Fabrication and Characterization of Keratin Hydrogel from Bovine Hair Waste

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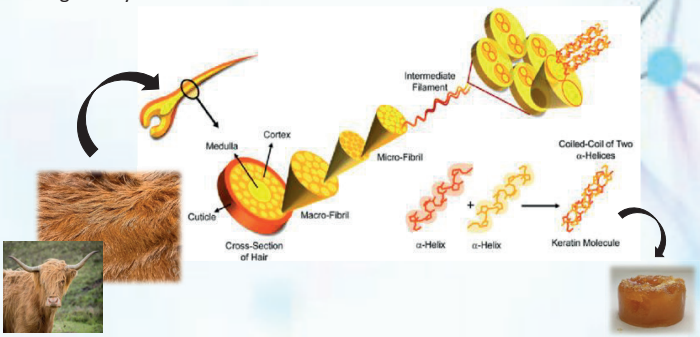
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Abstract

In conventional leather processing technology, bovine hair contains 95% keratin protein. The hair is eliminated from the skin by using many chemicals in the lime hair removal bath and released into the environment as wastewater. Within the scope of this study, we aim to reduce environmental pollution and, as an environmentally friendly process, to loosen the hairs on the skin without breaking from their roots by adding keratinase enzyme, and to evaluate it as a hydrogel by removing it from the system as a solution. Keratin-based hydrogels may be good candidates for use in a variety of application areas such as hygiene, food, cosmetics and agriculture.

Introduction

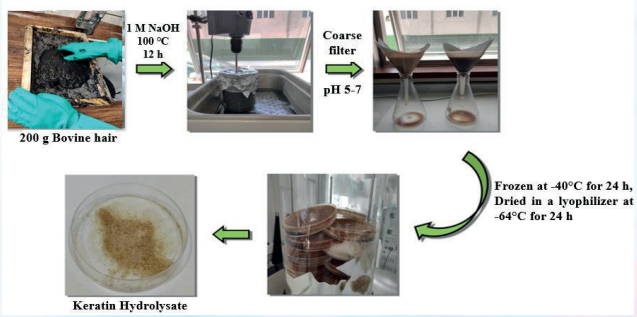
In the leather processing line, bovine hair comes out as waste as a result of the limescale hair removal process. In this step, bovine hair is made difficult to remove from wastewater by using various chemicals. For this reason, an enzymatic process is followed in the liming hair removal line in order to remove the hair from the wastewater without damaging it, and hair is obtained from the skin. For degreasing and removal of other impurities, a washing process is carried out with surfactant and alcohol, and the cleaned hairs are dried. Then, Keratin hydrolysate (KH) extraction is performed by alkaline process. The obtained KH is formed into hydrogel using Aam, NMBA and APS. SEM was used to characterize the porous structure of the obtained hydrogel, and FTIR was used to characterize the characteristic features of the gel. The thermal properties of hydrogels were investigated by TGA and DSC.



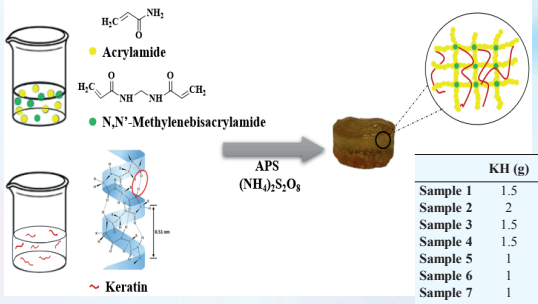
Material and Methods

N,N'-methylene bisacrylamide (NMBA, 98%), ammonium persulfate (APS, 99.9%), acrylamide (AAm), keratinase enzyme, sodium hydroxide (NaOH), and hydrochloric acid (HCl, 37%) were supplied from Sigma Aldrich. Bovine hair was supplied from Iskefe Leather tannery as a waste of the leather processing line and used to obtain keratin.

Keratin Hydrolysate Extraction



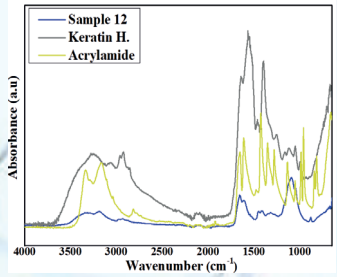
Synthesis of Keratin Hydrogels



	KH (g)	AAm (g)	NMBA (g)	APS (g)
Sample 1	1.5	2	0.1	0.75
Sample 2	2	2	0.05	0.75
Sample 3	1.5	2	0.01	0.75
Sample 4	1.5	6	0.01	0.75
Sample 5	1	6	0.05	0.75
Sample 6	1	4	0.1	0.75
Sample 7	1	4	0.01	0.75
Sample 8	1.5	4	0.1	0.75
Sample 9	1	2	0.05	0.75
Sample 10	1.5	6	0.1	0.75
Sample 11	2	4	0.01	0.75
Sample 12	1.5	4	0.05	0.75
Sample 13	1.5	4	0.01	0.75
Sample 14	2	6	0.05	0.75
Sample 15	2	4	0.1	0.75

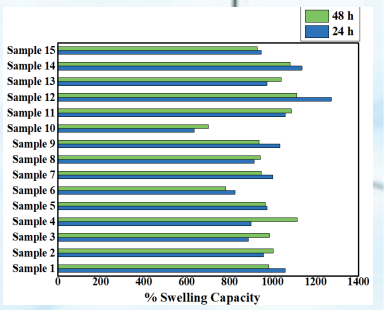
Results & Discussions

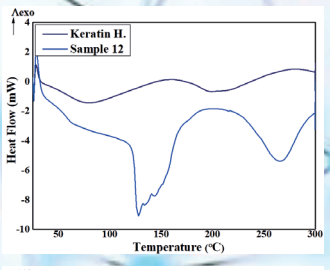
FTIR & Swelling Capacity & SEM & DSC & TGA Analysis

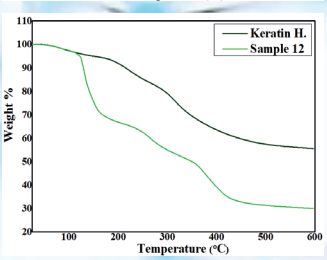


- FTIR was performed to study the structural properties of the fabricated hydrogels. For the extracted KH, the peaks at 3299 cm^{-1}, 1654 cm^{-1}, 1534 cm^{-1}, and 1244 cm^{-1} are related to amide A, amide I, amide II, and amide III bands, respectively [2].

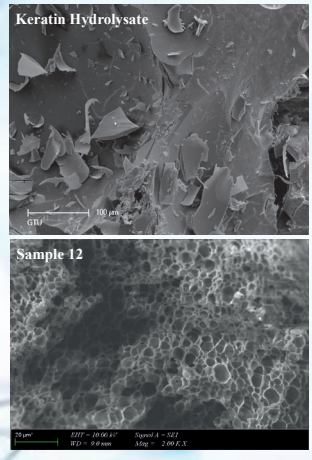
- The swelling ratios of the products were recorded between 702.1% to 1313.7%. Maximum swelling ratio was obtained for 48 h for sample 12.







- The denaturation peaks in the TGA and DSC curves prove that the maximum degredation temperature of the hydrogels obtained after polymerization is increased compared to the keratin hydrolysate [3], [4].



- SEM images confirm that the graft copolymers have a porous structure. Pore diameter value for sample 12 were calculated as 4.7±1.8 µm.

Conclusions

The biodegradable keratin waste during the processing of the bovine skin was successfully recovered by the enzymatic method and the resulting keratin hydrolysate was converted into hydrogel form. These high added value superabsorbent hydrogels can be used in various fields such as hygiene, food, cosmetics and agriculture.

References

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Acknowledgements

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