

***INBREEDING in the HERDS of DOMESTIC BREEDS
of PIGS***

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The influence of inbreeding on the reproductive capacity of sows Ukrainian Steppe White (USW) and Motley (USM) breeds was studied.

Cases of related mating were classified according to the methods of A. Shaporuzh and S. Wright in the modification of D. Kislovsky. Thus, the individuals obtained as a result of using different degrees of inbreeding were identified. The cases of distant (IV-V, V-V, V-VI) inbreeding in the studied herds are in the range: 0.7 ... 8.0%, mild (III-III, III- IV) - 73.5 ... 90.2, close (II-III, II-II, III-II) - 8.4 ... 22.5 and close (I-II, II-I, II-II) - 0.7 ... 5.0%.

It has been established that the index of prolificacy of sows USW breed, which have mild and distant degrees of inbreeding, increases in comparison with outbreed and inbreed animals by 2.8 and 3.7% ($P \geq 0.95$). With a further increase in the level of inbreeding, the prolificacy decreases by 8.9 ... 11.1% and the litter of pigs by 4.5 ... 5.7%. In the herd of USW with increasing degree of kinship, the reproductive qualities of sows are increased, and the optimum prolificacy and the litter of pigs are reached with inbreeding coefficients of 12.5% and 3.12%, respectively. Increasing the indexes of all features of inbreed and outbreed animals is 0.6 animals ($P \geq 0.999$) and 6.1 ($P \geq 0.95$) and 7.9 ($P \geq 0.99$) kg, respectively.

Keywords: pigs, breed, related breeding, degree and coefficient of inbreeding, outbreeding.

ІНБРИДИНГ В СТАДАХ ВІТЧИЗНЯНИХ ПОРІД СВИНЕЙ

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Досліджено вплив інбридингу на відтворювальну здатність свиноматок українських степових білої та рябої порід.

Класифікуючи випадки спорідненого парування за методами А. Шапоружа та С. Райта в модифікації Д. Кисловського виділені особи, отримані в результаті використання різних ступенів інбридингу. Випадки віддаленого (IV-V, V-V, V-VI) інбридингу в досліджуваних стадах знаходяться в межах 0,7...8,0%, помірного (III-III, III-IV) – 73,5...90,2, близького (II-III, II-II, III-II) – 8,4...22,5 та тісного (I-II, II-I, II-II) – 0,7...5,0%.

Встановлено, що у свиноматок УСБ породи з помірним та віддаленим ступенями інбридингу збільшується багатоплідність у порівнянні з аутбредними і інбредними на 2,8 і 3,7% ($P \geq 0,95$). З подальшим підвищенням рівня інбредності відбувається зниження багатоплідності на 8,9...11,1% та маси гнізда на 4,5...5,7%. У стаді УСП породи з ростом ступеня спорідненості спостерігається підвищення відтворювальних якостей свиноматок, причому, оптимальних значень багатоплідності та маси гнізда вони досягають при коефіцієнтах інбридингу відповідно 12,5% і 3,12%, з перевершенням за цими ознаками усіх інбредних та аутбредних тварин відповідно на 0,6 гол. ($P \geq 0,999$) та 6,1 ($P \geq 0,95$) і 7,9 ($P \geq 0,99$) кг.

Ключові слова: свині, порода, споріднене розведення, ступінь та коефіцієнт інбридингу, аутбридинг.

ИНБРИДИНГ В СТАДАХ ОТЕЧЕСТВЕННЫХ ПОРОД СВИНЕЙ

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Исследовано влияние инбридинга на воспроизводительную способность свиноматок украинской степной белой (УСБ) и рябой(УСР) пород.

Случаи родственного спаривания классифицировались по методам А. Шапоружа и С. Райта в модификации Д. Кисловского. Таким образом были выделены особи, полученные в результате использования различных степеней инбридинга. Случаи отдаленного (IV-V, V-V, V-VI) инбридинга в исследуемых стадах находятся в пределах: 0,7 ... 8,0%, умеренного (III-III, III-IV) – 73,5 ... 90,2, близкого (II-III, II-II, III-II) – 8,4 ... 22,5 и тесного (I-II, II-I, II-II) – 0,7 ... 5,0%.

Установлено, что у свиноматок породы УСБ с умеренным и отдаленным степенями инбридинга увеличивается многоплодие по сравнению с аутбредными и инбредными животными на 2,8 и 3,7% ($P \geq 0,95$).

С дальнейшим повышением уровня инбредности происходит снижение многоплодия на 8,9 ... 11,1% и массы гнезда на 4,5 ... 5,7%. В стаде породы УСР с ростом степени родства наблюдается повышение воспроизводительных качеств свиноматок, причем, оптимальных значений многоплодия и массы гнезда они достигают при коэффициентах инбридинга соответственно – 12,5% и 3,12%. Превышение по этим признакам всех инбредных и аутбредных животных составляет соответственно: 0,6 гол. ($P \geq 0,999$) и 6,1 ($P \geq 0,95$) и 7,9 ($P \geq 0,99$) кг.

Ключевые слова: свиньи, порода, родственное разведение, степень и коэффициент инбридинга, аутбридинг.

It is well known that inbreeding is one of the most influential methods of consolidating hereditary properties of animals, creating new, improving existing breeds, types and lines. Inbreeding has been used in livestock farming since ancient times and has a positive effect if it's using is skilled and practiced in small stages for a long time, and a negative (in many cases disastrous) - for the viability and productivity of animals when it is unskilled and especially uncontrolled use for a long time [1, 2].

An example of the skillful using of closely related breeding in the creation of Ukrainian Steppe White breed of pigs can serve the using by M.F.

Ivanov the close (I-II, II-I, II-II) degree of inbreeding. At the same time, very strong rejection of the offspring was carried out. It reached in the first generations up to 80-90%, combined with careful selection according to the parameters of the constitution, the exterior, the level of productivity and the high-grade feeding of animals [3].

The using of related breeding for breeding purposes was not limited to the creation of the Ukrainian Steppe White breed of pigs. As is known, almost all cultural breeds of farm animals in the world were created and improved with the using of various degrees of inbreeding [4,5,6,7,8]. During the last decades in Ukraine, there have been significant changes in the composition of pigs' breeds due to the creation and using of the new genotypes of the meat productivity direction. At the same time, as a result, the number of domestic local breeds of the universal direction of productivity were declined, which can not compete with newly created and foreign high-productivity genotypes for a number of economic and useful traits [10, 11].

At present, the biggest part of the breeding farms for the growing of domestic breeds of pigs have practically no opportunity to exchange of the breeding material due to the insufficient number and limited availability of animals in lines and families. Therefore, with the preservation of breeds in small closed populations using a breeding system that provides support for the long-term optimal level of heterozygosity, it is impossible to avoid related matings and especially distant degrees.

The purpose of researches was to determine the number of inbreed animals in the herds of Ukrainian Steppe White and Motley breeds and to establish the peculiarities of the impact of kinship of different degrees on the reproductive ability of sows.

Material and methods of researches. The studies were carried out under the conditions of the breeding farms of the SE "EF IABSR "Ascania Nova" of the Kherson region, which are the leaders in breeding the pigs of USW and USM breeds. In order to identify the differences in the productivity of inbreed and outbreed animals from the data of the pedigree records of 1-sv and 2-sv from 1987 to 2016, an analysis was made of the pedigrees of boars sire and sows. The degree of inbreeding was determined by A. Shaporuzh's method, taking into account the position of related animals in the lineage of the mother and father line, and the coefficient of inbreeding (F_x) according to the formula of S. Wright in the modification of D.A. Kislovskiy [12].

$$F_x = \sum [0,5^{n_1+n_2-1} \times (1 + fa)] \times 100,$$

The meanings of the symbols of the formula are as follows:

F_x – coefficient of inbreeding, %;

0.5 - the share of heredity obtained by the proband from each ancestor, depending on the number of pedigrees in which it is located;

n_1, n_2 – lines of maternal and paternal pedigrees, where a common ancestor is found;

fa – value of coefficient the growth of the homozygosity of the inbred ancestor.

Grades of inbreeding are universally recognized: distant - ($F_x = 0,01-0,78\%$), mild ($F_x = 0,79-3,12\%$), close - ($F_x = 3,13-12,49\%$), close - ($F_x = 12.50\%$ and above) and outbred ($F_x = 0$).

The processing of the researches results was carried out using the methods of variation statistics and the program EXCEL using the functions of "Data Analysis".

The results of researches. The analysis of the pedigrees of sows and boars in two herds indicates there were in addition to the purposeful fixing inbreeding in the herds also was a significant crossing of the parents. The majority of the examined sows of the Ukrainian Steppe White breed were obtained by the unrelated matings. At the same time, 123 inbred animals, or 16.1%, were detected, including: with a close degree of inbreeding - 14.6%, with mild - 84.6 and distant - 0.8% (Table 1).

Table 1. The structure of the pigs' herds by the degree of kinship

Livestock	USW				USM			
	sows		boars		sows		boars	
	ani- mals	%	ani- mals	%	animals	%	animals	%
Total:	762	100	298	100	614	100	318	100
outbred	639	83,9	258	86,6	460	74,9	256	80,5
Inbreeding de- grees:	123	16,1	40	13,4	154	22,3	62	19,5
<i>close (I-II, II-I, II-II)</i>	-	-	2	5,0	1	0,7	2	3,2
<i>close (II-III, II-II, III-II)</i>	18	14,7	9	22,5	13	8,4	8	12,9
<i>mild (III-III, III-IV)</i>	95	77,2	29	73,5	139	90,2	50	80,7
<i>distant (IV-V, V-V, V-VI)</i>	10	8,1	-	-	1	0,7	2	3,2

The share of inbred boars was 13.4%, the biggest part of cases had the mild degree (73.5%).

Among 614 sows of USW breed, 154 inbred animals (22.3%) were identified. The number of animals that are united by a close (I-II, II-I, II-II) degree of kinship is 0.7%, close (II-III, II-II, III-II) - 8.4; mild (III-III, III-IV) - 90.2 and distant (IV-V, V-V, V-VI) - 0.7%. In the boar population structure ($n = 318$), which were used for a 30-year study period, inbred animals were 62, or 19.4%, of which 84.0% were mild and distant

degrees.

The frequency of using the inbreeding in gene pool herds in the years of research was uneven. So, in the herd of Ukrainian Steppe Motley breed of pig in the initial monitoring period the share of related animals fluctuated within the limits of 16.7 ... 24.3%, with a minimum quantity in 1987-1988. In the years of the last five-year period, that is, in 2011-2016, there was a sharp reduction in the network of breeding farms involved in breeding this breed, the number of lines decreased from 11 to 8 and families from 25 to 11. Also decreased the number of separate individuals of these animals, which led to a rapid increase in the genetic similarity of ancestors in the offspring. In the herd of the Ukrainian Steppe White breed of pig the minimum level of related animals (14.7 ... 20.8%) was revealed in the period from 1991 to 1995; with the subsequent increase of this indicator to 25.9 ... 32.2 percent.

The analysis of the productivity of sows, which were obtained due to the different methods of breeding, is given in Table 2.

Table 2. Reproductive capacity of sows depending on the degree of inbreeding

Inbreeding	The level related according to (Shaporuzh)	Coefficient of inbreeding (By Wright)	Number of farrow	Productivity			
				The prolificacy, animals	at two month age		
					Number of animals	The litter of pigs, kg	Preservation, %
Ukrainian Steppe White breed							
C	II-II	12,5	12	10,1±0,20	8,7±0,27	143,2±4,36	87,8
	II-III; III-II	6,25	23	9,9±0,33	8,3±0,22	141,6±4,47	85,7
M	III-III; II-IV	3,12	54	10,7±0,23	8,9±0,15	143,3±2,25	84,6
	IV-III	1,56	94	10,6±0,20	8,9±0,16	145,1±2,47	84,8
	IV- IV	0,78	115	11,0±0,20	9,1±0,20	149,7±0,20	84,6
D	IV-V	0,39	7	11,1±0,20	8,3±0,20	153,7±0,20	76,9
Inbreeding		2,31	305	10,6±0,11	8,8±0,08	145,5±1,33	84,8
Outbreeding			1496	10,7±0,05	8,9±0,03	156,8±0,68	84,6
Ukrainian Steppe Motley breed							
C	I-II	25,0	1	9,0	8,0	142,0	88,9
C	II-II	12,5	13	10,5±0,51	9,0±0,32	155,7±7,99	87,2
	II-III; III-II	6,25	15	9,7±0,46	8,3±0,31	145,3±6,75	86,6
M	III-III; II- IV; IV-II;	3,12	40	10,4±0,35	8,8±0,21	158,6±2,79	87,0
	III-IV; IV-III	1,56	106	9,9±0,20	8,4±0,11	154,0±2,60	86,4
	IV- IV	0,78	165	9,9±0,14	8,4±0,09	151,1±2,08	86,3
D	IV-V	0,39	1	7,0	7,0	112,0	100,0
Inbreeding		2,04	341	9,9±0,10	8,4±0,06	152,5±1,49	86,6
Outbreeding			1149	9,9±0,05	8,4±0,03	150,7±0,78	86,8

In the studied herds of the USW breed, the inbreeding coefficients varied from 0.39 (for the distant degree of inbreeding - IV-V) to 12.5 (II-II), and in the herd of the USM to 25.0 (I-II). The average levels of inbreeding coefficients, respectively 2.31 and 2.04, indicate that there is no genetic closure in domestic breeds of pigs, which is directly related to the presence of a sufficient number of lines, despite the limitation of these populations.

There is no reliable difference of almost all reproductive characteristics between sows, which were received by inbreeding and outbreeding selection in two herds, except for the weight of litter of pigs during the weaning of piglets at 2 months of age. Thus, in the herd of the Ukrainian Steppe Motley breed, the inbreeding sows exceeded the outbreeding sows by 1.2%, and in the herd of Ukrainian Steppe White breed this index of the inbreeding sows was by 7.7%, less than the outbreeding sows had ($P \geq 0.999$).

However, the results of long-term observations indicate the double impact of varying degrees of inbreeding on the reproductive capacity of sows. In the herd of breed USW in animals with a coefficient of inbreeding of 0.78 and 0.39, the prolificacy increases in comparison with outbred and inbred sows by 2.8 and 3.7% ($P \geq 0.95$).

With the further increase in the level of kinship, the prolificacy decreases by 8.9 ... 11.1% and the weight of the litter of pigs by 4.5 ... 5.7%. The highest preservation of the offspring is characteristic of sows with a degree of inbredness - II-II.

In the herd of Ukrainian Steppe Motley breed with increasing of inbreeding degree, the reproductive capacity of sows is improving. At the same time, they achieve optimal prolificacy values with the inbreeding coefficient of 12.5%, and the weight of the litter of pigs is -3.12%, that exceeding the mean values, which all inbred and outbred animals have, by 0.6 animals ($P \geq 0.999$) and 6.1 ($P \geq 0.95$) and 7.9 kg respectively ($P \geq 0.99$).

A definite regularity in the manifestation of reproductive signs is revealed when various types of pairings are used. Thus, the mating of inbred boars with sows of varying degrees of the coefficient of inbreeding in the USW of the breed ensured the maximum level of prolificacy: ♂IV-III x ♀IV-IV and III-III, respectively, 14 and 15 animals, ♂III-III x ♀ III-IV (13.3 animals) and ♂III-II x ♀IV-IV (13,0) animals, with prevalence of outbred by 1,3 ... 4,3 animals (or 21,5 ... 40,2%).

When selecting inbred sows according to the degree of the inbreeding III-III with boars III-III and III-IV in the herd of USM breed, a maximum increase the prolificacy (12 0 and 12.5 animals) is observed, which is

more by 2, 1 (or 21.2%) and 2.6 animals (26.3%) as compared to the mating of outbreed animals. Variants of selection botocros (inbreed sows x outbreed boars) and topcross (inbreed boars x outbreed sows) in the herd of Ukrainian Steppe White breed led to a decrease (by 1.9 ... 8.1%) of all indicators of the reproductive ability of sows. More effective were the pairings of parental pairs in botocros in the herd of Ukrainian Steppe Motley breed, especially when sows have an inbreeding coefficient of 3.12%, which provides maximum weight of the litter of pigs and the prolificacy of sows.

Conclusions. At purebred breeding of domestic breeds of pigs of the Ukrainian Steppe White and Ukrainian Steppe Motley breeds at the breeding farms of the state enterprise "EF IABSR "Ascania Nova ", no cases of uncontrolled inbreeding were detected. The average coefficient of inbreeding in herds is 2.31 and 2.04. The use of inbreeding in the degrees $F_x = 0.39$ and 0.78 in the herds of USW of the breed is an effective way to increase the prolificacy of sows. In the herd of USM breed, the optimum values of prolificacy are attained at the coefficients of 12.5, and the weight of the litter of pigs is -3.12%, with all inbreed and outbreed animals exceeding by these factors by 0.6 animals and 6.1 and 7.9 kilograms, respectively.

The organization of breeding selection, based on a bot or topcross, in the herd of Ukrainian Steppe White breed is not effective, as this leads to a decrease in all the reproductive signs of sows.

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