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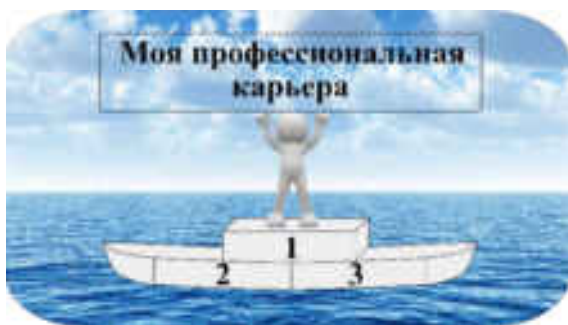


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**Международный научно-образовательный электронный журнал
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Журнал объединяет авторов на территории стран СНГ и помогает обмениваться передовыми научно-образовательными исследованиями.

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Abstract

Rutin (quercetin-3-O-rutinoside) is a bioactive flavonoid with strong antioxidant, anti-inflammatory, and vasoprotective properties. Species of the genus *Crataegus*, including *Crataegus turkestanica*, are known to be rich sources of rutin and other phenolic compounds. This study presents a comprehensive technological framework for the extraction of rutin from *C. turkestanica*, including raw material preparation, solvent extraction, advanced extraction techniques, and purification strategies. The influence of key parameters such as solvent composition, temperature, time, and particle size on extraction efficiency is critically evaluated. Analytical methods for rutin quantification and purity assessment are also discussed.

1. Introduction

Flavonoids are a major class of plant secondary metabolites with significant pharmacological relevance. Rutin, a glycoside of quercetin, is widely distributed in medicinal plants and has demonstrated therapeutic potential in cardiovascular protection and oxidative stress reduction.

Crataegus turkestanica, a species traditionally used in Central Asian medicine, contains appreciable levels of rutin in its leaves, flowers, and fruits. The development of efficient extraction technologies is essential for industrial utilization of this compound.

2. Raw Material Preparation

2.1 Plant Material

- Leaves and flowers (highest rutin concentration)
- Harvesting stage: flowering phase (optimal phenolic content)

2.2 Drying

- Air drying or oven drying at 40–50°C
- Moisture content reduced to <10%

2.3 Grinding

- Particle size: 0.3–1 mm
 - Enhances surface area and mass transfer
-

3. Solvent Extraction Techniques

3.1 Conventional Solvent Extraction

Solvents

- Ethanol–water mixtures (50–80% ethanol)
- Methanol (analytical scale)

Process Parameters

- Temperature: 40–70°C
- Time: 1–3 hours
- Solid-to-liquid ratio: 1:10 to 1:20

Mechanism

Diffusion-driven extraction of rutin from plant matrix into solvent, governed by Fick's law.

4. Advanced Extraction Methods

4.1 Ultrasound-Assisted Extraction (UAE)

Mechanism

Acoustic cavitation disrupts plant cell walls, improving solvent penetration.

Conditions

- Frequency: 20–40 kHz

- Time: 20–60 min
- Temperature: <50°C

Advantages

- Increased yield
 - Reduced extraction time
-

4.2 Microwave-Assisted Extraction (MAE)

Mechanism

Microwave energy causes rapid heating of intracellular moisture, leading to cell rupture.

Advantages

- High efficiency
 - Reduced solvent usage
-

4.3 Supercritical Fluid Extraction (SFE)

Solvent

- CO₂ with ethanol as co-solvent

Conditions

- Pressure: 20–30 MPa
- Temperature: 40–60°C

Limitations

- Less effective for polar compounds like rutin without modifiers
-

5. Purification of Rutin

5.1 Liquid-Liquid Extraction

- Removal of non-polar impurities using hexane

5.2 Column Chromatography

- Stationary phase: silica gel or C18
- Eluent: methanol–water gradients

5.3 Crystallization

- Final purification step for high-purity rutin
-

6. Analytical Methods

6.1 High-Performance Liquid Chromatography (HPLC)

- Detector: UV ($\lambda \approx 254\text{--}360\text{ nm}$)
- Most reliable quantification method

6.2 Spectrophotometric Methods

- Aluminum chloride colorimetric assay

6.3 Thin Layer Chromatography (TLC)

- Qualitative identification
-

7. Process Optimization

Parameter	Optimal Range
Ethanol concentration	60–70%
Temperature	50–60°C
Extraction time	30–90 min (UAE)
Particle size	<1 mm

Optimization tools:

- Response Surface Methodology (RSM)
 - Kinetic modeling
-

8. Yield and Efficiency

Method	Rutin Yield (%)
Conventional	Moderate
UAE	High
MAE	Very high
SFE	Moderate

9. Applications of Rutin

- Pharmaceutical (vascular protection, anti-inflammatory drugs)
 - Nutraceuticals and dietary supplements
 - Functional foods
 - Cosmetics (anti-aging formulations)
-

10. Environmental and Safety Considerations

- Ethanol preferred as green solvent
 - Reduction of toxic solvents (methanol)
 - Implementation of solvent recovery systems
-

11. Conclusion

The extraction of rutin from *Crataegus turkestanica* can be significantly enhanced through the use of optimized solvent systems and modern extraction technologies such as UAE and MAE. These methods improve yield, reduce processing time, and preserve the bioactivity of rutin. Industrial-scale implementation requires balancing efficiency, cost, and environmental sustainability.

12. Recommendations

- Use ethanol–water mixtures for safe and efficient extraction
 - Apply ultrasound-assisted extraction for higher productivity
 - Integrate chromatographic purification for pharmaceutical-grade rutin
-

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