

Extracting Antioxidant from Olive Oil Waste For Health Enhancing Products

J. Suhail Hassan, Dr.S. Prasanna

Department of Computer Application - PG
VISTAS, Chennai

Abstract- Olive oil manufacturing produces huge by-products, among which is olive mill wastewater (OMW), which was formerly considered environmental contaminants. More recent studies have shown the possibilities of OMW as a great source of bioactive compounds in the form of polyphenols such as hydroxytyrosol and oleuropein, whose antioxidant and anti-inflammatory properties have been well reported. The bioactive compounds have been found effective in preventing and treating some types of cancer such as lung, prostate, colon, and breast cancers. Moreover, antioxidants derived from OMW help ensure cardiovascular and neurological well-being, metabolic processes, and post-exercise recovery. The bioactive content of OMW is higher than in extra virgin olive oil, making OMW a rich source to derive functional foods and nutraceuticals. Leveraging OMW not only provides a sustainable solution to waste disposal but also presents opportunities to design health-promoting products, further facilitating human health and well-being.

Keywords: Olive mill wastewater (OMW), hydroxytyrosol, oleuropein, polyphenols, antioxidants, cancer prevention, cardiovascular health, functional foods, nutraceuticals, sustainable waste management

I. INTRODUCTION

Antioxidant Extraction from Olive Oil By-Products for Health-Boosting Products The world olive oil industry generates enormous amounts of by-products, such as olive mill wastewater (OMW), olive pomace, and olive leaves. Historically regarded as environmental pollutants because of their high organic load and phytotoxicity, these by-products are major disposal problems. Nevertheless, recent studies have identified them as valuable sources of bioactive compounds, especially phenolic compounds such as hydroxytyrosol, oleuropein, and tyrosyl, which are renowned for their strong antioxidant, anti-inflammatory, and antimicrobial activities.

PMC Importantly, research has indicated that only a limited amount of the phenolic compounds in olives are retained in the oil during processing, with most

being found in the by-products. Realizing this has generated interest in the creation of sustainable extraction technologies to recover these desirable compounds, converting waste into health-imparting ingredients for application in functional foods, nutraceuticals, and pharmaceuticals.

PMC+1 MDPI+1

New extraction methods, including membrane filtration and sustainable solvent extraction, have been researched to effectively extract these antioxidants from olive oil waste products. Compounds recovered showed a range of health benefits like cardiovascular protection, neuroprotection, and anticancer activities. Further, use of these extracts in food systems has been observed to improve the antioxidant activity of the foodstuffs and prolong shelf life.

Valorisation of olive oil waste not only treats environmental issues linked to its disposal but also

goes hand in hand with the precepts of circular economy, focusing on sustainability and efficiency of resources. Through utilization of the health-improving properties of such by-products, the olive oil sector can aid in the establishment of innovative, health-improving products alongside reducing its ecological impact.

II. LITERATURE SURVEY

Extraction of Antioxidants from Olive Oil Waste for Health-Promoting Products Valorisation of olive oil manufacturing by-products, especially olive mill wastewater (OMW), has attracted considerable interest because of its high content of bioactive compounds. OMW was once traditionally viewed as an environmental pollutant, but nowadays it is recognized for its ability to contribute to health-promoting products.

1. Composition and Health Benefits of OMW is a side-stream of olive oil production, which has very high levels of polyphenols including hydroxytyrosol, oleuropein, and tyrosyl. They have strong antioxidant and anti-inflammatory activities. OMW is found to have 10 times the number of polyphenols as compared to extra virgin olive oil and thus is an important source for bioactive products.

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Experiments have shown that OMW polyphenols extracted from OMW have been successful in the prevention and treatment of numerous cancers such as lung, prostate, colon, and breast cancer. Furthermore, these chemicals help in cardiovascular and neurological functions, metabolic process, and recovery after exercise.

2. Extraction Techniques Effective extraction of antioxidants from OMW is essential for their use in health products. Recent techniques like membrane filtration, environmentally friendly solvent extraction, and sequential microwave-ultrasound-assisted extraction have been investigated. These technologies are designed to achieve maximum recovery of bioactive compounds while ensuring sustainability and economy.

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3. Applications in Food Products Food products with OMW-derived antioxidants have demonstrated

positive outcomes. For example, baked goods supplemented with defatted olive pomace powder had high total phenolic content and improved anti-inflammatory activity. Such food products are not only healthy but also reduce waste in the olive oil sector.

4. Commercialization and Consumer Acceptance Commercialization of OMW-derived products is in full swing. Fattoria La Villa in Tuscany has launched "dark water" shots made from OMW, focusing on its medicinal properties. They are being sold as functional beverages, an indication of how consumers are willing to embrace OMW as a superfood.

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5. Environmental and Economic Implications The production of antioxidants from OMW fits the tenants of circular economy, ensuring sustainability and efficiency in utilization of resources. By converting waste materials into useful health-enhancing products, the olive oil sector is capable of reducing environmental issues of OMW disposal and opening up new economic prospects.

Conclusion:

Olive oil waste antioxidant extraction is a highly promising opportunity to promote human health, achieve environmental sustainability, and boost economy. Ongoing research and technology development in the areas of extraction science, product formation, and consumer awareness are mandatory to maximize the potential of health-beneficial products from OMW.

III. PROPOSED SYSTEM

Recovery of Antioxidants from Olive Oil Waste for Health-Promoting Products Valorisation of olive oil industry by-products, especially olive mill wastewater (OMW), has received a lot of interest owing to its high content of bioactive compounds. What was traditionally regarded as a source of environmental pollution is nowadays valued for its promising possibilities in health-promoting uses.

Composition and Health Beneficence of OMW is an olive oil extraction by-product, rich in polyphenols like hydroxytyrosol, oleuropein, and tyrosyl. These polyphenols have strong antioxidant and anti-

inflammatory activities. It has been found that OMW is rich in up to 10 times more polyphenols than extra virgin olive oil, and it is thus a good source for health-benefiting products.

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Research has shown the potential of OMW-derived polyphenols to prevent and treat different types of cancers, such as lung, prostate, colon, and breast cancers. Further, these molecules have roles in cardiovascular and neurological health, metabolic activity, and exercise recovery.

A. Extraction Techniques:

Effective recovery of antioxidants from OMW is essential for their use in health products. Sophisticated techniques like membrane filtration, sustainable solvent extraction, and sequential microwave-ultrasound-aided extraction have been studied. These technologies seek to recover maximum bioactive compounds while guaranteeing sustainability and affordability.

B. Applications in Food Products:

Incorporating antioxidants obtained from OMW into food items has yielded positive results. For example, breads and baked foods supplemented with defatted olive pomace powder contained higher levels of total phenolics and increased anti-inflammatory potential. These functional foods provide health benefits in addition to reducing waste generated in the olive oil processing industry.

C. Commercialization and Consumer Acceptance:

The commercialization of OMW-based products is gaining momentum. Companies like Factoria La Villa in Tuscany have introduced "dark water" shots derived from OMW, capitalizing on its health benefits. These products are marketed as functional beverage traction of Antioxidants from Olive Oil Waste for Health-Enhancing Products

The suggested system has the goal of converting olive oil production by-products, i.e., olive mill wastewater (OMW), into useful sources of antioxidants to be applied in health-promoting products. The process not only tackles environmental issues related to waste disposal but also aids in the production of functional foods and nutraceuticals.

Pre-Treatment of Olive Mill Wastewater OMW, olive oil extraction by-product, is full of polyphenols and

other bioactive compounds. Yet, its organic load and phytotoxicity are environmental problems. Pre-treatment includes

Filtration: Solid residues removal to lower turbidity.

pH Adjustment: Adjustment of pH levels to improve the stability and solubility of phenolic compounds.

Dilution: Lowering viscosity for easier subsequent extraction steps.

D. Bioactive Compounds Extraction:

Effective extraction of antioxidants from OMW is essential. The suggested system employs Membrane Filtration: Using techniques such as nanofiltration and reverse osmosis to concentrate phenolic compounds.

Solvent Extraction: Utilizing food-grade solvents (e.g., ethanol) for the extraction of polyphenols.

Sequential Microwave-Ultrasound-Assisted Extraction: Increasing efficiency and yield by bringing together microwave and ultrasound energy, as exemplified in plant waste extraction studies.

E. Purification and Concentration:

Following extraction, the phenolic-rich extract undergoes: Adsorption Techniques: Using resins to purify and concentrate individual antioxidants.

- Evaporation: Evaporation of solvents under vacuum pressure to achieve concentrated extracts.

- Drying: Converting liquid extracts to powder form to facilitate easier addition to products.

F. Formulation of Health-Boosting Products

The isolated antioxidants may be added to different products:

- Functional Foods: Addition of extracts to bakery foods, as research has proved increased phenolic levels and anti-inflammatory activity in bread supplemented with olive pomace. arXiv

- Beverages: Formulating functional beverages with OMW extracts, taking advantage of their high antioxidant levels.

- Nutraceuticals: Developing dietary supplements for addressing oxidative stress and inflammation-linked disorders.

G. Quality Control and Standardization:

Consistency and effectiveness are ensured through.

- Analytical Testing: Measuring phenolic content and antioxidant capacity with methods such as HPLC and spectrophotometry.

- **Standardization:** Creating reference standards for levels of bioactive compounds in final products.
- **Regulatory Compliance:** Maintaining compliance with food safety and nutraceutical legislation for protection of consumers.

H. Environmental and Economic Impact

Adopting this system provides: **Waste Reduction:** Prevention of environmental contamination by recycling OMW.

- **Economic Benefits:** Establishing new income sources for olive oil manufacturers through value-added products.
- **Sustainability:** Harmonizing with the principles of the circular economy by converting waste to useful resources, mirroring a change in consumer attitudes toward embracing OMW as a superfood.

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I. Environmental and Economic Implications.

The use of OMW in extracting antioxidants is in accordance with the circular economy principles, supporting sustainability and efficiency in resource utilization. By converting waste into high-value health-benefiting products, the olive oil sector can reduce environmental issues related to OMW disposal and generate new economic opportunities.



Conclusion:

- Olive oil waste extraction into antioxidants is a complex challenge with the potential to improve human health, encourage environmental sustainability, and stimulate

economic development. Further research and development on extraction technologies, product development, and consumer education are critical in order to achieve the full potential of OMW-derived health-improving products.

VI. AARCHITECTURE

V. System Architecture Overview:

- **Input Layer:**
 - Sensor Interfaces / Data Entry
 - Collect data from lab instruments or sensors (e.g., pH level, temperature, extraction duration).
 - Manual data entry via GUI.
- **Business Logic Layer:**
 - Extraction Process Module
 - Models' different antioxidant extraction methods (e.g., solvent extraction, supercritical fluid extraction).
 - Antioxidant Analysis Module
 - Applies algorithms to quantify antioxidant concentration (e.g., DPPH assay data).
 - Product Classification Module
 - Categorizes the output for different health-enhancing applications.
- **Data Layer:**
 - Database (e.g., MySQL, PostgreSQL)
 - Stores experiment data, antioxidant levels, extraction parameters, and product profiles.
- **Presentation Layer:**
 - JavaFX / Spring Boot + Thyme leaf
 - GUI dashboard for monitoring and visualization.
 - Interfaces to display charts, input data, and export reports.
- **Optional: IoT Layer:**
 - Raspberry Pi / Arduino Integration
 - If connected to lab instruments, data can be collected in real-time using serial communication or REST APIs.

Module	Description	Technologies Used
Sensor Communication	Reads data from lab equipment (optional)	Java Serial API / REST APIs
Data Collection Interface	Form or GUI to input and monitor data	JavaFX / Spring Boot
Extraction Algorithm Engine	Simulates or evaluates extraction results	Java, Custom logic, ML
Reporting Engine	Generates PDF/Excel reports	Apache POI / JasperReports
Database Layer	Stores all process and analysis data	Hibernate + MySQL/PostgreSQL
Authentication Module	Secures access to system	Spring Security

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