Review article: Shedding light on camel leather

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Abstract

Camel hides are the by-product of meat production. For years, camel hides have not received adequate attention compared to the skins and hides of other animal species, despite their unique characteristics. In this regard, this review aims to discuss all matters related to camel hides and leather. Whilst camel hides are more durable than those of other types and their leather competes with bovine and buffalo leather, due to similarities in their surface grain patterns, they are not utilized sufficiently. The reasons for that is because of the wastage of the final surface area of the finished leather, as a result of a high level of hide damage and defects in surface grain pattern, as well as the awkward shape of a camel's hump. However, camel domestication, applying modern farming systems and using modern tanning processes, may lead to an increase in camel hide marketing.

Keywords: histological characteristics, leather tanning, marketing, physical properties

Introduction

Camels play an important pivotal role in the life of pastoral people, because they can live and reproduce in lands with scanty vegetation, while other livestock species cannot survive under the same conditions (Faye, 2008; Faran *et al*., 2018; Chase, 2019).

There are two species of camels, one-humped Dromedary (*Camelus dromedarius*) and two-humped Bactrian (*Camelus bactrianus*), that are significantly commercially used in the world (Bhakat and Sahani, 2005; Yam and Khomeiri, 2016); Thence, it is customary that when speaking about camels, the term 'camel' refers to both species. Camels are mainly raised for meat, milk, milk therapeutic value, wool, hides, leather, tourism, trekking, racing, recreation, prestige, ploughing and transportation (Faye, 2008; Acharya and Babel, 2019; Abdullahi, 2019; Mirkena *et al*., 2018).

The expected future challenges of drought, environmental changes, global warming and threats of new disease on earth make the camel a viable livestock animal of the future (Kagunyu and Wanjohi, 2014). Currently, researchers in various fields are interested in maximizing camel use for the aforementioned reasons, but this interest has not yet included the production of camel hides. The conversion of animal skins or hides into leather is done through the leather tanning process, which is considered the only bridge to maximize the uses and economic value of animal skins as by-products (Rydin *et al.,* 2013).

Therefore, attributable to the paucity of information regarding improving camel hides and leather, this review paper is intended to look more closely at all that relates to camel hides and leather. Consequently, it will introduce information on the production of camel hides, hide and leather properties and the marketing of camel leather.

Production of camel hides

Based on the most recently available statistics of FAOSTAT (2019), the camel population has increased dramatically during the last 25 years, and has almost doubled during this period (Figure 1A). The change in the camel population after 2014 has had the highest impact, because it increased from 28 million in 2014 to 35 million in 2017. The majority of these, about two-thirds, are located in the Sub-Saharan African nations of Chad, Somalia, Sudan, Kenya and Niger (Table 1). That might be due to the increased interest in camel breeding during the last five years.

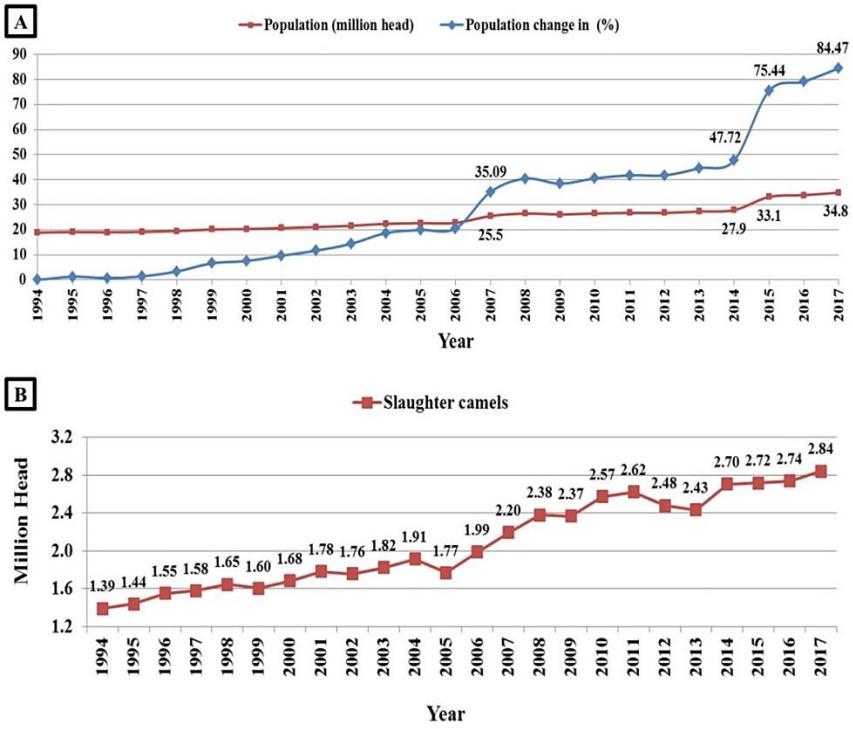

Figure 1. Statistics for the camels population from 1994 to 2017 (FAOSTAT, 2019);
A. Live camel population, B. Slaughtered numbers

MacNamara *et al*. (2003) assumed that the production of camel hides is associated with the slaughter rate. So far, data for camel hide production is unavailable, while the statistical figures for the production of hides and skins and leather of other animal species are limited in availability. Recently, Nasr (2015) stated that the difficulty in recording the numbers of camel hides is due to their slaughtering far away from authorized official slaughterhouses.

A recent observation by FAOSTAT (2019) noted that the number of camel hides increased gradually during the past quarter of a century to reach about 2.8 million pieces in 2007 (Figure 1B). Additionally, slaughter figures suggest that about 60% of the total camel hides are produced in the Middle Eastern and African countries, especially Sudan, Saudi Arabia, Somalia, Kenya, and the United Arab Emirates (Table 1). In this regard, MacNamara *et al*. (2003), Zeng and McGregor (2008) and Ibrahim (2013) illustrated that camel hide tanning is quite common in the Middle East in places such as Saudi Arabia and Egypt. However, the produced hides from these countries are still of poor quality.

Table 1: Top countries with a camel population and slaughtered camels in 2017.

Camel population		Slaughter camels	
Country	%	Country	%
Chad	20.9	Sudan	18.8
Somalia	20.7	Saudi Arabia	16.5
Sudan	13.9	Somalia	9.7
Kenya	9.6	Kenya	8.5
Niger	5.1	United Arab Emirates	6.6
Mauritania	4.2	Ethiopia	5.1
Other countries	25.6	Other Countries	35

Source: FAOSTAT (2019).

Hide and leather properties

During the camel lifespan, the skin plays an important role in controlling body temperature (Fath El-bab *et al*., 2017). Meanwhile, after slaughtering, the skin histological composition affects the physical properties of hides and thus the tanned leather's quality (Covington, 2011; Hekal, 2014).

The histological characteristics of camel skin are different from other domestic mammals and affect the hide and leather properties. Ansari-Renani *et al*. (2010) and Hekal (2014) found that two types of hair fibers cover camel skin; guard hair comes from the primary follicles and fine wool comes from the secondary follicles.

These two types of hair follicles give a special shape for the tanned leather surface as shown in scan electron micrographs introduced by Meles (2014) in Figure (2), which is considered coarser than bovine and softer than buffalo leathers.

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The other important point is the thickness of the dermis layer, which is relatively thicker in camel skin than in the skin of other large animals such as cattle and buffalos (Lee and Schmidt-Nielsen, 1962; Hekal, 2014). It has been observed that the increase in the thickness of the dermis layer is accompanied by an increase in the physical properties of camel leather, such as tensile and tear strength (Hekal, 2014). Moreover, Meles (2014) and Nasr (2017) noticed that the compactness of collagen fiber bundles in tanned camel leather improved its physical properties.

Despite the fact that the structure and distribution of glands in the dermis layer of camel skin differs in some respects from that described for domestic mammals (Dowling and Nay, 1962; Lee and Schmidt-Nielsen, 1962; Abdou *et al*., 2006; Hekal, 2014; Fath El-bab *et al*., 2017), no effect on hide or leather properties has been mentioned in previous research.

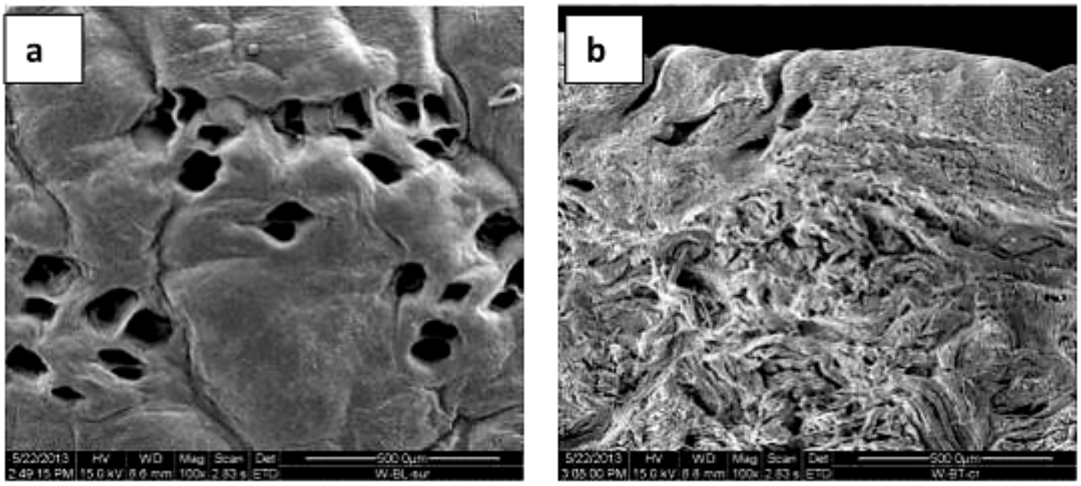

Figure 2. Scanning electron micrograph images of wet blue camel leather (Meles, 2014) a) Grain surface, b) Cross section

Although camel hides have the aforementioned histological advantages, tanned camel leather is still tanned in only a few tanneries. The literature revealed two main issues that limit the handling of camel hides. The first is the difficulty of collecting and transporting camel hides from their distant places to tanneries. The second is the wastage involved in the large surface area of camel hides. The actual reasons behind this wastage of the surface area are: (i) the distinctive shape of the hump that necessarily requires the hides to be cut from the back line; (ii) the dermatological defects due to external parasites, skin diseases and animal branding; (iii) the defects in the skinning and preserving methods used by pastoralists (Wayua and Kagunyu, 2012; Nasr, 2015; Jarso *et al*., 2018; Wanyoike *et al*., 2018; Acharya and Babel, 2019).

Meanwhile, after tanning camel hides and producing finished leather, the suitability of camel leather for some manufacturing purposes, like garments and upholstery, is questionable. This is ascribable to the increase in leather thickness and the smallness of cutting area. Designers have a belief that the thickness of the leather prohibits its use, as a result of its stiffness or difficulty in flexing, whereas the leather's damage means it is more suited to the manufacture of accessories only (MacNamara *et al*., 2003).

Consequently, previous research provided the attempts and the recommendations to maximize the uses of camel leather. Guya and Neme (2015) and Seid *et al*. (2016) flayed camel skins starting from the back line toward the abdomen (Figure 3), which produced non-curved hide in the hump area and thus increased its utilized area after tanning. Furthermore, Nasr (2017) introduced practical solutions in the tanning processes to resolve grain surface defects by applying modern finishing methods for producing particular types of leathers, such as nappa, nubuck, pigmented and corrected grain, which treated most defects and improved some of the physical properties. From a manufacturing point of view, when comparing the requirements needed for manufacturing different leather products (BASF, 2007) with the physical properties of tanned camel leather (Tables 2 and 3), it is clear that camel leather has high strength and can be used for a wide range of purposes such as garments, upholstery, footwear, bags, and other leather goods

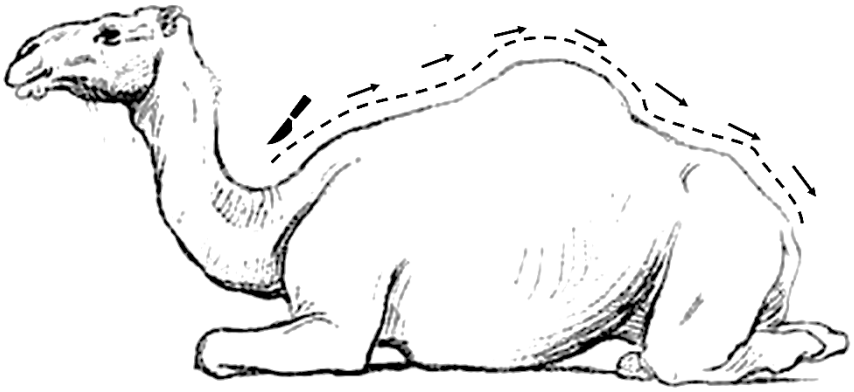

Figure 3. Flaying camel skin starting from the back line toward the abdomen.

Marketing camel leather

There is a lack of market awareness of camel leather in potential export markets. Especially for camel leather, production and marketing operations are well linked; however, the industry needs assistance to develop export markets for its products (MacNamara *et al*., 2003; Wayua and Kagunyu, 2012; Aujla *et al*., 2013; Wangui, 2016; Wanyoikeetal., 2018).

There are two important points that may promote the growth of camel leather marketing in the future, namely, the low price of camel hides (MacNamara *et al*., 2003) and the novelty appeal of camel leather in large markets that rely on a modern leather tanning industry, like in Italy, the United States, China and India (MacNamara *et al*., 2003; Goulding *et al*., 2007; Zeng and McGregor, 2008; Wanyoike *et al*., 2018).

From our point of view, after applying modern tanning techniques in the Middle East, some tanneries have become specialized in tanning camel hides only, such as the Al-Khazanh Tannery in the Emirates. Additionally, many advertisements for camel leather and its products have spread via online media promotions based on the durability of camel leather, with its distinguished unique properties as compared to leather from other species.

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Conclusion

Camel hides face various difficulties that partially or completely damage their uses in leather production, namely the difficulty in collecting and transporting camel hides, in addition to the wastage of the final surface area of the finished leather.

In contrast, camel leather has more advantages than other animal species' hides, particularly because of its low price, high strength and large surface area facilitating a wide range of manufacturing applications. In turn, this leads to a novel appeal in large markets.

Presently, camel hides are still of low quality and are used only for manufacturing little products such as small accessories. Therefore, domestication and the improvement of camel farming systems through advanced husbandry and management practices, rather than wild harvesting, will increase hide yield and quality.

Table (2): Tensile and tearing strengths properties of camel leathers.

Property	Value	Camel type	Tanning method	Reference
Tensile strength (kg/cm^2)	214.7 ± 25.2	Dromedary	Chrome	Salehi & Gharahdaghi (2013)
	203.6 ± 27.1	Dromedary × Bactrian		
	390.07 ± 29.47	Dromedary (Maghrabi)	Chrome	Hekal (2014)
	322.23 ± 33.23	Dromedary (Sudani)		
	246 – 291	Dromedary	Chrome	Meles (2014)
	211.6 – 220.8	Dromedary	Chrome	Dereje et al. (2015)
	215.68	Dromedary	Vegetable	Nasr (2015)
	241.87		Chrome	
	357.24		Combined	
	290.68	Dromedary	Combined (Nappa)	Nasr (2017)
	276.02		Combined (Nubuck)	
	295.95		Combined (Pigmented)	
	329.29		Combined (Corrected grain)	
Tear strength (kg/cm)	38.1± 3.2	Dromedary	Chrome	Salehi & Gharahdaghi (2013)
	33.7 ± 3.6	Dromedary × Bactrian		
	68.14 ± 3.85	Dromedary (Maghrabi)	Chrome	Hekal (2014)
	70.57 ± 4.70	Dromedary (Sudani)		
	99.34 – 10.6	Dromedary	Chrome	Meles (2014)
	43.16 – 48.80	Dromedary	Chrome	Dereje et al. (2015)
	28.75	Dromedary	Vegetable	Nasr (2015)
	50.89		Chrome	
	69.60		Combined	
	69.23	Dromedary	Combined (Nappa)	Nasr (2017)
	69.67		Combined (Nubuck)	
	73.37		Combined (Pigmented)	
	86.94		Combined (Corrected grain)	

Table 3. Elongation, water vapor permeability and water absorption properties of camel leathers.

Property	Value	Camel type	Tanning method	Reference
Elongation (%)	61.0 ± 3.7	Dromedary	Chrome	Salehi & Gharahdaghi (2013)
	63.4 ± 4.0	Dromedary × Bactrian		
	83.84 ± 3.06	Dromedary (Maghrabi)	Chrome	Hekal (2014)
	84.86 ± 2.62	Dromedary (Sudani)		
	46.13 – 49.27	Dromedary	Chrome	Meles (2014)
	52.98 – 55.40	Dromedary	Chrome	Dereje et al. (2015)
	24.43	Dromedary	Vegetable	Nasr (2015)
	45.86		Chrome	
	84.57		Combined	
	51.87	Dromedary	Combined (Nappa)	Nasr (2017)
	68.36		Combined (Nubuck)	
	54.11		Combined (Pigmented)	
	48.19		Combined (Corrected grain)	
Water vapor permeability (mg/cm^2hr)	12.95	Dromedary	Chrome	Meles (2014)
	4.82	Dromedary	Combined (Nappa)	Nasr (2017)
	5.43		Combined (Nubuck)	
	1.45		Combined (Pigmented)	
	1.41		Combined (Corrected grain)	
Water absorption (%)	75.27 – 80.37	Dromedary	Chrome	Dereje et al. (2015)
	127.79	Dromedary	Vegetable	Nasr (2015)
	134.14		Chrome	
	138.97		Combined	
	95.13	Dromedary	Combined (Nappa)	Nasr (2017)
	123.24		Combined (Nubuck)	
	108.45		Combined (Pigmented)	
	91.57		Combined (Corrected grain)	

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