

ОСОБЕННОСТИ АККУМУЛЯЦИИ МЕДИ В ЩЕТИНЕ СВИНЕЙ РАЗЛИЧНЫХ ПОРОД

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Приведены результаты оценки содержания меди в щетине свиней ландрасской, кемеровской и скороспелой мясной пород. Исследования выполнены на клинически здоровых шестимесячных животных в хозяйствах Новосибирской, Кемеровской областей и Алтайского края. Условия содержания животных стандартные с типовым кормлением. Элементный анализ проб щетины свиней выполнен методом атомно-эмиссионной спектроскопии с индуктивно-связанной плазмой. Обработку данных проводили с применением Microsoft Office Excel и Statistica 8 (StatSoft Inc., USA), в том числе используя непараметрические методы. Установлен убывающий ранжированный ряд по уровню меди в волосе свиней для пород: ландрасская → кемеровская → скороспелая мясная. В виде отношения он представлен как 5,1 : 4,5 : 1. Показатели меди в щетине свиней ландрасской, кемеровской и скороспелой мясной пород составили 44,0; 39,0 и 8,7 мг/кг соответственно. Аккумуляция меди в щетине свиней ландрасской и кемеровской пород зафиксирована в 5,6 и 4,5 раза больше, чем в скороспелой мясной ($p < 0,001$). Однородностью показателей отмечены скороспелая мясная и кемеровская породы, у них зарегистрирован наименьший межквартильный размах и отношение крайних вариантов. Исследованиями с использованием критерия Краскела-Уоллиса установлено, что порода влияет на аккумуляцию меди в щетине свиней. Различия зарегистрированы в парах: скороспелая мясная – кемеровская и скороспелая мясная – ландрасская породы ($p < 0,001$). Наиболее сходные результаты изучения животных на основании кластерного анализа выявлены между кемеровской и ландрасской породами. Скороспелая мясная порода отличается относительной устойчивостью к аккумуляции меди в щетине. Полученные данные можно предварительно принять в качестве физиологической нормы концентрации меди в щетине свиней различных пород, районированных в Западной Сибири.

Ключевые слова: медь, щетина, свиньи, влияние пород

PECULIARITIES OF COPPER ACCUMULATION IN THE BRISTLES OF PIGS OF DIFFERENT BREEDS

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The results of assessing the copper content in the bristles of pigs of Landrace, Kemerovo and Early maturing meat breeds are presented. The study was carried out on clinically healthy six-month-old animals in the farms of Novosibirsk and Kemerovo regions and Altai Territory. The conditions for keeping animals were standard with typical feeding. Elemental analysis of pig bristle samples was carried out by inductively coupled plasma atomic emission spectrometry. The data was processed using Microsoft Office Excel and Statistica 8 (StatSoft Inc., USA), including nonparametric methods. A decreasing ranged series was established according to the level of copper in the hair of pigs for Landrace → Kemerovo → Early maturing meat breeds. As a ratio, it is represented as 5.1 : 4.5 : 1. Copper in the bristles of Landrace, Kemerovo and Early maturing meat breeds amounted to 44.0, 39.0 and 8.7 mg/kg, respectively. The accumulation of copper recorded in the bristles of Landrace and Kemerovo pig breeds was 5.6 and 4.5 times higher than that of Early maturing meat breed ($p < 0.001$). The Early maturing meat and Kemerovo breeds were characterized with the homogeneity of indicators; they had the smallest interquartile range and the ratio of the extreme variants. The study using Kruskal-Wallis criterion established that the breed affects the accumulation of copper in the bristles of pigs. Differences were registered in pairs: Early maturing meat – Kemerovo and Early

maturing meat – Landrace breeds ($p < 0.001$). The most similar results of studying animals based on cluster analysis were found between Kemerovo and Landrace breeds. Early maturing meat breed is relatively resistant to copper accumulation in the bristles. The data obtained can be tentatively taken as a physiological norm for the accumulation of copper in the bristles of pigs of various breeds zoned in Western Siberia.

Keywords: copper, bristles, pigs, influence of breeds

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Conflict of interest

The authors declare no conflict of interest.

INTRODUCTION

The stability of the chemical composition in the body is one of the most important living conditions for humans and animals, changes in which lead to a wide range of diseases [1]. In this regard, the amount of accumulation of chemical elements in the tissues and organs, the relationship between them and the biochemical components of the body at different levels are being studied. Topical issues are related to the individual mineral status and health of animals, the impact on a person who consumes food of animal origin¹⁻³ [2].

Copper is one of the important chemical elements for realizing the genetic potential of mammals, in particular pigs, by influencing gene expression. It serves as a mineral component and a cofactor for many enzymes in the body [3]. Copper has prooxidant and antioxidant effects necessary for the full provision of biological processes and the development of diseases [4]. For example, copper is a component of superoxide dismutase and glutathione peroxidase, a decrease in the activity of which leads to impaired antioxidant protection. But excessive intake of supplements containing copper can induce systemic lipid peroxida-

tion and oxidative stress [5]. Pigs, according to studies, rarely need additional introduction of copper, provided a balanced diet, which is based on grain feed [6].

Evaluation of the mineral status of animals by the concentration of certain chemical elements in skin derivatives is of interest to many scientists [7, 8]. Copper belongs to the group of elements with a high enrichment coefficient, which indicates an insignificant susceptibility to exogenous contamination, the concentration in skin derivatives is mainly due to endogenous factors [9].

The assessment of the ecological safety of objects of inanimate and wildlife is carried out in various constituent entities of the Russian Federation, including the Siberian regions [10–12]. Assessment of the interior of agricultural animals includes studies of the content of chemical elements in organs and tissues, hematological and immune biochemical parameters of blood. It is necessary for assessing the state of animal health and monitoring the environmental background, which affects the safety and quality of agricultural products⁴ [13]. Interpretation of the results of these studies is difficult due to the lack of reference intervals

¹Zayko O.A. Variability and correlation of chemical elements in organs and tissues of pigs of early maturing meat breed SM-1: dis. abs. of PhD in Biology. Novosibirsk, 2014. 183 p.

²Narozhnykh K.N. Variability, correlations and the level of heavy metals in organs and tissues of Hereford cattle in the conditions of Western Siberia: dis. abs. of PhD in Biology. Novosibirsk, 2019. 163 p.

³Strizhkova M.V. Content, variability and correlation of macronutrients in organs and tissues of black-and-white cattle: dis. abs. of PhD in Biology. Novosibirsk, 2018. 126 p.

characterizing the permissible content of various chemical elements in organs and tissues of animals [14].

The purpose of the research is to establish the interbreed features of the accumulation of copper in the hairline of pigs of various breeds, zoned in Western Siberia.

MATERIAL AND METHODS

The study was conducted in 2016–2020. on groups of clinically healthy pigs of three breeds: Early maturing meat (EM-1), Kemero-vo and Landrace, raised on the farms of the Novosibirsk, Kemerovo regions and the Altai Territory. The animals were kept in standard conditions for this species using meat fattening⁵. The pigs were vaccinated in accordance with the plans of veterinary preventive measures. Specialists systematically performed elements of a general study, conducted a study of habitus, skin, skin derivatives, mucous membranes and a special study. The animals were provided with standard feeding with a complete feed, depending on the live weight of the animals. The diets are balanced in terms of nutrients, minerals and vitamins. In particular, the amount of copper, depending on the change in the live weight of animals, was in all groups from 19 to 38 mg per head per day. Control of compound feeds according to the range of guaranteed and additional indicators was carried out in accordance with the established procedure^{6, 7}. The animals were watered from their own sources of domestic drinking water supply, while the water quality corresponded to the second class of GOST⁸.

Water, soil and feed were studied for the content of heavy metals, including copper in the ar-

eas of pig breeding by the Center for Collective Use of Scientific Equipment for Multielement and Isotope Research of the Siberian Branch of the Russian Academy of Sciences (SB RAS) of the Institute of Geology and Mineralogy.V.S. Sobolev and the Institute of Inorganic Chemistry. A.V. Nikolaev of the Siberian Branch of the Russian Academy of Sciences⁹ [15].

The subject of this research is pig bristles. Samples were obtained from the dorsal neck using ethanol-cleaned stainless-steel scissors. They are represented by the guard hair. The total number of samples was 65. A sample of bristles was taken, it was cleaned from contamination and further sample preparation in accordance with the relevant GOSTs. Elemental analysis was performed directly by inductively coupled plasma atomic emission spectrometry using an iCAP-6500 spectrometer from Thermo Scientific (USA) [16].

The data obtained was processed with Microsoft Office Excel and Statistica 8 software (StatSoft Inc., USA). The Shapiro-Wilk and Kolmogorov-Smirnov test were used to assess the nature of the distribution. The following indicators were assessed: arithmetic mean, error of arithmetic mean, median, standard deviation, interquartile range, maximum and minimum values of copper content in bristles. As an alternative to univariate analysis of variance, the nonparametric Kruskal-Wallis test was used to establish the differences in copper accumulation between the breeds. Cluster analysis was carried out to combine the breeds with homogeneous characteristics using the Ward's method. Manhattan distance was used as a distance metric.

⁴Sebezhenko O.I., Korotkevich O.S., Konovalova T.V., Biryulya I.K., Petukhov V.L., Kamaldinov E.V., Narozhnykh K.N., Osadchuk L.V. Biochemical, hematological and mineral parameters in pigs of two breeds reared in large industrial complexes of Western Siberia // 3 rd International Symposium for Agriculture and Food. Ohrid: Faculty of agriculture and food, 2017. P. 100.

⁵GOST 28839-2017. Agricultural animals. Pigs. Zootechnical requirements for the content of fattening. Instead of GOST 28839-90; intro. 2018-07-01. M.: Standartinform, 2017.4 p.

⁶GOST R 51550-2000. Compound feed concentrates for pigs. General technical conditions. - Introduced for the first time; intro. 2001-01-01. M.: PPC Publishing house of standards, 2002. - 10 p.

⁷GOST R 51850-2001. Compound feed products. Acceptance rules. Packaging, transportation and storage; introduced for the first time; intro. 2004-01-01. M.: IPK Publishing house of standards, 2002. 4 p.

⁸GOST 2761-84. Sources of centralized drinking water supply. Hygienic, technical requirements and selection rules (with amendment No. 1). Instead of GOST 17.1.3.03-77; intro. 1986-01-01. M.: Standartinform, 2006.12 p.

⁹Syso A.I. Heavy metals in the environment as a threat to plants, animals and humans // Agrochemistry in the XXI century. Materials of the All-Russian Scientific Conference with International Participation, dedicated to the memory of Academician V.G. Mineeva. Edited by V.A. Romanenkov. 2018. pp. 30–33.

RESULTS AND DISCUSSION

As a result of a number of tests, it was found that the quantitative characteristic of the level of copper in the bristles of pigs from Kemerovo and early maturing meat breeds is characterized by a normal distribution. In the Shapiro-Wilk test, it was found that the W-criterion is 0.97 ($p > 0.05$). The hypothesis about the normal distribution of the same trait in Landrace pigs was rejected.

Table 1 presents data on the level of copper in the hair of pigs of the considered breeds. Ranking the breeds according to the studied trait, it was found that the decreasing series looks as follows: Landrace breed → Kemerovo breed → early maturing meat breed, as relative indicators, taking into account the median: 5.1: 4.5: 1. Significant differences were established among animals of the Landrace breed by the ability to accumulate copper in the bristle, which is expressed by a significant ratio of extreme options. There is no information in the scientific literature on the differences in the accumulation of chemical elements in the body of pigs of different breeds. But it is known about the essential features of the exchange of copper in the body in different breeds of sheep and its physiological consequences for animals¹⁰.

The concentration of copper in the bristles of pigs of the Kemerovo and Landrace breeds is 4.5 and 5.6 times higher, respectively, than this indicator of the early maturing meat breed ($p < 0.001$).

No differences were found in the content of copper in the derivative of the skin in pigs of

the Landrace and Kemerovo breeds. It should be noted that on the territory of Western Siberia there is no heavy metal pollution outside the sanitary and hygienic zones [17].

The level of accumulation of chemical elements in the hairline of animals makes it possible to determine the individual mineral status, which is important for farm animals kept in a group way. At the same time, the data obtained can serve as standard indicators for animal breeds zoned in a certain territory, since information on this issue in the literature is scattered. According to the researchers, there are levels of copper accumulation in pig hair of 3–7 and 8–15 mg / kg, both deficient and normal, respectively¹¹. In comparison with these values, an excess of descriptive statistics was recorded in animals of the Landrace and Kemerovo breeds.

The study of the content of chemical elements in organs, tissues, skin derivatives of various breeds and types is relevant for solving the question of the presence or absence of hereditary factors [18]. In this study, the EM-1 breed turned out to be more homogeneous in terms of the copper content in the bristles, the smallest interquartile range and the ratio of the extreme variants were recorded (see Fig. 1). Animals of the Kemerovo breed were distinguished by similar characteristics.

After calculating the Kruskal-Wallis criterion, it was found that the breed factor affects the amount of copper deposition in the bristle of pigs ($p < 0.001$), if we evaluate the three breeds together. There are significant differ-

Содержание меди в щетине свиней некоторых пород, районированных в Западной Сибири, мг/кг
The content of copper in the bristles of some pig breeds zoned in Western Siberia, mg / kg

Breed	<i>n</i>	$\bar{X} \pm Sx$	<i>Me</i>	σ	IQR	lim	Extreme variant ratio
Kemerovo	26	39,4 ± 1,6	39,0	7,9	12,2	25 – 56	1 : 2,2
EM -1	18	8,72 ± 0,2	8,7	1,0	1,7	7,2 – 10,9	1 : 1,5
Landrace	21	49,2 ± 8,0	44,0	36,7	68	7,7 – 110	1 : 14,3

Note. *Me* - median, σ - standard deviation, IQR - interquartile range.

¹⁰Radostits O.M., Gay C.C., Hinchcliff K.W., Constable P.D. Veterinary medicine: a textbook of the diseases of cattle, sheep, pigs, goats and horses // Toronto: Saunders Elsevier, 2007. 2180 p.

ences in the pairs SM-1 - Kemerovo breed and SM-1 - Landrace breed ($p < 0.001$). Analysis of the data obtained indicates interbreed differentiation in the concentration of the studied chemical element in the bristles, which is a factor confirming the role of heredity in the predisposition and resistance to copper accumulation in the bristles of pigs.

In fig. 2 shows the similarity between the considered breeds of pigs in terms of the copper content in the bristles. It was found that the Kemerovo and Landrace breeds are more similar in comparison with animals of the early maturing meat breed.

Studies have established the hereditary determinism of the accumulation of chemical elements in organs, tissues and derivatives of the skin of farm animals [15, 19].

CONCLUSION

Interbreed differences in the accumulation of heavy metals in derivatives of the skin of pigs of breeds zoned in Western Siberia have been established. Indicators of the presence of copper in the bristles of pigs of early maturing meat, Kemerovo and Landrace breeds were 8.7; 39.0 and 44.0 mg / kg, respectively. The influence of the rock on the metal accumulation process was established ($p < 0.001$). Indicators on the content of copper in the bristles of pigs of various breeds, zoned in the territory of Western Siberia, can be preliminarily used as a physiological norm.

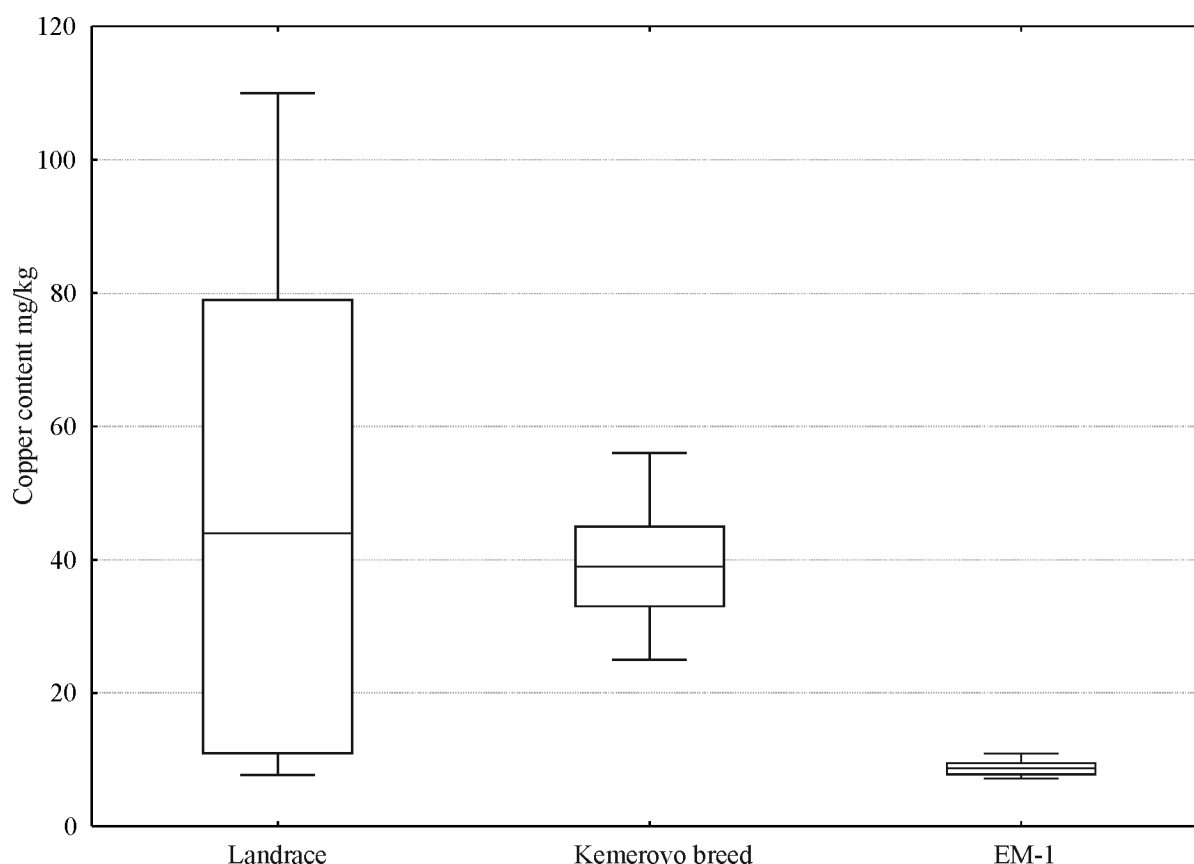


Рис. 1. Диаграммы размаха содержания меди в щетине свиней некоторых пород

Fig. 1. Diagrams of copper content range in the bristles of some pig breeds

¹¹Puls R. Mineral levels in animal health: diagnostic data. Canada: Trinity Western University Press, 1988. 240 p.

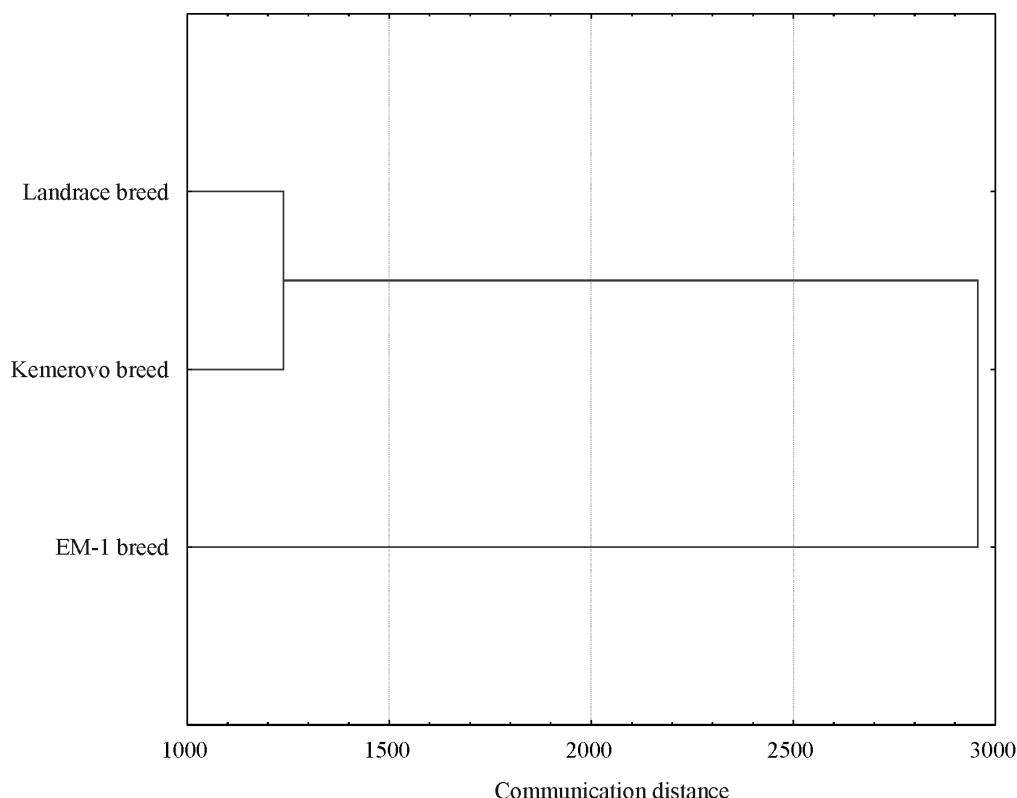


Рис. 2. Дендрограмма межпородного сходства содержания меди в щетине свиней

Fig. 2. Dendrogram of interbreed similarity of copper content in pig bristles

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