Biobased ropes

Developing solutions for a more eco-friendly aquaculture industry

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Aquaculture is an industry that creates economic growth, employment and economic stability, especially in rural areas and along coastal areas in Europe and the European Union is keen on large-scale expansion of aquaculture overall.

Offshore mussel aquaculture has been identified as a promising sector for the expansion and growth of the European aquaculture. Among the bottlenecks identified for European mussel farming are environmental concerns.

Currently, the sector makes use of ropes that are fossil-oil based and non-biodegradable, growth in the industry will require more rope production which could in turn significantly contribute to plastic pollution in the marine environment.

In addressing this challenge, BIOGEARS has developed biobased rope prototypes and is currently examining their potential use in Integrated Multi-Trophic Aquaculture (IMTA) systems combining mussels and seaweed in sea trials in suspended culture systems in offshore and sheltered marine sites in the South-eastern Bay of Biscay, Spain.

Seaweed is another high potential, valuable marine source which until now has been underexploited in Europe and which is suitable for co-cultivation with mussels.

The aim is to develop durable, fit-for-purpose and marketable, biobased ropes that are compostable in industrial composting conditions and hence have a highly reduced carbon footprint and less environmental impact along the whole value chain.

A cost-effective & suitable alternative

Traditional aquaculture ropes are manufactured from polyolefin multifilament and monofilament yarns with UV stabilisation for long term sun exposure. Polyolefin ropes are cost-effective and suitable for a wide range of fishing applications.

To develop fit-for-purpose alternative for aquaculture, suitable materials were needed and to identify these different rope types were selected and their mechanical and functional properties analysed.

Target properties for the BioGears alternative were identified for maximum mussel culture efficiency. Numerous tests took place to identify the most suitable compounds and compounding strategy to obtain the balance between the functional and biodegrading properties.

This included mineral and organic additives, and blends with other biopolymers with higher biodegradability behaviour in mesophilic conditions (home composting). Once suitable compounds identified and the range of linear density, tenacity and elongation for the BioGears prototype intermediate filaments were defined, the biobased compounds were used to produce yarns using the mono- and multifilament extrusion process. These yarns were transformed into ropes specifically designed for mussels and seaweed suspended aquaculture.

In June 2021, two rope prototypes were selected for mussel suspended culture and four prototypes for seaweed culture. The prototypes for mussels and seaweed have the same composition but involve a different rope design and in the case of seaweed ropes, they have two different diameters.

Meeting the needs of the industry

In order to show that the BioGears prototype ropes are fit for purpose and meet the industry needs, field demonstration tests for validation at sea (TRL 5-7) started in July 2021 and will run until the end of the project (April 2023).

The sea tests are taking place in three experimental sites, under different energy conditions, including an exposed-high energy area, where ropes have been deployed in a longline based at 50 m depth; a sheltered-low energy area, where ropes have been suspended from a raft at 15 m depth and a marine station, in which seeding of seaweed and IMTA proof of concept lab trials at taking place.

Throughout the sea trials, regular monitoring of the performance of the ropes is taking place under numerous parameters such as environmental, growth performance, quality and microplastics.

A sustainability assessment, in terms of technical, economic and environmental perspectives, of the BioGears is currently ongoing. The aim of this assessment is to compare the benefits of the product against conventional gears in the whole lifecycle, from their manufacture until their end of life (EoL).

Technical assessment included examining the textile intermediates and lab prototypes, as well as the ongoing assessment of the ropes during the field trials, which will offer the basis for the overall validation of BioGears and to assess the

potential for implementation at industrial scale.

The economic assessment takes in account numerous different elements including cost of raw materials, processing costs for textile intermediates and ropes, production yield and quality of mussels and seaweed, and the end-of-life possibilities, including the 'ecological cost' due to material lost in sea.

Environmental assessment is taking place, on one hand to test the ropes biodegradability and compostability in various conditions, and on the other hand, to calculate the environmental impacts of BioGears prototypes using the Life Cycle Analysis approach.

On top of sustainability assessment, a market analysis of the BioGears for mussel and seaweed culture has been conducted. The main objective of this research was to explore the potential market and the main drivers of the moving to alternatives in Europe, and also to estimate the minimisation of plastic use in the European aquaculture sector through the introduction of this product into the market.

Exploring its potential

To explore the potential acceptance and implementation of the BioGears alternative in the European market stakeholders' surveys were conducted. The surveys were conducted online and targeted aquaculture stakeholders and consumers (the general public). To complement the data collected through surveys, in-depth personal interviews with aquaculture producers and suppliers were also carried out.

The sectors targeted for the market analysis interviews has been the Spanish mussel sector of Galicia (first producer in Spain and in Europe); the Spanish marine fish producing sector (representing 95 percent of companies that produce marine fish in Spain and being the third largest finfish producer country in the EU).

The project focuses mainly on the Atlantic area, with several partners from Spain, which is the top producer of mussels in Europe in terms of volume. The other partners are based in Ireland, where mussel production is important for the country's aquaculture sector, and Belgium, which does not grow mussels at large scale, but has numerous smaller scale or start-ups producing mussels and is a large-scale importer and consumer market.

More broadly across Europe, it appears that the BioGears alternative will be valuable to other mussel sectors operating in different sea basins through replicability and scale up via the transfer of results from the Blue Lab.

Developing more sustainable ropes

BIOGEARS works with a concept called Blue Lab, which is an innovative laboratory to pilot new and economically viable solutions to address a marine challenge, in this case plastic litter in the marine environment, a hot topic in ocean governance. The consortium teams up research and industry stakeholders, combining multidisciplinary competences, to together develop innovative ropes in support of a thriving and sustainable blue economy in Europe.

The Blue Lab concept works at the interface between research and commercial exploitation, testing and piloting innovative products and services so that results from research are taken forward closer to the market. Within BIOGEARS, the Blue Lab aims to also support the replication of research and its implementation in other European Regions.

The impacts of the project are threefold, impacting sustainability through the development of more sustainable ropes and aquaculture systems (IMTA); economically through supporting aquaculture growth through the development of new biobased products and value chains generating circular economy; and socially through supporting new policy on plastic in the sea, new employment, quality and healthy products and boosting responsible consumption.

It is expected that the results of the project will be useful for entities along the biobased value chain and key stakeholders including aquaculture industry (mussel and seaweed producers, product processing, distribution and logistics).

The list of potential interested parties also includes materials producers for marine applications, including fibres, yarn and textile producers, rope manufacturers and distributors, bodies and authorities involved with standards and certifications, policy makers, research institutions and academics, and wider public and consumers.

The BIOGEARS consortium includes Azti, Gaiker and Itsaskorda from Spain; Centexbel from Belgium; and Erinn from Ireland.

BIOGEARS is a European Maritime and Fisheries Fund (EMFF) funded project that focuses on creating biobased ropes for use in mussel and seaweed aquaculture, to cut down on marine litter in the European aquaculture industry.

The three-and-a-half-year project, which started in November 2019 and runs until April 2023, has a budget of EUR€1.1m (US$1.25m) to develop innovative biobased ropes that are circular and biodegradable in composting facilities, as an alternative to the currently used fossil-based non-biodegradable plastic rope products. The outputs are expected to support a more sustainable offshore aquaculture sector in Europe.

BIOGEARS (863708) has received funding from the EMFF programme. This output reflects the views of the author only and is his/her sole responsibility; it cannot be considered to reflect the views of the European Climate, Infrastructure and Environment Executive Agency (CINEA) or any other body of the European Union. The European Commission and the Agency do not accept any responsibility for use that may be made of the information it contains.