



WEIHENSTEPHAN · TRIESDORF
University of Applied Sciences

CIPCA 2025

***Advancing Alternative Proteins
in the Mediterranean Region***

***Midterm Results and
Technological Insights***

Prof. Dr.-Ing. Özlem Özmutlu
Prof. Dr. Halil Mecit Öztop



The PRIMA programme is supported
under Horizon 2020, the European
Union's Framework Programme for
Research and Innovation



ProxIMed

CIPCA 2025

X International Conference on Food Proteins and Colloids



16th - 18th June 2025

Universidade Católica Portuguesa - Porto



CATOLICA
FACULTY OF BIOTECHNOLOGY
PORTO



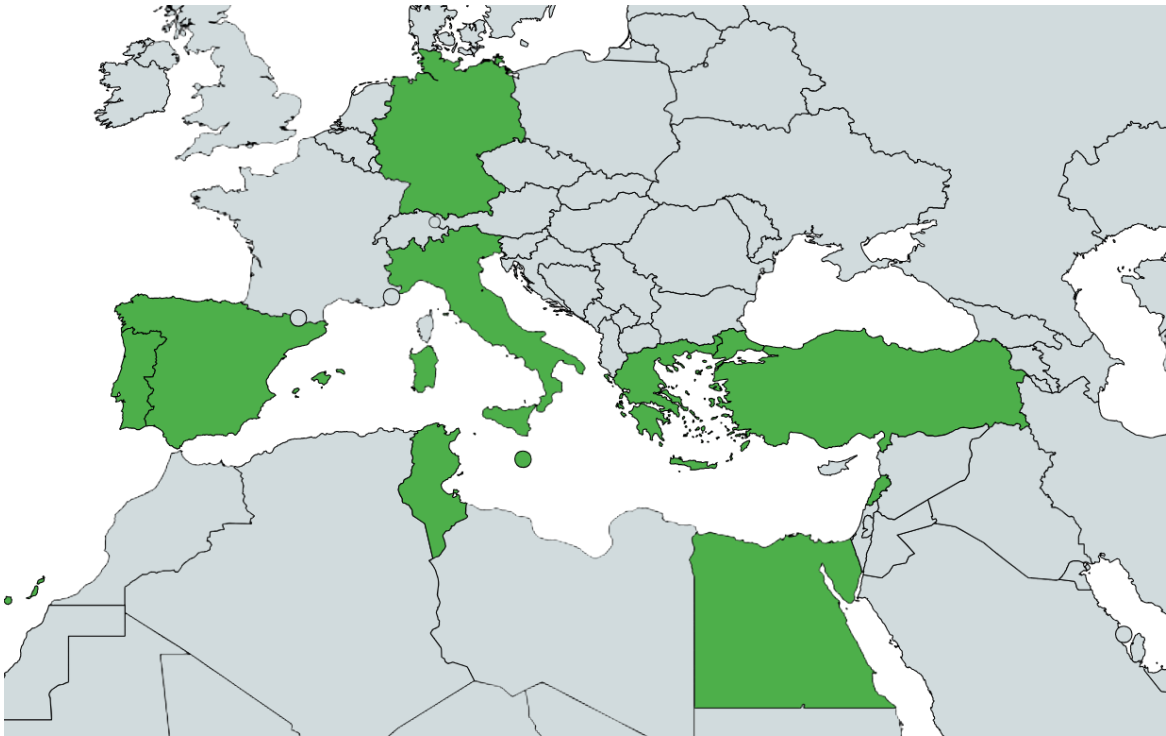
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PORTO



PRIMA
PARTNERSHIP FOR RESEARCH AND INNOVATION
IN THE MEDITERRANEAN AREA

ProxIMed

Exploration and Implementation
of Products with Alternative
Proteins in Mediterranean
Region



10 Countries



17 Partners



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ProxIMed's Mission

- ProxIMed aims to revolutionize **protein consumption** in the **Mediterranean region** through **innovation** and **sustainability**.
- The project focuses on developing over **20 alternative protein products** with the active involvement of consumers, industry partners, and innovative technologies.
- By **reducing environmental impact, improving food security, and enhancing food choices**, ProxIMed strives to shape a **healthier and more sustainable future** for the Mediterranean population.



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Visual Summary of ProxIMed



Protein Sources of ProxIMed



Traditional alternative protein sources

Lentil | Faba Bean | Chia Seed

Terrestrial sources

Mallow | Tomato Leaves

Aquatic sources

Duckweed | Microalgae

Microbial sources

Mycoprotein | Insects

Agri-food by products

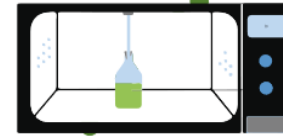
Tomato pomace | Dates by products | Sesame cake

Market Launch of the New Alt-Proteins



With the help of industrial partners (TAT, UL, FFL, PS), 2 selected products will be launched in Turkish and Tunisian markets.

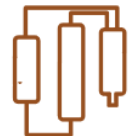
Pre-processing/Extraction/Fractionation Methods



Microwave Heating



Microwave Vacuum Drying



Supercritical Fluid Extraction



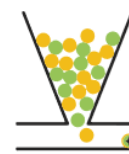
Ultrasonication(US)



In Liquid Plasma



Microfluidization



TriboTec

Product Nutrition, Safety & Health Aspects



Functionality



Allergenicity



Bio-accessibility



Bioavailability



Consumer



Quality



Sensory



Economic



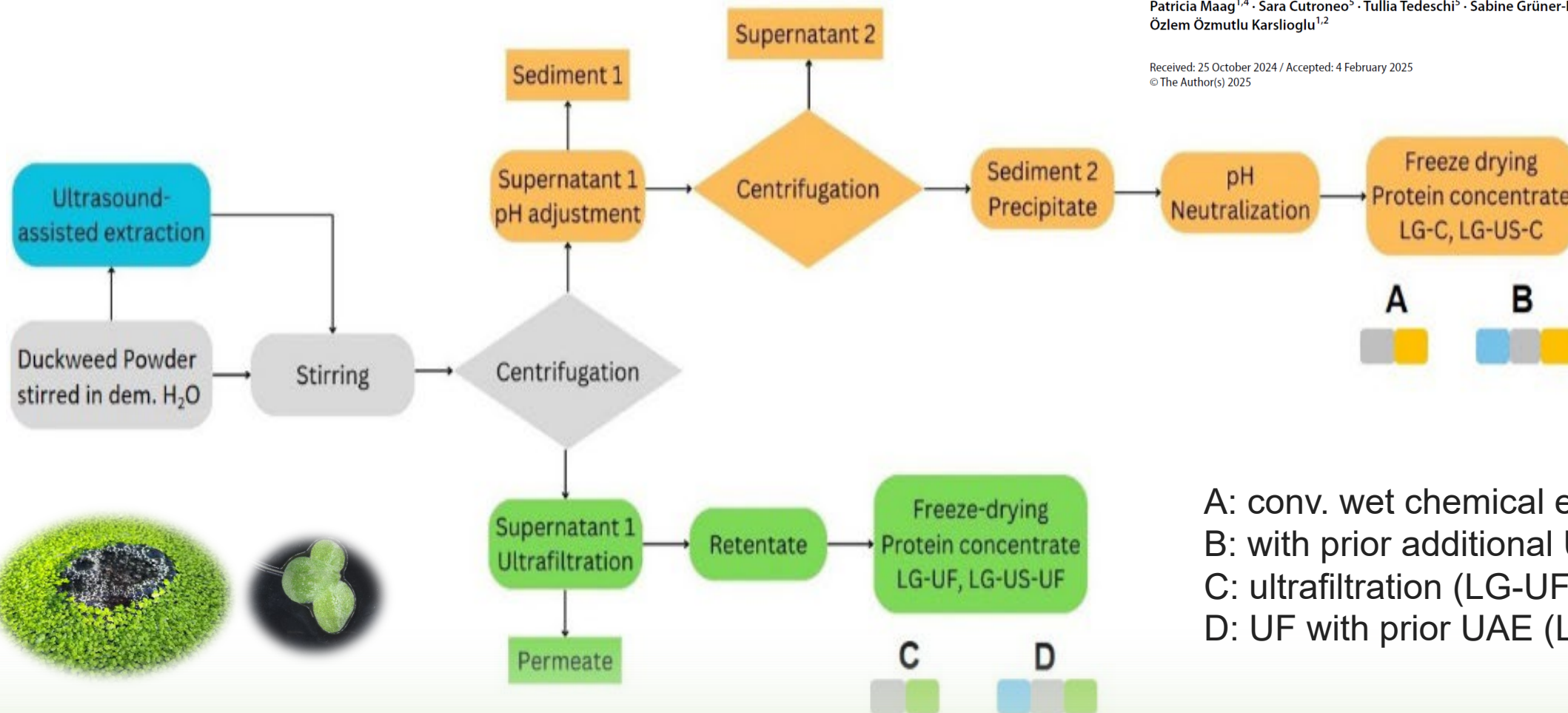
Sustainability

Aquatic Source: Duckweed

Optimization of Protein Extraction from Duckweed Using Different Extraction Processes

Patricia Maag^{1,4} · Sara Cutroneo⁵ · Tullia Tedeschi⁵ · Sabine Grüner-Lempar³ · Cornelia Rauh⁴ · Özlem Özmutlu Karşlioglu^{1,2}

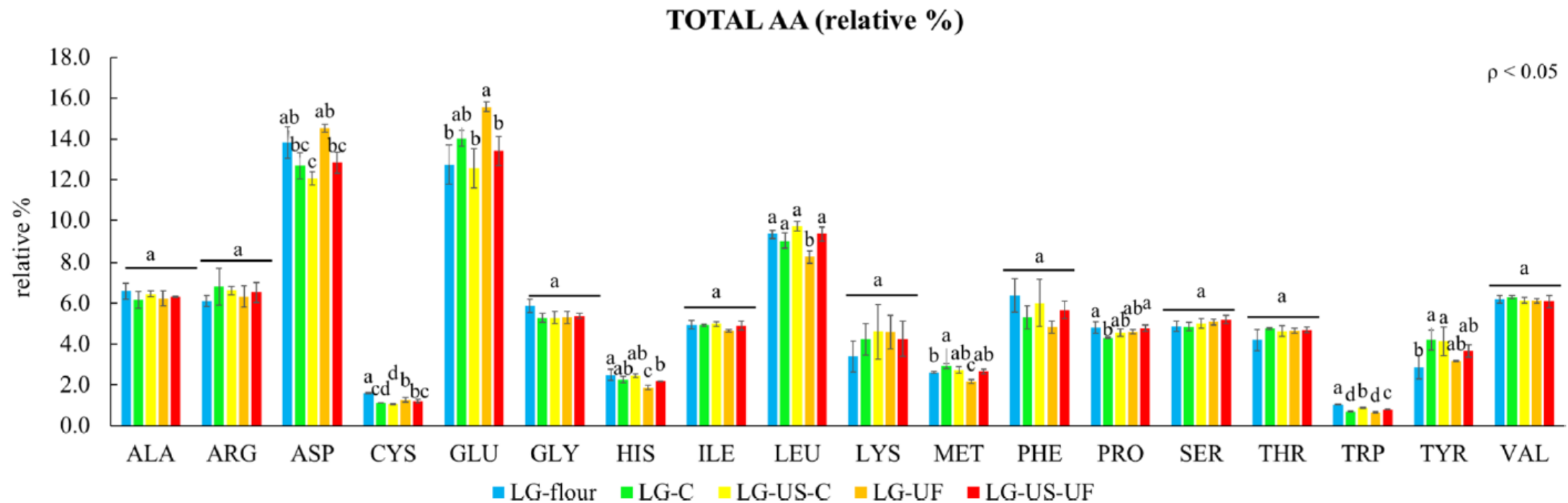
Received: 25 October 2024 / Accepted: 4 February 2025
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Aquatic Source: Duckweed



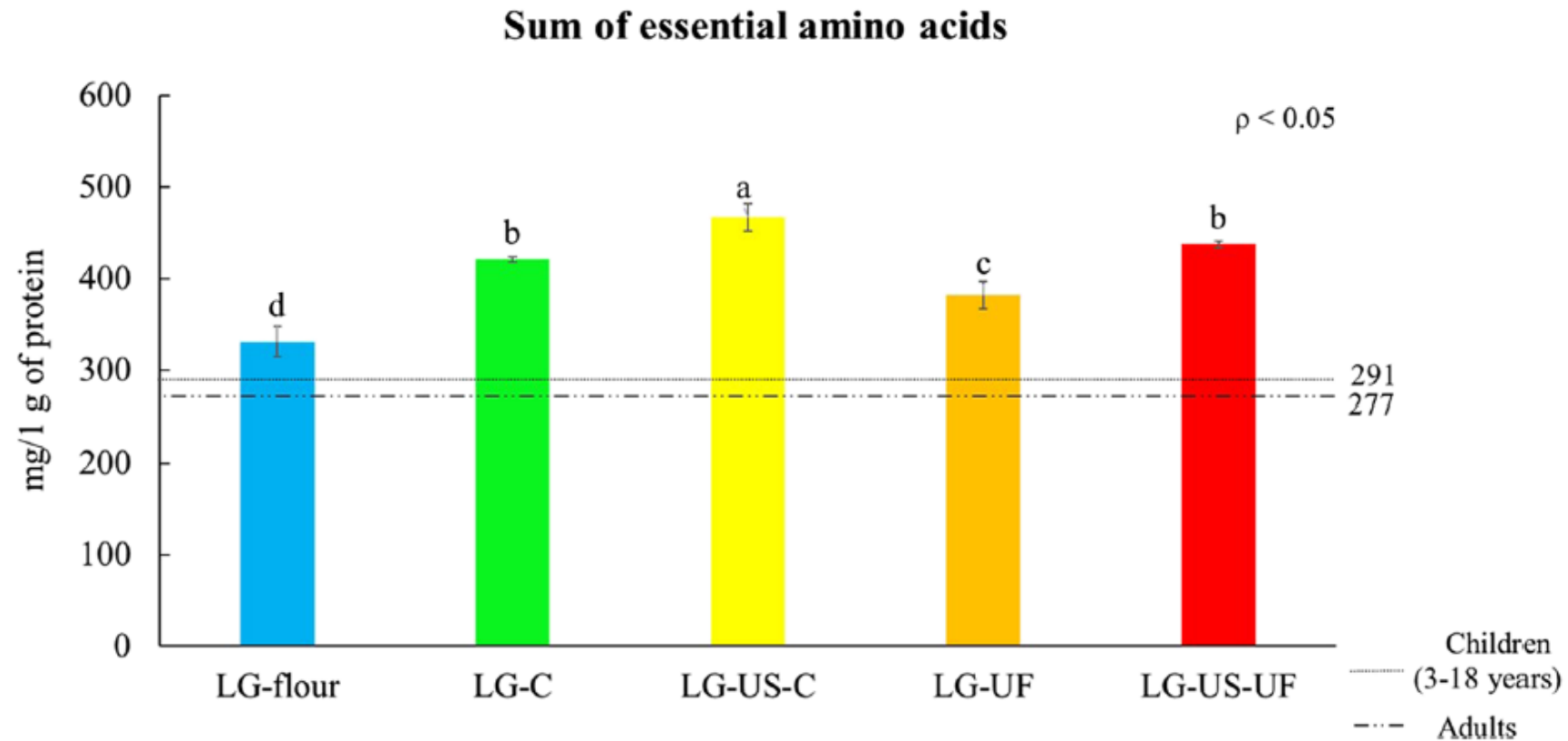
Total amino acidic profile expressed as relative % of amino acid on total protein



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Aquatic Source: Duckweed



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ProxiMed



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Aquatic Source: Duckweed

Children (3–18 years)	His	Ile	Leu	Lys	SAA	AAA	Thr	Trp	Val
LG flour	1.15	1.21	1.12	0.52	1.34	1.66	1.24	1.16	1.14
LG-C	1.30	1.51	1.36	0.81	1.62	2.13	1.76	0.97	1.45
LG-US-C	1.51	1.64	1.57	0.94	1.63	2.45	1.83	1.30	1.51
LG-UF	1.05	1.40	1.22	0.87	1.34	1.76	1.68	0.90	1.38
LG-US-UF	1.31	1.57	1.47	0.85	1.62	2.19	1.81	1.16	1.47
Adults	His	Ile	Leu	Lys	SAA	AAA	Thr	Trp	Val
LG flour	1.22	1.21	1.16	0.55	1.40	1.79	1.34	1.28	1.17
LG-C	1.38	1.51	1.41	0.87	1.69	2.30	1.91	1.06	1.48
LG-US-C	1.61	1.64	1.62	1.01	1.70	2.64	1.98	1.43	1.55
LG-UF	1.12	1.40	1.26	0.93	1.40	1.90	1.83	0.99	1.42
LG-US-UF	1.40	1.57	1.52	0.91	1.69	2.36	1.97	1.28	1.50



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Terrestrial Sources: Mallow Leaf Proteins

- The mallow leaf (*Malva sylvestris* L.) was collected from the garden in Bayındır district of Izmir in November 2023 (Fig. 1).
- Total dry matter content of mallow leaf was $21.52 \pm 0.03\%$ and the protein content of mallow leaf in dry basis was found $44.18 \pm 0.23\%$.



Fig. 1. The mallow leaf

Isoelectric Precipitation

The buffer solution was added to mallow leaves and the mixture was homogenized with using homogenizer (Daihan, HG-A5A). Then, the mixture was arranged in water bath at a certain temperature for 30 min to extract proteins into the solvent. After that, the mixture was filtered with cheesecloth and then centrifuged (6000 rpm, 20 min) to remove fiber part. The pH value of supernatant was adjusted to 3.5 and stirred for 30 min and then centrifuged (6000 rpm, 30 min). The pellet was freeze-dried (Liyolife) at $-48\text{ }^{\circ}\text{C}$ for 15 h. In ultrasound assisted extraction, the ultrasound was used before the extraction process, and it continues in the same way afterwards.

pre-heating ($55\text{ }^{\circ}\text{C}$) +
ultraturax 5 min

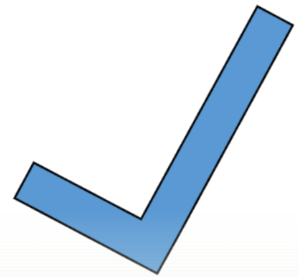
ULTRASOUND
ASSISTED
EXTRACTION
YIELD: %60.04

Extraction Temperature:
 55°C
pH value: 10
Extraction time: 30 min
Solution/solid ratio: 10
mL/g
20 min Ultrasound

Mallow leaves
(30.147 g)
59.01% protein
1.72 g protein
powder



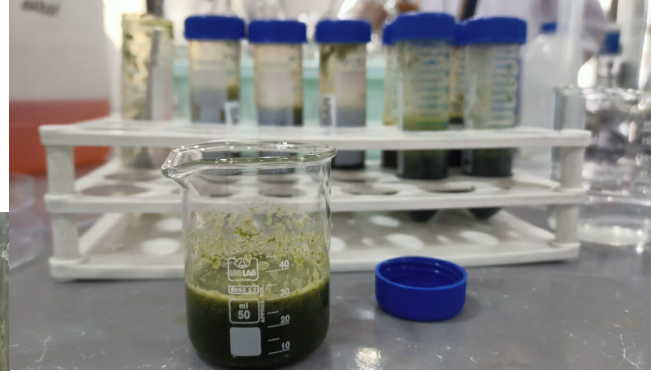
To determine the effect of **mechanical disruption** on protein extraction from mallow leaves and increase protein yield, extraction was performed under optimum conditions with the addition of pre-heating ($55\text{ }^{\circ}\text{C}$) and increasing the ultraturax time by 5 min. With this method, it was determined that the protein yield reached %60.04.



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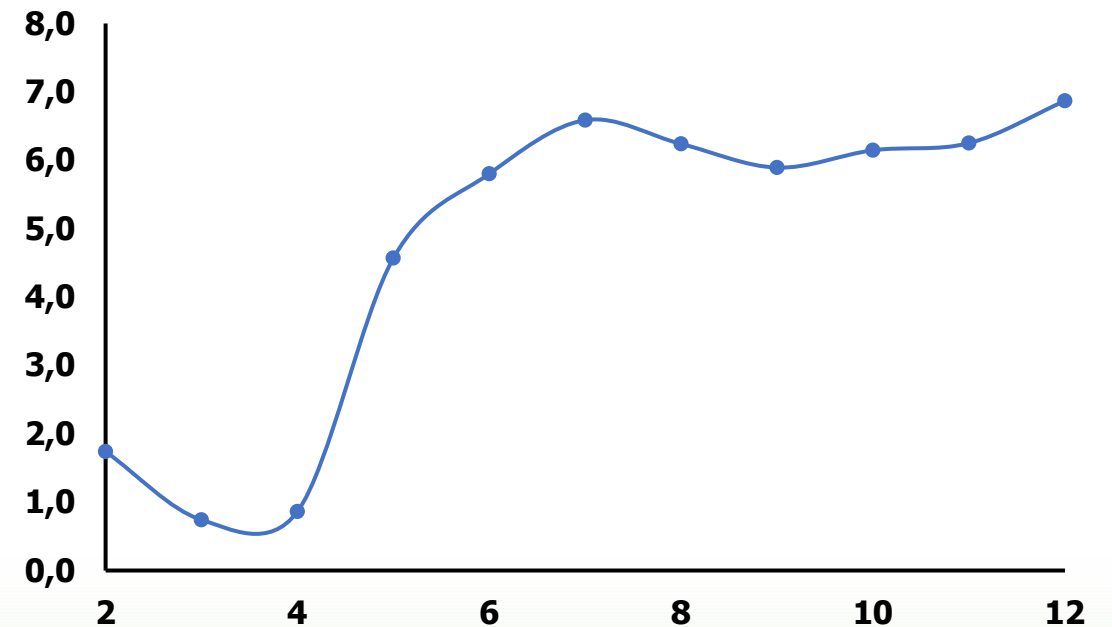
Terrestrial Sources: Tomato Leaves



*Initial tomato leaves
crude protein content
on dry basis: approx.
25%*

- Alkaline – Isoelectric point extraction is currently being done
- Experiments are still at the initial stages of optimization
- A solubility curve was determined to determine the suitable extraction pH and isoelectric point which was found to be 3.0
- **PROBLEMS FACED:** Yield from first trials was too low to analyse the sample.
- More trials will be done to understand the protein content and recovery yield of extracts

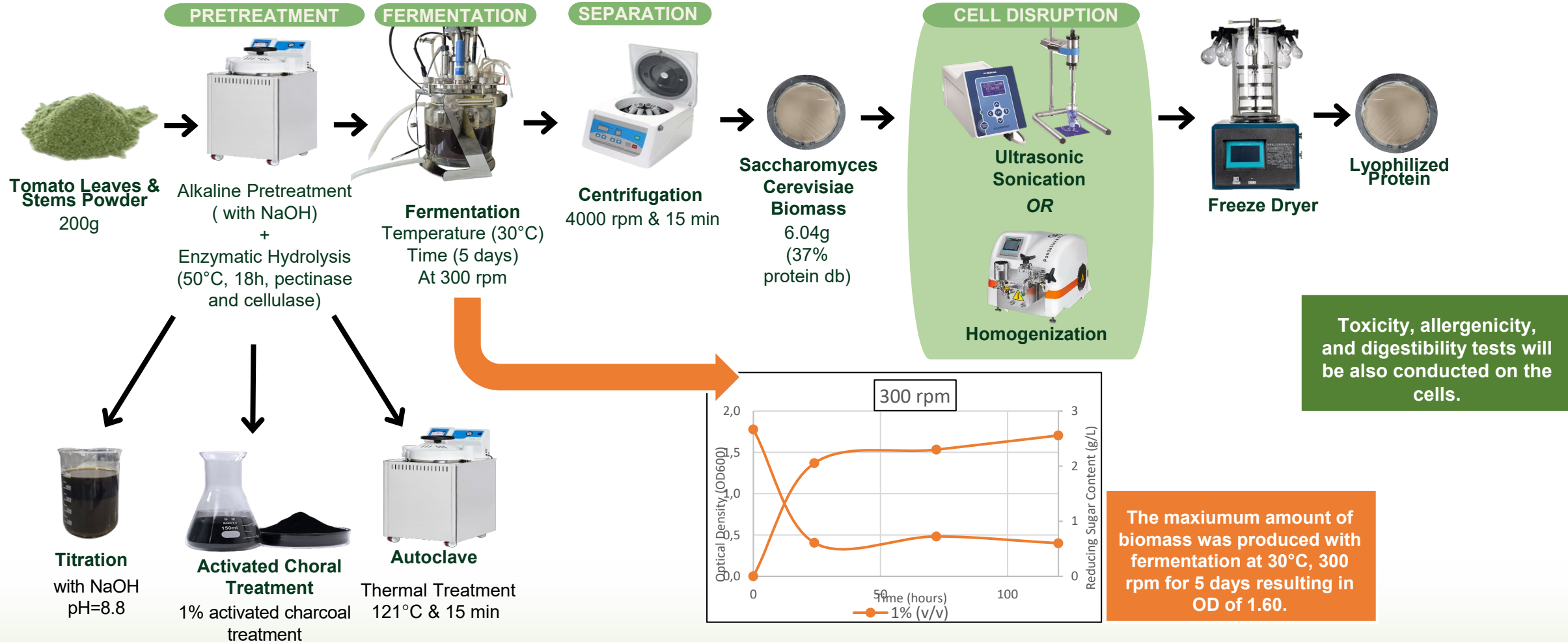
Solubility (% w/w) vs. pH for tomato leaves



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Production of Single-Cell Protein from Tomato Leaves & Stems



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Agro-food by products: Tomato Pomace

Tomato Pomace

**Initial tomato pomace crude protein content on dry basis:
15.53 %*

Extraction methods:

1. Alkaline – Isoelectric Point extraction
2. Microwave-Assisted Alkaline Extraction
3. Ultrasound-Assisted Alkaline extraction

Alkaline – Isoelectric point extraction

Extraction Parameters considered:

1. Extraction Temperature (Room temperature, 50°C and 70°C)
2. Solid: Solvent Ratio (1:5, 1:10 and 1:20)
3. Alkaline pH (9-12) and Acidic pH (3-6)
 - Solubility curve determined
- Suitable pH of 11-3.9 was decided for optimal extraction

Microwave Assisted Extraction was done considering different powers (60%, 80% and 100%) while keeping the time constant for 3 minutes.



Ultrasonic assisted extraction (300W)

Was done considering different durations at 100% amplitude (5 minutes, 15 minutes and 30 minutes).

Protein Content and Protein Recovery yield

Protein content of the protein extracts ranged between 42.61 % and 45.12%

Protein recovery yield ranged between 27.6% and 36.31%
MWAE and USAE were able to increase the protein recovery yield while reducing the extraction time significantly

Functional properties of extracted proteins using MWAE and USAE were enhanced



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Our Products

	Alt-protein Source	Products to be Developed
	Tomato Pomace	Fermented vegetable pickle in protein enriched solution Protein powder as an ingredient
	Tomato Leaf	Fermented vegetable pickle in protein enriched solution Protein powder as an ingredient
	Faba Beans	Easy mix vegan/vegetarian meatballs: A powder mix to prepare meat ball analogues Protein powder as an ingredient
	Sesame Cake	Tahini enriched with sesame protein Protein powder as an ingredient
	Date by-product	Protein powder as an ingredient
	Microalgae	Protein powder as an ingredient Capsules as supplement

	Alt-protein Source	Products to be Developed
	Mycoprotein	Powder as food ingredient Capsules as supplement Dessert
	Algae/Date/Sesame cake	Dairy substitutes
	Insects	Protein powder as an ingredient Food products will be determined based on consumer studies (e.g. sport nutrition snack bars; meat and fish analogues) Animal feed
	Lentil	Protein powder as an ingredient
	Chia Seed	Protein powder as an ingredient
	Mallow	Protein powder as an ingredient Capsules as supplement



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Consumers' Acceptance

Focus Group Studies in Türkiye, Tunisia & Portugal

- Key purchasing decisions are driven by **price, convenience, and trust in familiar brands.**
- **Personal recommendations** from family or friends hold more weight than marketing or studies in influencing food choices.
- Meat is culturally associated with a complete meal, with a **strong preference for local, fresh market ingredients** over supermarket options.
- There is **resistance to new ingredients** or deviations from traditional preparation methods, as these changes can be seen as disrespectful.
- **Familiarity** with ingredients, like dates and sesame, **increases acceptance of new products.**



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Consumers' Acceptance

Product-Specific Insights

- *Insect proteins*: Disliked in recognizable forms; better accepted as powders. Hygiene, health benefits, and sustainability should be emphasized.
- *Mycoproteins*: Accepted if taste and texture are good; require more consumer education.
- *By-product proteins (dates, sesame, tomato)*: Higher acceptance due to familiarity and perceived sustainability.

Marketing Recommendations

- Tailor pricing strategies to economic conditions.
- Use a mix of advertising, consumer promotions, and social media—especially influencer marketing for younger audiences.
- Ensure culturally sensitive messaging to build trust and interest.



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Integrating Consumer Voices into Innovation



Our iterative, multi-method approach ensures consumers are not just subjects of study — they are **co-creators** in shaping viable, desirable, and culturally aligned alternative protein products



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Duckweed | Microalgae

Microbial sources

Mycoprotein | Insects

Agri-food by products

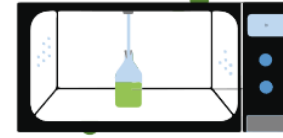
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Market Launch of the New Alt-Proteins



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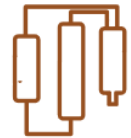
Pre-processing/Extraction/Fractionation Methods



Microwave Heating



Microwave Vacuum Drying



Supercritical Fluid Extraction



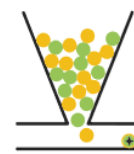
Ultrasonication(US)



In Liquid Plasma



Microfluidization



TriboTec

Product Nutrition, Safety & Health Aspects



Functionality



Allergenicity



Bio-accessibility



Bioavailability



Consumer



Quality



Sensory



Economic



Sustainability

Thank you!



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IN THE MEDITERRANEAN AREA

Thank you for your attention!

Happy to have your questions & comments.



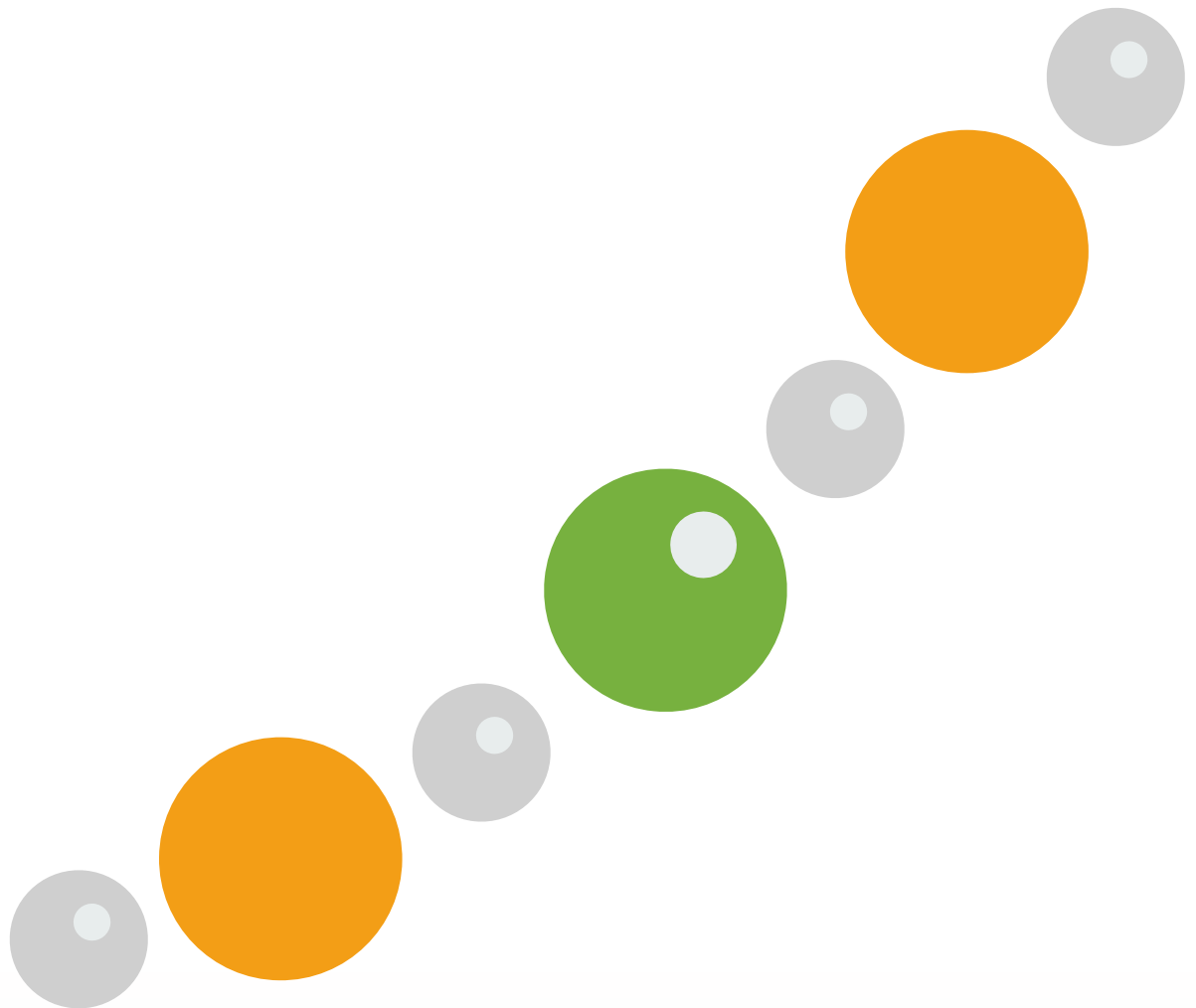
<https://proximedprima.eu/>



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Back up



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Our Vision

"A future where alternative protein sources redefine diets, promoting health and sustainability."

- In this vision, ProxIMed envisions a shift towards protein sources that not only meet dietary needs but also **align with ecological and economic goals**.
- By integrating **low-input and available raw materials** with **innovative extraction processes**, ProxIMed seeks to create a **paradigm shift in the way people perceive and consume proteins** in the Mediterranean.
- The vision extends beyond product development, aiming to instill a **long-lasting positive impact on health, the environment, and the overall well-being of communities in the region**.



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Our Partners



**ODTÜ
METU**

Middle East Technical University
(METU) - **TURKIYE**

American University of Beirut (AUB) - **LEBANON**



Focus Foodlabs (FFL) - **GERMANY**

TAT Gıda Inc. - **TURKIYE**



University of Sfax (UoS) - **TUNISIA**

AINIA- **SPAIN**



Arid Regions Institute (IRA) - **TUNISIA**

Proteinsecta (PS) - **SPAIN**



proteinsecta



WEIHENSTEPHAN TRIESDORF
University of Applied Sciences

HSWT - **GERMANY**



University of Parma (UNIPR) - **ITALY**

Assiut University (AU) - **EGYPT**



GreenSurvey
Institut für Marktforschung
Prof. Dr. Menrad GmbH

Green Survey (GS) - **GERMANY**

Aristotle University Thessaloniki (AUTH) - **GREECE**



**ARISTOTLE
UNIVERSITY
OF THESSALONIKI**



Uluova Dairy Company (UL) - **TURKIYE**

Malta College of Arts, Science and Technology (MCAST)
MALTA



MCAST



Universidade Catolica Portuguesa (UCP) - **PORTUGAL**

Deutsche Institut für Lebensmittel (DIL) - **GERMANY**



Work Packages

Work Packages					
WP #	WP Title	Participant #	Lead Participant	Start Month	End Month
1	Management and Coordination	1	HSWT1	1	48
2	Consumers' acceptance	1	HSWT2	1	48
3	Protein production through innovative technologies	2	METU	3	42
4	Product development and sensorial evaluation	10	AINIA	12	48
5	Economic and Environmental assessment	3	GS	1	48
6	Health, Nutrition & Safety Aspects	7	AUTh	6	48
7	Business model development	1	HSWT3	24	48
8	Dissemination and Communication Activities	2	METU	1	48

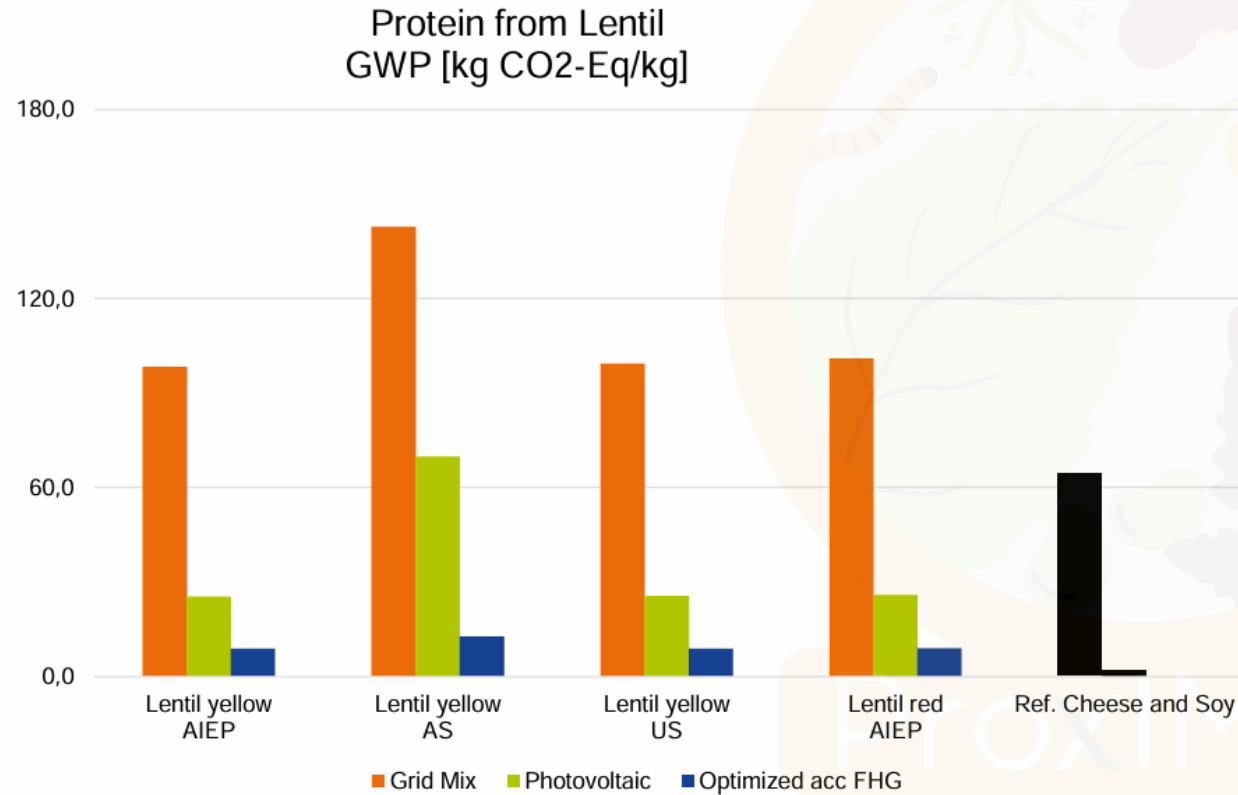


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First Life Cycle Assessment results

Interpolation of optimizing according to literature



- Application on lentil protein shows the potential: down to ~9 kg CO₂-Eq/kg
- Able to compete with established protein products

Source:

Wu et al. (2024) A life cycle assessment of protein production from wheatgrass: Optimization potential of a novel vertical farming system; in Elsevier Sustainable Production and Consumption;

<https://doi.org/10.1016/j.spc.2024.08.031>



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Task 3.2: Production of proteins from duckweed (also known as water lentil), chia seed, and lentil (HSWT1)



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ProxIMed



Traditional Source: Lentil *(Lens Culinaris Medik.)*

Alkaline Solubilisation

Central Composition Design

Factor	Min. value	Max. value
pH	7	11
Concentration	5%	20%
Temperature	20°C	50°C
Time	60 min	120 min



Factor	Selected optimum values
pH	9
Concentration	5%
Temperature	50°C
Time	30 min



Proteinyield Fit	94,18%	-	84,55%
Real Proteinyield	92,10%	91,32%	-
Real Protein content	60,10%	64,15%	-



Yellow lentil

Red lentil

Green lentil

Isoelectric Precipitation

Box-Behnken-Trialplan

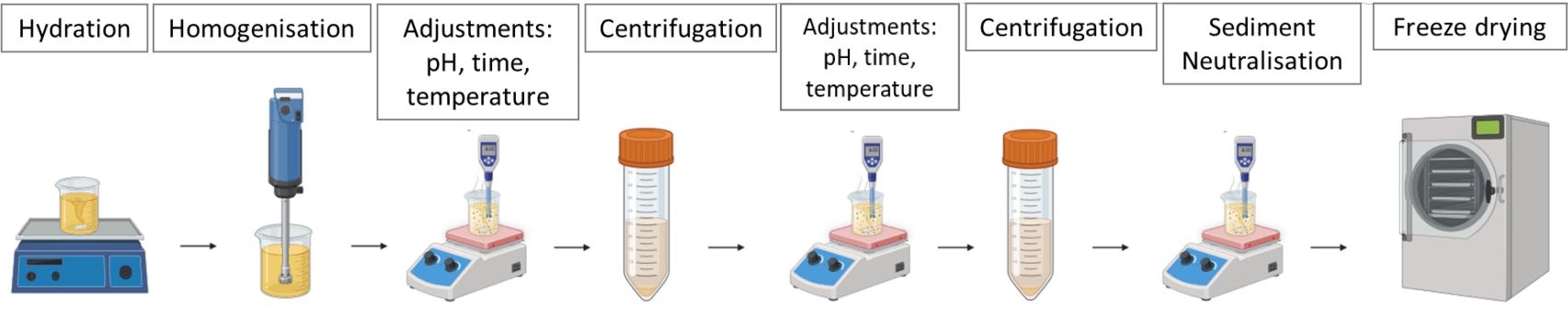
Factor	Min. value	Max. value
pH	4	5
Temperature	4°C	50°C
Time	30 min	90 min



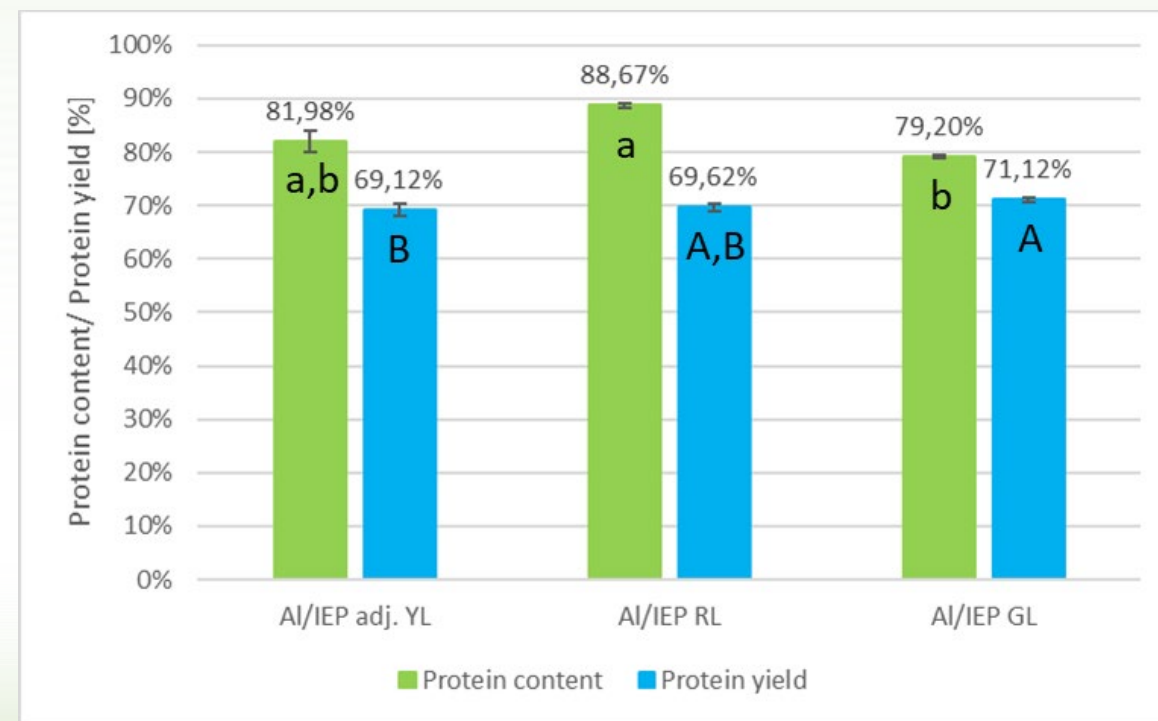
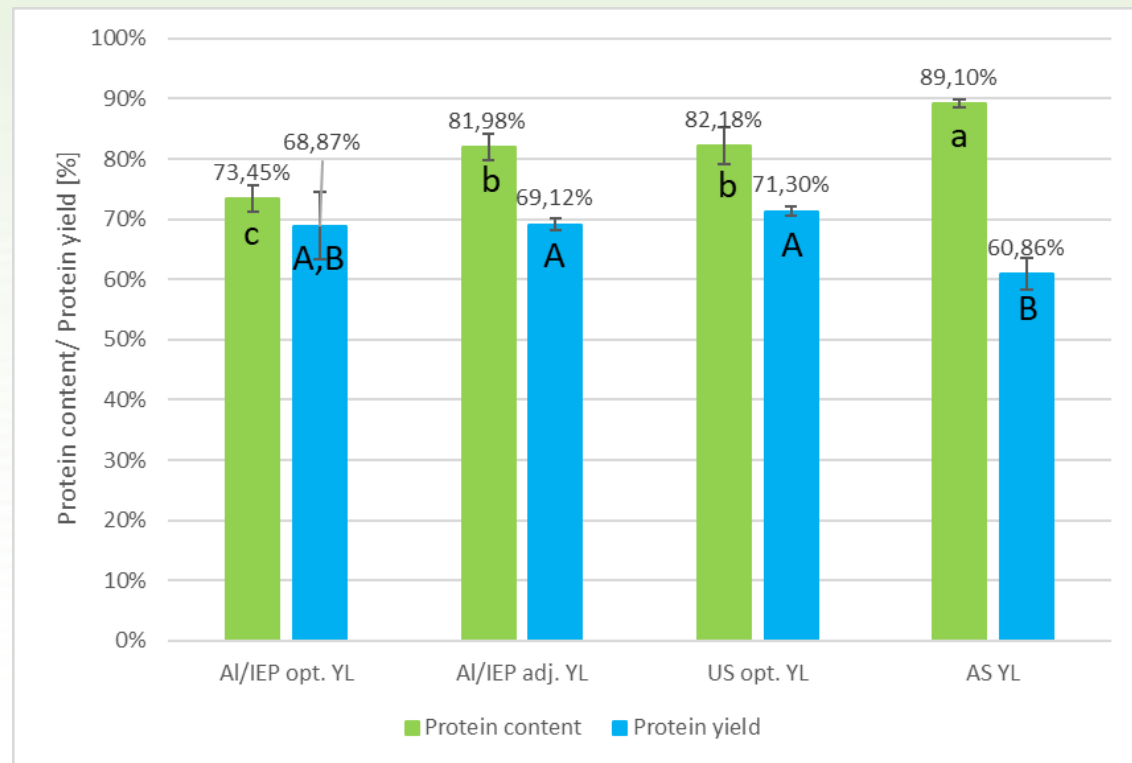
Factor	Selected optimum values
pH	5
Temperature	RT
Time	30 min



Proteinyield Fit	70,11%	-	-
Real Proteinyield	69,45%	-	-
Real Protein content	85,79%	-	-

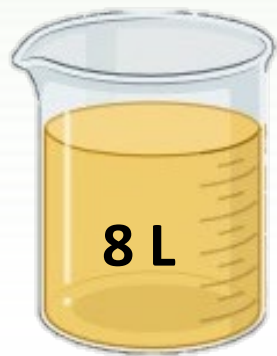


Traditional Source: Lentil



Protein Production for Porto

Alkaline Solubilisation



Conc.: 5%

Protein content: 24.06%

pH: 9
Temp.: 50°C
Time: 30 min

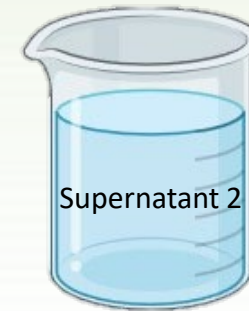


Sediment 1

Protein yield: 8.56%
Protein content: 4.35%
Protein [g]: 8.24g

Isoelectric Precipitation

pH: 5
Temp.: RT
Time: 30 min



Sediment 2

84.4g

Protein yield: 69.45%
Protein content: 85.79%
Protein [g]: 66.83g

Protein yield: 15.77%
Protein content: 26.21%
Protein [g]: 15.17g

Aquatic Source: Duckweed

Table 12 Amino acid score estimated for duckweed samples compared to the requirements set by FAO, 2011 for children (from 3 to 18 years) and adults

Children (3–18 years)	His	Ile	Leu	Lys	SAA	AAA	Thr	Trp	Val
LG flour	1.15	1.21	1.12	0.52	1.34	1.66	1.24	1.16	1.14
LG-C	1.30	1.51	1.36	0.81	1.62	2.13	1.76	0.97	1.45
LG-US-C	1.51	1.64	1.57	0.94	1.63	2.45	1.83	1.30	1.51
LG-UF	1.05	1.40	1.22	0.87	1.34	1.76	1.68	0.90	1.38
LG-US-UF	1.31	1.57	1.47	0.85	1.62	2.19	1.81	1.16	1.47
Adults	His	Ile	Leu	Lys	SAA	AAA	Thr	Trp	Val
LG flour	1.22	1.21	1.16	0.55	1.40	1.79	1.34	1.28	1.17
LG-C	1.38	1.51	1.41	0.87	1.69	2.30	1.91	1.06	1.48
LG-US-C	1.61	1.64	1.62	1.01	1.70	2.64	1.98	1.43	1.55
LG-UF	1.12	1.40	1.26	0.93	1.40	1.90	1.83	0.99	1.42
LG-US-UF	1.40	1.57	1.52	0.91	1.69	2.36	1.97	1.28	1.50



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