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Extract value from wool waste: keratin and the circular economy

Student Worksheet 2

Activity 2: Keratin flocculation

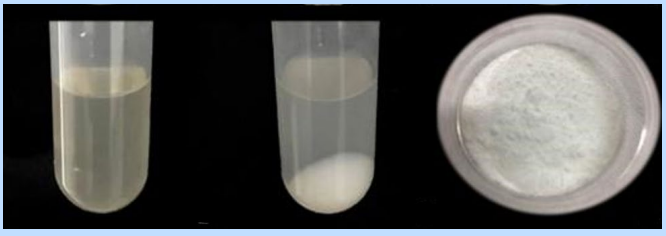
Collecting the keratin

Once the solution containing the extracted protein is obtained, it can be precipitated by using several methods: addition of salts to change the ionic strength or changing the solvent polarity, temperature, or pH.

The moment the protein is denatured, it 'opens up' and interactions that were previously intramolecular become intermolecular, aggregating the protein and increasing its hydrophobic character. This decreased affinity to water can evolve toward aggregation and polymerization phenomena, which can be
- disordered, giving rise to precipitation, flocculation, and coagulation
- ordered, generating more or less stable gels.

Precipitation is characterized by the loss of solubility alone, due to association phenomena and consequent separation of proteins from solution.

Flocculation occurs when floccules, that is, large micellar aggregates, are formed, without denaturation of the protein structures. This occurs when protein micelles of colloidal size no longer exhibit electrostatic repulsions, and thus, aggregate.



After precipitation from the extracted keratin solution (left), keratin sinks to the bottom of the tube (centre), and this can then be collected and dried to give keratin powder (right).

Image: Adapted from Materials 2021, 14(16), 4696

Flocculation of proteins can be achieved 1) by changing the pH by adding weak acid solutions, and 2) through treatment with organic solvents miscible with the aqueous phase (such as ethanol or acetone) in which the proteins are dissolved.

Complete the table below and answer the following questions:

	Observations (changes in appearance, speed of change, etc.)
Acetone	
Vinegar	
Ethanol	
Lemon juice or citric acid solution 6% (m/m)	

What is the appearance of the protein after flocculation?

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What is the appearance after drying?

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