

# Pilot Scale Study on Sulfide-Free Enzymatic Unhairing for Ethiopian Hides and Skins

*Towards Sustainable and Circular Economy Pathway*



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# Preamble

- Sulfide-free Enzymatic Unhairing Process
- Waste Valorization
  - Hair Waste
  - Fleshing Waste
- Occupational Health & Safety at Tannery
- Effluent Treatment
- Cleaner Practices
- Waste to Wealth



**Enzymatically removed hairs**

# Objectives

I

- Screening and selection of enzymes

II

- Determination of enzyme activity

III

- Optimization of enzymatic unhairing process

IV

- Physical strength characteristics of crust leathers

V

- Waste valorization

# Screening and Selection of Enzymes

## Screening of commercial enzymes

Enzyme A

Enzyme B

Enzyme C

Enzyme D

Enzyme E

Enzyme F

Enzymes	% Enzyme offer (w/w)				
A	0.05	0.1	0.2	0.3	-
B	0.5	1	1.5	1.75	2
C	0.25	0.5	0.75	0.85	1
D	1	3	5	-	-
E	1	3	5	-	-
F	1	2.5	5	-	-
	Partial unhairing only				
	Unhairing observed with short hairs				
	Grain off observed				

Unhairing efficiency

Short hairs free pelt

Defleshing efficiency

## Selected Enzymes

Enzyme A

Enzyme B

Enzyme C

# Characterization of Enzymes

pH

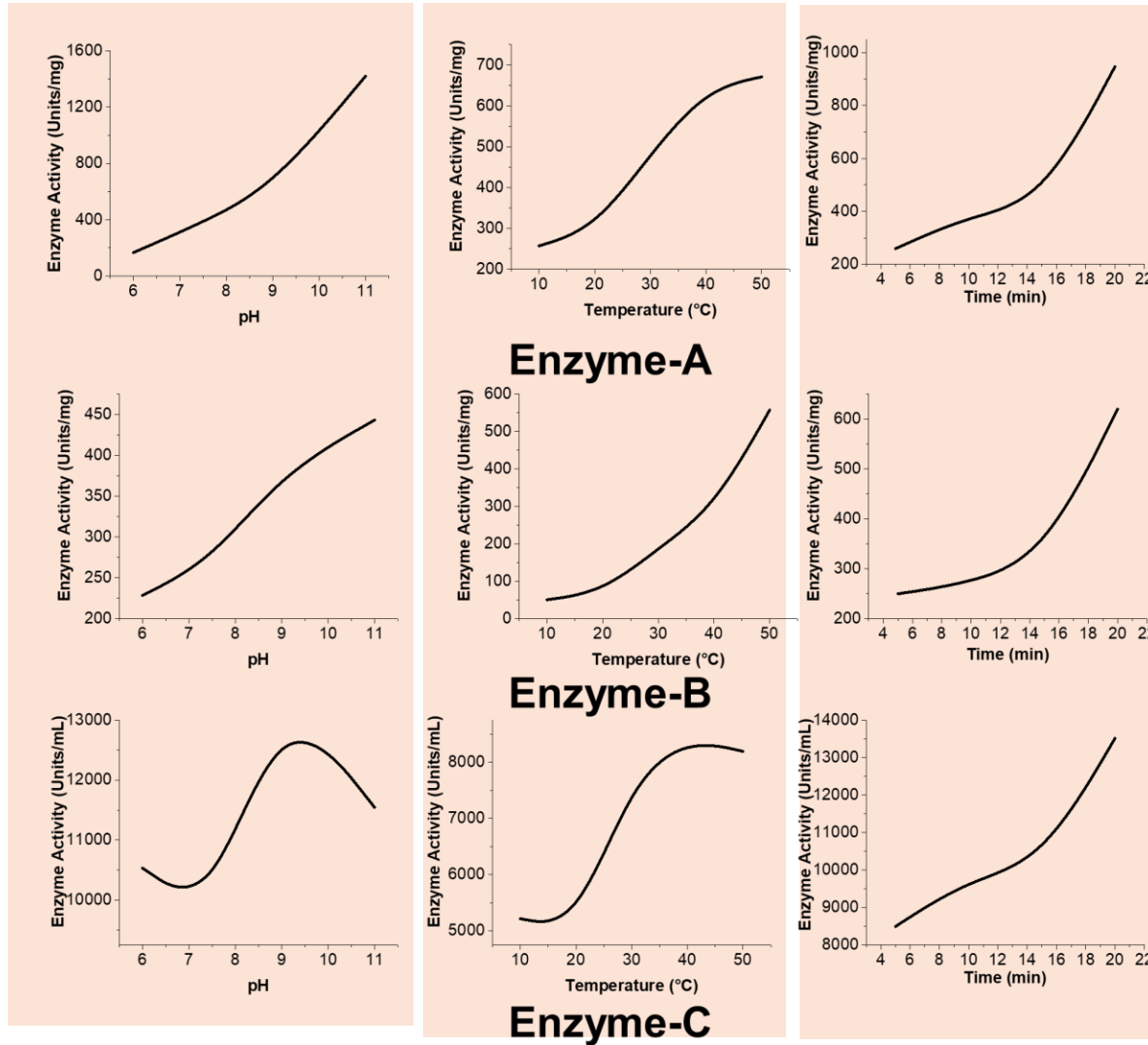
Temperature

Time

Enzyme A

Enzyme B

Enzyme C



Enzyme activity

# Enzymatic Unhairing Trials-Ethiopian Raw Materials

## Method of Application

Raw Materials	Enzyme A	Enzyme B	Enzyme C
Cow Hides	Drum	Drum	Drum
Sheep Skins	Drum	Drum & Paste	Drum & Paste
Goat Skins	Drum	Drum & Paste	Drum & Paste

## Percentage of Enzyme Offer

Raw Materials & Methods	Enzyme A	Enzyme B	Enzyme C
Hides-Drum	0.1 - 0.2%	1.5 - 1.75%	0.5 – 0.85%
Skins-Drum	0.15 - 0.2%		
Skins-Paste	--		



Species	Cow-D	Sheep-D	Goat-D	Sheep -P	Goat-P
Enzyme A					
Enzyme B					
Enzyme C					

# Strength Characteristics of Sheep Garment Leathers



Sheep garment leathers

S. No.	Enzymatic trials	Tensile Strength (N/mm <sup>2</sup> )	Tear Strength (N/mm)
1	Enzyme A (Paste method, Yellow)	11.2	53.1
2	Enzyme B (Paste method, Beige)	10.4	42
3	Enzyme C (Paste method, Blue)	16.9	42.5
4	Enzyme B (Blue, Code A)	15.5	36.5
5	Enzyme C (Red, Code B)	19.8	46.9
6	Enzyme B (Red, Code C)	20.8	45.9
7	Enzyme C (Beige, Code D)	9.4	21.3



# Environmental Assessment

## Effluent Load Sheep Skin Trials

Enzymatic trials	COD (g/skin)
Enzyme A (Drum method)	58.54
Enzyme B (Drum method)	60.35
Enzyme C (Drum method)	77.28
Enzyme B (Paste method)	55.72
Enzyme C (Paste method)	85.29

- IUE 6 (soaking to bating): COD 250-600 (g/skin)
- COD reduction of approx. **72%**

## Effluent Load-Hide Trials (Enzyme A )

Parameter	Enzymatic Trials (kg/ton)	Conventional Technology* (kg/ton)	% Reduction
S <sup>2</sup> -	0	2-9	100.00
<b>COD</b>	34.85	130	73.19

- IUE 6 (soaking to bating): COD 120-160 (kg/ton)

## Enzyme Economics

	Enzyme A	Enzyme B	Enzyme C
<b>Price per kg (USD)</b>	13	8	17
<b>Price per ton of hides/skins (USD)</b>	26	110	128

Sodium Sulphide	
<b>Price per kg (USD)</b>	1.02
<b>Price per ton of hides (USD)</b>	20.42
<b>Price per ton of Skin (USD)</b>	30.63

# Conclusion and Recommendations

Enzyme A	Enzyme B	Enzyme C
<ul style="list-style-type: none"> <li>• Suitable for both hides and skins</li> <li>• pH adjustment before enzyme addition</li> <li>• Temperature control required- 25-35°C</li> <li>• Optimum percentage of enzyme for hides range from 0.1%-0.15% and for skins range from 0.15%-0.2%</li> </ul>	<ul style="list-style-type: none"> <li>• Suitable for both pasting and drum application</li> <li>• More suitable for pasting application for skins</li> <li>• Optimum percentage of enzyme required for pasting application range from 1.5%-1.75%</li> <li>• Fibre opening and swelling found to be better</li> <li>• Drum scudding followed by mild bating operations are required</li> </ul>	<ul style="list-style-type: none"> <li>• Pasting application method suitable for skins with minimum duration of 16-20 h</li> <li>• Optimum percentage for the pasting application range starts from 0.75%-0.85%</li> <li>• Optimum enzyme offer for hide 0.5%-0.75%</li> </ul>

***Waste Valorization (Hair and Fleshing Wastes): Fertilizer, Fatliquor and Leather Chemicals***

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