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Comparative Scanning Electron Microscopic study on the dorsal surface of the hand between two mammalian species and the human

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Abstract

The research is concerned with the comparative study of an important organ of the body of the living organism which called the skin between two types of mammals, namely the Baboon (*Papio hamadryas*) and Squirrel (*Tamias striatus*) on one hand, and human on the other. The study was based on the dorsal electron description of the skin and the identification and to compare the composition structures of the skin surface of the hair of the medium density to the densest in the monkey and squirrel, as well as the dead cells surrounding the hair in both the human and the monkey and the squirrel. The structures that have also been identified are the simple corneal layer in the cornea as well as the highly corneal and permeated by the pores of the sweat pore characteristic of the baboon and squirrel. The comparison and description, specifically for the skin of the apparent hand, is an input to the knowledge of similarities and differences between humans and those.

Keywords: Babon, Squirrel, Hand, Skin, Cornea

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1. Introduction

The scanning electron microscopic study of the dorsal surface of the hand is new application in the field of scanning electron microscopic studies. The aim of this study is the scanning electronic description of the dorsal surface of the hand of and compare this description with baboon and squirrel. In preparation for this study it is necessary to know some of the important structures in the hand such as the dorsal skin and its content of hair and some structures that we will get to know the details after the scanning electron microscopic examination. Skin is the largest organ in the body, it covers the body's entire external surface serving as a first order barrier against pathogens, ultraviolet light, some chemicals and provides a mechanical barrier to injury. It also regulates temperature and amount of water released into the environment (Yousef and Sharma, 2017), but not all skin is the same, skin structure differs slightly according to where it is on our bodies. The dorsum of the hand is a very specialized region with thin and fragile skin characterized by poor subcutaneous tissue (Adani, 2015). The skin varies in thickness, it is thicker on the dorsal and extensor than on the ventral and flexor aspects of the body, in general skin is composed of three main parts, epidermis a superficial layer of stratified epithelium that develops from ectoderm, dermis an underlying layer of connective tissue that is largely mesodermal in origin and subcutaneous tissue a layer of connective tissue that is largely mesodermal

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in origin and subcutaneous tissue a layer of fatty areolar tissue that overlies the more densely fibrous fascia (Rahilly *et al.*, 2008). Epidermal appendages are intradermal epithelial structures lined with epithelial cells with the potential for division and differentiation. These are important as a source of epithelial cells, which accomplish epithelialization should the overlying epidermis be removed or destroyed in situations such as partial thickness burns, abrasions or split thickness skin graft harvesting such as Sebaceous glands, sweat glands Apocrine glands, Mammary gland and Hair follicles, also all vertebrates cover their skin with epidermis and dermis (Amirlak, 2017). Hair in mammals the characteristic threadlike outgrowths of the outer layer of the skin (epidermis). The typical mammalian hair consists of the shaft, protruding above the skin and the root, which is sunk in a pit (follicle) beneath the skin surface except for a few growing cells at the base of the root. The structural unit of a hair follicle consists of the hair follicle itself with an attached sebaceous gland and arrector pili muscle (Kerk *et al.*, 2018). The hair is dead tissue all composed of dead cells which are mainly filled with keratin protein (Bhushan, 2010). Scanning Electron Microscope (SEM) is very used for big magnification of a given sample, generally to evaluate hair surface morphological conditions. The sample is coated with a carbon-gold film in order to lead electric current then under high vacuum, an electron beam is directed over it and the scattering is assessed by a detector, thus the image is generated (Velasco *et al.*, 2009). There are several techniques to examine the skin surface using a SEM, which is used to highlight some features and structures that distinguish the skin. Skin debris (desquamated epithelial cells and apparent skin oils) was examine used the SEM (Burnett, 2016). The fine structure of nuptial pad surface of the anuran amphibians which appear on digits during the breeding season was examined by SEM (Kyriakopoulou-Sklavounou *et al.*, 2012).

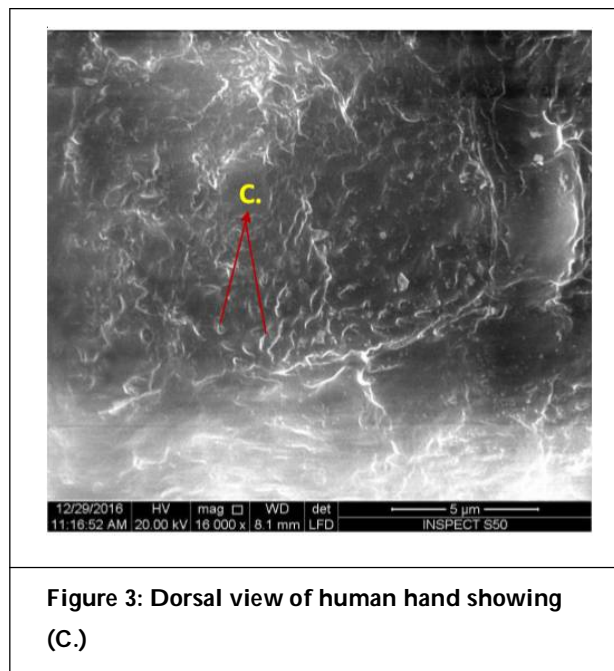
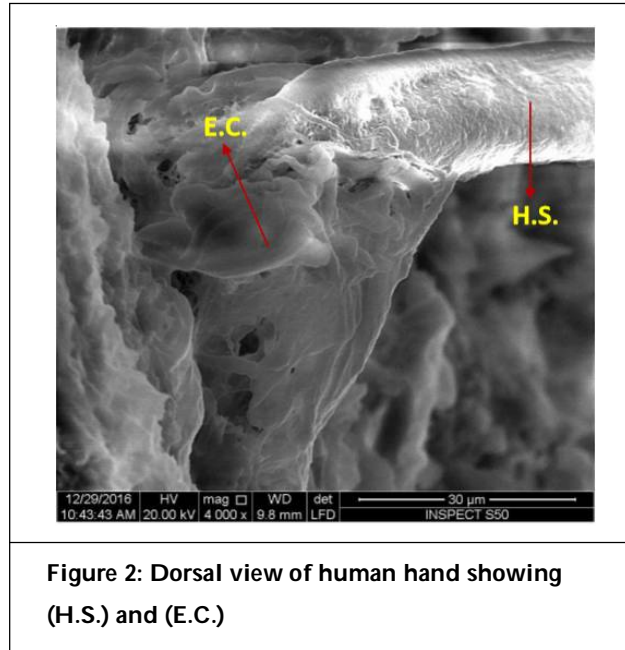
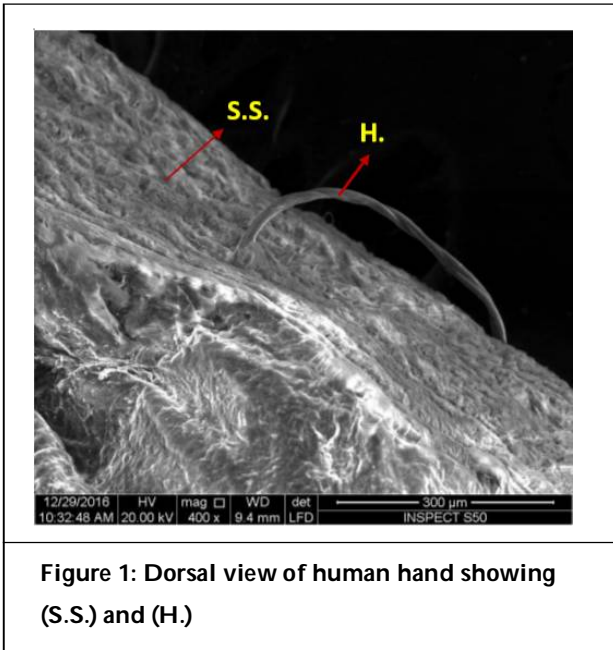
2. Materials and methods

The living creatures selected in this study are two types of mammals that exist in the environment of Saudi Arabia, Squirrel (*Tamias striatus*) which falls under the order Rodentia, Baboon (*Papio hamadryas*) which falls under the order Primates and the Human. Initially, the animals research and human were anesthetized using one of the following drugs (Hydromorphone, Oxymorphone, Morphine, Fentanyl), with dosage (0.10 to 0.20 mg/kg Hydromorphone, 0.05 to 0.10 Oxymorphone mg/kg, from 0.50 to 1.0 Morphine mg/kg, from 0.005 mg/kg To 0.010 Fentanyl mg/kg) where intramuscular IM was injected, After anesthesia animals were cut the hands and kept with a formaldehyde stabilizer (10%). The hands were then amputated. For preparation of tissues for SEM we used (Bancroft and Gamble 2002) method as follows, the specimens were cut immediately into small pieces no more than 0.5 cm × 0.5 cm and fixed directly with an initial fixer of 4% glutaraldehyde in 0.2 ml phosphate buffered solution (pH 7.2), then placed in the refrigerator at 4°C for 4 h and then the samples was washed well three times in a 0.2 ml phosphate buffered solution and then transferred the sample to the secondary fixer of 1% osmotic acid in the phosphate buffered solution (pH 7.2) and was stored in the refrigerator at 4°C for 4 h. Then the samples were washed in 0.2 ml phosphate buffered and de-watered the samples with a series with progressive concentrations of ethyl alcohol up to absolute alcohol. Then the samples were dried in the air and placed on a small metal base stubs and fixed by gluey adhesive called the graph (carbon) and then the samples were covered with gold using the unit of air discharge. Finally, the samples were examined with a SEM (Bancroft and Gamble, 2002).

3. Results

3.1. Human hand

The dorsal surface of healthy human hand skin is characterized by three layers of tissue, epidermis, dermis and tissue under the skin. The visible part of those tissues on the surface is the epidermis which consists of four layers of cells including the crusty surface layer, which consists of about 15 to 40 rows of dead cells which are being constantly shed and replaced, also they are filled with a strong non-permeable water material called keratin. The stratum corneal layer (Stratum corneum) in the human hand is a simple cornea of dead cells called corneocyte extending on the surface of the hand, some corneocytes have even stronger interdigitating structures often correlating with the mechanical use of a body skin area. The skin surface also covers with medium density delicate hair (Figures 1 and 3). The part of the hair seen above the skin is called the hair shaft consist of a cuticle and a cortex of hard keratin surrounding, its emerged from a follicle in the skin and made up of dead cells that have turned into keratin. Epidermal cells of the skin form concentric layers around the hair with some dead cells of the epidermis (Figure 2).



3.2. Monkey hand

The surface of the monkey hand covers with a complexion of epidermis and dermis. The skin is permeated with thick hair that extends to the surface with a thick hair shaft outside the hair follicle, the root of a hair is situated in an epidermal tube known as the hair follicle, deep into either the dermis or the subcutaneous tissue. The follicle is dilated at its base to form the bulb which is a dynamic organ found in mammalian skin and It is resides in the dermal layer of the skin and made up of 20 different cell types each with distinct functions which is surrounded by a dense array of dead epidermal cells that also spread to the surface of the skin (Figure 4). The skin of the monkey hand covers with a very horny, corneal layer made up of dead cells and extending on the surface of the hand, In addition to the presence a lot of squamous cells projections (Figures 5 and 6). The monkey hair shaft has an outer flat overlapping scales called keratin scales which prevent the hair from matting together (Figure 7). Another area of the dorsal surface with two different magnifications we can see the layer which is composed of 15-20 layers of flattened cells with no nuclei and cell organelles called stratum corneum which is the outermost barrier of mammalian bodies also made up of dead cells and composed of keratinocytes at different stages, joined together with corneodesmosomes embedded in a hydrophobic lipid

matrix and there's a small ridges cross the stratum corneum cells called epidermal ridges, also in addition to the presence of sweat pore in center of stratum corneum (Figures 8 and 9).

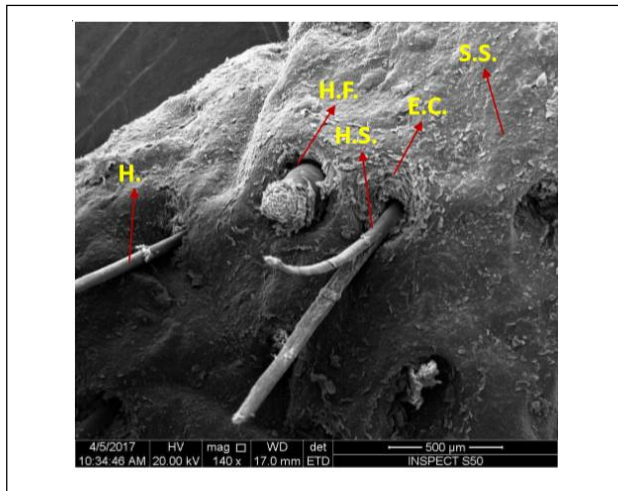


Figure 4: Dorsal view of monkey hand showing (H.), (H.S.), (H.F.), (E.C.) and (S.S.)

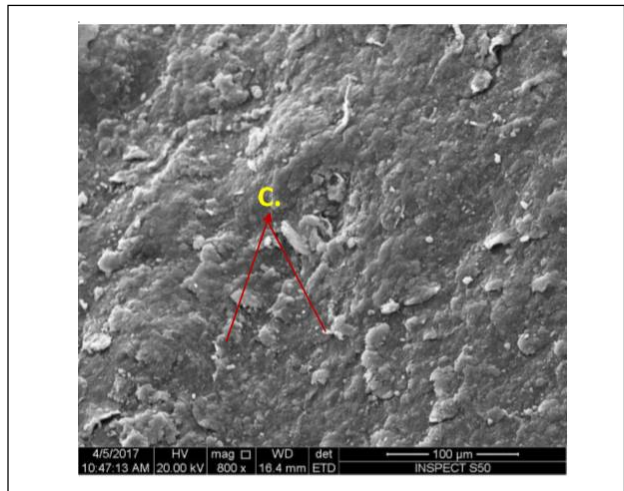


Figure 5: Dorsal view of monkey hand showing (C.)

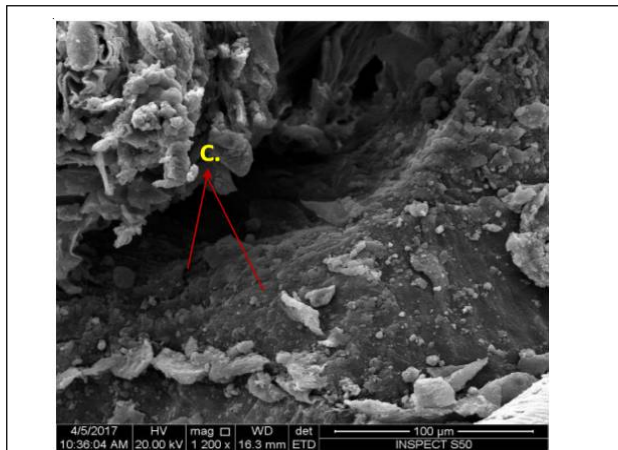


Figure 6: Dorsal view of monkey hand showing (C.)

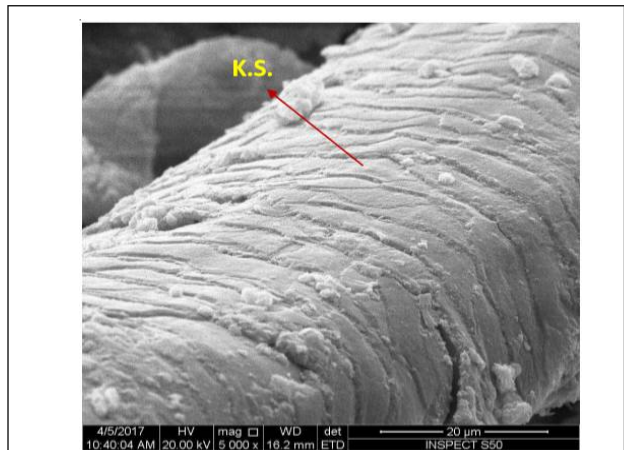


Figure 7: Dorsal view of monkey hand showing (K.S.)

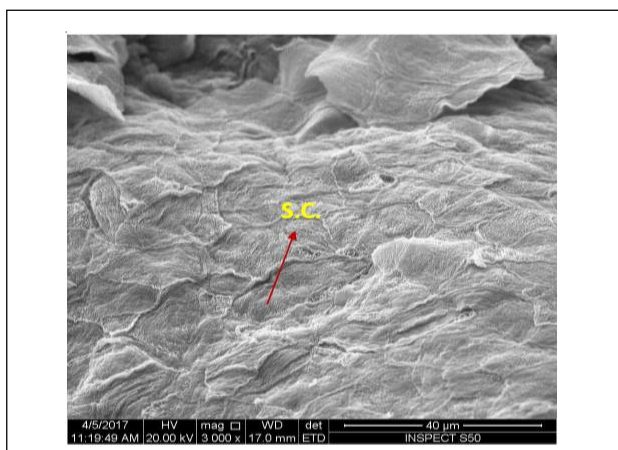


Figure 8: Dorsal view of monkey hand showing (S.C.)

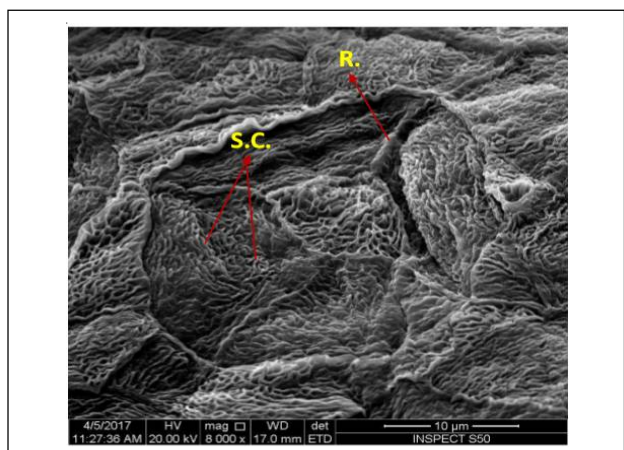


Figure 9: Dorsal view of monkey hand showing (S.C.) and (R.)

3.3. Squirrel hand

The surface of the hand of the squirrel skin is composed of epidermis and dermis permeated by very thick hair extends to the surface with a semi-thick hair shaft surrounded by a group of dead skin cells, which also spread on the surface of the skin intensively (Figures 10 and 11). Squirrel hair is characterized by a semi-regular layer of keratin scales which cover the entire hair shaft (Figure 12). In another area at the skin surface we observed a horny, corneal layer from dead cells extending on the surface of the hand (Figure 13). Also there are a single skin cells called squamous cells projections, these cells overlap one another to form the outermost layer of the skin and are eventually shed by the process of desquamation (Figure 14).

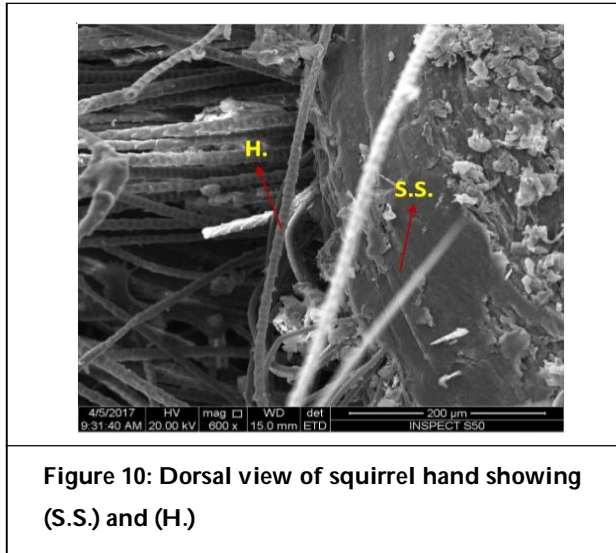


Figure 10: Dorsal view of squirrel hand showing (S.S.) and (H.)

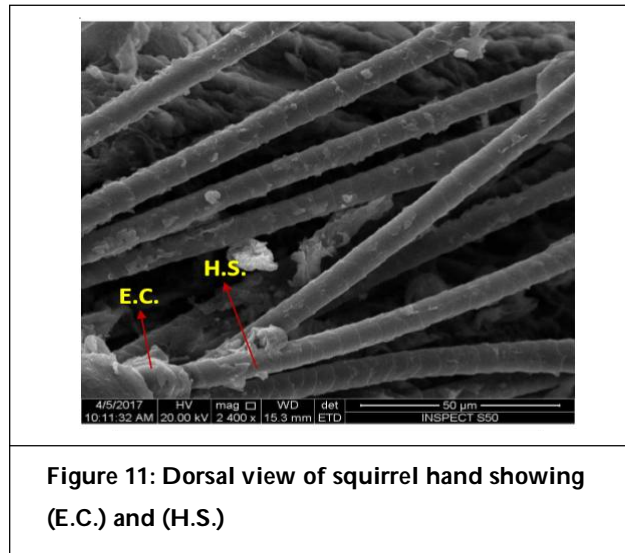


Figure 11: Dorsal view of squirrel hand showing (E.C.) and (H.S.)

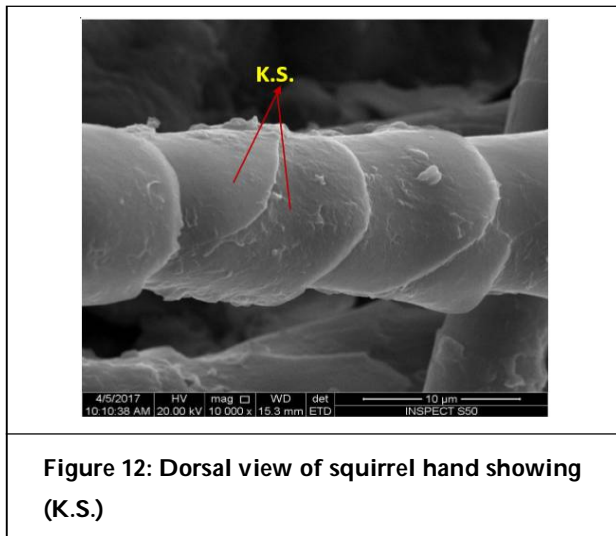


Figure 12: Dorsal view of squirrel hand showing (K.S.)

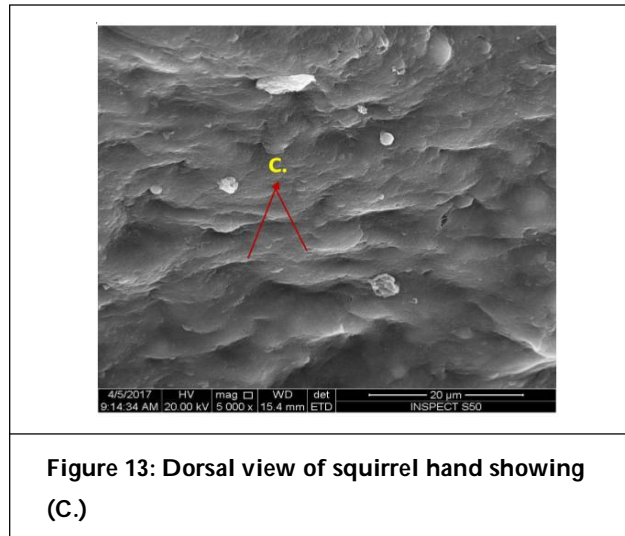


Figure 13: Dorsal view of squirrel hand showing (C.)

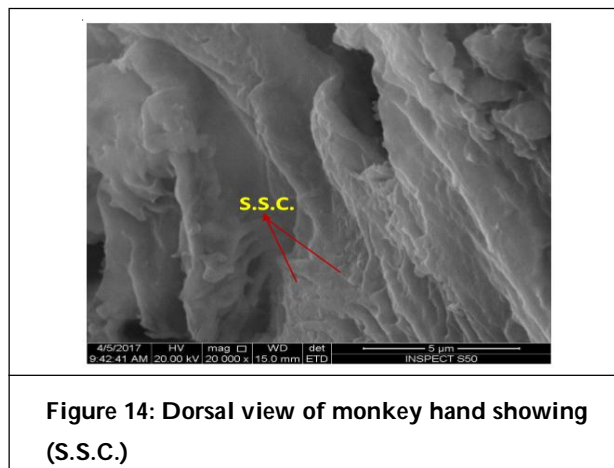


Figure 14: Dorsal view of monkey hand showing (S.S.C.)

4. Discussion

In this research, we have relied on the study of the larger organ, which covers the human body and the bodies of many other animals. An electron microscopic study and description extending from the virtual surface of the hand skin in humans and two types of mammals to the structures that make up the surface of the skin in humans and compared to the apparent skin of some mammals. The skin of human hands, baboon monkey and squirrel is a highly complex organ with a variety of advanced functions, one of the most important being to act as a barrier to excess water loss, and xenobiotic and microbial assaults its composed of the main layers, the epidermis is the outer skin layer and dermis is the subcutaneous skin under the skin and subcutaneous tissue (Sjovall *et al.*, 2018; Yousef and Sharma, 2017; Rahilly *et al.*, 2008; and El Gammal *et al.*, 2007). It can be seen from the electronic examination for the dorsal surface of the skin in human, monkey and squirrel. The surface is composed of several layers overlaid and arranged in rows composed of dead cells, that are the end products of terminal differentiation of epidermal keratinocytes which are the corneal layer, it is slightly corneal in the human and is increased in the monkey and squirrel respectively, and this is consistent with what is mentioned (Matsui and Amagai, 2015; and Stucker *et al.*, 2015) in the formation of the corneal layer in the human. The examination of the skin surface of the visible hand in both the human and the monkey and the squirrel also revealed the existence of the keratin cornea, which is composed of the epidermis and the cortex and is surrounded by the shift of hair visible on the surface of the skin, this is approved by the study, (Rahilly *et al.*, 2008). But the monkey is characterized by the existence of keratin scales extended on the shift and surface of the hair to prevent the overlap of hair with each other and be almost regular covering the entire hair in the squirrel. Hair is a component of the large tissue with the ability of some bacterial reactions which can have an effect on the morphology of hair in human, monkey and squirrel so, the thickness of the hair in each of the human and the monkey and the squirrel where the less thickness in humans and increase in the monkey and squirrel and this refers to the physical and mechanical properties of hair as indicated (Kerk *et al.*, 2018; and Velasco *et al.*, 2009). But hair in humans, monkeys and squirrels are similar to the presence of hair follicle extending from the dermis and consists of several types of cells as mentioned (Yousef and Sharma, 2017; Bhushan 2010; and Rahilly *et al.*, 2008). When examined with several different magnification power, the difference in the corneal layer of the human, monkey and squirrel was revealed, with a corneal cornea, which varies in size according to composition and shape (Stucker *et al.*, 2015). While in the monkey and squirrels as well as several magnifications of the corneal layer, the difference in the shape of cells formed for the cornea, which is many and complex and part of it is also sparse to give the ridges, it is also evident in humans (Stucker *et al.*, 2015).

5. Conclusion

The skin of human hands, baboon monkey and squirrel is a highly complex organ with a variety of advanced functions, one of the most important being to act as a barrier to excess water loss. The final differentiation of keratinocytes in the epidermis which is the stratum corneum is slightly increased in human followed by monkey and squirrel respectively. The thickness of the hair in each of the human, the monkey and the squirrel where the less thickness in humans and increase in monkey and squirrel.

Ethical Consideration

The authors ensured that all ethical and other basic principles were considered. A permission to carry-out this study was given by the Institutional Review Board Committee of the Deanship of Scientific Research, with the IRB number (IRB-PGS-2017-10-076).

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Appendix

Abbreviations

C.	Corneocytes
E.C.	Epidermal Cells
E.R.	Epidermal Ridge
H.	Hair
H.F.	Hair Follicle
H.S.	Hair Shaft
K.S.	Keratin Scales
R.	Ridge
S.C.	Stratum Corneum
S.P.	Sweat Pore
S.S.	Skin Surface
S.S.C	Squamous Skin Cells Projections

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