A Novel Approach for Making Upholstery Leather Using Solid Waste Generated from Leather Industry as Organic Fillers

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A Novel Approach for Making Upholstery Leather Using Solid

Waste Generated from Leather Industry as Organic Fillers

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Abstract

The leather industry produces large volumes of solid wastes, particularly fleshing and trimming residues, which are rich in collagenous proteins but often disposed of without value recovery. This study presents a sustainable approach to transforming these protein rich wastes into functional fillers for upholstery leather applications. Fleshing waste was hydrolysed under controlled thermal–alkaline conditions to extract collagen hydrolysate with a suitable molecular weight distribution for film forming and fibre binding properties. The obtained hydrolysate was refined through fat removal and pH adjustment to enhance stability and compatibility with conventional retanning systems.

A protein based filler was formulated by blending the purified hydrolysate with natural polysaccharides and eco friendly crosslinkers to achieve optimal viscosity, penetration behaviour, and filling capacity. Rheological and particle size analyses confirmed the formation of a stable, uniform dispersion suitable for drum application. When applied during the retanning stage, the synthesized filler demonstrated excellent fibre plumping characteristics, improved fullness, and enhanced grain tightness, comparable to or better than commercial protein fillers used in upholstery leather manufacture.

Mechanical testing of finished leathers showed improvements in softness, thickness, and tensile properties while maintaining desirable hand and

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flexibility. The process significantly reduces dependence on synthetic fillers and offers an environmentally responsible pathway for managing tannery solid waste. This work highlights an effective circular economy strategy that converts low value leather residues into high performance functional materials for sustainable upholstery leather production.

Keywords : Leather solid wastes; collagen hydrolysate; protein filler; upholstery leather; waste Valorization, circular economy, retanning.

1. Introduction

The global leather industry generates substantial solid waste, which poses serious environmental challenges when not effectively utilized [1]. Among these residues, fleshing waste is a major issue, often constituting up to 50–60% of total tannery waste [2]. Rich in collagen, fats, and proteins, these materials hold potential as raw inputs for developing eco-friendly products [3]. The process supports circular economy “intra valorisation” by reducing landfilling and incineration of solid waste and lowering consumption of petrochemical based synthetic fillers [4].

Lower pollution load (reduced solid waste, potentially lower COD/BOD and heavy metal discharge) contributes to several sustainability and SDG targets identified for the leather sector [5]. Traditional methods for waste management, such as landfilling or incineration, contribute to pollution and resource loss

[6]. This research seeks to valorise fleshing waste by converting it into functional fillers for leather processing, aligning with modern sustainability and circular economy strategies [7]. The work aims to demonstrate a scientifically sound method to transform waste into highvalue, biodegradable fillers suitable for upholstery

leather production [8].

2. Methodology

2.1 Raw material collection and segregation

Collection of representative tannery solid wastes (fleshing, trimmings, from beam house stage.

2.2 Segregation into collagen rich soft wastes and leather fibre rich dry fractions, followed by washing to remove adhering dirt, lime and soluble salts.

2.3 Preparation of collagen based organic filler

Controlled thermal–alkaline or enzymatic hydrolysis of collagen rich wastes to obtain collagen hydrolysate with a targeted molecular weight distribution suitable for film forming and fibre binding behaviour.

Defatting, filtration and pH adjustment to improve storage stability and compatibility with common retanning systems.

Blending with natural polysaccharides and benign crosslinkers to achieve desired viscosity, penetration profile and filling capacity for application in wet end processing.

2.4 Preparation of leather powder based organic filler

Drying of processed solution further into a spray drying technique to get powder according to the leather application.

3. Application in upholstery leather processing

3.1 Application: The formulated filler was applied during the retanning stage of upholstery leather processing.

3.2 Evaluation: Finished leathers were characterized for fullness, grain pattern, softness, tensile strength, and other physical properties following standard test methods (ISO/IS standards).

Use of collagen based filler in the re-tanning stage on chrome tanned or metal free crusts at controlled pH and temperature conditions. Optional inclusion of leather powder based filler in selected finishing coats to enhance surface coverage, body and defect masking in upholstery articles.

The formulated filler was applied during the re-tanning stage of upholstery leather processing. Finished leathers were characterized for fullness, grain pattern, softness, tensile strength, and other physical properties following standard test methods (ISO/IS standards).

4. Results and Discussion

The developed collagen-based filler demonstrated excellent stability and uniform dispersion behaviour suitable for application in wet-end processes. Particle size distribution and rheological studies confirmed the homogeneous nature of the formulation. Application trials revealed enhanced fibre plumping, fullness, and firmness, producing leathers with improved grain tightness and physical aesthetics.

Mechanical testing indicated notable improvements in softness and tensile strength compared to conventional commercial fillers. The filler exhibited strong compatibility with re-tanning agents, avoiding issues such as uneven penetration or surface roughness. These results underline the potential of collagen hydrolysate fillers as sustainable alternatives to synthetic variants, achieving both economic and environmental benefits. The process supports circular economy “intra valorisation” by reducing landfilling and incineration of solid waste and lowering consumption of petrochemical based synthetic fillers.

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