PROSPECTS FOR THE UTILISATION OF PIGSKIN OBTAINED FROM PIGS OF DIFFERENT BREED-OF-ORIGIN IN UKRAINE

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Abstract

The epidermis and dermis grow with time in pigs of all studied genotypes. The highest rates of skin growth are observed during the first month of age (the surface area of dermis increases by 29.4-62.5%) and then up to four months of age (the surface area of dermis increases by 5.3-23.0%). During subsequent stages of life, the surface area of dermis increases by 2.5-14.2% and 8.8-18.7% at 6 and 12 months of age, respectively. The absolute and relative thickness of the papillary dermis in pure-bred and hybrid pigs produced from "white" breeds (Large White and Landrace) are greater than those of pigs produced from "coloured" breeds (Pietrain and Duroc). The relative thickness of the papillary dermis increases with age in pigs of all studied genotypes. Notably, the relative thickness of the papillary dermis in pigs of different origin at the age of 120, 180 and 365 days is practically similar, which proves that both metabolism and adaptation are stabilised. Satisfactory suitability of pigskin as a raw material for the leather industry has been established, based on the morphology and main structural features of skins, obtained from pigs of the most popular breeds and genotypes – such as Large White, Landrace, Pietrain, as well as their hybrids: F_1 ½ (LW + L), F_1 ½ (P + D) and F_2 ¼ (LW + L+P+D) – which are common for commercial pig production in Ukraine.

Keywords: commercial pig, skins, popular breeds and genotypes, morphology, structural features.

Introduction

In Ukraine, there is a clear downward annual trend in numbers of all livestock species in the last 10-15 years. In particular, between 2010 to 2015, the number of pigs averaged about 7.5-8.0 million heads. The decline in the number of pigs down to 5.5-6.0 million heads since 2015 was caused by various issues associated with the spread of the African swine fever virus. In 2020, we can see a trend towards stabilisation and even increase in numbers of pigs up to earlier levels. The pig industry per se provides valuable energy foods (such as pork and back fat), as well as organic fertilisers of good quality, for the country's population. Moreover, pigskin is quite essential as a raw material for leather foot-wear and accessories industry. The leather industry is supplied with a large number of pigskins, whose utilisation has been increasing systematically due to their high availability and low cost of production. On the one hand, today, the usage of pigskin as a raw material for foot-wear manufacturing becomes increasingly popular, which is associated with its availability and relatively low cost. On the other hand, pigskin does not make a truly presentable appearance and it is predominantly used as a lining material rather than as the shell fabric. This is mainly due to the fact that pigskin is not elastic enough, it gets wet easily and tends to have a rather rough, hard surface and long-lasting odour. Besides, pig skin is not durable enough, which results in a texture full of holes in the end product.

Our research is aimed at finding out whether pigskin is currently suitable as a raw material for the leather industry, based on the morphology and main structural features of skins, obtained from pigs of the most popular breeds and genotypes – such as Large White, Landrace, Pietrain, as well as their hybrids: F_1 ½ (LW + L), F_1 ½ (P + D) and F_2 ¼ ((LW + L) + ½P) – which are common for commercial pig production in Ukraine.

Materials and methods

A research study was carried out under conditions of the pig farm of Artsyz Meat Company Ltd in Artsyz sub-region of Odesa region; the farm's production capacity is 16,000 heads of growing fattening pig stock. The conceptual experimental design is presented in Table 1.

Table 1. Experimental design.

Groups of pigs	Group description	Breed and breed-of-origin		
		sows	boars	offspring
I	Control	LW	LW	LW
II	Experimental	L	L	L
III	Experimental	P	P	P
IV	Experimental	LW	L	½ (LW + L)
V	Experimental	P	D	½ (P + D)
VI	Experimental	½ (LW + L)	½ (P + D)	¼ (LW + L+ P + D)

Note: LW – Large White breed; L – Landrace breed; P – Pietrain breed; D – Duroc breed.

We examined reproductive, fattening and carcass traits of young pigs of different origin using conventional zootechnical methods. Moreover, for the purpose of studying specific biological features of Pietrain pigs in more detail with respect to their level of adaptation and suitability of pigskin as a raw material, our task was to examine histological peculiarities of skin of Pietrain pigs as compared to those of other, the most common commercial lines and hybrids.

Samples of pigskin were collected at different age: at birth, at 30, 120, 180 and 365 days of age. All the samples were taken at one and the same anatomico-topographic site, that is, the right shoulder blade of the pig. The samples, taken using a sampling probe and standardised by size and shape, were fixed in 10% formalin.

The laboratory analysis of the skin samples was conducted at the Laboratory of Histology, Cytology and Embryology of the Petro Mohyla Black Sea National University using the equipment designed by the author and employing modified methods [4], with application of K. Zeiss optical instruments and Linvatec-2 halogen light source (USA) of 10-240 Wn.

Contrast staining in the histological preparations was undertaken using a correction filter ZhZGM 2.5x (Belarus). Microphotographs of histological sections were taken with digital camera Nikon D-60 (Austria) using a standard trinocular tube 1.6x and integrated digital exposure detector Minolta-EK (Japan). Morphometric analysis of tissue structures was performed with an integrated ocular micrometre. Reliability of the results obtained for glandular tissues was achieved through waxed reconstruction. This technique involves frozen semi-thin (15 mm) sectioning for histological spatial orientation with further synthesising 3-D images (MICAM, Belgium).

Correction of microphotographs was performed using Microsoft Office Picture manager and FastStone Image Viewer applications. The results obtained were analysed statistically using Microsoft Excel application, focusing on the calculation of standard deviations [1].

Results and discussion

According the data obtained, the epidermal layer is relatively thin, averaging 4-6% of the dermis thickness in the shoulder region. Such a tendency can be observed practically in all examined samples. This fact stems from relatively stunted hair growth, which is typical for the skin microstructure of domesticated representatives of this sub-species [3].

It has been established that hybrids, produced from Pietrain and Duroc breeds, especially tend to have thinner epidermal layer.

Macroscopically, the skin surface is made up of convoluted folds. As is seen in histological sections of skin samples of pigs representing older-age groups, cord tissues below such folds form long and narrow ridges, which are perpendicular to the surface of organs and embedded in the dermis to some extent. Such an architectonics contributes to peculiar pattern of the outer surface of the skin [2].

According to the data acquired from micrographs, the epidermis, being observed in caudal direction, includes the following layers: basal, spinous, granular and corneous; it can be observed in contrast exclusively in animals of older-age groups. It should be noted that a clear layer that can be detected around wrists is absent in the skin covering the shoulder blade of the pig.

As can be inferred from the microphotographs, the dermis lies deep to the epidermis, being separated from the latter by the basement membrane, which prevents interpenetration of adjacent layers. The dermis is well vascularised, which is associated with increased needs for thermoregulation in the absence of thick hair coat [5]. There is a large number of sebaceous glands within this layer. A distinctive feature of the dermal layer of the pigskin is that there is no division of the dermis into the papillary and reticular layers as the hair bulbs that serve as a boundary reference line are located within the hypodermis.

Since the quality of pigskins is determined by peculiarities of the dermal layer structuring, detailing of the pattern of its components is of great practical interest. By employing light optical techniques, we have discovered that elastic fibres form an extensive thin network in the dermis. They are the thinnest and locate perpendicularly to the skin surface, immediately beneath the epidermis. The analysis of histological sections enabled us to establish that in the apical layer of dermis, in the vicinity of the basement membrane, there are also elastic fibres of varying diameter, approaching in different directions. Such fibres can be often observed optically as almost homogeneous mass in the preparations of young piglet skin samples whereas in caudal direction we can observe immature elastic fibres that exhibit a moderate intensity of staining.

As follows from the micrographs (shown in Figures 1 and 2), the morphology of connective tissue that constitutes the bulk of the pig skin dermis shows the absence of distinct separation of layers. Looser upper layer gradually transforms into denser fraction wherein massive fibrous component prevails. Collagen is the main structural component of the dermis that ensures elasticity and firmness of the skin. It is worth noting that among the current variety of types of collagen, only certain types can be detected in the dermis using available light optical methods [5]. In particular, type III collagen is predominant in the post-natal skin, and its content increases during the first days of piglets' lives. According to our observations, in the skin of pigs of older-age groups, thinner fibres of type III collagen wrap around coarse fibres of type I collagen, thus determining the spatial orientation of the latter ones. Other types of collagen are amorphous and cannot form fibrils. At the micro level, they can be detected as peculiar acidophilic poorly stained cavities in between fibres.

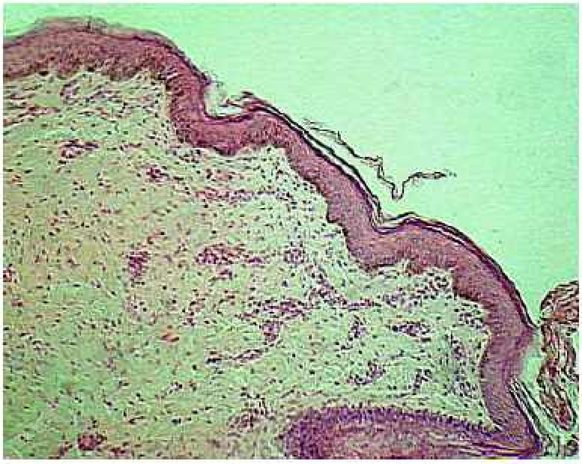

Figure 1. A sample from a Pietrain pig (30 days of age). Shoulder blade skin. Black area. Bömer's haematoxylin, counterstaining using a modified method by Tsinzerling. Correction filter ZhZGM 2.5x, X90.

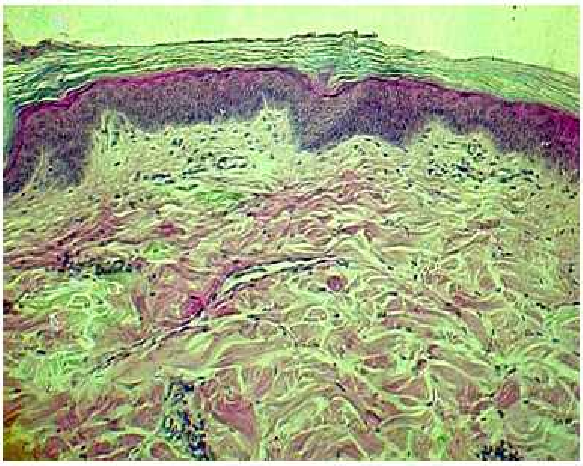

Figure 2. A sample from a Large White x Landrace pig (30 days of age). Shoulder blade skin. Bömer's haematoxylin, counterstaining using a modified method by Tsinzerling. Correction filter ZhZGM 2.5x, X90.

It has been established that collagen fibres (seldom their bunches) in the apical layer of dermis are delicate and thin; they are characterised by a relatively uniform distribution. In the medial layer, these fibres get thicker and form bundles and dense clusters. Collagen fibres in the region of shoulder blade are of better type which explains firmness and elasticity of the skin observed at this topographic region.

As has been described above, the contact between the epidermis and dermis results in the appearance of inner convoluted folds [2]. Our observations show that such folds are less prominent or absent in young pigs. It is likely due to the presence of hair coat in piglets that protects the skin from excessive mechanical shear, which is compensated by epidermal folds in pigs of older-age groups [2, 3].

Taking into consideration the existing stereotypic characteristics, there are some age- and breed-specific differences within certain histological components of the pig skin. As regards the first ones, the thickness of each layer increases with time. The dynamics of growth of organ components is shown in Table 2. The analysis of the data obtained has revealed a common biological pattern of growth: the epidermis and dermis grow with time in pigs of all studied genotypes. The highest rates of growth are observed during the first month of age (the surface area of dermis increases by 29.4-62.5%) and then up to four months of age (the surface area of dermis increases by 5.3-23.0%). During subsequent stages of life, the surface area of dermis increases by 2.5-14.2% and 8.8-18.7% at 6 and 12 months of age, respectively.

With regard to the selection and adaptive ability, the papillary layer of dermis is of research interest; the growth of this layer is indicative of higher adaptive ability, and hence higher breeding value of the pig. For instance, in our study, we have established that the absolute and relative thickness of the papillary dermis in pure-bred and hybrid pigs produced from "white" breeds (Large White and Landrace) are greater than those of pigs produced from "coloured" breeds (Pietrain and Duroc). Moreover, there is a common biological pattern, that is the relative thickness of the papillary dermis increases with age in pigs of all studied genotypes. Notably, the relative thickness of the papillary dermis in pigs of different origin at the age of 120, 180 and 365 days is practically similar, which proves that both metabolism and adaptation are stabilised.

Table 2. Age-specific peculiarities of shoulder-blade skin layers of pigs of different breed- or hybrid origin (in mcm), n = 6.

Breed/hybrid	Colour	Skin layer, mcm			
		Epidermis	Papillary dermis		Dermis
			mcm	% thickness	
At birth					
LW	white	34.0±2.27	300.0	36	830.0±16.23
L	white	31.0±1.53	284.0	35	810.0±16.23**
P	black spotted	23.0±1.26**	167.0	29	575.0±11.01
½ (LW + L)	white	30.0±2.25	278.0	37	750.0±15.26
½ (P + D)	red	24.0±2.13**	186.0	31	600.0±13.74**
¼ (LW + L + P + D)	white	26.0±1.46	218.0	34	640.0±15.83**
At 30 days of age					
LW	white	54.0±2.02	496.0	46	1079.0±24.49
L	white	51.0±2.49	472.0	45	1048.0±22.61
P	black spotted	37.0±2.91***	274.0	37	740.0±27.75**
½ (LW + L)	white	49.0±3.19	424.0	41	1035.0±28.11
½ (P + D)	red	41.0±2.14**	311.0	39	797.0±25.64***
¼ (LW + L + P + D)	white	52.0±2.13	447.2	43	1040.0±31.48
At 120 days of age					
LW	white	75.0±1.29	880.0	71	1240.0±30.55
L	white	72.0±1.13	815.0	67	1216.0±32.86
P	black spotted	51.0±2.96***	512.0	59	868.0±29.37**
½ (LW + L)	white	65.0±2.88**	767.0	64	1199.0±34.46
½ (P + D)	red	58.0±2.35***	599.0	61	982.0±30.43**
¼ (LW + L + P + D)	white	69.0±2.03*	690.0	63	1095.0±27.79**
At 180 days of age					
LW	white	81.0±3.50	890.0	69	1290.0±33.64
L	white	79.0±3.33	862.0	68	1268.0±31.40
P	black spotted	59.0±2.98***	624.0	63	991.0±28.52**
½ (LW + L)	white	76.0±3.60	843.0	68	1240.0±32.43
½ (P + D)	red	64.0±3.00**	654.0	65	1007.0±29.61**
¼ (LW + L + P + D)	white	77.0±3.48	810.0	67	1209.0±34.36*
At 365 days of age					
LW	white	85.0±4.68	1015.0	72	1410.0±37.88
L	white	83.0±3.71	966.0	70	1380.0±34.79
P	black spotted	67.0±3.32*	696.0	65	1070.0±32.46**
½ (LW + L)	white	81.0±3.54	932.0	69	1350.0±41.72
½ (P + D)	red	73.0±4.12	797.0	67	1190.0±35.80*
¼ (LW + L + P + D)	white	80.0±4.28	951.0	71	1340.0±37.14

Note: *P<0,05; **P<0,01; ***P<0,001; epidermis is the sum of smooth and wrinkled caudices.

Conclusions

The epidermis and dermis grow with time in pigs of all studied genotypes. The highest rates of skin growth are observed during the first month of age (the surface area of dermis increases by 29.4-62.5%) and then up to four months of age (the surface area of dermis increases by 5.3-23.0%). During subsequent stages of life, the surface area of dermis increases by 2.5-14.2% and 8.8-18.7% at 6 and 12 months of age, respectively.

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The relative thickness of the papillary dermis increases with age in pigs of all studied genotypes. Notably, the relative thickness of the papillary dermis in pigs of different origin at the age of 120, 180 and 365 days is practically similar, which proves that both metabolism and adaptation are stabilised.

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