Studies on Ethiopian Sheep Skins as an Opportunity for Value Addition Part I: Histological, Microscopic and Chemical Characterization of Abyssinian and Wanke Sheepskins

by

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Abstract

The leather industry is one of the priority sectors in Ethiopia, which has been identified as potentially competitive in the global market. Ethiopian tanners face a shortage of raw material input for 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. About fourteen sheep breeds are recognized in Ethiopia. Among the available resources, Wanke sheepskins, indigenous to lowland of Ogaden area of Somali Region take prime position based on their availability. Meat of Wanke sheep is in high demand in international market, but the skin commands low price not only due to availability but also less demanded by tanners due to natural problems associated with the skin. In this paper the histological, chemical and physical characteristics of Wanke sheepskins have been analyzed using various tools and techniques. This characteristic understanding of the Wanke sheepskins will enable the development of process strategy to produce Wanke leathers with improved properties.

Introduction

Ethiopia is one of the countries in the world that possess large livestock population. Ethiopia stands eighth for cattle, twelfth for sheep and eighth for goat livestock populations.[1] 53.4 million cattle, 25.5 million sheep and 22.78 million goat livestock population are found in Ethiopia, with a share of 2.5% of the world livestock population.[2] Even though the country is endowed with the high livestock population, the availability of hides and skins to be processed into leather in tanneries is low in Ethiopia. About fourteen sheep type or breeds are recognized in Ethiopia. These are Simen, Sekota, Farta, Tikur, Wollo, Menz, Washera, Horro, Arsi-Bale, Adilo, Bonga, Afar, Black head, Somali (Wanke) and Gumuz.[3] The common name for highland sheep for example Menz breed is Abyssinian sheep.

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Editor Note: Part II, describing process technology for making high value leathers with improved properties from Wanke sheepskin, will soon be published.

The Blackhead Somali is indigenous to the Ogaden area of the Somali Region of Ethiopia. Somali region possesses 9,053,000 sheep and 8,542,000 goats, which represented about 32.4% of the national resource. There are about 1.316 million sheep and 0.548 million goats in Jijiga zone and 0.913 million sheep and 0.776 million goats in Shinile zone the majority of sheep breed types inhabiting the eastern and southern rangelands of the region are the Wanke.[4] The Blackhead Somali is distinguished by the black color of the head. The body is predominantly white but other colors may be observed. The hair is short, stiff and shiny. Both rams and ewes are hornless, though males can sometimes have rudimentary horns. The forehead is convex and the nose tends to be of the Roman type. The ears are short and pointed with an outward-forward inclination. Most animals have a well-developed dewlap, which sometimes extends from the chin to the chest with considerable fat deposits. The tail is a fat rump type with a very distinct fat depot having a thin tip sticking straight backward and sometimes hanging downward.[5]

Challenges of Ethiopian Leather Industry

A major problem with the leather sector is from the supply of raw hides and skins due to low off- take levels and poor recovery rate. Tanneries are not interested in purchasing sheep skins coming from lowland areas due to the poor quality of the raw material. Ethiopian tanners could not produce high value leather from Black Head "Wanke" sheepskins. This is because the raw material has high natural fat deposition, very thin substance and low strength. Also, the surface has too many defects like scratches and rib marks. Due to this, leather made out of Black head usually has low selection result compared to high land sheepskins. Usually 'Wanke' skins are used for making of lining leather due to their poor quality. The main objective of this study is to understand histological, microscopic and chemical characteristics of Black Head "Wanke" sheep skin so that a suitable improvement can be strategized and introduced.

Materials and Methods

Characterization of Sheepskins

Dry salted Abyssinian and Wanke sheepskins were used for the study. The grain surface pattern of Abyssinian and Wanke sheepskin were studied using Stereo Microscope. Samples from butt region of crust leather were examined. All the images were photographed at same magnification. The surface fineness or coarseness of Abyssinian and Wanke sheepskin were assessed by analyzing the surface with respect to hair pore count. Number of hair pore per in^2 were counted and recorded. Histological features of Abyssinian and Wanke sheepskin at different part and stage of the skin along the production line for making leather have been analyzed.

Cross section of raw Abyssinian and Wanke skins from butt, neck and belly region after main soaking, were observed under light microscope. Cross section were prepared after passing a sequence of procedure for preparing specimen for histological analysis like dehydration, clearing, infiltration, embedding, block preparation, sectioning and staining. The cross sections were sectioned with a thickness of 50 microns and were stained with Hematoxylin and Eosin.[6] Magnifications of 12.5 X objective lens was used in generating images of the cross sections. Measurements were made using Adobe Photoshop software. The thickness of grain and corium were measured and the grain to corium ratio was calculated.

To analyze the effect of process on Abyssinian and Wanke sheepskins, different samples were taken from neck, belly and butt regions at different stages along the production line and characterized using Scanning Electron microscope (SEM). The main chemical characterization parameters used were the fat content,[7] nitrogen content[8] and hydroxyproline content,[9] chrome content.[10] They were used to compare the chemical characters of both Abyssinian and Wanke sheep at different stages along the process following a standard procedure.[7]

Result and Discussion

Grain Surface Pattern

Samples from butt region of crust leather were examined using Stereo Microscope. The grain surface pattern of Abyssinian and Wanke sheepskin is shown in Figure 1. The presence of coarse and fine hairs was seen from the surface morphology figures of Abyssinian and Wanke sheepskins. Though association of coarse and fine hairs was evident in Abyssinian and Wanke skins, the distribution was rather random and there was less orderliness in the grouping.

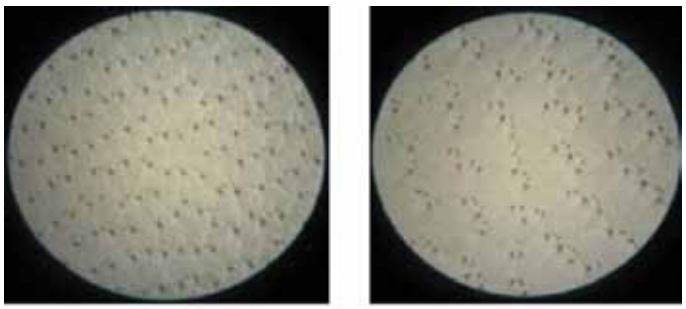

Figure 1. Grain surface pattern of Abyssinian and Wanke sheep skin at crust stage.

Hair Pore Count

The average number of hairs per sq. inch of skins surface, in butt location is 14516 ± 25 and 10000 ± 25 for Wanke and Abyssinian sheepskins, respectively. Thus it is clearly evident that Wanke sheepskin has more number of hairs per square inch than Abyssinian sheepskin. This gives an indication that the natural grain pattern of Wanke is finer than Abyssinian

sheep skins.[11] Shelly reported the hair pore count of the USA domestic hair sheep cross breeds ranges from 8.3 to 10.3 per mm^2 (5354 to 6645 hair pores per sq inch.).[12] whereas the CLRI report indicates the Indian sheep skin having about 8000 hair pores per sq inch.[13] It is observed that the Ethiopian sheep skins have more hair pores than Indian and USA origin sheep skins. The increased hair pores in the Ethiopian sheepskins results in fine and superior grain pattern of sheepskins as compared to other regions.

Histological Analysis

Cross section of raw Abyssinian and Wanke sheep skin from butt, neck and belly region after main soaking, were observed under microscope. Figure 2 show images of the cross sections after main soaking stage. From the figure the thickness of grain and corium layer was measured and tabulated in Table I. The higher the grain to corium ratio indicates more grain layer and less corium layer and vice versa. Butt region of Wanke sheepskin has higher grain to corium ratio indicating more grain layer and less corium layer. In neck region, Abyssinian has equal layers of grain and corium layer, whereas Wanke sheepskin has less grain and more corium layers. In belly region, both Abyssinian and Wanke sheepskin have equal proportions of grain and corium layer. From the figure and table it is clear that Neck region has more thickness, loose and spongy structure. The insertion angle of hair follicles seems to be slightly higher in Wanke sheepskin than Abyssinian especially in the neck and butt region. The diameter of the fiber bundles seems to be very low in both with the Abyssinian skin being marginally better. The angle of weave is low as expected of sheepskins.

The cross sections of lime pelt and wet blue leather for both Abyssinian and Wanke are shown in Figures 3 and 4, respectively. Cross sections of the limed pelt (Figure 3) appear to bring out the demarcation between the grain and corium remarkably along with the delineation of fiber bundles. In Wanke sheepskin, the looseness decreases from neck, butt, and belly while in Abyssinian it is in the order of butt, belly and neck. Cross section of the wet blue leathers (Figure 4) appears to have compact fiber weave in Abyssinian than in Wanke sheepskin, which is very evident in butt and belly regions. However, the neck regions of Wanke sheepskin appear to be more compact than Abyssinian.

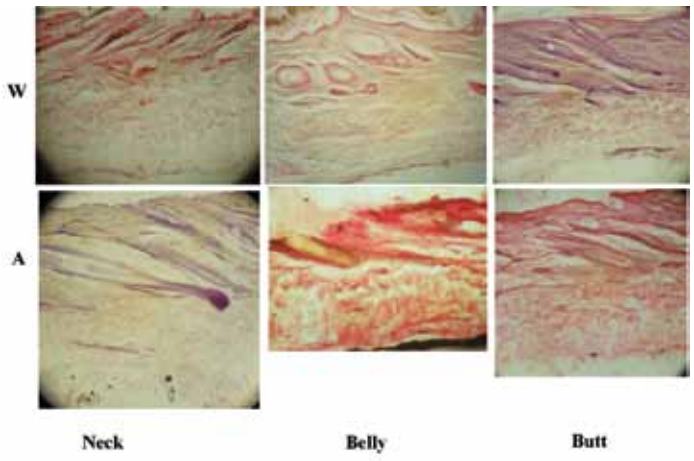

Figure 2. Cross section of Wanke (W) and Abyssinian (A) skin at raw stage (after main soaking).

TABLE I
Grain to Corium ratio at various areas of Abyssinian and Wanke sheep skins.

Breed	Grain Thickness, mm	Corium Thickness, mm	Total Thickness, mm	Grain to Corium Ratio
Butt				
Abyssinian	0.48± 0.07	0.74±0.09	1.22±0.04	0.64±0.07
Wanke	0.63±0.01	0.54±0.02	1.16±0.01	1.16±0.02
Neck				
Abyssinian	0.73±0.03	0.7±0.01	1.43±0.03	1.04±0.03
Wanke	0.57±0.02	0.61±0.02	1.17±0.02	0.93±0.02
Belly				
Abyssinian	0.31±0.03	0.38±0.04	0.69±0.04	0.8±0.04
Wanke	0.4±0.01	0.39±0.04	0.79±0.04	1.03±0.04

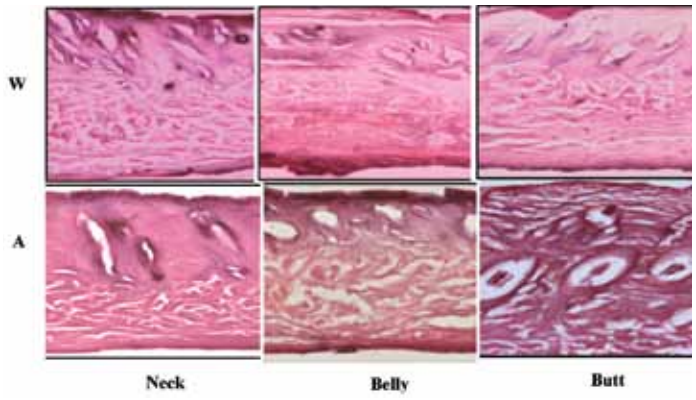

Figure 3. Cross section of Wanke (W) and Abyssinian (A) skin after liming.

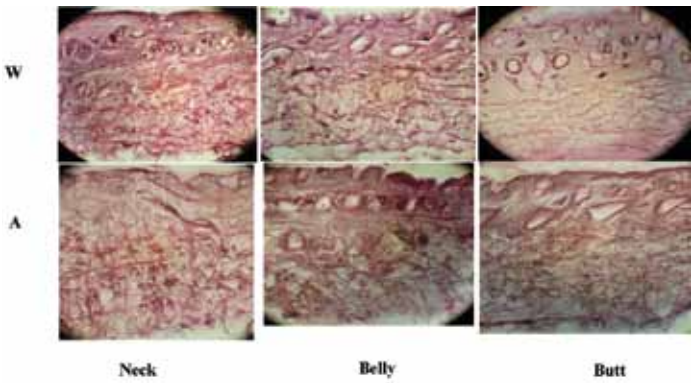

Figure 4. Cross section of Wanke (W) and Abyssinian (A) skin at wet blue stage.

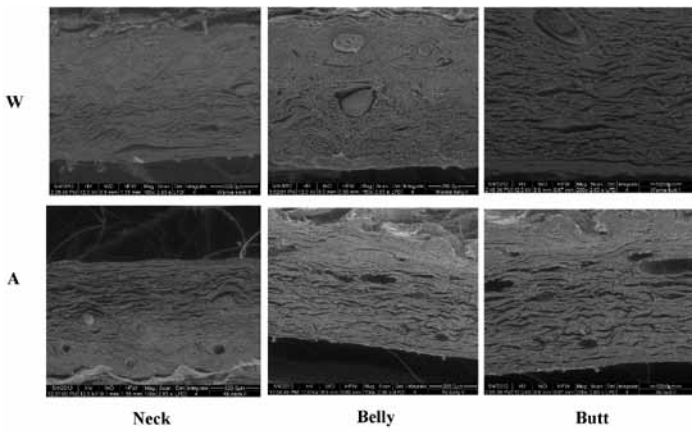

Figure 5. SEM images of cross section of Wanke (W) and Abyssinian (A) at raw stage (Neck-100x; Belly-150x; Butt-200x).

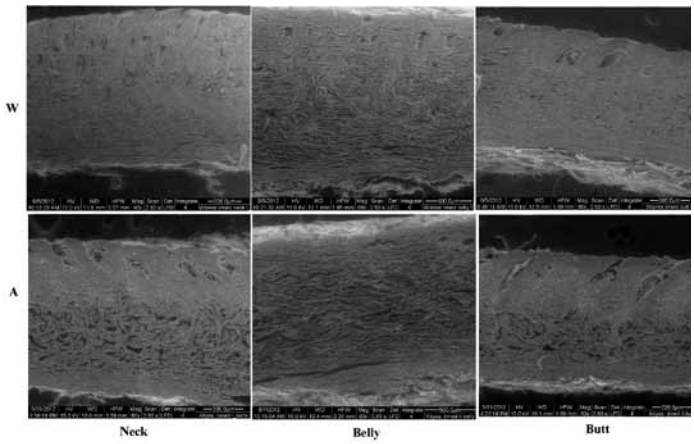

Figure 6. SEM images of cross section of Wanke (W) and Abyssinian (A) after liming (Neck-80x; Belly-60x; Butt-80x).

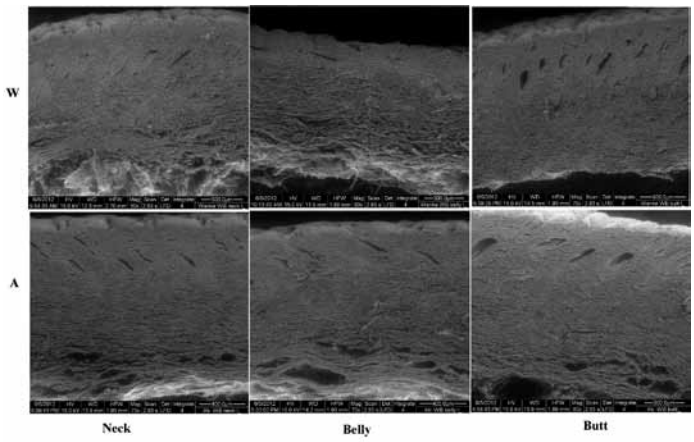

Figure 7. SEM images of cross section of Wanke (W) and Abyssinian (A) at wet blue stage (Neck-70x; Belly-80x; Butt-80x).

Scanning Electron Microscopy Analysis

The fibre structure of skin after main soaking from butt, neck and belly locations is shown in Figure 5. From the figure it could be visualized that the hair roots are deeply rooted in neck region for both Abyssinian and Wanke sheep skin and more number of hair roots could be seen in Wanke sheepskin. In belly region also the hairs are deeply rooted. Fiber compactness seems comparable in butt regions for both origins but Abyssinian seems looser in belly and neck regions.

SEM images of limed pelt shown in Figure 6, depicts that Abyssinian sheep skin appear more open than Wanke sheep skin, especially in neck and belly regions. Fibers of Abyssinian seem more entangled than Wanke sheep skin as it can be seen from neck and butt regions. The fibers of Wanke sheepskin seem to be more uniformly arranged in butt, belly and neck regions. Neck region of Wanke sheepskin seem more spongy and thicker than Abyssinia sheepskin. Butt regions of Wanke sheepskin seem to be cemented and less open when compared to Abyssinia. The belly region of Abyssinia appears looser

than Wanke sheepskin. For both origins, the neck portion is higher in thickness and spongier than butt regions. From the SEM images of wet blue shown in Figure 7, it can be seen that there is comparable fiber compactness especially in butt regions. It seems more number of hair roots in Wanke than Abyssinian sheep skin as can be seen in butt region. The depth of the hair root appeared a little longer for Wanke than Abyssinian sheepskin.

Chemical Characteristics

The Abyssinian and Wanke sheepskins at different stages of the process were estimated for fat, nitrogen; hide substance, hydroxyproline and chromic oxide content. The results are shown in Table II. From the table it is observed that Wanke has more fat content than Abyssinian sheepskin. This could be attributed to the fact that when fat is removed by degreasing process, the final leather becomes thin or papery. Nitrogen and hydroxyproline content is slightly higher in Abyssinian than in Wanke sheepskins. This indicates that Abyssinian has more collagen content than Wanke sheepskins. The Chrome content at wet blue stage is higher for Abyssinian than Wanke sheepskins, as expected owing to higher hide substance value.

TABLE II
Chemical properties of Abyssinian and Wanke sheep skins.

Chemical tests	Abyssinian	Wanke
% Fat	4.51±0.31	7.55±0.30
% N (Kjeldhal)	11.88±1.11	11.00±0.61
Hide substance	60.83±1.2	56.32±1.8
% Cr_2O_3	3.13±0.08	2.74±0.04
% Hydroxyproline	7.59±0.61	6.33±1.13

Moreover, the calculated chromium to hide substance value indicates that the Abyssinian sheepskins have more reactive sites than Wanke sheepskins. The sample of Abyssinian and Wanke at different stages, free of moisture was weighed in milligrams and housed in a tin capsule. Then it was analyzed with CHNS analyzer. The results are given in Table III. The % nitrogen for Abyssinian sheepskin (i.e. 14.1%) is higher when compared to Wanke sheepskin (12.9%) at pickle stage. It is also consistently higher for Abyssinian at wet blue. The nitrogen content is lower in wet blue than pickle pelt and this may be due to the presence of chromium leading to proportion changes. From The nitrogen content of the Wanke sheepskin is lower by a factor of 8.5% compared to the Abyssinia sheepskin.

CONCLUSIONS

Ethiopia has ample source of Wanke sheep especially in the lowland area of the country; however the skin is not adequately utilized. Leather making from Wanke sheepskin was limited to low value leathers such as used for lining. The present study has tried to understand the problem and the possible solution scientifically. The histological analysis showed that the Wanke sheepskin has less compactness when compared to the Abyssinian sheepskin. The high fat content and comparatively low nitrogen and hydroxyproline content values obtained for Wanke sheepskin also indicated the poor substance and looseness problem associated with. Development of value added leather from this untapped resource would enable Ethiopian tanners to benefit more because the raw material is very cheap compared to normal Abyssinian sheepskin and their size is usually extra-large to large.

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TABLE III
Percentage composition of N, C, H and S for the substrate at different stages.

Breed	Stage	N [%]	C [%]	H [%]	S [%]	C/N ratio
Abyssinia	Pickled	14.10±1.23	42.28±1.39	6.17±0.35	1.13±0.55	2.99±1.23
Wanke	Pickled	12.9±1.68	42.27±1.68	6.34±0.48	0.73±0.06	3.27±1.68
Abyssinia	Wet blue	11.16±0.18	37.06±0.79	5.83±0.07	1.81±0.01	3.32±0.5
Wanke	Wet blue	10.66±0.23	35.95±0.82	5.55±0.17	1.53±0.01	3.37±0.5

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