Studies of Ethiopian Sheepskins as an Opportunity for Value Addition, Part II: Optimization and Characterization of Wanke Upper and Garment Leathers

by

H. Mohammed,[1] G. Aysanew,[1] R. Aravindhan,[2] J. Raghava Rao[2]* and N.K. Chandra Babu[2]

[1]*Leather Industry Development Institute,*
Addis Ababa, Ethiopia

[2]*Central Leather Research Institute, Council of Scientific & Industrial Research*
Adyar, Chennai, India

Abstract

Ethiopian tanners face a shortage of raw material input for the production of leather. The government strategically planned for importing raw skins from neighboring countries and also for effective utilization of available raw material resources in the country. The meat of Wanke sheep is in high demand in international markets, but the skin commands low price not only due to low availability but also less demand by tanners due to natural problems associated with the skin. Hence, tanners treat the skin as a reject. The problems of Wanke skin include high natural fat deposition, thin substance and low strength. Usually, leathers made out of Wanke skins have low selections compared to Ethiopian sheep skins and are mainly utilized for making lining leather. In this work, efforts have been made to develop a process technology for making high value leathers with improved properties from Wanke sheepskin.

Introduction

A major problem with the Ethiopian leather sector is from the supply of raw hides and skins. In addition there is a competition for the best origin (highland) sheepskin, which drives the price abnormally to a high level. Tanneries are not interested in purchasing sheepskins coming from lowland areas due to the poor quality of the raw material. Wanke or Black head sheepskin is one such variety where Ethiopian tanners could not produce high value leather.

Ethiopian tanners have faced a shortage of raw material as an input for the production of leather. Moreover the government has planned more effective utilization of available raw material resources in the country. Among the available resources, Wanke sheepskins take priority position as an untapped resource and found significantly in the lowland regions of the country. Wanke sheepskin is also important because the meat of Wanke Sheep is highly in demand in the international market.[1] Their size is good; almost 80-90% are either large or extra large. In addition the price of the raw material is very low. Even though Wanke sheepskins have many economical advantages because of absence of appropriate technologies for solving the problems of Wanke sheepskin, it is treated as a reject for tanneries to process it to leather. Thus the main objective is to develop a process technology for making high value leather from Wanke sheepskins.

*Corresponding author e-mail: clrichem@mailcity.com; Tel: + 91 44 2441 1630; Fax: + 91 442491 1589.
Manuscript received October 4, 2013, accepted for publication February 25, 2014.

MATERIALS AND METHODS

Dry salted Wanke sheepskins were used for the study. Leather processing chemicals starting from soaking to crust preparation used were of commercial grade from different chemical companies.

Process Design and Standardization

The problem associated with the Wanke sheep skins have been understood after thorough study of the histology, SEM and chemical characterization (Part I).[2] Based on the observations made, process methodologies were devised to address the problem, and a number of trials were conducted to standardize the process for making high quality leather from Wanke sheep skins. The strategy was mainly aimed at solving the following issues viz;

- Proper degreasing
- Improving the thickness of Wanke sheep skin
- Improving the fullness of the leather
- Improving the softness of the leather
- Improving the strength properties of the leather

Physical Characterization of the Skin

Strength Characteristics

Wanke sheepskins were converted to crust leathers following the process strategy designed. The resulting crust leathers were tested for physical strength properties. Sampling and conditioning were done according to the standards ISO 2418:2005 and ISO2419:2005.[3,4] Mechanical properties such as tensile strength and elongation at break,[5] tear strength and tear load,[6] softness (with rim size of the ring at 25mm) were measured.[7] These properties of the leather were used to compare the leathers produced from Wanke sheep skin and those from Abyssinia highland sheep skin.

Organoleptic Properties

The organoleptic properties such as softness, fullness, roundness, smoothness of grain, uniformity of color and overall appearance of the crust leather were evaluated. The values range from 1-10; higher value represent better is the property. The result of the organoleptic property of the leather was used as the basis in planning further improvement in the overall property of the leather made from Wanke sheepskin.

Pilot Scale Trials for Making Wanke Garment and Ladies Upper Leathers

Optimized post tanning processes were employed to develop garment and ladies upper leather from Wanke sheep skins. 25 Wanke sheepskins were used for each pilot scale trial. The leather products were analyzed for physical and organoleptic characteristics.

RESULT AND DISCUSSION

Processing Strategy

The recipes for processing the skins were designed based on the available information on problems associated with Wanke sheepskin and also on the histological and chemical characteristics determined.[2] Particularly the high fat content, poor substance and rib marks were taken into consideration. Owing to the high fat content, thorough degreasing was planned. However, in order to make sure that Wanke sheep skin doesn't have double layer and that the layers should not separate into two when the fat between the layers is removed during processing (taking the case of New Zealand Merino sheep skin), pretanning was carried out before degreasing. This strategy would help in protecting the matrix from collapsing due to removal of excessive fat in Wanke sheepskin. The Wanke sheepskin was pretanned with a phenolic replacement syntan. After stabilizing the matrix with pre-tanning syntan, the skins were thoroughly degreased, repickled followed by chrome tanning and basification. After degreasing, the skins were subjected to beaming on wooden beams to mechanically degrease the skin. It was observed that without pretanning also there was no problem of double layer effect on Wanke sheepskins. Thus pretanning was not carried out for subsequent trials.

The next strategy was planned to improve the thickness of the Wanke sheepskins. In order to do so, the skins were subjected to longer liming. The duration of liming was close to 50 hours, which resulted in better opening up of the fibers and gave softer leather. The next strategy focused on improving the fullness of the leather, for which Wanke sheepskins were tanned using vegetable tanning materials. Subsequently, the chrome tanned and vegetable tanned Wanke leathers were retanned using proper choice of syntans and fatliquors to produce garment and upper leathers, respectively. The process recipes for making full chrome garment and semi chrome upper leathers are shown in Table I and II, respectively. The physical properties of the crust leathers processed using the optimized process recipe is presented in Table 3. From the table, it could be observed that the leather products satisfy the standard requirement of sheep garment and light use sheep upper. From the % elongation and the softness values it could be inferred that the full chrome leathers are much softer than the semi chrome leathers, and the former would be much suitable for garment or softy upper leathers and the latter would be suitable for making upper leathers. Scanning Electron Microscopic images of crust leathers produced from full chrome garment and semi chrome upper leathers are shown in Fig. 1 a and b, respectively. It could be observed from Fig.1a that the fibers are uniformly arranged, whereas the fibers of the semi chrome upper leathers are more compact and coated as observed in Fig. 1b.

TABLE I
Optimized process recipe for full chrome garment leather from dry salted Wanke Sheep skins.

Process	Percent	Chemicals	Time	Remark
Soaking	200	Water		
	0.1	Soda Ash		
	0.25	Preservative		
	0.1	Wetting Agent		Leave overnight
Painting	10	Water		
	2	Sodium sulphide		
	5	Lime		
Apply the paste uniformly on to the flesh side and pile it over night. Next day Unhairing				
Reliming	100	Water		
	10	Lime		
Dip the unhaired skins in this lime liquor for 2 days. Then do fleshing				
Deliming	100	Water		
	1	Ammonium Chloride	45’	pH< 8.0
Bating	0.25	Bating Agent	60’	Temp 36-38°C
				Drain/wash
Pickling	100	Water		
	10	Salt	10’	°Be 6-7
	0.2	Formic Acid		
	1	Sulphuric Acid	3x15’+40’	pH 2.0-2.5
				Two day ageing
Depickling	100	Water		
	8	Salt	20’	
	0.6	Sodium bicarbonate	20’	
	0.6	Sodium bicarbonate	20’	
	0.6	Sodium bicarbonate	20’	pH 4.5-5.0
Degreasing	4	Degreasing agent	2 hours	
Washed with 4% saline water 4 times and then Beamed				
	4	Degreasing agent	2 hours	
Washed with 4% saline water 4 times and then Beamed				
Repickling	100	Water		
	10	Salt	10’	
	0.2	Formic Acid		
	1	Sulphuric Acid	3x 10’	pH 2.6-2.8;

Table I continues on next page.

Table I continued.

Process	Percent	Chemicals	Time	Remark
				drain 50% liquor
Tanning	50	Water		
	7	Basic Chromium Sulphate	30’	
	100	Water	30’	
Basification	0.5	Sodium formate		
	0.5	Sodium bicarbonate	3x15’+45’	pH 3.6-3.8
	2	Phenolic replacement syntan	30’	
After piling for 48 hours, sam set and shave the leathers to a desired thickness (0.6 mm). Subsequently, post tanning was carried out.				
Add	200%	Water, 45°C		
	0.5	Formic Acid	30’	pH=3.0-3.3
				Drain/Wash/Drain
Re-chroming	100	Water, 40°C		
	3	Aliphatic Aldehyde	15’	
	5	Basic Chromium Sulphate	60’	
	1	Sulfited fish oil	20’	
	2	Sodium Formate	x5’+20’=4.0	
Neutralization	100	Water, 40°C		
	1	Sodium Formate		
	2.5	Neutralizing syntan	45’	pH 6.0/6.2
	0.3	Sodium Bicarbonate	45’	Drain/Wash/Drain
	100	Water, 45°C		
	3	Acrylic resin		
	2	Aromatic Sulphonic acid syntan	30’	
Dyeing	4	Red	60’	
Fatliquoring	50	Water, 60°C		
	5	Lecithin based fatliquor		
	4	Alkyl phosphates and neutral oils		
	6	Synthetic fatliquor	60’	
Fixation	2	Formic Acid (1:10 cold)	20’	
	1.5	Formic Acid (1:10 cold)	20’	pH 3.4/3.6
				Drain/Wash/Drain
		Pile and L/O/N Next day sam set and Hang over dry		

TABLE II
Optimized process recipe for semi-chrome upper from dry salted Wanke sheepskins. (Process from soaking to degreasing are similar to earlier Table I).

Process	Percent	Chemicals	Parameter	Time
Tanning	50	Water		
	5	Salt		10’
	12	Wattle tannin powder		60’
	12	Wattle tannin powder	Check Ø	60’
	50	Water		60’
	0.5	Formic Acid	pH=3.5	30’
		Pile O/N		
		Next day		
	50	Water		
	15	Myroblan		60-120
	0.5	Formic Acid	pH=3.0-3.5	30’
		Drain, Wash, pile O/N		
Stripping	100	Water		
	1	Sodium Sulphite		30’
		Drain, Wash, Drain		
	100	Water		
	1	Oxalic acid		30’
		Drain, Wash, Drain		
	50	Water		
	0.25	Formic Acid	pH=3.0	20’
Rechroming	6	Basic Chromium sulphate		
	4	Chrome syntan		
	1	Chrome stable synthetic fatliquor		
	1	Ester based fatliquor		
	1	Sulphited fish oil		60’
	4	Protein filler		60’

Table II continues on next page.

Table II continued.

Process	Percent	Chemicals	Parameter	Time
Basification	1	Sodium formate		
	1	Sodium bicarbonate	pH=4.0	3x10'+ 30'
		Drain/Wash/Pile		
Neutralization	100	Water		
	4	Neutralization syntan	pH=5.5	45'
	50	Water		
	0.25	Bio polymeric syntan		20'
Retanning	2	Acrylic resin syntan		20'
	2	Synthetic fatliquor		20'
	2	Phenolic replacement syntan		
	4	Melamine resin		
	4	Wattle tannin powder		
	2	Dispersing Agent		60'
Fatliqoring	50	Water		15'
	3	Sulfited fish oil		
	2	Synthetic fatliquor		
	8	Synthetic fatliquor		
	2	Lanloline based fatliquor		
	5	Lecithin based fatliquor		
	3	Semi synthetic fatliquor		
	0.1	Preservative		60'
	3	Wattle tannin powder		30'
	4	Formic Acid		3x15'+30'

TABLE III
Physical Characteristics of Crust Leathers resulted from optimized process.

Physical tests	Direction	Full Chrome		Semi Chrome	
		Abyssinia	Wanke	Abyssinia	Wanke
Tensile Strength (Mpa)	Parallel	20±0.50	20±1.00	19±2.00	23±1.00
	Perpendicular	12±0.50	16±0.50	16±2.00	18±1.00
Elongation (%)	Parallel	38±0.50	44±0.50	35±1.00	42±0.50
	Perpendicular	64±0.50	43±1.00	43±2.00	40±0.50
Tear Strength (N)	Parallel	27±0.50	24±1.00	31±1.00	27±1.00
	Perpendicular	36±1.00	25±1.00	26±0.50	21±1.00
Softness		4.57±0.13	5.77±0.33	4.9±0.20	4.93±0.46

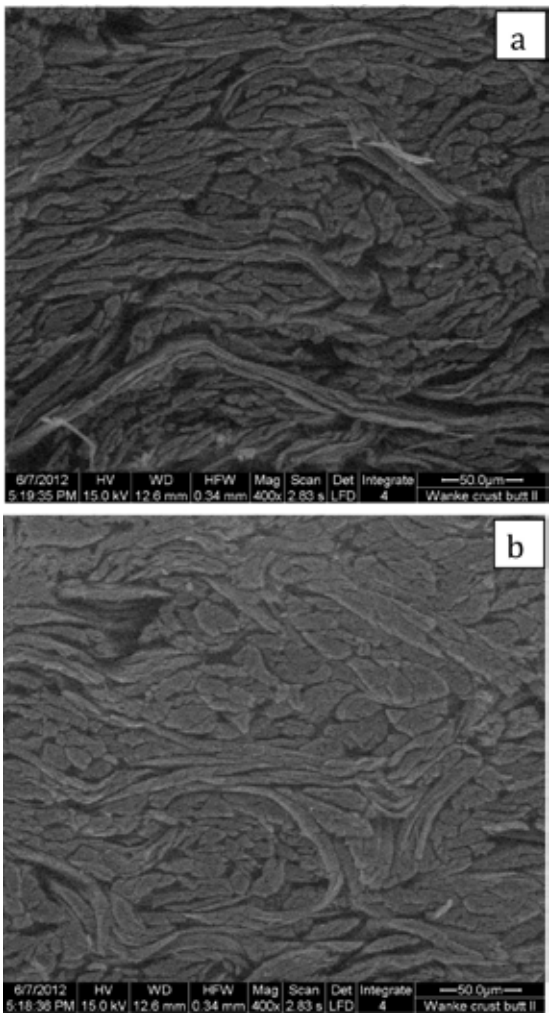

Figure 1. SEM image of cross section of Wanke leathers at crust stage (a) full chrome garment leather and (b) semi-chrome upper leather.

Organoleptic Properties

Leathers produced after thorough degreasing followed by chrome tanning and improved post tanning gave better fullness and softness suitable for garment leather. On the other hand, the leathers produced by semi chrome process and improved post tanning showed best results in terms of fullness and softness, which are suitable for upper leathers. Evaluation of the properties such as softness, fullness, roundness, smoothness of the grain and general appearance of crust leathers for full chrome and semi chrome leather were made and the results of the evaluation are presented in Table 4. It is observed from the organoleptic properties that both the type of leathers (Full chrome and semi chrome) produced from Wanke sheepskins exhibited better bulk properties.

Pilot Scale Trials for Making Wanke Garment and Ladies Upper Leathers

The optimized recipe as provided in Table 1 and 2 were employed for processing 25 samples of Wanke sheepskins to garment leathers and ladies upper leathers, respectively. Developed leathers showed better bulk properties and strength characteristic on par with the results obtained in lab scale trials. In order to establish the efficient utility of these leathers, it was proposed to develop garments and ladies shoes using the developed leathers.

The physical characteristics carried out on full chrome and semi chrome leathers made from Wanke sheepskins are tabulated in Table 5 and 6, respectively. From the table it is observed that full chrome and semi chrome Wanke crusts leathers showed improved strength properties on par with the standard range for upper and garment leathers. Slight

improvement in the thickness of the semi chrome leather was also observed, which could be attributed to the vegetable tanning of the leathers. Table 7 shows the organoleptic properties of garment and upper leathers processed in pilot scale trails. It could be observed that the properties of leathers were comparable to that of the results obtained in experimental trials.

TABLE IV
Organoleptic properties of Crust Leathers resulted from optimized process.

Parameters	Full chrome		Semi chrome	
	Wanke	Abyssinia	Wanke	Abyssinia
Softness	9	9	9	9
Fullness	9	8	9	9
Roundness	8	8	8	8
Smoothness of grain	8	9	8	7
Uniformity of color	8	8	8	8
Overall appearance	9	9	9	9

TABLE V
Physical Test Results of full chrome Wanke sheep garment leather (Pilot scale trials).

Physical Tests	Test Result
Tensile strength (N/mm^2)	29±1.00
Percent Elongation	94±2.00
Double Edge tear load-parallel (N)	30.40±1.05
Double Edge tear load-perpendicular (N)	32.10±1.20
Average double Edge tear (N)	31.30±1.80
Double edge tear load (N/mm)	46.60±1.10
Single Edge tear load-parallel (N)	12.60±1.60
Single Edge tear load-perpendicular (N)	18±2.00
Average single edge tear load (N)	14.90±0.80
Single edge tear load (N/mm)	20.60±0.90

TABLE VI
Physical Test Results of semi-chrome Wanke sheep upper leathers (Pilot scale trials).

Physical Tests	Test Results
Tensile Strength (MPa) Parallel	23±1.00
Tensile Strength (MPa) perpendicular	18±1.00
Elongation (%) Parallel	42±0.50
Elongation (%) Perpendicular	40±0.50
Thickness (mm)	0.75
Tear Strength (N) Parallel	27±10
Tear Strength (N) Perpendicular	21±10
Softness	4.93±0.50

TABLE VII
Organoleptic property of Wanke leathers.

Parameters	Full Chrome (for Garment)	Semi Chrome (for Upper)
Softness	9	9
Fullness	9	9
Roundness	8	8
Smoothness of grain	8	8
Uniformity of color	8	8
Overall appearance	9	9

Figure 2. Leather and products developed from Wanke sheepskins.

Ladies garment and a pair of ladies shoes were designed and developed in the design studio of Leather Industry Development Institute, Addis Ababa, Ethiopia. Developed products are shown in Fig. 2. The designers did not face any problem in handling the leathers during the preparation of garment or footwear.

CONCLUSIONS

Leather making from Wanke sheepskin was limited to low value leathers. The problem of this skin to make value added leather, such as shoe upper and garment leather, existed for many years; but scientific approach to deal with the problem was not followed to solve the problem. This research report has tried to understand the problem and the possible solution scientifically. Characterization of Wanke sheepskin through various scientific tools led to understanding of the problem associated with the skin and development of suitable process strategy to make value added leather. Leathers made from Wanke skins through full chrome process exhibit good softness, fullness, fine grain and improved strength properties suitable for softy upper and garment leather. On the other hand, the semi-chrome processing of Wanke skins resulted in leathers with uniform fullness, roundness and fine grain characteristics suitable for upper leather.

ACKNOWLEDGEMENTS

The work has been carried out as a part of Twinning Project between CSIR-Central Leather Research Institute, Chennai, India and Leather Industry Development Institute, Addis Ababa, The Federal Democratic Republic of Ethiopia. (CSIR-CLRI communication no.:1037)

REFERENCES

1. Berhanu, G., Hoekstra, D., Samson, J.; Heading towards commercialization? The case of live animal marketing in Ethiopia. Improving Productivity and Market Success (IPMS) of Ethiopian Farmers Project Working Paper 5. ILRI (International Livestock Research Institute), Nairobi, Kenya. 2007.
2. Mohammed, H., Aysanew, G., Aravindhan, R., Gnanamani, A., Raghava Rao, J. Chandra Babu, N.K.; Studies on Ethiopian sheep skins as an opportunity for value addition Part I: Histological, microscopic and chemical characterization of Abyssinian and Wanke sheep skins, *JALCA* **109**, 76-81, 2014.
3. ISO 3376:2002, Standard test method for determination of Tensile strength of leather.
4. ISO 3377:2002, Standard test method for determination of Tear strength and Tear Load.
5. IUP 36, Measurement of leather softness.
6. SLC 9 (IUC 9), Substances extractable with dichrolomethane, Official methods of analysis. The Society of Leather Technologist and Chemists, Northampton, UK, 1996.
7. IUC 10, Determination of nitrogen and hide substance.