Evaluation of Egyptian Camel Hides for Leathers Manufacturing

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Abstract: The efficiency of using different tanning and finishing methods for manufacturing of Egyptian camel leather has been evaluated. Three different tanning methods (chrome, vegetable and combined) were used to tan pelts according to its grade. Four different finished leather articles (nappa, nubuck, corrected grain and suede) were produced from chrome tanned leathers to improve their appearance. The results of both physical and chemical properties illustrated that the combined tanning method produced the highest leather quality followed by chrome and vegetable tanning, respectively. Furthermore, the nappa leathers had the highest quality followed by nubuck, suede and corrected grain, respectively. Additionally, the produced leather articles showed no visual defects in grain side. These results clarify the ability of using Egyptian camel leathers for manufacturing of garments, shoe upper, upholstery, lining and sole manufacturing.

Key words: Camel • Hides • Leather • Tanning • Chrome • Vegetable

INTRODUCTION

Camels are considered the most important livestock in arid and semi-arid regions. There are about 27 million camels in the world, of which 85% are found in Africa and 15% in Asia. In Egypt, there are about 142 thousand heads of camels that can produce around 46 thousand tons of milk, 3700 tons of meat and 1400 tons of hides per annum [1]. The one-humped camel (Camelus dromedarius) is the only specie found in Egypt, where three major breeds prevail i.e. the Nile Delta, the Bisharian and camels of Upper Egypt [2]. They are kept mostly by nomads for their milk, meat, hair and hides as well as for transportation [3]. Hides and skins in Egypt are by-product of slaughtered animals. Thus, leather production is based only on heavy and light leathers of cattle, sheep and goat skins [4]. Although camel hides are important resources that could contribute a significant income to pastoralists, they are not manufactured in Egypt due to several constrains: I. Camels are slaughtered by Bedouin in desert areas outside slaughterhouses, which makes it difficult to collect the hides. II. The long distance between desert areas and tanneries increases the transportation costs. III. Due to lack of interest by pastoralists, camel hides contain much blemishes and markings from diseases, parasites, poor curing and flaying defects which caused poor quality for finished leathers [5]. In Egypt nowadays, the leather production process comprises collecting the skins or hides from slaughterhouses, preserving them with salt then transporting them to the tanneries. Most tanneries are located in Cairo or Alexandria and relied mainly on the chrome tanning method [4]. Leather tanning and finishing methods are developed to produce different types of leathers, which can be used in different uses such as garments, footwear, luggage and upholstery [6]. Several investigators have studied the physical properties of Egyptian camel hides and leathers [7-9]. Although camel leathers are characterized with higher strengths than cow leathers [5], there is still a lack in regarding evaluation of camel leather properties following tanning and finishing by different methods to use it in manufacturing.

Thus, this paper aims to compare different tanning and finishing methods on quality of Egyptian camel leather, as well as their ability to avoid the apparent defects.

MATERIALS AND METHODS

Thirty one-humped male camel hides at marketing age (24-30 months) were used in the presented study. All hides were subjected to the same beamhouse steps; soaking, liming, unhairing, fleshing, deliming, bating and pickling. After that pickled pelts were classified visually into three grades according to their defects in total pelts area such as mechanical injuries, flaying defects and
others caused by diseases or parasites. Pelts contained defects less than 15% from total surface area classified as grade I. Pelts contained 15-25% defects classified as grade II, while grade III contained pelts with defects more than 25%. Fig. 1 shows schematic diagram for work plan. Three different tanning methods were used to produce leathers as follows:

- **Vegetable leathers**: tanned with 20% mixture of quercitron and mimosa extracts powder and fatliquored with 8% fatliquor.
- **Chrome leathers**: tanned with 10% chromium (III) sulphate (33% basicity) and fatliquored with 10% fatliquor.
- **Combined leathers**: tanned with 8% chromium (III) sulphate (33% basicity) then re-tanned with 10% mixture of quercitron and mimosa extracts powder and fatliquored with 10% fatliquor.

According to finishing method, six finished articles were produced (five leathers in each article) as follows:

- **Full grain leather (Nappa)**: was taken from grade (I) without making any mechanical modifications in surface characteristics. Thus, it included the three different tanning methods.
- **Nubuck leather**: was taken from grade (II). The grain surface was lightly buffed to create a velvety finish or nap.
- **Corrected grain pigmented leather** was taken from grade (II). The grain surface was strong abraded to remove imperfections before the surface coating is applied. A decorative waterproofed grain pattern was then embossed into the surface.
- **Suede leather** was taken from grade (III). The grain surface had many imperfections. So, the flesh side was fine buffed to create a distinctive nap.

Samples for various physical and chemical tests from all leathers were obtained as per ASTM methods [10]. Specimens were conditioned at 20°C±2°C and 65±4% RH over a period of 48 hrs. Physical properties such as tensile strength, percentage elongation at break, split tear strength, static water absorption; shrinkage temperature and flexibility were 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). Chemical properties such as % moisture, total ash content, % chromic oxide, % oils and fats, pH and degree of tannage have been carried out for control and experimental leathers according to standard procedures.

Data were analyzed using GLM procedure of SAS [11] to evaluate the differences among produced leathers with different tanning or finishing methods. Significant differences were detected using the Duncan Multiple Range Test.
The fixed effect model used was $Y_{ij} = \mu + T_i + e_{ij}$ where, $Y_{ij}$ = The observation taken on leather (j), $\mu$ = Overall mean, $T_i$ = a fixed effect of the (i) tanning methods (i=3 vegetable, chrome and combined tanned leathers) or finishing methods (i=4 nappa, corrected grain, nubuck and suede leathers), $e_{ij}$ = Random error assumed to be normally distributed with mean = 0 and variance = $\sigma^2$. 

**RESULTS AND DISCUSSIONS**

Results of physical and chemical properties measured on leathers tanned with three tanning methods are displayed in Table 1.

### Tanning Material Effect

#### Physical Properties: The results showed that elongation (24.43%), tensile (215.68 kg/cm²) and split tear (28.75 kg/cm) values were the lowest values in vegetable tanned leathers followed by those tanned with chrome with corresponding values 45.86%, 241.87 kg/cm² and 50.89 kg/cm, respectively. On the other hand, combined tanned leathers resulted in physical properties with values 84.57%, 357.24 kg/cm² and 69.60 kg/cm, respectively. This trend was expected in accordance with other investigators [12-15], who found the same trends in leathers produced from another animal species. Covington [16] explained that chrome tanning depending on making short, rigid and non-labile cross-links with carboxyl groups in collagen fibers, while in vegetable tanning the cross-links is weaker and more labile with amino groups in collagen fibers. Thus, combined tanning method in this study produced the highest quality leathers because it combined both advantages of chrome and vegetable tanning methods. The effect of using this method is also extended to elongation results. In this regard, fibers elasticity may be affected by quantity of fatliquors added in finishing step. Thus, vegetable tanned leathers were the lower in fat percentage the lower in elongation value. Moreover, the shrinkage temperature was the lowest value (72°C) in vegetable tanned leathers than other leathers (100°C) which tanned with chrome or combined tanning methods.

#### Table 1: Least squares means and SEM of camel leather properties tanned with different tanning methods.

<table>
<thead>
<tr>
<th>Method</th>
<th>N</th>
<th>Tensile (kg/cm²)</th>
<th>Elongation (%)</th>
<th>Split Tear (kg/cm)</th>
<th>Water Absorption (%) 2 hrs</th>
<th>Water Absorption (%) 24 hrs</th>
<th>Moisture (%)</th>
<th>Ash (%)</th>
<th>Cr oxide (%)</th>
<th>Fat (%)</th>
<th>pH</th>
<th>Tanning Degree (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetable</td>
<td>5</td>
<td>215.68*</td>
<td>24.43*</td>
<td>28.75*</td>
<td>127.79</td>
<td>129.45</td>
<td>14.02</td>
<td>0.86</td>
<td>5.77</td>
<td>5.02</td>
<td>58.82*</td>
<td></td>
</tr>
<tr>
<td>Chrome</td>
<td>20</td>
<td>241.87*</td>
<td>45.86*</td>
<td>50.89*</td>
<td>134.14</td>
<td>137.07</td>
<td>14.21</td>
<td>4.40</td>
<td>3.27</td>
<td>9.12</td>
<td>4.62</td>
<td></td>
</tr>
<tr>
<td>Combined</td>
<td>5</td>
<td>357.24*</td>
<td>84.57*</td>
<td>69.60*</td>
<td>138.97</td>
<td>141.37</td>
<td>14.00</td>
<td>4.14</td>
<td>2.32</td>
<td>9.28</td>
<td>4.56</td>
<td>39.42*</td>
</tr>
</tbody>
</table>

SEM = 11.76 3.70 4.18 2.25 2.33 0.20 0.25 0.23 0.31 0.10 4.44

Significant ** ** NS NS NS NS NS NS NS NS NS

* Significant at P<0.05
** Significant at P<0.01
NS: Not Significant

a, b, c in the same column means with different superscripts are significantly different (P<0.05).

#### Table 2: Least squares means and SEM of camel leathers properties finished with different methods.

<table>
<thead>
<tr>
<th>Method</th>
<th>N</th>
<th>Tensile (kg/cm²)</th>
<th>Elongation (%)</th>
<th>Split Tear (kg/cm)</th>
<th>Water Absorption (%) 2 hrs</th>
<th>Water Absorption (%) 24 hrs</th>
<th>Moisture (%)</th>
<th>Ash (%)</th>
<th>Cr oxide (%)</th>
<th>Fat (%)</th>
<th>pH</th>
<th>Tanning Degree (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nappa</td>
<td>5</td>
<td>283.35*</td>
<td>29.36*</td>
<td>80.06*</td>
<td>135.35*</td>
<td>137.98*</td>
<td>14.22</td>
<td>4.10</td>
<td>3.32</td>
<td>8.16</td>
<td>4.68</td>
<td></td>
</tr>
<tr>
<td>Nubuck</td>
<td>5</td>
<td>269.63*</td>
<td>47.45*</td>
<td>35.38*</td>
<td>151.43*</td>
<td>154.67*</td>
<td>14.62</td>
<td>4.58</td>
<td>3.28</td>
<td>9.48</td>
<td>4.50</td>
<td></td>
</tr>
<tr>
<td>Corrected</td>
<td>5</td>
<td>174.03*</td>
<td>51.12*</td>
<td>47.59*</td>
<td>114.52*</td>
<td>117.90*</td>
<td>13.86</td>
<td>4.52</td>
<td>3.14</td>
<td>9.58</td>
<td>4.66</td>
<td></td>
</tr>
<tr>
<td>Suede</td>
<td>5</td>
<td>238.48*</td>
<td>55.51*</td>
<td>34.52*</td>
<td>135.27*</td>
<td>137.73*</td>
<td>14.14</td>
<td>4.40</td>
<td>3.36</td>
<td>9.26</td>
<td>4.62</td>
<td></td>
</tr>
</tbody>
</table>

SEM = 10.80 2.44 5.33 3.17 3.26 0.28 0.08 0.05 0.24 0.06

Significant ** ** NS NS NS NS NS NS NS NS NS

* Significant at P<0.01
NS: Not Significant

a, b, c in the same column means with different superscripts are significantly different (P<0.05).
These results were in agreement with BASF [6], who illustrated that shrinkage temperature of chrome tanned leathers is 100 °C while shrinkage temperature in vegetable tanned leathers ranged from 70-85°C. This could be due to that the generated cross-links are stronger in chrome tanned leathers than in vegetable tanned leathers. Meanwhile, all tanned leathers were resistant for flexibility test until thirty thousand flexures without any cracks.

Chemical Properties: The results showed that total ash, chrome oxide, fat percentages and tanning degree were affected (P<0.01) among all tanned leathers. Total ash content recorded the lowest value with vegetable tanning method (0.86 %) compared to both chrome (3.58%) and combined (3.32%) tanning methods. This may be due to the absence of chromium salts in ash [6]. For reasons related to manufacturing properties, vegetable tanned leathers should be more toughness and less flexible than other leather types. Thus, fatliquors were added in fatliquoring step with percentages 8, 10 and 10% for vegetable, chrome and combined tanned leathers which reflected in fat percentage values in finished leathers to be 5.77, 9.12 and 9.28%, respectively. In the meantime, tanning degree is a property for leathers tanned with vegetable materials and not applied in nonorganic tanned leathers such as chrome tanned leathers [10]. Thus, tanning degree values were higher in vegetable tanned leathers than combined tanned leathers due to amount of vegetable extract added in tanning which was 20% with vegetable tanned leathers as a main tanning agent and 10% with combined tanned leather as a re-tanning agent. On the other hand, moisture percentage and pH values were insignificant differed among all leathers and in accordance with BASF [6] limitation values for leathers uses in various manufacturing purposes.

Finishing Method Effect: The results presented in Table 2 demonstrate the physical and chemical properties measured in chrome tanned leathers, which finished with four different methods.

Physical Properties: Results of physical properties showed that buffing or abrasion operation in finishing steps negatively affected (P<0.01) at the quality of finished leathers especially strengths values. Thus, nappa leathers were the highest strengths values the highest quality which were not mechanical abraded. On the other hand, nubuck leathers showed higher quality (P<0.01) than both suede and corrected grain leathers because they were lightly buffed at grain side. Although suede leathers are expected to be of lower quality than corrected grain leathers, the opposite result was observed. Removing the upper leather layer by hard abrasion in corrected grain leathers might be the reason for weakness in strengths values unlike suede leathers which were light buffed from flesh side. Static water absorption test after 2 and 24 hours were also affected by buffing, abrasion or other mechanical changes in grain side which was reflected clearly in corrected and nubuck leathers. Although coating grain side with decorative waterproofed grain, which might be the reason for lowering water absorption value in corrected grain leathers, however buffing grain side might be the reason for the high water absorption value in nubuck leathers. Additionally, flexibility for all finished leathers was done until thirty thousand flexures and no cracks were shown at all four groups.

To date, no previous research explained the differences in physical properties between different types of finished camel leathers. However, some investigators discussed properties of camel leathers tanned with chromium salts. Hekal [9] determined tensile strength, elongation and split tear strength and found it 390.07 kg/cm², 83.84% and 68.14 kg/cm for Maghrabi camel leathers and 322.23 kg/cm², 84.86% and 70.57 kg/cm for Sudan camel leathers respectively. These values were higher than those obtained in the presented study. Furthermore, Azzam and Abdelsalam [8] reported that tensile strength and elongation determined in finished leathers ranged from 107.5 to 202.9 kg/cm² and from 17 to 28.9% in dromedaries fed on different desert plants. These values tend to be lower than those obtained in the presented study. On the other hand, other investigators [5, 8, 17] measured tensile strength and elongation on dromedary camel leathers and their result values were within range by those obtained in the presented study.

Chemical Properties: The results clarified that all finished leathers were similar in chemical properties due to the similarity of tanning method with chromium salt. By comparing physical and chemical properties of camel leathers obtained from this study with BASF [6] limitation range, it can be concluded that Egyptian camel leathers can be used in wide different uses e.g. garment, gloves, chamois, lining, upholstery, sole and shoe upper leathers.
CONCLUSIONS

Egyptian camels are facing numerous problems in caring and husbandry, which was reflected on their hides’ quality. Egyptian camel hides contained different defects in grain side surface which can be observed clearly after pickling step before tanning. Thus, the classification of pickled pelts is necessary to determine suitable tanning and finishing methods. Also, the diversity in tanning and finishing methods is a good solution to overcome these defects and to produce different articles that can be used in manufacturing of garment, footwear and bags. Last but not least, the attention in live camel caring, slaughtering, preserving and collecting camel hides in desert areas will maximize the benefits instead of current situation in Egypt.

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