field study).
Four aquatic (e.g. OECD TG 201, transcriptomic analysis of fish embryo) and seven terrestrial test methods (e.g. ISO 15685, OECD TG 222) were selected to examine the ecotoxicological responses of six biopolymers and modified natural polymers (e.g. alginate, chitosan, CMC). The dataset generated was used to identify sensitive methods based on a LOEC (Lowest Observed Effect Concentration) comparison as well as OECD TG 216 threshold (±25% deviation of treatment to control activity) analysis for soil microbial functional tests. To validate laboratory tests for field scale predictions, the identified sensitive test methods were applied in a one-year laboratory and outdoor field study (single substances/ substance mixtures).
Biopolymer exposure impaired microbial-driven soil cycles, such as potential nitrification (ISO 15685) and extracellular enzymatic activities (ISO 20130), with both inhibitory and stimulatory effects >25% depending on substance and concentration. Collembola and earthworm-related endpoints were mainly unaffected. Aquatic test results indicated that physicochemical properties (e.g. solubility, ionic charge) can be linked to the ecotoxicological outcome of the test.
For the laboratory and outdoor field study, ISO 15685 and ISO 20130 were performed. Extracellular enzymatic activity data showed a correlation between lab and field incubated samples, while potential nitrification activity correlated poorly over time. This could be linked to the degree of specialization of the microbial groups relevant to maintaining the soil functions.
Overall, biopolymers can cause ecotoxicological responses and should not be excluded from regulation without further evaluation. Incorporating soil microbial functional tests alongside aquatic tests is recommended for a comprehensive polymer assessment.

3.19.P-We285 Ecotoxicity assessment of Seaweed-Based Packaging Materials using Capitella teleta
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Biodegradable and bio-based materials, such as those derived from seaweed, corn, cellulose and other natural polymers, are being developed as sustainable alternatives to petroleum-based plastics. However, their increased use has not been matched by in-depth research on their environmental fate and potential ecotoxicological risks. To address this knowledge gap, this study evaluated the impact of brown seaweed-based single-use food packaging materials on Capitella teleta, a marine invertebrate often used as a relevant model organism for assessing ecotoxicity. The first part of the work focused on the characterisation of commercially available brown seaweed-based single-use boxes using Fourier Transform Infrared Spectroscopy (FTIR), Scanning Electron Microscopy (SEM), and contact angle. The data provided insights into the surface chemistry, morphology, microstructure, and hydrophobic character of these materials. In the second part, exposure experiments with Capitella teleta were done using two approaches: 1) disc material (3 mm) and 2) crushed fibre (sieved to 1000 µm). The experiments were conducted over six weeks by incubating 120 mg of samples in 12g of sediment in the artificial seawater. The measured endpoints included initial adult count (number of males and females), adult survival during each sift, time to sexual maturity, time to first reproduction, number of reproductive events, eggs per brood tube, and stages of the eggs produced in the brood tube.
Key findings from the chemical characterisation using FTIR confirmed the functional groups, as expected, while SEM imaging provided evidence of the surface coating. Contact angle measurements indicated a highly hydrophilic nature. A series of experiments was also conducted to obtain statistical data, and these provided evidence of uniformity in the coating of the commercial boxes and confirmed high data reproducibility. Ecotoxicity tests with Capitella teleta offered preliminary insights into the impact of these materials. This work contributes to the broader understanding of the environmental fate and potential risks associated with seaweed-derived packaging materials, supporting evidence-based evaluation of their suitability as sustainable alternatives to petroleum-based plastics.

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3.19.P-We286 Development and demonstration of sustainable bio-based materials for the marine environment
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Polymer-based applications are increasingly used across marine sectors, yet their fossil-fuel-based origins are considered unsustainable. The SeaBioMat project explores bio-based alternatives that could replace conventional materials while maintaining their performance. Building on earlier findings that PLA-flax composites perform well and generate fewer microplastics than polypropylene, SeaBioMat aims to advance these materials to higher TRL levels and explore additional bio-based and biodegradable polymers for composite and textile use. The project considers the entire life cycle and potential environmental interactions, such as microplastic formation and its effect on the marine environment, to ensure a lower ecological footprint. A key research task is to assess micro- and nanoplastic generation from the degraded materials, their effects on marine organisms, and material behaviour under realistic environmental conditions. To properly understand these degradation processes, the newly developed materials will undergo accelerated ageing under controlled but representative marine conditions, where extrinsic factors such as water, oxygen, microbial activity, mechanical abrasion, and UV radiation will be decoupled. Ageing will be followed by detailed mechanical and physicochemical characterisation, including tensile testing, crystallinity and molecular-weight analysis, FTIR/RAMAN spectroscopy, and gravimetric measurements. Within this framework, we will assess the potential impacts of the developed materials, focusing on their durability, degradability, and ecotoxicological effects compared to current synthetic-based materials. We will specifically focus on understanding how exposure to UV radiation, mechanical stress and temperature may lead to the formation of micro- and nanoplastics, and on determining the potential toxic effects of these microplastics on aquatic organisms such as microalgae, and benthic invertebrates such as copepods and bivalves. Microplastics generated during ageing and abrasion will be analysed using RAMAN/FTIR spectroscopy and Nile Red staining, and their ecotoxicity will be assessed through targeted bioassays. Leaching of substances from bio-based materials and their ecotoxicological impacts on the marine environment will also be studied. The expected outcomes will provide valuable insights into the environmental compatibility of bio-based polymers and support the development of sustainable materials for marine applications.

3.19.P-We287 Biodegradable Safe and Sustainable by Design Polymers for Packaging of Oily Food and Cosmetic Products

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Biodegradable polymers offer promising alternatives to conventional plastics, yet their adoption requires robust methods to assess safety, environmental fate and overall sustainability. The E-OILÉ project addresses this need by developing and validating new biodegradable materials for monodose packaging of oily foods and cosmetic products while applying a fully integrated Safe and Sustainable by Design (SSbD) framework. The project focuses on understanding regulatory requirements, identifying data needs, and ensuring that new materials comply with safety, performance and environmental criteria across their entire life cycle.

A key challenge is that biodegradable polymers do not behave like conventional plastic materials and therefore require adapted methodologies for characterisation, biodegradation and risk assessment. To address this, the project combines early-stage regulatory review, requirements definition, and targeted data collection for modelling. High-quality experimental information on material properties, toxicity, and environmental degradation will support the development of digital twins capable of predicting biodegradation processes.

The safety assessment integrates new in vitro methods to evaluate potential hazards to human health, including cytotoxicity, genotoxicity, skin irritation and inflammation using relevant human cell models. Environmental safety is addressed through ecotoxicological testing in freshwater, marine and terrestrial systems. Suitability for food and cosmetic contact is evaluated through migration testing and risk assessment based on European legislation.

Sustainability is examined through LCA, S-LCA and LCC, complemented by circularity indicators to capture resource efficiency, end-of-life performance and potential environmental benefits compared to fossil-based packaging.

Overall, this work provides a comprehensive framework for evaluating biodegradable polymers that integrates regulatory compliance, mechanistic understanding of biodegradation, human and environmental safety and holistic sustainability. The results will support the safe implementation of biodegradable packaging and offer transferable approaches for the broader assessment of emerging polymer materials.