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A novel approach to the sustainability of hop cultivation: assessing the bioactive potential of hop leaves

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INTRODUCTION

It is estimated that hop leaves account for approximately 25% of the plant, calculated on a dry basis, depending on the variety under consideration. Traditionally considered a by-product of hop cultivation, they have recently attracted attention for their rich phytochemical content, including phenolic compounds, flavonoids and other bioactive compounds, making them a promising candidate for use in functional foods and nutraceuticals.

AIM OF STUDY

The aim of the present study was to evaluate the antioxidant potential and nutraceutical profile of hop leaves collected at harvest time in central Italy. Furthermore, an investigation was conducted to ascertain the impact of diverse drying techniques on the phytochemical profile of the samples, with the objective of identifying the optimal system for preserving the fresh biomass at the time of harvest.

RESULTS

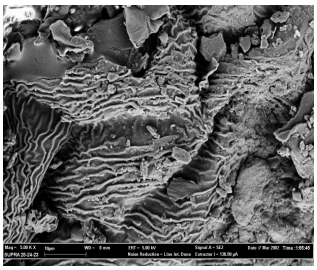
Hop variety	Code
Chinook	V1
Centennial	V2
Comet	V3
Columbus	V4
Cascade	V5

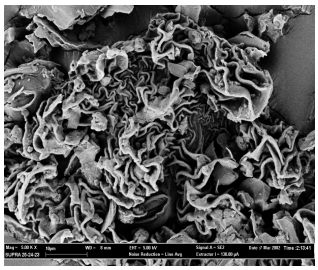
List of samples analyzed

	DF	TPC	FLC	AC_{ABTS}	AC_{DPPH}	Chl α	Chl β	Chl tot	TC	Thl
Variety (V)	4	131.6**	4.6**	15.5**	1566.9**	40.5**	298**	549.8**	105.8**	5751.4**
Treatment (T)	1	6267.5***	715.7***	1283.7***	162002***	107.9***	2252.1***	3346.1***	813.6***	26191.2***
V * T	4	103.2**	6.3**	15.9**	1313.7**	28.5**	334.3**	517.2**	143.1**	1575.7**
Error	30	0.35	0.01	0.01	206.4	1.1	1.4	1.4	0.1	50.3

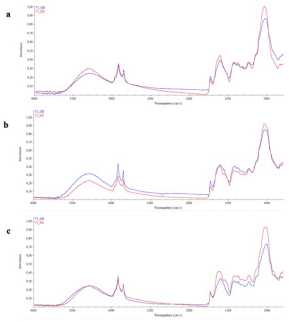
DF: degrees of freedom; TPC: total phenolic content; FLC: total flavan content; AC_{ABTS}: antiradical capacity (ABTS in vitro test); AC_{DPPH}: antiradical capacity (DPPH in vitro test); Chl α: Chlorophyll α; Chl β: Chlorophyll β; Chl tot: Total Chlorophyll; TC: Total Carotenoids; Thl: Total thiols. **p < 0.01; ***p < 0.001

Factorial analysis based on phytochemical traits of leaf samples from different hop varieties subjected to different drying treatments.

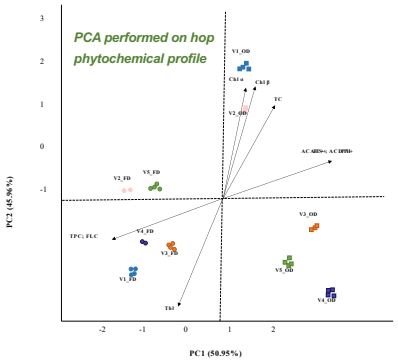


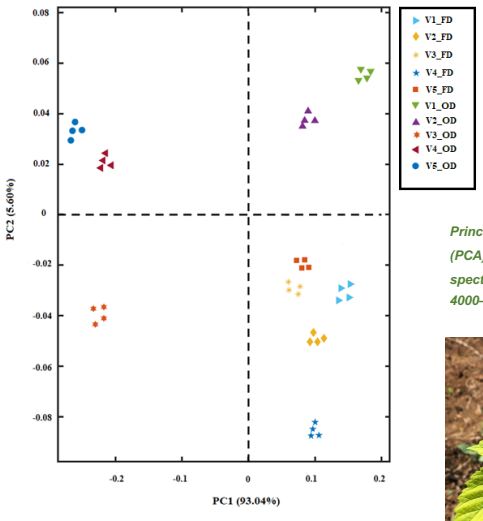


*SEM micrographs of V10 and V5 sample**



Average IR spectra of Humulus lupulus leaf extracts analyzed.





Principal component analysis (PCA) performed on the FTIR spectral dataset in the range 4000–800 cm⁻¹

**For the SEM we thank Prof. I. Cacciotti of N. Cusano University in Rome*

CONCLUSIONS

Organic Waste from Hop Cultivation:

- Hop production generates significant organic biomass, particularly leaves and stems, comprising approximately two-thirds of the total harvest.

Potential:

- Hop leaves present a promising source of bioactive compounds for the food, cosmetics, and pharmaceutical industries.

Stabilization:

- Drying is essential to stabilize hop biomass for extended storage and downstream processing.

Phytochemical Composition:

- Hop leaves exhibit high levels of soluble polyphenolic compounds and non-phenolic pigments.
- In some cases, the antioxidant profile is comparable to, or surpasses, that of traditionally dried herbs such as green tea.

Drying Method Efficacy:

- Freeze-drying preserved the broadest spectrum of nutraceutical compounds across samples.
- Oven drying maintained higher carotenoid levels in specific cultivars, namely Centennial, Comet, and Cascade.
- Optimal drying method selection should be guided by cost considerations and the intended application of the final product.

Analytical Characterization:

- ATR-FTIR spectroscopy effectively differentiated drying treatments.
- Spectral data revealed structural alterations in key leaf constituents such as cellulose, hemicellulose, and cutin.

Economic and Agronomic Impact:

- On-farm drying infrastructure could enable hop growers to diversify income streams, e.g., through production of herbal teas.
- Promotes a circular economy model and adds value to agricultural by-products.

Materials & methods

For M&M, please refer to Macchioni, V., Picchi, V., & Carbone, K. (2021). Hop leaves as an alternative source of health-active compounds: Effect of genotype and drying conditions. Plants, 11(1), 99; https://doi.org/10.3390/plants11010099.

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