INVESTIGATING ADSORPTIONCAPACITIES AND INTERACTIONS OF ELECTROCHEMICALLY TREATED WASTE ACTIVATED SLUDGE FOR ITS POTENTIAL USE AS FERTILITZER

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ABSTRACT

As the global population rapidly grows, food producers are faced with the task of feeding as many as ten billion people by 2050. The current state of fertilizer use cannot sustainably support this growth, and the overuse and mismanagement of fertilizers has led to degraded soil, water, and air quality over time. On average, the recovery efficiency of nitrogen by crops is only about 50% due to rapid dispersion/loss of applied fertilizers to the environment. Due to leaching and runoff of fertilizer, eutrophication and hypoxia of surrounding water bodies often occurs, creating significant environmental issues. In addition, about four billion tons of solid waste from municipal wastewater treatment plants are produced annually on a global basis, with much of it being disposed of in landfills or via incineration at a high cost. A potential solution to both of these issues is the development of novel fertilizers that recycle nutrients from wastewater treatment plants. This study investigates the chemistry of a novel set of fertilizers derived from waste activated sludge (WAS), a byproduct of municipal wastewater treatment, that has been electrochemically treated (EWAS) to remove pathogens and release ammonium (NH_4^+) and nitrate (NO_3^-). WAS and EWAS were applied to agricultural soil and a potting mix to conduct laboratory batch adsorption experiments. The resulting aqueous samples were analyzed to determine the concentrations of nitrogen (N), phosphorous (P), carbon (C), and other macro and micronutrients adsorbed to the soil and released into solution. Commercially available inorganic and natural fertilizers were used to compare their soil chemistry dynamics to EWAS and WAS. Results indicate that EWAS releases a higher percentage of organic and total carbon into solution than any other treatment due to the structure of the organic matter becoming deformed by the alkaline electrolysis process. EWAS and WAS also released less total nitrogen into solution than any other treatment, which, if extrapolated to a field setting, could have positive implications for reduced runoff. This is likely due to biomolecules present in the organic matter in EWAS/WAS being bound to clay minerals (i.e., organoclay complexation of N-containing organic molecules), as well as differences in solubility of the forms of nitrogen released by the various fertilizers. Amongst all treatments, the amount of ammonium released into solution decreases over time while the amount of nitrate released increases. This is likely partially due to the nitrification process which transforms ammonium/ammonia into nitrate via nitrifying bacteria. Additionally, this decrease in the amount of ammonium released corresponds

to an increase in ammonium adsorption over time. EWAS, however, adsorbed the least amount of ammonium, again likely due to the disruption of the organic matter structure via alkaline electrolysis, effectively limiting ammonium from being chelated to organic ligands. Overall, this project is ongoing, but EWAS preliminarily demonstrates promise as an effective and sustainable fertilizer.