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Comparative Histology of The Skin Between Sumba Ongole Cattle (*Bos indicus*) and Bali Cattle (Bos sondaicus)

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Abstract

This study aims to determine the histological structure of the skin and the distribution of sweat glands in Sumba ongole and Bali cattle. Skin samples from the nuchalis and fascia superfialis dorsalis regions were collected from six Sumba ongole cattle slaughtered at the East Sumba slaughterhouse and six Bali cattle slaughtered at the Oeba Kupang slaughterhouse. The samples were fixed in 10% formalin, histological preparations were made, and HE staining was performed. The results showed that the histological structure of the skin of Sumba ongole and Bali cattle was similar to other mammals, with three layers: epidermis, dermis, and hypodermis. The mean number of sweat glands in the nuchalis region of Sumba ongole cattle (13.33 ± 5.13/mm2) was higher than that of Bali cattle, while the fascia superfialis dorsalis region of Bali cattle had a higher average number of sweat glands (13.66 ± 4.16/mm2) than in Sumba ongole cattle.

Keywords: Bali cattle, histology, skin, Sumba ongole cattle, sweat glands

Introduction

East Nusa Tenggara (NTT) is one of the areas in Indonesia with a semi-arid climate. A characteristic feature of regions with semi-arid climates is the difference between a relatively short rainy season with high rainfall intensity and a longer dry season. During the dry season, exposure to UV sunlight is quite long, which results in high temperatures. The differences in climatic conditions in the dry land islands of East Nusa Tenggara (NTT) have the potential for the development of beef cattle. Sumba Ongole cattle and Bali cattle are the cattle that are used as food products of animal origin (BPS NTT, 2014; Priyanto, 1998).

The resistance of livestock to heat in the tropics is a very important factor. The skin is one of the integumentary systems that functions as the main defense when there is an invasion of disease or physical disorders such as exposure to UV rays. It protects from mechanical stress and helps metabolic processes in the body. The skin generally represents as much as 16% of a cow's total body weight, which influences its ability to maintain body temperature without changing its physiological status and productivity (Tyler and Ensminger, 2006).

Cattle maintain a normal body temperature by balancing both heat gain and heat loss. The exchange of heat in the animal's body occurs through different pathways, including radiation, conduction, convection, and evaporation (Reese, 2004). Sweating is a physiological response that occurs due to an increase in body and environmental temperature during physical activity or thermal stress experienced by animals or humans. The integumentary system, particularly the skin where sweat glands are located, plays an essential role in the body's physiological response mechanisms. One of the functions of the sweat glands is to regulate body temperature (Mescher, 2012). This study aims to determine the histological structure of the skin of sumba ongole cattle and bali cattle and the distribution of sweat glands.is a non-steroidal anti-inflammatory drug that works by inhibiting COX-2. COX-2 as an enzyme in charge of converting prostaglandin H2 into prostaglandin E2 which plays a role in the incidence of inflammation, pain and fever. Prostaglandins in the kidneys function to maintain salt and water homeostasis and to maintain blood flow to the kidneys. The clinical side effects of using oxicam class of drugs are decreased sodium excretion, decreased potassium excretion and decreased renal perfusion. Decreased sodium excretion can lead to peripheral oedema, hypertension, and usually chronic heart failure. Hyperkalemia can occur, causing cardiac arrhythmias. Renal function becomes decreased, resulting in acute kidney failure. Renal function failure in the form of interstitial nephritis or papillary necrosis (Brater 1999).

Meterials and Methods

Skin samples were collected from six Sumba ongole (Bos indicus) cattle that were slaughtered at the Slaughterhouse of East Sumba, and six Bali cattle (Bos sondaicus) that were slaughtered at the Oeba Slaughterhouse. Each sample was incised in two regions: the superficial layer of the nuchalis and the fascia superficialis dorsalis, with a size of approximately 1 cm3. The sample collection criteria were healthy cattle, with a body weight range of 200-300 kg and an age range of 2-5 years. The samples were fixed in 10% formaldehyde, and histological preparations were made. This was followed by HE staining and microscopic observation at the Laboratory of the Faculty of Medicine and Veterinary Medicine, Undana..

Results and Discussion

The microscopic overview of the skins of Sumba Ongole cattle (*Bos indicus*) and Bali cattle (*Bos sondaicus*) revealed that they consist of three layers: epidermis, dermis, and hypodermis. Each of these layers is composed of other structural components and has a different function, which helps the body's metabolic mechanism of Sumba Ongole and Bali cattle maintain their physiological status against heat and mechanical stress. The microscopic images of the epidermis, dermis, and hypodermis layers of Sumba Ongole and Bali cattle can be seen in Figure 1.

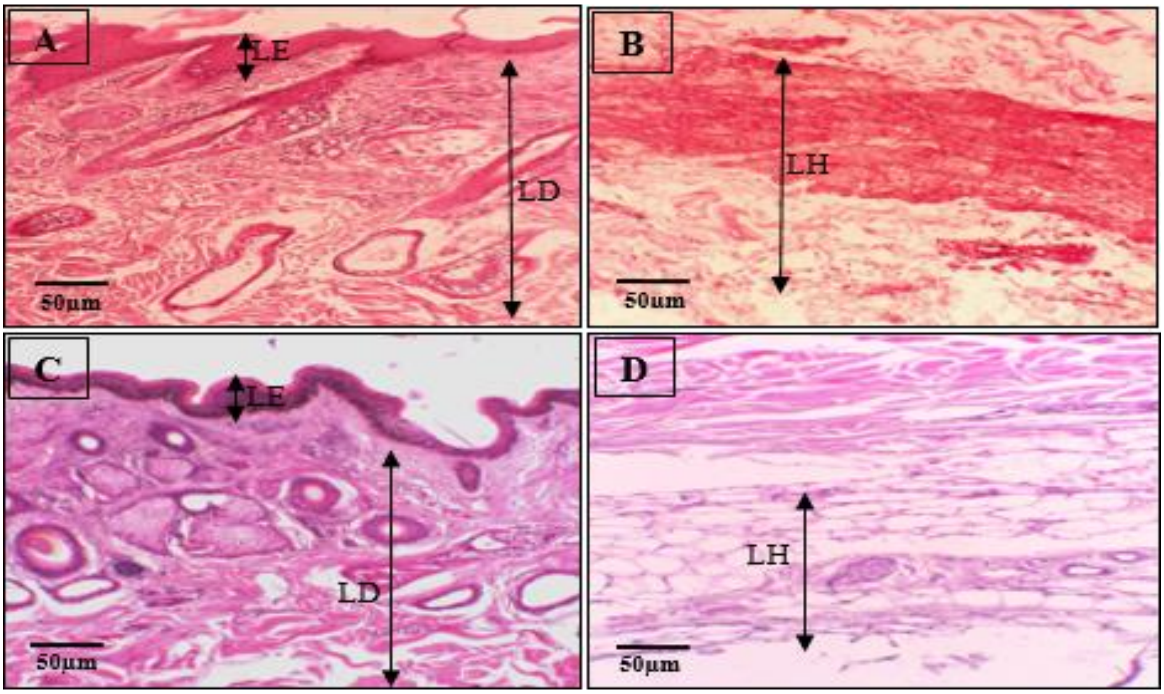

Figure 1. Histological structure of the skin of Sumba ongole and Bali cattle in the nuchalis region. A and B = Sumba ongole cattle, C and D = Bali cattle. Epidermis layer (LE), Dermis layer (LD), Hypodermis layer (LH). HE, 10x.

Epidermal Layer

The epidermal layer in the nuchalis region and the fascia superficialis dorsalis region in Sumba Ongole and Bali cattle have the same histological structure. This layer is composed of four stratums, namely: stratum corneum, stratum granulosum, stratum spinosum, and stratum basale (Figure 2).

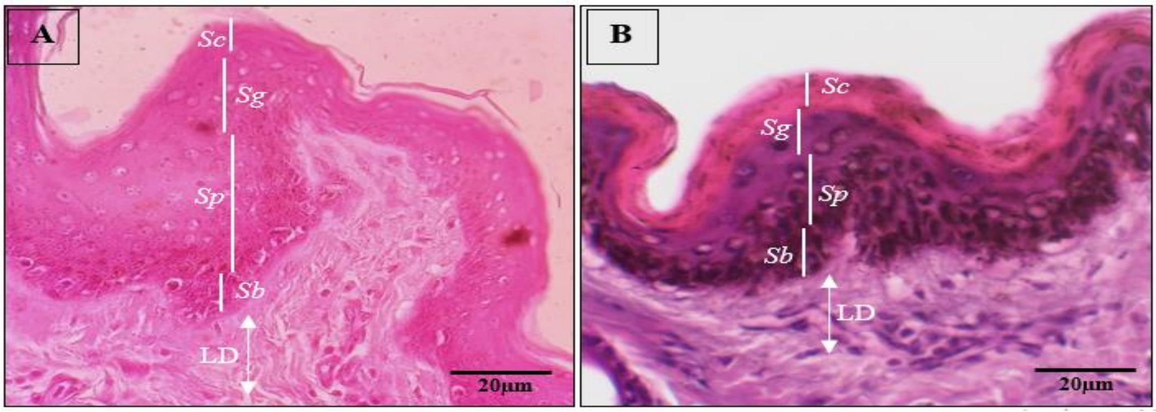

Figure 2. Histological structure of the epidermal layer of the nuchalis region in Sumba Ongole and Bali cattle. A = Sumba ongole cattle, B = Bali cattle. stratum corneum (Sc), stratum granulosum (Sg), stratum spinosum (Sp), stratum basal (Sb), and dermis layer (LD). HE, 40x.

The stratum corneum in Sumba Ongole and Bali cattle consists of multiple layers of dead, flat, and non-nucleated cells. The stratum corneum in Bali cattle appears to be thicker than that of Sumba Ongole. This layer has the ability to phagocytose harmful pathogenic agents that penetrate the skin. Additionally, there are Merkel cells present, which function as mechanical mechanoreceptors for touch, pain, heat, and cold (Mescher, 2012; Humbert and Agache, 2004). According to Mescher (2012), the stratum corneum is a layer that is often shed due to the keratinization process.

The stratum granulosum in Sumba Ongole cattle is composed of three rows of polygonal cell layers, while in Bali cattle, it is composed of two rows of polygonal cell layers. In Bali cattle, the cytoplasm of cells in the stratum granulosum appears more basophilic than in Sumba Ongole cows. According to Rina (2013), the basophilic or acidophilic color differences are caused by acid-base reactions in cell components, small molecular adsorption that adheres to large molecules, and different types of solubility depending on the level of solubility in the cell. Junqueira and Carneiro (2007) state that the cytoplasm of cells in the stratum granulosum contains a basophilic mass called keratohyalin granules. This stratum plays a role in the keratinization process and acts as a barrier against the penetration of most foreign bodies.

The stratum spinosum in Sumba Ongole and Bali cattle is the thickest layer of the epidermal and consists of cuboid to flattened epithelial cells, also known as polygonal cells. The cells become more flattened as they approach the surface. The thickness of the stratum spinosum varies depending on the anatomical location of the animal.

The basal stratum in Sumba Ongole and Bali cattle appears to have a layer of columnar to cuboidal cells. Melanocyte cells are also present in this stratum, located between the cells of the basal layer. Melanocytes are responsible for synthesizing melanin and transferring it to keratinocytes, thereby determining skin pigment. These cells are limited to the skin and are present in the basal layer and hair follicles (Mescher, 2012). Fiarley (2001) states that the basal stratum functions as a site for cell mitosis or replacement of damaged cells, as well as a point of attachment between the epidermis and dermis.

Previous research conducted by Saravanakumar and Thiagarajan (1992) on cattle and buffalo, stated that animals with a thin epidermis had better heat tolerance than those with a thick epidermis. This is attributed to the skin's absorption ability, which is influenced by skin thickness, hydration, moisture, and animal metabolism. Absorption can occur through epidermal cells rather than through intercellular gaps (Tortora and Derrickson, 2006).

Dermal Layer

The dermis layer on the skin of Sumba Ongole cattle and Bali cattle contains hair follicles, arrector pili muscles, sebaceous glands, sweat glands, and blood vessels. The dermis layer consists of papillary and reticular layers (Figure 3). The reticular layer appears thicker than the papillary layer, and there is dense, irregular connective tissue that spreads out in the form of webbing. According to Sorrel and Caplan (2004), differences in the thickness of the papillary layer depend on age and anatomical location. These results demonstrate structural similarities with other types of cattle studied by Hossain et al. (2016) and Alsodany et al. (2019).

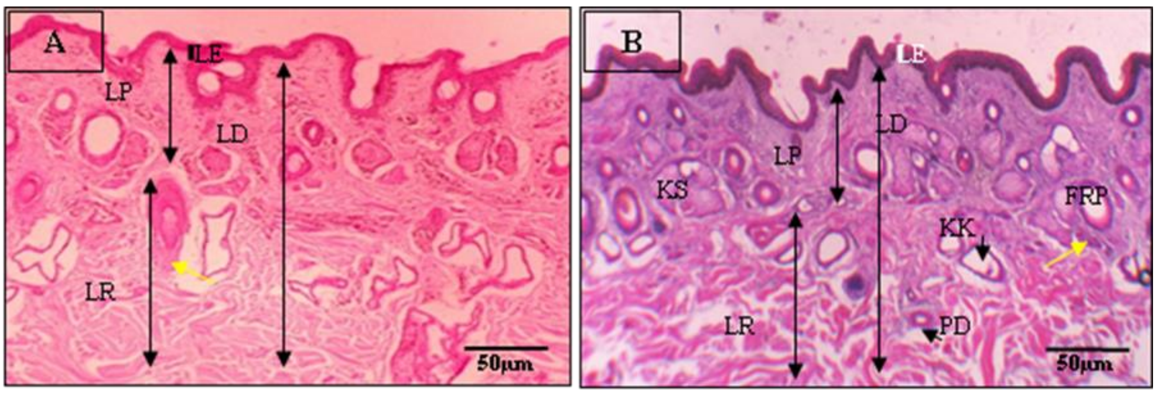

Figure 3. Dermis layer of Sumba ongole and Bali cattle in the nuchalis region. A = Sumba ongole cattle, B = Bali cattle. Epidermis layer (LE), Dermis layer (LD), Papillary layer (LP), Reticular layer (LR), Hair follicles (FR), Blood vessels (PD), Sebaseous glands (KS), sweat glands (KK), Arrector pilli (yellow arrow). HE,10x.

Based on observations, there are primary hair follicles and secondary hair follicles in the dermis layer (Figure 4). Primary hair follicles are the mature hair follicles that extend from the dermis layer to the surface of the epidermal layer, while secondary hair follicles are newly developing follicles. According to Alsodany et al. (2019) and Mescher (2012), the function of hair follicles is to assist in regulating body temperature, protect the skin from injuries, and facilitate blood circulation, which provides nourishment to the skin.Primary and secondary hair follicles in the nuchalis and fascia superficialis dorsalis regions vary in size, ranging from the smallest to the largest. The distribution of hair follicles in the two regions also varies in terms of quantity. According to Adams and Cornje (2003), the number of hair follicles varies depending on their anatomical location.

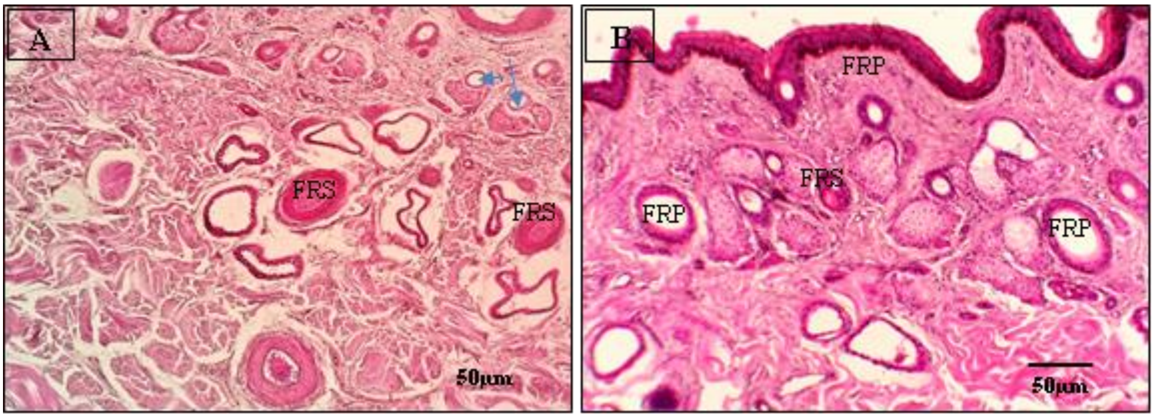

Figure 4. Histological structure of hair follicles in Sumba Ongole cattle and Bali cattle in the fascia superfialis dorsalis regions. A = Sumba ongole cattle, B = Bali cattle. Primary Hair Follicles (FRP), Secondary Hair Follicles (FRS), and Blood Vessels (PD). HE, 10x.

The type of sebaceous glands in Sumba Ongole cattle and Bali cattle shows similarities with several animals, including buffalo (Umeri and Mamoori, 2016; Ali, 2008), goats (Adib Moradi and Sheibani, 2000), and sheep (Katas and Daglıoglus, 2009). Samuelson (2007) states that sebaceous glands produce sebum (oil) which is secreted through a holocrine process. Sebum has specific functions in maintaining the stratum corneum, preserving skin moisture, acting as an antifungal and antibacterial agent, reducing friction with neighboring cells, providing thermal insulation, contributing to vitamin D synthesis, and preventing water entry into hair and skin.

The sweat glands in the dermis layer of the skin of Sumba Ongole cattle and Bali cattle are distributed between the papillary and reticular layers and are directly associated with the hair follicles. The sweat glands are tubular in shape and are embedded in the dermis. They are lined with cuboidal cells and myoepithelial cells. According to Monteiro (2007), myoepithelial cells assist in secreting into the mouth of the hair follicle duct. The average distribution of sweat glands in Sumba Ongole cattle and Bali cattle in the nuchalis region the fascia superfialis dorsalis regions can be observed in Table 1.

Table 1. Average number of sweat glands in Sumba Ongole cattle and Bali cattle/mm2

No	Cattle Species	Regio	
		Nuchalis/mm^2	*Fascia superficial dorsalis*/mm^2
1.	Sumba Ongole cattle	13,33 ± 5,13	10,66 ± 2,51
2.	Bali cattle	9,66 ±3,21	13,66 ± 4,16

The difference in the number of sweat glands in Sumba Ongole and Bali cattle is thought to be caused by different breeds, species, sex, anatomical regions, and climatic conditions. According to Rohankar et al. (2018), the number of sweat glands makes it easier for animals to maintain the body's homeostatic status.

Sweating is a physiological response to an increase in body temperature during physical activity or thermal stress in animals and humans, and it is the most effective way to regulate body temperature (Mescher, 2012). Sweat glands primarily consist of water and salt. In the presence of metabolic instability caused by heat from the sun, the secretion of sweat glands plays a vital role in regulating the animal's body temperature.

The presence of more hair follicles, sebaceous glands, and sweat glands enhances the body's metabolic mechanisms for heat gain or loss in response to changes in seasons and temperature (Rohankar et al., 2018). Macneill et al., (2005) states that hair thickness helps protect the animal's body from excessive heat and facilitates evaporation mechanisms. This suggests that a greater number of follicles in Sumba Ongole cattle and Bali cattle plays a significant role in maintaining their physiological status and regulating body temperature under different seasonal and dry land island conditions.

Hypodermis layer

The hypodermis layer in Sumba Ongole cattle and Bali cattle lies beneath the dermis and consists of loose connective tissue, adipose tissue, blood vessels, and nerves. Adipose cells are round in shape and appear to be displaced. In Sumba Ongole cattle, the adipose cells were densely packed and smaller in size, while in Bali cattle, the adipose cells were large. According to Karundeng et al., (2014), the density of adipose tissue, including its shape, size, and number, varies based on species, age, nutritional status, and animal anatomy.

The hypodermis layer acts as a barrier between the skin and bone (Mescher, 2012; Junqueira and Carneiro, 2007). It provides physical protection against mechanical stress, helps regulate body temperature, serves as an energy storage site, aids in thermal regulation, and facilitates movement of the skin (Karundeng et al., 2014; Mescher, 2012).

Conclusion

The histological structure of the skin in Sumba Ongole cattle and Bali cattle is similar to that of other mammals, consisting of three layers: the epidermis, dermis, and hypodermis. In the nuchalis region, Sumba Ongole cattle have a higher mean number of sweat glands compared to Bali cattle, whereas the fascia superfialis dorsalis region of Bali cattle shows a higher average number of sweat glands than in Sumba Ongole cattle. The difference in the number of sweat glands between Sumba Ongole cattle and Bali cattle is thought to be influenced by various factors, including different breeds, species, sexes, anatomical regions, and climatic conditions.

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