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Characterization of red deer skins

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Deer skins, which are light, decorative and have good heat isolation, are used as upper leathers especially in cold countries for better protection from the extreme conditions. In the present study, besides some chemical analysis of deer skins, morphological and histological characteristics of deer wools and skins obtained from wild red deers of Republic of Tuva in Russia were investigated.

The chemical analyses of deer skins such as volatile matter, matter soluble in dichloromethane, fatty acid contents by Gas Chromatography (GC) were performed. Besides, thermal resistance properties of deer skins were investigated. For determination of histological and morphological properties of deer skins, formaldehyde was used to protect the structural properties of skin samples and they were displayed by Automated Upright Microscopy (AUM), Scanning Electron Microscopy (SEM) and Table Top Scanning Electron Microscopy (TSM).

The results indicated that deer skins had mainly fatty acids from high amounts to lower which are saturated and unsaturated such as C16:0, C18:0, C13:0, C14:0 and C16:1, C18:1*(cis)*, C18:2(*trans*), C20:3 respectively. Also average thermal resistance value of the skins was found as 0.65 m^2K/W. In addition to thermal resistance value, also histological and morphological structure confirmed their high heat insulation property which is needed especially for upper and garment leathers.

Keywords: Deer skin, Wool, Staining method, Photomicrographs of deer skins, Gas Chromatography.

Introduction

In the past, whilst the shoes have been used for only protecting material from external environment, nowadays they are indispensable wearing materials because of increasing expectations of the customers. For these reasons, shoe industry has a quite different importance within leather industry. Shoe upper leathers must not only protect the foot from external factors but also provide adequate hygiene and comfort. Comfort of leather shoes can be defined as the comfort provided with the combination of natural structure and different physical, chemical properties of leather.(1) Generally, different leather types like bovine, ovine, egzotic and also deer skins are used for this purpose.

Deer skins are used as upper leathers especially in cold countries due to their unique properties like lightness, decorativeness and good heat isolation capacity. Although the researches on deer skins/hides go to 1980s, it is understood that there is a lack of fundamental research whereas there are several studies about egzotic leather manufacturing.(2,3) Clark and Webster 1985 investigated the physical properties of the deer skins like tear and tensile strength.(4) The properties of different type of leathers such as emu and deer skins in comparison to traditional garment leathers was also reported.(5) Besides, Fukunaga et al. 2010 described the morphological and biochemical characteristics of yeso sika deer skin, the seasonal changing of protein content and tensile strength of these skins.(6) Dandar 2005 stated that especially the foot area of deer furs could be used as a footwear material.(7)
In the present study, it is aimed to characterize the wild red deer skins (*Cervus elaphus)* of Republic of Tuva in Russia by determination of some histological, morphological and chemical properties.

Materials and methods

Material

The skins of *Cervus elaphus L.* of Artiodactyla class of Cervides family known as Red Deer[8] were collected by hunters in autumn season in Republic of Tuva in Russia. For histological studies, the samples taken from the different area of each skin were fixed in formalin (10%) after slaughtering and kept in glass bottle until microscopic analysis. Later the skins were salted to prevent the microorganismal attacks until manufacturing processes. Also, for fatty acid ester analysis, GC grade hegzane (Merck) was used.

Methods

Tanning Process of Deer Skins

The tanning process were carried in accordance with Dandar 2005.[7]

Chemical Analysis of Deer Skins

Determination of Volatile Matters and Matter Soluble in Dichloromethane

Leather samples were prepared in accordance with TS EN ISO 4044 (2009)[9] and volatile matter was determined according to TS EN ISO 4684.[10] The matter soluble in dichloromethane of samples was performed by Solvent Extraction System (SES).[11]

Analysis of Fatty Acid Methyl Esters by GC

The fatty acid methyl esters analysis was carried out on an Agilent 7890 gas chromatography operated with an injector and data were acquired by solution software. First natural fat of the deer skin was transesterified to produce esters according to TS 4504 EN ISO 5509[12] and analyzed in accordance with TS 4664 EN ISO 5508.[13]

Thermal Resistance Test of Deer Skins

The thermal resistance properties of leathers was determined in accordance with TS EN ISO 31092 [14] by SDL Atlas Sweating Guarded Hot-Plate Thermal Resistance test device.

Histological and Morphological Analysis of Deer Skins

The skin samples taken from the 10% of formalin blocked in paraffin and the samples were taken vertically to skin surface with 3 µm thicknesses. For this purpose, automated upright research microscopy, scanning electron microscopy, and tabletop scanning electron microscopy devices were used for displaying the cross section of deer skins and their hair follicles.[15]

Displays of the Samples with Automated Upright Research Microscopy (AUM)

Skin samples were stained with Collagenase-Van Gieson, Van Gieson and Hematoxylin staining techniques for obtaining displays[16,17]. For this purpose, Automated Upright Microscopy and Olympus DP71 digital camera were used.

Displays of the Skins with Scanning Electron Microscopy (SEM)

SEM analysis were carried in accordance with Zengin 2007[11]; Şen 2005[18] and Wagner 1999[19].

Displays of the Samples with Tabletop Scanning Electron Microscopy(TSM)

TM 1000 Tabletop scanning electron microscopy (TSM) was used for displaying the skin samples. After placing the skin samples to holder, it is cooled down to -15°C under pressure and the temperature of chamber is accurately monitored and controlled by a microprocessor.

Results and discussions

Chemical Analysis

Determination of Volatile Matter and Matter Soluble in Dichloromethane

Average values of volatile matter and matter soluble in dichloromethane (%) of deer skins were determined as 9.64% and 3.32% respectively.

Determination of Fatty Acid Methyl Esters by GC

Fatty acid methyl esters composition of deer skin was presented in Table 1. Accordingly, it was determined that deer skins had mainly fatty acids from high amounts to lower which are saturated such as palmitic (C16:0), stearic (C18:0) and tridecanoic acid (C13:0) and myristic acid (C14:0) and unsaturated palmitoleic (C16:1), oleic (C18:1*cis)*, C18:3 (*trans*), C20:3, oleic acid (C18:1n9c), α-linolenic (C18:3n3) and long chained nervonic acid (C24:1) fatty acids respectively.

Table 1 Fatty acids of deer skins

Name of the Fatty Acid	Rate (%)	Name of the Fatty Acid	Rate (%)
C11:0	0.53	C18:1n9c	8.98
C12:0	0.17	C18:2n6t	1.59
C13:0	6.56	C18:3n3	2.80
C14:0	4.63	C22:0	1.21
C14:1	0.47	C20:3n6	1.50
C15:0	1.50	C24:0	1.68
C16:0	31.77	C20:5n3	2.03
C16:1	4.43	C24:1	2.88
C17:0	0.80	C22:6n3	2.1
C18:0	13.23	Unidentified	11.65

Thermal Resistance Properties of Deer Skins

The result of the thermal resistance test was found as 0.65 m^2K/W and it is known that this property is one of the most decisive factor in clothing comfort effecting on comfort level. Because of the structure of the winter hair of deer skins which impedes the penetration of water (15) and having less hydrophilic character than the corium(7) compose the reasons of expection of high heat isolation from deer skins. However, there has been limited information about thermal resistance mostly focused on protective properties rather than the comfort properties.

Histological Analysis of Deer Skins

In terms of histological and morphological properties of deer skins, the proportions of medulla inside the coarse fibers were determined high and the medulla cells were polygonal shapes. It was considered that the honeycomb shapes inside the medulla layers were provided the increased heat resistance which give good heat insulation for especially upper leathers. Lastly, it was determined that the group of seven or eight fine fibers located around the one coarse fiber provided better heat insulation.

Displays of the Samples with Automated Upright Research Microscopy (AUM)

The images of the AUM were presented in Figure 1, 2 and 3. It was determined that the follicles, stained by different techniques, comprised of inner and outer sheath and Huxley and Henle layer generating from epithelial cells, around cuticle of inner sheath.[20,21] Outer sheath was formed in the Basale and stratum spinosum cell of epidermis layer.

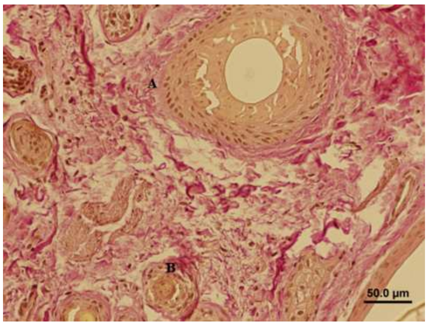

Figure 1 Display of cross-section of guard hair stained with collagenase and Van Gieson

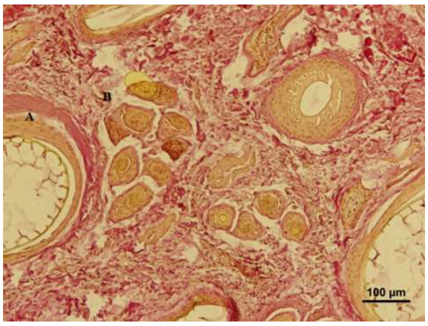

Figure 2 Displays of cross-section of guard hair (A) and fur fibers (B) stained with Van Gieson

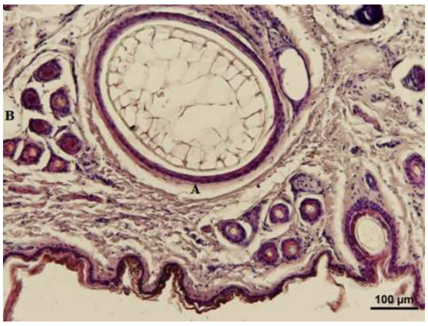

Figure 3 Displays of cross-section of guard hair (A) and fur fibers (B) stained with Hematoxylin

Displays of the skins with Scanning Electron Microscopy (SEM)

Bachrach 1953 described that peltries have a varied hair growth and one of them is guard hair which is straight, resilient, and somewhat coarse and reflects light well, thus giving lustrous appearance to the surface. Second type of the fiber of wild animals is described as fur fibers and the term fur is applied to the fine, soft and often silky hair like forms.[22]

Two types of fiber on the skin surface were shown in Figure 4. As it was seen from the figure that the guard hair (A) was located in the deep layer of the papillary and it was long and had large diameter. Besides, fur fibers (B) described as the second type of fiber was very fine and close to the grain surface.

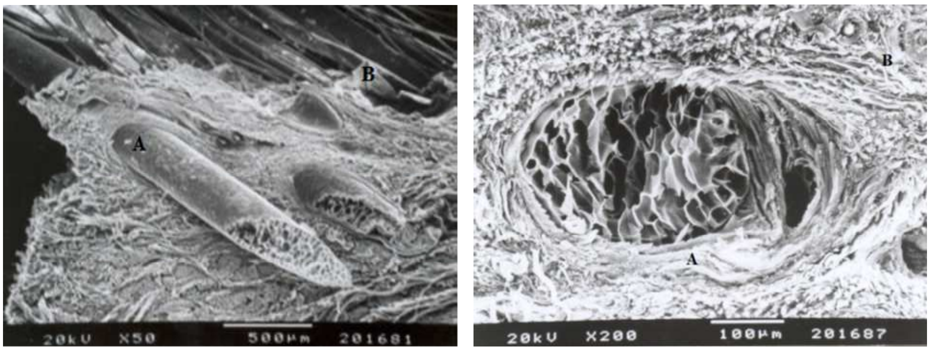

Figure 4 SEM micrographs of the guard hairs (A) and fur fibers (B) of deer.

Displays of the skins with Tabletop Scanning Electron Microscopy (TSM)

The cross section of the guard hair, fur fiber were clearly seen in Figure 5. As a result of these micrographs, guard hairs seemed to be a honeycomb and guard hairs were surrounded by at least 6 or 8 fur fibers.

The epidermis, dermis, guard hairs (A) and fur fibers (B) can be clearly seen in Figure 7 and 8 together.

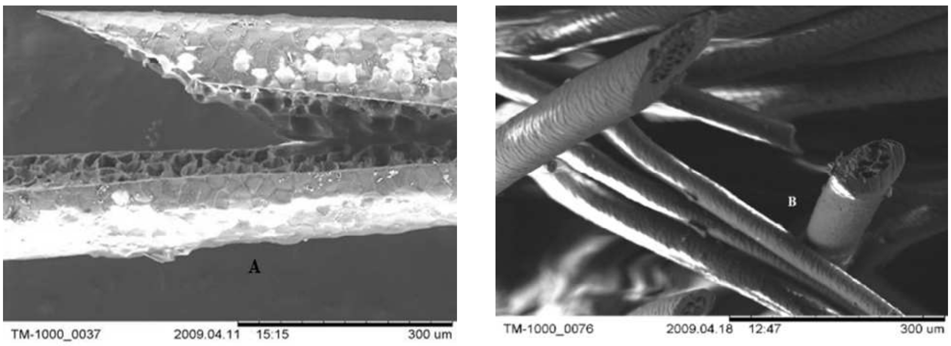

Figure 5 TSM micrograph of the guard hair (A)[23] and fur fibers (B) (*300).

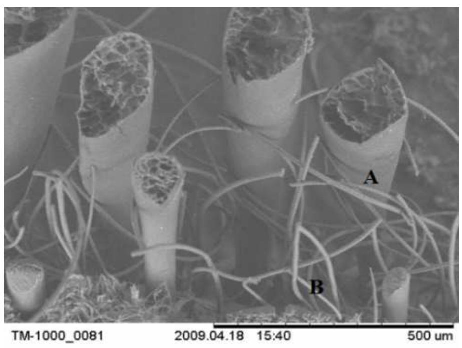

Figure 6 TSM micrograph of guard hairs (A) and fur fibers (B) (*200).

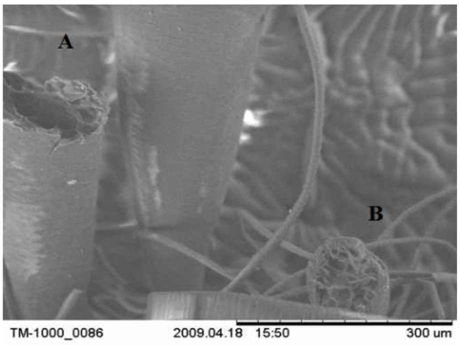

Figure 7 TSM micrograph of guard hairs (A) and fur fibers (B) (*300).

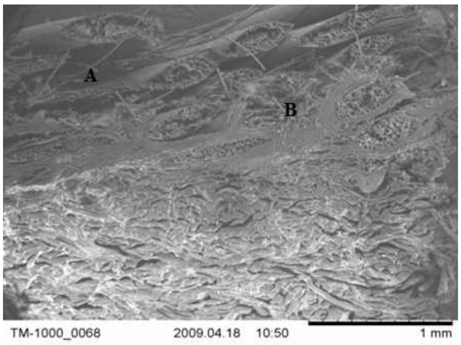

Figure 8 TSM micrograph of cross section of deer skin with guard hairs (A) and fur fibers (B) (*60)(23)

Conclusions

Histological and morphological results showed that red deer skins have two different hair types as guard hairs and fur fibers. Guard hairs were found longer than the fur fibers and approximately the 80-85% of fiber thickness was consisted of the medulla showing a hollow structure that could be the reason of fragile property of guard hair. Furthermore, the micrographs of fur fibers showed that the ratio of the medulla was found lower in comparison to guard hair. Also, some parts of cuticle cells of the fur fibers were hardly visible. Accordingly, it was understood that the fur fibers mainly consisted of cortex with a nearly ratio of 2/3 to total thickness of fur fiber. Having high volume of this layer provides to fur fibers flexibility and resistance. When the fatty acid composition of deer skins were compared with sheep skins, it can be understood that deer skin had significant differences in the fatty acid composition.

Deer skins are mainly used as upper and also garment leathers especially in cold countries for better protection from the extreme conditions due to their potential of good thermal resistance. When the high expectation of thermal resistance property from leather materials is considered, deer skins can be alternative to protective leather products according to its high thermal resistance value. As it was described by also Oğlakçıoğlu and Marmaralı 2010, higher thermal resistance values and insulation properties are preferred from clothing materials used for protection from cold.

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