

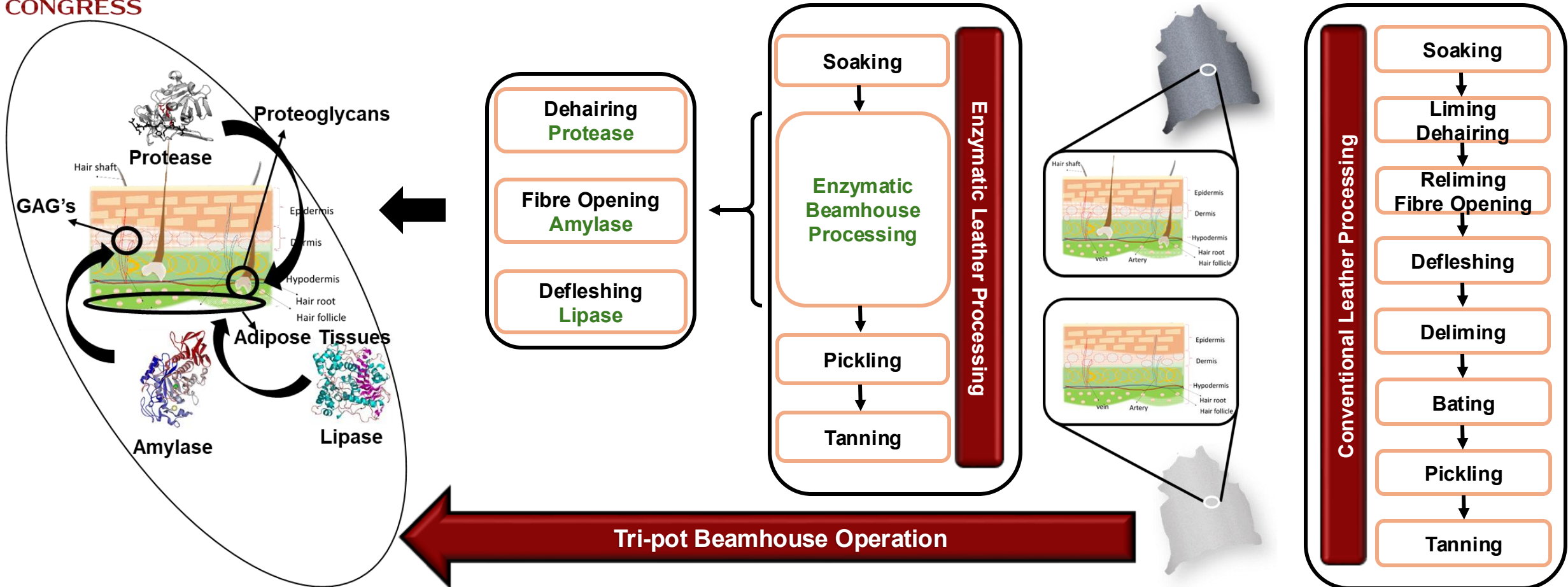
Multi-Enzymatic Beamhouse Operation: Influence of Cleaner Technology in Leather manufacture

Authors

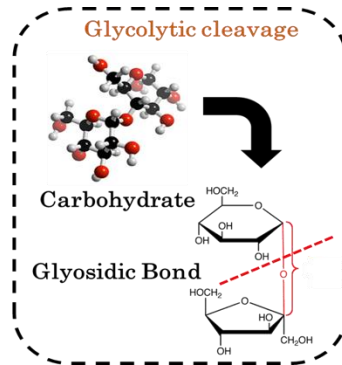
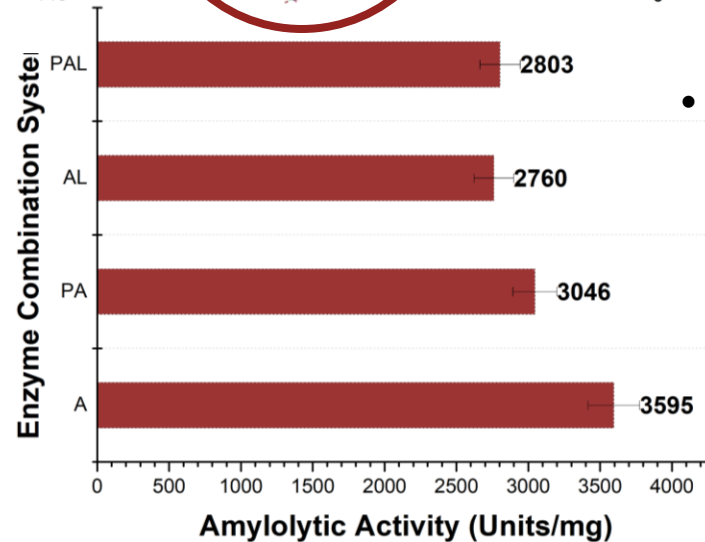
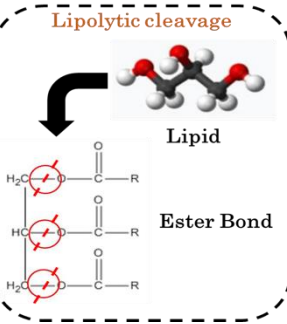
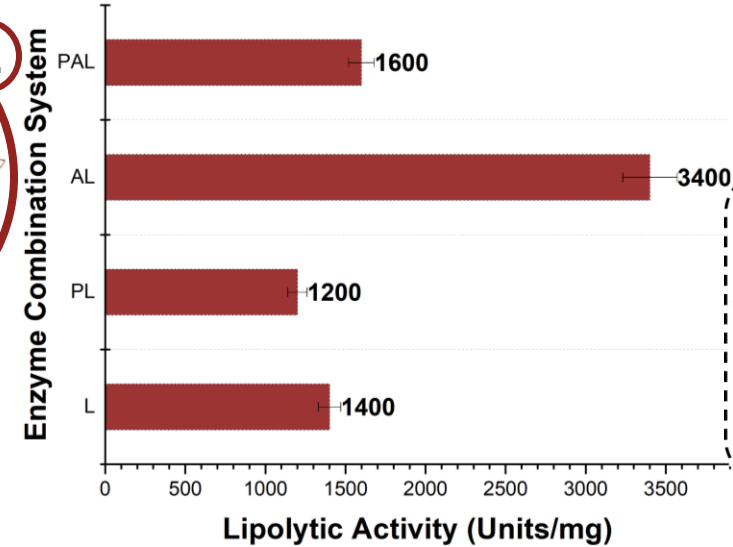
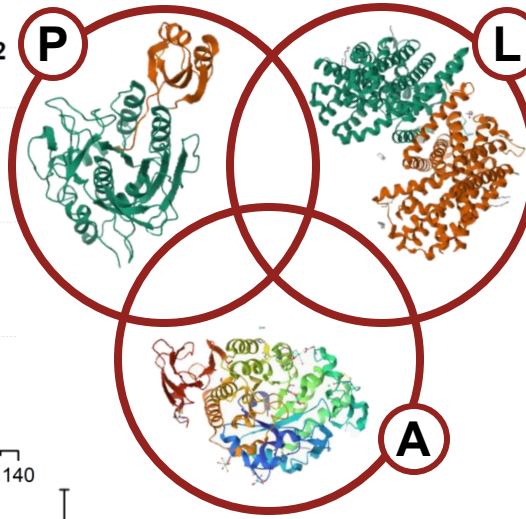
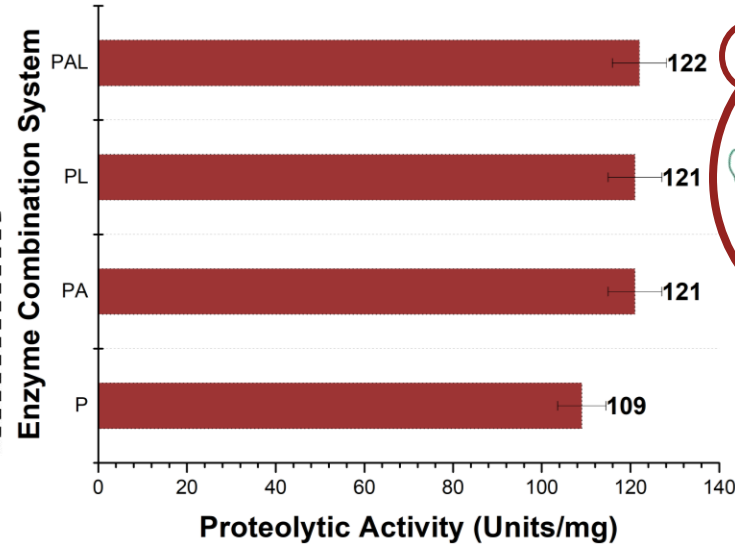
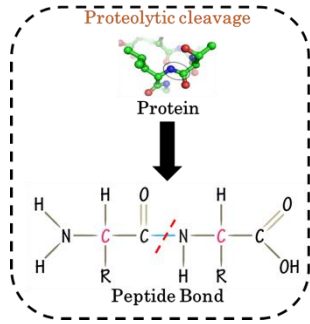
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Research Scholar
Anna University

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Overview of the Research Work



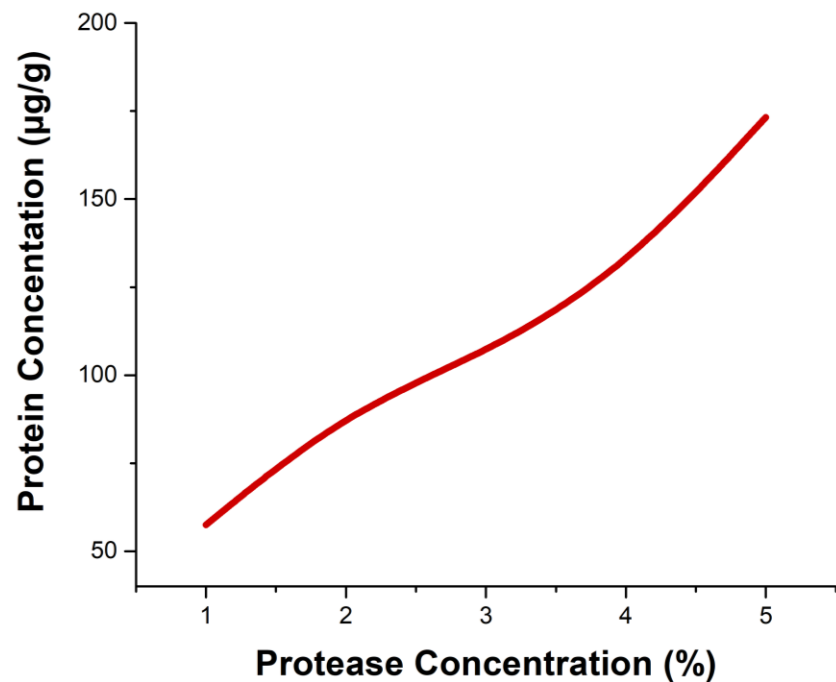
Enzyme Crosstalk



- The combined catalytic action of enzyme combinations upon casein substrate shows a marginal increase in the catalytic activity of the protease upon casein
- PAL enzyme system complexing provides lipase with increased active site through protein folding.

- Lipase shows significant inhibition upon the activity of amylase

Enzymatic Unhairing - Protease



Inference

- 4 & 5% of protease enzyme shows complete dehairing

1% Protease



Raw Skin



2% Protease



Raw Skin



3% Protease



Raw Skin



4% Protease



Raw Skin



5% Protease

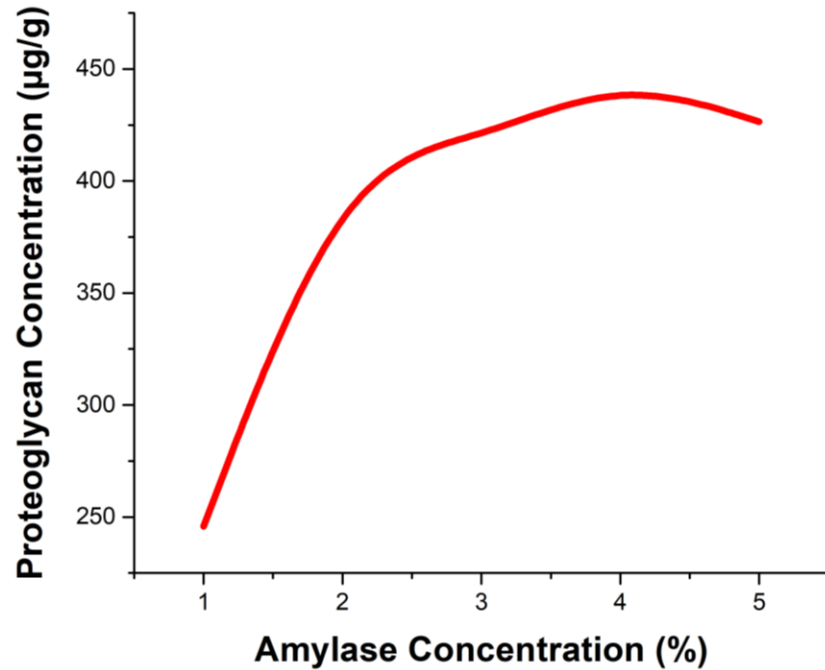


Grain



Enzymatically Unhaired Pelt

Enzymatic Fiber Opening - Amylase



1% Amylase



Raw Skin



2% Amylase



Raw Skin



3% Amylase



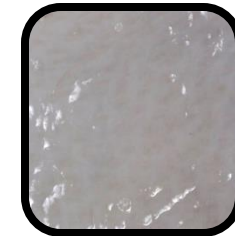
Raw Skin



4% Amylase



Raw Skin



5% Amylase



Raw Skin

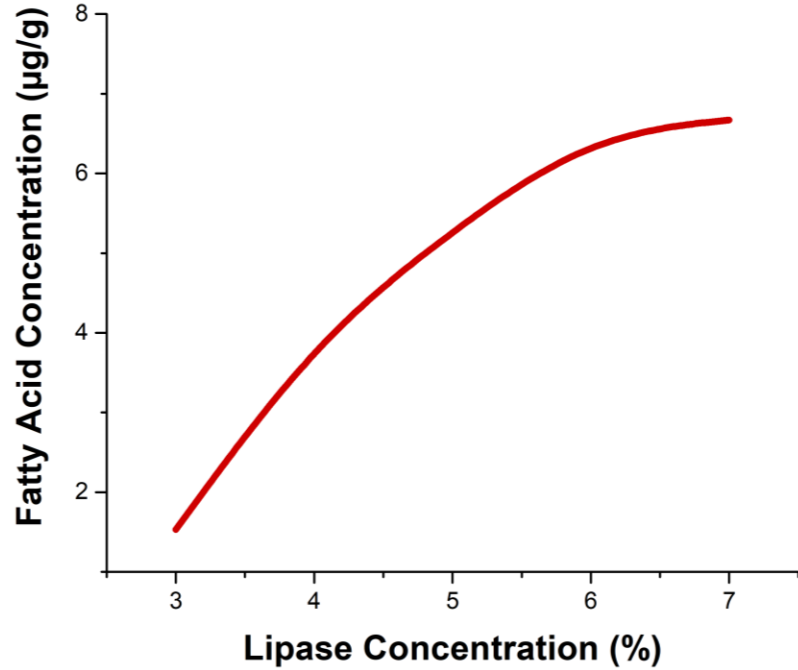


Enzymatically Unhaired and Fiber Opened Pelt

Inference

- 2% of amylase enzyme with 4% protease showed better protein release

Enzymatic Defleshing - Lipase



Inference

- 5 to 6% of lipase with 4% protease showed better defleshing



Enzymatically Unhaired and Defleshed Pelt

Tri-pot System

Process	Chemical	% Offer
Soaked Raw Goat Skin		
Tri-pot	Water	30
	Protease*	X
	Amylase	2
	Lipase	5

***X – 3%, 4% and 5%**

3% Protease



Raw Skin



Grain



Flesh side

4% Protease



Raw Skin



Grain



Flesh side

5% Protease



Raw Skin



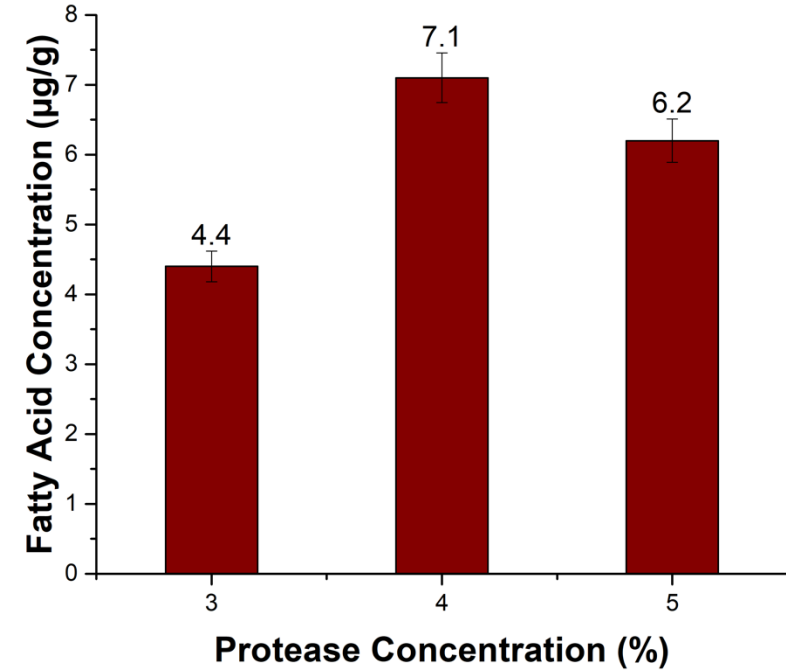
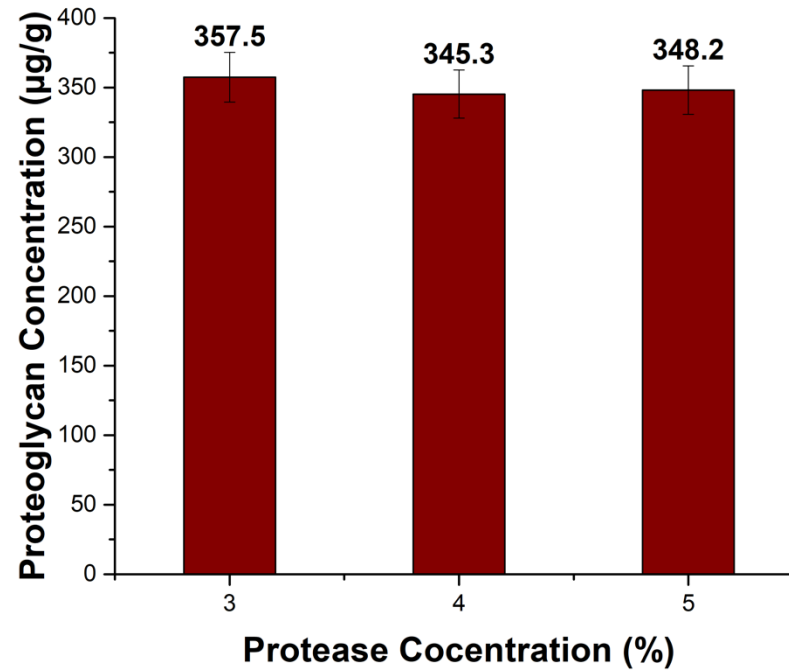
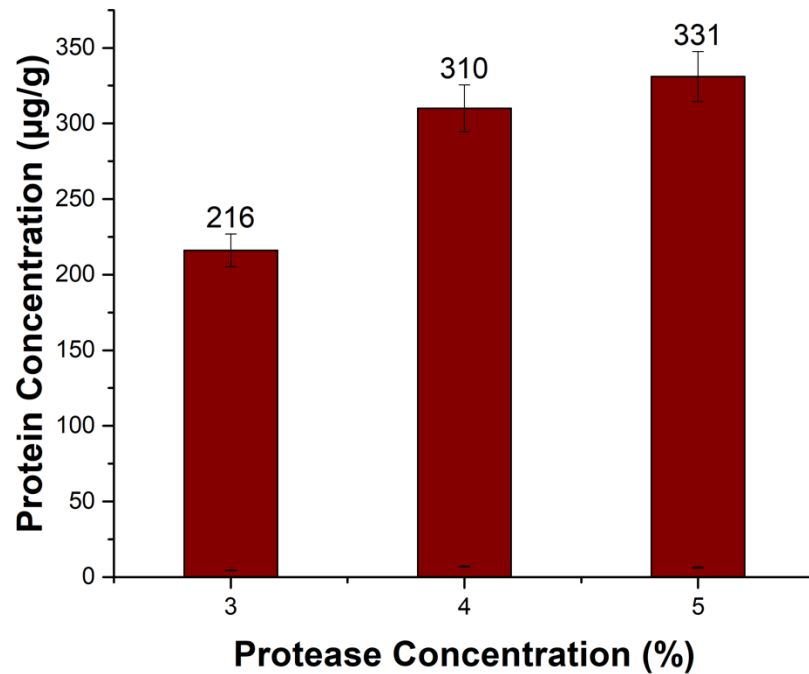
Grain



Flesh side

Enzymatically Unhaired, Fiber Opened and Defleshed Pelt

Tri-pot System



Tri-pot System

Trial I

Process	Chemical	% Offer
Soaked Raw Goat Skin		
Bipot	Water	30
	Protease	4
	Amylase	2

Trial II

Process	Chemical	% Offer
Soaked Raw Goat Skin		
Bipot	Water	30
	Protease	4
	Lipase	5

Trial III

Process	Chemical	% Offer
Soaked Raw Goat Skin		
Tripot	Water	30
	Protease	4
	Amylase	2
	Lipase	5

Enzymatically Processed Pelt



Microscopic Image of Vegetable tanned leather



Cross Section image



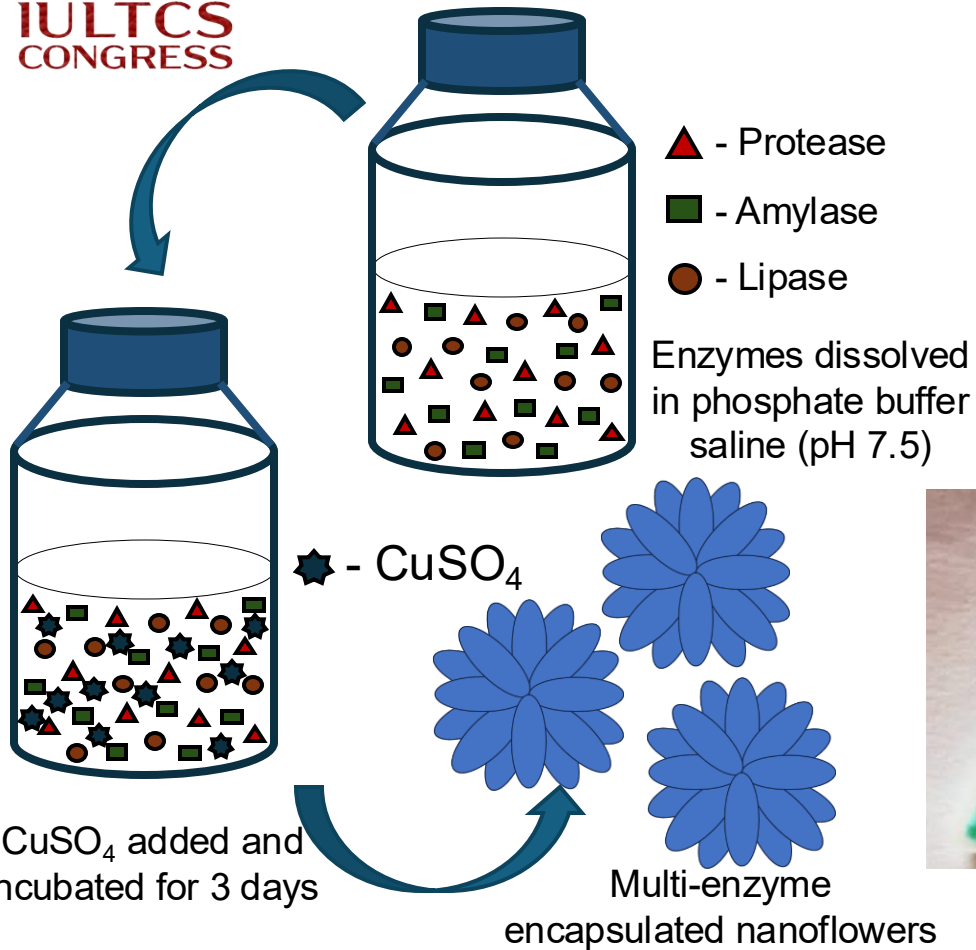
Ts

80°C

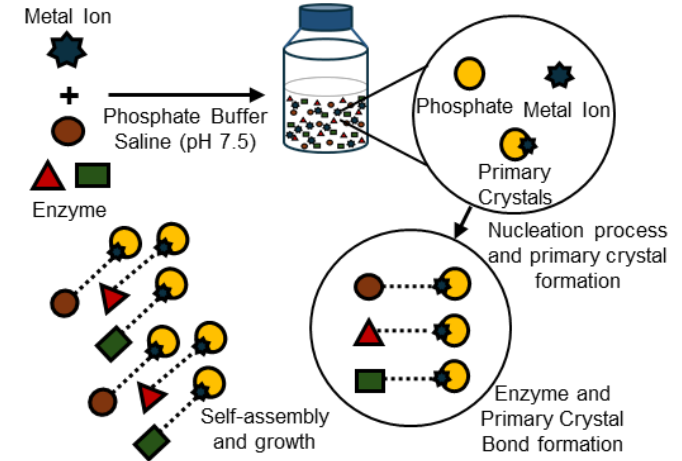
78°C

79°C

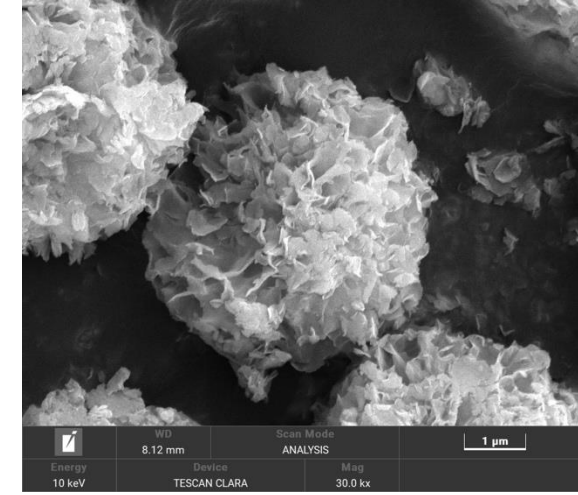
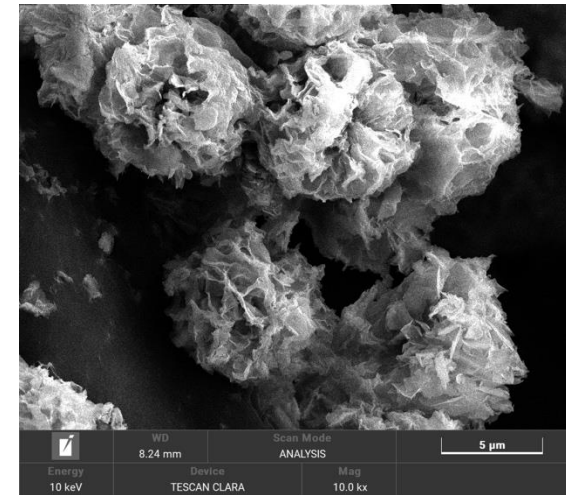
Multi-enzyme System - Nanoflowers



Components	Quantity
Protease	10 g/L
Amylase	10 g/L
Lipase	10 g/L
CuSO_4	30 g/L

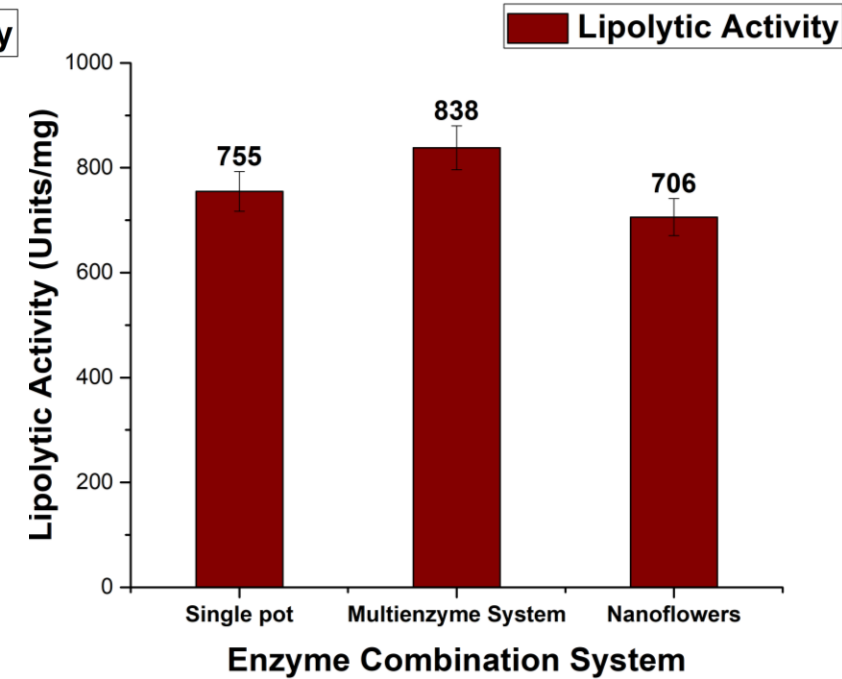
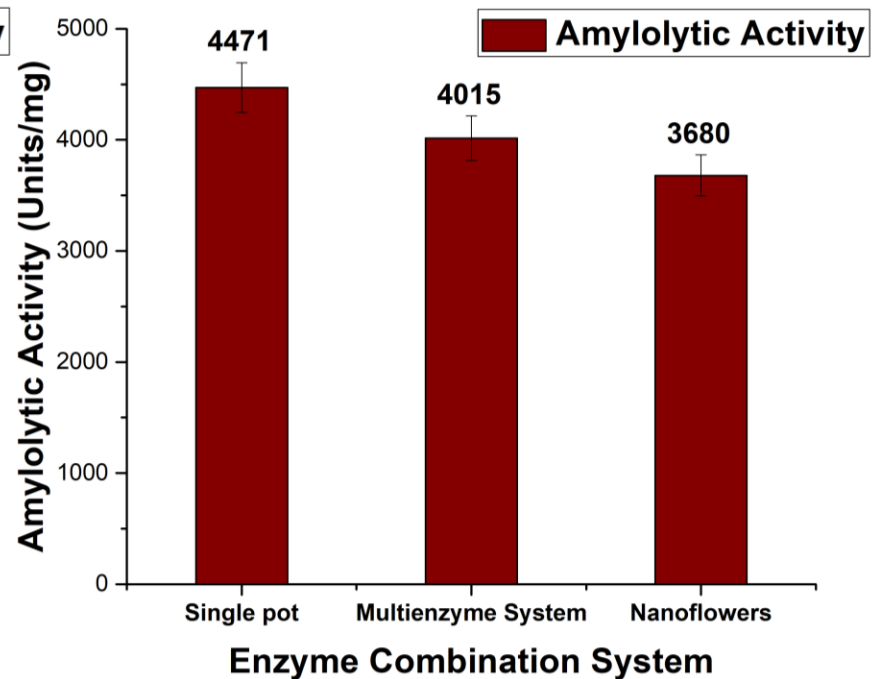
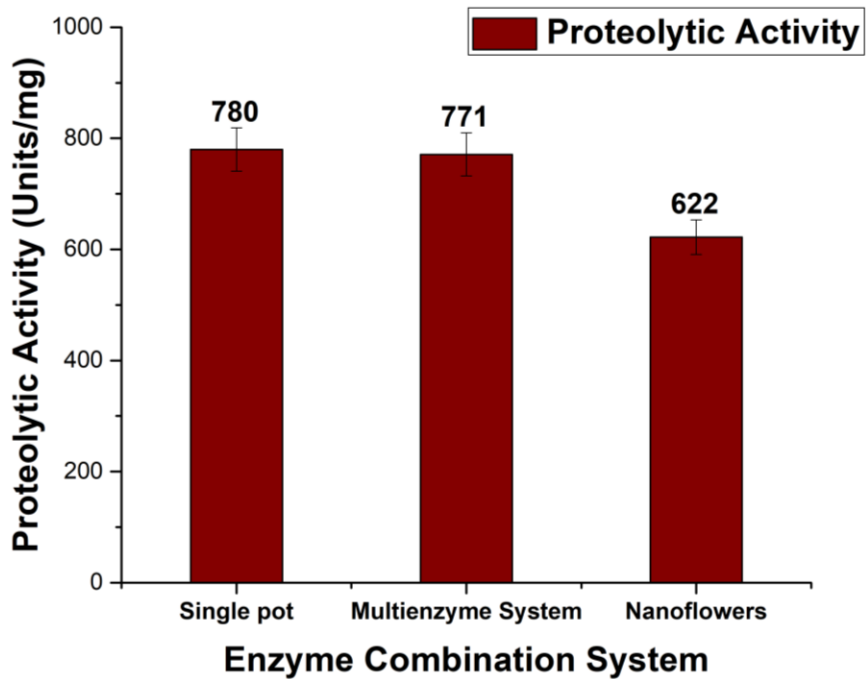


Nanoflowers

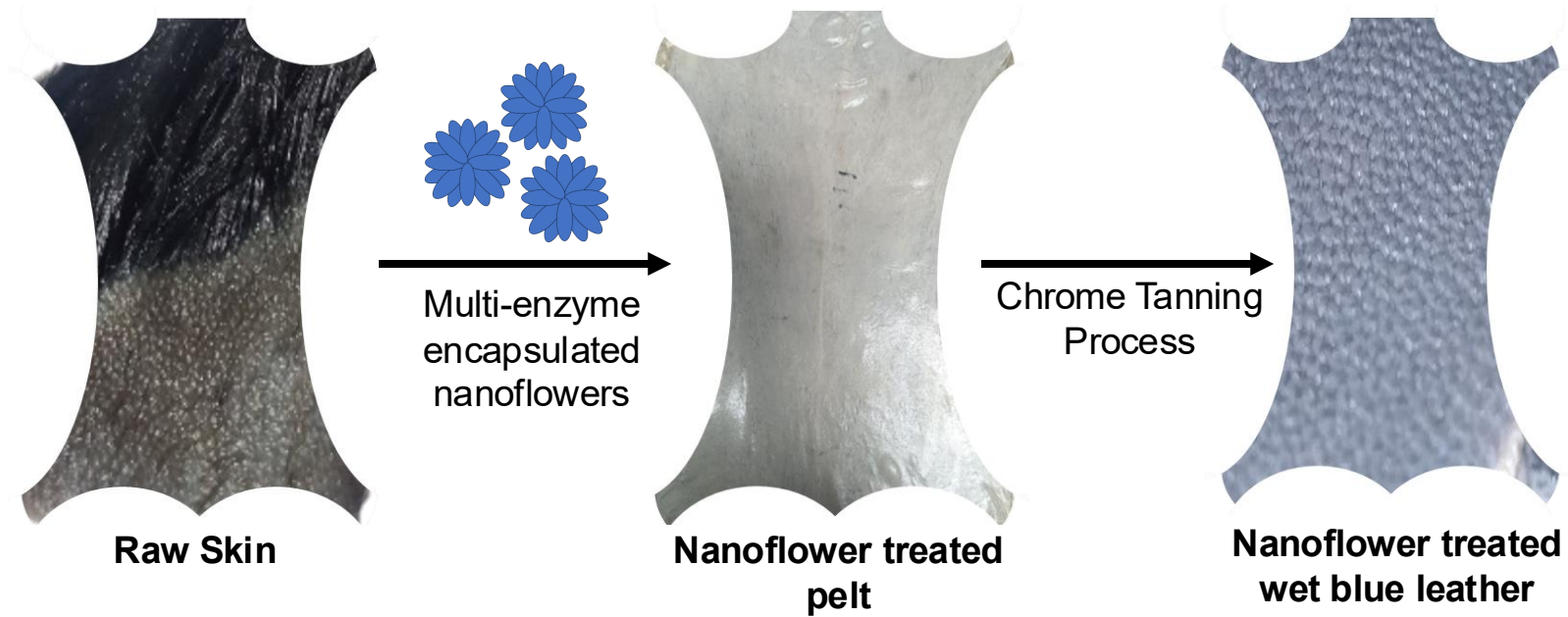
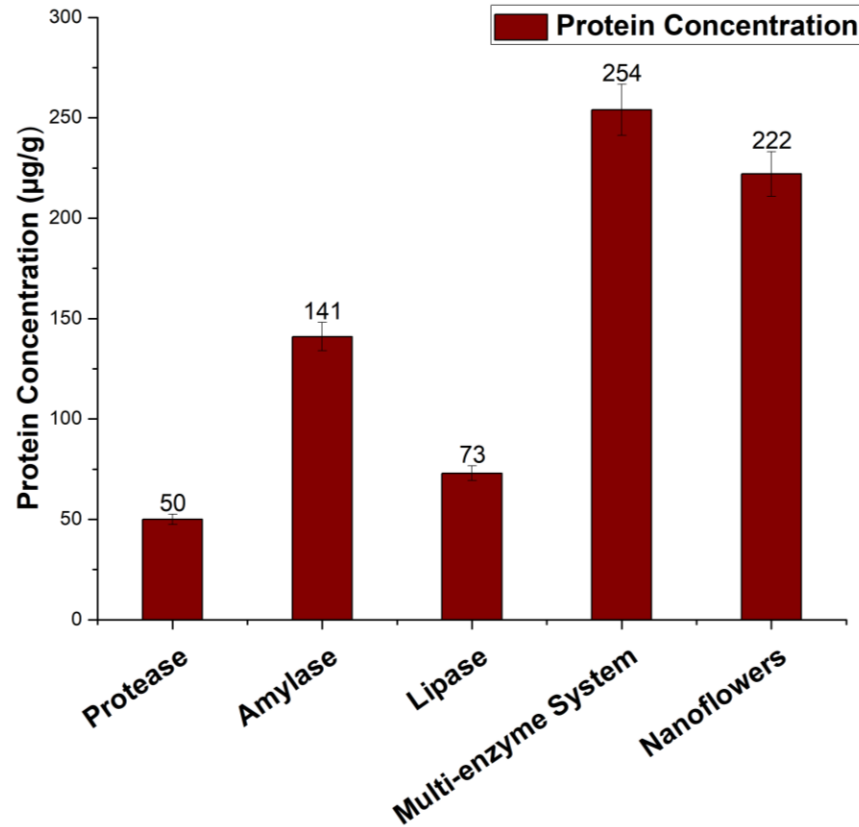


SEM Images of Nanoflowers

Multi-enzyme System - Nanoflowers



Multi-enzyme System - Nanoflowers



Strength Characteristic of Optimized Enzymatically Treated Crust leather:

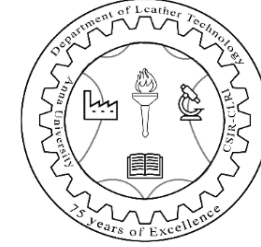
- Tensile strength - 21.91 N/mm²
- Maximum load - 453.50 N
- Elongation at break - 53.45%
- Tear strength - 60.36 N/mm

Summary

- In a multi enzyme system,
 - Protease activity upon the amylase and lipase is negligible
 - Protease and lipase activity in the tripot system (PAL system) has significantly increased
- Nanoflower multi-enzyme encapsulation technique provides wide scope of leather application in tripot beamhouse operation



Thank You



I sincerely thank,

- 1. IULTCS Congress 2025 for providing the opportunity**
- 2. Dr. GC. Jayakumar, Principal Scientist, CSIR-CLRI, for his guidance and support**
- 3. The Director, CSIR-CLRI and The Head, Department of Leather Technology, Anna University for providing the opportunity**
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- 5. AC Tech Association of Leather and Footwear Alumni (ALFA) for providing financial support**
- 6. Mr. Venkataramanan, Former President ALFA, for providing financial support**