EVALUATION OF EXTRACTION TECHNIQUES FOR ACTIVE PRINCIPLES FROM *Lavandula angustifolia* And *Rosmarinus officinalis*

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Abstract

This paper compares some extraction methods applied to Lavandula angustifolia and Rosmarinus officinalis: cold and hot maceration, reflux extraction and Soxhlet extraction. The obtained extracts were evaluated in terms of yield and physical characteristics, emphasizing the influence of extraction technique on the recovery and quality of bioactive compounds. Hot maceration and Soxhlet extraction resulted in more concentrated extracts, characterized by increased density and refractive index, due to the enhanced release of lipophilic constituents. Cold maceration preserved thermosensitive compounds but provided lower extraction efficiency. A gradual acidification of lavender aqueous extracts was observed over time, attributed to the progressive release of phenolic components.

1. INTRODUCTION

Medicinal plants have been used for thousands of years for therapeutic purposes due to their rich content of bioactive compounds that provide numerous health benefits [1].

Today, their use in the pharmaceutical, cosmetic and food industries continues to expand, driven by the increasing demand for natural and safe products [2].

Among the most commonly used medicinal plants, *Lavandula angustifolia* (lavender) and *Rosmarinus officinalis* (rosemary) are well known for their anti-inflammatory, antioxidant, antimicrobial, wound-healing and soothing properties. Lavender is especially valued for its relaxing, antimicrobial and anti-inflammatory effects, widely applied in aromatherapy and dermatological formulations [3]. Rosemary, another valuable medicinal plant, exhibits strong antioxidant and anti-inflammatory activities, being used to improve skin health, digestion and blood circulation [4].

To fully harness their therapeutic potential, efficient extraction of active compounds – such as essential oils, flavonoids, phenolics and other bioactives – is essential, as the extraction process strongly depends on factors such as temperature, solvent type and extraction time [5].

2. EXPERIMENTAL DETAILS

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Three extraction methods were used to obtain active compounds from *Lavandula angustifolia* and *Rosmarinus officinalis*: cold and hot maceration, reflux extraction and Soxhlet extraction.
Cold maceration is a static process governed by slow diffusion and passive equilibrium, with a risk of incomplete extraction and low yield unless the extraction time is extended or combined with agitation.
Reflux extraction represents a balanced system between diffusion and constant temperature, being a versatile and efficient method for medicinal plants containing thermostable compounds.
Soxhlet extraction is an active process, thermodynamically controlled through high temperature, continuous solvent renewal, and repeated extraction cycles. This technique provides optimal yield in a relatively short time, although it involves a higher energy consumption.

2.1 Materials and methods

The refractive index (RI) and relative density shall be determined in accordance with the Romanian Pharmacopoeia [6].
The refractive index is determined with the refractometer, and the relative density with the pycnometer.
The pH is measured with an calibrated pH-meter (Consort model) and viscosity is measured with a viscometer (FungiLab model).

2.2. Synthesis procedures

For cold maceration, 20 g of each dried plant were moistened with a small amount of ethanol and mixed with 100 mL of vegetable oil. The container was sealed and shaken to remove air bubbles, then kept at room temperature for the required maceration period. After completion, the oily extract was strained through gauze and, if necessary, filtered again to obtain a clear extract. The final product was transferred into a dark container to protect sensitive compounds from light and properly labelled.
For hot maceration, the weighted plant (lavender and rosemary) was placed in a heat-resistant container with vegetable oil and heated in a water bath at 40-50ºC for 2-4 hours, with occasional stirring to prevent overheating. After extraction, the oil was strained though gauze, and filtered if necessary to obtain a clear extract. The oily extracts were transferred into amber glass containers, labelled and stored in a dry, dark place. A few drops of vitamin E were added as an antioxidant to improve storage stability.
Dried lavender (10 g) was mixed with distilled water (100 mL) in a round-bottom flask and heated in a water bath under reflux for 60 minutes. The condensed vapours continuously returned over the plant material, ensuring efficient extraction without solvent loss. After cooling, the extract was filtered and stored for further analysis.

2.3. Yield determination

The extraction yield was calculated in order to evaluate the efficiency of each extraction technique. After filtration, a measured volume of lavender extract was evaporated to dryness under controlled conditions to determine the mass of recovered bioactive fraction.
The extraction yield (%) was calculated according to the following formula:

$$\eta(\%) = \frac{m_{dry\ extract}}{m_{dried\ plant}} x100$$

3. RESULTS AND DISCUSSIONS

Following the experiments performed, significant differences were observed between the extraction methods analysed in terms of physicochemical parameters.

3.1. Characterization of physico-chemical properties

Table 1. Cold maceration

Oil extract	Density [g/cm^3]	Refractive index	Viscosity [cP]	pH
Lavender	0.92	1.470	99.22	6.5
Rosemary	0.93	1.480	191.3	6.0-6.5

Table 2. Hot maceration

Oil extract	Density [g/cm^3]	Refractive index	Viscosity [cP]	pH
Lavender	0.93	1.769	140	6.5
Rosemary	0.94	1.470	136.3	6.5

The extraction yield (%) calculated for lavender extract:

$$\eta(\%) = \frac{7.55}{8.607} x100$$

Where:

Crucible mass (empty): 4.435 g
Mass of lavender (dried plant): 8.607 g
Mass of dry extract residue: 7.55 g
The calculated extraction yield for lavender was: $\eta = 87.72\%$

The extraction yield (%) calculated for rosemary extract:

$$\eta(\%) = \frac{6.38}{8.450} x100$$

Where:
Crucible mass (empty): 4.462 g
Mass of rosemary (dried plant): 8.450 g
Mass of dry extract residue: 6..38 g
The calculated extraction yield for rosemary was: $\eta = 75.47\%$

3.2. Reflux extraction

The visual appearance of the lavender extract obtained by reflux extraction is shown in Figure 1, highlighting the efficient release of bioactive compounds into the solvent [7].

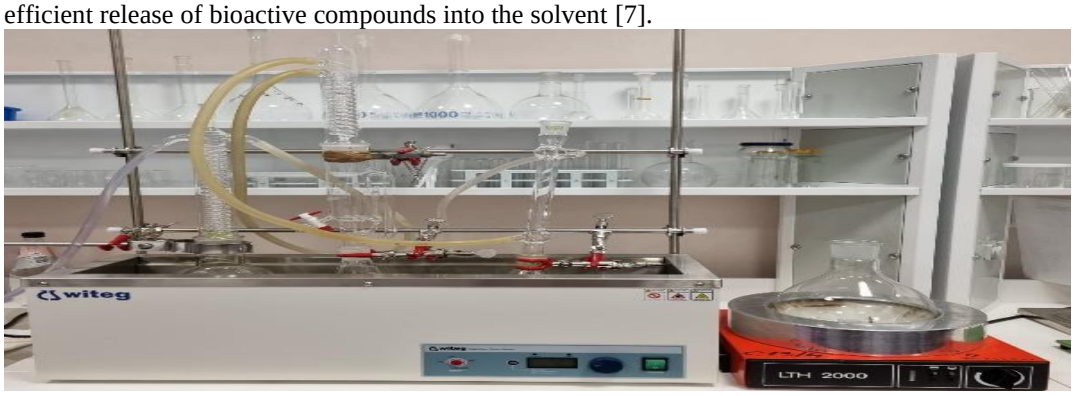

Figure 1. Lavender extract obtained by reflux extraction

3.3. The pH of lavender extract

Figure 2 illustrates the pH values recorded immediately after extraction (a) and after several days of storage (b), indicating a slight acidification associated with the release of phenolic compounds [8].

a)

b)

Figure 2. The pH value: a) after extration; b) after few days

The pH value of the lavender extract gradually decreases from neutral to slightly acid over time, as phenolic compounds are released, indicating a progressive stabilization of the extract.

3.4. Soxhlet extraction

The ethanolic extract obtained using Soxhlet method is presented in Figure 3, showing a more intense colour due to the enhanced extraction efficiency of this technique.

Figure 3. The obtaining ethanolic extract of lavender

3.5. The pH of ethanolic lavender extract

Figure 4 presents the pH variation of the ethanolic lavender extract obtained by Soxhlet extraction, demonstrating the impact of the high-temperature extraction process on extract stability.

Figure 4. The pH of ethanolic lavender extract

4. CONCLUSIONS

Following the experiments performed, significant differences were observed between the extraction methods analyzed in terms of physicochemical parameters. Hot maceration resulted in more concentrated extracts, with slight modifications in density, pH, viscosity and refractive index compared to cold maceration. The density increased slightly due to the higher content of extracted active compounds (by approx. 0.005-0.010 g/cm3), while the refractive index also showed a moderate increase (0.002-0.005 units).

The pH of the aqueous lavender extract gradually decreased from a neutral value to slightly acidic over time, as phenolic compounds were released, indicating progressive extract stabilization. After a few days, the extracts reached a chemical equilibrium following the initial release of active constituents.

Overall, hot maceration can be considered a more efficient method for obtaining extracts rich in active principles, whereas cold maceration is preferred for applications requiring greater stability and subtle sensory properties.

Compared to lavender, rosemary showed a slightly lower yield, which may be related to differences in plant matrix structure and the lower solubility of some terpene compounds in the selected solvent system

In conclusion, the selection of the extraction method should be made according to the intended purpose: preserving sensitive compounds, maximizing yield, therapeutic use or cosmetic formulation. These aspects are essential for the development of effective and safe products based on standardized plant extracts.

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