Production of alternative proteins by solid-state fermentation of marine sources

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Nowadays, the world challenges the economic and technological development of societies without compromising natural resources. Global population is estimated to reach >9 billion people by 2050[1] exacerbating this problem. Unless appropriate measure and policies are implemented, severe and unsustainable increase in food production of approx. 70% will be need[2]. With this increment in world population and well-being, the demand for protein as a food-nutritional component is rising sharply. EU markets highlight a growing demand for healthy (nutritious and well-balanced diets), sustainable (from environmental, economic, and social perspectives) and ethically produced proteins. Therefore, profound changes and major transformation of the sources of proteins are highly required and the development of alternative proteins with minimal environmental impact is the most plausible solution[3].

Besides, in accordance with the new EC’s circular economy action plan for the transition of EU to a circular economy, novel products must be sustainable since design phase to reduce pressure on natural resources, focus on sectors that use most resources and where the potential for circularity is high (which includes food and nutrients, and thus, proteins), ensure circularity and less waste, empower consumers and create sustainable growth and jobs[3].

Taking all of this into account, one of the objectives of the project “Alternative PROteins from MIcrobial fermentation of non-conventional SEA sources for Next-Generation food, feed and non-food bio-based applications (PROMISEANG)[3]” is to develop novel alternative proteins from marine underexploited sources, mainly marine invertebrate and macroalgae discards and industrial biowastes, through solid-state fermentation, to generate new protein-enriched microbial biomass, which is known as single cell proteins (SCP), meeting market requirements for food, feed, and non-food (biomedicine, pharma and cosmetic) bio-based applications. Research on novel protein streams from sustainable alternative sources will contribute to increase the protein availability in the EU and reduce the actual dependency on imports.

Furthermore, following a zero-waste approach, this biorefinery will also recover interesting non-protein bio-compounds and molecules such as antioxidant phenolic compounds, enzymatic extracts, versatile polysaccharides, multipurpose lipids, etc.

Therefore, following the scheme of Figure 1, after selecting the marine substrate and strains, we have been optimizing the operational conditions of solid-state fermentation (SSF) through tests on 500 mL flasks with 10 g of substrate, inoculated with 2 mL of spore suspension and incubated for 7 days, complemented with modelling using statistical tools. Once the fermentation bioprocess was optimized and the protein extracts proved safe and nutritious, SSF are being scaled up to its maximum capacity (5 kg).

In addition, it was studied the extraction of the lipid fraction from marine biomass or from fermentation-based protein-rich extracts by applying AOAC official method and analyzed the composition of the lipid fraction by GC-MS. Special attention was paid to omega-3 fatty acids, phospholipids, and medium-chain triglyceride for food applications.

Finally, it was also studied the extraction of other biocompounds from biomasses such as polyphenols and other polysaccharides such as carrageenan and pigments. These extractions were assayed with deep eutectic solvents as well as water extraction of hydrosoluble compounds.

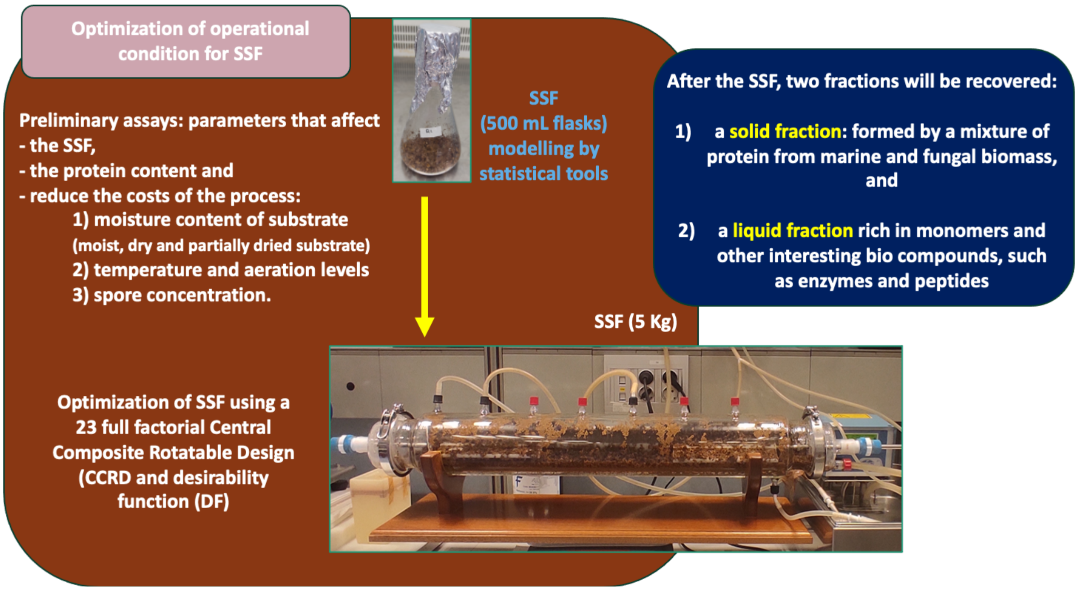

Figure 1. Production, optimization and scale-up of solid-state fermentation (SSF)

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References

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[2] FAO/WHO. The state of food security and nutrition in the world (2020).
[3] Project proposal "Alternative PROteins from MIcrobial fermentation of non-conventional SEA sources for