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DI RIPRESA E RESILIENZA



MISSIONE 4 - Istruzione e Ricerca

SPOKE 6 - Innovazione e sicurezza degli ambienti di vita nell'era digitale e verde

WP5 - Valorisation of typical regional food for the improvement of health and well-being of consumers through an innovative nutraceutical and nutrigenomic approach

Project RESCUE-Bio:

Companies Pierpaoli Srl, SYNBIOTEC Srl

Project H.E.A.R.T.:

Company Nautes Spa



Work Package 5



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DEGLI STUDI
DI URBINO
CARLO BO



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WP5

Task

Unicam

Uniurb

UNICAM, WP5 spoke 6 WP leader:

Sauro Vittori

UNIURB, WP5 spoke 6 WP cp:

Elena Barbieri

1

Maggi

Lucarini

Characterization of macro- and micronutrients, bioactive compounds and flavors, in selected typical food and aromatic plants of Marche Region

2

Silvi

Albertini

Evaluation of the ability to induce well-being and health by food and plant extracts and their constituents

3

Vittori

Formica

Recovery of valuable compounds from food by-products

4

Caprioli

Fraternale
Micucci

Development of nutraceuticals and functional foods

5

Gabbianelli

Amatori

Gene expression regulation, Cancer, Molecular pathology

6

Polzonetti

Barbieri

Grappasonni De Santi

Personalized strategies for a healthy diet and increase of citizen's awareness

Vitality, Next Generation EU—PNRR MUR project ECS_00000041- VITALITY



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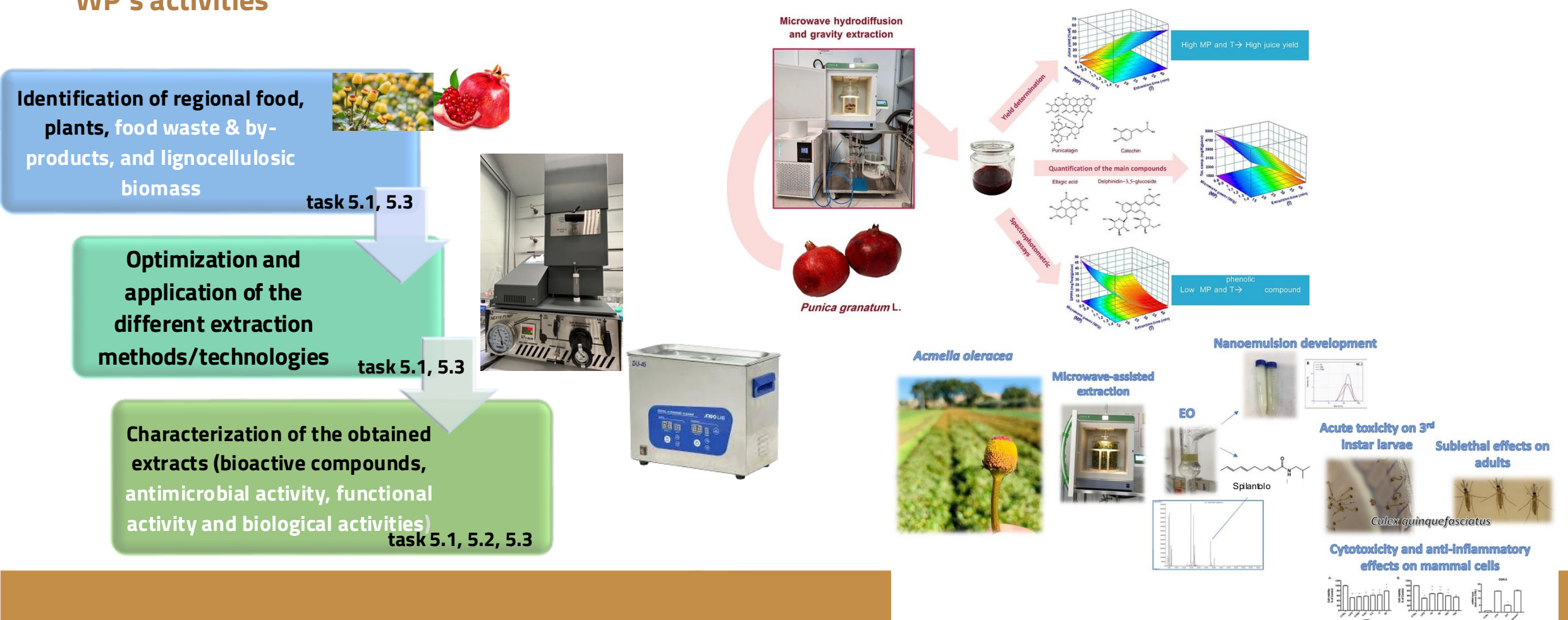


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- **Work Package 5 – Valorization of typical regional food for the improvement of health and well-being of consumers through an innovative nutraceutical and nutrigenomic approach**

WP's activities





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○ Work Package 5 – Valorization of typical regional food for the improvement of health and well-being of consumers through an innovative nutraceutical and nutrigenomic approach

WP's activities

Identification of regional food,
plants, food waste & by-
products, lignocellulosic
biomass

task 5.1, 5.3

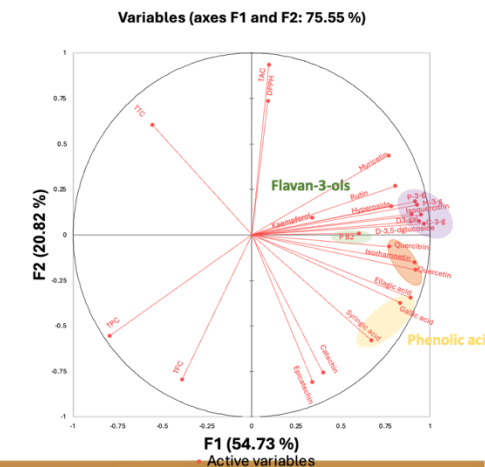
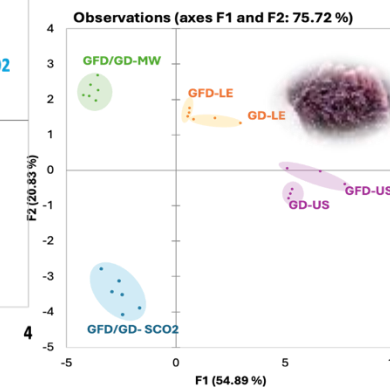
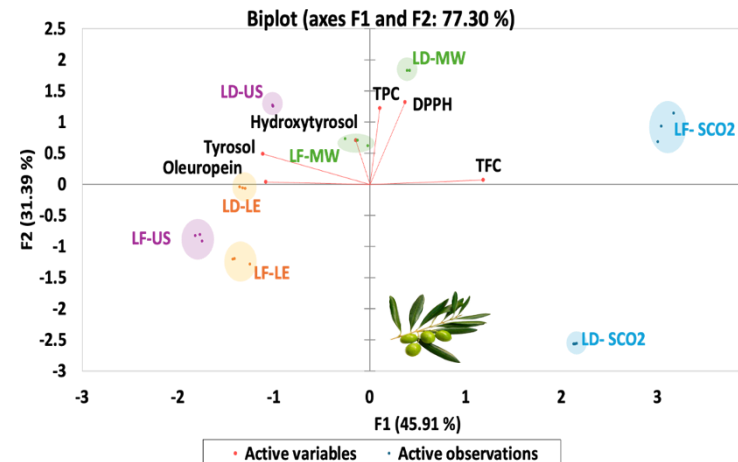
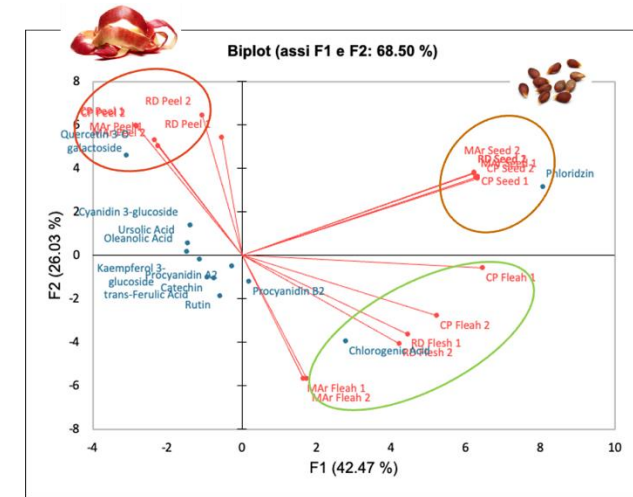
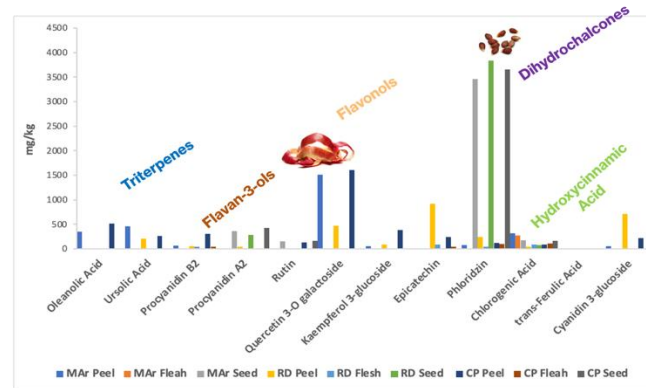
Optimization and
application of the
different extraction
methods/technologies

task 5.1, 5.3

Characterization of the obtained
extracts (bioactive compounds,
antimicrobial activity, functional
activity and biological activities)

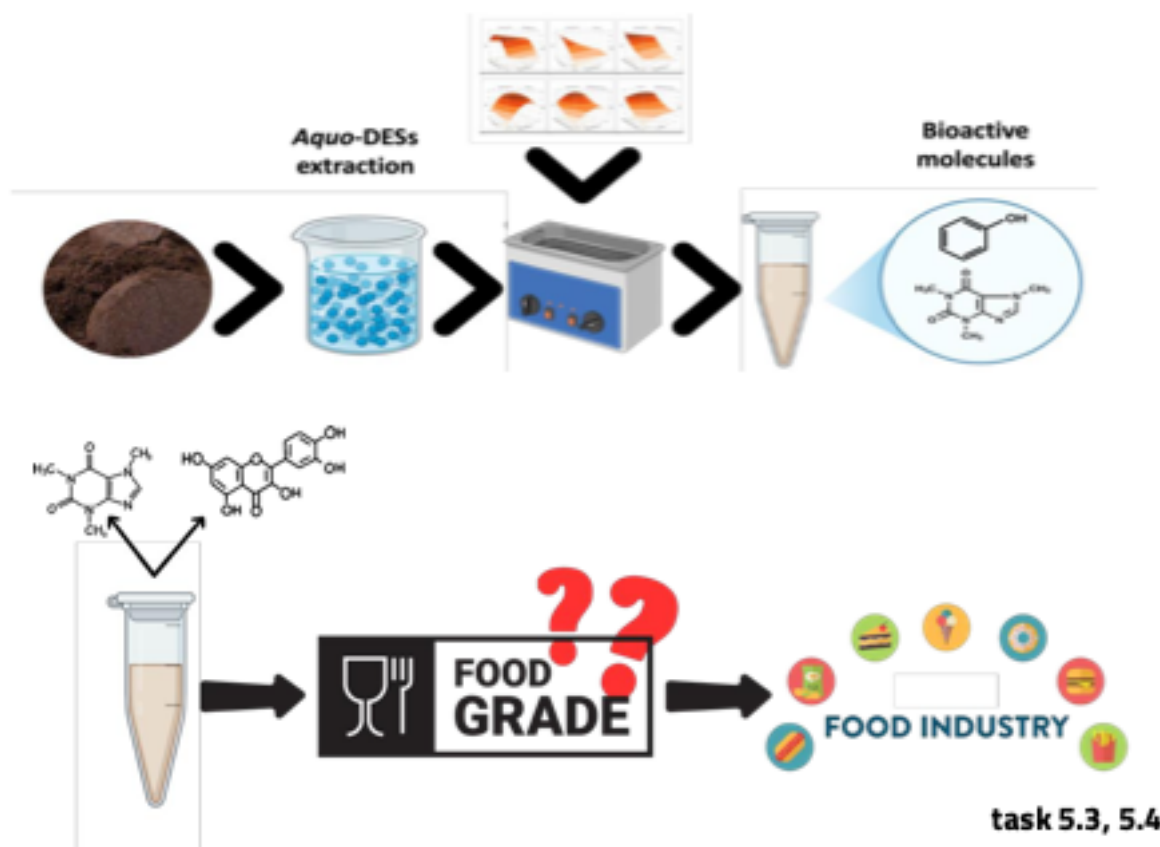
task 5.1, 5.2, 5.3

Results





- **Work Package 5 – Valorization of typical regional food for the improvement of health and well-being of consumers through an innovative nutraceutical and nutrigenomic approach**



Key Outcomes

- Water-based DESs extract caffeine & chlorogenic acids
- Outperforms conventional solvents for polyphenols
- Ready-to-use solvents, no purification needed

Green Process Validation

- Confirmed by multiple sustainability metrics
- Minimal environmental footprint
- Supports circular economy goals



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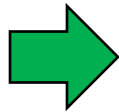
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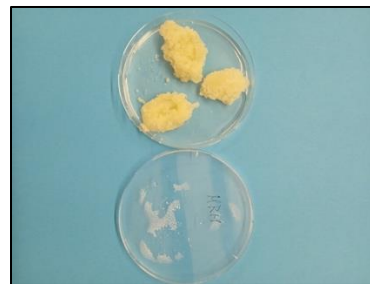
The ripe pulp of the fruit contains meristematic cells that can regain the ability to divide if appropriately stimulated



Mela Rosa
Marchigiana



Initial
proliferation of
meristematic cells
from pulp
explants



Callus culture

The composition of the phytocomplex remains constant over time
In the fruit pulp, triterpenic acids are present in minimal quantities

Table 1

Triterpenic acids and β -Sitosterol content ($\mu\text{g}/100$ mg of dried pulp or callus cultures $\pm$ standard deviation, and percentage) of MRM pulp and callus cultures after methanolic and ethanolic extraction, quantified by GC-FID.

Compound	Pulp 2017 (100 % MeOH) ^a		Callus 2017 (100 % MeOH) ^a		Callus 2022 (100 % MeOH) ^a		Callus 2022 (70 % EtOH) ^a	
β -Sitosterol	46.74 $\pm$ 1.128	96.39	120.90 $\pm$ 2.69	2.24	184.41 $\pm$ 2.93	5.59	168.63 $\pm$ 2.29	5.16
Oleanolic acid	0.10 $\pm$ 0.01	0.21	42.10 $\pm$ 1.90	0.78	120.44 $\pm$ 2.25	3.65	76.05 $\pm$ 1.16	2.33
Ursolic acid	0.38 $\pm$ 0.01	0.78	174.43 $\pm$ 3.58	3.23	334.36 $\pm$ 5.42	10.13	321.69 $\pm$ 4.10	9.84
Maslinic acid	0.43 $\pm$ 0.01	0.89	963.30 $\pm$ 17.62	17.82	361.63 $\pm$ 4.97	10.96	378.69 $\pm$ 5.19	11.58
Corosolic acid	0.41 $\pm$ 0.00	0.84	676.77 $\pm$ 3.85	12.52	337.13 $\pm$ 6.69	10.21	342.56 $\pm$ 3.71	10.48
Pomolic acid	0.16 $\pm$ 0.00	0.34	17.10 $\pm$ 1.47	0.32	79.60 $\pm$ 0.08	2.41	39.76 $\pm$ 0.60	1.22
Annucoic acid	0.07 $\pm$ 0.00	0.14	504.57 $\pm$ 2.59	9.34	587.51 $\pm$ 8.32	17.80	595.61 $\pm$ 3.50	18.21
Tormentic acid	0.20 $\pm$ 0.01	0.41	2905.63 $\pm$ 33.51	53.76	1295.56 $\pm$ 9.07	39.25	1347.03 $\pm$ 10.04	41.19
Total	48.49 $\pm$ 1.12		5404.80 $\pm$ 46.69		3300.63 $\pm$ 6.04		3270.01 $\pm$ 21.96	

^a Extraction solvent.



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- **Work Package 5 – Valorization of typical regional food for the improvement of health and well-being of consumers through an innovative nutraceutical and nutrigenomic approach**

WP's activities

Identification of regional
food, food waste & by-
products, lignocellulosic
biomass and plants

task 5.1, 5.3

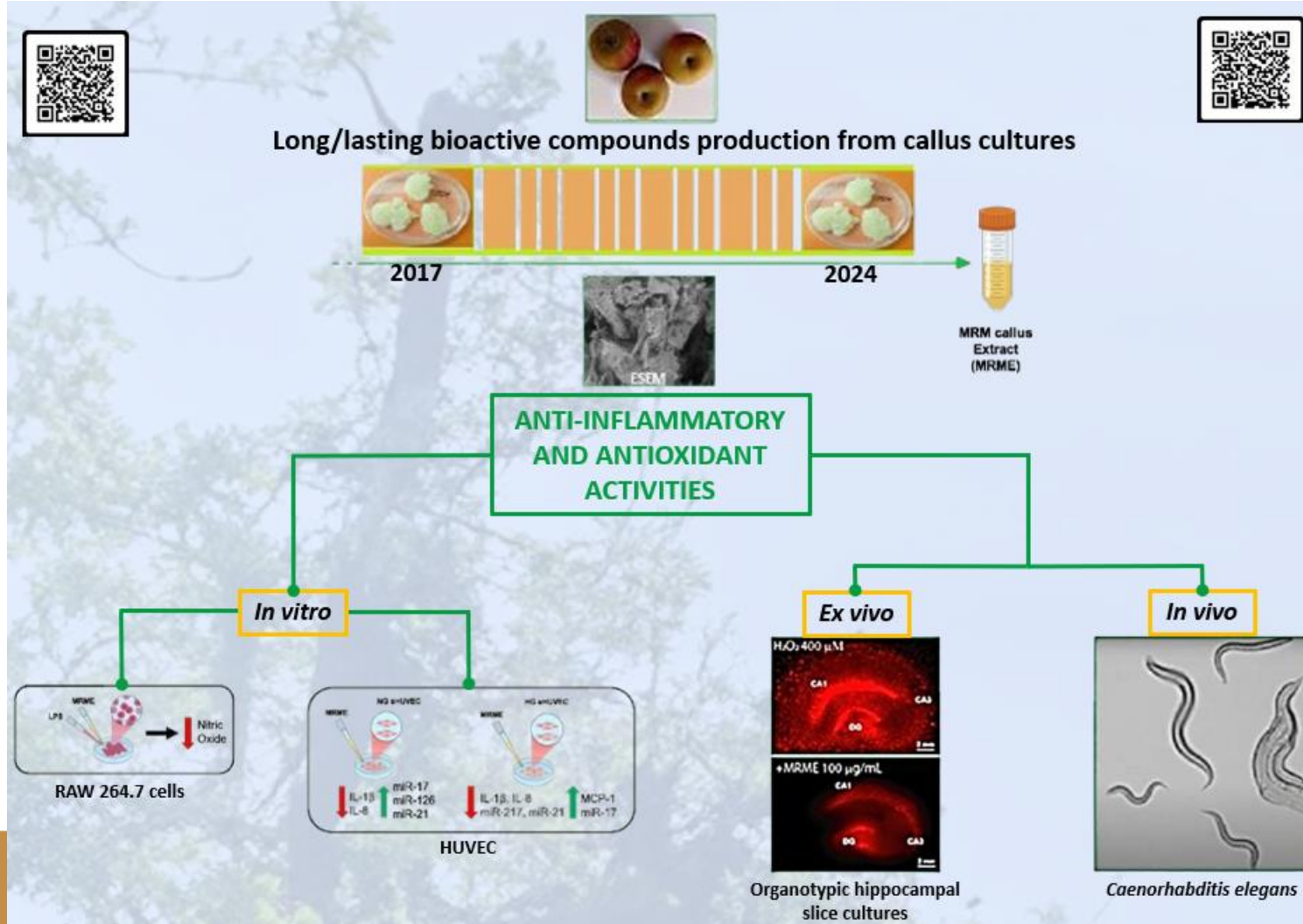
Optimization and
application of the
different extraction
methods/technologies

task 5.1, 5.3

Characterization of the obtained
extracts (bioactive compounds,
antimicrobial activity, and
biological activities)

task 5.1, 5.2, 5.3

Results





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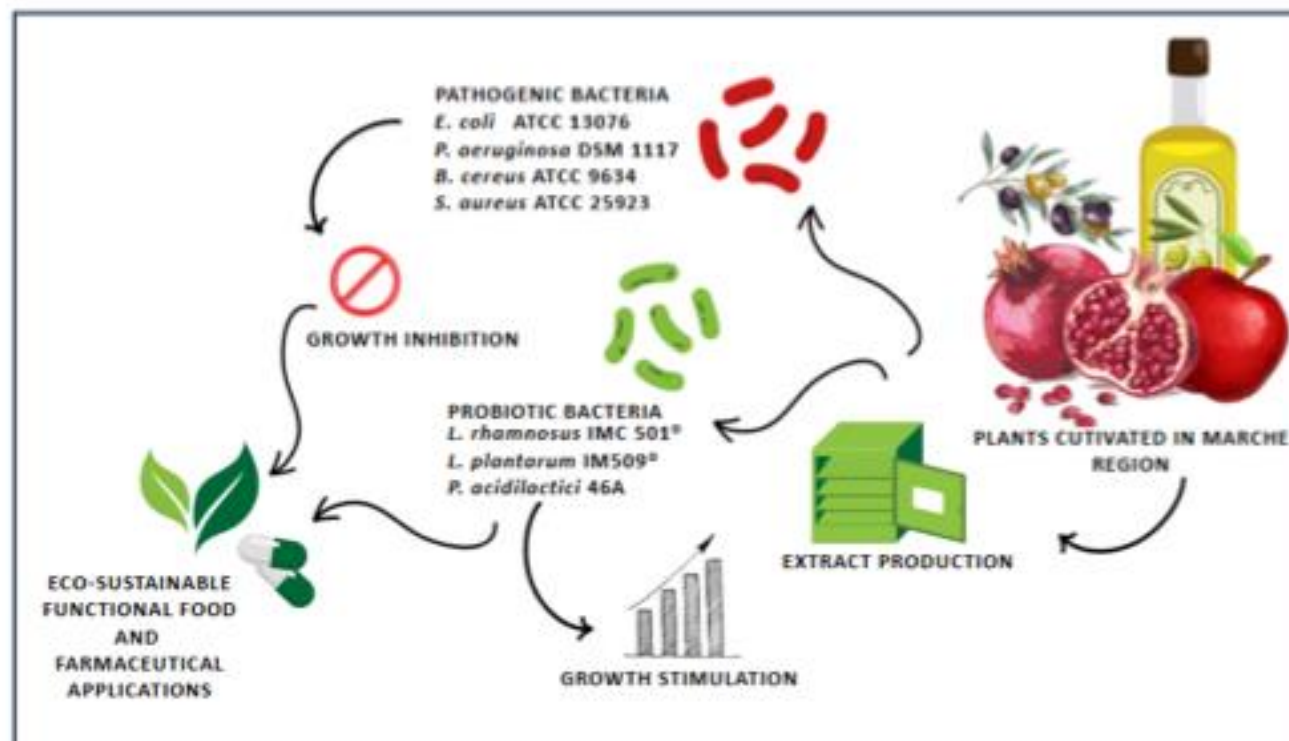
- **Work Package 5 – Valorization of typical regional food for the improvement of health and well-being of consumers through an innovative nutraceutical and nutrigenomic approach**

WP's activities

Results

**Characterization of the obtained extracts
(bioactive compounds, antimicrobial
activity, and biological activities)**

task 5.2





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- **Work Package 5 – Valorization of typical regional food for the improvement of health and well-being of consumers through an innovative nutraceutical and nutrigenomic approach**

WP's activities

Development and formulation of
nutraceuticals, functional food
and cosmeceutical

task 5.3, 5.4

Characterization of the
different prototypes

task 5.2, 5.3, 5.4



Cosmeceutical



**Vegetable
based- gelatin**

+



Mixture



**Functional
Food**



less sugar,
rich in fiber,
rich in
bioactive
compounds



Nutraceutical



Grape kombucha

Polyphenols at concentration of approximately 11%
Anthocyanins and flavonols are the major compounds



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WP's activities

Evaluation of the Nutrigenomic effect of Mela Rosa Marchigiana callus extract on cellular senescence

task 5.4, 5.2, 5.5



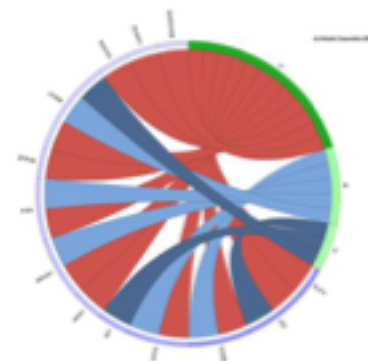
task 5.5

Multi-Omics Analysis of Transcriptome and Genome-Wide DNA Methylation of Mela Rosa Marchigiana Callus Extract-senescent treated HUVEC cells via RNA-Seq and Nanopore Sequencing.



Results

A: HALLMARK TNFA SIGNALING VIA NFKB
B: HALLMARK UV RESPONSE UP
C: HALLMARK TGF BETA SIGNALING



Pathway analysis of differentially expressed genes (DEGs) revealed TNF α signaling as the most significant pathway modulated by the extract in senescent HUVEC cells. Interestingly, the extract was able to counteract the up-regulation of this pathway triggered by senescence.

Methylation analysis indicated that the effect of Mela Rosa Marchigiana callus extract on gene expression was not mediated by DNA methylation, suggesting the involvement of alternative regulatory mechanisms exerted by the extract.



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WP's activities

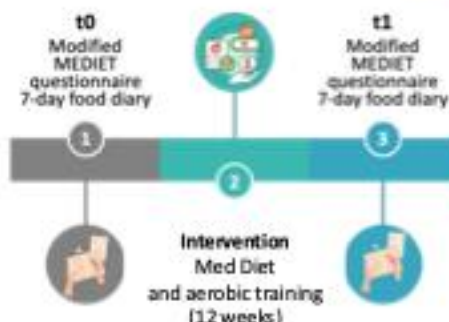
Sweet MOVIS project, which focuses on the development and application of physical activity and nutritional education programs within breast cancer survivors with the attention on glycemic control

Task 5.6

VITHAS project, which focuses on the impact of a predominantly plant-based dietary approach within the university community and ERDIS (employees and students)

Task 5.6

Results

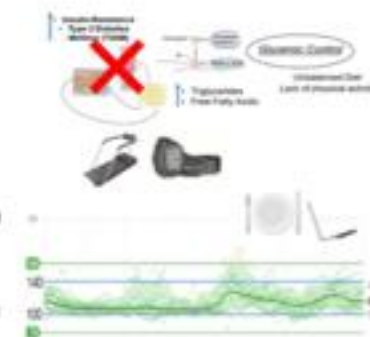


|| Fat mass, insulin, HOMA-IR, and triglycerides in both groups

|| $\dot{V}O_{2max}$ improved more in the IA

|| Time in Range (70 - 120 mg/dL and 70 - 140 mg/dL) in both groups

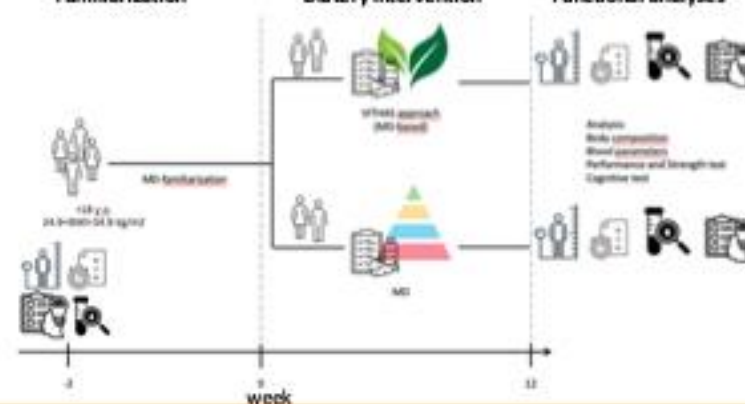
|| Mean of Daily Differences (MDD) showed a significant differences between groups considering the active and no active days in relation to food intake



Familiarization

Dietary intervention

Functional analyses





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Special issue

Valorization of typical regional food for the improvement of health and well-being of consumers

Last update 5 June 2024

This Special Issue has been created to share with the scientific community the results that will be obtained by the research program of the National Recovery and Resilience Plan (co-founded by the European Union—Next Generation EU—PNRR MUR project ECS_00000041- VITALITY) related to the valorization of typical regional food (Marche region, Italy) for the improvement of health and well-being of consumers through an innovative nutraceutical and nutrigenomic approach.

This project aims to investigate strategies that can increase the well-being of citizens by making available, in various forms, food-derived bioactive compounds that can counteract chronic inflammation, oxidative stress and maintain healthier conditions. Among the potential products that are rich in bioactive compounds, a particular emphasis is placed on typical central Italy foods of vegetable origin. In this perspective, the most widespread healthy and ancient varieties occurring in the Mediterranean diet habits were chosen. Food chemistry, biochemistry, microbiota, nutrigenomic, functional properties of bioactive compounds, nutraceuticals and personalized strategies for healthy eating are considered.

The University of Camerino and University of Urbino Carlo Bo are involved in this project.

Guest Editors:

Elena Barbieri

Sauro Vittori

*29 articles accepted /
64 articles submitted*

<https://www.sciencedirect.com/special-issue/100K7V7K0N5>



○ **Work Package5 – Valorization of typical regional food for the improvement of health and well-being of consumers through an innovative nutraceutical and nutrigenomic approach**

On-going steps

- ✓ Final selection of probiotic bacteria and prebiotic substrates for testing possible synbiotic combinations (task 5.2)
- ✓ Application of green procedure (DES) on spent coffee waste (task 5.3)
- ✓ Development of fermented functional beverage obtained by grape pomace waste (task 5.4)
- ✓ Assessment of DNA methylation levels in the promoter regions of genes modulated by the extract in young HUVEC, senescent HUVEC and senescent HUVEC treated with the extract (task 5.5)
- ✓ Intervention (12 weeks dietary intervention), evaluation of body composition and blood parameters, strenght and performance test, cognitive test (task 5.6)



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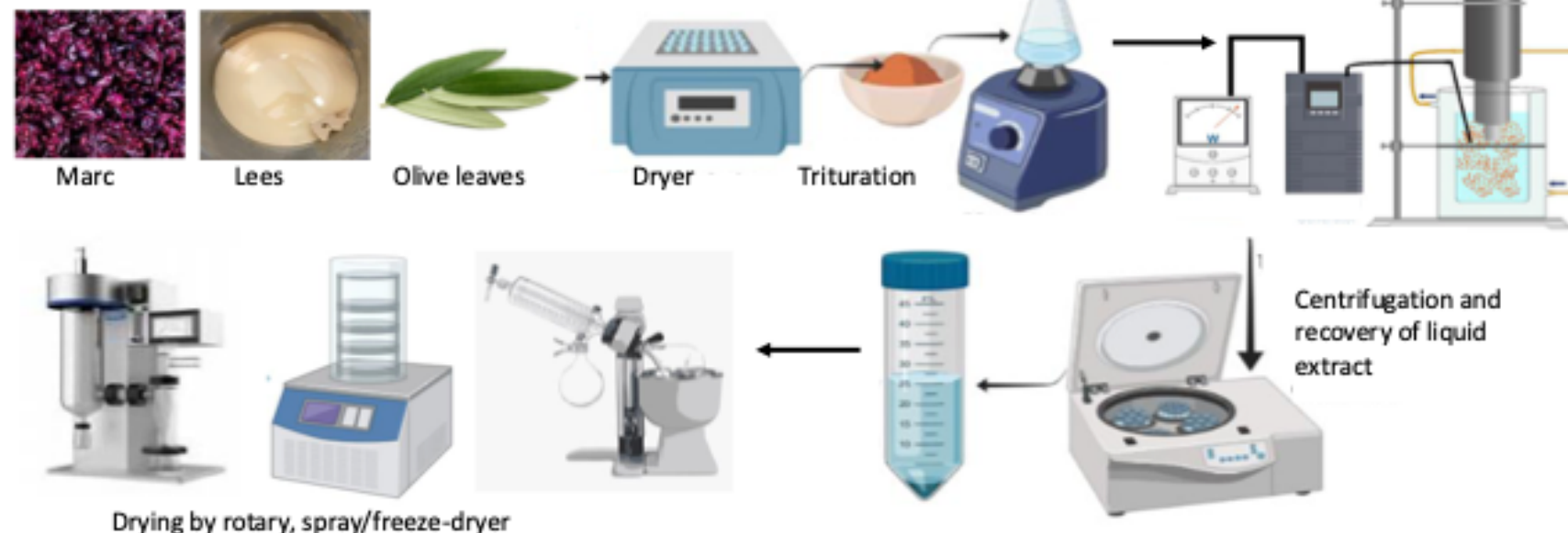
- **Work Package 5 – Valorisation of typical regional food for the improvement of health and well-being of consumers through an innovative nutraceutical and nutrigenomic approach**

Progetto RESCUE-Bio

Company: PIERPAOLI Srl, SYNBIOTEC Srl



Solvent addition and sonication



- **Three starting plant n** (marc and lees of Lacrima di Morro D'Alba and olive leaves)
- Drying of matrices on air dryers at 40°C
- Crushing of matrices
- **Addition of solvent 1** (ethanol/water 70/30) and sonication at room temperature
- **Addition of solvent 2** (glycerin/water 50/50) and sonication at room temperature
- Separation of extract by centrifugation
- Drying by rotary evaporator and spray/freeze-drier



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FORMULATION OF DIETARY SUPPLEMENT IN CAPSULES

- Dry extract of lees + probiotics SYN BIO (*L. rhmanosus* IMC 501® and *L. paracasei* IMC 502®)
- Dry grape marc extract + probiotics SYN BIO



STABILITY PLAN



At each time-point, the following parameters will be evaluated:

- ☐ Organoleptic Characteristics (appearance, color, odor, flavor)
- ☐ Aw
- ☐ Probiotic count

Checkpoints	+4°C	25°C 60% RH	40°C 75% RH
T zero	X	X	X
T 1 month	X	X	X
T 3 months		X	X
T 6 months	X	X	
T 12 months		X	
T 18 months	X	X	
T 24 months	X	X	

FORMULATION OF FUNCTIONAL CHOCOLATE BARS

- Dry extract of lees + probiotics SYN BIO (*L. rhmanosus* IMC 501® and *L. paracasei* IMC 502®)
- Dry grape marc extract + probiotics SYN BIO



Marangoni
CHOCOLATO

Checkpoints	25°C 60% RH
T zero	X
T 1 month	X
T 3 months	X
T 6 months	X
T 12 months	X
T 18 months	X
T 24 months	X



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Nautes – who we are

We are a **DIGITAL DESIGN COMPANY**.

Strategic partner for the **DIGITAL TRANSFORMATION** of business processes.

A creative laboratory that builds customised projects with a **high innovation content**, from the concept and design phase to development and engineering.

Founded in 2001 as a **university spin-off**, Nautes became a private research laboratory accredited by MIUR and in 2016 was certified as an Innovative SME.

Today we are a solid and competent Group driven by a common goal: to **create digital innovation for and with the customer**.

Naute@s
A **DIGITAL** DESIGN COMPANY.



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The H.E.A.R.T. ecosystem

MAIN STAKEHOLDERS

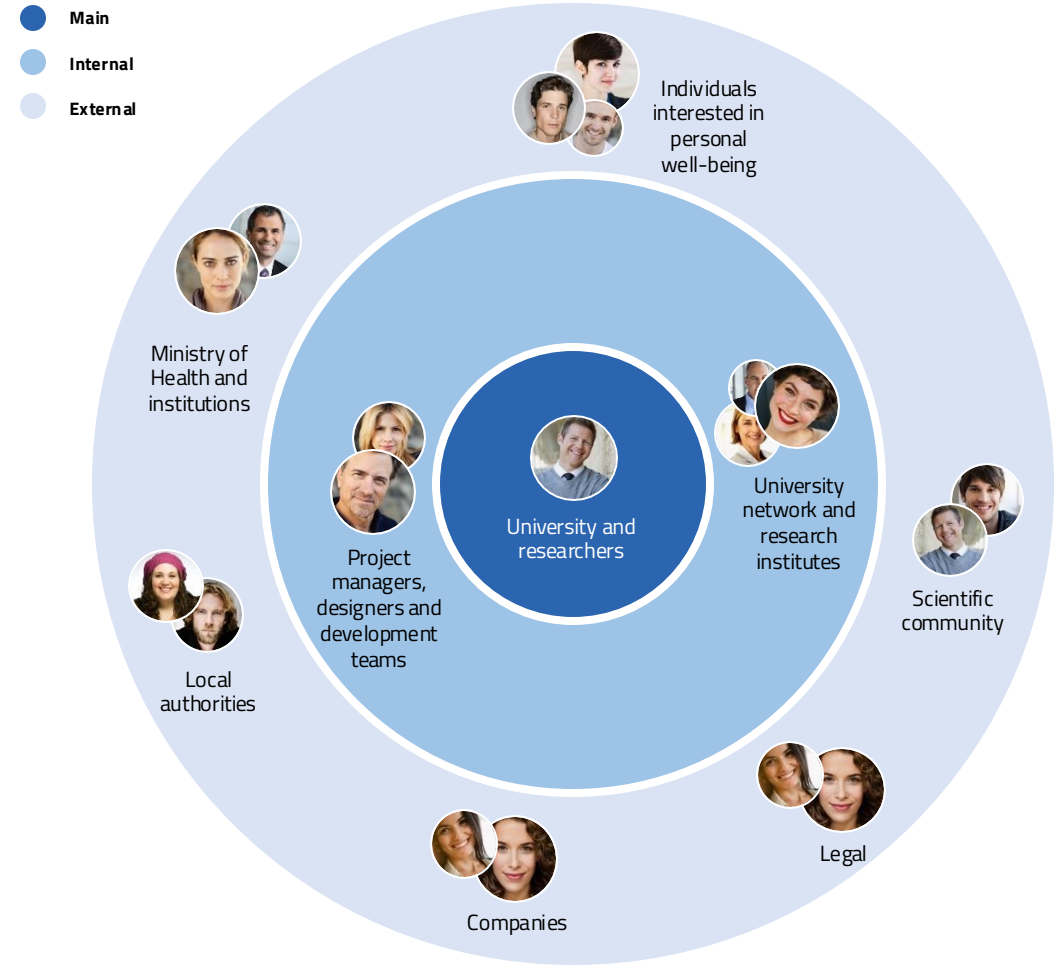
- University and researchers

INTERNAL STAKEHOLDERS

- Project managers, designers and development teams
- University network and research institutes

EXTERNAL STAKEHOLDERS

- Individuals interested in personal well-being
- Local authorities
- Scientific community
- Legal
- Ministry of Health and health institutions
- Companies interested in improving the wellness of their human resources





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