Spring 2026

Biochemistry and Molecular Biology Brown Bag Series

Pauline Dalton

"Novel Aqueous Processing of Keratin"

Tuesday, March 17, 2026

11:00 AM

103 Biological Sciences Building

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https://science-math.wright.edu/biochemistry-and-molecular-biology

Abstract

Keratin, a fibrous structural protein, is one of the most abundant biomaterials on Earth, readily available from sources like wool, hair, feathers, and horns. Its unique hierarchical structure, characterized by a high content of disulfide bonds and extensive hydrogen bonding, imparts remarkable mechanical strength and chemical resistance[2]. However, these inherent properties also present significant challenges for its efficient processing and refabrication into value-added materials. The limited solubility and thermoplasticity of native keratin necessitate harsh processing conditions, often leading to denaturation and degradation, thus hindering its broader application potential in advanced material science.

Recent advancements [2], showcase a novel approach to overcome these limitations through the strategic use of thiol-based Michael-type addition. This water-based method efficiently alters keratin's structure, transforming brittle and fragile native keratin into flexible, moldable bioplastics. While this chemical modification enables a significant improvement in processability and material properties, a current limitation lies in the irreversibility of the Michael-type addition, meaning the modified keratin does not readily revert to its original building blocks or inherited assembly characteristics. Here, to enable true circularity and expand applications, the reversibility of thiol-based Michael-type addition are exploited. This aims to achieve dynamic control over keratin's properties, allowing for multiple reprocessing cycles while preserving its natural building blocks and inherent self-assembly, leading to more sustainable material solutions.

Additionally, chemical modification of keratin proteins thru phosphorylation is explored. Unlike sulfitolysis-based methods, which rely on reducing disulfide bonds followed by Michael-type addition, phosphorylation targets nucleophilic amino acid residues like serine and threonine. This allows negatively charged phosphate groups to be added to the keratin surface, increasing its polarity and water compatibility through electrostatic interactions and hydrogen bonding. Interestingly, this goes against previous results seen with other proteins like rice protein, where phosphorylation did not contribute to improved solubility unless disulfide bonds were broken. But keratin's cysteine-rich structure may allow surface-level changes to be enough to make it dispersible.

References:

1. **Shavandi A, Silva TH, Bekhit AA, Bekhit AE. Keratin: dissolution, extraction and biomedical application. Biomaterials science. 2017;5(9):1699-735.**
2. **Trojanowska DJ, Zych A, Sganga S, Tirelli N, Boventi M, Rinaldi C, Simonutti R, Athanassiou A, Perotto G. Upgrading keratin into a moldable bioplastic. Matter. 2025 Apr 2;8(4).**