Cyclo.Cloud: Development of Fish Scale Waste-Derived Materials for Adsorbance of Aquatic Pollutants

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The objective was developing a biosorbent of heavy metals by upcycling Oreochromis niloticus fish scale waste (FSW) to mitigate the toxic, synergistic interactions of heavy metals and microplastics in the environment. Five phases were conducted. Pretreatments to maximize removal of contaminants were evaluated through pollution exposure and adsorption capacity measurements. Phytotoxic effects on plants were evaluated for treated and untreated solutions over 7 days. SEM/EDS surface analysis and adsorption analysis were conducted. FSW was transformed into cloud form for testing with electrocoagulation. Heavy metal adsorption was optimized by deproteinization pretreatment (DP), which minimized removal of collagen and hydroxyapatite while removing noncollagenous proteins, outperforming the control by up to 24.5 percentage points. The optimal duration was 3 days, with alkaline pHs optimal for heavy metal adsorption. A positive correlation between lower optical absorbance and lower post-treatment contaminant levels (per ICP-OES) supported higher heavy metal removal rates. Plant growth improved by up to 179% and germination rates increased by 60%. Surface analysis indicated heavy metal deposits due to adsorption. Cyclo.Cloud successfully removed up to 82% of heavy metals due to the increased surface area augmenting the number of adsorption sites. Electrocoagulation enhanced removal by 3-20 percentage points. At $0.23/kg to treat 1000L of polluted water to EPA drinking water standards, Cyclo.Cloud is a cost-effective, viable biosorbent implementable in water resource recovery facilities. Cyclo.Cloud promotes a circular economy by reclaiming polluted water, repurposing waste, and preventing toxic heavy metal impacts. Usable Cyclo.Cloud prototypes were created.

Awards Won:
United States Environmental Protection Agency: The Patrick Hurd Sustainability Award covers travel for the ISEF finalist to attend and participate in EPA's National Sustainable Design Expo
U.S. Agency for International Development: Third Award Climate and Environmental Protection