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EXTRACTION PROCESS OF TULSI:

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ABSTRACT :

Tulsi, also known as holy basil, is a highly revered and widely used plant native to the Indian subcontinent. It's a perennial shrub that holds immense significance



Keywords: Keywords: Tulsi, Ocimum , extraction methods, phytochemicals, essential oils, herbal medicine.

Religious and Cultural Significance

In Hinduism, Tulsi is considered a sacred plant and a manifestation of the goddess Lakshmi. It's commonly found in the courtyards of Hindu homes and temples, often planted in a dedicated pot or structure. The plant is worshipped daily, and its leaves are used in religious rituals, particularly for Lord Vishnu and his avatars. The act of tending to the plant is considered a form of worship, believed to bring piety and protection to the home. Botanical Information.

- Scientific Name: *Ocimum tenuiflorum* (also widely known by its synonym *Ocimum sanctum*).

- Family: Lamiaceae (the mint family).

- Varieties: The most common types are Ram Tulsi (with broad, light green leaves) and Krishna or Shyam Tulsi (with purplish-green leaves). There is also a wild variety called Vana Tulsi.

- Appearance: It is a branched, aromatic subshrub with hairy stems and strongly scented leaves that are either green or purple. The plant produces small, purple or white flowers.

• Key Active Compounds

Tulsi's therapeutic effects are attributed to its complex chemical composition. The most significant compounds found in its essential oil and extracts include:

Eugenol: A phenolic compound with potent antimicrobial, anti-inflammatory, and antioxidant properties. It's a major component of Tulsi essential oil.

Cineole (Eucalyptol): Contributes to its distinct aroma and has been studied for its anti-inflammatory and bronchodilator effects, which are beneficial for respiratory health.

Caryophyllene and Methyl Chavicol: Other key aromatic compounds that contribute to the plant's medicinal properties.

Ursolic Acid: A triterpenoid compound found in the leaves, known for its anti-inflammatory, antioxidant, and anti-cancer properties.

Flavonoids, Triterpenoids, and Tannins: These are other classes of compounds present in Tulsi extracts that provide various health benefits.

Extraction of TULSI

The extraction of Tulsi (*Ocimum tenuiflorum*) is a versatile process, with different methods used to obtain various types of extracts, each with a unique profile of active compounds.

Here is a detailed breakdown of the main extraction techniques, from traditional to modern, high-tech methods.

TYPES OF EXTRACTION PROCESS.

- 1. Maceration**
- 2. Soxhlet Extraction**
- 3. Stem Distillation**
- 4. Advance Extraction Techniques**
 - 4.1 – Ultrasonic Assisted Extraction Process**
 - 4.2 – Microwave Assisted Extraction**
 - 4.3 – Supercritical Fluid Extraction**
 - 4.4– Enzyme-Assisted Extraction (EAE)**
- 5. Comparative Analysis of Extraction Methods**

• 1.MACERATION :

-It is a simple and popular procedure, which is used often to produce tinctures or concentrated herbal extracts.

• Procedure:

- Preparation: Finely powdered or dried Tulsi material is taken.
- Soaking: The powder is taken together with an appropriate solvent (e.g., ethanol, methanol, water, or a mixture) in a closed container and allowed to gather (or macerate) for a long time, perhaps a few days to a few weeks, with occasional shaking.

• Filtration:

Through filtration (e.g., filter paper) the liquid extract (miscella) is separated from the solid plant residue (marc).

• Separation:

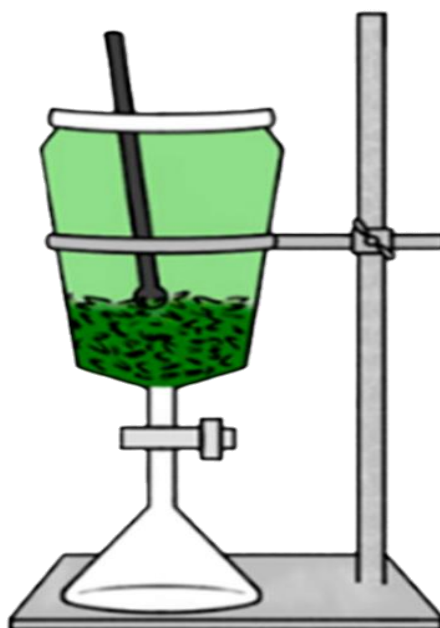
The resulting clear filtrate is concentrated by removing the material's

Solvent (often using a rotary evaporator under low temperature and pressure) to provide a thick extract in either solid or semi-solid form.

• Concentration :

The levels of concentration obtained from the extraction of tulsi depends on the solvent, and extraction times used in the maceration process.

Research has indicated extraction efficiencies of approximately 6% - 7.2% with the use of ethanol as a solvent.

•DIAGRAM:**Figure: Maceration****2.SOXHLET EXTRACTION:**

It is a hot continuous solvent extraction technique, generally producing a greater concentration of non-polar, or semi-polar compounds.

Process:

Loading: Drying and grinding the Tulsi material is placed within a porous thimble and placed inside the Soxhlet apparatus

Extraction:

This thimble is above a flask which contains the solvent (hexane, ethanol, etc). The solvent is heated to boiling temperature and vapoured to the condenser where it condenses back to a liquid and drips onto the Tulsi material in the thimble.

Procedure:

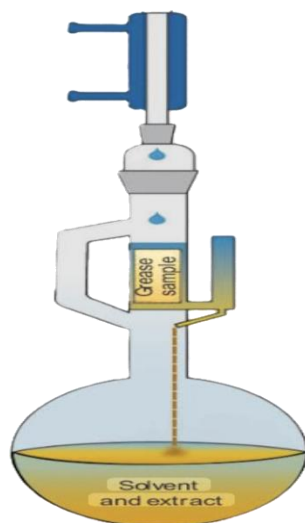
- 1). Soxhlets apparatus consist of heating metel with the RBF, condenser and tube, conical flask.
- 2). Take the soxhlet apparatus assembly, take a thimber(thimber is made up of filter paper).
- 3). The material which is extracted is placed inside the thimber with the help of spatula.
- 4). Load the thimber containing the material inside the chamber of soxhlet apparatus.
- 5). After placing the thimber inside the chamber then cover the top of thimber with the help of glass rod
- 6). Then add 2-3 piece of poraclein for avoding the bumping. Then gress the chamber with the help Of petroleum gelly Then fit this chamber in RBF and fit the stand screw perfectly.
- 7). Then place the condenser on soxhlets apparatus then attach the pipe lower side of the condender as inlet of hold bottom and collect another side of the tube to the water supplier. i.e outlet, upper side.
- 8). Take the measure solvents(ethanol) and add in soxhlet chamber with the help of funnel.
- 9). The sovent moves down in a chamber and moves down in RBF.
- 10). Then turn on the water supply, thoroughly inlet water rises to top of condenser and goes towards
- 11). Then start the heating metel and adjust the temperature. Then the solvents start boiling th moves towards the condenser and then cool and drop by drop inside the thimber containing Extracted.
- 12). When the chamber is completed filled with sufficient quantity then this liquid is extracted to the syphen Tube and the chamber is completely empty.
- 13). The final extract is collected in RBF, then collect it in bottle and labelled it.

• Siphoning:

The solvent builds up in the thimble and extracts the compounds. Once the liquid level rises to the top of the siphon tube, the solvent containing the extract drains back into the boiling flask, leaving the extracted compounds behind. This process continues on and assuring that fresh solvent is always being used for extraction.

• CONCENTRATION :

The concentration of a tulsi extract via Soxhlet extraction depends on the solvent and the starting plant material, but it typically results in a percentage yield of about 5-10% by weight

• DIAGRAM

•Figure: Soxhlet Extraction Process

STEAM DISTILLATION:

-This is the broadest and most traditional technique for essential oil extraction.

-Steam distillation is a common technique used to extract essential oils from Tulsi leaves. In this process steam is passed through the plant material and, in turn, the volatile compounds evaporate and, then condense in another phase. Steam distillation is an excellent method for producing high-quality essential oils, but it requires the appropriate equipment.

• CONCENTRATION:

-The concentration, or yield, of essential oil obtained from Tulsi (Holy Basil) by steam distillation typically ranges from 0.1% to 0.4%. This means that for every 100 grams of plant material, you can expect to extract between 0.1 and 0.4 grams of essential oil.

• DIAGRAM:

• Figure: Stem Distillation

• 4. Advance Extraction Techniques:

-These methods are typically preferred for their efficiency, higher purity yield, and reduced use of toxic solvents

-Advanced extraction techniques include methods like microwave-assisted extraction (MAE), ultrasound-assisted extraction (UAE), and supercritical fluid extraction (SFE), which are more efficient.

Faster, and often use less solvent than traditional techniques like Soxhlet extraction. Other advanced

Methods are enzyme-assisted extraction (EAE) and pressurized liquid extraction (PLE), which can improve yield and selectivity while sometimes preserving delicate compounds better.

• 4.1 Ultrasonic Assisted Extraction Process

High-frequency sound waves are used in Ultrasound-Assisted Extraction (UAE), a green extraction method, to break down cell walls and improve the release of target compounds from a solid matrix into a solvent.

Through the rapid formation and collapse of micro-bubbles, or acoustic cavitation, the process produces localized high-energy effects like shockwaves and micro-jets that enhance extraction efficiency and facilitate mass transfer. Faster extraction rates, greater yields, less solvent consumption, less energy consumption, and the capacity to function at low temperatures—which helps preserve heat-sensitive compounds—are some of the main advantages of UAE.

• CONCENTRATION:

The concentration obtained from ultrasonic-assisted extraction (UAE) of tulsi depends on the specific compound and the optimization of extraction parameters, but studies show high yields are possible, such as 7.17 mg/g of total flavonoids and 13.92 mg/g of total polyphenols under optimized conditions. Other studies report specific compound yields like 11.21 mg of ursolic acid per gram of dried leaf powder, or a maximum of 2.41% essential oil yield for *O. basilicum* (a type of basil).

Factors that influence concentration Extraction

Parameters:

The final concentration is highly dependent on optimizing factors like temperature, extraction time, solvent type and concentration, and the solid-to-solvent ratio.

Method optimization:

A study showed that optimized UAE conditions provided yields that were significantly higher than conventional heat reflux extraction (HRE).

Compound type:

Different compounds will have different optimal extraction conditions and achievable concentrations.

• 4.2 Microwave Assisted Extraction:

This is an accelerated solvent extraction technique that uses microwave energy to rapidly heat the solvent in contact with the plant material.

Procedure:

Mixing:

Dried and powdered Tulsi material is mixed with a suitable solvent (e.g., ethanol or water) in a microwave-safe extraction vessel.

Microwave Treatment:

The mixture is subjected to microwave irradiation for a short period. The microwaves rapidly heat the solvent and the moisture within the plant cells.

Cell Rupture:

The quick heating of the intracellular water leads to a high pressure build-up, causing the cell walls to rupture (cell disintegration). This releases the bioactive compounds (phenolics, flavonoids, etc.) into the surrounding solvent.

Separation:

The extract is cooled, filtered to remove the solid plant residue, and then concentration.

• CONCENTRATION:

The concentration of essential oil obtained from tulsi extraction using Microwave Assisted Extraction (MAE) varies based on the microwave power level and extraction time. Here's a breakdown of the yields obtained in a study¹:

-Blended Mode Microwave Hydrodiffusion and Gravity (MHG): 5% w/w yield of essential oil, with a high concentration of oxygenated compounds.

- Single-Power Microwaving:

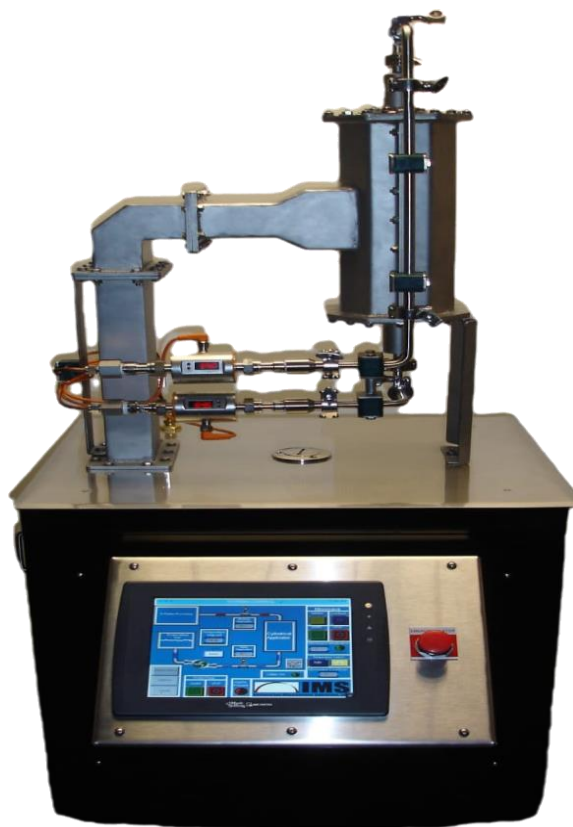
- 170 W: 1.9% w/w yield, with low eugenol content.

- 340 W: 2.9% w/w yield.

- 510 W: 1.0% w/w yield.

-The blended mode MHG protocol, which involves a strategic mix of high-, medium-, and lowpower microwaves, results in a higher yield and better quality of essential oil compared to single-power microwaving. The essential oil obtained through this method contains a higher concentration of eugenol, a desirable compound

• DIAGRAM



• DIAGRAM: Microwave Assisted Extraction

• 4.3 Supercritical Fluid Extraction:

SFE employs supercritical as a solvent to extract lipophilic compounds from plant materials. This method is Environmentally friendly and yields high-purity extracts without the use of toxic solvents. It is particularly suitable for Extracting essential oils and triterpenoids from Tulsi.

-Supercritical Fluid Extraction (SFE) is a separation technique that uses a solvent, typically carbon dioxide, at temperatures and pressures above its critical point to extract essential oils and bioactive compounds from plant materials, such as Tulsi.

Applications

1. mEssential oil extraction: SFE is used to extract high-quality essential oils from Tulsi.
2. Pharmaceutical applications: SFE can be used to extract bioactive compounds for pharmaceutical use.
3. Food and beverage industry: SFE can be used to extract flavorings and fragrances. SFE is a promising technique for extracting valuable compounds from Tulsi, offering advantages over traditional extraction methods. Supercritical Fluid Extraction (SFE)

Procedure for Tulsi:**Step-by-Step Procedure =**

1. Sample preparation: Tulsi leaves are dried and ground into a fine powder to increase surface area.
2. Loading the extractor: The Tulsi powder is loaded into the extraction vessel.
3. Pressurization: The extractor is pressurized with carbon dioxide (CO₂) to the desired Pressure (typically above 73 bar).
4. Heating: The extractor is heated to the desired temperature (typically between 31°C to 40°C).
5. Static extraction: The CO₂ is allowed to flow through the Tulsi powder for a specified Period, allowing the essential oils and bioactive compounds to dissolve in the supercritical fluid.
6. Dynamic extraction: The CO₂ is continuously flowed through the extractor, and the extracted compounds are collected in a separator.
7. Depressurization: The pressure is slowly released, allowing the CO₂ to evaporate and leaving behind the extracted compounds.

• 4.4 Enzyme-Assisted Extraction (EAE):

The process of EAE uses specific enzymes to digest cell walls and release intracellular compounds. This is more effective for increasing the yield of bioactive compounds, while being environmentally friendly. The gaps are often referred to cost and enzymes with optimum concentration and conditions for use.

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Multi-functionality: EAE can simultaneously extract and modify compounds in the process.

Drawbacks

- 1.COST: Although enzymes are found naturally in many foods, the manufacturing cost may be higher than that of other extraction techniques.
- 2.Limited availability: Explaining EAE as a proprietary process may limit advocacy for its use and Discourage widespread product availability.
3. Digestive enzymes: When consuming enzymes, they will not be preserved. Typically, enzymes Must meet quality standards or, if they are human enzymes, continue to be beneficial after being heated to deactivate nonactive enzymes.

• PROCEDURE:

1. Enzyme selection: Enzyme selection suitable for Tulsi extraction.
2. Enzymatic treatment: Tulsi is treated with enzymes to break the cell walls.
3. Extraction: Extraction of bioactive compounds via a solvent.
4. Purification: Extracts are purified to obtain good quality bioactive compounds.

• Applications

1. Pharmaceuticals: EAE can be used to extract bioactive compounds for pharmaceutical applications.
2. Food and beverages: EAE can be used to extract flavorings and fragrances.
3. Cosmetics: EAE can be used to extract bioactive compounds for cosmetic applications.

EAE is a promising technique for extracting valuable compounds from Tulsi, offering advantages over traditional extraction methods.

Example: Polyphenol Extraction from Grape Skins

Enzymes like cellulase and pectinase break down the grape skin's cell wall.

Polyphenols (like resveratrol) are released into solution.
Extracted polyphenols are used in supplements or functional foods.

Conclusion:

The extraction method chosen for Tulsi depends on the target compound, solvent polarity, and thermal sensitivity. Modern techniques such as ultrasonic, microwave-assisted and supercritical fluid extraction offer efficient and sustainable alternatives to traditional methods.

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