PROJECT DESIGN AND ANALYSIS OF A PRIMARY PROCESSING UNIT FOR MEDICINAL PLANTS COLLECTED FROM WILD FLORA

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ABSTRACT: This study focuses on the design and economic evaluation of a technological unit for the primary processing of medicinal plants collected from wild flora. It highlights key technological processes, equipment, and financial indicators, aiming to provide a sustainable and efficient processing model for medicinal herbs in Romania.

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KEY WORDS: processing, medicinal plants, wild flora

1. INTRODUCTION

Medicinal plants contain bioactive compounds with therapeutic effects and have been used for centuries in traditional medicine. They are valuable resources for the pharmaceutical, cosmetic, and food industries due to active constituents such as alkaloids, flavonoids, essential oils, and tannins. Romania, with its favorable climate, has a rich spontaneous flora that is in demand both domestically and internationally.

Knowledge about medicinal plants evolved from animal observations and oral traditions and was documented in ancient civilizations such as the Sumerians, Egyptians, Greeks, Romans, Chinese, and Indians. Figures like Hippocrates, Dioscorides, and Paracelsus contributed to the development of phytotherapy and pharmacognosy, laying the foundations for modern scientific research.

Today, the main challenges include biodiversity loss, overharvesting, and quality maintenance. The WHO recommends sustainable harvesting, controlled cultivation, adherence to ecological conditions, and product standardization. Pharmacological research and regulatory harmonization are essential for ensuring product safety and efficacy.

Medicinal plants will continue to be essential in agriculture, pharmacy, and

nutrition, and their sustainable conservation and responsible use require collaboration among authorities, researchers, industry, and local communities.

2.WILD FLORA AND MEDICINAL SPECIES

Table 1. Medicinal plant species and bioactive components

Species	Part used	Active compounds	Properties
Cornflower	Flowers	Flavonoids, anthocyanins	Digestive and ocular disorders
Chamomile	Flowers	Essential oil, flavonoids	Calming, antiseptic, anti-inflammatory
Chicory	Aerial parts / Roots	Inulin, sesquiterpene lactones	Detoxifying, digestive
Thyme	Leaves	Essential oil, flavonoids	Antiseptic, expectorant
Plantain	Leaves	Mucilages, flavonoids	Anti-inflammatory, healing
Lemon balm	Leaves	Essential oil, flavonoids	Calming, digestive
Wild sage	Leaves	Essential oil, flavonoids	Antiseptic, digestive
Comfrey	Rhizomes	Allantoin, mucilages	Regenerative, anti-inflammatory
Black hawthorn	Fruits	Anthocyanins, vitamins	Antioxidant, cardiovascular
Rosehip	Fruits	Vitamin C, carotenoids	Immunostimulant
Hawthorn	Fruits	Flavonoids, tannins	Cardiotonics
Quince	Fruits	Pectins, vitamins	Digestive, antioxidant




Figure 1. Medicinal plant species

3. PRIMARY PROCESSING TECHNOLOGICAL PROCESSES

3.1 Preparation of raw material

Immediate storage protected from moisture and light. Quality control before and during processing.

3.2 Technological flows

Includes drying, grinding, extraction, and formulation stages for different plant parts.

- Flowers (Cornflower, Chamomile): Drying 35–40°C; yield 3–5 kg fresh → 1 kg dry.
- Aerial Parts (Chicory, Yarrow): Drying 40–50°C; yield 4–7 kg fresh → 1 kg dry.
- Leaves (Plantain, Lemon balm): Drying 30–50°C; yield 4–9 kg fresh → 1 kg dry.
- Rhizomes (Valerian, Comfrey): Washing, drying 35–40°C; impurities ≤3%, drying loss ≤14%.
- Fruits (Milk thistle, Rosehip): Drying 5–10 days; yield 4–5 kg fresh → 1 kg dry.

3.3 Unit layout

Dimensions: 33 m × 81 m, height 18 m. The plant includes compartments for raw material reception, drying, sorting, primary processing, and packaging.

Equipment: conveyor belts, drying tunnel, optical sorting, CO_2 extraction, lyophilizer, nitrogen generators, biomass heating plant.

3.4 Schematic technological flow

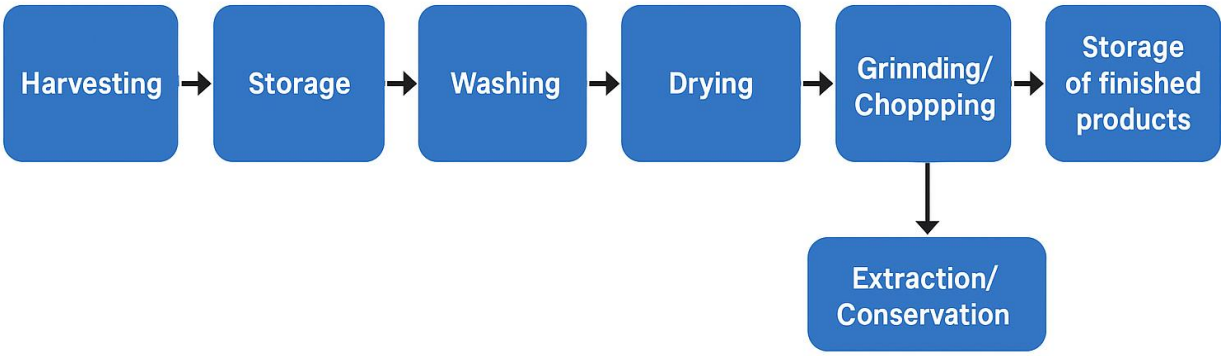

Figure 2. Schematic technological flow

4. ECONOMIC ANALYSIS

4.1 Investment calculation

Equipment	Cost (lei)
Optical sorting	120,000
Ultrasonic washer	45,000
Drying tunnel	85,000
CO_2 extractor	220,000
Granulator	75,000
MAP packaging system	55,000
Total	600,000

4.2 Operating Expenses

- Utilities: 2,880 lei/year
- Raw and auxiliary materials: 20,000 lei/year
- Additional expenses: 9,500 lei/year
- Total operating expenses: 632,380 lei/year

4.3 Production price and profit

- Profit 20%: 126,476 lei
  VAT 19%: 144,182 lei
  Production price: 63.23 lei/kg
  Delivery price: 90.30 lei/kg

4.4 Economic Indicators

- Annual turnover: 903,038 lei
  Annual profit: 126,476 lei
  Profit rate: 14%
  Investment payback period: 5 years

4.5. Extended SWOT Analysis

Strengths	**Weaknesses**
Access to natural resources; low costs	High seasonality; weather dependency
Automation and digitalization	Higher initial investment for smart technologies
Ecological certification and traceability	Need for staff training

Opportunities	**Threats**
Growing demand for ecological products	International competition
EU funding for digitalization	Strict EU regulations

Opportunities	Threats
Integration into short supply chains	Climate changes affecting wild flora

5. CONCLUSIONS

- The study emphasizes the importance of designing a sustainable technological unit for the primary processing of medicinal plants collected from wild flora in Romania, aimed at both efficiency and environmental preservation.
- A diverse range of medicinal plants, including chamomile, cornflower, thyme, and rosehip, contain bioactive compounds such as flavonoids, essential oils, and vitamins, which have various therapeutic properties.
- Harvesting methods are mainly manual or mechanical, with only about 30% of available biomass being collected to ensure ecological sustainability.
- The primary processing involves key technological steps such as drying, grinding, extraction, and formulation tailored to different plant parts, with specific temperature and duration parameters to optimize yield and quality.
- The layout of the processing plant spans 33 m × 81 m with a height of 18 m, incorporating functional compartments and sophisticated equipment like conveyor belts, optical sorting, CO_2 extraction, and lyophilizers.
- The total investment for the machinery amounts to approximately 600,000 lei, with annual operating expenses estimated at 632,380 lei, including utilities, materials, and additional costs.
- The production price is established at 63.23 lei/kg, with a subsequent sale price of 90.30 lei/kg to ensure a profit margin of 20%, resulting in an annual turnover of circa 903,038 lei and a profit rate of 14%.
- The economic analysis indicates a payback period of the investment of about 5 years, highlighting the financial viability of the unit.
- The SWOT analysis reveals strengths such as resource access, low production costs, and ecological certification, but also points out weaknesses like seasonality and initial technology costs.
- Future opportunities include expanding demand for ecological products, leveraging EU funding for digitalization, and integrating into short supply chains, while threats involve climate change impacts and increasing international competition.

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