

## ALIMAR Project: Valorization of Mediterranean jellyfish during summer blooms

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Since approximately the mid-90s, jellyfish blooms have been observed in the Mar Menor lagoon, primarily of the fried egg jellyfish (*Cotylorhiza tuberculata*) and the barrel fish (*Rhizostoma pulmo*), although other species are also present. Some studies have estimated the number of jellyfish in the lagoon at nearly 70 and concentrations of between 68 and 81 jellyfish per 100 m<sup>2</sup>, depending on the area. This phenomenon is linked to various factors, including climate change, overfishing, and pollution.

It is clear that the jellyfish blooms in certain areas of the Mediterranean coast during the summer period represents a serious problem from an ecological and economic point of view, mainly related to the tourism and fishing sectors. Currently, local authorities hire fishermen to set nets to catch jellyfish before they reach the beaches and, every 3 to 5 days, remove them to dry in the sun, generating abundant waste that has no further treatment. It is therefore necessary to seek alternatives for their removal from seawater and subsequent treatment, seeking not only to generate benefits but also to reduce the costs of implementing possible alternatives.

On the other hand, this increase has generated scientific interest not only due to its ecological and socioeconomic impact, but also because of the biotechnological potential of these organisms for obtaining commercially valuable compounds. Among these compounds, collagen stands out, widely used in the cosmetic, pharmaceutical, and biomedical industries.

The objective of the ALIMAR project (carried out in the framework of AGROALNEXT, Complementary Plan in Agrofood area for Murcia region), was to analyse, in a preliminary way, the possibilities of management and valorisation of several marine species present in the Mediterranean Sea due to their proliferation at certain times of the year. The project combined bibliographic analysis with experimental work conducted at the the Marine Research Institute (IIM-CSIC), using raw materials collected in the Mar Menor area by the Spanish Institute of Oceanography (IEO-CSIC). The obtaining of collagen from jellyfish was studied, using isolation methods developed in the IIM for skins of different fish species with slight modifications and also by supercritical extraction as a more sustainable alternative and even higher yield.

Experimental work included drying trials (oven drying at 60°C and freeze-drying at -80°C), collagen extraction using different protocols for *R. pulmo* and for *C. tuberculata*, combining traditional acid/alkali treatments and SFE (CO<sub>2</sub>-based), implemented for the first time in jellyfish.

Drying experiments revealed that jellyfish biomass contains more than 94% water, with final dry matter yields ranging from approximately 4% to 7% depending on species and anatomical fraction. Freeze-drying improved sample recovery but is economically unfeasible for large-scale application, whereas oven drying and, potentially, air or solar drying were identified as more realistic options for coastal operations, provided that adequate protection against predation is implemented. Among the species studied, *R. pulmo* demonstrated greater structural integrity during handling and drying, making it the most suitable candidate for further processing.

Likewise, the collagen obtained was characterized by SDS-PAGE electrophoresis and the amino acid profile. Collagen yields ranged from 2.5% to 18% on a dry basis using conventional methods and up to 30% using supercritical fluid extraction. However, despite the higher yield observed in SFE, compositional analysis revealed an excessively high ash content and low protein percentage, indicating significant salt retention, non-collagenous contaminants and incomplete purification. This result highlights the need to optimise the purification stage prior to supercritical extraction by washing with water or dialysis to remove salts and obtain a product comparable to collagens obtained from other marine species. In contrast, conventional methods based on acetic acid produced collagens of higher purity, with low ash

content and a protein ratio similar to described for type I collagen in bibliography and in previous analyses carried out in the IIM laboratory. This confirms their suitability for use in cosmetic and biomedical applications or as nutritional supplements.

The collagen characterized by SDS-PAGE showed band patterns corresponding to  $\alpha 1$ ,  $\alpha 2$  and  $\beta$  chains, consistent with the type I collagen structure. Amino acid analysis further confirmed the typical collagenous profile, with high proportions of glycine, proline, and hydroxyproline, which are essential for the stability of the triple-helix structure. This supports the validity of the extraction protocols used and suggests that jellyfish collagen may have mechanical and biochemical properties comparable to the mammalian collagen, as reported in previous publications. Therefore, the possibility of using jellyfish as sustainable sources of collagen with functional and bioactive potential is clear.

However, the yield of collagen obtained from jellyfish is significantly lower than that obtained from other marine species or by-products such as cod, salmon or blue shark skin. Therefore, unless there is a substantial difference in the final product obtained from these different raw materials, it does not seem economically viable. On the contrary, if any specific distinguishing characteristics between collagen obtained from jellyfish and collagen obtained from other marine species are demonstrated that justify a much higher price, it might be reasonable to consider its commercial exploitation, as suggested by emerging commercial initiatives.

The ALIMAR project confirms the biotechnological potential of Mediterranean jellyfish species as alternative sources of collagen and reducing pressure on terrestrial resources. While technical and economic challenges persist—particularly in large-scale jellyfish processing—the findings support further research into process optimization, product purification, and functional validation to ensure their safety and efficacy in industrial applications.

Finally, the project contributes to the sustainability and blue economy objectives promoted by the European Union, demonstrating that Mediterranean marine resources (even those considered problematic or invasive) can be transformed into high added-value raw materials through targeted biotechnological approaches.