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## Influence of Chinchilla Skin Microstructure on Furs Properties.

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### ABSTRACT

This paper presents the results of the study of the structure of chinchilla skin of various colors. During the fifty years of chinchilla domestication in Russia, the thickness of their skin has been increased by almost 2 times, which indicates the improvement of their operational properties and the need to increase the duration of conservation, dressing and dyeing processes. It has been established that the chinchilla skin has a small thickness with a strongly developed hair cover. The change in the thickness of the skin in the topographic areas has not been affected by the color of skin: the thickest is characteristic of rump, while the smallest is on the sides. It is shown that the epidermis of chinchilla skin is very thin and constitute  $\leq 1.8-2.7\%$  of its thickness. In contrast to other types of furs, where the reticular dermis is dominated by a corpus papillare, chinchilla skin is dominated by a papilla layer with a thickness of 78-83% of the dermis. The range of variability in the depth of hair follicles in the chinchilla skin indicates different levels of hair maturation due to seasonal dimorphism. It was found out that not only papilla roots of hair pierce the papilla but also the reticular dermis, and the prevailing number of hair follicles lies in the fat layer, so that the protruding hair follicles from the skin look like a short "hedgehog", which requires a more careful degreasing of the skin to prevent damage to the knife hair roots and their fallout.

**Keywords:** chinchilla, haircolor, skinmicro structure

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## INTRODUCTION

In the 80s of the last century in Russia began to engage in chinchilla breeding [1], which has not received a significant spread despite the exceptional beauty and high value of fur [2-5]. Technological properties of chinchilla skin are determined by their histological structure [6], and first of all by the peculiarities of skin tissue organization [7]. The duration of processing of raw materials during production operations [8] and indicators of physical and mechanical properties of skin [9] depend on the thickness of the skin and the ratio of its layers. The existence of many varieties of chinchillas of various colors and shades [10-14], differing in size [15-20], allows us to hypothesize the differences in the properties of their skin. In this regard, for the development of industrial production of chinchilla skin and finished products [21] is still relevant to the study of the characteristics of the chinchilla skin, considering the influence of hair color.

One of the important indicators of the properties of fur is the thickness of the skin, which affects the weight and durability of fur [22]: the thinner the skin, the lighter the product made of such skin. The thickness of the skin on different areas of the same skin varies and depends on the characteristics of the animal's body structure and lifestyle. Depending on the thickness of the skin, there is a distinction between skins with thin skin about 0.06-0.1mm, with medium skin about 0.12-0.6mm and thick skin about 0.7-1 mm and more. The skin with more developed hair have, as a rule, a thinner epidermis. The thickness of the skin depends on the topographic area of the skin, age, sex, lifestyle, season and area of the animal. The skin of terrestrial animals have thicker skin on the chine than on the belly[23].

Previous studies have shown that the thickness of chinchilla skin, measured on its longitudinal sections, is not the same on different parts of the body and ranges from 170 to 400 microns in different individuals, on the belly-from 150 to 300 microns. Measurements of the thickness of skin of pre-dry chinchilla showed the following results: on the sacrum-170-210microns, on the side-130-160microns, on the belly -90-120microns, an average of about 0.19mm [24]. In the 70s of the last century, the thickest skin (more than 0.17mm) was located on the chine from the middle of the body to the base of the tail and at the end of the muzzle, the thinnest skin (0.13-0.16mm)-on the front of the back and on the sides of the body, the thinnest (0.10-0.12mm) was on the belly and the lower part of the body. Sex differences in the topography of chinchilla skin by its thickness have not been previously found [24, 25].

*Epidermis*-is an outer layer of skin that makes up 1÷4% of the total thickness of the skin, preventing the penetration of various chemicals, water and bacteria, as well as delaying the evaporation of moisture and partially reducing the heat output of the body. The epidermis is usually thinner in animals with well-developed thick hair [26].

As you know, *the dermis*, which is the main layer of skin, lies under the epidermis and is separated from it by a thin layer. Thanks to the consider able thickness and fibrous structure of the dermis, it determines the strength and plasticity of the skin. The dermis is a connective tissue part of the skin, which is divided into two layers: papillary and mesh, between which there is no clear boundary due to the gradual transition of one layer to another. In this connection, the identification of layers causes significant difficulties in their micro morphology.

*The papilla layer* ad joins the basal membrane and repeats all the contours of the epidermis. Numerous papillae extending into the epidermis are made of loose connective tissue consisting of thin bundles of collagen, elastic and reticular fibers. *The meshlayer* is formed by the mesh ligature of fibrous elements, mainly by bundles of collagen fibers, between which elastic fibers and rare cellular elements are located. Furry animals' skin usually contains sebaceous and sweaty glands, blood and lymphatic vessels, nerve endings, hair roots and muscles that straighten hair.

## MATERIALS AND METHODS

Chinchilla skin of 8-month age after pre-dry canning in the amount of 150 pieces of 30 skin of each color type were chosen as the object of research. From a considerable variety of color types of chinchillas studied: the most popular color - "standard", the darkest and most commercially successful - "black velvet", the lightest - "white Wilson", as well as chose a relatively intermediate position on the color scale of color - "beige" and "violet". For the study of the histological structure of the skin, 10pelts of each color were

selected.

During the experimental analysis the following parameters were determined: area, thickness and ratio of skin layers, the level of occurrence of hair follicles in the chinchilla skin of three color types.

There search was conducted in three topographic areas: chine, rump and belly.

*Determining the thickness of the chinchilla skin.* Thickness was measured with the help of Meisner's thickness gauge on different topographic areas of the skin by inserting a chinchilla between the fixed lower cheek of the device and the upper chinchilla skin pressing against the direction of hair growth. The thickness of the skin was measured to an accuracy of 0.1mm.

*To determine the thickness of the skin and its individual layers,* preparations of vertical cuts of the skin were used, in which hair roots were examined separately in the longitudinal section. After the drug was placed on the slide

Table using an ocular micrometer with a fission price of 4.4 microns, the total thickness of the skin was determined by measuring in a straight line from the epidermis surface to the lower boundary of the skin. Measurements were made at low magnification of the microscope (lensX8, eye pieceX15). Then the thickness of each layer of skin was determined. The epidermis thickness was determined by measuring in a straight-line from its surface to the beginning of the papillary layer of dermis. The thickness of the papillary layer was determined by measuring the distance from the inner side of the epidermis to the base of the spindle hair roots. The thickness of the mesh layer was measured from the base of the hair roots to the border with the subcutaneous layer.

Preparations of vertical and tangential cuts were made from the skin of the studied opographic areas of skin of each color. To study the *histological structure of the chinchilla skin*, samples were taken from different types of chinchilla skin. The material fixed in 10% neutral formaldehyde was poured into paraffin with subsequent coloring with hematoxylin and eosin. Morphometry of the studied structures was carried out under the microscope MBI-3 (eyepiece15, lens8.20) using the eyepiece micrometer MOB1x16.

Measurement results were processed in accordance with the methods of mathematical statistics on small samples with a number of tests equal to 30. The obtained data confirmed the reliability of the conducted experiments with probability  $P > 0.95$ .

### RESULTS OF INVESTIGATION

The results of measurements of skin thickness of different color types of the studied lot are presented in Table1. The thickness of chinchilla skin can be categorized as "particularly thin" or "thin". The results of the study show that over decades of chinchilla domestication in Russia, the thickness of the chinchilla skin has been significantly increased: while in 1970 it was 0.1 to 0.4mm [24] in various areas of skin, it currently ranges from the smallest on the side ( $0.3 \pm 0.06$ mm) to the largest on the diaper ( $0.7 \pm 0.13$ mm), which indicates an improvement in the operational properties of skin during the selection process.

**Table1: Thickness of chinchilla skin of different coloring by topographic areas (n=150; 30)**

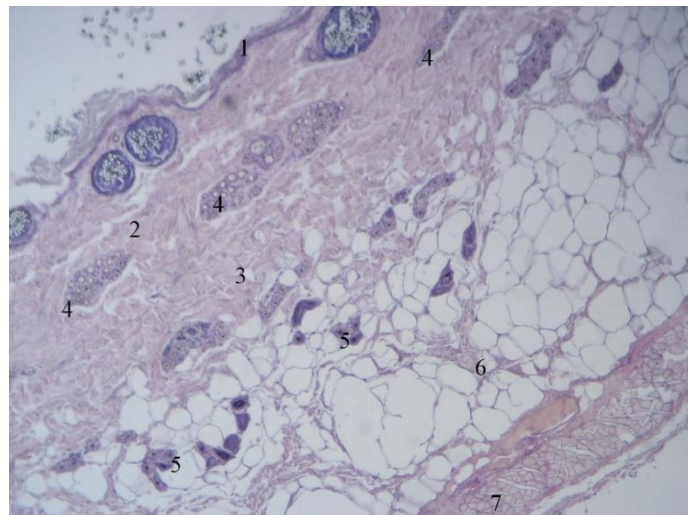
<i>Skin thickness, mm</i>		
Color type	$X \pm m_x$ , mm	Cv, %
<i>Chine</i>		
Standard	$0.41 \pm 0.01$	3.5
White Wilson	$0.41 \pm 0.01$	4.4
Violet	$0.45 \pm 0.01$	3.6
Black velvet	$0.41 \pm 0.01$	3.9
Beige	$0.41 \pm 0.01$	4.4
<i>Rump</i>		

Standard	0.63±0.02	3.1
White Wilson	0.63±0.02	3.7
Violet	0.46±0.01	4.0
Black velvet	0.46±0.01	3.5
Beige	0.70±0.02	3.0
<i>Side</i>		
Standard	0.40±0.01	4.1
White Wilson	0.40±0.01	4.0
Violet	0.36±0.01	4.7
Black velvet	0.41±0.02	4.7
Beige	0.37±0.01	4.4

Increasing the thickness of the skin is the basis for improving the wear resistance of fur as the most vulnerable performance indicator of chinchilla skin. On the other hand, such a significant, more than double increase in thickness requires a change in the previously existing modes of technological processing [ 27] and, above all, an increase in the duration of the processes of conservation, dressing and dyeing. The change in the thickness of the skin in the topographic areas does not depend on the color type of skin: the largest thickness is characteristic of the rump, and the smallest - on the sides. Thicker on the capping are the light-colored skin types and "standard" coloring, and vice versa on the chine-the colors "violet", and on the sides – the colors "black velvet", that is, there is no direct relationship between the color type of skin and its thickness, and we can speak in general about the equation of chinchilla skin of different batches in thickness. The chinchilla skin has a small thickness with a strongly developed hair cover, which reflects the general pattern of inverse dependence of the degree of development of these parts of the outer cover of mammals.

However, the selection of homogeneous color is characterized by an arrowrange of changes in the thickness of skin, which is illustrated in the graphs and indicates the positive effect of selection on the homogeneity of the properties of skin in the batch.

The chinchilla skin consists of several layers differing in structure: epidermis, dermis, fat layer and subcutaneous muscles (Fig. 1).



**Figure1 – Standard-colored chinchilla skin with increase of 100, cross section: 1-epidermis, 2- papilla layer, 3- mesh layer, 4- hair bundles, 5-hair roots, 6- hypodermis, 7- muscle plate.**

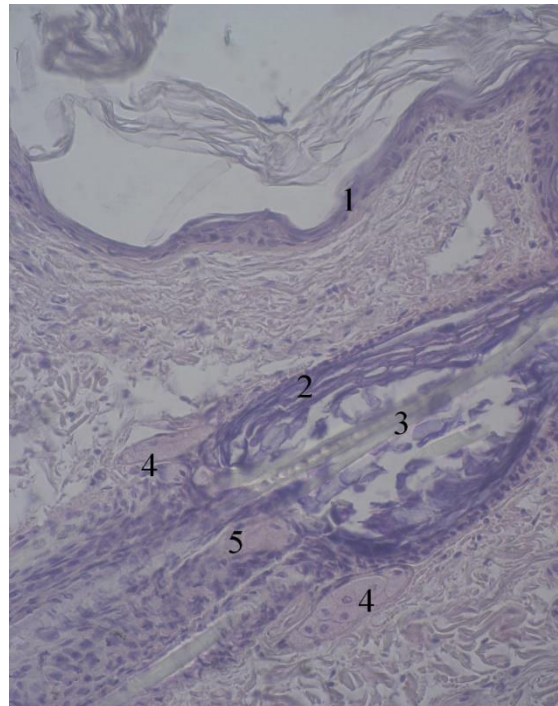
According to our data (Table 2), the epidermis of chinchilla skin is quite thin and makes up 1.8-2.7% of the thickness of the skin, which confirms the significant thickness of chinchilla.

**Table 2 Thickness of skin and its individual layers of different color types (n=150)**

Topographic area under study	Skin thickness, $\mu\text{m}$	Thickness of skin layers			
		epidermis		dermis	
	$X \pm mx, \mu\text{m}$	$X \pm mx, \mu\text{m}$	%	$X \pm mx, \mu\text{m}$	%
<b>Standard Color</b>					
Rump	580.2 $\pm$ 8.0	11.6 $\pm$ 1.3	1.9	568.4 $\pm$ 4.6	98.1
Chine	535.4 $\pm$ 6.1	9.6 $\pm$ 1.3	1.8	525.8 $\pm$ 3.2	98.2
Belly	490.7 $\pm$ 4.9	10.5 $\pm$ 1.6	2.0	480.9 $\pm$ 2.8	98.0
<b>Violet</b>					
Rump	596.2 $\pm$ 8.0	12.5 $\pm$ 1.3	2.1	583.7 $\pm$ 4.1	97.9
Chine	550.2 $\pm$ 8.0	13.7 $\pm$ 1.4	2.5	536.4 $\pm$ 4.7	97.5
Belly	500.7 $\pm$ 4.6	13.5 $\pm$ 1.9	2.7	487.2 $\pm$ 4.2	97.3
<b>Beige</b>					
Chine	590.2 $\pm$ 8.0	11.8 $\pm$ 1.3	2.0	578.4 $\pm$ 3.9	98.0
Chine	540.2 $\pm$ 8.2	11.3 $\pm$ 2.1	2.1	528.9 $\pm$ 4.1	97.9
Belly	493.3 $\pm$ 3.0	11.3 $\pm$ 2.0	2.3	482.0 $\pm$ 3.8	97.7
<b>Black Velvet</b>					
Rump	580.2 $\pm$ 8.0	11,6 $\pm$ 1,3	1.9	568.4 $\pm$ 4.6	98.1
Chine	540.2 $\pm$ 8.2	11,3 $\pm$ 2,1	2.1	528.9 $\pm$ 4.1	97.9
Belly	490.7 $\pm$ 4.9	10,5 $\pm$ 1,6	2.0	480.9 $\pm$ 2.8	98.0
<b>White Wilson's</b>					
Rump	596.2 $\pm$ 8.0	12,5 $\pm$ 1,3	2.1	583.7 $\pm$ 4.1	97.9
Chine	535.4 $\pm$ 6.1	9,6 $\pm$ 1,3	1.8	525.8 $\pm$ 3.2	98.2
Belly	500.7 $\pm$ 4.6	13,5 $\pm$ 1,9	2.7	487.2 $\pm$ 4.2	97.3

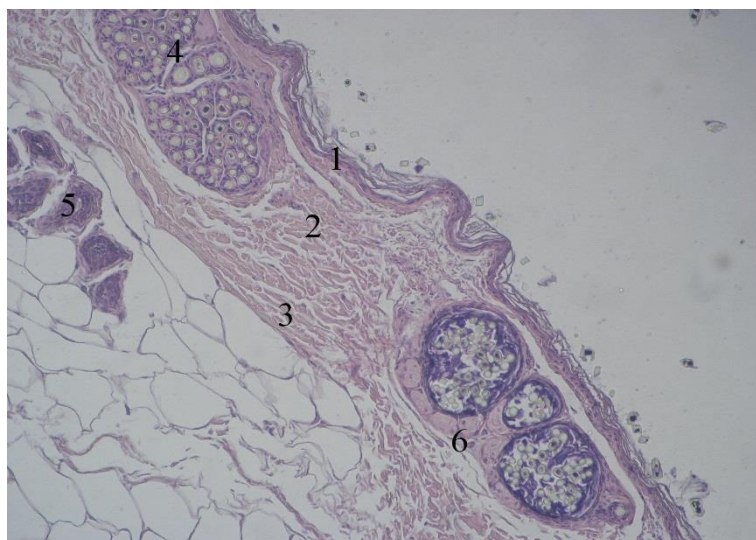
Currently, the boundary of dermis layers in mammals is determined by the depth of occurrence of bulbs of spindly hair and tubular glands, which is confirmed by the illustration presented in Figure 2. One of the main supporting proteins of the dermis is collagen. The smallest structural unit is the subfibrillas, which, grouped together, form fibrillas. Fibrils are combined into fibers and a set of fibers forms a collagen beam.





**Figure 2: Beige chinchilla hair root, longitudinal section, 400 magnification: 1-epidermis, 2-hairfollicles, 3-hair, 4- sebaceousiron, 5 –hair papillae**

Previously, chinchilla skin was thought to be free of sweat glands and sebaceous glands were small and numerous [28]. With the help of modern histological analysis, we have established the presence of sweat glands in the chinchilla skin, the number of which is extremely small (Fig.3). In the skin, chinchilla reach the muscles that lift the hair, which is associated with their active work, providing a change in the angle of hair inclination and thermal conductivity of fur.



**Figure 3: Cross-section of beige chinchilla skin, enlargement 200: 1-epidermis, 2-papillalayer, 3- net layer, 4-hair bundle, 5 -sweat gland fragment, 6 – secretory parts of sebaceous gland**

Chinchillas in the dermis also have two layers: papilla and mesh. The papilla layer is located directly below the epidermis. The net layer is located under the papilla layer. The ratio of layers in the chinchilla dermis of different color types is presented inTable3 andFigure4.

**Table 3: Thickness of dermis layers of chinchilla skin of different color types (n=50)**

Topographic area under study	Thickness of the dermis				Ratio of dermis layers
	Nipple		Mesh		
	X±mx, μm	%	X±mx, μm	%	
<b>Standard Color</b>					
Rump	464.2±38.6	80	116.0±33.5	20	4.0:1
Chine	417.6±35.1	78	117.8±36.2	22	3.5:1
Belly	407.3±30.6	83	83.4±28.3	17	4.9:1
<b>Violet</b>					
Rump	482.9±34.3	81	113.3±35.3	19	4.3:1
Chine	440.2±37.2	80	110.0±33.1	20	4.0:1
Belly	395.6±31.9	79	105.1±28.9	21	3.8:1
<b>Beige</b>					
Rump	466.3±32.4	79	123.9±29.0	21	3.8:1
Chine	421.4±35.6	78	118.8±30.2	22	3.5:1
Belly	399.6±29.6	81	93.7±29.2	19	4.3:1
<b>Black Velvet</b>					
Rump	464.2±38.6	80	116.0±33.5	20	4.0:1
Chine	421.4±35.6	78	118.8±30.2	22	3.5:1
Belly	407.3±30.6	83	83.4±28.3	17	4.9:1
<b>White Wilson's</b>					
Rump	482.9±34.3	81	113.3±35.3	19	4.3:1
Chine	417.6±35.1	78	117.8±36.2	22	3.5:1
Belly	395.6±31.9	79	105.1±28.9	21	3.8:1

Thus, the skin consists of epidermis, dermis and subcutaneous fat, which are in morpho functional unity. Many properties of the skin as a whole depend on the ratio of papillary and net layers, the number of hair follicles and their angle of occurrence.



**Figure 4: Tangential cut of chinchilla skin of “standard” coloring (increase 300): 1-epidermis, 2-papillalayer, 3- mesh layer, 4- sebaceous gland, 5-cut hair root, 6 -hypodermis, 7-hair bundle**

Unlike other fur species, where the dermis is dominated by a mesh layer, chinchilla have a different

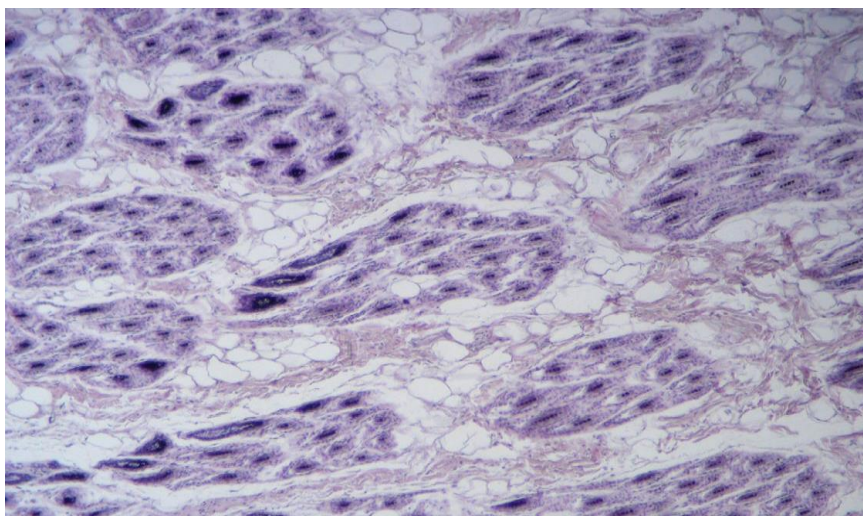
ratio of dermis layers due to their “special thickness”. The chinchilla skins are dominated by a papilla layer with a thickness of 78-83% of the dermis thickness. Accordingly, the thickness of the mesh layer of the dermis skin of chinchilla skins is 17-22%, and the ratio of dermis layers is not affected by the color type of skins.

The depth of hair follicles is the most important criterion for the morphological maturity of the skin tissue and has the maximum value in the skin of the diaper, and the smallest value is different on the belly. Measurements were made on 10 chinchilla skins of each color type in three topographic areas: chine, rump and belly. Data on the depth of hair roots in each topographic area are shown in Table4, and a cross section of skin tissue of chinchilla skin in Figure 5.

**Table 4: Depth of hair follicles in the skin of chinchilla skins (n=50)**

Painting of the skins under study	Depth of hair follicles in the skin					
	chine		stump		belly cap	
	X±mx,µm	Cv,%	X±mx,µm	Cv,%	X ±mx,µm	Cv, %
Standard	217.2±10.6	23.9	232.4±11.5	24.2	189.5±8.7	22.3
Violet	223.4±9.9	21.6	240.6±11.5	23.5	198.8±9.7	24.0
Beige	220.1±10.9	24.2	237.4±12.0	24.7	192.4±9.2	23.5
Black Velvet	221.2±10.7	22.8	232.4±11.5	24.2	194.5±8.5	23.2
White Wilson	219.2±9.6	21.9	237.4±12.0	24.7	187.5±7.7	21.5

The data obtained indicate a significant range (21.5-24.7%) of variability in the depth of hair follicles in the skin tissue of chinchilla skin. Such a different level of hair maturation, in our opinion, may be due to seasonal dimorphism of chinchillas.



**Figure 5: Cross section of chinchilla skin**

Currently, the most frequent complaints from consumers about the quality of chinchilla fur products [29, 30] concern the appearance of hair roots on the dermis side, looking like a short "hedgehog" [31]. However, these claims have no basis, as they are a consequence of the biological peculiarities of the chinchilla skin. Unlike most fur animals with hair follicles in the papilla layer, chinchilla roots pierce the papilla and mesh layer, and the majority of hair follicles are in the fat layer, a sour study has shown. That's why consumers can see the protruding hair follicles from the skin in the finished fur product. From a technological point of view, such a feature of chinchilla skins requires a more attentive and careful approach to the process of skins degreasing, so as not to damage the hair roots with a knife, the cutting of which will cause them to fallout.



## CONCLUSION

The experimental study made it possible to establish that the skin tissue of chinchilla skins has an insignificant thickness with a strongly developed hair cover. It has been established that during the fifty years of chinchilla domestication in Russia, the thickness of their skin has been increased by almost 2 times, which indicates the improvement of their operational properties and the need to increase the duration of conservation, dressing and dyeing processes. It has been established that the chinchilla skin has a small thickness with a strongly developed hair cover. The change in the thickness of the skin in the topographic areas has not been affected by the color of skin: the thickest is characteristic of rump, while the smallest is on the sides. It is shown that the epidermis of chinchilla skin is very thin and constitutes 1.8-2.7% of its thickness. In contrast to other types of furs, where the reticular dermis is dominated by a corpus papillare, chinchilla skin is dominated by a papilla layer with a thickness of 78-83% of the dermis. The range of variability in the depth of hair follicles in the chinchilla skin indicates different levels of hair maturation due to seasonal dimorphism. It was found out that not only papilla roots of hair pierce the papilla but also the reticular dermis, and the prevailing number of hair follicles lies in the fat layer, so that the protruding hair follicles from the skin look like a short "hedgehog", which requires a more careful degreasing of the skin to prevent damage to the knife hair roots and their fall out.

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