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Termite Frass Lignin: A Long-Term Source for Anticorrosive Uses

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Introduction

The current study describes a long-term supply of lignin derived from termite frass. Lignin was extracted using Klason's method and tested for inhibitory efficiency using polarisation tests. Electrochemical impedance spectroscopy was used to analyse the electrochemical performance of the coated sample on carbon steel. In a corrosive environment, the anticorrosive property was found (0.1 M NaOH and 0.5 M NaOH). The morphological examination of the surface of both bare metal and lignin-coated metals was recorded using atomic force microscopy (AFM), scanning electron microscopy (SEM), and energy-dispersive X-Ray spectroscopy before and after exposure to the corrosive environment (EDX).

In a 0.5 M NaOH solution, the lignin demonstrated the greatest inhibitory efficacy at 600 ppm. Furthermore, potentiodynamic polarisation experiments and electrochemical impedance spectroscopy revealed that lignin coated carbon steel had a 70 percent corrosion inhibition efficacy. The protection of the metal surface against corrosion when coated with lignin was further confirmed by AFM and SEM investigations. As a result, the study recommends termite frass lignin as a long-term biological source for anticorrosive applications.

Lignin is the second most prevalent biopolymer, accounting for over a third of all organic carbon in the biosphere. It consists of three basic monomers, p-coumaryl, coniferyl, and sinapyl alcohols, and is a key component of plant cell walls. The only difference between these units is the replacements at the third and fifth carbons. In softwood lignin, the main monomer is coniferyl alcohol (90–95%), which only has a methoxyl group on the 3rd carbon, whereas in hardwood lignin, there are two monomers: coniferyl (25–50%) and sinapyl (50–75%) alcohols with methoxyl groups on the 3rd and 5th carbons, respectively. P-coumaryl alcohol is more prevalent in forests and grasses, accounting for 10–25 percent of coniferyl alcohol and 25–50 percent of sinapyl alcohol. As a result, lignin's dry weight is affected.

Living organisms, particularly termites, find it difficult to consume lignin. In low-land tropical systems and rainforests, termites account for up to 95 percent of the insect biomass. Although just 185 of the 2600 termite species are designated pests, they have a significant economic impact. Damage and preventative treatment costs are estimated to be in the range of $15–20 billion dollars worldwide, with $2–3 billion in the United States alone. Termites eat cellulose, hemicellulose, lignin, and lignin derivatives as part of their diet. The termite gut provides a unique environment for specialised cellulytic and hemicellulytic microbes that degrade 74–99% cellulose and 65–87% hemicellulose, respectively. Although symbiotic white rot fungus can degrade lignin, no lignin-degrading microorganisms have been found in termite guts. Lignin is exceedingly refractory, as seen by the presence of over 70% lignin in the West Indian drywood termite Cryptotermes brevis, demonstrating that lignin is not easily digested. As a result, lignin from termite frass can be isolated and used as a sustainable bioresource.

There are numerous applications for lignin in sectors such as biofuel, carbon fibres, high-performance concrete strength aids, binding and dispersion agents, and agrochemical formulations. The current work examines the anticorrosive properties of lignin

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derived from a unique source by putting the samples to potentiodynamic polarisation and electrochemical impedance experiments to determine the corrosion inhibitory effects. The surface of bare metal and metal coated with lignin was compared before and after being exposed to a corrosive environment, and the results were published here.

The IR spectra of lignin standard were used to authenticate the lignin recovered from termite frass. The inclusion of an inhibitor (lignin) reduced the corrosion current and, as a result, the corrosion rate, according to potentiodynamic polarisation tests. The results of the Tafel polarisation method and the EIS approach were nearly identical. High polarisation resistance (Rp) and low double layer capacitance were shown to be associated with effective corrosion resistance (Cdl). The inhibitor concentration enhanced the impedance of the inhibited substrate. Langmuir's adsorption isotherm was followed by lignin adsorption on carbon steel in corrosive solution. The delta G value of 16.128 kJ mol1 (less than 20 kJ mol1) was used to corroborate this.

When compared to bare metal under corrosive conditions, the anticorrosive effect was determined to be 70.34 percent, and the corrosion rate was very low. These findings, together with AFM, SEM, and EDX surface morphology of the control and test specimens, corroborated the protective effects of lignin. As a result, the study demonstrates that lignin has corrosion-protecting properties and can be used in anticorrosive applications. The results reported here, however, are confined to carbon steel. As a result, this research should be expanded to include other metals. The study's findings point to lignin from termite frass as a long-term biological source for reducing the amount of money spent on corrosion prevention.