Bioconversion of chemical effluents from marine gelatine production: Production of a probiotic under circular economy philosophy

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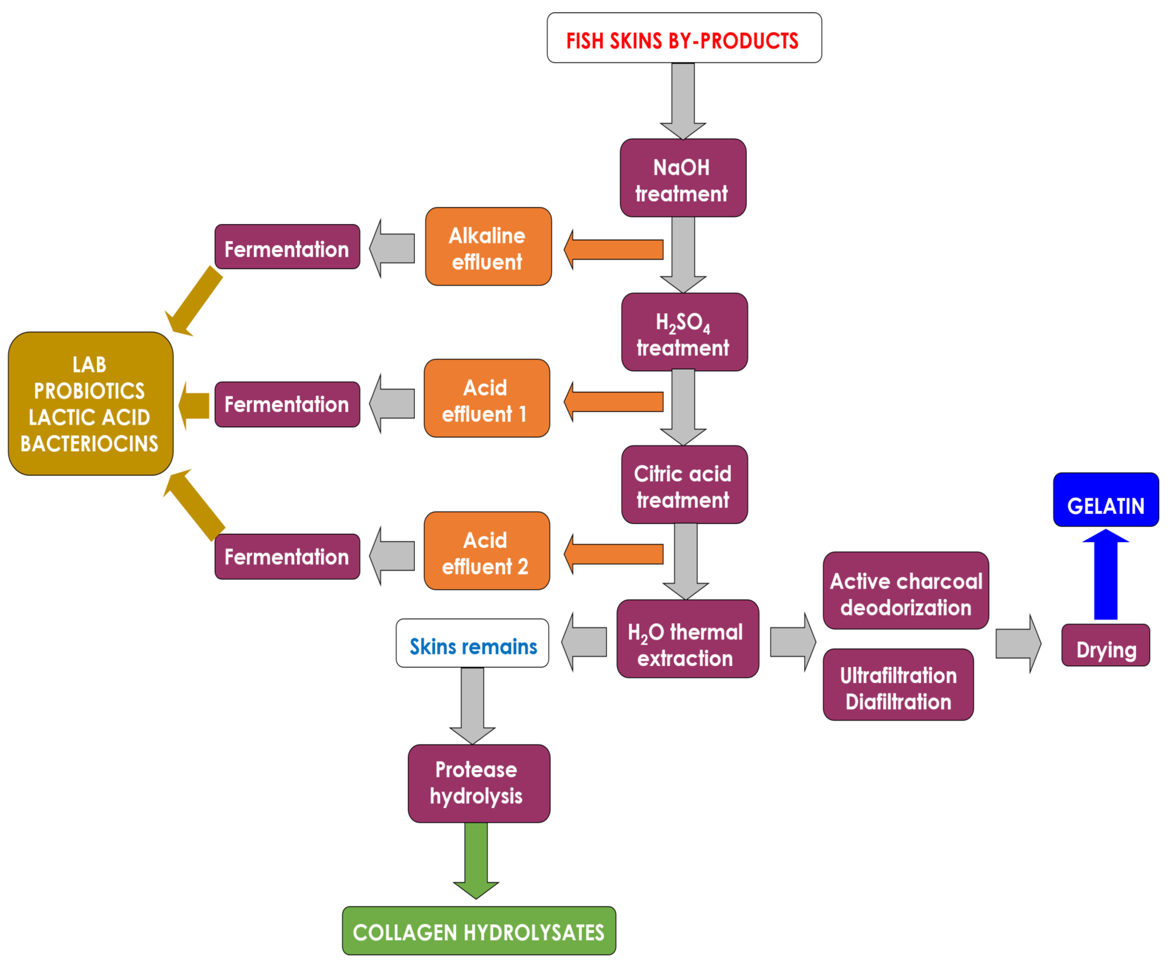
Motivation & Objectives

- **Gelatin** is a protein biopolymer obtaining by partial hydrolysis of collagen.
- **Skins** of various **fish** species are **industrial by-products** rich in collagen.
- **Chemical treatments** are needed for the production of gelatin.
- **Effluents** from these treatments are **large** in volume and its **depuration** is mandatory. The **composition** of such effluents is mainly **protein**.

The **aims** of the present work are:

- To depurate and **valorize gelatin effluents (GE)** under **biorefinery** concept.
- To formulate **low cost media** for the culture of lactic acid bacteria using **GE** as source of peptones.
- To produce **biomass (probiotics)** and **lactic acid** on GE reducing production costs and following **circular economy** principles.

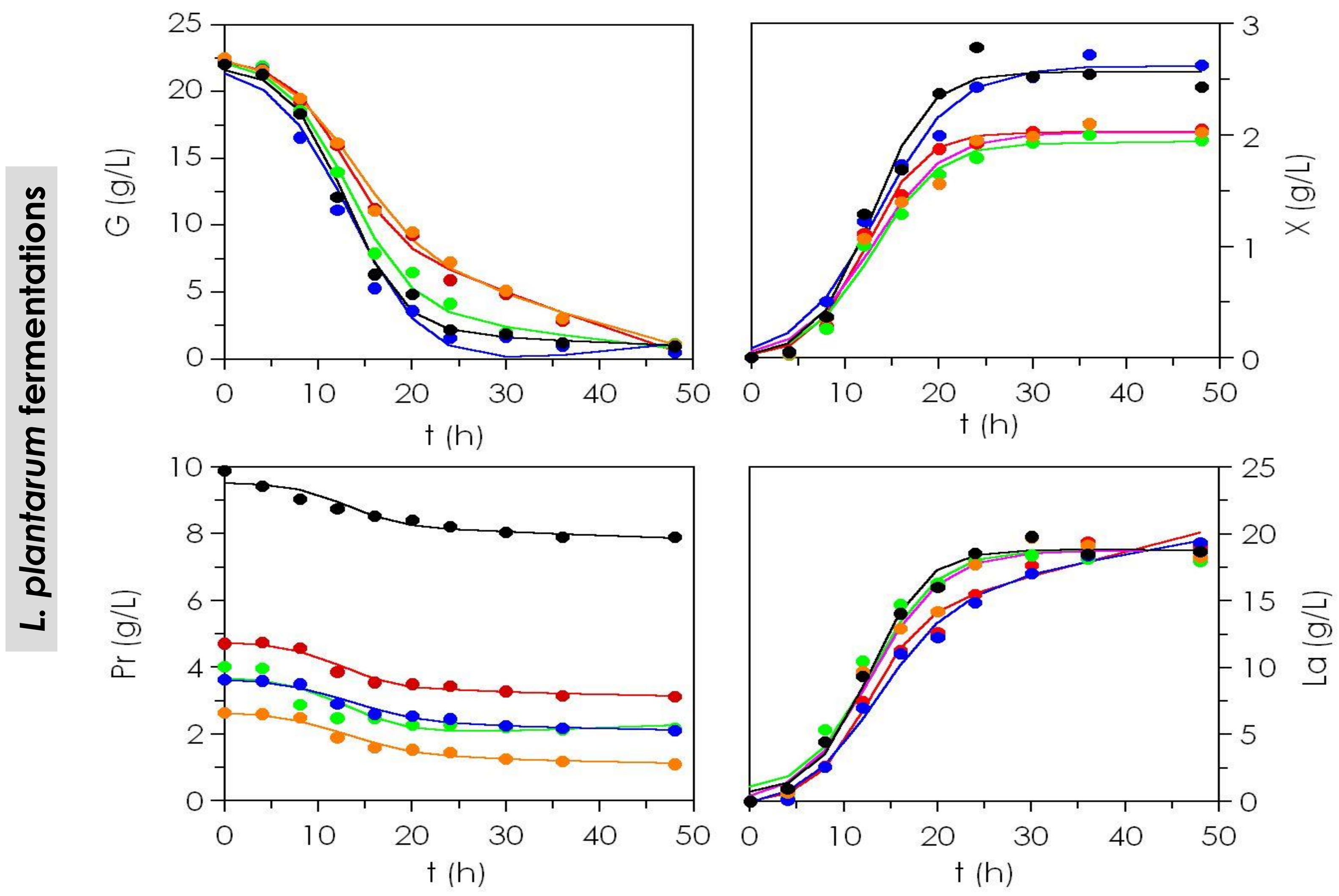
Materials & Methods



- **GE** from **salmon (SA)**, **tuna (TU)**, **shark (SH)** and **turbot (Tr)** were prepared combined, proportionally, alkaline and acid effluents. Protein content ranged 2.6-4.6 g/L.
- All **media from GE** simulating commercial **MRS** (control medium), but without commercial peptones (meat extract and bactopeptone).
- ***Lactobacillus plantarum*** was the lactic acid bacteria (LAB) used to GE conversion/valorisation.
- **Fermentations** were performed on batch culture using 300 mL flasks at 30ºC, initial pH=6, 200 rpm of agitation and without control of pH and aeration.

Ingredients (g/L)	SA	TU	SH	Tr	MRS
Glucose	20	20	20	20	20
Yeast extract	4	4	4	4	4
CH_3COONa	5	5	5	5	5
$C_6H_{14}N_3O_7$	2	2	2	2	2
K_2HPO_4	2	2	2	2	2
$MgSO_4$	0.2	0.2	0.2	0.2	0.2
$MnSO_4$	0.05	0.05	0.05	0.05	0.05
Tween 80	1	1	1	1	1
Meat extract	-	-	-	-	8
Bactopeptone	-	-	-	-	10
Gelatin Effluents	4.6	3.7	2.6	4.0	10

Results & Discussion



Mathematical modelling

Biomass production (*X*)
$$r_X = \frac{dX}{dt} = \mu_{mX} \cdot X \cdot \left(\frac{K-X}{K}\right)$$

Lactic acid production (*La*)
$$r_{La} = \frac{dLa}{dt} = \alpha_{La} \cdot \frac{dLa}{dt} + \beta_{La} \cdot X$$

Glucose uptake (*G*)
$$r_G = -\frac{dG}{dt} = \frac{1}{Y_{X/G}} \cdot \frac{dX}{dt} + m_X \cdot X$$

Protein uptake (*Pr*)
$$r_{Pr} = -\frac{dPr}{dt} = \frac{1}{Y_{X/Pr}} \cdot \frac{dX}{dt} + m_X \cdot X$$

- Experimental data of bioproductions and nutrient consumptions were accurately modeled by proposed equations (R^2>0.981). The robustness of the equations in the description of experimental trends was very high (p<0.001). All parameters were always statistically significant.
- Based on these parameters we can conclude that maximum growth and maximum growth rate (X_m and v_X) were significantly higher (p<0.05) in the media **MRS** and formulated with **GE-TU**. Maximum lactic acid production was similar in all cases, but growth rates were higher in **MRS**, **GE-Tr** and **GE-SH**.
- Nutrient intakes (glucose and protein) profiles were quite similar in all fermentations. In all media, the consumption of glucose was exhaustive and the protein uptake was always around 2 g/L.
- From a economical viewpoint, the decrease in the cost of biomass production of *L. plantarum* (in €/g of bacteria) using GE as source of protein substrate, replacing the peptones present in the commercial medium MRS, was around 4-folds. In the case of the lactic acid, the reduction obtained with residual peptones (in €/g of La) was of 3-folds.

Conclusions

- **GE** provide a valuable source of organic nitrogen (proteins, peptides and amino acids) for microbiological applications.
- **LAB productions** are supported by low-cost media formulated with GE as source of protein based ingredient.
- **Metabolite production costs** are reduced between 3 and 4-folds using low-cost media.
- **GE** can be completely valorized in terms of circular economy avoiding its management and depuration or dumping.

References

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Acknowledgments

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