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Evaluating Microplastic Pollution in the St. John's River: A Multi-County Analysis and Exploring Novel Ferrofluid Remediation Approaches

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Extended Abstract

Microplastic pollution in aquatic environments has emerged as a pressing ecological concern, posing threats to wildlife and potentially human health and demands an urgent need for effective solutions to mitigate the growing problem of microplastic contamination in inland waterways [1,2]. This study explores the prevalence of microplastic pollution in the St. John's River and evaluates the efficacy of ferrofluids as a remedial tool. Water samples were collected from six distinct locations along the river, traversing rural to urban environments across five Florida counties. The samples underwent a process of microplastic isolation using Buchner funnel-based filtration a vacuum pump system for efficient particle extraction, followed by identification and quantification of microplastics using a 1000x digital microscope [3,4]. Statistical analyses were conducted using the Kruskal-Wallis test to compare microplastic concentrations across sampling sites and a two-sample t-test to evaluate the effectiveness of ferrofluid treatment in reducing microplastic levels.

The analysis of the collected data revealed a statistically significant escalation in microplastic concentrations from rural upstream areas (less than 5 particles per liter) to urban downstream regions (more than 10 particles per liter). This pattern corroborated hypothesis, which postulated a progressive increase in microplastic concentration along the river's course. In contrast, samples from inland freshwater sources, specifically local lakes, displayed minimal microplastic contamination (0-5 particles per liter), underscoring the river's role in microplastic accumulation.

We also assessed the potential of ferrofluids in microplastic remediation. Applying ferrofluids to highly contaminated urban water samples resulted in a statistically significant reduction in microplastic levels ($p < 0.05$), confirming our second hypothesis. However, the effectiveness of ferrofluids varied between the levels of initial contamination, indicating a potential limitation in their application at sites with extremely high pollution levels.

This research underscores the growing issue of microplastic pollution in urban waterways and emphasizes the need for a formalized set of microplastic sampling and monitoring with periodic reporting [5]. Such reports will be greatly useful in isolating major sources of microplastic pollution across the river that, in turn, will allow for effective and sustainable intervention and remediation methodologies. The findings from this study also suggest that ferrofluids show promise as a microplastic remediation technology. The next step in this study aims to investigate and implement optimized ferrofluids-based applications under varying environmental, geographic and urban layout to enhance their efficacy and deployment in pollution control strategies.

Furthermore, amplifying public awareness of the severe repercussions of plastic pollution is vital [4]. Promoting the effectiveness of ferrofluid technology as a sustainable solution can catalyze societal transitions towards environmentally conscious behaviors and policies. Educational initiatives that underscore the severity of plastic pollution and advocate for sustainable practices are pivotal for the protection of our ecological systems.

The imperative to propel research and development in ferrofluid technology is crucial for enhancing its efficacy and economic viability. Continuous innovation is essential to augment the performance characteristics of ferrofluid systems and achieve cost reductions. Economic analyses are instrumental in this context, providing critical insights into cost-saving strategies and optimizing the allocation of resources.

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