Scholars Journal of Engineering and Technology
Abbreviated Key Title: Sch J Eng Tech
ISSN 2347-9523 (Print) | ISSN 2321-435X (Online)
Journal homepage: https://saspublishers.com

Manufacture of Shoe Upper Leathers from Sudanese Camel Hides

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DOI: 10.36347/sjet.2022.v10i07.004 | **Received:** 09.06.2022 | **Accepted:** 13.07.2022 | **Published:** 19.07.2022

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Abstract **Original Research Article**

Sudan is one of the African countries with higher livestock population. The total livestock population of the country is estimated at 31.78 millions of cattle, 41 millions of sheep, 32.22 millions of goats and 4.92 millions of camels. This huge population of livestock provides many opportunities for the development of the leather sector in the country. The main source of raw material for the Sudan tanning sector comes from sheep, goat and cattle. Camel (*Camelus dromedarius*) is one of the most important livestock uniquely adapted to hot dry environments. Sudan holds the second largest camel population in the world (about 4.92 million). Camels in Sudan and elsewhere are classified as pack (heavy) and riding (light) types according to their function. Recent studies have been made to classify the camels according to their performance (dairy camels, meat camels, dual purpose camels and racing camels). In the present study, camel hides were used for manufacture of upper crust leathers and compare with conventional cow hides. Histological analysis of the camel hide and cow hide has been carried out at soaking operation. The physical and chemical analysis indicates that the experimental camel leathers are comparable to control cow leathers in terms of all the properties. The bulk properties for the experimental leathers are better than control leathers. Scanning electron microscopic analysis for both control and experimental leather samples show good separation of fiber bundles. The chemical and physical characteristics of the experimental camel leather revealed that the camel hide raw material was suitable for making of shoe upper leather. In Sudan camel was considered as best alternative animal to conventional raw materials such as sheep, goat and cattle due to its higher off take rate.

Keywords: Camel, Camelus dromedaries, Cow, Chrome tanning ,Wet blue.

1. INTRODUCTION

Sudan has the richest livestock population in Africa, i.e. cattle, sheep, goats and camels. Sudan has largest population of camels among Arab and African countries and the tanning sectors depend only on sheep, goats and cattle for making of different leather products. Camels are classified as under: Class: mammals, Order: Artiodactyla, Sub- rder: Tylopoda and Family: Camiladae. There are two genera in this family including Camelus genus (camels in ancient world) and lama genus (camels in the new world, camels without hump). The Camelus genus includes two species: *Camelus dromedarius* (dromedary) and Bactrian camels (*Camelus bactrianus*) [1].

Camels in the Sudan and elsewhere are classified as pack (heavy) and riding (light) types according to the function they perform and probably as a result of the selection applied for this trait by the various camel keeping tribes. The Sudanese heavy type constitutes the majority of the camels kept by nomads in Sudan. Two types of camels can be identified on the basis of body conformation and tribal ownership: the Arab and Rashidi Camels. On the other hand, the riding camels are restricted to the north-east of the country between the River Nile and Red Sea. For Sudanese riding camels there are two main types, namely Anafi and Bishari Camels [2].

According to the World Food Organization (FAO), there were 24,644,228 camels in the world 85% of which have been living in Africa (equal to 20,969,015 camels) [3] . Sudan ranks first among the Arab countries and second in Africa with respect to animal population. The Sudan is considered as the second country in the world in camel's population (more than 4 millions). The history of the dromedary camel in the Sudan is even more obscure. Camels in the Sudan are spread in a belt configuration; it extends between latitudes 12°-16°N. This belt is characterized by erratic rainfall, less than 350 mm. and contains two main regions: the Eastern state, whereas camels are found in the Butana plains and the Red Sea hills and the Western Regions (Darfour *et al*,).

In Sudan the production systems include: traditional nomadic system, transhumant or semi-nomadic system, sedentary or semi-sedentary system and intensive system which is limited to racing and dairy camels [4].

Camel hides are being considered as an additional source of raw material for the tanning industries [5]. Although camel leathers are characterized with higher strengths than cow leathers , there is still a lack in regarding evaluation of camel leather properties following tanning and finishing by different methods to use it in manufacturing [6]. The tanning process is based on the conversion of putrescible skin or hides to a non-putrescible material. Leather making involves operations like soaking (rehydration), liming, deliming, pickling, tanning, posttanning and finishing processes [7] , (Fig. 1) [8].

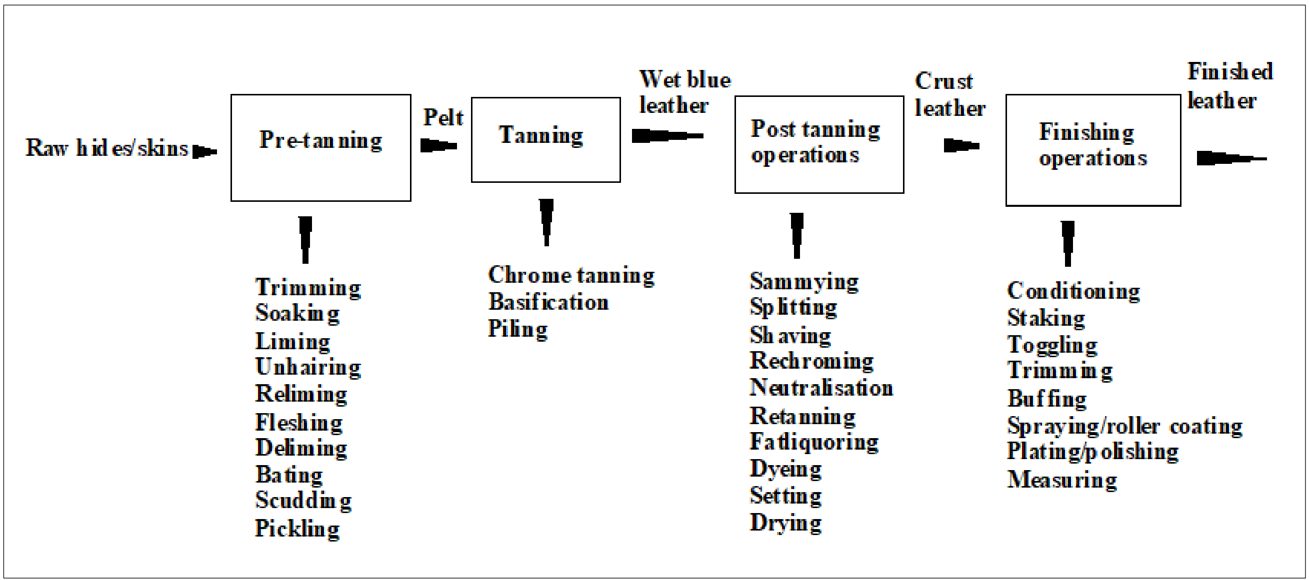

Fig 1: Process flow sheet for conventional leather processing

Tanning is a meaningful process in the leather industry, which improves thermal stability, mechanical properties and porosity of leather [9]. In the leather industry, basic chromium sulphate is preferred as tanning agent, mainly because of its lower cost and better reactivity with collagen fiber [10]. Chrome tanning is one of the most popular tanning systems because of the excellent qualities of chrome tanned leather such as high hydrothermal stability, good dyeing characteristics and softness [11]. The aim of this study to evaluate the camel hide for its suitability as a source of raw material for leather manufacture and compare with cow hide that used mainly in Sudanese tanneries.

2. MATERIALS AND METHODS

2.1 Materials

Wet salted camel hides obtained from a local abattoir located at Khartoum were used as raw material for experimental processes and wet salted cow hides were used as raw material for control processes. The chemicals used for tanning and post tanning processes were of commercial grade. The chemicals used for the analysis of spent liquor were of analytical grade.

2.2 Methods

2.2.1 Histological studies of camel hides using H & E (Hematoxyline-Eosin) staining

Tissue processing for histological study is a procedure of removing water from cells and replacing it with a medium which solidifies allowing thin sections to be cut on a microtome. Once tissue is properly fixed it goes through a process which involves the following steps: dehydration, clearing and infiltration (Fig. 2) [12].

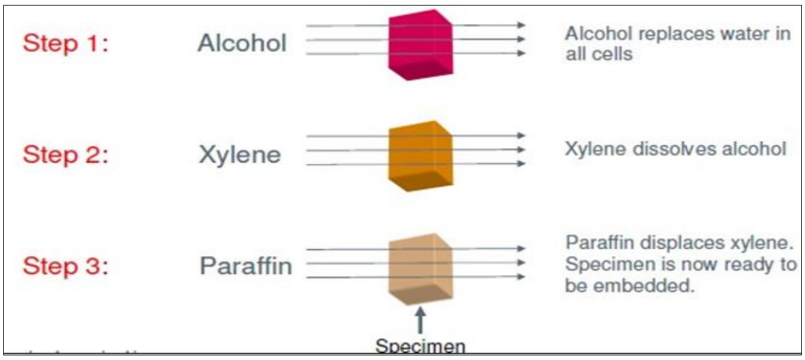

Fig 2: Tissue processing steps [12]

Histological examination was carried out on the soaked camel hides (experimental) and cow hides (control). Samples were taken and preserved in 10% formalin for 48 hours. The fixed samples were dehydrated in an aqueous alcohol series (50 to 100%) and then cleared in xylene. Samples were finally embedded in paraffin wax and 10µm sections were cut on a microtome, mounted and stained with H & E stain [13].

2.2.2 Tanning Processes

The conventional chrome tanning process has been carried out using wet salted camel hides (experimental) as given in the Table 1. The conventional chrome tanning process has been carried out using wet salted cow hides (control) as given in the Table 1. The post tanning process mentioned in Table 2 is followed for both experimental and control leathers.

Table 1 Tanning process for camel hides (Experimental) and cow hides (Control) for manufacture of upper leathers

Process	%	Product	Duration (min)	Remarks
Soaking	500	Water	1 hr	
Liming and unhairing	100 4 2	Water Lime Sodium sulphide	4 hr	pH 11-12
Deliming and bating	100 1.5 1	Water Ammonium sulphate Bating agent (oropon)	2 hrs	pH 8-8.5 Check with indicator phenolphthalein, gave colorless
Washing	200	Water	15 min	
Pickling	100 10 0.75	Water Salt Sulphuric acid (dilute 1:10 with water)	2 hrs	pH 2.8-3
Tanning	8	Basic chromium sulphate	4 hrs	
Basification	1 0.5	Sodium formate Sodium bicarbonate	45 min 60 min	pH 4
Washing	300	water		Drain, piling overnight, sammed, set out, shaved 1.2 mm and shaved weight noted

Table 2: Post-tanning process for camel hides (Experimental) and cow hides (Control) for manufacture of upper leathers

Process	%	Product	Duration (min)	Remarks
Washing	200	water	10 min	
Neutralization	0.75	Sodium bicarbonate	3×15	pH 5-5.5
Retanning, Dyeing and fatliquoring	100	water		
	8	Syntan	90 min	
	3	Acid dye brown	45 min	
	9	Synthetic fatliqour	90 min	
Fixing	1	Formic acid	3×10 + 30	pH 3.5
Washing	300	water	10	Drain the bath and pile overnight. Next day samming and setting out, toggling, staking trimming, buffing and finishing.

2.2.3 Measurement of Hydrothermal Stability of Leathers

The shrinkage temperature of control (cow) and experimental (camel) leathers has been determined using Theis shrinkage tester [14]. 2X0.5 cm^2 piece of tanned leather cut from the official sampling position has been clamped between the jaws of the clamp and has been immersed in solution containing 3:1 glycerol: water mixture. The solution has been continuously stirred using mechanical stirrer attached to the shrinkage tester. The temperature of the solution has been gradually increased and the temperature at which the sample shrinks has been measured as the shrinkage temperature of the leathers.

2.2.4 Physical Testing and Hand Evaluation of Leathers

Samples for various physical tests from experimental and control crust leathers have been obtained as per IULTCS methods [15]. Specimens have been conditioned at $20 \pm 2\,^{o}C$ and 65 ± 2 % R.H over a period of 48 hrs. Physical properties such as tensile strength, percentage elongation at break [16], grain crack strength [17] and tear strength [18] have been measured as per standard procedures. Each value reported is an average of four samples (2 values along the backbone and 2 values across the back bone). Experimental and control crust leathers have also been assessed for softness, fullness, grain smoothness, grain tightness (break), general appearance and dye uniformity by hand and visual examination. Three experienced tanners rated the leathers on a scale of 0-10 points for each functional property, where higher values indicate better property of leathers.

2.2.5 Scanning Electron Microscopic Aanalysis of Leather Samples

Samples from experimental and control crust leathers were cut from official sampling position. Samples were directly cut into specimens with uniform thickness without any pretreatment. All specimens were then coated with gold using Edwards E306 sputter coater. A Leica Cambridge Stereoscan 440 Scanning electron microscope was used for the analysis. The micrographs for the cross section were obtained by operating the SEM at an accelerating voltage of 20 KV with different lower and higher magnification levels.

2.2.6 Evaluation of Chemical Constituents in Leathers

The chemical constituents such as total ash content % , Moisture %, Fats and oils % and Chrome oxide (Cr_2O_3) have been carried out for control and experimental leathers according to standard procedures [19].

3. RESULTS AND DISCUSSIONS

3.1 Histological Studies

Histological properties of the raw camel hide (experimental) and raw cow hide (control) has been analysed using the H & E staining. The histological examination of the camel hide revealed that is suitable raw material for leather making similar to cow hide. Optical microphotographs of soaked cow hides (control) from butt regions, observed under light microscope (40x magnification) as given in Fig. 3. Optical microphotographs of soaked camel hides (experimental) from thick regions, observed under light microscope (40x magnification) as given in Fig. 4. It is seen that the collagen fibres from experimental soaked camel hides are more compact, compared to control soaked cow hides. The fibre compactness feature of the camel leather leads to produce different products

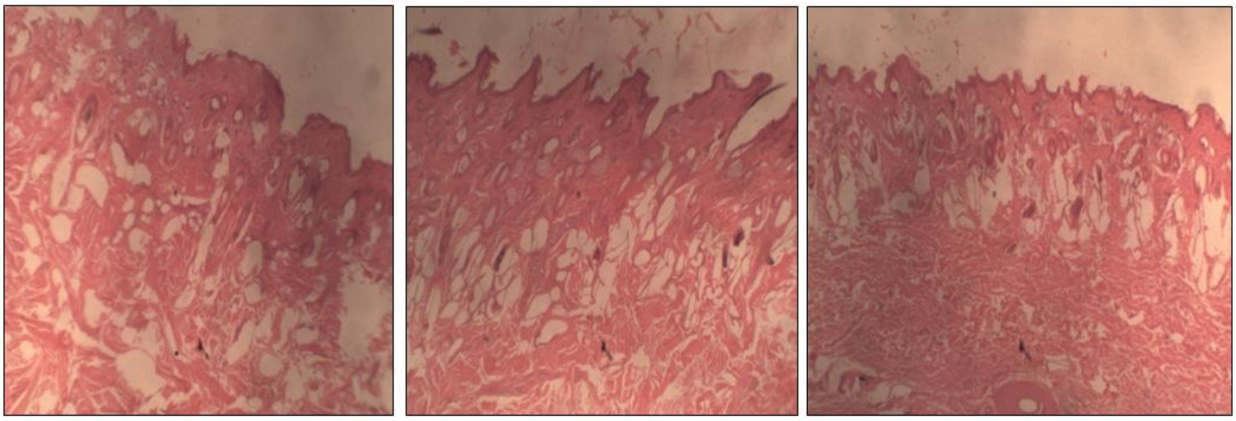

Fig. 3: Optical microphotographs of green bovine leather at 40* magnification

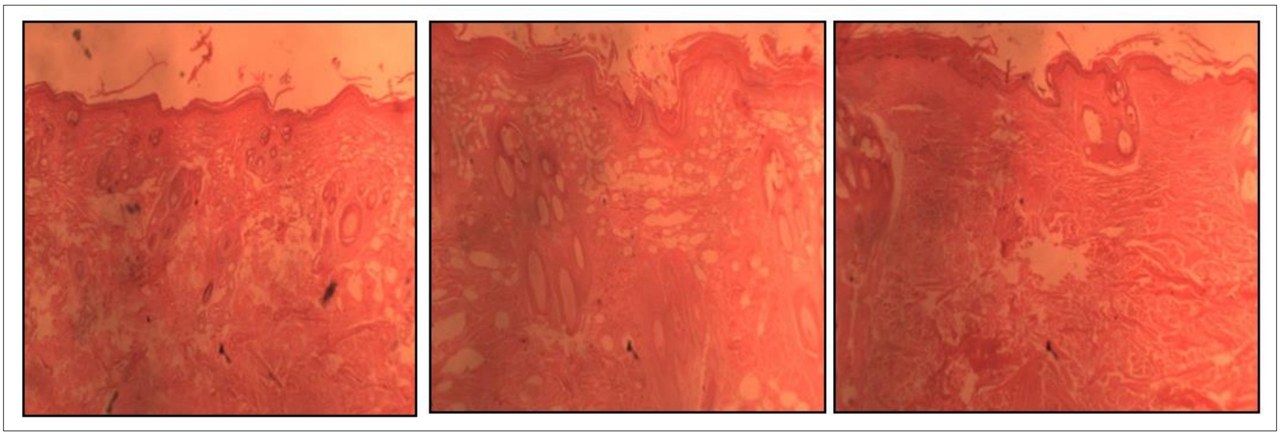

Fig. 4: Optical microphotographs of green camel leather at 40* magnification

3.2 Hydrothermal Stability of Experimental and Control Leathers

Shrinkage is a phenomenon, associated with dimensional changes of hide, skin or leather when subjected to heating. The temperature at which the material shrinks is termed as "shrinkage temperatur" (T_s); and this varies when the hide or skin is tanned. Shrinkage temperature value (T_s °C) of a specimen in water as the heating medium, is taken as measure of hydrothermal stability and the boil test (viz, test for curling of leather in boiling water) is used even today, to assess the completion of chrome tanning [20]. The shrinkage temperature of both experimental and control leather is given in Table 3.

Table 3: Shrinkage temperature of experimental and control crust leathers

Experiment	Shrinkage temperature (°C)
Camel leather	112±1
Cow leathers	111±1

3.3 Organoleptic Properties of Crust Leathers for Experimental and Control

The organoleptic properties (visual assessment) of upper crust leathers for experimental (camel) and control (cow) are shown in Fig. 5. From the figure, it is observed that experimental crust leathers exhibited good softness, fullness, smoothness, general appearance and dye uniformity compared to control leathers.

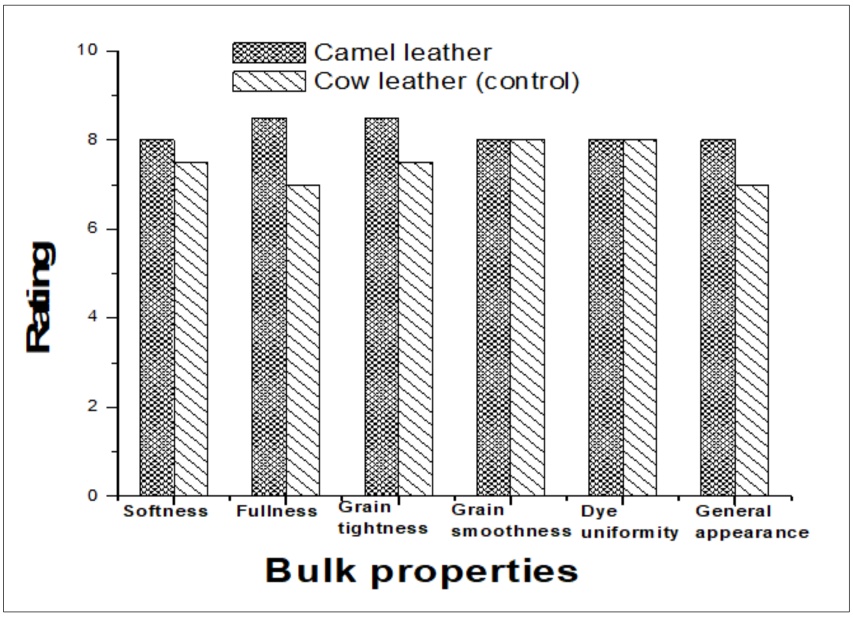

Fig. 5: Graphical representation of organoleptic properties of the Experimental and control leather

3.4 Physical Strength Characteristics of Experimental and Control Crust Leathers

The physical strength measurements of experimental camel and control cow leathers are given in Table 4. The physical strength measurements viz., tensile strength, tear strength has been found to be better for experimental leathers. The values for load at grain crack for both experimental and control leathers were comparable. All the physical strength parameters for both control and experimental leathers are found to meet the requirement of BIS standards for upper leathers [21]. It is seen that the softness of experimental leathers are better than that of the control leathers. This is in accordance with the observations made by subjective evaluation on softness (Fig. 5).

Table 4: Physical strength Characteristic of experimental and control crust leathers

Parameter	Experimental camel leather	Control Cow leather	BIS standards
Tensile strength (Kg/cm^2)	263±2	215±3	200
Elongation at break (%)	63±1.6	58±1.6	40-65
Tear strength (Kg/cm)	66±1.7	54±0.7	30
Load at grain crack (kg)	41±1.5	36±1.5	20
Distention at grain crack (mm)	13±0.5	12±07	7

3.5 Scanning Electron Microscopic Analysis of Leather Samples

Scanning electron micrograph of crust samples from both experimental (Fig. 6.A) and control leathers (Fig. 6.B) showing well separated and opened up fibres. However, more compact and coated fibres are seen in the case of experimental leather (camel) and it is possess better fullness. The fibre compactness seems more clear and resembles the cow hides. This feature of the camel leather explain that the raw material is suitable for the manufacture of shoe upper leathers

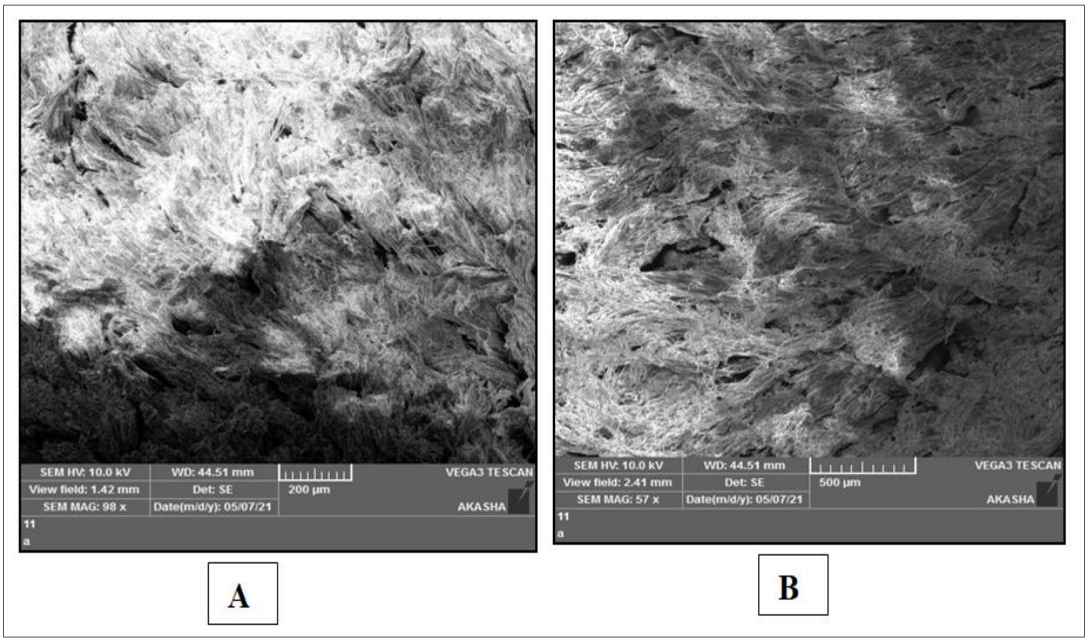

Fig. 6: Scanning electron microphotograph of chrome tanned camel leater (A) and chrome tanned cow leather (B)

3.6 Chemical Analysis of the Crust Leather

The chemical analysis values of experimental crust leathers and control are given in Table 5. The chemical analysis data for the experimental leathers is comparable to that of control leathers.

Table 5: Chemical analysis of experimental and control crust leathers

Parameter	Experimental Camel Leather	Control Cow Leather
Moisture %	14	12
Total ash content %	6.4	6.2
Fats and oils %	4.8	4.3
Chrome oxide (Cr_2O_3)	3.8	3.5

4. CONCLUSIONS

The main source of raw material for the Sudan leather sector comes from sheep, goat and cattle. Camel hides are being considered as an additional source of raw material for the tanning industries. In the present study, camel hides were used for manufacture of upper crust leathers and compare with conventional cow hides. The physical and chemical analysis indicates that the experimental leathers are comparable to control leathers in terms of all the properties. The bulk properties for the experimental leathers are better than control leathers. Scanning electron microscopic analysis for both control and experimental leather samples show good separation of fiber bundles. The chemical and physical characteristics of the experimental camel leather revealed that the camel hide raw material was suitable for making of shoe upper leather. In Sudan camel was considered as best alternative animal to conventional raw materials such as sheep, goat and cattle due to its higher off take rate.

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