

TECHNOLOGICAL PROCESSES IN THE PROCESSING AND DRYING OF MULBERRY (*MORUS ALBA*) LEAVES FOR TEA PRODUCTION

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1. Introduction

Mulberry (*Morus alba*) leaves have long been recognized not only as the primary food source for silkworms but also as a rich source of bioactive compounds such as flavonoids, alkaloids, phenolic acids, and polysaccharides. These components contribute to a variety of health benefits, including antioxidant, antidiabetic, and anti-inflammatory properties, making mulberry leaf tea an attractive functional food.

Recent studies have shown that the chemical composition and therapeutic properties of mulberry leaves are significantly affected by the processing methods employed during tea production. Each stage — from harvesting and withering to rolling, fermentation, fixation, drying, and packaging — plays a critical role in preserving the leaf's nutritional value and sensory qualities.

This study aims to analyze the technological processes involved in the production of mulberry leaf tea and evaluate how different techniques impact the final product's quality and functional properties.

2. Materials and Methods

2.1. Raw Material Collection

Fresh, healthy, and mature *Morus alba* leaves were collected in the early morning hours from organically grown trees. Leaves were inspected for damage, pests, and contamination, and only undamaged leaves were selected.

2.2. Pre-processing

Leaves were sorted, cleaned to remove dust and foreign particles, and then subjected to pre-wilting (withering) under shade for 6–12 hours at ambient temperature (25–30°C) to reduce moisture content and improve flexibility.

2.3. Rolling

The softened leaves were rolled by hand or mechanical rollers to rupture cell walls, enabling the release of enzymes and cellular juices that contribute to flavor and fermentation.

2.4. Fermentation (optional)

Some samples underwent a controlled fermentation process in a humidity-controlled chamber (25–28°C, 85% RH) for 4–6 hours to initiate enzymatic oxidation. This step modified the color and aroma of the leaves, similar to black tea processing.

2.5. Fixation

For green-style mulberry teas, thermal fixation was carried out using a microwave or hot-air method (90–100°C for 1–2 minutes) to inactivate polyphenol oxidase enzymes and prevent over-oxidation of phenolic compounds.

2.6. Drying

Leaves were dried using three different techniques:

- **Sun drying:** natural air circulation for 24–48 hours
- **Hot-air drying:** 50–60°C for 4–5 hours
- **Microwave drying:** 360W for 5–7 minutes

Moisture content was reduced to below 6% to ensure long-term shelf stability.

2.7. Chemical Analysis

- **Total Phenolic Content (TPC)** was measured using the Folin–Ciocalteu method.
- **Total Flavonoid Content (TFC)** was analyzed spectrophotometrically.
- **Antioxidant activity** was evaluated using DPPH and ABTS radical scavenging assays.

2.8. Packaging and Storage

Dried mulberry leaf tea was stored in airtight, opaque packaging materials under cool and dry conditions to minimize oxidation and preserve sensory quality.

3. Results

3.1. Effect of Drying Methods on Bioactive Compounds

Among the drying methods tested, microwave drying preserved the highest levels of phenolic compounds (up to 390.89 mg GAE/g extract) and flavonoids (up to 39.09 mg QE/g extract), compared to sun drying and hot-air drying, which showed partial degradation due to prolonged exposure or high heat.

3.2. Antioxidant Activity

Samples dried using microwave methods exhibited higher DPPH radical scavenging activity ($IC_{50} = 22.6 \mu\text{g/mL}$) than those subjected to sun drying ($IC_{50} = 35.4 \mu\text{g/mL}$), indicating better preservation of antioxidant compounds.

3.3. Sensory Evaluation

Tea produced from non-fermented (green tea-like) leaves had a fresh grassy aroma and lighter infusion color, while fermented samples had a deeper color and stronger taste, indicating successful enzymatic oxidation.

4. Discussion

The study demonstrates that technological parameters such as drying temperature, fermentation duration, and fixation method significantly affect the quality of mulberry leaf tea. Particularly, **microwave fixation and drying** offer advantages in preserving bioactive compounds and antioxidant potential, while also reducing processing time.

Fermentation was found to alter the phenolic profile of the tea, enhancing flavor complexity but slightly reducing total antioxidant content. These trade-offs suggest that the choice of processing technique should be aligned with the desired product profile — functional health benefits vs. traditional sensory attributes.

Inadequate drying or improper storage can lead to microbial spoilage or oxidation of bioactive compounds. Therefore, optimized drying methods and suitable packaging are essential to maintain the shelf life and efficacy of mulberry leaf tea.

5. Conclusion

Mulberry leaf tea is a promising herbal beverage with significant health benefits. This study underscores the importance of each technological process — from harvesting to drying — in preserving the functional and nutritional value of the final product. Optimizing processing parameters, particularly drying and fixation techniques, is crucial to ensuring product quality and consumer satisfaction.

Future research should focus on standardizing processing methods and exploring new drying technologies (such as freeze-drying or vacuum drying) to further enhance the quality and stability of mulberry leaf tea.

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