
2. **Weight of Oilseed Used:** This is the initial weight of the oilseed before the extraction process. Again, it can be measured using a scale.

To calculate the oil yield:

1. Measure the weight of the oil obtained after extraction.
2. Measure the weight of the oilseed used for extraction.
3. Plug these values into the formula above to find the oil yield percentage.

It's important to note that oil yield can vary depending on factors such as the quality of the oilseed, the extraction method (solvent extraction, mechanical pressing, etc.), and the efficiency of the extraction equipment

Determination Of Density Of Oil

1. **Measure Volume:** Take a clean, dry graduated cylinder or volumetric flask and measure a known volume of the oil. Make sure the cylinder or flask is dry because water can affect the density measurement.
2. **Weigh the Oil:** Carefully weigh the oil using a precise balance. Make sure to use a container that accounts for the weight of the container itself.
3. **Calculate Density:** Once you have the volume and weight of the oil, you can calculate the density using the formula:

$$\text{Density} = \frac{\text{weight of oil sample}}{\text{volume of oil sample}}$$

RESULT AND DISCUSSION

We have seen the effect of time by taking temperature constant on orange peel oil. The estraction time depends on the material, solvent, extraction temperature. Longer the extraction efficiency may be improve. the positive relationship only holds to a certain limit of extraction duration where further time prolongation does not increase the extraction efficiency . On the other hand, longer extraction time also impairs the quality of essential oils and is more time- and energy- consuming. Temperature is one of the factors affecting the extraction process because the amount of oil is obtaines different from amount of oil when it is at a different temperature.

Effect of Extraction time

Time (min)	Temperature (degree Celsius)	Quantitiy of oil extracted (ml)	Percentage yield value
20	**100**	**0.5**	0,33
40	**100**	**1.8**	1.2
60	**100**	**2.5**	1.6
80	**100**	**3.3**	2.2

Several factors can influence the extraction time in the steam distillation of essential oils from orange peel. Understanding these factors is crucial for optimizing the extraction process. Finely grinding or chopping the orange peel increases the surface area available for extraction. Smaller particle sizes facilitate better contact between the orange peel and steam, leading to faster extraction. Higher steam temperatures can accelerate the extraction process by promoting the volatilization of essential oil components from the orange peel. However, excessively high temperatures may also cause thermal degradation of heat-sensitive compounds.

Increasing the pressure in the steam distillation apparatus can raise the boiling point of water, leading to more efficient extraction. However, excessive pressure may cause structural damage to the plant material or alter the composition of the essential oil. The amount of water relative to the mass of orange peel affects the efficiency of steam distillation. A higher water-to-orange peel ratio can promote better steam penetration and extraction of essential oil constituents, potentially reducing extraction time.

Extending the duration of distillation allows more time for the essential oil components to be released from the orange peel and carried over by the steam. However, there is an optimal duration beyond which further extraction may yield diminishing returns.

Pre-treating the orange peel, such as by maceration or soaking in water, can help break down cell walls and enhance the release of essential oil constituents during steam distillation. Proper pre-treatment can reduce extraction time and improve extraction efficiency. Agitating the mixture of orange peel and water during distillation can improve the distribution of steam and facilitate the release of essential oil components. This can lead to faster extraction compared to static conditions. T he quality and variety of orange peel used can impact the extraction time. Factors such as the ripeness, freshness, and variety of oranges can influence the composition and yield of essential oil, thereby affecting extraction kinetics. the design and efficiency of the steam distillation apparatus, including the size and shape of the extraction vessel, the effectiveness of condensation, and the insulation of the system, can affect extraction time

CONCLUSION

In this study, steam distillation was employed to extract essential oil from orange peel, and several factors affecting the extraction process were investigated. The extraction yield, chemical composition, and extraction time were analyzed to evaluate the efficiency and effectiveness of the method.

Factors affecting extraction time were investigated, including the particle size of orange peel, temperature of steam, pressure, water-to-orange peel ratio, duration of distillation, plant material pre-treatment, agitation, orange peel quality and variety, equipment design, and operator skill and experience. Optimizing these factors can lead to faster extraction times and improved extraction efficiency.

Overall, steam distillation proved to be a reliable method for extracting essential oil from orange peel, with the potential for various industrial and therapeutic applications. Further research could focus on optimizing extraction parameters, exploring the biological activities of the essential oil, and developing value-added products. By understanding and controlling the factors influencing extraction, the quality, purity, and yield of essential oils can be enhanced, contributing to their commercial viability and utilization in diversion

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