

Green by Design: The Smart Science Behind Sustainable Food Packaging

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*As concerns over plastic waste and food safety grow, a pioneering EU-funded project called **NOVISHPAK** is working to replace traditional seafood packaging with a smart, biodegradable alternative made from seaweed and fish production waste. The initiative aims to revolutionise how we package, protect, and perceive Mediterranean fish products. **THINK** speaks with the **NOVISHPAK team** to learn how sustainability and freshness are prioritised in their design.*

Plastic pollution continues to be one of the most pressing environmental issues of our time. From the depths of the ocean to the highest mountaintops, plastic waste has found its way into virtually every ecosystem on Earth.

A significant proportion of this waste originates from food packaging – materials that are often used once and discarded, ending up in landfills and in our seas.

In the Mediterranean region, where fish and seafood are staples of the local diet and a key driver of the economy, this problem is particularly acute. Traditional plastic packaging is not only a major contributor to marine pollution but also a missed opportunity for resource efficiency and innovation.

That's where NOVISHPAK comes in – a European-funded research project that aims to completely rethink how we package fish and seafood by creating biodegradable and intelligent packaging films. What makes this initiative stand out is its holistic approach: the packaging is not just environmentally friendly but also smart, safe, and designed with the food it protects in mind.

At its core, NOVISHPAK embodies the principles of the circular economy, transforming what would otherwise be discarded into something of value: 'We're using resources that would otherwise go to waste,' says Roderick Abdilla, research support officer at the University of Malta. Rather than relying on fossil fuel-based plastics, NOVISHPAK's materials are developed from seaweed extracts and fish production waste, combining sustainability with functionality. The result? An elegant example of how waste can become a resource – and how food and environmental safety can go hand in hand.

WHY FOCUS ON MEDITERRANEAN FISH?

Fish is not only a culinary mainstay in the Mediterranean; it is also a major industry that spans fishing, aquaculture, processing, and export. Yet the industry remains highly reliant on traditional single-use plastic packaging, much of which ends up in the very waters that provide its livelihood.

With growing concerns about microplastics and the environmental footprint of food packaging, there is a clear demand for more sustainable options. NOVISHPAK's



biodegradable films, sourced from locally available by-products, could offer a compelling solution.

The benefits are multifaceted:

- **Environmental:** By replacing plastic with biodegradable materials, the packaging can naturally decompose, reducing the long-term impact on marine ecosystems.
- **Economic:** The use of fish waste and seaweed adds value to by-products that would otherwise go unused, supporting a circular economy.
- **Social:** With built-in indicators for spoilage and possibly mercury, the packaging enhances food transparency and consumer trust.

'The current materials used are mostly plastic,' Abdilla explains. 'We want to replace those with something that's made from waste and can biodegrade – supporting both the circular economy and environmental goals.'

SMARTER PACKAGING FOR FRESHER FISH

Of course, the push for sustainable packaging is not new. But what sets NOVISHPAK apart is its integration of intelligent features directly into the packaging material. Unlike traditional food packaging, which simply acts as a barrier between food and the outside world, NOVISHPAK's films are designed to actively monitor the freshness of the food they enclose.

One of the project's key innovations is a colourimetric freshness indicator embedded in the packaging film. 'One of the main aims is to make these films colourimetric,' Abdilla explains. 'They will change colour when the fish

inside starts to spoil – so the consumer knows immediately whether the product is still edible! This colour change occurs in response to spoilage-related compounds. It's a simple yet powerful tool that could change how both consumers and retailers manage food storage and sales.

Rather than relying on expiration dates or a 'sniff test', people could soon be able to tell at a glance whether their fish is still good to eat. This has the potential to reduce food waste significantly, particularly in the retail and hospitality sectors, where uncertainty about freshness often leads to premature discarding of food.

Even more ambitiously, the NOVISHPAK team is exploring the development of mercury detection sensors. Given the increasing concern over heavy metal contamination in fish, this feature could add an entirely new dimension to food safety, alerting consumers to dangerous levels of mercury in real time. If successful, this innovation could empower people to make more informed choices – particularly vulnerable populations like pregnant women and children, for whom mercury exposure can be especially harmful.

TURNING SEAWEED AND FISH WASTE INTO PACKAGING

Creating packaging from biodegradable materials is no small feat – particularly when that packaging must perform just as well as plastic. The NOVISHPAK team has had to carefully engineer a material that is not only sustainable but also durable, food-safe, and functional under real-world conditions. ➤

Right: The Novishpak film without an indicator incorporated into it

Bottom: The Novishpak film with a green indicator in it that turns red in the presence of amines released from decaying fish

Photos courtesy of the Novishpak team



The packaging film is composed of two main ingredients:

- Gelatin derived from fish waste – This protein-based polymer provides structural integrity, forming a strong and flexible matrix.
- Sodium alginate extracted from seaweed – A carbohydrate polymer that enhances film flexibility, water resistance, and biodegradability.

This combination of biopolymers yields a compostable material tailored to the unique needs of seafood packaging. However, this did not come without its challenges. Seafood packaging – especially for fresh or processed fish fillets – must withstand moisture while maintaining barrier properties and mechanical strength. To address this, the team crosslinked the polymers in a way that enhances strength without sacrificing flexibility.

One of the main technical hurdles was achieving hydrophobicity – that is, making the film resistant to water so that it does not degrade or dissolve prematurely. This was essential to ensure the material remains intact in the cold and wet conditions commonly associated with seafood packaging. Another key consideration was the integration of freshness indicators, which need to remain chemically stable, non-toxic, and unable to migrate into the food. This added another layer of complexity, as the indicators must remain effective without compromising the film's integrity or safety.

THE UNIVERSITY OF MALTA'S ROLE IN NOVISHPAK

NOVISHPAK is a multidisciplinary and multi-institutional effort, drawing on expertise from across several European states. As a key player in the project, the University of Malta is actively involved in research on the synthesis and analysis of the packaging films. The UM team, headed by Prof. Ruben Gatt and including Prof. Pierre-Sandre Farrugia and Dr Roderick Abdilla from the Metamaterials Unit, is focused on studying the chemical, mechanical, and structural properties of the materials. Their work involves understanding how different polymer ratios and treatments affect the strength, elasticity, moisture resistance, and biodegradability of the films.


Meanwhile, together with the University of Malta, partner institutions (listed below) are handling other components of the project. These include the development of colourimetric freshness indicators and antimicrobial functionality, as well as testing various synthesis methods for scalability. By exploring several pathways in tandem, the consortium aims to identify the most efficient and cost-effective route to market. This collaborative model allows NOVISHPAK to tackle the challenge from multiple angles, integrating scientific, technical, and commercial expertise.

A BROADER IMPACT FOR MALTA AND BEYOND

The potential impact of NOVISHPAK goes beyond technical innovation. Locally, it could reduce Malta's reliance on imported plastic packaging while creating new opportunities in green technology and food safety research.

'Since we import nearly all of our plastic packaging, creating a local alternative made from by-products available here would be a major advantage,' Abdilla notes. 'It's also a great platform for students and researchers to explore further innovation.' Perhaps more importantly, the project could benefit public health. 'People will be eating fish with fewer toxins, less microplastic contamination,' says Abdilla. 'That's not just a packaging issue – it's a food safety issue.'

Although still in the development phase, NOVISHPAK is making encouraging progress. Having launched just six months ago, the project is already showing promise and is set to continue through to 2027. Currently, it sits slightly below the midpoint on the Technology Readiness Level (TRL) scale, indicating that it has moved beyond the theoretical idea and proof-of-concept stage, and into further material improvement and sensor development. With interest growing among fish industries across the Mediterranean, there is strong potential for real-world application and wide-reaching impact.

NOVISHPAK is more than just another eco-friendly innovation – it is a blueprint for the future of food packaging. By combining waste reduction, intelligent monitoring, and circular design, it has the potential to redefine not just how we package fish, but how we think about packaging altogether. It could become a scalable model for a range of other food products and fresh produce. It is a powerful demonstration of how applied research can deliver real-world benefits, striking a balance between technological sophistication and environmental responsibility. 

The University of Malta is a participating partner in NOVISHPAK, in consortium with Hellenic Agricultural Organization (Dimitra), the National Kapodistrian University of Athens, Greca Pesca, École Supérieure des Sciences de l'Aliment des Industries Agroalimentaires, Université Mohammed Premier Oujda, Leibniz Institute for Agricultural Engineering and Bioeconomy, the International Centre for Advanced Mediterranean Agronomic Studies (Montpellier), and the University of Tunis El Manar. The NOVISHPAK project is financed by Xjenza Malta (formerly the Malta Council for Science and Technology) through the PRIMA initiative of Member States, Associated Countries, and Participating Countries, which is in turn supported by the European Union.