REVIEW ARTICLE

RECORDS OF PHARMACEUTICAL AND BIOMEDICAL SCIENCES

Aromatic Plants & Their Volatile Oils: Varieties of Extraction Techniques of Volatile Oils, Emphasis on Jasminum oil.

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Abstract

This review represents different types of extraction techniques of volatile oils from aromatic plants, Jasmine Oil in specific, starting from Classical old techniques & passing through new innovative techniques. Due to a wide application of volatile oils since a very long time ago till nowadays, the tendency to get and to know the exact components, that are causing either the valuable and memorable essence, pharmacological effects or other beneficial applications for humans, is increased and is the main reason to get inventions in such field. Then after having classical techniques, the sight is moved towards new green energy idea and to get maximum yield as possible within short period with high quality. Hereby, in this review, the different extraction techniques of volatile oils would be reviewed to find out the most suited valued techniques used for extraction of volatile oils from *Jasminum Officinale*. *Jasminum Officinale*, a member of the Oleaceae family, has been researched for any potential pharmacological effects. *Jasminum Officinale* can be used to treat a variety of conditions, including Mental Depression**,** Erectile Dysfunction**,** Neurological Stress, and Menstrual Disorders. It can also be used as an analgesic, an antispasmodic, a galactogogue, and more.

Key words: Extraction techniques, Volatile oils, *Jasminum Officinale*, Erectile Dysfunction, Neurological Stress, Mental Depression, Menstrual Disorders.

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1. Introduction

Since antiquity, human societies have sought therapeutic solutions from nature to treat various ailments. Medicinal plants have been integral to human history, serving not only as sources of medicine but also fulfilling diverse needs such as nutrition, agriculture, perfumery, flavoring, textiles, and shelter. The recognition of their medicinal and economic significance is increasingly acknowledged across both developed and developing nations. Traditional medical systems, which have long utilized plant-derived remedies, continue to contribute meaningfully to modern pharmacology and are witnessing a resurgence in global interest and application. (**Batool et al., 2020**).

Aromatic plants and their derivatives have attracted considerable scientific interest due to their potential as natural agents for promoting growth and enhancing health. These derivatives—such as exudates, balsams, essential oils, and oleoresins—are distributed across various plant organs, including flowers, leaves, stems, roots, and foliage. Essential oils, also referred to as volatile oils, are complex mixtures of highly concentrated secondary metabolites that serve multiple ecological and physiological roles within the plant. They comprise a wide array of organic compounds, notably terpenoids, benzenoids, nitrogen-containing constituents, and organosulfur compounds, each contributing to their multifaceted bioactivity. (**Bernáth, 2001**). Essential oils are highly concentrated, volatile, and hydrophobic compounds characterized by distinct aromatic and flavor attributes. Beyond their sensory properties, these oils exhibit a wide range of bioactivities. Their multifunctional nature has led to their widespread incorporation in aromatherapy and healthcare practices. Additionally, essential oils are extensively employed across various sectors, including the cosmetics industry, food and beverage flavoring, perfumery, spice production, natural pesticides, insect repellents, and herbal drink formulations. (**Samarth et al., 2017**).

The practical use of essential oils has been somewhat constrained by their limited stability when exposed to air and elevated temperatures. Therefore, a detailed understanding of their physicochemical properties and chemical composition is essential to ensure their optimal and effective application across various fields. (**Sharma et al., 2019**).

Insights from traditional medicine have demonstrated that numerous essential oils derived from aromatic plants exhibit therapeutic potential in the prevention and management of viral respiratory tract infections. This has gained relevance during the global COVID-19 pandemic, where such infections have caused widespread health and socioeconomic burdens worldwide. (**Salem and Ezzat, 2021**).

The chemical constituents are Jasmine (alkaloid), saliciylic acid, resin, indol and alcoh (**Al-Rawi and Chakravarly, 1964**). Traditional applications of this plant indicate a broad spectrum of therapeutic properties, including analgesic, antidepressant, anti-inflammatory, antiseptic, aphrodisiac, sedative, expectorant, and uterine tonic effects. Both jasmine essential oil and absolute have been reported to alleviate skin inflammation, improve skin tone, and enhance emotional well-being. (**Fatouma et al., 2010**). The investigation into this field has revealed that the stems of *Jasminum* species have traditionally been employed in folk medicine to manage chronic inflammatory conditions such as ulceration, angiitis, enteritis, and colitis. Previous phytochemical studies on the *Jasminum* genus have led to the isolation of several bioactive constituents, including iridoids, sesquiterpenes, flavonoids, and saponins. However, the phytochemical profile of *Jasminum officinale* has not been thoroughly explored.

2- Taxonomy of *J. Officinale*: (USDA Animal & plant health inspection, (https://acir.aphis.usda.gov/s/cird-taxon/a0ut0000002iNMMAA2/jasminum-officinale)

Kingdom:	Plantae
Phylum:	Tracheophyta
Class:	Magnoliopsida
Order:	Lamiales
Family:	Oleaceae
Genus:	Jasminum
Species:	*Jasminum officinale*

3. Extraction methods of Volatile oils from Aromatic Plants:

3.1. Classical techniques:

3.1.1. Expression (Cold Pressing) Technique:

Cold pressing, also known as expression, is the conventional method predominantly employed for extracting volatile oils from the peels of citrus fruits. In this process, mechanical pressure is applied to rupture the oil glands located in the outer layer of the peel, releasing the essential oils. The initial extraction yields an aqueous emulsion, which is subsequently subjected to centrifugation to separate and recover the essential oil. (**Ferhat et al., 2007**). In this process, the essential oil extracted from citrus peels is obtained, which is widely utilized in the food and pharmaceutical industries. It serves as a flavoring agent or additive in various applications, including food products, cosmetics, and household care formulations.

3.1.2. Extraction by Hydro-distillation:

In this method, the plant material is directly immersed in water within an alembic and subjected to boiling. The extraction system typically consists of a heat source and a distillation vessel (alembic) that holds both the plant material and water. The setup also includes a condenser and a receiving flask (carafe), which facilitate the condensation of the vapor and the subsequent separation of the essential oil from the distillate. (**Meyer-Warnod 1984**).

3.2. New Innovative extraction techniques:

3.2.1. Supercritical Fluid Extraction technique (SCFE):

- Fluids enter the supercritical state when exposed to specific thermodynamic

- conditions, namely, the critical temperature **(Tc)** and critical pressure **(Pc)**. In this state, the fluid exhibits gas-like diffusivity and flow characteristics while maintaining liquid-like solvent capabilities. Fluids at supercritical state exhibit very interesting properties.

low viscosity,
high diffusivity,
Have density close to that of liquids.

3.2.2. Subcritical extraction liquids - SWE:
Subcritical state Subcritical conditions refer to a state in which the solvent is maintained at a temperature below its critical temperature (Tc) and a pressure above its critical pressure (Pc), or vice versa (see **Figure 1**). Several studies have demonstrated the use of water in its subcritical state as an effective solvent for the extraction of volatile oils. (**Özel et al., 2006**). **SCFE** was used for the extraction of several volatile oils (**Moura et al., 2005, Khajeh et al., 2004**).

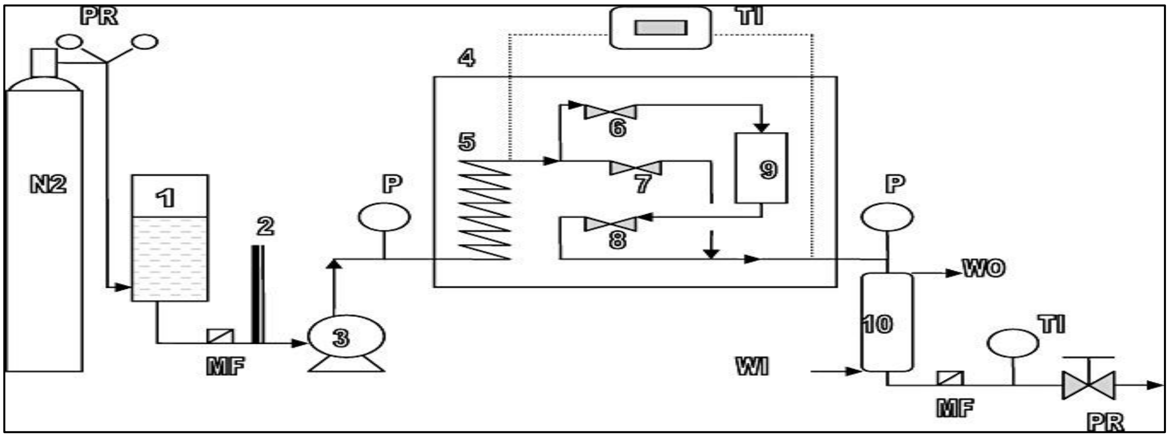

Figure 1: schematic diagram of the subcritical water extraction system 1, water reservoir; 2, burette; 3, pump; 4, oven; 5, preheater; 6, inlet water; 7, bypass stream; 8, outlet water; 9, extraction cell; 10, heat exchanger; MF, micro-filter; P, pressure indicator; PR, pressure regulator; TI, temperature indicator; WI, cooling water in; WO, cooling water out. (Khajenoori et al., 2009).

3.2.3. Ultrasound assisted extraction of volatile oils (UAE)
Ultrasound enhances the release of volatile oils from plant matrices by accelerating cell disruption, thereby facilitating more efficient and selective extraction. When combined with conventional methods such as hydrodistillation or solvent extraction, ultrasound significantly intensifies the overall extraction process. (**El Asbahani et al., 2015**).
It was specifically developed for the targeted isolation of bioactive compounds with potential therapeutic applications, (**Castro-Lopez et al., 2016**). **Figure 2**

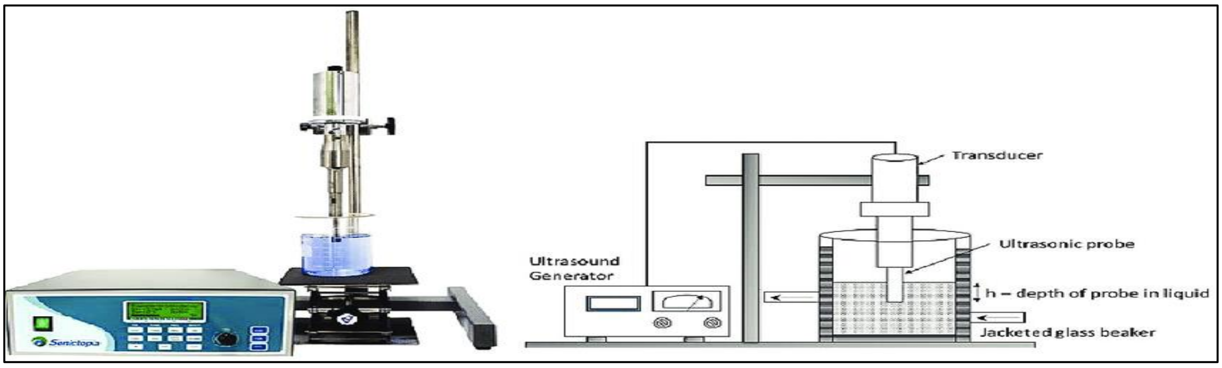

Figure 2: Schematic representation of ultrasound-assisted extraction equipment. (Dutta et al., 2021)

3.2.4. Microwave assisted extraction (MAE):
Microwaves are considered a form of green, environmentally friendly energy, consisting of electromagnetic waves with frequencies ranging from 300 MHz to 30 GHz and corresponding wavelengths between 1 centimeter and 1 meter. (**Cardoso-Ugarte et. al., 2013), (Gharekhani et al., 2012**). **Figure 3**

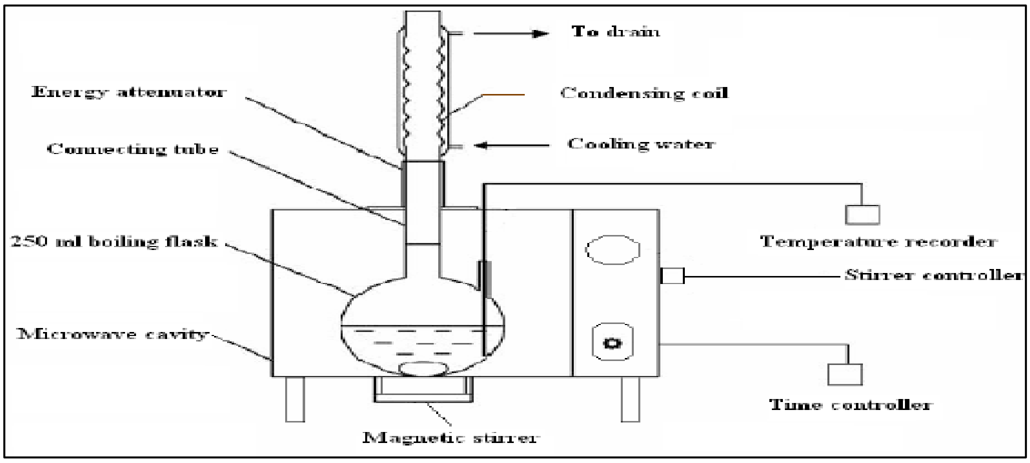

Figure 3: Apparatus for microwave-assisted extraction (Nurdin et al., 2014)

3.2.5. Compressed air microwave distillation (CAMD)

The first application of microwave-assisted extraction (MAE) for isolating volatile oils from aromatic plants was introduced by Craveiro et al. in 1989. (**Craveiro et al., 1989**). This process operates on the principle of steam entrainment, utilizing compressed air instead of steam to extract volatile oils. In this method, the plant matrix—immersed in water—is heated by microwaves while being continuously infused with compressed air. The volatile oil components become entrained in the steam and are subsequently transported to a recovery vessel located outside the microwave chamber, within a refrigeration system (see **Figure 4**).

Water and aromatic compounds are condensed and collected in proportions like those obtained through conventional methods, but within a significantly reduced time frame of just a few minutes (**Chemat et al., 2012**).

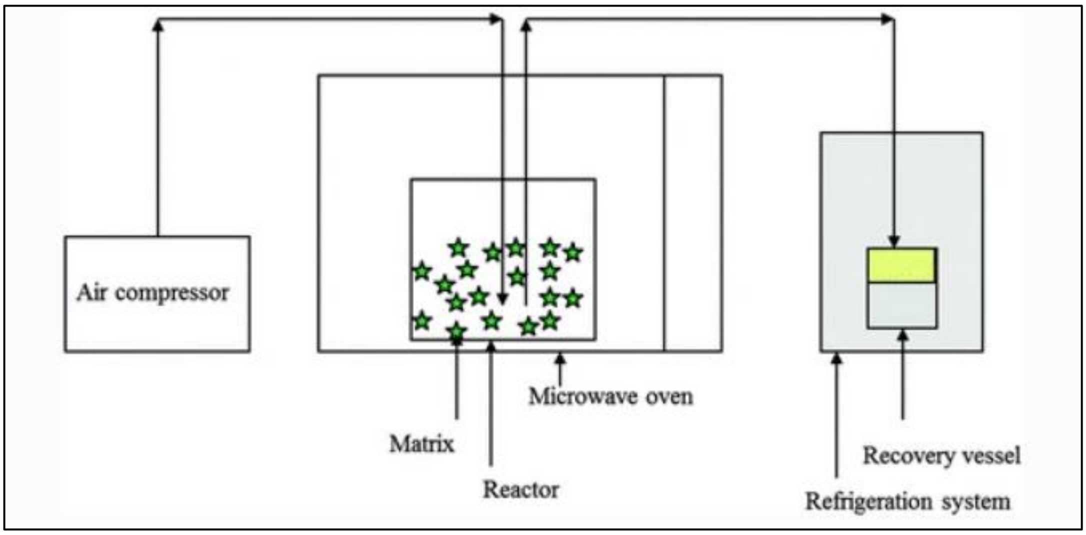

Figure 4: Compressed air microwave distillation (CAMD) (Chemat et al., 2012)

3.2.6. Vacuum microwave hydro-distillation (VMHD)

Vacuum microwave-assisted extraction (VMAE) is a technique that integrates microwave-assisted extraction within a vacuum environment. Under vacuum conditions, the boiling point of the extraction solvent is reduced compared to atmospheric pressure, allowing the solvent to boil and reflux at lower temperatures. This facilitates efficient interaction between the solvent and the sample, making the method particularly suitable for the extraction of thermolabile compounds while minimizing thermal degradation (see **Figure 5**). Furthermore, the removal of air from the extraction chamber significantly reduces or prevents oxidation of oxygen-sensitive constituents. (**Destandau et al., 2013**).

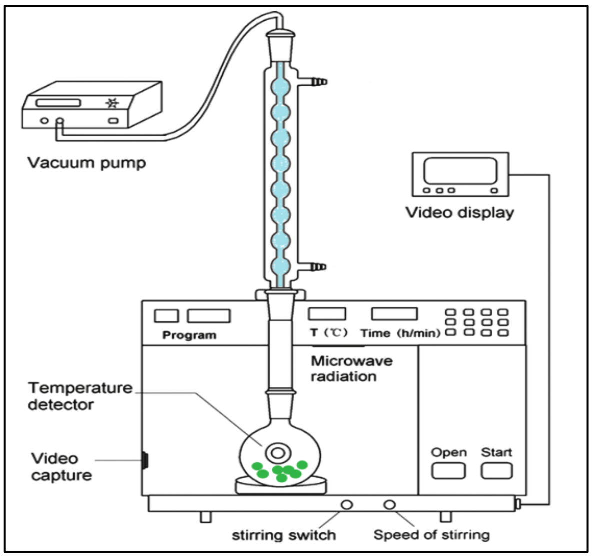

Figure 5: Vacuum microwave assisted extraction apparatus (Destandau et al., 2013).

3.2.7. Microwave assisted hydro-distillation (MAHD)

Microwave-assisted solvent extraction presents a particularly attractive approach for the isolation of essential oils. This method, known as Microwave-Assisted Hydro-distillation (MAHD), combines the rapid volumetric heating capability of microwaves with conventional solvent extraction techniques (see **Figure 6**). The result is a significant reduction in extraction time, often allowing the process to be completed within just a few minutes (**Fazlali et al., 2015**). When Microwave-Assisted Hydro-distillation (MAHD) was used in place of conventional Hydro-distillation (HD), a similar yield of essential oil was achieved in a significantly shorter extraction time. (**Moradi et al., 2018**).

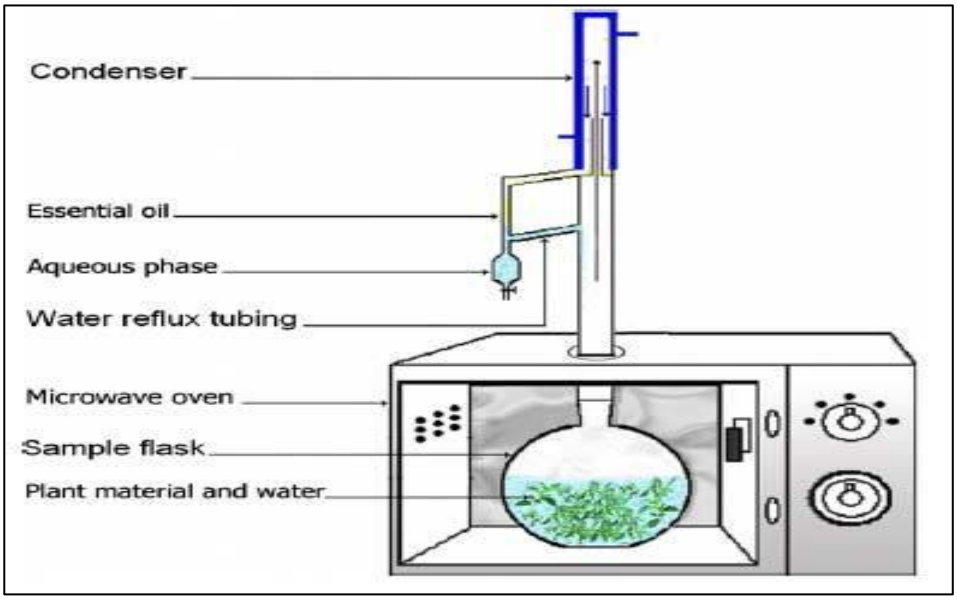

Figure 6: Microwave-assisted hydro-distillation apparatus Microwave hydro-diffusion and gravity (MHG) (Destandau et al., 2013)

3.2.8. The microwave steam distillation (MSD) and microwave steam diffusion (MSDf):

Microwave Steam Distillation (MSD) (**Figure 7**) has been explored for the extraction of volatile oils from orange peels and dried lavender flowers. This innovative technique has demonstrated greater efficiency compared to conventional steam distillation (SD), offering substantial advantages such as significantly reduced extraction times—for example, achieving equivalent yields in just 6 minutes at an optimized power of 500 W, as opposed to 2 hours required by SD. Moreover, MSD produces volatile oils with cleaner profiles and enhanced quality, without notably altering their chemical composition. (**Sahraoui et al., 2008**).

Microwave Steam Diffusion (MSDf) has been investigated as an extraction method for the volatile oils of various plant materials, including lavender and orange peel. (**Farhat et al., 2011**). This technique is based on the same fundamental principle as Microwave Steam Distillation (MSD), with the primary difference being that the vapor phase travels downward through the plant material during the extraction process.

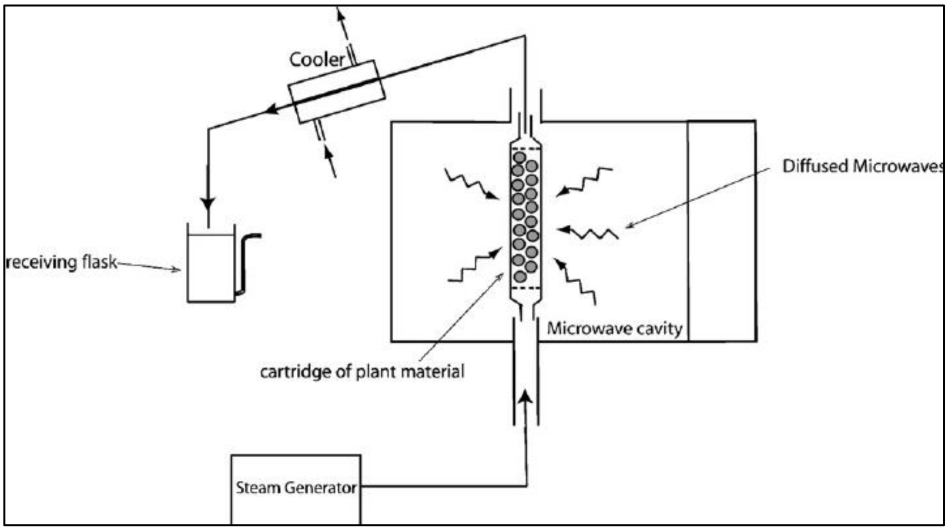

Figure 7: Microwave steam distillation apparatus (Sahraoui et al., 2008).

3.2.9. Solvent free microwave extraction (SFME)

The fundamental principle of this technique involves the microwave-assisted dry distillation of fresh plant material without the use of water or organic solvents (see **Figure 8**). Solvent-Free Microwave Extraction (SFME) is distinct from both Microwave-Assisted Extraction (MAE), which typically requires organic solvents, and Hydro-distillation (HD), which involves substantial water usage. (**Filly et al., 2014**). (**Li et al., 2013**).

3.2.10. The instant controlled pressure drops:

Instant Controlled Pressure Drop (DIC) is a thermo-mechanical technique in which the plant material is exposed to high-pressure saturated steam for a short duration, leading to the rapid evaporation of internal moisture upon sudden pressure release. This abrupt decompression causes structural modifications within the matrix, enhancing the release of volatile compounds., **Figure 9** (**Martínez-Meza et al., 2021**).

4. Extraction Methods of Jasmine Oil used in this expriment:

The following methods were used in the extraction of Jasmine oil in the experimental steps,

4.1. Organic Solvent extraction using n-Hexane:

For solvent extraction, a Soxhlet apparatus was employed. Rose petals were placed in a porous thimble, and **n-hexane** vapor was condensed and circulated over the plant material to dissolve volatile compounds. The solvent–extract mixture, referred to as *concrete oil*, was collected in the receiving flask.

The concrete was then subjected to rotary evaporation at controlled temperature to recover the solvent without degrading heat-sensitive constituents. The residue was dried with anhydrous sodium sulfate, filtered, and traces of solvent were removed by nitrogen flushing.

To obtain the *absolute oil*, the concrete was treated with ethanol to dissolve the aromatic fraction and separate natural waxes. After filtration, ethanol was evaporated, and the remaining traces were removed by nitrogen bubbling, yielding the final absolute oil. **(Younis, A. et al., 2006)**.

Figure 8: Solvent free microwave extraction device (Meng et al.,2013)

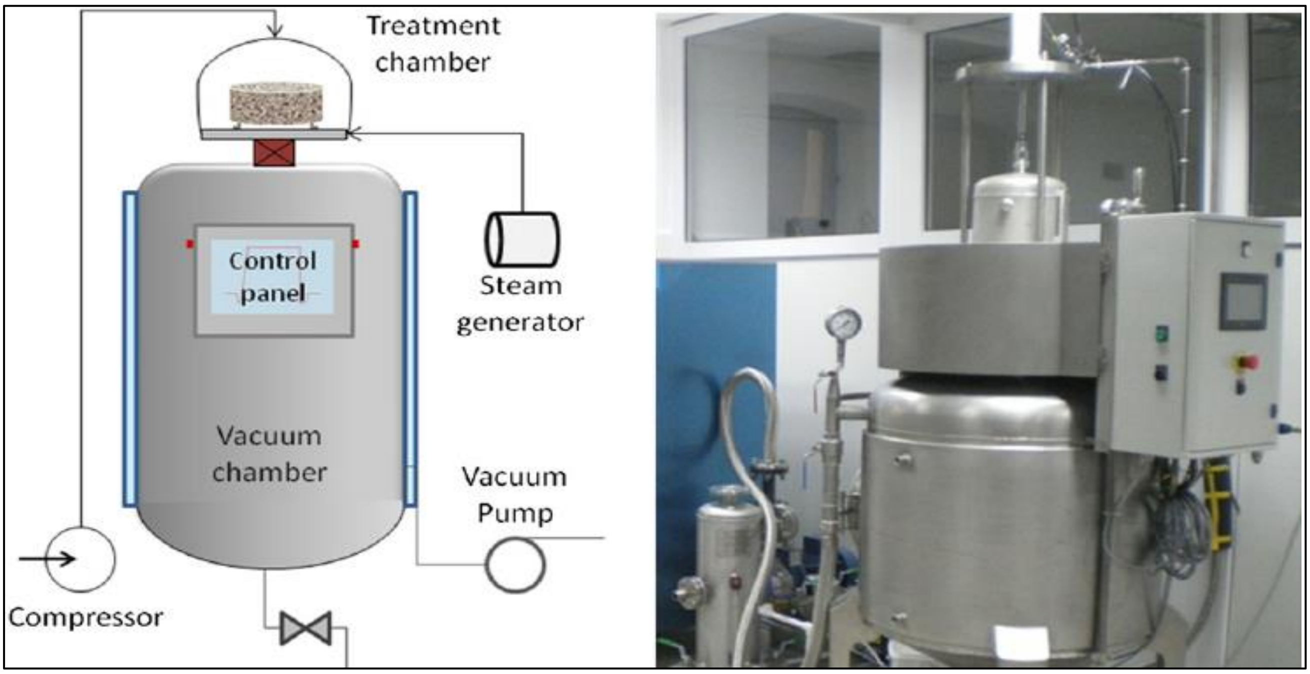

Figure 9: Instant controlled pressure drop (DIC) apparatus (Allaf et al., 2013)

4.2. Organic Solvent extraction using Super Critical Fluid – Freeze dried:

Supercritical refers to any compound that is above its critical temperature and pressure. There is no liquid or gaseous form at the supercritical stage. A fluid is an intermediate between a liquid and a gas that has characteristics of both liquid and gas molecules. **(Akram, A., et al., 2017)**

In this method, fresh *Jasminum* flowers were dried using freeze drying process, when water is dehydrated by a process called freeze-drying, it vaporizes straight from a solid ice crystal state to a vapor state without first going through the typical liquid condition. Freeze-drying produces goods that look nearly identical to the originals, which is its primary benefit. **(Chen et al., 2000)**

Temperature and pressure both had an impact on the oil yield. As the pressure increased between different pressure bar limits, it had a major impact on the oil yield. At maximum bar used as maximum limit, the maximum oil yield was achieved. **(Rassem et al., 2019)**

4.3. Organic Solvent extraction using Super Critical Fluid – Air dried:

In This method, SCF technique was used for Jasmin oil extraction, but the difference here from the above method is that the petals of Jasmin plant (flowers) were left to be dried at room temperature, then took to be used & to be applied for SCF method. **(Zhang et al., 2018)**

4.4. Hydro-distillation extraction.

This is an old traditional method for extraction of Jasmin oil from *Jasminum Officinale*. The method is well described above. (**Meyer-Warnod 1984**).

5. Conclusion

In conclusion, modern extraction technologies provide considerable advantages over traditional methods for the isolation of volatile oils from aromatic plants. These innovative techniques offer enhanced control over extraction parameters, effectively reducing the risk of undesirable reactions such as oxidation or thermal degradation—factors that are particularly critical when handling thermo-sensitive constituents. Furthermore, they can achieve higher yields of volatile oils with superior quality, better preserving the natural aromatic and biological properties of the original plant material.

This review has highlighted and summarized ten advanced extraction techniques: Supercritical Fluid Extraction (SCFE), Subcritical Water Extraction (SWE), Ultrasound-Assisted Extraction (UAE), Microwave-Assisted Extraction (MAE), Compressed Air Microwave Distillation (CAMD), Vacuum Microwave Hydro-distillation (VMHD), Microwave-Assisted Hydro-distillation (MAHD), Microwave Steam Distillation (MSD), Microwave Steam Diffusion (MSDf), Solvent-Free Microwave Extraction (SFME), and Instant Controlled Pressure Drop (DIC). These methods represent a significant step forward in the efficient, eco-friendly, and high-quality extraction of volatile oils from natural sources. In addition, we discussed different extraction methods of Jasmine Oil from *Jasminum Officinale*.

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