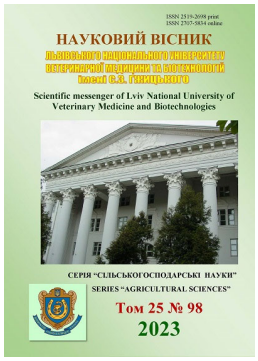

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Biological features of the formation of meat productivity of rabbits of chinchilla breed depending on crossing with meat breeds

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Rabbit breeding is a special branch of animal husbandry characterized by high fertility and growth intensity. The main way of intensification of rabbit farming involves such selection measures that adapt rabbit populations of keeping in industrial conditions, ensure high reproductive properties of female rabbits, preservation of rabbits in nests, high growth rate, fattening and meat qualities of animals. The research was conducted on the basis of the experimental rabbit farm of the Cherkasy Research Station of Bioresources of the National Academy of Sciences on the population of female chinchilla (Chinchilla) rabbits and males of the Gray giant rabbit (Gray giant rabbit), New Zealand white rabbit (New Zealand white rabbit) and young rabbits obtained from these three combinations. As the result of the conducted research, it was found that under the conditions of intensive production of rabbit meat, the reproductive qualities of female chinchilla rabbits in combination with males of the Gray giant and New Zealand white rabbits breeds increase, namely: high fertility – on 1.8–5.2 %; milk yield – on 1.8–7.4 %. The weight of the nest at weaning was probably ($P < 0.001$) higher in female rabbits of the combination Chinchilla x New Zealand white rabbit and was 5.29 ± 0.13 kg, which is 869 g more than the purebred peers of the chinchilla breed and 380 g more than the combination Chinchilla x Great giant rabbit. The best indicators of fattening and meat productivity were found in young rabbits of $^{1/2}$Chinchilla $^{1/2}$Gray giant rabbit and $^{1/2}$Chinchilla $^{1/2}$New Zealand white rabbit origin. The fattening indicators of the rabbits of these groups compared to the rabbits of the control group accordingly increased: live weight at 90 days of age – on 4.0 and 3.8 % ($P < 0.05$); average daily increases – on 4.7 and 5.4 % ($P < 0.05$; $P < 0.01$); waist width – on 5.6 and 8.7 % ($P < 0.01$). The research also revealed that the group of young rabbits $^{1}/_{2}$Chinchilla $^{1}/_{2}$New Zealand white rabbit by origin had a higher slaughter yield and the indicators of which exceeded and rabbits of the second group ($^{1}/_{2}$Chinchilla $^{1}/_{2}$Gray giant rabbit on 3.6% and the first (Chinchilla) – on 4.1 %, and the expenses of feed per 1 kg of increase by group was 3.85 accordingly; 3.75; 3.7 kg. Crossbred rabbits $^{1}/_{2}$Chinchilla 1/2New Zealand white rabbit and $^{1}/_{2}$Chinchilla $^{1}/_{2}$Gray giant rabbit according to this indicator prevailed over purebred peers (Chinchilla) on 2.6 and 3.9 %, accordingly.

Key words: *rabbit breeding, crossbreeding, reproduction features, preservation, live weight, feeding indicators.*

Introduction

The global trend in the development of rabbit breeding and breeding experience require constant improvement of existing genotypes and the creation of new ones, most adapted to the latest advanced technologies of rabbit breeding and keeping.

To achieve the goal, it is necessary to cause the desired changes in the heredity of the rabbit genotype and accumulate them in a number of generations by the selected appropriate selection system and feeding and maintenance technology (Aleksandrov & Valueva, 1995; Bashcenko et al., 2019; Boiko et al., 2020; 2021).

The main indicators on which the intensification of rabbit meat production depends are the live weight of rabbits at birth and weaning, their preservation in nests, growth rate and payment of feed in increments (Gonchar & Shevchenko, 2011; Bashcenko et al., 2019; Darmohray et al., 2019; Lesyk et al., 2020; 2022).

However, the more features are taken into account during selection, the smaller the effect can be achieved for each of them. Therefore, when starting breeding work in rabbit breeding, you should focus on one or two traits, not neglecting others, which should be at least at an average level. At the first stage, attention is paid to maternal qualities: live weight at birth, live weight at weaning (35 days), preservation (Luchyn et al., 2003; Sedilo et al., 2018; Mykhailiutenko et al., 2022; Rivis et al., 2022).

In order to speed up obtaining the desired productive indicators, it is worth using crossbreeding which pursues several goals – to enrich the heredity of one of the breeds, and on the basis of two or more breeds to create a new breed (genotype), which would summarize all the positive aspects of the breeds that were taken for crossing, and according to the main of them and significantly exceeded them (Kotsyubenko, 2012). The purpose of such work is to combine different breeds in such a way that production efficiency is generally maximal (Carneiro et al., 2015; Boiko et al., 2020).

Research of existing genotypes for combining ability (combinability) can be carried out both in direct and in reverse (reciprocal) crossing. According to the results of crossing, the best, highly productive interbreed offspring should be selected, which should be used in further industrial work (hybridization) as parental and maternal forms (Luchyn, 2013).

To achieve the goal, it is necessary to use such breeds of rabbits that are superior to others in traits with high heritability that are controlled by genes of additive action and traits that show the best combinatorial ability in the form of the heterosis effect. The effect of heterosis should be higher, especially when the breeds are significantly different genetically from each other, or hereditarily distant (Leslie, 1982; Luchyn, 2008).

If the selected traits are positively correlated with each other, such as live weight at birth, milk yield and survival of offspring in the nest, selection for these three indicators will increase the intensity of the manifestation of fattening traits in young rabbits (Nigmatullin, 2011).

Receiving the maximum effect of heterosis is possible when creating genotypes, the offspring of which can best be combined in terms of basic quantitative indicators during crossing. To do this, it is necessary to create a maternal form in which the reproductive properties of female rabbits prevail (focus) and two or more parental forms, the offspring of which are dominated by fattening and meat indicators (Luchyn, 2008). A successful combination of these genotypes of rabbits will ensure the maximum increase in their productivity (Kotsyubenko, 2011).

The aim of the study

The aim of the work is to determine and to compare the reproductive qualities of female rabbits and their offspring of the chinchilla breed both during purebred breeding and when crossing them with males of the Gray giant rabbit and New Zealand white rabbit breeds and to evaluate their offspring by fattening and slaughter performance indicators in conditions of intensive industrial production.

Material and methods

The research was conducted in the conditions of the experimental rabbit farm of the Cherkasy Agricultural Research Station of Bioresources of the National Academy of Sciences, where the technology of intensive production of rabbit meat is used.

The genotype of rabbits bred in the farm is chinchilla, Gray giant rabbit, New Zealand white rabbit and their hybrids. The average monthly number of rabbits is 300, of which 60 are the main female rabbits.

In order to improve the meat productivity of chinchilla breed rabbits(Chinchilla), the genotype of which is most adapted to the production and climatic conditions of central Ukraine and at the rabbit farm of the research station, males of the gray giant (Gray giant rabbit) and New Zealand white rabbit (New Zealand white rabbit) breeds were used for industrial crossing, in which fattening and meat qualities are more pronounced. The scheme of the experiment is given in table. 1.

Table 1
Scheme of combining female rabbits of chinchilla breed (n = 15)

Groups	Genotypes		Offspring, F1
	females ♀	males ♂	
I control	Chinchilla	Chinchilla	Chinchilla
II research	Chinchilla	Gray giant rabbit	$^1/_2$Chinchilla$^1/_2$Gray giant rabbit
III research	Chinchilla	New Zealand white rabbit	$^1/_2$Chinchilla$^1/_2$New Zealand white rabbit

Note: The live weight indicators varied within the following limits: female rabbits of the chinchilla breed and their crossbreeds 4200–4600 g and 4500–4800 g – breeders of three breeds

The main elements of the technology present in the study:

- insemination of female rabbits on the 10th day of lactation;
- weaning of rabbits at 28 days of age;
- fattening period from 28 days to 90 days of age.

The evaluation of the reproductive capacity of female rabbits is determined by their index of reproductive quality of female rabbits (Breeding Value of Female Rabbits) (Luchyn et al., 2004):

Index of reproductive quality of female rabbits = V + 10m + 5z,

where: V – the average weight of one rabbit at birth, g;
m – milk yield of female rabbits, kg;
z – the number of rabbits at weaning, total;
10 and 5 are numbers, correction coefficients.

Evaluation criteria for female rabbits: multifertility, number of stillborn rabbits, high fertility, milk yield, nest index at weaning at 28 days of age, index of reproductive quality of female rabbits (Index of reproductive quality of female rabbits).

For crossbreeding, by the pair-analog method, 3 groups of female rabbits of different origins, 10 heads each, were selected, the scheme of the experiment is shown in Table 1.

In order to determine the fattening and meat indicators of young rabbits obtained from three combinations, using the pair-analog method, 3 groups of 30-day-old experimental rabbits, 15 heads each, were formed (Table 2).

Table 2
Scheme of the fattening research of young rabbits, n = 15

Groups	No.	Genotype	Productive indicators						
Control	I	Chinchilla	live weight of young rabbits in 30-90 days-old	average daily increments, g	body length, cm	chest girth, cm	loss index %	loin width, cm	Indicator of Complex Evaluation
Research	II	1/2Chinchilla1/2Gray giant							
	III	1/2Chinchilla1/2New Zealand white							

The evaluation of fattening and meat qualities was carried out by determining the "Indicator of complex evaluation" of young rabbits (ICE) at 3 months, since at this age rabbits have the most positive correlation between indicators of average daily growth and the evaluation index (Luchyn, 2005):

$$I = 5.1 (K + 2H);$$

where: 5.1; 2 – correction coefficients;
K – daily average growth (from birth) in grams;
H is the width of the waist (at the points adjacent to the knee joints) in centimeters.

The received materials of scientific research were processed by the methods of mathematical statistics using the software package "Statistica – 12.1" and Excel (Microsoft Office 2010) in the Windows environment on a personal computer according to the algorithms of N.A. Plohinsky.

Results and discussion

It is known that when assessing breeding and productive qualities of female rabbits, their reproductive indicators are of great importance. Evaluation of the reproductive capacity and maternal qualities of female rabbits for different combinations of rabbits are given in Table 3.

Table 3
Reproduction qualities of female rabbits of different genotypes, n = 15

Groups	Indicators			
	multifertility of rabbits	including stillborn rabbits	big fertility, g	nest weight, g
I control	11.4 ± 0.5	0.87 ± 0.19	57 ± 2.5	599 ± 11.31
II research	11.1 ± 0.5	0.70 ± 0.21	60 ± 2.1	629 ± 13.51*
III research	10.7 ± 0.49	0.90 ± 0.26	58 ± 2.06	569 ± 13.5

Note: *P < 0.05; **P < 0.01; ***P < 0.001 compared to the control group

Analyzing the data in Table 3, we can see that the multifertility indicators were higher in female rabbits of the 1st and 2nd experimental groups, in which it was 11.4 ± 0.5 and 11.1 ± 0.5 heads accordingly, which by 6.5 and 1.0 % higher than in female rabbits of the 3rd research group (10.7 ± 0.49 head).

As a result of the research, it was also found that the number of stillborn rabbits with an improbable difference was less in female rabbits of the 2nd group (0.7 ± 0.21 points), while in the first group this indicator was 0.87 ± 0.19 points. The highest number of stillborn rabbits was observed in female rabbits of the 3rd research group, namely 0.9 ± 0.26 heads.

Fertility was greater in female rabbits of the 3rd and 2nd experimental groups, where interbreeding was used and amounted to 58 ± 2.06 and 60 ± 2.1 grams, respectively, which is 1.7 and 5.3 % higher in relation to this indicator of purebred female rabbits of the 1st group (57 ± 2.5 grams).

When summarizing the three previous indicators of the third table, we can see that the rabbits nest weight at birth was higher in female rabbits of the 1st and 2nd research groups and was 599 ± 11.31 and 629 ± 13.51 grams, respectively, which was 9, 5 and 10.5% with a probability of P < 0.05 higher than female rabbits of the 3rd group (569 ± 13.5 g).

The second maternal indicator that directly affects the intensity of growth of rabbits during the suckling period, their better preservation, which in general had a positive effect on the weight of the nest at weaning and the subsequent fattening capacity of young rabbits, is milk yield. One of the important indicators in determining the milk yield of female rabbits is the number of rabbits in the nest at the age of 20 days (Table 4).

Table 4
Indicators of milk yield female rabbits on 20 days of lactation, n = 15

Groups	Milk yield (20 days of lactation)		
	heads	nest weight, g	preservation, %
I control	9.4 ± 0.31	2.68 ± 0.07	89.27
II research	9.9 ± 0.38	2.73 ± 0.06	95.2
III research	9.4 ± 0.25	2.88 ± 0.04*	95.9

Note: *P < 0.05; **P < 0.01; ***P < 0.001 compared to the control group

From the data in Table 4, it can be seen that up to the age of 20 days, rabbits of the combination of chinchilla and gray giant (II research group) retained the most rabbits, in which this indicator was 9.9 ± 0.38 heads, which is 5.3 % higher than in female rabbits of the first and second research groups. The percentage of survival of rabbits in the nest was higher in female rabbits of the third research group (Chinchilla x New Zealand white rabbit) and was at the level of 95.9 %, while in the 1st group this indicator was 89.27 % and in the 2nd – 95.2 %.

The second indicator that directly characterizes the milk production of female rabbits is the live weight of a nest of rabbits at the age of 20 days. Our studies revealed that it was the highest in female rabbits of the 3rd and 2nd research groups and was 2.88 ± 0.04 (P < 0.05) and 2.73 ± 0.06 kg, respectively, while in female rabbits of the first control group, the weight of the nest of rabbits at this age was at the level of 2.68 ± 0.07 kg, or 200 and 50 g less.

As it's known, the high milk productivity of females contributes to the intensive growth of rabbits in the suckling period and their greater output at weaning, which in general has a positive effect on the mass of the nest of rabbits in this technological period. In addition, the average weight of rabbits in the nest at weaning gives an estimate not only of the reproductive performance of female rabbits, but also indicates phenotypic predispositions - the future fattening and meat productivity of young rabbits. In our research, we weaned rabbits from their mothers at 28 days of age, and indicators of nest development at this age are shown in Table 5.

Table 5
Indicators of nest development of young rabbits by weaning at 28 days of age, n = 15

Groups	Indicators				Index of reproductive quality of female rabbits
	number of rabbits	1 average body weight, g	nest weight, kg	Preservation, %	
I control	9.1 ± 0.27	494 ± 16.15	4.43 ± 0.09	96.8	129.3
II research	9.9 ± 0.38	503 ± 16.75	4.91 ± 0.18	100.0	136.8
III research	9.3 ± 0.25	570 ± 15.25**	5.29 ± 0.13***	98.9	133.3

Note: *P < 0.05; **P < 0.01; ***P < 0.001 compared to the control group

From the data in the table 4 it can be seen that the indicator of the number of weaned rabbits was higher in female rabbits of the 2nd and 3rd research groups and was 9.9 ± 0.38 and 9.3 ± 0.25 heads accordingly, while in female rabbits of the first control group this indicator was at the level of 9.1 ± 0.27 goals, which is 0.5 and 0.9 goals, accordingly from the previous groups.

An important indicator of the reproductive capacity of female rabbits is the nest weight at weaning. From the results of our research, it can be seen that this indicator was probably higher in female rabbits of the 3rd (5.29 ± 0.13 kg; P < 0.001) and 2nd (4.91 ± 0.18) research groups, which, respectively, 19.4 and 4.9 % higher than in the 1st control group.

Taking into account the different level of indicators of performance of female rabbits, especially those that can directly affect the further development of young rabbits, and for the objective evaluation of female rabbits, the Index of reproductive quality of female rabbits was used. From the data in the table 5, it can be seen that the highest index of Index of reproductive quality of female rabbits was in the female rabbits of the second research group (Chinchilla x Gray giant rabbit) and was 136.8, and the lowest – in the female rabbits of the first control group (129.3), while the female rabbits of the second research group occupy an intermediate place according to this indicator (133.3).

Therefore, our research revealed that under the conditions of intensive production of rabbit meat, the reproductive qualities of female rabbits of chinchilla breed in combination with males of the Gray giant and New Zealand white rabbit breeds increase by 10–15 %.

The study of the growth and development of agricultural animals is one of the actual issues in zootechnical science and practice. It is known that indicators of weight and linear growth of growing animals judge the speed of growth. In this regard, the goal of our research was to monitor the change in live weight of purebred and crossbred rabbits over the period from 30 to 90 days of age (Table 6).

Table 6
Growth intensity of young rabbits, n = 15

Groups	Live weight of one rabbit in age, g		Daily average increase, g
	30 days	90 days	
I control	519 ± 6.64	2723 ± 34.46	36.6 ± 0.5
II research	523 ± 6.54	2837 ± 45.11*	38.4 ± 0.67*
III research	516 ± 6.18	2830 ± 44.4*	38.7 ± 0.7**

Note: *P < 0.05; **P < 0.01; ***P < 0.001 compared to the control group

From the data in Table 6, it can be seen that a certain difference was observed in the intensity of growth during the growing period from 30 to 90 days of age between the young rabbits of the control and research groups. Therefore, if at the time of fattening at the age of 30 days in terms of average live weight between purebred and crossbred young rabbits, no significant difference was observed, then at the end of the growing period (90 days) due to higher growth energy, the superiority of the young of the second and third research groups over the control group was noted and it was accordingly 4.2 and 3.9 %.

It should be noted that the same regularity was observed in the young rabbits of the research groups in terms of daily average growth. Therefore, the daily average gains for the period of 30–90 days in the second and third research groups were at the level of 38.4 and 38.7 grams, which is 4.9 and 5.7 % higher than peers of the first control group (36.6 g).

One of the most important problems of modern rabbit breeding is obtaining high-quality rabbit meat with the lowest costs. In many rabbit farms, the meatiness of rabbits has become one of the most important criteria for their evaluation. The biological basis of increased fleshiness is the accelerated growth of rabbits and reduced intensity of fat formation. Meatiness refers to the ability of animals to build up a greater or lesser amount of muscle tissue. The content of meat in a carcass depends on many factors, which can be divided into two main groups: the *first* is heredity factors (breed or breeding, breeding qualities); the *second* – factors of the external environment (feed, feeding, growing conditions. Some fattening and slaughter indicators of young rabbits are given in Table 7.

From the data in Table 7, it can be seen that the lifetime index of meatiness (waist width) in rabbits of the 2nd and 3rd research groups at the age of 3 months was accordingly 6.66 and 6.89 cm, while in the young of the first control group this indicator was at the level of 6.29 cm or accordingly less 5.6 and 8.7 %.

Table 7
Separate fattening and slaughter indicators of young rabbits, n = 15

Groups	Indicators				Indicator of Complex Evaluation
	loin width in 3 month age, cm	weight of couple carcass, g	slaughter outcome, %	Expenses of complete compound feed per 1 kg of increase, kg	
I control	6.29 ± 0.125	1417 ± 15.9	50.92	3.85	49.18
II research	6.66 ± 0.062**	1453 ± 26.2*	51.22	3.75	51.72
III research	6.89 ± 0.09**	1503 ± 28.9**	53.10	3.70	52.48

Note: *P < 0.05; **P < 0.01; ***P < 0.001 compared to the control group

Slaughter indicators (age 90 days), in particular, the average weight of a paired carcass in the second and third experimental groups, respectively, was 1453 and 1503 grams, which is 36 and 86 grams (2.5 and 6.1 %) more than in the third control group.

Slaughter yield was higher in young rabbits of the third research group, which exceeded the analogues of the second research group of rabbits by 3.6 % and the first – by 4.1 %.

The expenses of complete granulated compound feed per 1 kg of increase was the highest in the first control group (3.85), and the lowest in the third experimental group (3.7), while the young of the second experimental group took an intermediate place according to this indicator (3.75).

The Indicator of Complex Evaluation (ICE), which reflects the breeding value of rabbits and determines their further use: for breeding use or slaughter for meat in young rabbits of the 2nd and 3rd research groups (51.72 and 52.48) was also better in relation to purebred peers of the 1st control group (49.18).

Therefore, the use of industrial crossing when combining the maternal genotype of chinchilla rabbits with the parental genotypes of the breeds of Gray giant rabbit and New Zealand white rabbit not only increased the reproductive and maternal indicators of female rabbits, but also ensured an increase in the fattening productivity of rabbits, that is:

- ♦ improved feed conversion;
- ♦ reduced direct expenses for the production of a rabbit meat unit;
- ♦ increased the net income and profitability of rabbit meat production.

Conclusions

Taking into account the current state of industrial intensive production of rabbit meat and the results of our research, the following conclusions can be made:

♦ the combination of the maternal genotype of chinchilla rabbits with the parental genotypes of the gray giant and New Zealand white breeds has a positive effect on the reproductive qualities of female rabbits;

♦ the nest weight of rabbits at birth was higher in female rabbits of the 1st (W x W)) and 2nd (W x NE) experimental groups and was 599 ± 11.31 and 629 ± 13.51 grams, respectively, which was 9 .5 and 10.5 % with the probability of $P < 0.05$ higher than female rabbits of the 3rd (W x NB) group (569 ± 13.5 g);

♦ the highest rate of milk production was in female rabbits of the 3rd (W x NB) and 2nd (W x SE) research groups and was 2.88 ± 0.04 ($P < 0.05$) and 2.73 ± 0, respectively, 06 kg, while in female rabbits of the first control group, the weight of the nest of rabbits at this age was at the level of 2.68 ± 0.07 kg, or 200 and 50 g less;

♦ the weight of the nest at weaning was probably ($P < 0.001$) higher in female rabbits of the combination of Ш x NB (5.29 ± 0.13 kg) and Ш x NB, which is 19.4 and 4.9 % higher, respectively, than in 1 to the control group of purebred rabbits (Ш x Ш);

♦ research revealed that under the conditions of intensive production of rabbit meat, the reproductive qualities of female chinchilla rabbits in combination with males of the gray giant and New Zealand white breeds increase by 10–15 %;

♦ due to the higher growth energy, the advantage of the young of the second (1/2Ш1/2CB) and the third (1/2Ш1/2NB) experimental groups over the control (Ш) in terms of live weight at 90 days of age was noted and it was 4.2 and 3.9 % in accordance;

♦ the slaughter yield was higher in the young rabbits of the third (1/2Ш1/2NB) experimental group, which exceeded the analogues of the second (1/2Ш1/2CB) experimental group of rabbits by 3.6 % and the first (Ш) – by 4.1 %.

♦ consumption of complete granulated feed per 1 kg of growth was the highest in the first (Ш) control group (3.85), and the lowest in the third (1/2Ш1/2NB) experimental group (3.7), while the young of the second (1/2Ш1/2CB) of the experimental group took an intermediate place according to this indicator (3.75).

Conflict of interest

The authors claims no conflict of interest regarding the presentation and research results.

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