CHROMOSOMAL POLYMORPHISM IN THE POLISH LANDRACE AND POLISH LARGE WHITE SWINE BREEDS

CHARAKTERYSTYKA POLIMORFIZMU CHROMOSOMOWEGO ŚWIŃ RAS PBZ I WBP

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ABSTRACT

The evaluation referred to polymorphism of heterosomes and autosomes and it was based on measuring their areas in the Polish Landrace and Polish Large White breed sows. The average surface area of sex chromosomes in the researched Polish Landrace breed sows amounted to 7.48 μm^2, with the range of values between 6.98 μm^2 and 8.13 μm^2, while for the Polish Large White sows it amounted to 8.01 μm^2, between 6.61 μm^2 and 10.89 μm^2 respectively. The average surface area of autosomes in the researched Polish Landrace sows amounted to 143.77 μm^2, while for the Polish Large White sows it amounted to 150.01 μm^2. In both analyzed breed groups the variability within sex chromosomes was found to be larger than that of autosomes. The variability rate of the surface area of sex chromosome chromatids in a group of the Polish Landrace breed sows amounted to 5.27%, whereas for the Polish Large White breed sows it amounted to 12.06%. The variability of the autosomal chromosome surface areas amounted to 4.92% and 7.12% respectively.

STRESZCZENIE

Ocenie poddano polimorfizm heterosomów i autosomów w oparciu o pomiar ich powierzchni u loch ras polska biała zwisłoucha i wielka biała polska. Średnia powierzchnia chromosomów płci u badanych loch rasy pbz wynosiła 7,48 μm^2, przy zakresie wartości od 6,97 μm^2 do 8,13 μm^2, natomiast u loch rasy wbp 8,01μm^2 odpowiednio od 6,61μm^2 do 10,89μm^2. Średnia powierzchnia autosomów wynosiła 143,77μm^2 u badanych loch rasy pbz, a u loch wbp 150,01μm^2. Stwierdzono znacznie większą zmienność w obrębie chromosomów płci, niż autosomów w obu analizowanych grupach rasowych. Współczynnik zmienności powierzchni chromatyd chromosomów płci w grupie loch rasy pbz wynosił 5,28% a rasy wbp 12,07%. Zmienność powierzchni chromosomów autosomalnych wynosiła odpowiednio 4,92% i 7,12%.

SŁOWA KLUCZOWE: polimorfizm, chromosomy, lochy, rasa wbp, rasa pbz

DETAILED ABSTRACT

Badania przeprowadzono na 40 lochach (20 rasy wbp i 20 rasy pbz). Hodowlę limfocytów prowadzono z pełnej krwi obwodowej na podłożu RPMI 1640 z dodatkiem surowicy cielęcej, LF-7 i antybiotyku. Preparaty płytek metafazowych wykonano zgodnie z ogólnie przyjętymi metodami. Płytki metafazowe barwiono rutynowo oraz techniką GTG. Preparaty analizowano w mikroskopie świetlnym przy powiększeniu 1250 razy. Ocenie poddano polimorfizm heterosomów i autosomów w oparciu o pomiar ich powierzchni wykorzystując program komputerowy MultiScan Karyotype v. 8.01..

Wszystkie badane lochy wykazywały prawidłowy charakterystyczny dla gatunku i płci zestaw chromosomów 2n=38,XX. Średnia powierzchnia chromosomów płci u badanych loch rasy pbz wynosiła 7,48 μm^2, przy zakresie wartości od 6,97 μm^2 do 8,13 μm^2, natomiast u loch rasy wbp 8,01 μm^2 odpowiednio od 6,61 μm^2 do 10,89 μm^2. Z kolei średnia powierzchnia autosomów wynosiła 143,77 μm^2 u badanych loch rasy pbz, a u loch wbp 150,01 μm^2. Współczynnik zmienności powierzchni chromatyd chromosomów płci w grupie loch rasy pbz wynosił 5,28% a rasy wbp 12,07%. Zmienność powierzchni chromosomów autosomalnych wynosiła odpowiednio 4,92% i 7,12%.

Stwierdzono znacznie większą zmienność w obrębie chromosomów płci, niż autosomów w obu analizowanych grupach rasowych. Większą zmiennością wielkości powierzchni chromosomów metafazowych charakteryzowały się lochy rasy wbp w porównaniu z lochami rasy pbz. Świadczy to o większym polimorfizmie powierzchni chromosomów u badanych loch rasy wbp.

INTRODUCTION

Each animal species is characterized by a set of chromosomes which is unique in regard to their number and morphology. Analysis of mitotic chromosomes at the metaphase stage provides the most information on the karyotype of a researched animal, as at that point they reach high condensation of chromatids, which constitutes the basis for classifying them into particular morphological groups [1].

The evaluation of chromosome set regularity requires taking into account the existence of chromosomal polymorphism. The concept of chromosomal polymorphism consists in two or more genetically conditioned phenotypes existing in a population with a frequency higher than it would result from mutations. Chromosomal polymorphism is usually referred to at the level of the variability of morphological structure or chromosome number variability.

The attempts of defining of chromosomal polymorphism were made many times in the case of both people and many species of animals, measuring the length of chromosomes, looking for correlations between polymorphic variants and defined fertility indices, as well as defining the DNA content in polymorphic variants of the Y heterosome [1]. In reference to chromosomes, two different forms of polymorphism may be distinguished, e.g., chromosome length polymorphism (sex chromosome relative length was evaluated, especially of the sheep, cattle, horse, and swine Y chromosome) [2, 3, 8], polymorphism of the number and size of sections of chromosomes unique in terms of structure and function (the size of centromeric heterochromatin blocks, as well as of nucleolar organizer

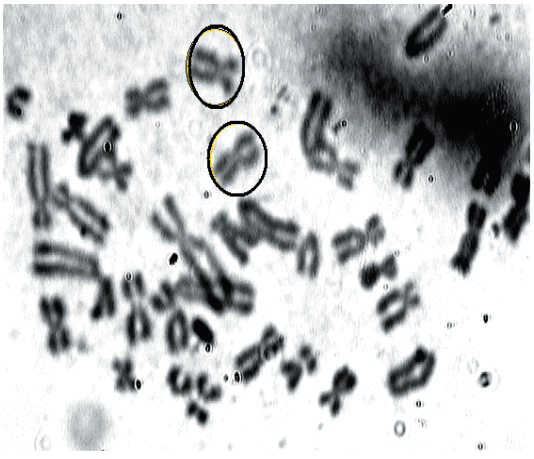

Figure 1. A metaphase plate of Polish Landrace breed sow

Rysunek 1. Płytka metafazowa lochy rasy pbz.

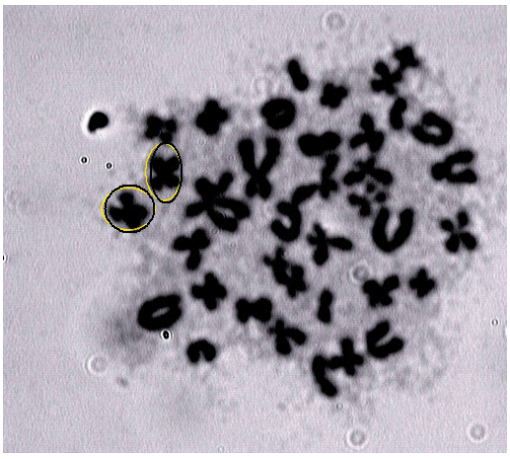

Figure 2. A metaphase plate of Polish Large White breed sow.

Rysunek 2. Płytka metafazowa lochy rasy wbp.

Table 1. Average measurement values of chromosome surface areas
Tabela 1. Średnie wartości pomiarów powierzchni chromosomów

The researched characteristic	The Polish Landrace breed n=20	The Polish Large White breed n=20	The significant difference between the average values
Average surface area of sex chromosomes (μm^2)	7.48	8.01	0.53*
Average surface area of autosomal chromosomes (μm^2)	143.77	150.01	6.24*
Average surface area of chromosomes (μm^2)	151.25	158.02	6.77*
Average relative surface area of sex chromosomes (%)	5.21	5.35	0.14
Percentage of sex chromosome chromatids (%)	4.94	5.07	0.13

regions) [8, 10], and chromosome number polymorphism [1, 4].

The goal of this study is to evaluate chromosome size polymorphism on the basis of measurements of sex chromosome and autosomal chromosome surface areas in the Polish Landrace and Polish Large White breed sows.

MATERIAL AND METHODS

The research was done on 40 sows (20 of the Polish Large White and 20 of Polish Landrace breeds). Lymphocyte raising was conducted with the use of full peripheral blood based on the RPMI 1640 medium with the addition of veal serum, LF-7, and an antibiotic. The preparations of metaphase plates were made according to generally accepted methods [5]. A routine method, as well the GTG technique using the Giemsa stain, was applied for staining of the metaphase plates [5]. The preparations were analyzed by means of an optical microscope at the magnification of about 1x1,250, and by means of the MultiScan Karyotype v. 8.01 software [4].

Measurements of the chromosome sizes were performed for each sow in twelve metaphase plates by means of the "surface area" function and then saved in the Statistica program. Average sex chromosome and autosome sizes were calculated (μm^2). The significant differences between the average values was verified by the t Student test [6].

The relative sex chromosome surface areas (%), as well as the percentage of heterosomes (%), were calculated by means of the following formulas:

The relative size of sex chromosomes = [the sum of heterochromosome surface areas (μm^2) / the sum of autosome surface areas (μm^2)] x 100%.

The percentage of sex chromosomes = [the sum of heterochromosome surface areas (μm^2) / the sum of autosome and heterochromosome surface areas (μm^2)] x 100%.

The variability of the chromosomes' researched characteristics was estimated by calculating the standard deviation (S_x) and the variability rate (V_x) [6]. The results have been presented in the two tables.

RESULTS AND DISCUSSION

The selected pictures of metaphase plates with the sex chromosome (XX) marked are shown in the fig. 1 (the Polish Landrace breed) and fig. 2 (the Polish Large White breed).

While analyzing the metaphase plates, the correct and characteristic for the species and sex 2n=38,XX chromosome set was found in all the researched sows.

The table 1 provides the measurement results of the average surface areas for sex chromosomes, autosomes, and the set of metaphase chromosomes, as well as for their percentage in relation to a complete chromosome set of the researched group of sows.

The Polish Landrace breed sows were characterized by smaller average values of sex chromosome and autosome surface areas in comparison to the average values of chromosome surfaces observed in the Polish Large White breed sows. Similarly, the total average surface of chromosomes in a metaphase plate occurred to be smaller in the Polish Landrace breed sows. The resulting differences between the average chromosome surface areas turned out to be statistically relevant (Table 1).

In turn, the average relative surface area of sex chromosomes and the percentage of sex chromosome chromatids were slightly larger in the Polish Large White breed sows than in the Polish Landrace breed sows, and the observed differences in average values of those characteristics turned out to be statistically irrelevant (Table 1.)

Table 2. The presentation of the variability of the researched chromosome characteristics
Tabela 2. Charakterystyka zmienności badanych cech chromosomów

The researched characteristic	Variability measure	The Polish Landrace breed n = 20	The Polish Large White breed n=20
Surface area of sex chromosome chromatids (μm^2)	Sx	0.39	0.97
	Vx	5.28	12.07
	Gap	6.97-8.13	6.61-10.89
Surface area of autosomal chromosome chromatids (μm^2)	Sx	7.08	10.69
	Vx	4.93	7.13
	Gap	126.33 -158.99	127.27 – 164.64
Surface area of sex and autosomal chromosomes (μm^2)	Sx	7.15	11.19
	Vx	4.73	7.08
	Gap	133.61 -166.03	134.57– 173.73
Relative surface area of sex chromosomes (%)	Sx	0.38	0.62
	Vx	7.26	11.67
	Gap	4.37 – 5.88	4.17 – 6.70
Percentage of sex chromosome chromatids (%)	Sx	0.34	0.56
	Vx	6.95	11.13
	Gap	4.18 – 5.49	4.01 – 6.28

The Table 2 shows the results representing the variability of sex chromosome and autosome surface areas in the researched groups of the Polish Landrace breed and Polish Large White breed sows.

While analyzing the variability of metaphase chromosome surface areas in the Polish Landrace breed and Polish Large White breed sows, variability in the average heterosome surface area was found to be larger than the autosomal chromosome surface area in both researched breed groups (Table 2). It was observed that the differentiation in terms of both sex chromosome (6.61-10.89) and autosome (127.27–164.64) surface areas was larger in the Polish Large White breed sow group in comparison to the Polish Landrace breed sow group (6.97-8.13; 126.33 -158.99) (Table 2).

Sex chromosome and autosome surface areas turned out to be more polymorphic in the researched group of the Polish Large White breed sows, which is proven by the variability rate amounting to 7.08 in comparison to the Polish Landrace breed sow group, where the Vx amounted to 4.73 (Table 2).

The calculated sex chromosome relative surface areas and the percentage of sex chromosome chromatids were characterized by larger variability in the researched group of the Polish Large White breed sows (Table 2).

The observed differences in values of the characteristics defining metaphase chromosome surface area between the researched groups of the Polish Large White and Polish Landrace breed sows show the higher polymorphicity of chromosome surface areas in the Polish Large White breed sows.

In the last years, the development of cytogenetic tests resulted in diagnosing many cases of chromosomal irregularities in farm animals of great economic significance. As a result of those researches, the unfavourable influence of carrying of karyotype anomalies, especially on reproduction characteristics and animal development, was shown [9].

The diploid number of chromosomes and the specificity of morphology and banding patterns are the distinctive characteristics of a given animal species. The series of research works confirms the fact that the karyotype of a domestic pig (Sus scrofa domestica L.) is much less immune to disorders arising in consequence of negative impact of the environment in comparison to other farm animals. The most polymorphic pig chromosome sections include constitutive heterochromatin blocks and nucleolar organizer regions (NOR) [1, 10].

The cytogenetic tests enable evaluation of karyotype regularity, i.e. the number and morphology of chromosomes characteristic for a given species. However, no direct relationship has been clearly established between chromosome size polymorphism and the productive traits of animals. Nevertheless, the observed chromosomal polymorphism may be used for searching for chromosomal markers or mapping of genes of economically relevant productive traits [1, 3]. The analysis of chromosome polymorphism made within a single breed population enables showing of interspecimen differences and establishing a breed tendency [6, 8].

CONCLUSION

The number of chromosomes of the researched sows belonging to the Polish Landrace and Polish Large White breeds was 2n = 38,XX, which is correct for that species and sex.

The interbreed differences were found in terms of autosome and sex chromosome sizes, as well as the sex chromosome and autosome total surface areas in diploid cells of the researched Polish Landrace and Polish Large White breed sows.

The Polish Large White breed sows were characterized by the greater variability of metaphase chromosome surface area sizes in comparison to the Polish Landrace breed sows. This shows higher polymorphicity of chromosome surface areas in the Polish Large White breed sows.

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