

2020 IULTCS Young Leather Scientist Grant

Identification: YLSG2020_applicantname

COMPLETE APPLICATION FORM (click application area)

Basic Research Machinery/Equipment Environmental/Sustainability

1) Applicant Information

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By submitting this application, I commit to develop the project as outlined in the attached Research Project Plan and to complete a written report by February 28, 2021 with the following items:

- 1) Introduction
- 2) Materials and Methods
- 3) Results and Discussion
- 4) Conclusion
- 5) Suggestion for Future Work
- 6) References

2) Research Project Plan outline – Maximum 3 pages

Title:

Study on molecular level collagen structure changes of enzymatic depilation using X-Ray Scattering

Introduction:

Unhairing, a crucial beamhouse process, conventionally uses sulfides to break down disulphide (S-S) bonds in the cysteine (Cys) residue of the keratin [1]. The use of sulfides increases the total dissolved solids as well as chemical and biochemical oxygen demand (COD and BOD) in the effluent [2,3], contributing to the environmental impact of the leather industry [4]. Recently, enzymes has been gaining attention as a potential sustainable alternative to the conventional depilation process [5,6], showing a significant reduction of pollution load in the process effluent [7].

The depilation process removes keratin and epidermis as well as alter the collagen fiber structure [8]. The changes to fiber structure can be analysed microscopically and histological analysis while electrophoresis is used to assess enzymatic degradation of collagen [5]. These changes affect the grain surface and the quality of the final leather produced.

Type I collagen are aligned in a quarter stagger structure, resulting in repeating gap/overlap regions within the fibril [9]. As a result, the ordered arrangement of collagen during leather production at the molecular level can be analysed with X-ray scattering technique [10]. However, studies focused on structural features of collagen caused by unhairing are limited. Our group has previously established synchrotron-based small-angle X-ray scattering (SAXS) as a tool for studying structural features of collagen with each step of beamhouse operation [11,12], as well as tanning using various tanning agents [13]. Similarly, SAXS has also been used to describe molecular level packing of keratin by Rafik et al. [14]. Ideally, novel unhairing enzymes suited for industrial application should have enzymatic activity specifically directed towards keratin and epidermis with minimal damage to collagen. A comprehensive study on depilation using SAXS will provide crucial insight into molecular level structural features of collagen and its relationship with organoleptic properties of the final leather produced.

Objectives:

The objective of the study is to evaluate the performance of a novel environmental isolate for enzymatic depilation of skin/hide for leather manufacturing. The study also aims to use SAXS to elucidate molecular level structural features changes of collagen caused enzymatic depilation compared to conventional unhairing process.

Methods:

Skin/hide unhairing with enzymes from a novel environmental isolate will be assessed in terms of:

1. Efficacy of hair removal and changes to fiber structure
2. Molecular level structural feature changes of collagen and other skin components
3. Thermal and organoleptic properties of the final leather
4. Pollutant load of process effluent

Hypothesis/Expected Results:

We expect the novel enzyme to produce leather with thermal and organoleptic properties comparable to conventional process, with a significantly lower pollutant load in the process effluent. SAXS analysis is expected to elucidate the relationship between molecular level structural features of skin/hide and changes in fiber structure of skin caused by depilation.

Research benefit for the local or global leather industry (one sentence only):

Provide a sulfide-free alternative of depilation for a sustainable and future-ready leather industry.

Literature

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