From Farm to Tailings: Modified Keratin for Water Reclamation

Jaime McGale, Muhammad Zubair, Aman Ullah

Faculty of Agricultural, Life and Environmental Science; University of Alberta

Background

- Production of crude oil involves the extraction of bitumen from oil sands.[1]
- The wastewater created is known as Oil Sands Process-affected Water (OSPW) and is stored in tailings ponds.[1]
- OSPW is acutely toxic and contains organic pollutants.[1]
- These organics can cause corrosion in industrial systems.[1]
- Over 830 million cubic meters of tailings ponds are stored in Alberta's Athabasca Oil Sands.[1]

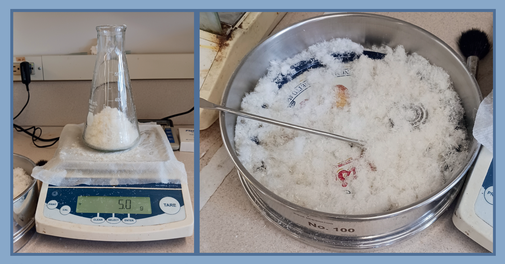

Figure 1: Chicken Feathers

- Chicken feathers create over 5 million tons of biowaste annually.[1 2]
- Chicken feathers consist of over 90% keratin, which can be utilized for research purposes instead of ending up in the landfill. [1 2]
- Keratin has been studied previously as a biosorbent, but modification can increase its capabilities.[3]

Objective

The purpose of this study was to develop a biosorbent using keratin and a compatible crosslinking agent, in order to remove organics from oil sands process-affected water.

Methodology

- Keratin within the chicken feathers was dissolved using sodium sulfite, EDTA, tris-base and urea
- Solutions were stirred and heated at approx. 60-75°C

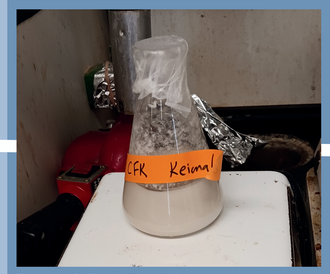

Figure 2: Dissolved Keratin

- Solutions were centrifuged for 3-5 minutes and modified with a crosslinking agent and polymer to increase adsorption capabilities
- Created 1%, 2% and 3% concentrated solutions

Figure 3: Centrifuged Solution

- Solutions were stirred and heated
- Then centrifuged for 3-5 minutes and purified through dialysis
- Finally, they were dried in a vacuum oven, ground into powder and tested

Figure 4 and 5: Finished Powders

Results

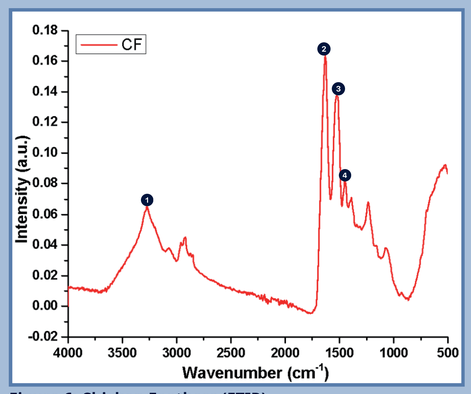

Figure 6: Chicken Feathers (FTIR)

Graph 1: Intensity

- **1**: Peaks at 0.065
- **2**: Peaks at 0.165
- **3**: Peaks at 0.135
- **4**: Peaks at 0.080

- FTIR (Fourier transform infrared) was used to help determine the functional groups present in the samples

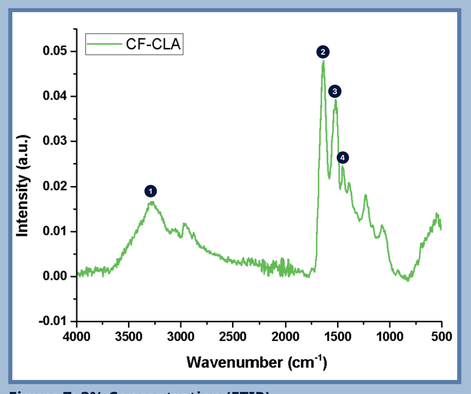

Figure 7: 3% Concentration (FTIR)

Graph 2: Intensity

- **1**: Peaks at 0.017
- **2**: Peaks at 0.048
- **3**: Peaks at 0.039
- **4**: Peaks at 0.025

- The modified sample (3%) has less intense readings, but a similar structure, as it contains fewer bonds and a difference in polarity

Discussion

- Using the FTIR results, we determined the presence of specific functional groups.
- Functional groups: H-bonded O-H, C=O, N-O, and C-H (or O-H)
- The intensity analysis helped to compare the changes in the modified product.
- The 3% concentrated product had less intense readings.
- This can mean the concentration of certain chemical bonds is lower in this sample.
- The developed products and data collected can be used for the removal of organics from wastewater
- Due to time restraints we were unable to perform the adsorption procedure, but our data can be applied to complete it in the future

Acknowledgments

I would like thank Dr. Aman Ullah and Dr. Muhammad Zubair for this opportunity, and Keiona Reyes for her help in this experiment. Thank you to Canada Summer Jobs and WISEST for their sponsorship.

References

1.Arshad, M., Khosa, M. A., Siddique, T., & Ullah, A. (2016, November). Modified biopolymers as sorbents for the removal of naphthenic acids from oil sands process affected water (OSPW).*Chemosphere*,*163*,334-341
2.Khosa, M. A., & Ullah, A. (2014, August). In-situ modification, regeneration, and application of keratin biopolymer for arsenic removal. Journal of Hazardous Materials, 278, 360-371
3.Fahim, N. H., Sarkandi, A., & Montazer, M. (2024). Keratin extraction and its application: extraction of wool keratin and application in diversified fields. In *The Wool Handbook* (pp. 501-531)