PROLIFIC

GAZETTE #1

In this issue

About PROLIFC

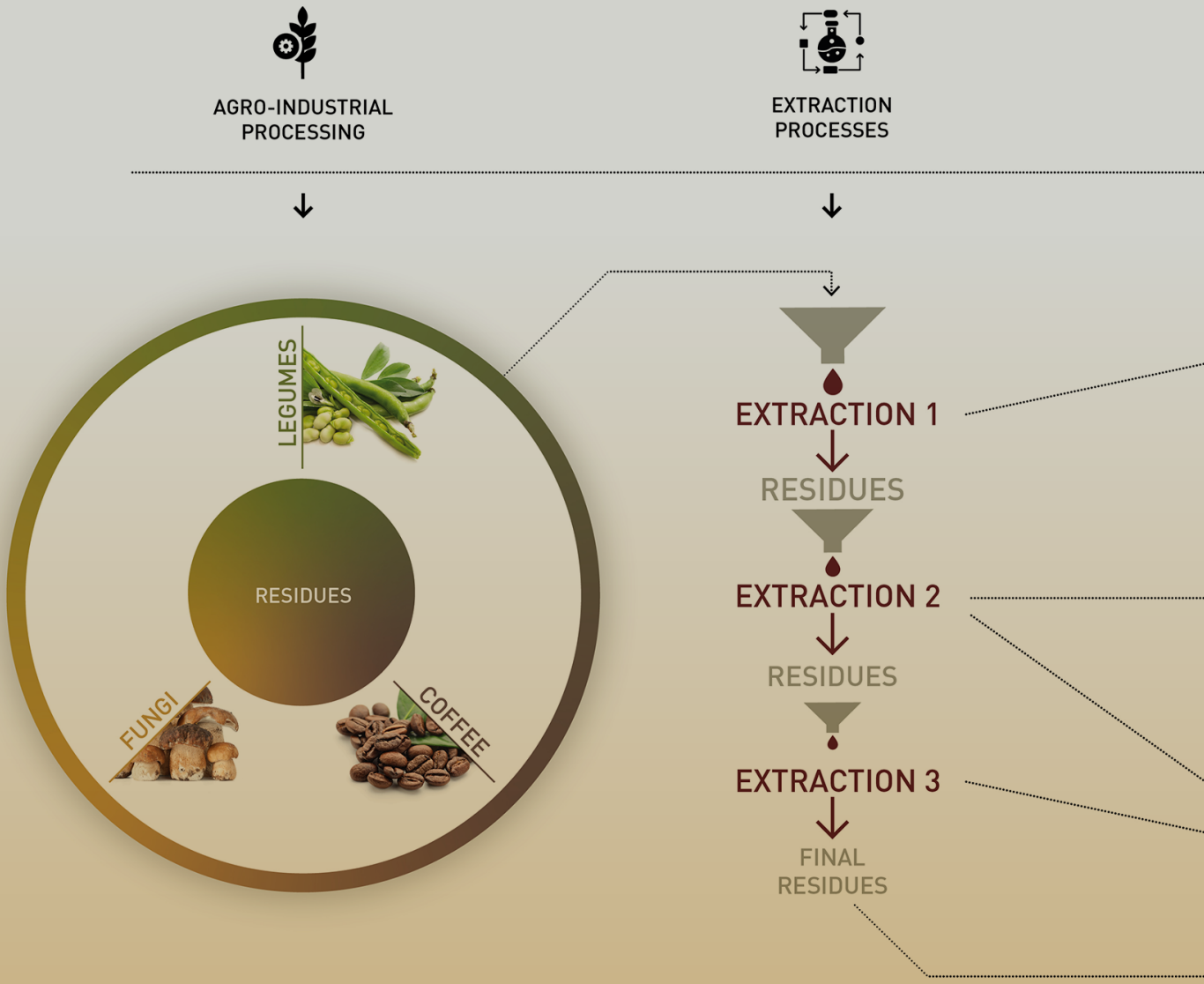
Globally, 1.3 billion tons of biomass per year accrue as co-products, residues and waste along the food chain (from field to fork). Agro-industrial residual biomass, side streams and food production byproducts may represent rich sources of valuable ingredients. Yet their potential is to be developed.

This is where PROLIFIC comes in. The project aspires to recover significant amounts of proteins, peptides, fibers and other value added compounds from legumes, fungi and coffee residues.

For that, the PROLIFIC team optimizes, validates and scales up an integrated array of extraction processes starting from wasted seeds of peas, green beans and chickpeas, leftovers of different fungi species, coffee silver skin and non-compliant coffee green beans

We hope you enjoy reading about our initial steps and succeses.
On behalf of all partners,
the PROLIFIC management team.
P. Corvini, A. Tassoni and R. Hochstrat

The PROLIFIC approach: a cascading approach to valorise agro-industrial side streams



PROLIFIC feedstocks

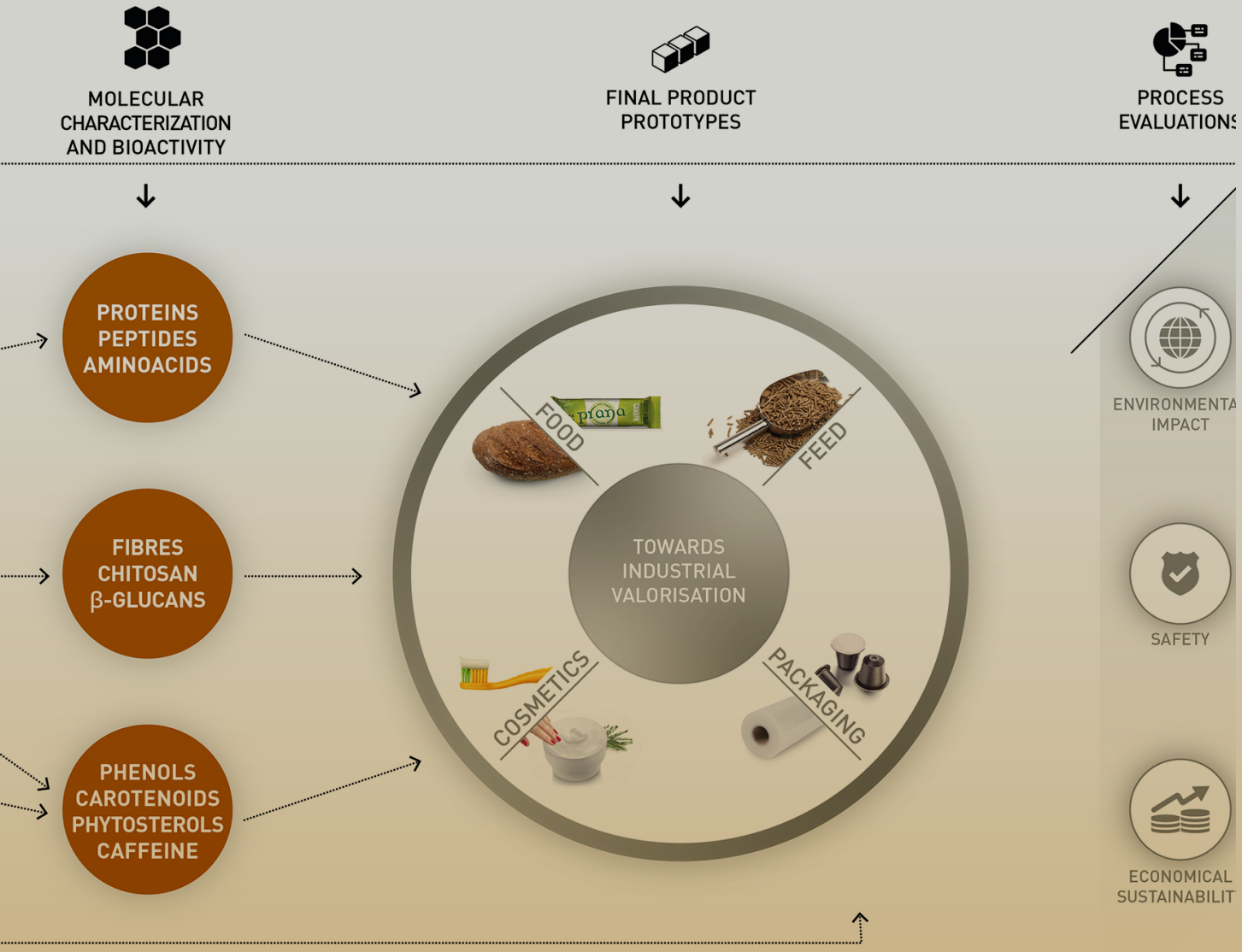
Legumes, fungi and coffee residues form a mix of seasonal and year round available feedstocks. We utilise processing residues of

- Chickpeas, green peas and green beans
- Oyster mushroom
- Shiitake
- Portobello mushroom
- Green coffee beans (before roasting)
- Coffee silver skin (after roasting)

PROLIFIC extraction methods and targets

New and improved methods to capture valuable compounds. They aim at minimising the use of chemical, such as solvents, in protocols:

- environmentally friendly aqueous extraction (EFAE) of proteins
- enzyme-assisted (EAE, soluble or immobilised enzymes) protein extraction
- ultra-sound-assisted protein extraction (UAE)
- subcritical water and supercritical CO2 extraction, ultrasound-ethanolic extraction for other valuable compounds such as polyphenols, chitosan and other fibres



PROLIFIC prototypes

A broad range of product prototypes from different industrial sectors, e.g.

- high protein baked goods and breakfast cereals
- functional packaging for meat products for extended shelf life
- nutrient enriched or antimicrobial ingredients for animal feed
- anti-aging or whitening property compounds for cosmetic products

PROLIFIC assessment

Applicability of processes and marketability of products requires us to

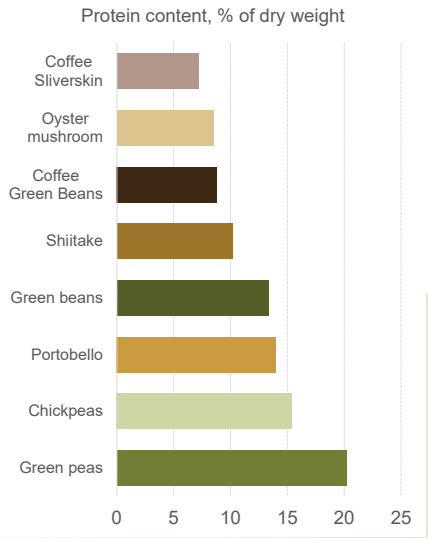
- to observe legal compliance
- to assess environmental impact and benefits
- to quantify economic gain

There is potential in agro-industrial residues

PROLIFIC uses agro-industrial side streams from fungi, legumes and coffee cultivation or processing. Why to exploit them?

Mushrooms, peas and beans, and coffee do not only belong to different botanical families, they also differ in composition and content of specific compounds. Whilst some are rich in proteins, others contain more carbohydrates and fibres, or molecules with specific activity and function such as polyphenols, phytosterols or chitosan.

This also applies for the side-streams which accrue with harvesting and agro-industrial processing. The nutritional composition of the residues is quite promising. PROLIFIC analysis confirmed e.g. 8-20 % of protein in dry matter in non-food plant parts or non-compliant seeds. The legumes present the highest content but also some mushrooms contain considerable amounts. For the active compounds, e.g. polyphenols, coffee green beans are by far the most "rich" feedstock, at least on a fresh weight basis. Their total phenolic content is up to 25 mg gallic acid equivalent (GAE) per gram. Coffee silverskin, fungi and legumes range between 3-9 mg GAE per gram fresh weight.



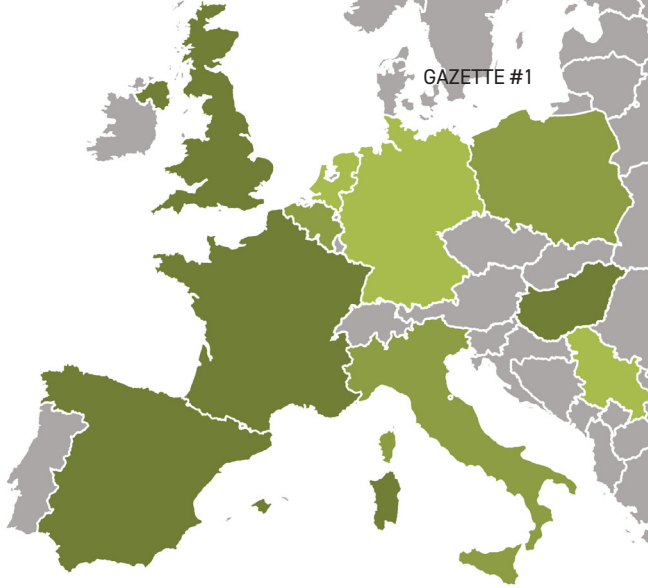


What happens to these side-streams today?

We consulted with our feedstock providers, Illy caffè, Conserves France and Pleurette on the current utilization or disposal routes for their coffee, peas and fungi side-streams.

Legumes residues are either sent to pig feed production or are exploited energetically in biogas plants. Due to contamination with growth substrate (wood, soil) fungi residues are rarely suitable for biogas production but may be composted, however, at a certain cost. Waste coffee residues are most often not utilized at all, though options for feed production and paper making exist.
PROLIFIC aims to elaborate more sustainable exploitation routes towards higher value segments for these residues - because it is a meaningful mass stream. Just take a look at the following numbers.

„The content of valuable compounds in agro-industrial residues is similar to that of the harvested good. So, why waste them?"



Green pea producing countries in Europe. The darker the colour the higher the annual production.

Feedstock „production“

Almost 90 % of Europe's fungi is grown in only eight EU countries. The total production of 12.9 mill. tons comes with approx. 5-15 % of residues, an estimated amount of 210'000 tons per year.

Peas, beans and chickpeas, the three legumes considered in PROLIFIC, are grown at 1.83 mill. tons per year with France, Spain, Italy and the UK leading the statistics. Side-streams can amount to 10-25 %, which sums up to approx. 340'000 tons.

Europe imports 3.7 mill. tons of green coffee beans. The top importers here are Germany and Italy, followed by France and Spain. As producers apply different selection criteria, the share of non-compliant beans is difficult to estimate. Yet, coffee silverskin, the fine tegument that covers the coffee seed, is removed inevitably during processing and roasting. It can constitutes from up to 4 % of the initial coffee amount or as much as 148'000 tons per year.

„Across Europe an estimated amount of 700'000 tons of such agro-side streams could be valorised.“

A decisive question: Are the residues safe to use?

PROLIFIC prototypes target applications in the food, feed, cosmetics and packaging sector, This means compounds derived from our extraction will make it into consumer products. They must thus be safe for use and must not harm human health.

We therefore tested all feedstock samples for chemical and microbial contamination. Neither pesticides nor heavy metals were found above limit values. Occasionally, *Listeria monocytogenes* was detected. But the bacterium was successfully inactivated in the final product prototype.

Also during the course of the project, we will carefully observe compliance of fractions and prototypes with sector regulations. Proper storage, stabilisation and control of critical extraction or production steps will be considered when shaping and prioritising utilisation routes.

Further reading
Tassoni et al. (2020)
„Food Sustainability: Promising By-Products for Valorization“
Molecules, Vol. 25 Issue 6
DOI: 10.3390/molecules25061383

Recovering proteins

In exploring innovative protein extraction methods, partners IRIS and Uni Parma went different ways. Where did they arrive?

The PROLIFIC feedstock exhibit different protein contents. Chickpeas and peas contain considerable amounts of protein (12 to 20 % of dry weight). Also coffee green beans and coffee silverskin still contain about 9 % and 7 % respectively. Whilst among the fungi the value varies between 5 to 14 %, depending on species and variety.

How to make the most of it in an initial step of the extraction cascade?

For this, PROLIFIC investigated three different methods. A mere aqueous extraction, an enzyme assisted hydrolysation and an ultra-sound assisted approach. Initial findings of the two latter methods are presented here.

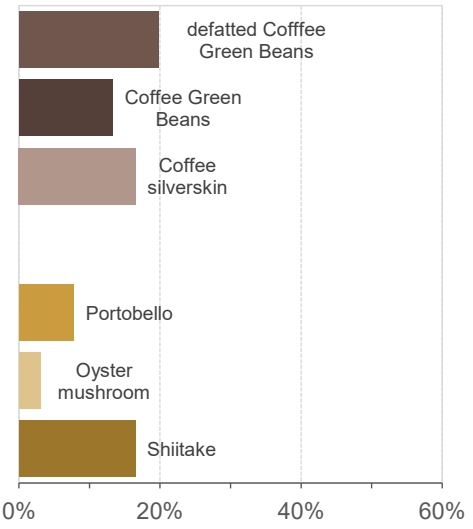
The power of sound

Protein extraction using alkaline solutions could benefit from the use of ultrasonic power. Ultrasound assisted extraction (UAE) is a non-classical extraction method that can enhance the extraction efficacy by promoting the rupture of the cell wall of the plant material due to the influence of acoustic cavitation. This facilitates the mass transport from the plant material to the solvent.

We tested the extraction efficiency at different set points for acoustic energy and temperature of the process. Roughly speaking, the harsher the conditions, the better the extraction efficiency. Yet this also impacts the protein quality.

A particular challenge was to balance the yield of proteins with their quality and integrity.

Initial issues with a relatively high degree of amino acid racemization could be controlled by adaptation of reaction conditions.



Efficiencies of UAE (left) and EAE (right) Values indicate how much of the protein

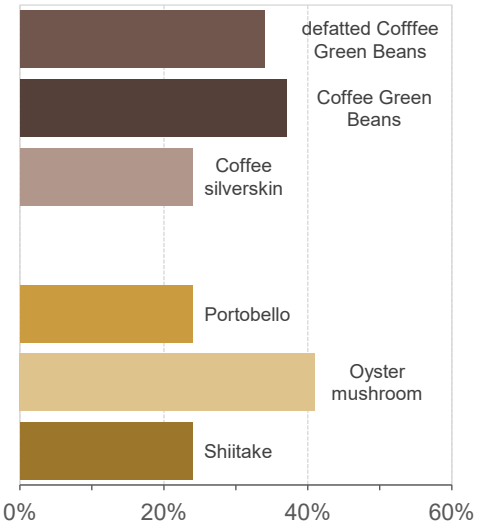
With an optimized protocol we were able to recover 20 % of the proteins from coffee green beans. This protocol will be up-scaled very soon by our project partner BBEPP.

„Ultrasound assisted extraction is a green, non-thermal and eco-friendly technology to enhance mass transfer processes.“

Lab-scale set-up for EAE of coffee green beans at Uni Parma

Letting enzymes do the job

A different approach to enhance protein extraction is use of enzymes. Other thand ultrasound, they facilitate the process by biochemical reactions instead of physical interaction. Essentially the extraction is accelerated by partial digestion of the protein.
The challenge here is to stop the hydrolysis at an appropriate stage and to remove the enzyme from the final protein solution.



protein extraction methods.
content of a feedstock was extracted

In our case we used papain or alcalase for this Enzyme Asssisted Extraction (EAE). The extraction efficiencies observed on the coffee feedstocks and different fungi ranged between 20 and 40 %, which is higher than for the UAE. However, the method yields a mix of peptides, i.e. proteins of shorter length and lower molecular weight.

To further assess the methods, it is also important to understand and control disturbing influences, e.g. interferences of non-protein nitrogen compounds or the effects of the technological processes on protein integrity and quality.

„Detailed chemical and molecular characterization is key to identify most promising extraction techniques and applications for proteins from different feedstocks."

Óscar Rodríguez

Senior Research Scientist
at IRIS Technology Solutions
PhD in Chemistry Science and Technology.
Responsible in PROLIFIC for ultrasound-assisted extraction methods development and assessment
E: orodriguez@iris.cat

Tullia Tedeschi

Assistant Professor at University of Parma, Department of Food and Drug
Responsible in PROLIFIC for enzyme-assisted protein extraction and conversion as well as molecular characterzation
E: tullia.tedeschi@unipr.it

Prospects for bio-degradable packaging

A PROLIFC workshop to highlight approaches and projects towards more sustainable and functional food packaging

This workshop, held on 11-12 September 2019, was dedicated to one particular aspect of the PROLIFIC project: the transformation of agro-industrial residues into packaging materials.

Illycaffè as partner of the PROLIFIC consortium hosted this workshop and gathered an audience from research and industry. Participants exchanged on state of the art, latest research and trends in bioplastics, especially for food packaging material.

Bio-based plastics and functional ingredients

Speakers nicely exemplified the various options for utilizing biomass-derived compounds in food packaging.

It is possible to extract and chemically modify molecules from feedstock which can potentially be used as new monomer for the production of bio-polymers. Such bio-plastic can replace mineral oil based polymers in packaging applications.

This can also be achieved by replacing part of the polymer matrix with organic fillers extracted from biomass. An approach the PROLIFIC project pursues to produce e.g. more sustainable coffee capsules, as Annamaria Celli from University of Bologna reported.

Further ambitions are directed towards improving the shelf-life of perishable goods by functional packaging. The encapsulation of active compounds like polyphenols, or coatings containing chitosan potentially bring anti-bacterial, anti-fungal or anti-oxidant properties.

Regulation rules

Various speakers highlighted the importance of regulation to eventually promote the use and production of alternative materials. Particularly the Single-use-plastic regulation is challenging with respect to the definition of bioplastics.

Careful adaptation of legislation is key. Otherwise investment decisions towards bio-based plastics are put at risk.

Further info and presentations are available at our website.
www.prolific-project.eu/illy-workshop

Show-casing first PROLIFIC food prototypes

Initial volorisation paths for pea and fungi residues

BBI JU organized a Stakeholder Forum on December 4, 2019 in Brussel to fuel the discussion and exchange on prospects and best-practices of bio-economy. An exhibition with 100 BBI JU granted projects represented a multitude of approaches to integrate waste biomass into value chains by converting them into marketable products. More than 600 participants made BBISF a big success.

From the PROLIFIC project we presented initial food prototypes on our booth.

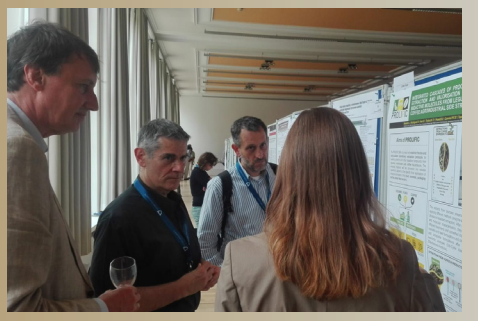
Partner Stolzenberger Bakery had brought a variety of high-protein bread – which attracted considerable attention: different cereal breads, gluten-free ones and all with approximately 20 % protein, derived from our pea or chick-pea feedstock using an environmentally friendly aqueous extraction.

Partner IGV contributed first specimen of pea flour and pea protein enriched extrudates – an initial step towards high-nutritional sports food or breakfast cereals. They can also form a base ingredient for vegan meat surrogates.
Similarly, residues from oyster mushroom cultivation, such as cut stem extremities can easily be directly converted into healthy snacks.

News

Outreach to industry

The PROLIFIC commercial partners have attended various conferences and fairs. They raised awareness of the industry for our utilization routes, extraction processes and consumer product prototypes. It was and is mportant to familiarize the market players with new approaches and untapped opportunities. Anuga, cocotea, Vitafoods and the EuroFoodChem conference were events on which we addresses the food sector.



PROLIFIC on Italian TV

Already in its early stage, PROLIFIC reached out to the general and regional public. Annalisa Tassoni, our Scientific Coordinator from University of Bologna, took a film team to her labs to explain how the partners exploit agro-industrial residual to create more sustainable every-day consumer products and food.
Watch on youtube

Kick-off & further meetings

The full consortium convened for the first time in September 2018. Two intensive days to reconfirm project objectives and to take the first steps on a long journey. Since then tremendous progress has been made and we learned a lot about the extraction processes and new pre-prototypes each time we met. And admittedly, food served by our hosts was always that delicious that there was - almost - no food waste!

Networking

PROLIFIC also liaised with initiatives outside the project more directed towards the promotion of circular solutions and their exploitation like the Greenweek, Ecomondo, BBI Stakeholder Forum and the Ketbio network.

Consortium

Contact & key figures

Coordinator

Philippe Corvini
University of Applied Sciences and Arts
Northwestern Switzerland,
School of Life Sciences FHNW
Hofackerstr. 30, CH-4132 Muttenz
E: philippe.corvini@fhnw.ch

Scientific Coordinator

Annalisa Tassoni
Department of Biological Geological and
Environmental Sciences
Alma Mater Studiorum - University of Bologna
Via Irnerio 42, IT-40126, Bologna
E: annalisa.tassoni2@unibo.it

Project key figures

Call: BBI 2017.R4 – Proteins and other bioactive ingredients from side streams and residues
Research & Innovation Action project

Project duration: 4 years
01/09/2018 – 31/08/2022

Funding:
4.67 M€ EU contribution / 5.3 M€ total cost

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