FINAL REPORT
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RENDERABLE FLOCCULANTS FOR WASTEWATER TREATMENT

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Summary of Previous Progress:

Since initiation of the project we have carried experiments with biodegradable formulations of flocculants from different blood sources including porcine, chicken and turkey. We have performed extraction and characterization of flocculants, as well as their testing in the laboratory and field conditions. We have visited a number or rendering and waste water facilities to study treatment procedures and equipment, and performed field tests.

Lay Overview of Project and Goals:

Every rendering plant has a water treatment system for purification of a wide range of wastewater from rendering, poultry, meat and food processing, to recover proteins and fats to produce high quality fats and protein meals, and meet eluent standards. In many cases the use of flocculants is required to achieve optimum purification efficacy and high total solids content in the sludge. Flocculants are additives that facilitate the removal of particles or colloidal material from a liquid. Most of currently used flocculants are synthetic and their application in large scale agriculturally-related processes is becoming a growing concern for consumers, public, and regulatory entities due to lack of biodegradability and potential toxicity of accumulated contaminants. Since last year we are working with Dr. Rafael Garcia on development a **novel biodegradable flocculant** prepared from blood to replace synthetic compounds. Successful development of a highly efficient biodegradable flocculant will help to address these issues and provide environmentally friendly way for treatment of wastewaters generated in rendering processes, and also reduce costs associated with use of chemicals.

The flocculants used in rendering and other wastewater treatment applications are often synthetic polymers, most commonly derivatives of polyacrylamide (PAM), a known cause of abundant problems in rendering systems, including coating of cooker surfaces and downgrading of products. While synthetic polymer flocculants are attractive due to their high effectiveness and low cost, there is growing concern regarding the environmental and health impacts of these substances. Consequently, there is currently significant academic and commercial interest in the development of bio-based alternatives to synthetic polymer flocculants. While many bio-based flocculants have been investigated, typically they must be used in at considerably higher concentrations in order to achieve equivalent results.

We teamed up with Dr. Rafael Garcia (ARS USDA) and developing a novel natural biodegradable flocculant based on hemoglobin recovered from livestock slaughter blood, that can be used as a replacement for PAM. Hemoglobin-based flocculants were found to be as

efficient as PAM at similar or lower concentrations. This year we propose to use modified preparation technique to enhance flocculant efficacy, and test its performance in field conditions.

Progress since Last Report (since the last ACREC meeting *ONLY*):

Since last meeting we focused on chemical modification of hemoglobin with ultimate goal to decrease application rate and increase efficacy. Results of our studies indicate that chemically-modified hemoglobin can be much more efficient than unmodified hemoglobin. Such chemical modification can be achieved by using inexpensive chemicals (e.g., MeOH). Overall, after optimization, chemically modified hemoglobin can be a considerably cheaper solution, thus benefiting the industry. We also tested modified hemoglobin using more relevant model – diluted whole milk (x35 times diluted), making it more suitable for rendering waste water applications.

Fig.1. Effect of methylated hemoglobin on milk solution. At loading over 250 ppm clears milk solution quickly, and is very easy to filter to achieve almost clear water. 400 ppm solution after filtering was almost perfectly clear.

Currently, we are working on further improving methylation yield and efficacy of modified flocculant.

Significance to the rendering industry:

Currently available biodegradable solutions are far too expensive and lack efficacy to replace synthetic flocculants such as PAM. At the same time, use of PAM becomes growingly more expensive because of additional costs associated with appropriate disposal and additional cleaning steps. Specifically, for the rendering industry, PAM accumulates in the wastewater sludge at the levels of 0.1-0.3 wt. %, leading to a number of issues. Even though wastewater sludge consists mainly from fat and protein, it cannot be returned to the rendering process because presence of PAM interferes with the final product quality and digestibility. A typical rendering facility that processes ~10^6 gallons of water per day produces about 30 tons of sludge daily. Had they been able to return this sludge back to the rendering process, it would generate additional $3,000 - 5,000 of revenue daily. Instead, renderers have to pay $1,500 - 2,000 per day for its disposal. It can be expected that use of a protein-based flocculant will help to solve this problem – and one of the goals of this project is to study whether or not the sludge generated using our flocculant can be rendered without compromise of the quality of the rendered products.

Intellectual Property Development?

IP for the hemoglobin-based flocculant technology has already been patented and belongs to USDA (Dr. Garcia is one of the inventors in the patent). No new IP was developed or expected to be developed during this project.