Lipid-containing and lipid-synthesizing structures of the young Poltava Meaty Breed boars' skin

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Abstract. The fulfillment of a number of the most important physiological functions of the skin is directly related to skin lipids. This article presents the results of studying the lipid-containing and lipid-synthesizing structures of the young Poltava Meat Breed boars' skin. Morphofunctional epidermis features, sebaceous glands and adipose tissue cells of the hypodermis and their relationship with other skin structures were studied. The boars of Poltava Meat Breed, upon reaching the live weight of 100 kg, have certain specific features of skin structure, which plays an important role for developing efficient methods of selecting, breeding and keeping the animals, which would raise the functional abilities of highly productive animals and help obtaining high-quality production from them.

1 Introduction

Lipids are a wide group of fats and fat-like substances which are an important part of biological systems, related to fulfilling of various vital functions in cells (cell membranes are involved in cellular signaling, transport, movement of proteins, growth, differentiation and storage of energy) [1-3], and in the body as a whole, lipids have many functions [4-5]: storage, structural, protective, energetic, heat-insulating.

There is a wide dynamic range of lipid concentrations in biological samples [6]. There are especially many lipids in the cells of the liver, kidneys, nervous tissue, and skin.

Skin lipids are critical to the structure and function of the skin. Starting from the depth of the hypoderm, through the ceramide-rich epidermis and ending with lipids on the skin surface, there are a huge number of different lipids playing important roles [7]. Thus, 3 main types of structures can be distinguished in the skin, actively producing and secreting fats and fat-like substances. These include: 1) the epidermis, during the keratinization of which the lipids of stratum corneum skin barrier are formed; 2) sebaceous glands; 3) cells of adipose tissue, located mainly in the hypodermis (subcutaneous fat) and, to a lesser extent, in the dermis. These three groups of structures synthesize and secrete fats that differ in their

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chemical structure and, in connection with this, perform different functions to one degree or another.

In addition, the skin microbiome is an important source of skin lipids that should not be ignored [8-10].

Skin lipids perform a number of important functions:

- physicochemical function: they are a "building solution" for establishing the physicochemical barrier function of the skin;
- biochemical function: they act as signals in a complex signaling network occurring at the epidermal level;
- the function of microecology: lipids obtained from sebocytes and keratinocytes change the composition of the microbial flora of the skin [11].

In general, it should be noted that many of the most important functions of the skin (protective, thermoregulatory, etc.) are realized, among other things, due to skin lipids and adipose tissue cells in the hypodermis.

In dermatological studies, the study of lipids is given increased attention, since they are important for assessing the condition of the skin and new analytical possibilities of lipidomics [12-15]. However, literary sources have practically no data on lipids, lipid-containing and lipid-synthesizing structures of the skin of farm animals and especially pigs. Considering the importance and functions of the skin, we believe that the study of skin structures and its lipids is of great importance for predicting and assessing the farm animals' health, resistance and productivity.

The aim of the work is to characterize the epidermis, sebaceous glands, and adipose tissue cells of the hypodermis as lipid-containing and lipid-synthesizing structures of the skin of Poltava Meat Breed boars.

2 Materials and methods

The work was carried out on a pure-bred livestock of Poltava Meat Breed Pigs in possession of JSC "Plemzavod Belovodskiy" of the Lugansk region, Ukraine.

The environmental conditions, such as feeding and keeping the animals, or carrying out zooveterinary measures, met the technological standards developed by the Institute of Pig Breeding and Agroindustrial Production of the UAAS (Ukrainian Academy of Agrarian Sciences), taking into account the animals' age, live weight and physiological state. The pigs were fed by concentrate prepared with the use of our own feed, and kept in groups, under zero grazing conditions.

The research was carried out on skin samples taken from a group of animals (n = 16), formed from an array of boars, fattened for the purpose of "control slaughter" (to determine the meat qualities of the breed), which reached a live weight of 100 kg at the age of 6.5 months. The animals in the group were selected by the analog pair method. The data on the genotype of the boars were taken from the pedigree and zootechnical records.

Sampling and study of the morphological structure of the skin were carried out according to the method of G.D. Katsa (2013) [16].

The thickness of the stratum corneum (as the outer layer of the epithelium) and the thickness of the underlying layers of the epithelium (as the inner underlying layers of the epithelium), the length of the projections of the epidermis, the length of the excretory duct of the sebaceous gland, the distance from places of opening of the duct of the sebaceous gland to the surface of the skin, the depth of the secretory sections of the sebaceous, the area of the secretory surface of the sebaceous glands, the area of the fat cells of the subcutaneous adipose tissue in tenfold repetition were measured on stained sections using a digital microscope Delta Optical Genetic Pro Z (ScopeImage 9.0). Based on the primary data, the total thickness of the epidermis and the ratio of the outer and inner layers of the epidermis were calculated.

Statistical data processing was performed using the STATISTICA (6.0) software package. The mean value of the trait (M), the error of the mean (mM), the coefficient of variation (Cv), the values of the minimum and maximum variant of the population (lim) were calculated.

3 Results

The epidermis of the studied animals' skin is represented by a well-developed stratified squamous keratinizing epithelium. It has an average thickness of 79.38 μm (lim 48.94 - 99.15 μm and an average level of variation, the index of which (Cv) was 20.77%.

The most important component of the epidermis, on which its functional activity depends, is the stratum corneum. It plays a de-cisive role in the formation of a protective barrier. The studied animals have rather thick, multi-row, and loose stratum corneum. The cells of this layer are non-nuclear, in the form of gradually exfoliating scales.

The thickness of the stratum corneum reaches an average of 17.42 microns (lim 12.46 - 26.29 microns), which is on average 21.95% (lim 15.48-46.41%) of the total thickness of the epidermis. In some areas of the epidermis, peeling surface layers of the stratum corneum of different size and thickness are observed. The group variability of the stratum corneum thickness (Cv) index was 23.37%. In most boars (56.25%), the stratum corneum is lipid-lubricated (Fig. 1).
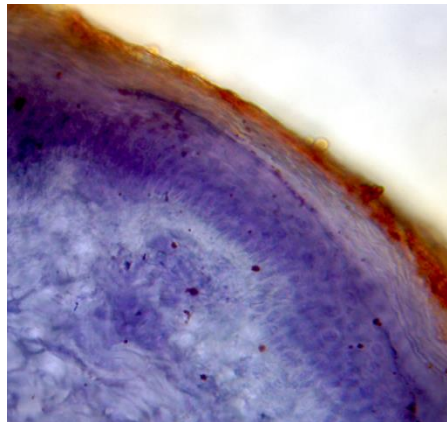

Fig. 1. Epidermis of Poltava Meat Breed boars upon reaching the live weight of 100 kg (vertical cut ×400). (Stained with Sudan III and Carazzi's Hematoxylin).

The inner underlying layers of the epidermis are well developed in boars. In the basal row, the nuclei of cells are large, oval in shape, elongated perpendicular to the surface of the skin. As they approach the stratum corneum, the nuclei of the cells become more rounded and shrink, and then flatten. The thickness of the inner underlying layers reaches an average of 61.95 microns (lim 35.47-79.86 microns), with group variability (Cv) equal to 25.24%. The ratio of the outer and inner underlying layers of the epidermis was 0.28 with the variability of the trait from 0.18 to 0.38, with cv = 22.5%.

A rather long excretory duct of the sebaceous gland (on average 114.6 microns, lim 44.76 - 179.77 microns, Cv = 47.39%) opens into the hair sheath in the upper third of the hair follicle (Fig. 2). at an average distance of 978.74 microns from the skin surface (lim 119.03 - 2077.38 microns, Cv = 67.96%), which is 33.72% of the total skin thickness.

The depth of the secretory sections of the sebaceous glands is on average 1339.83 microns (lim 596.55 - 2378.06 microns, Cv = 46.32%), or 41.61% of the total skin thickness.

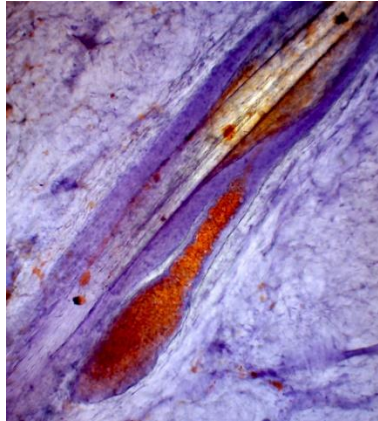Their area is on average 3273.87 mm2 (lim 654.87 - 9777.34 μm2) and Cv = 81.97%

Fig. 2. The sebaceous gland of the skin of a young Poltava Meat Breed boar upon reaching the live weight of 100 kg (vertical cut ×400). (Stained with Sudan III and Carazzi's Hematoxylin).

In Poltava Meat Breed animals, the hypodermis (subcutaneous fatty tissue) consists of large fat cells of various shapes and sizes and thin, rare collagen fibers (Fig. 3).
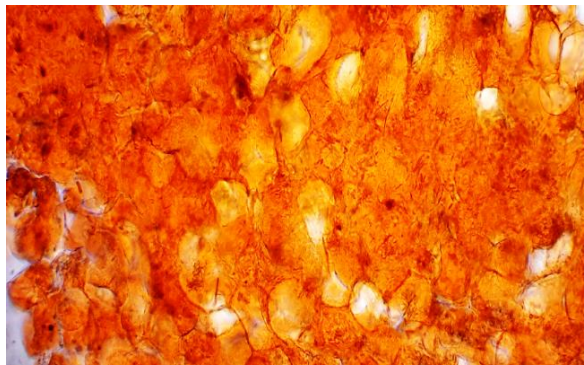

Fig. 3. Fat cells in the bacon of Poltava Meat Breed boars, obtained in "purity", upon reaching the live weight of 100 kg (×100). (Stained with Sudan III and Carazzi's Hematoxylin).

According to our research, the sizes of fat cells of Poltava Meat Breed boars vary very widely, ranging from 2802.83 to 5673.87 µm2. Their average area is 4006.21 ± 265.68 µm2 at $Cv = 23.91\%$. The hypodermis of the skin in these animals is characterized by well-pronounced "sudanophilia.

4 Discussion

The lipid-containing and lipid-synthesizing structures of the skin of Poltava Meat Breed boars upon reaching the live weight of 100 kg are characterized by morphological and functional features, due, in our opinion, to various factors, such as the phylogenesis of this animal species, long-term selection, climatic and technological factors.

The epidermis of the studied animals' skin is relatively thick and well developed. The hypodermis consists of a great number of large fat cells and is subject to varying degrees of destructive elements, which may be due to specific features.

The stratum corneum plays a critical role in the formation of the skin's protective barrier. In the studied animals, it was distinguished by equability, uniformity and sudanophilia.

The studied indices of skin layers had variability values not exceeding 33%, which indicates the uniformity of animals according to these indices in the skin structure of individuals, the most important organ of defense and adaptation, and therefore, in terms of the ability to perceive and respond to acting external factors.

It should be noted that the variability of indicators characterizing the morphofunctional features of the sebaceous glands, in contrast to the layers of the skin, is distinguished by a significant level of variation. These indicators cannot serve to indicate the studied animals breeds, but most likely they indicate the tension in the functioning of the sebaceous glands under these conditions, primarily under the influence of technological and natural-climatic factors.

In general, Poltava Meat Breed boars have well-developed lipid-containing and lipid-synthesizing structures of the skin, organically built into the skin structure. This is reflected in the greater genetic constancy of the epidermis layers parameters and in the presence of lipid lubrication of the stratum corneum in most animals.

We believe that some features of the lipid-containing and lipid-synthesizing structures of the studied animals' skin, namely: the high variability of the sebaceous glands parameters reflects the insufficient efficiency of the skin systems to carry out various functions in the given technological and ecological-climatic conditions, which can lead to a decrease in the genetically determined breeding value and productivity of the animals and to a decrease in the quality of raw materials.

5 Conclusion

Poltava Meat Breed boars have specific features of lipid-synthesizing and lipid-containing structures of the skin, which is important to develop effective methods of selectioning, breeding and keeping animals, the methods that would enhance the functional capabilities of highly productive animals and obtain high-quality products from them.

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