# HISTOLOGICAL STUDIES ON THE SKIN OF BROILER CHICKEN

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**Abstract**

*Histological studies were undertaken on the skin of six male commercial broiler chicken of six to eight weeks of age, slaughtered at Meat Technology Unit, Mannuthy. The skin consisted of an outer thin epidermis and inner thick dermis. The per cent contribution of epidermis and dermis to total width of skin was 2.01±0.01 and 97.99±0.01 respectively. The epidermis presented two major layers viz., stratum germinativum and stratum corneum. The dermis consisted of three distinct layers from superficial to deep viz., stratum superficiale, stratum profundum and lamia elastica. The stratum profundum consisted of a superficial stratum compactum and a deep stratum laxum which was the thickest among all the layers of skin. The lamina elastica separated the subcutaneous tissue from the dermis and was the thinnest layer.*

**Keywords**: *Broiler chicken, skin, histology*

Poultry industry has taken a quantum leap in the last three decades and now India ranks fourth in egg production and eighth in broiler production in the world. Chicken meat has always been the favourite and dominated the global poultry industry. This also generates millions of tonnes of waste which if not properly disposed, becomes one of the major environmental pollutants. Hence it is essential to find alternate ways to utilize the wastes from poultry industry to bring in new industries and job opportunities and make the poultry industry more profitable. The present study was conducted to assess the histomorphological features of skin in broiler chicken. It will be contributory to the existing knowledge to identify the disease conditions associated with the skin and will also form a basis for future research on techniques for processing chicken skin to realize its full potential.

## Materials and Methods

Histological studies were undertaken on the skin of six male commercial broiler chicken of six to eight weeks of age, slaughtered at Meat Technology Unit, Mannuthy. After manual defeathering skin of dorsal abdomen region was removed and fixed in 10 per cent neutral buffered formalin. Sections of 5µm thickness were taken for histological studies and stained by Haematoxylin and eosin staining technique

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(Luna, 1968), Van Gieson's method for collagen fibres (Luna, 1968), Verhoeff's elastic stain (Singh and Sulochana, 1996), Masson's trichrome method for muscles and collagen fibres (Luna, 1968), Ayoub-Shklar method for keratin and prekeratin (Luna, 1968), Mallory's phosphotungstic acid hematoxylin method (PTAH) for muscles (Luna, 1968), Gomori's method for reticular fibres (Luna, 1968). The micrometrical parameters were measured using an ocular micrometer. The data were analyzed statistically (Snedecor and Cochran, 1994).

**Results and Discussion**

The skin of broiler chicken comprised of an epidermis and a dermis as observed by Lucas and Stettenheim (1972) (Fig.1). In the present study in all the birds the thickness of epidermis was 28.50±0.56µm and was lined by stratified squamous epithelium and consisted of two major layers *viz*., inner living *stratum germinativum* and outer acellular keratinized *stratum corneum* as reported earlier by Bacha and Bacha (2012) in chicken. In fowl epidermal thickness was 17.5µm (Ahmed *et al*., 1968) and 23µm (Lucas and Stettenheim, 1972). Picasso *et al*. (2016) reported that the thickness of epidermis in adult rhea was found to be 38.81 µm. The epidermis was entirely devoid of blood vessels and received nourishment from the capillaries of the superficial dermis. It was thin and presented numerous, small, rounded and pointed primary and secondary folds. According to Stettenheim (2000), epidermal cells proliferated, differentiated and matured as they moved towards the surface of the skin, and ultimately shed off from the surface constantly as individual cells or as fragments or larger pieces of the cornified layer.

The *stratum corneum* was 12.42±0.26µm thick (Fig.1) and consisted of several layers of flattened, eosinophilic dead cells that disintegrated away from the surface. In the homogenous mass of cells in this layer nuclei was absent and they joined together to form a thin keratinized layer. According to Lucas and Stettenheim (1972) *stratum corneum* of chicken skin measured 16µm. These results are in accordance with the present study. The *stratum corneum* contributed to 43.76±1.33 per cent of the total epidermal thickness in broiler chicken.

The *stratum germinativum* consisted of three major layers *viz*., an outermost *stratum transitivum*, an intermediate *stratum intermedium* or *stratum spinosum* and a basal layer or *stratum basale* or *stratum cylindricum* in all the birds (Fig.1) in agreement with the observations of Ahmed *et al*. (1968) in chicken and Picasso *et al*. (2014) in southern screamer. The *stratum germinativum* was 16.00±0.43µm thick and contributed to 56.29±0.33 per cent of the total thickness of epidermis. Sebokeratinocytes with large number of intracellular vacuoles were also seen in between these layers of epidermis which is similar to the reports of Lucas and Stettenheim (1972) and Menon and Menon (2000) in chicken. According to Samuelson (2007) in avian skin, the keratinocytes produced a lipid emulsion as well as keratin proteins and hence could be called sebokeratocytes.

In the present study in all the birds the outermost *stratum transitivum* consisted of a single layer of flattened cells with degenerating nuclei in which the final processes of keratinization was seen. The *stratum intermedium* or *stratum spinosum* presented one to two layers of large, polyhedral shaped cells without distinct boundary, spherical nuclei and prominent nucleoli in all the birds. *Stratum basale* or *stratum cylindricum* was the inner most layer of the *stratum germinativum.* It comprised of a single layer of clear cylindrical cells with distinct cell boundary, basophilic cytoplasm and elongated nuclei placed perpendicular to the length of the skin. These are in agreement with the observations of Lucas and Stettenheim (1972) in fowl. Nickel *et al*. (1977) stated that in avian skin, the *stratum basale* in epidermis was analogue to the *stratum cylindricum* and *spinosum* of the mammalian epidermis. A thin basement membrane consisting of collagen and reticular fibres was seen at the epidermal-dermal junction separating the epidermis from the dermis (Fig.1). Downward projection of epidermis into the dermis, as seen in mammals, was absent in all the birds.

According to Ahmed *et al.* (1968) and Lucas and Stettenheim (1972) in chicken and

**Fig.1. Section of skin, Dorsal abdomen, Broiler chicken. H&EX400**

1. Epidermis, Stratum corneum
2. Epidermis, Stratum germinativum
3. Epidermis, Stratum transitivum
4. Epidermis, Stratum intermedium
5. Epidermis, Stratum basale
6. Dermis, Stratum superficiale
7. Dermis, Stratum compactum

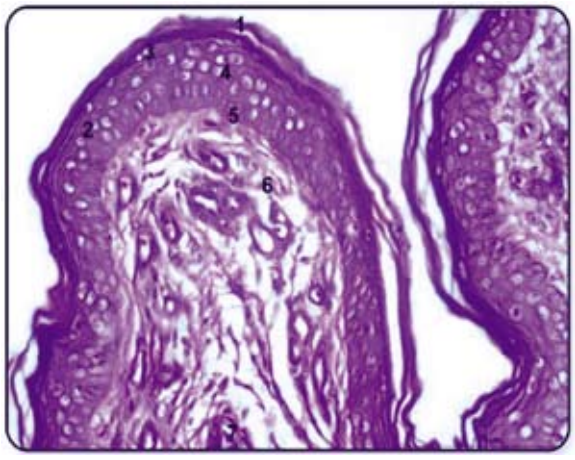
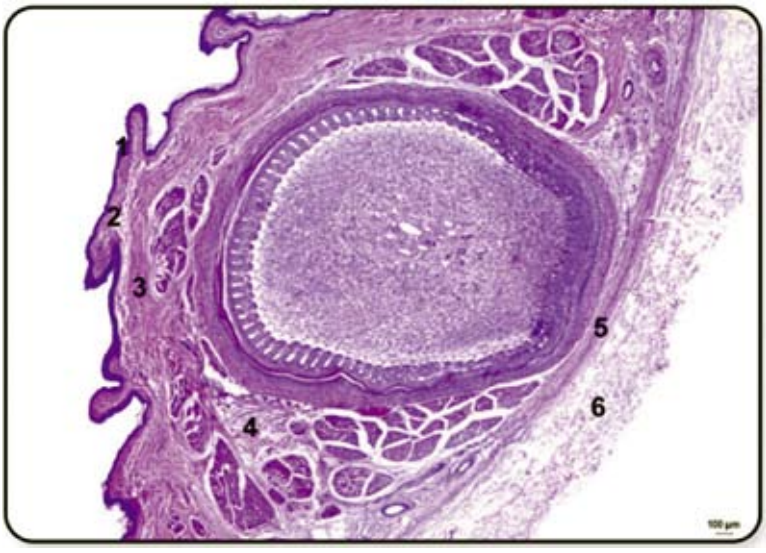



**Fig. 2. Section of skin, Dorsal abdomen, Broiler chicken. H&EX40**

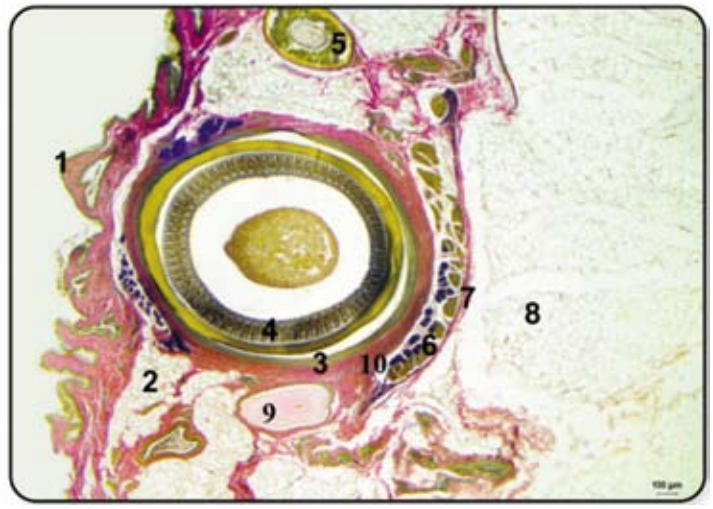
1. Epidermis
2. Dermis, Stratum superficiale
3. Dermis, Stratum compactum
4. Dermis, Stratum laxum
5. Lamina elastica
6. Subcutaneous tissue




Weir and Lunam (2004) in emu, the dermis of the chicken skin consisted of three distinct layers from superficial to deep *viz*., *stratum superficiale*, *stratum profundum* and *lamia elastica* as seen in the present study (Fig.2). The *stratum profundum* consisted of a superficial *stratum compactum* and a deep *stratum laxum.* The dermis was composed mainly of fibrous connective tissue, blood vessels, nerves and feather follicles were also seen embedded in it. Dermal papillae noticed in mammals were absent similar to the present study. The dermis, formed the main component of the leather and its strength and flexibility depended on the dense collagen network and few elastic fibres (Engelbrecht *et al*., 2009 and Weir and Lunam 2011).

Dermis contributed to about 98.38±0.02 percent of the total thickness of the skin in all the birds under study. The mean dermal thickness was 1490.03±1.30µm. According to Lucas and Stettenheim (1972) in chicken, the thickness of dermis was 50 µm in chicken and showed increased thickness in the areas where more than one follicle was present. The variations in the measurements observed from the present study might be because of the difference in age of birds. The *stratum superficiale* comprised of loosely arranged collagen fibres lying parallel to the epidermis, few elastic fibres and numerous capillaries in all the birds. This layer was seen projecting into the folds of the skin just below the epidermis.

**Fig. 3. Section of skin, Dorsal abdomen, Broiler chicken. Verhoeff's method for elastic fibres X 100**




1. Epidermis
2. Dermis, Stratum laxum
3. Feather follicle
4. Contour feather
5. Filoplume feather
6. Arrectores plumorum muscle
7. Lamina elastica
8. Subcutaneous tissue
9. Herbst corpuscle
10. Elastic tendon

The filoplume feathers were seen in this layer (Fig.3). These observations corroborated the reports of Lucas and Stettenheim (1972), and Ahmed *et al.* (1968) in chicken; Weir and Lunam (2004) in emu and Picasso *et al*. (2016) in rhea skin. A layer of small vessels called superior capillary layer marked the boundary between *stratum superficiale* and *stratum profundum*. The abundance of capillaries in this layer could be related to the role of skin in thermoregulation.

In the present study in all the birds the *stratum compactum* consisted of dense connective tissue with thicker, coarse, wavy bundles of collagen fibers, few elastic and reticular fibres, blood vessels and large number of fibroblasts (Fig.2). The collagen bundles in this layer were thicker compared to the bundles of *stratum superficiale* and lay parallel to the epidermis. They were aligned in two directions, that is, either longitudinal or transverse to the long body axis. This arrangement of collagen bundles with the scarcity of elastic fibres provided strength to the skin while maintaining flexibility without wrinkling (Kardong and Bells, 1998).

In the junction between *stratum compactum* and *stratum laxum* a layer of larger vessels called deep capillary layer was noticed (Fig.2). Reticular fibres were seen surrounding these blood vessels. These observations are in agreement with the observations of Lucas and Stettenheim (1972) in chicken and Picasso *et al*. (2016) in rhea skin.

The *stratum laxum* in all the birds consisted of loosely arranged connective tissue, smooth muscle and abundant adipose tissue (Fig.3). It was the thickest layer in all the birds under study. Homberger and de Silva (2000) reported that the fat deposits in *stratum compactum* and *stratum laxum* of the avian skin acted as a non-compressible hydraulic tissue for the movement of feathers inside the dermis.

Numerous blood vessels, nerves and obliquely placed feather follicles were also noticed (Fig. 3). The contour feathers were mostly seen in this layer surrounded by feather follicles and each follicle was surrounded by a layer of collagen fibres. Smooth muscle fibres of the dermis were seen attached to the follicle on either end and at this point of attachment a large number of elastic tendons were seen. Large herbst corpuscle was also seen close to the feather follicle. Each corpuscle presented axis cylinder in the central part and was surrounded by outer and inner lamellae of concentric layers of connective tissue fibres. Numerous blood vessels and veins were observed close to the lamina elastica. Reticular fibres were seen mainly around blood vessels and in between the adipose tissue. These observations are in corroboration with the observations of Lucas and Stettenheim (1972) in chicken; Weir and Lunam (2004) in emu and

Picasso *et al*. (2016) in rhea skin. The sensorial organs herbst corpuscles were always related to the attachment of the muscles of the feather follicle (Weir and Lunam, 2004).

The *lamina elastica* separated the subcutaneous tissue from the dermis. It was the thinnest layer and consisted of a few elastic fibres intermingled with some collagen and reticular fibres in all the birds under study (Fig.3). These observations are parallel with the observations of Lucas and Stettenheim (1972) and (Nett and Trully, 2003) in fowl. Stretching of *lamina elastica* allowed the movement of adipose tissue at compression points during feather movement (Homberger and De Silva, 2000). Picasso *et al.* (2014) found that in southern screamer, the *lamina elastica* was irregular unlike other birds. Abundant elastic fibers in the dermis and the irregular *lamina elastica* provided great stretchability to the skin.

Loose subcutaneous connective tissue was seen above the muscular fascia of the body and below the dermis. Abundant fatty deposits and large blood vessels were seen in the subcutis in all the birds in present study (Fig.3). This is in agreement with the observation of Ahmed *et al.* (1968) in chicken. The avian subcutis was characterized by abundant loose connective tissue, fat and muscles for regulation of skin tension (Nett and Trully, 2003).

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