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Morphology of the Skin of Surti Buffalo as Compared to that of the Other Breeds of the Buffalo and the Ox and Its Role in Thermoregulation

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ABSTRACT

The Skin of the adult Snrti buffalo was nearly twice thicker than that of the one year old Surti buffalo calf. The thickness of the skin as well as that of its various layers in the Surti buffalo was almost similar to that of the other breeds of water buffalo but it was thicker than that of the skin and various layers of the skin of the Ox and Egyptian buffalo. Hair follicles and sweat glands per unit area were a few like those of the other breeds of water buffalo and unlike those of the Ox. Their number in the adult, decreased to about one third of the same in the calf. The melanin pigmentation was quite intense on the dorsal surface, moderate on the latral surface and least on the ventral surface. The dermis was quite rich in capillaries and arterio-venous anastomosis were seen in the dermis of adult as well as that of the calf.

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INTRODUCTION

Skin is one of the organs for thermoregulation (Montagna, 1962). Hair coat offers insulation, creates micro climate around the animal while the sweating and capillary network of the dermis facilitates the heat loss by evaporation and radiation respectively (Jenkinson, 1972). The skin pigmentation enhances the absorption of radiant energy (heat) and in the same way the bare skin also absorbs more radiant energy as compared to the insulated skin (Chandra and Bharadwaj, 1969a; Majeed *et al.*, 1974).

Thickness of the various layers of skin, number of hair follicles and sweat glands per unit area, extent of pigmentation and vascularity of dermis may be used as the parameters to investigate the mechanism of thermoregulation by skin. This type of work in Surti buffalo was not available in the literature reviewed and hence the present work was carried out.

MATERIALS AND METHODS

Autopsy skin samples from different regions viz., forehead, neck (dorsal and ventral), back, tail, fore-arm, thorax (lateral and ventral), abdomen (lateral and ventral) and leg, were obtained from six Surti buffalo calves of about one year in age from the Department of Anatomy and from four adult Surti

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buffaloes from the local abattoir and were processed to prepare eight microns thick horizontal and vertical paraffin sections.

They were examined unstained for melanin pigmentation while Ehrlich's haematoxylin and eosin staining was used on vertical sections to measure the thickness of various layers of the skin and on horizontal sections to count the number of hair follicles per unit area. The capillary net work in the dermis was observed in both the types of sections. The measurements of thickness were recorded by using an occular micrometer eye piece.

The average of ten measurements in different fields per animal, was taken. Number of hair follicles was counted in a field of 1500 microns in diameter, measured with the help of the stage and occular micrometer scales (10x occular and 10x objective). The average of such ten fields, was taken from which the number of hair follicles per one square cm was calculated. From the above mentioned averages of the measurements and the numbers in different regions of the skin, the average values per animal were worked out.

RESULTS AND DISCUSSION

The microscopic structure of the skin in the Surti buffalo was found to be almost similar to that in the Egyptian buffalo (Hafez *et al.*, 1955), Murrah buffalo (Chandra, 1972), non-descript buffalo (Singh *et al.*, 1973) and Nili-Ravi buffalo (Majeed *et al.*, 1975).

The average thickness of stratum corneum in the Surti buffalo was found to be 45.4 microns while the same in the Egyptian buffalo and cattle was reported to be 11 microns and 5 microns respectively by Hafez *et al.* (1955). In Surti buffalo calves it was found to be 19.8 microns while in non-descript buffalo calves Singh *et al.* (1973) reported it to be 14 microns. In Nigerion breeds of cattle it was reported by Amakiri (1973) to be 13 microns. The stratum corneum is a protective layer and prevents water dispersion from the lower cutaneous tissues to the surface, when exposed to high atmospheric temperature. Hafez *et al.* (1955) mentioned that due to higher thickness of stratum corneum in the buffalo as compared to that in the cattle insensible perspiration and heat dissipation through water evaporation is delayed. The Surti buffalo along with the other breeds of Indian buffalo stands at lower level of efficiency so far as heat dissipation is concerned due to the thickness of stratum corneum as compared to that in the Egyptian buffalo and the cattle.

The average thickness of main epidermis excluding stratum corneum and papillomatous epidermis in Surti buffalo was found to be 45.3 microns and 128 microns respectively. Hafez *et al.* (1955) reported them to be 50 microns and 115 microns respectively in the Egyptian buffalo. Thus, these measurements were found to be almost similar in both the breeds of buffalo. In Surti buffalo calf it was 34.5 and 66.5 microns respectively. These measurements in the calf of the other buffalo breeds were not available in the literature reviewed.

The epidermis on the dorsal part of the body in Surti buffalo had most intense melanin pigmentation while the lateral parts of the body were moderately pigmented and the ventral parts revealed the least pigmentation. This observation was in agreement with those of Hafez *et al.* (1955) in Egyptian buffalo, Chandra and Bharad-

waj (1969a) in Murrah buffalo, Singh *et al.* (1973) in non-descript buffalo and Majeed *et al.* (1974) in Nili-Ravi buffalo. Cutaneous pigmentation has been suggested to influence the adaptability of breeds of cattle to the tropical heat (Brody, 1948). Buffalo becomes restless quickly as compared to the cow due to the direct exposure to heat as dark colour of buffalo absorbs solar heat readily. Badreldin and Ghany (1952) argued that although the black pigmented buffalo-skin limited the adaptability to exposure to direct sunlight, yet in shade it aided in a more efficient dissipation of heat. The dark pigmented skin is a good defence against ultraviolet rays and is advantageous in dissipating the surplus heat during shading after intense radiation (Hafez *et al.*, 1955).

Hafez *et al.* (1955) designated papillary layer as the "Thermostat" layer while Dowling (1964) named it as the "functional layer" in heat tolerance. Zebu cattle had thinner papillary layer (1.49 mm) as against thicker papillary layer (1.68 mm) in Jersey. Thinner papillary layer is necessary for better heat dissipation in the cattle of tropical region and thicker papillary layer is required for heat retention and protection against cold in temperate zone (Walker, 1957; Dowling, 1964). The average thickness of the papillary and reticular layers of the dermis was 805.9 and 5008 microns respectively in the adult Surti buffalo and 570.7 and 2573 microns respectively in the Surti buffalo calf. The thickness of the papillary and reticular layers in the other breeds of the buffalo was not available in the literature reviewed.

The general pattern of the capillary branches in the dermal papillae and arterioles at the level of sebaceous glands observed in Surti buffalo agreed with the findings of Hafez *et al.* (1955) in Egyptian buffalo, Chandra (1972) in Murrah buffalo and Majeed *et al.* (1975) in Nili-Ravi buffalo. Occurrence of arterio-venous anastomosis in reticular layer of the dermis of Surti buffalo skin was found to be similar to the finding of Chandra and Bharadwaj (1969b) in Murrah buffalo. No such arterio-venous anastomosis was reported in Egyptian cattle (Hafez *et al.*, 1955). Majeed *et al.* (1975) stated that skin of the buffalo is highly vascular which must be helping buffalo to loose heat load absorbed by its black colour when exposed to direct sunlight by physical process of radiation, convection in shadow and through conduction during wallowing or shower bath as reported by Minnet (1947). The average thickness of skin of adult Surti buffalo and calf was 5.8 mm and 3.1 mm respectively. Hafez *et al.* (1955) recorded the average thickness of skin in Egyptian buffalo and cattle to be 6.5 mm, and 4.3 mm respectively. Sisson and Grossman (1953) reported thickness of the skin in cattle to be 3 or 4 mm. According to Hafez *et al.* (1955), the thick skin of buffalo hinders heat conductivity. However, it protects the buffalo from high ambient temperature provided that they are not exposed to direct solar radiation.

The hair follicle unit in the Surti buffalo consisted of the bulb of the hair and the shaft, sebaceous gland, arrector pili muscle and a single sweat gland. This is similar to that in the other breeds of the buffalo (Hafez *et al.*, 1955; Nair and Benjamin, 1963; Chandra, 1972; Singh *et al.*, 1973 and Majeed *et al.*, 1975) and in the Ox

(Findlay & Yang, 1948; Cartar & Dowling, 1954; Hafez *et al.*, 1955; Nair & Benjamin, 1963 and Jenkinson, 1969). Thus, the number of sweat glands per unit area will be the same as that of the hair follicles per unit area in the buffalo and the ox.

The number of the hair follicles and sweat glands per square centimeter of skin was found to be 155 in the adult Surti buffalo and 453 in the calf, while the same was reported to be 394 in Egyptian buffalo (Hafez *et al.*, 1955), 146.6 in Nili-Ravi buffalo (Majeed *et al.*, 1975), 138 in Formosan buffalo (Yamane and Ono, 1936) and 160 in non-descript Indian buffalo as well as in the Murrah buffalo (Nair and Benjamin, 1963). In cattle this number is reported to be very high viz., Egyptian cattle 2633 (Hafez *et al.*, 1955), 1696 in Zebu cattle (Carter and Dowling, 1954), 1130 in Jersey and 1200 in Sahiwal (Pan, 1963).

The number of hair follicles and sweat glands per unit area in Surti buffalo is quite less than that in the Egyptian buffalo. While this number in Surti buffalo was almost similar to that in other breeds of the Indian and Pakistani buffaloes. The structure of sweat glands observed in Surti buffalo was similar to that of Egyptian buffalo (Hafez *et al.*, 1955), Murrah buffalo (Chandra, 1972) Nili-Ravi buffalo (Majeed *et al.*, 1975). The flexuous course of the ducts of sweat glands observed in Surti as well as other breeds of buffalo differed from the straight course of these ducts in the ox as reported by Nay (1959) and Jenkinson (1969).

Cows and horses loose most of their heat through evaporation by sweating. This role of sweat glands in buffaloes is not clearly understood. The thermoregulatory reactions of the buffalo and pig are however, greatly affected by behavioural thermoregulation (Jenkinson, 1972). The buffalo therefore, due to its peculiar structural characters of skin viz., (I) Thicker stratum corneum, (II) Thicker skin, (III) Higher concentration of melanin pigmentation, (IV) Sparce hairs and sweat glands with flexuous course of their ducts etc., might not be able to dissipate heat as efficiently as that in the cattle.

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