ANTIFOULING ACTIVITY OF NATURAL ACTIVE COMPOUNDS THROUGH BIOASSAYS AND FIELD IMMERSION TESTS

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Abstract

A growing concern for environmental issues is observed in the development of marine paints and coatings. This study is part of ECOPAINT PACA project and is focused on the comparison of the activity of several natural compounds to those of commercial biocides on the adhesion of marine bacteria and macroorganisms. *In vitro* and *in situ* tests were carried out on the selected compounds and on coatings containing them.

Keywords: Fouling, North-Western Mediterranean, Bacteria

Introduction

Any object immersed in seawater will rapidly attract the attention of marine fouling, causing severe problems on dynamic or static structures such as vessels, platforms, buoys or fishnets. Antifouling coatings generally comprise biocides or active compounds which could inhibit the settlement of marine micro- and macro-organisms [1]. In the past decade, the antifouling paint industry has been totally disrupted with the ban of tributyltin oxide or tributyltin-based compounds by the International Maritime Organization. The ECOPAINT PACA project aims at developing innovative antifouling paint technologies with long-time efficiency and limiting toxic products. In accordance with the European Biocidal Products Directive, the selected active compounds have to inhibit the adhesion of target marine organisms on immersed structures without toxicity and to exhibit no ecotoxicity against non-target organisms.

Materials & methods

3 wt. % of commercial active compounds [SeaNine™ 211N (SN), Preventol® A4S (Dichlofluanid), copper oxide (Cu_2O), copper sulfate ($CuSO_4$), and bis(tri-*n*-butyltin)-oxide (TBTO)] were dispersed separately in a polymer matrix (Metamare™ B175). Eleganediol previously extracted from the brown alga *Bifurcaria bifurcata* [2] and two commercial natural compounds (e.g. farnesol and capsaïcin) were used. TBTO was used as a toxic reference. Panels coated with paints together with a reference panel coated with the matrix only were immersed in duplicates. The immersion was performed for 6 months in Toulon bay. Macrofouling development was followed every month and a score, called N factor, was given. The N factor depends on the intensity and the type of species settled on the surface. An anti-adhesion test was performed for assessing the EC_{50} of each substance on three pioneer marine bacteria [3]. Two *Pseudoalteromonas* spp. and one *Polaribacter* sp. were used. The ecotoxicity of each substance was also assayed on five species (i.e. *Phaedactylum tricornutum, Acartia tonsa, Crassostrea gigas, Paracentrotus lividus, Psetta maxima)*.

Results & discussions

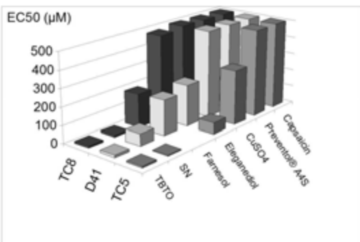

Fig. 1. Adhesion response (EC_{50}) for the three bacterial strains with all the assayed compounds.

Figure 1 shows the ability of each substance to inhibit the adhesion of three marine bacterial strains. TBTO was found unsurprisingly to be the most efficient compound against all the strains but SN exhibited also a high activity. Natural compounds such as eleganediol displayed interesting results with quite good anti-adhesion activities against two of the three strains associated with no toxic effects. Preventol® A4S showed no activity as it is classified as a fungicide. Figure 2 shows that four coatings exhibit a good antifouling activity over 6 months of immersion. Coatings containing SN, Cu_2O and Preventol® A4S were efficient against macrofouling. Farnesol, eleganediol and capsaicin did not show any effective enhancement of the antifouling activity of the coating. Finally, a correlation was established between the N/N_{ref} ratio and the adhesion response (EC_{50}) from bioassays. Ecotoxicity tests showed that TBTO, SN and $CuSO_4$ are highly toxic towards phytoplankton, crustacea, bivalve molluscs, echinoderms and fish juveniles. Eleganediol and Preventol® A4S exhibited moderate toxicity whereas capsaicin was not toxic towards all species. Therefore, promising results were shown for Preventol® A4S-based coatings considering its activity/ecotoxicity ratio.

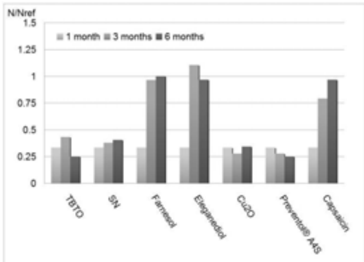

Fig. 2. *In situ* activity of coated panels through the assessment of the N factor (*Adapted from the French standard NFT-34-552 (September 1996))*. N = antifouling efficiency of the active compound-based coatings. N_{ref} = antifouling efficiency of the polymer matrix-based reference coating.

Conclusion

This study highlighted the difficulties encountered to found and to assess the antifouling efficiency of new eco-friendly antifoulants. To replace TBTO or copper-based compounds in antifouling coatings, the active compounds have to inhibit the adhesion of foulers on immersed structures without toxicity and to exhibit no ecotoxicity on non-target marine organisms.

References

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