

## Modern Trends in Processing and Packaging Medicinal and Aromatic Plants

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### **Abstract:**

In recent years, the demand for synthetic products has declined and continues to do so. Conversely, there is a growing interest and need for natural herbal products and related items, such as food, medicine, herbal tea, and cosmetics. The increased consumption of certain plant species due to the current epidemic has highlighted the significance of medicinal and aromatic plants. These plants, which are crucial raw materials for the pharmaceutical, food, beverage, cosmetics, and various other industries, are examined from multiple perspectives in this book. The studies address a wide range of uses for certain plant families and species, covering topics from economics to production, soil conditions to fertilization, cultivation techniques to yield parameters, and microbiological, antioxidant, and antimicrobial properties to applications in meat and dairy products, as well as morphological, physiological, and biochemical properties to essential oil processing.

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**Keywords:** Medicinal and Aromatic plants, Processing, packaging, Marketing, Innovative Technologies. Modern techniques.

### **Introduction:**

Since ancient times, people have gathered plants to fulfill various needs. Medicinal and aromatic plants (MAPs) have been used in fields ranging from medicine to cosmetics for thousands of years and continue to be used today as medicines, food supplements, cosmetic ingredients, and insecticides. Recently, the production and trade of these plants have increased due to growing awareness of sustainable development, environmental protection, and healthy living. During the COVID-19 pandemic, there has been a heightened focus on the antiviral potential of plant-based preparations and their effectiveness in supporting the immune system. Consequently, the medicinal plant-based industry holds significant economic growth potential.

Globally, it is challenging to determine the exact number of species used as medicinal and aromatic plant material. Estimates from the late 1970s by the WHO listed 21,000 medicinal species, and today, there are an estimated 422,000 plant species worldwide, with 50,000 classified as medicinal and aromatic. China alone has 4,941 of its 26,092 native species used for such purposes. The international trade of MAPs is similarly difficult to quantify. Most MAPs are exported from developing countries, while the major markets are in developed nations. Between 2011 and 2020, MAPs exports increased

by 5%, reaching \$68.5 million, with Asian and European countries leading the market. About 46.8% of global MAPs imports go to European countries, driven by a growing interest in alternative treatments in developed nations.

With its diverse flora and endemic plants, is a significant exporter of MAPs. Although the exact number of medicinally used plants in Turkey is not known, it is estimated to be around 500, with approximately 200 species having export. Despite this potential, Turkey's MAPs exports have not reached the desired level. Medicinal and aromatic plants have been widely used in Turkey and Egypt for thousands of years, and consumer interest in herbal methods is rising due to health concerns, the safety of herbal products compared to synthetic drugs, and their lower cost. This growing interest is creating new income opportunities for rural populations, many of whom gather MAPs from the wild. However, collectors often receive a small share of the final product's value due to a lack of awareness of the plants' true value, inability to market them in desired forms, or lack of access to buyers.

This study aims to provide an overview of the international markets for MAPs, it also covers the production, trade, and marketing of MAPs, and suggests strategies to enhance its export opportunities.

### **Objectives of the Research:**

- Investigate current methods and technologies used in the processing of medicinal and aromatic plants to ensure maximum preservation of their active compounds.
- Examine innovative packaging solutions that maintain the quality, potency, and shelf life of medicinal and aromatic plants.
- Develop and propose quality control measures and standards for processing and packaging to ensure consistency, safety, and efficacy of the products.
- Explore sustainable and eco-friendly processing and packaging methods to minimize environmental impact and promote sustainable development.
- Ensure that modern processing and packaging methods meet health and safety standards to protect consumers from contamination and degradation of plant materials.
- Explore opportunities for expanding the market reach of processed and packaged medicinal and aromatic plants through improved processing and packaging practices.
- Identify and review the regulatory requirements for the processing and packaging of medicinal and aromatic plants in different markets.
- Analyze the economic benefits of modern processing and packaging techniques for producers, processors, and consumers.

### **Medicinal and Aromatic Plants Production:**

Turkey and Egypt, with their advantageous geographical location, hosts many endemic plants. Some medicinal and aromatic plants are cultivated, while others are harvested from the wild, similar to practices in many parts of the world. In Turkey, cultivated medicinal and aromatic plants include cumin, anise, thyme, fenugreek, poppy, fennel, mint, and coriander. Plants such as laurel, mahaleb, linden flower, sage, rosemary, licorice root, and juniper bark are gathered from nature.

The production of medicinal and aromatic plants has generally increased over the years. For instance, the area used for anise cultivation was 211,542 decares in 2011 but decreased to 155,317 decares by 2020, resulting in a production amount of 10,716 tons in 2020 with an anise yield of 69 kg per decare. Conversely, cumin cultivation areas have grown by 6% over the last decade, reaching 212,132 decares, with production also increasing to 14,000 tons and a yield of 66 kg per decare.

Thyme cultivation areas have expanded significantly, with a 137.7% increase over the past ten years. In 2020, 23,866 tons of thyme were produced, with an average yield of 129 kg per decare. Black cumin cultivation areas have grown by 43% in the last five years. Coriander cultivation has also seen notable growth, with 2,455 decares planted in 2020 yielding 188 tons of coriander. Fennel production areas have expanded by

approximately 41%, leading to a production of 4,365 tons from 22,204 decares.

Sage production has also increased, with a 60% rise in cultivated area over the past five years, resulting in a tripling of yield from 6,655 decares. Fenugreek cultivation areas have expanded fivefold over the past decade, reaching 6,521 decares and producing 713 tons. Carob production areas increased by 88%, resulting in 18,806 tons of production from 9,299 decares.

There have been significant increases in the wild harvesting of certain medicinal and aromatic plants. Carob, a wild-harvested plant, saw collection increase from 23 tons in 2011 to 642 tons in 2020. Bay leaves collection grew from 12,329 tons in 2011 to 32,537 tons in 2019. The amount of linden collected rose from 3 tons to 76 tons over the past ten years.

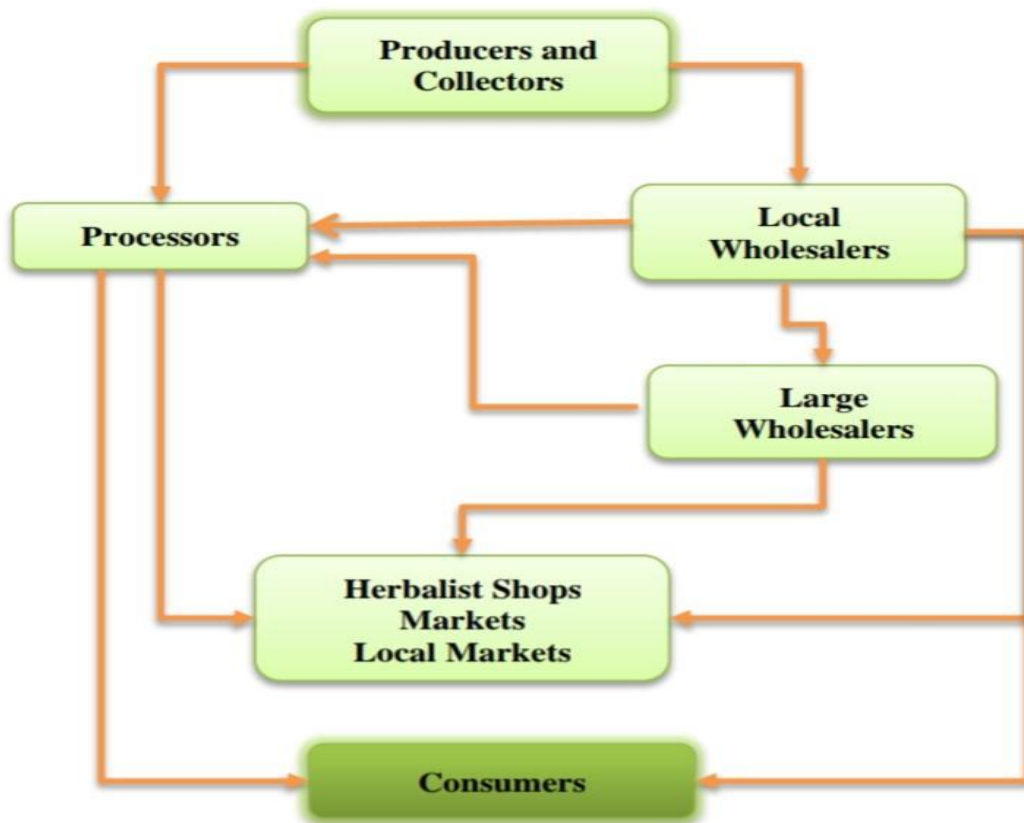
Due to the significant portion of medicinal and aromatic plants being wild-harvested, obtaining reliable statistical data remains challenging.

### **Medicinal and Aromatic Plants Marketing:**

In MAPs marketing, the supply chain often spans six or seven stages, involving primary collectors, producers, local contractors, regional wholesale markets, large wholesale markets, and specialized suppliers. Industry typically sources from suppliers and wholesalers rather than directly from smallholders due to the substantial quantities and variety of raw materials required, rendering product traceability nearly impossible. Presently, exporters aiming for traceability often resort to contract farming and buy-back agreements to meet customer demands (FAO, 2005).

In Turkey and Egypt, the marketing channels for medicinal and aromatic plants vary depending on the product. The domestic marketing channel for these plants is illustrated in Figure 1. Manufacturers and collectors sell products to local wholesalers and packaging firms. Local wholesalers generally secure products by coordinating with collectors based on specific demands from processing companies or major wholesalers. Processing firms procure products directly from local collectors and producers, especially from large wholesalers. Processed and packaged items are distributed in the domestic market through herbalists, markets, neighborhood stores, or exported overseas.

In a study conducted in Isparta province, it was found that 29% of lavender-producing enterprises market their products through a distribution channel that includes producer-factory-firms-consumer, 22% follow a path of producer-merchant-wholesaler-retailer-consumer, and 19% sell directly through the producer-factory route. Only 6.35% of producers sell directly from the producer to the consumer.



## Methodology:

### The New Strategies of Processing and Packaging Medicinal and Aromatic Plants in Egypt:

#### 1. *Advanced Extraction Techniques:*

##### A. Supercritical Fluid Extraction (SFE)

**Description:** Utilizes supercritical CO<sub>2</sub> to extract bioactive compounds.

**Advantages:** High efficiency, purity, and environmentally friendly.

**Implementation in Egypt:** Adoption in high-end processing facilities for premium product lines.

##### B. Microwave-Assisted Extraction (MAE):

**Description:** Uses microwave energy to heat solvents in contact with plant material, enhancing extraction efficiency.

**Advantages:** Reduced processing time and energy consumption.

**Implementation in Egypt:** Employed in medium to large-scale operations to improve extraction yields.

### **C. Ultrasound-Assisted Extraction (UAE):**

**Description:** Uses ultrasonic waves to break cell walls and enhance solvent penetration.

**Advantages:** Increased extraction rate and quality.

**Implementation in Egypt:** Integrated into traditional extraction processes to boost productivity.

## ***2. Sustainable Packaging Solutions***

### **A. Biodegradable Packaging:**

**Materials Used:** Plant-based plastics, biodegradable films, and compostable materials.

**Advantages:** Reduced environmental impact and improved consumer appeal

**Implementation in Egypt:** Piloted by eco-conscious brands and supported by government initiatives for sustainable development.

### **B.Active Packaging:**

**Description:** Incorporates active substances that interact with the product to extend shelf life.

**Advantages:** Maintains freshness, prevents microbial growth, and extends product shelf life.

**Implementation in Egypt:** Used for high-value products destined for export markets.

### **C. Intelligent Packaging:**

**Description:** Includes sensors and indicators to monitor product condition.

**Advantages:** Provides real-time information on freshness, spoilage, and storage conditions.

**Implementation in Egypt:** Experimental phase in high-tech processing plants with potential for broader adoption.

## ***3. Technological Assessment:***

**Objective:** To evaluate the effectiveness and feasibility of new technologies in MAP processing and packaging.

**Technologies Assessed:** Processing: Supercritical fluid extraction, microwave-assisted extraction, and ultra-sonication.

**Packaging:** Biodegradable materials, active and intelligent packaging, and vacuum packaging.

**Criteria:** Efficiency, cost-effectiveness, sustainability, and impact on product quality.

## ***4. Laboratory Experiments:***

**Objective:** To validate the effectiveness of selected processing and packaging techniques.

**Setup:** Controlled experiments to test new extraction methods and packaging materials.

**Parameters:** Yield, purity, shelf-life, and preservation of bioactive compounds.

## **5. Market Analysis**

**Objective:** To understand market demands and consumer preferences related to MAPs.

**Approach:** Analysis of market trends, consumer surveys, and sales data.

**Outcome:** Insights into market opportunities and consumer expectations regarding product quality, sustainability, and packaging.

### **Benefits of New Methods of Processing and Packaging Medicinal and Aromatic Plants:**

**First:** The adoption of advanced extraction techniques such as Supercritical Fluid Extraction (SFE), Microwave-Assisted Extraction (MAE), and Ultrasound-Assisted Extraction (UAE) significantly enhances the quality and safety of medicinal and aromatic plant products. These methods ensure a higher purity and potency of extracted compounds, reducing the risk of contamination and preserving the natural properties of the plants. This results in products that are not only more effective but also safer for consumers, meeting both local and international quality standards.

**Second:** Sustainable packaging solutions, including biodegradable and compostable materials, contribute to reducing the environmental footprint of the medicinal and aromatic plant industry in Egypt. By moving away from conventional plastic packaging, these eco-friendly alternatives help minimize waste and pollution. This shift aligns with global trends towards sustainability and caters to the growing consumer demand for environmentally responsible products. Additionally, active and intelligent packaging extends product shelf life, reducing food waste and ensuring better resource utilization.

**Third:** Adopting new technologies and methods necessitates ongoing training and professional development, leading to a more skilled workforce. This focus on education and skill enhancement improves overall industry standards and productivity. Furthermore, collaboration with universities and research institutions fosters innovation, keeping the industry competitive and at the forefront of global trends. Companies that invest in research and development can continuously improve their products and processes, ensuring long-term growth and sustainability.

**Fourth:** The focus on cultural awareness and sensitivity through these new methods encourages the preservation of traditional knowledge and practices. This cultural enrichment not only benefits the local communities but also adds value to the products by highlighting their unique heritage. Personal growth for those involved in the industry, from farmers to researchers, is another significant benefit. Engaging with cutting-edge technologies and international markets fosters a sense of achievement and pride, motivating continuous improvement and innovation.

### **Results of study:**

- ✓ Improved Extraction Efficiency and Product Quality Research into modern extraction techniques, such as Supercritical Fluid Extraction (SFE), Microwave-Assisted Extraction (MAE), and Ultrasound-Assisted Extraction (UAE), has demonstrated significant improvements in extraction efficiency and product quality. These methods enable the isolation of higher purity and potency compounds from medicinal and aromatic plants. This results in products with enhanced therapeutic efficacy and a longer shelf life, meeting both consumer expectations and regulatory standards.
- ✓ Economic and Market Expansion Analysis of modern trends has shown that adopting advanced processing and packaging methods can boost economic growth and market expansion. High-quality, traceable products have a competitive edge in international markets, leading to increased export opportunities for producers. Compliance with international standards and certifications, such as ISO and GMP, enhances the credibility of Egyptian products on the global stage. This not only increases export revenues but also attracts foreign investment, stimulating further economic development in the sector.
- ✓ Enhanced Industry Standards and Workforce Development The study highlights the importance of continuous professional development and training in adopting new technologies. This emphasis on education improves industry standards and overall productivity. Collaboration with academic and research institutions fosters innovation and keeps the industry competitive. Companies that invest in research and development are better positioned to improve their products and processes continuously, ensuring long-term growth and sustainability.

### **Strategic Recommendations:**

Based on the results, the study recommends several strategic actions for the industry. These include investing in advanced extraction technologies, adopting sustainable packaging solutions, and pursuing international certifications to enhance product credibility. Additionally, fostering collaborations with academic institutions and investing in workforce development are crucial for maintaining competitiveness. Engaging in community outreach and promoting cultural heritage can further enhance the social and economic benefits of the industry.

**Conclusion:**

Due to their functional properties, medicinal and aromatic plants are also used in different industrial areas along with their traditional use. The widespread use of medicinal and aromatic plants has increased with the increase of people's awareness of health, their desire to take precautions against diseases and to create their own treatments. Accordingly, their production and trade has increased both in the world and in Turkey. This has not as yet, however, resulted in substantial benefits to developing countries or particularly benefits to growers and producers.

MAPs are both wild harvested and cultivated in the world as well as in Egypt. It is seen that awareness and interest in the economic, social and environmental benefits and importance of MAPs have increased in the world in recent years. These plants are important in terms of biodiversity, as well as in the protection of wildlife. Especially in small family farming, MAPs have the potential to provide an opportunity for high income.

Egypt is at an important point in terms of surface area, climate and gene centers. Therefore, it has rich endemic plant diversity. MAPs constitute a significant part of this endemic diversity in Turkey. However, in Egypt since MAPs are exported as raw materials, its value added is low. In Egypt, MAPs cleaning, sorting, classification, processing and packaging are done only in spice and herbal tea production. Therefore, processed and standardized MAPs production is insufficient.



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