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From waste to resource: sustainable protocols to develop health and cosmetic products from hop leaves

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INTRODUCTION

The therapeutic potential of the hop plant has been hypothesized from centuries, but research and an extensive experimental work is required to test its efficiency, to understand the role of its components, and to design systems able to properly deliver it. The main idea of this project is to exploit the bioactive compounds extracted from the waste of the hop plant: the leaves, which are not used for commercial aims and are often burned after the harvest.

It is hence crucial to understand how to optimize the extraction of bioactive compounds, and to make possible their use in different kind of products. The aim is to evaluate the biological activity of at least a few of the functional groups present in hops, in particular in their influence into amyloid aggregation.

EXPERIMENTS WITH BIOACTIVE COMPOUNDS

All data are obtained for human insulin in phosphate buffer 50 mM, pH 7,4 at 37°C in gentle agitation, in absence and presence of saponins and xanthumol, as a function of time.
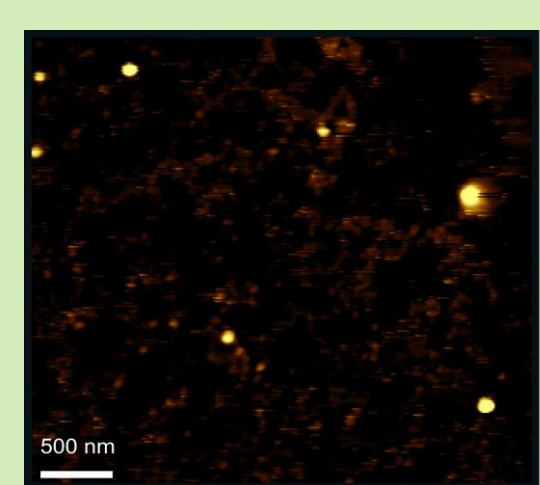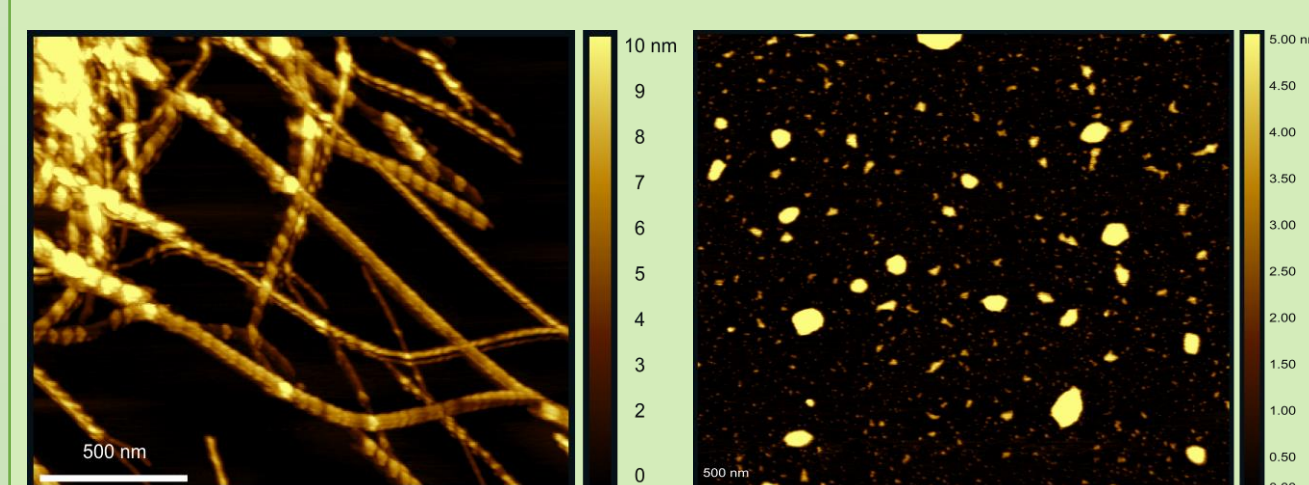
UV-Vis absorption results

SAPONINS ✓   XANTHUMOL ✗
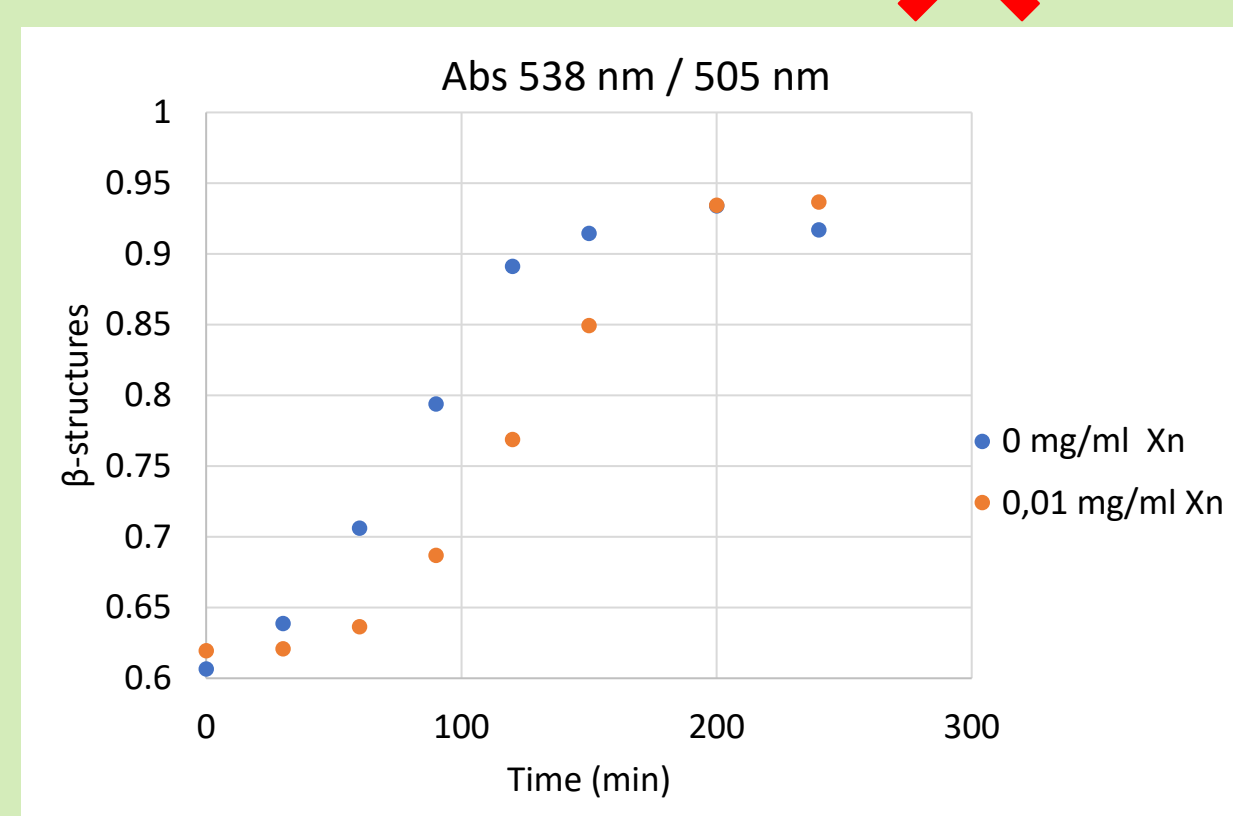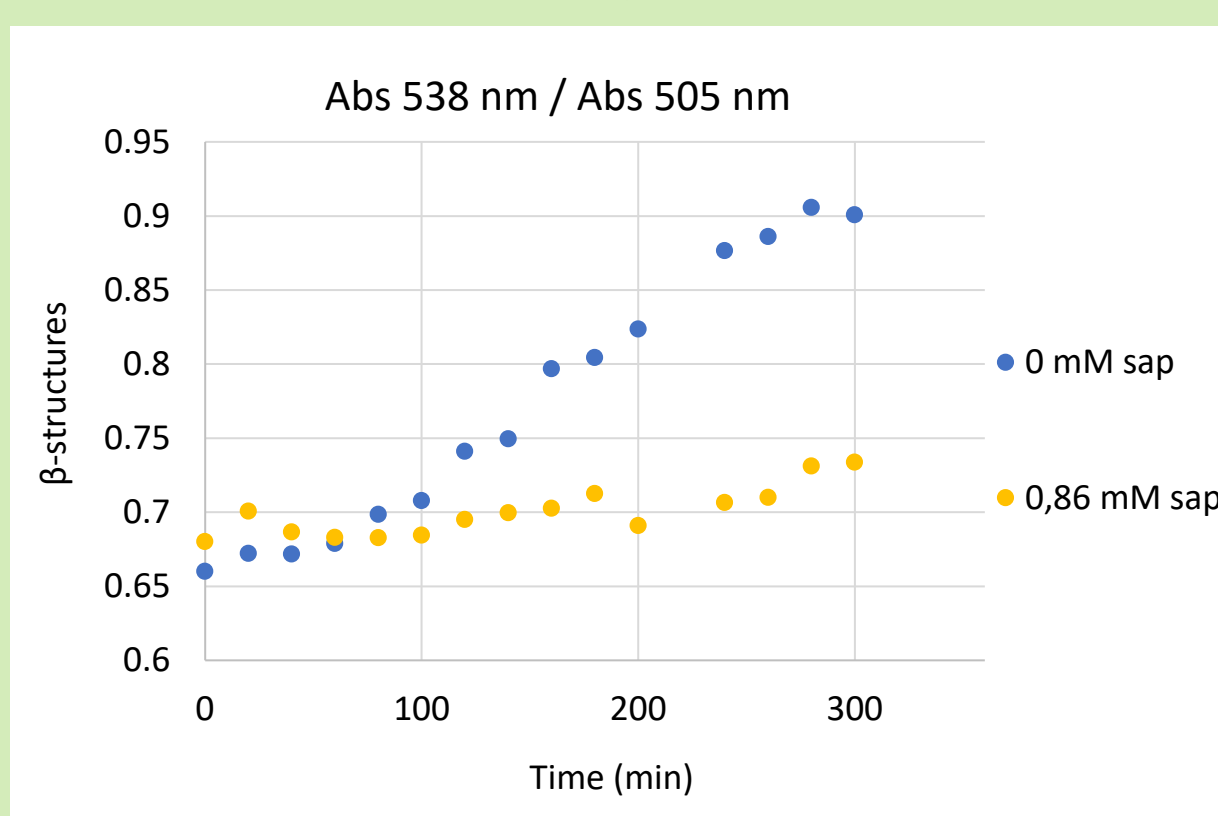
AFM results

Insulin without saponins   Insulin with saponins   Only saponins

EXPERIMENTS WITH HOP EXTRACT

All data are obtained for human insulin in phosphate buffer 50 mM, pH 7,4 at 37°C in gentle agitation, in absence and presence of the hop leaves extracts (at different concentrations), as a function of time.

SAXS data

α-helix   β-sheets
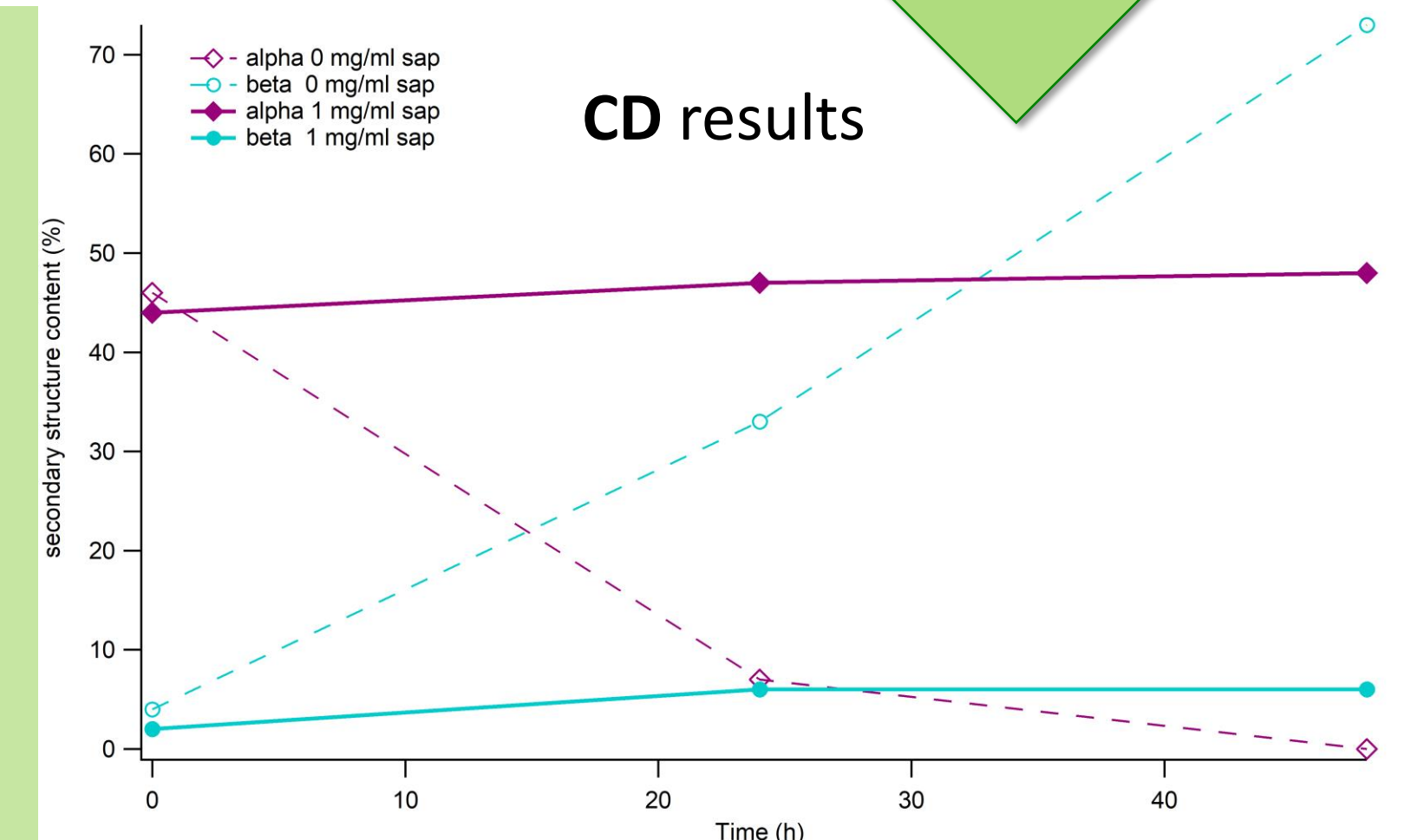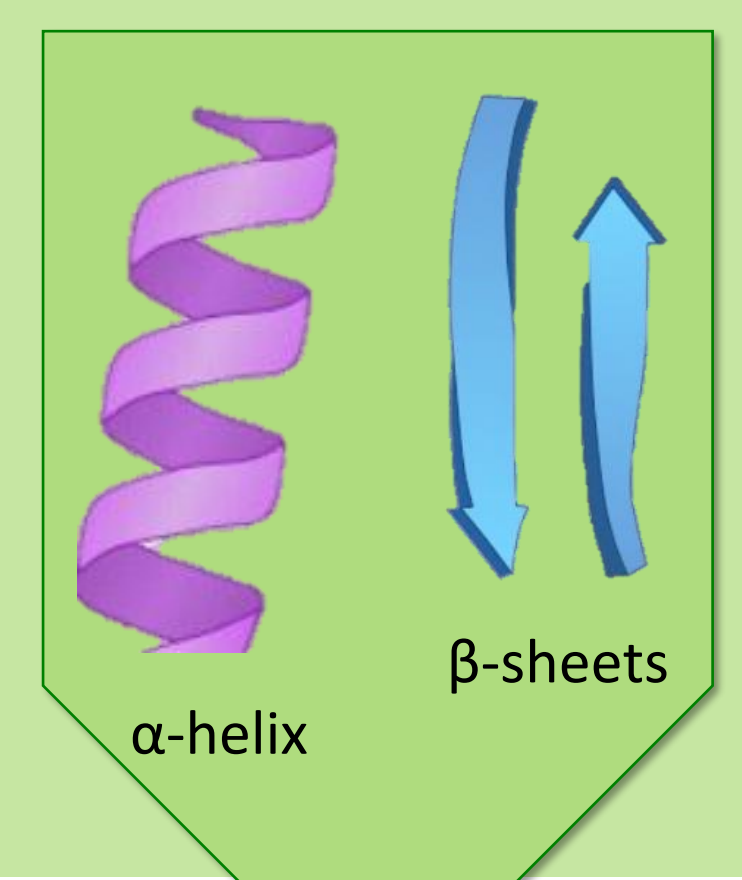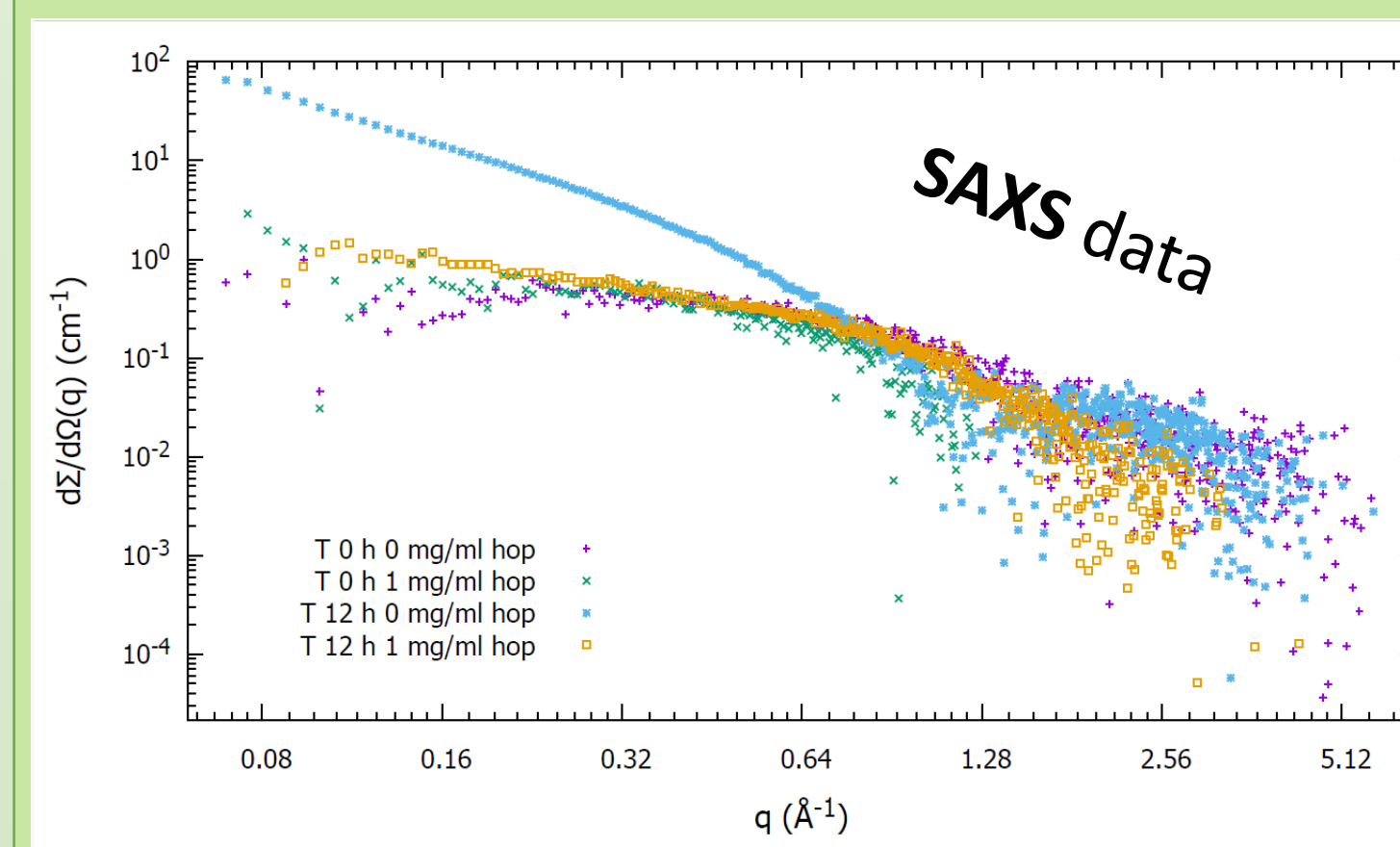
CD results

COSMETIC PRODUCTS with Pierpaoli s.r.l.

Qualitative microbiological analysis

ANALYTICAL RESULTS			
Determination	Value/Uncerta in	Unit of measure	Start/end date of analysis
Moulds and yeasts	< 10	UFC/1g	From 18/07/2023 to 21/07/2023
Total Viable Aerobic Count	< 10	UFC/1g	From 18/07/2023 to 21/07/2023

From the microbiological analysis of the extracts no trace of mold or yeast or microbial load has been found. Since no preservatives were included in the extract, and it was stored at room temperature, it can be hypothesized that the antimicrobial properties of the plant themselves functioned as preservatives.

Addition of hop glyceric extracts (1%) in cosmetic bases: shampoo and conditioner.

Stability test

3 samples were produced for each product and maintained for 3 months at 3 different environmental conditions

SHAMPOO			
	1° day		3° month
	pH	Viscosity (P)	pH	Viscosity (P)
T 4 °C	5,3 ± 0,1	35 ± 5	5,2 ± 0,1	34 ± 5
TA	5,3 ± 0,1	36 ± 5	5,2 ± 0,1	33 ± 5
T 40°C	5,3 ± 0,1	34 ± 5	5,1 ± 0,1	31 ± 5

CONDITIONER			
	1° day		3° month
	pH	Viscosity (P)	pH	Viscosity (P)
T 4 °C	3,9 ± 0,1	67 ± 5	3,9 ± 0,1	82 ± 5
TA	3,9 ± 0,1	66 ± 5	3,8 ± 0,1	80 ± 5
T 40°C	3,8 ± 0,1	65 ± 5	3,8 ± 0,1	93 ± 5

pierpaoli

Shampoo and conditioner with hop leaves extracts maintained both their pH and viscosity values within the original parameters.

BIOACTIVE COMPOUNDS   EXTRACT IN ETHANOL   EXTRACT IN WATER   EXTRACT IN GLYCERINE

CITOTOXICITY TESTS

We performed cell viability tests (MTT) in the presence of hop leaves extract produced in ethanol and in water.

The MTT assay found that ethanol extract is not tolerated by the cells (due to the ethanol), while the extract obtained in water is not cytotoxic at all.

EXTRACT IN ETHANOL ✗

EXTRACT IN WATER ✓
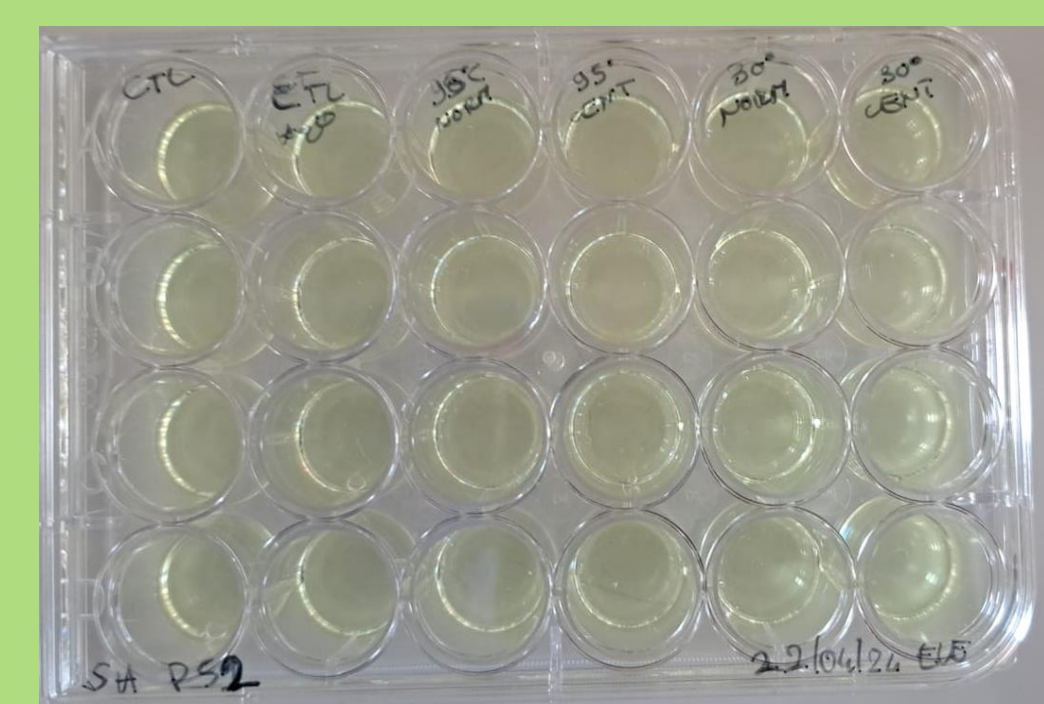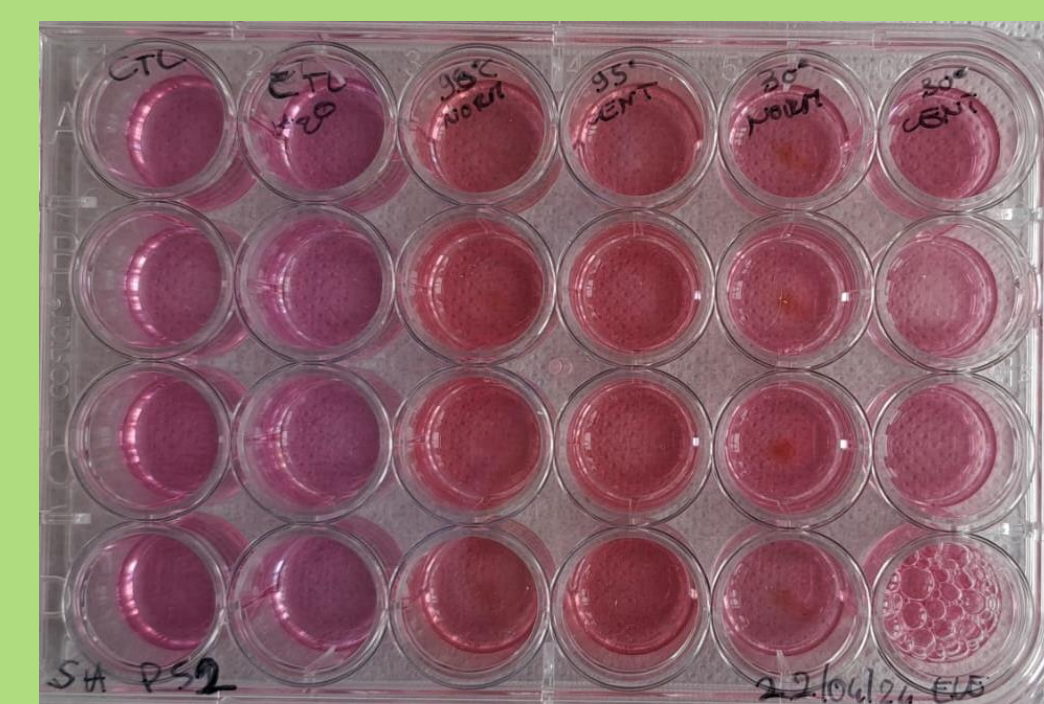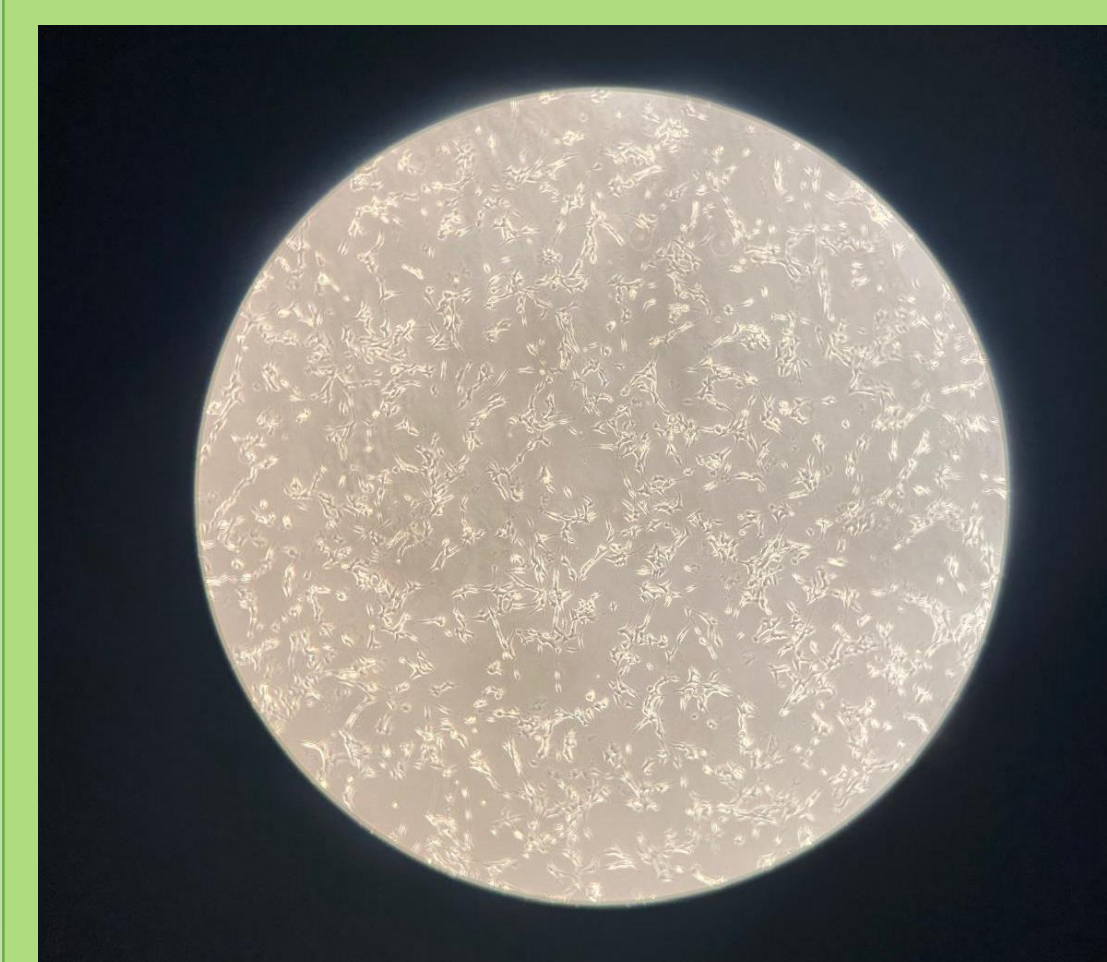
The aim of this project is to vehiculate benefic compounds present in waste, hop leaves, into different kind of products.

We have produced different types of hop extract for different types of application, from amyloid aggregation to cosmetic products. Our results confirm that hop extract, produced from plant waste, has several potential beneficial applications.

The biomass of hops can be a **precious resource for the pharmaceutical and cosmetics industries**, for this reason it is good to investigate its potential, in order to be able to propose a circular economy model.

References: [1] Sabbatini G., Mari E., Ortore M.G., Mobbili G. A multi-disciplinary investigation on the perspectives of hop by-products utilization: progress towards circular economy, *submitted*

[2] Mari E., Vilasi S., Moretti P., Mangione M. R. and Ortore M.G. Saponins Effect on human insulin amyloid aggregation... *in preparation*