







# From Food Waste to High-Value Compounds: Sustainable Green Approaches for **Product Development**

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Spoke: 8; Work Package: 8.1; Task: 8.1.1

## **Abstract**

Nowadays there is a growing interest in food waste recovery by both consumers and companies. Food waste of plant origin is a source of bioactive compounds such as phenolic acids, anthocyanins, flavonoids, phytosterols, carotenoids, and tocopherols with well-known antioxidant, anti-glycemic, and antimicrobial properties. Food waste recovery combined with the use of green and sustainable technologies is a viable alternative with broad prospects.

## **Materials & Methods**

1. Fennel stems and bulbs were subjected to ultrasonic-assisted aqueous extraction (UAE) and optimization by Box-and-Behnken design using three factors: power, time and s/L ratio at three different levels. The response was expressed as chlorogenic acid content (mg/L). Extracts were characterized to assess antioxidant activity, volatile organic compounds (VOCs) by GC-MS analysis, ascorbic acid content by HPLC and total polyphenol content (TPC).

2. The extraction efficiency of oleanolic acid in five solvents (ethyl acetate, acetone, n-butanol, dimethyl carbonate (DMC) and 2-methyltetrahydrofuran (2-MeTHF) was tested. In addition, it was evaluated whether the Aglianico pomace extract obtained from EtOAc enriched in oleanolic acid Fr. 1 was able to promote glucose uptake via glucose membrane transporters (GLUT) and two other fractions (2 and 3 - both lacking oleanolic acid)

3. The preparation of hydrogels from soy protein isolate (SPI) and polyphenols (caffeic, gallic and chlorogenic acids) of natural origin under mild air oxidation conditions was evaluated.

4. The in vitro antimicrobial activity of extracts from spent coffee grounds (SCGs) was tested. Four different extracts obtained from liquid CO<sub>2</sub> (CO<sub>2</sub>Liq) and supercritical CO<sub>2</sub> (CO<sub>2</sub>SCR) were tested, each conducted in the presence or absence of 5% EtOH and complexed with hydroxyapatite (HA). Staphylococcus aureus and Staphylococcus infantis were used as a reference microorganism The growth of bacteria in the presence of LB medium as a general control or different concentrations of SPC formulations was measured by optical density at 600 nm after 18 hours of incubation.



4th Study



### **2nd Study**



Aglianico Pomace



#### Studies on the extraction of Oleanolic Acid from red grape pomace

#### Composition of extracts by NRM and LC-MS-based.

	Oleanolic acid	Glycerol	9(Z), 11(E) CLA Malic acid	Citric acid	Glucose and Fructose	Proline
EtOAc	$0.34~\pm~0.01~Bb$	0.38 ± 0.01 Da	$0.06 \pm 0.01$ Ac $0.06 \pm 0.00$	$Cc = 0.00 \pm 0.00$	$0.00 \pm 0.00$	$0.00~\pm~0.00$
DMC	$0.38~\pm~0.03~Ab$	$0.45 \pm 0.01 \ Ca$	$0.02 \ \pm \ 0.00 \ Bc \qquad 0.04 \ \pm \ 0.00 \ B$	Ec $0.00 \pm 0.00$	$0.00 \pm 0.00$	$0.00 ~\pm~ 0.00$
Acetone	$0.11 ~\pm~ 0.01 ~Dc$	$0.60 \pm 0.03$ Aa	$0.01 \ \pm \ 0.00 \ Cd \qquad 0.08 \ \pm \ 0.00 \ J$	Bc $0.02 \pm 0.00$ Bd	$0.17 \ \pm \ 0,01 \ Bb$	$0.00 ~\pm~ 0.00$
2-MeTHF	$0.18~\pm~0.01~Cb$	$0.47 ~\pm~ 0.01 ~Bca$	$0.03 \pm 0.01$ Be $0.09 \pm 0.00$	Ad $0.03 \pm 0.00$ Ae	$0.12 \pm 0.02$ Cc	$0.00 ~\pm~ 0.00$
Butanol	$0.04 \pm 0.00$ Ede	0.51 ± 0.02 Ba	$0.01 \pm 0.00$ Ce $0.05 \pm 0.00$	Dd 0.02 ± 0.00 Bde	0.25 ± 0,02 Ab	$0.10 \pm 0.01$ Ac

DMC emerged as the best solvent for oleanolic acid extraction according the to green chemistry principles

(GLUT).

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#### **ANTIMICROBIAL ACTIVITY**



Antimicrobial activity of spent coffee grounds extracted by different methods and complexed with hydroxyapatite. The graphs represent growth curves of S. aureus (A and C) and S. infantis (B and D) in the presence of LB medium as general control or different concentrations of SPC formulations. Growth was measured by optical density at 600 nm after 18 h of incubation. Statistical analysis was performed by two-way ANOVA, comparing each condition with the untreated control. \*, p < 0.05; \*\*, p < 0.01; \*\*\*, p < 0.001.

#### Reference

Argenziano, R. et al. All natural mussel-inspired bioadhesives from soy proteins and plant derived polyphenols with marked water-resistance and favourable antibacterial profile for wound treatment applications, Journal of Colloid and Interface Science, 652, 2023, 1308-1324, 10.1016/j.jcis.2023.08.170.

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The illustrates the figure antimicrobial SCGs activity of extracted using liquid or supercritical  $CO_2$ , with or without ethanol, and complexed with hydroxyapatite as a vehicle (HA; HA+SCG\_CO<sub>2</sub>LigEtOH, HA+SCG\_CO<sub>2</sub>Liq,

HA+SCG\_CO<sub>2</sub>SCREtOH, and  $HA+SCG_CO_2SCR$ , respectively). These were tested across various concentrations of total phenolic content (TPC), ranging from 500 to 1 µg/mL. Both **HA+SCG\_CO<sub>2</sub>LiqEtOH** and **HA+SCG\_CO<sub>2</sub>Liq** demonstrated bacteriostatic activity only against *S.aureus*, with HA+SCG\_CO<sub>2</sub>Liq showing efficacy greater (**A**). Conversely,

HA+SCG\_CO<sub>2</sub>SCREtOH and HA+SCG\_CO<sub>2</sub>SCR also exhibited bacteriostatic effects against S. *infantis*, even though at higher concentrations (**D**). Notably, HA+SCG\_CO<sub>2</sub>SCREtOH reduced S. aureus growth even at lower concentrations (C), suggesting its potential as a promising antimicrobial agent.

