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USAGE OF DIFFERENT BLUP METHODS IN INDEX EVALUATION OF POLTAVSKE SRIBLO RABBIT BREED

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In the work, a comprehensive BLUP AM evaluation of the breeding value of the Poltava silver rabbit breed was carried out according to myostatin and progesterone receptor genes, taking into account paratypic factors. A detailed analysis of the components of the reproductive capacity of female rabbits of the Poltava silver breed was carried out, and the most promising of them, from the point of view of selection, were considered. When compiling linear models according to the BLUP Animal Model, it is proposed to evaluate the reproductive characteristics of rabbits based on indicators of the number of rabbits born (excluding stillbirths) at the age of 40 days and the value of average daily growth. A selection index was developed for evaluating the reproductive capacity of female rabbits, which includes BLUP AM - evaluation of reproductive and maternal traits. The values of the selection index of female rabbits of the Poltava silver breed in terms of reproductive ability ranged from -0.035 to +0.140. When selecting animals, it is advisable to use the value of the selection index taking into account the age and serial number of lactation, and to improve the reproducibility of the BLUP AM value - estimates based on individual characteristics.

Key words: rabbits, breeding value, Best Unbiased Linear Prediction, Genomic Best Unbiased Linear Prediction

Relevance. Assessment of breeding (genetic) value is the most difficult and important stage in breeding stage of animals, since based on the calculation results, animals are selected into a group of parents and not accurate conclusions based on insufficiently substantiated methods can lead to a decrease productivity of animals in the next generation and, as a consequence, a decreas

In developed countries, the daughter-peer assessment method was replaced by one developed in the 1970s. (Henderson, 1973) the best linear unbiased prediction (BLUP) method, which is currently considered the most theoretically based method allowing with minimal it is a mistake to access the breeding (genetic) qualities of the animals [3,4]. This methodology has undergone a number of improvements from the

"father" model BLUP SM to the "animal" model BLUP AM is currently a traditional method for assessing breeding (genetic) value [4].

Currently genomic breeding (genetic) value is used to determine selection criteria for many types of farm animals. It was proposed to combine traditional methods for determining breeding (genetic) value with genomic data to improve the accuracy of estimates [5-7]. Also has found the opportunity to integrate information from a matrix of additive relationships (affinities) and matrices of molecular genetic markers SNP (G) into a combined matrix and has developed the Single Step Genomic BLUP (gGBLUP) method [7, 8]. Matrix is conventional relationship matrix modified to include genomic data. Thus, the gGBLUP method combines all available phenotypic, pedigree and genomic information, in one procedure for calculating genomic breeding value values for genotypic genotyped and non-genotyped animals using a combined matrix H, this allows use all available information in genetic improvement programs for different species farm animals [9, 10].

Purpose of work. This study is aimed at studying the reliability of the breeding (genetic) value of the traits of Poltava Silver rabbits, calculated based on the use of two methods: traditional single-trait animal model (BLUP) with single-trait model genomic animal model (gGBLUP).

Material and methods. The research was carried out on the basis of the experimental farm of Cherkassy Experimental Station of Bioresources of NAAS.

Experimental rabbits of the Poltava Silver breed were kept in battery cages with an area of one compartment of 0.54 m^2. At the same time, the mother herd and the weaned young were kept separately. The cages were equipped with suspended hopper feeders for granulated compound feed. Animals were watered through auto-drinkers.

Young animals were separated by sex and kept in cages with 3-4 heads in a cage after weaning at 45 days, Males at the age of 3 months after selection based on live weight were placed in individual cages until reaching the age of breeding use - 150-160 days.

Feeding of rabbits in the farm was carried out taking into account for nutrients according to the live weight, age, sex and productivity of the animals. For feeding rabbits in the farm, granulated compound feed was used all year round, which contained: concentrated fodder, grass flour, feed additives of animal origin, mineral substances and premixes.

Optimal microclimate parameters (constant temperature, relative humidity, air movement speed) were maintained in the room of the crawler farm. Lighting was artificial with a duration of 16 hours.

The meat productivity and reproductive capacity of rabbits has determined according to zootechnical records in accordance with the "Instructions for bonituvannya of rabbits" [11].

The following formula was used to estimate the breeding value of rabbits based on the BLUP "animal model" taking into account the effects of individual genes:

$$y = X\beta + Wg + Za + e$$

where y is a vector of observations, b is a vector of fixed effects; g – vector of fixed effects of genotypes of a separate locus; a – vector of random additive genetic effects; e – vector of residues; X, W, Z are the corresponding matrices.

The following factors were included in the BLUP model: average daily gains in live weight of offspring obtained from a tested male in the period 45–90 days, feed costs per unit gain offspring's obtained from a tested males in a period of 45–90 days, average weight of a pair of young carcasses obtained from tested male at the age of 90 days, fertility and survival of rabbits (daughters), randomized factor of year (three levels) and season of the year (four levels). The model also has included polymorphic variants of rabbits myostatin gene and progesterone receptor (three levels). BLUP model which ahs described above was also used for gGBLUP but G was constructed differently. Solutions of genomic breeding values from gGBLUP can be decomposed into SNP effects as modeled in Wang et al [12]

To compare the breeding value of different male rabbits by traits, the relative breeding value (RBV, %) indicator was used, which was calculated according to the formula:

$$RBV = (BV + P) * 100$$

where P is the average productivity of the daughters of all males; BV is the breeding value determined by the BLUP method

Blood has isolated from the ear vein of rabbits and used for molecular genetic evaluation of rabbits for myostatin and progesterone receptor. Isolation and electrophoretic separation of DNA restriction fragments was carried out according to generally accepted methods. Primers were used to amplify the rabbit myostatin gene [13]:

F: 5`-TAACTGAAAAGAACCCTCTAGTAGC -3`
R: 5'- TCGGTAGTTGTTTCCCACTTT -3`

Primers has used to amplify the rabbit progesterone receptor gene [13]:

F:5'- GAAGCAGGTCATGTCGATTGGAG -3'
R:5'- CGCCTCTGGTGCCAAGTCTC -3'

Covariance components were calculated using REML-method algorithms of the GenStat 12.1 software package. The breeding value of animals was determined by the BLUP "animal model" method using the BLUPF90 program package [14, 15].

Results of research. Distribution of allele frequencies in relation to polymorphic variants of the MSTN AND PGR gene in rabbits of the Poltava Silver breed has presented in table. 1.

Table 1. Distribution of allele frequencies in relation to polymorphic variants of the MSTN AND PGR gene in rabbits of the Poltava Silver breed in cross-section of their genealogical lines

Gene	Allele	Line					
MSTN	C	1871817	1847213	1811231	1894136	1832221	1811231
	T	0,388	0,415	0,388	0,402	0,367	0,389
PGR	A	0,612	0,585	0,612	0,598	0,633	0,611
	G	0,449	0,456	0,454	0,444	0,436	0,452
Count of animals	120	89	94	104	114	117	108

It was established that the highest values of the frequency of the allele C of the MSTN gene had the rabbits of lines 1847213, 1871817 and 1894136 (10.9%, 3.7% and 7.5% higher relative to the average value). The minimum values were noted in rabbits of line 1832221 (2% lower relative to the average value). Among the rabbits of line 1811231, the T allele was most common (10.1% higher relative to the average value), and the least in animals of line 1941524 (13.4% lower relative to the average value).

The results of the genetic diversity of rabbits from different lines of the Poltava silver breed by polymorphisms C34T of the MSTN gene and G2464A of the PGR gene are presented in the table. 2. Based on data on allele frequencies and genotypes of Poltavske Sriblo breed rabbits of different lines, information about their population-genetic structure was extracted from indicators of heterozygosity and the Wright fixation index. Analyzing the data in table 2, it is necessary to respect those that are significant to the Wright's fixation coefficient F_{is} in rabbits of different lines for two genes that will be inherited by excess homozygotes in these groups.

Table 2. Genetic diversity of rabbits from different lines of the Poltava silver breed by polymorphisms C34T of the MSTN gene and G2464A of the PGR gene

Gene	Indicator	Line						
MSTN	Ho	1871817	1847213	1811231	1894136	1832221	1811231	1941524
	He	0,481	0,472	0,474	0,480	0,473	0,481	0,476
	Fis	0,519	0,528	0,526	0,520	0,527	0,519	0,524
PGR	Ho	0,04	0,01	0,04	0,02	0,01	0,03	0,04
	He	0,495	0,494	0,489	0,495	0,494	0,490	0,493
	Fis	0,505	0,506	0,511	0,505	0,506	0,510	0,507
Count of animals	120	89	94	104	114	117	108	120

In the processing of a BLUP method for assessing the breeding value of rabbits of the Poltava Sriblo breed, data on polymorphism for the myostatin gene were analyzed for signs of meat productivity (average gain). The values of the selection index of rabbits of the Poltavske Sriblo breed ranged from -0.035 to +0.189 (table 3, 4). It has been established that in a large number of rabbits of the Poltavske Sriblo breed, which is used for evaluation of animals, during the period 2022-2024 there was a closeness to the large warehouse of pellets that were involved in the evaluation.

Table 3. BLUP evaluation pf Poltavske sriblo rabbit breed according to meat productivity (n = 500)

Line	Daily weight gain, g	BV± for genetic base	RBV, %	REL, %
1871817	40±0,1	+0,189	101,0	74,0
1847213	39±0,3	+0,134	101,0	65,7
1811231	39±0,1	-0,054	99,8	69,5
1894136	42±0,2	0,145	99,9	64,7
1832221	40±0,2	-0,141	99,5	62,6
1811231	39±0,3	+0,157	100,5	67,8
941524	41±0,2	+0,101	100,1	71,0

Note: BV is the breeding value of rabbits, which includes the genotype factor; RBV – relative breeding value; REL is the reliability of the estimation of breeding value

Analysis of the results of the assessment of the country for 2024 years allows us to identify the relationships between the number of daughters who take part in the assessment and the interaction between the results of the breeding assessment. values. The correlation for the number of daughters corresponding to the

development of the EBV index was 0.512 (p>0.05). The highest values of the BLUP index were characteristic of males 1847213 (+0.157), 1871817 (+0.149) and 1894136 (+0.154). They confirmed the values of the breeding value: 103.3% and 101.5% and 100.7% similar. An indicator of the reliability of assessing the breeding value of rabbits hovering at the boundaries lim = 75.1-81.3.

Table 4. BLUP evaluation of Poltavske Sriblo rabbit breed according to reproductive traits (n = 500)

Line	Rabbits were planted at 40 days for 1 female, heads	BV± for genetic base	RBV, %	REL, %
1871817	5±0,5	+0,140	102,3	66,8
1847213	6±0,4	+0,087	101,5	66,5
1811231	5±0,5	-0,085	98,4	67,7
1894136	56±0,5	+0,047	100,9	66,5
1832221	6±0,4	+0,015	100,3	67,7
1811231	5±0,4	+0,045	100,7	78,1
941524	5±0,5	-0,035	102,3	66,8

Note: BV is the breeding value of rabbits, which includes the genotype factor; RBV – relative breeding value; REL is the reliability of the estimation of breeding value

An increase in reliability indicators was found with a decrease in values in rabbits assessed by two methods for all additional signs. When considering all the following classes, the importance of tribal (genetic) reliability values, insured using the GBLUP method, was significantly lower, the difference between indicators. BLUP insurance, there has been an increase in the reliability of estimates in the world, according to all available data (table 5).

Table 5. Reliability of assessing Poltavske Sriblo rabbits using different BLUP methods (n = 500)

Evaluation traits	Method of evaluation	REL, %					
		>= 90%	81-90	71-80	61-70	51-60	<=50
Daily weight gain	BLUP	2,81	2,82	2,88	2,79	2,81	2,90
	g-BLUP	2,63	2,74	2,71	2,70	2,63	2,81
Rabbits were planted at 40 days for 1 female	BLUP	2,57	2,85	2,85	2,81	2,74	2,80
	g-BLUP	2,49	2,54	2,48	2,63	2,61	2,71

It was established that obtaining data from molecular genetic markers before the procedure for assessing the breeding (genetic) value of rabbits, which provides data on the productivity of daughters, allowed us to significantly increase the

reliability of the assessment breeding (genetic) value by 2.2–2.4% in a group of animals with reliability, BLUP is 80–71%; by 4.6–7.3% in a group of bulls with BLUP reliability of 70-61%; by 7.6–8.4% in the group of rabbits with a reliable BLUP of 60–51%; by 14.9–15.2% in the group with reliability BLUP 50% and less for signs of meat productivity and yield. In male rabbits that had a high reliability of assessment (81% or more) by the BLUP method, the reliability of gBLUP increased to 1.6%.

Conclusions. The results indicate the usefulness of the genomic data collection and gBLUP method to increase the reliability of assessing breeding (genetic) value rabbits, which provide data on the productivity of their beds. Increased reliability of breeding (genetic) value of meat productivity and yield value became 0.1 to 15% of animals assessed by the BLUP AM method.

References

1. Textbook animal breeding: Animal Breeding and Genetics for BSc Students. Kor Oldenbroek, Liesbeth van der Waaij. Center for Resources and Animal Breeding and Genomics Group, Wageningen University and Research Centre, 2014, 311 p.

2. Shevchenko E. A., K. V. Kopylov Genomna ta BLUP ocinka kroliv novozelandskoi biloi porody riznoi liniynoi prinadleznosti. Bilogia tvarin. 2014. T. 16, № 1. S. 6-12

3. Henderson C. R. Estimates of shanges in herd environment. Journal dairy science. 1949. № 8. R. 706-709.

4. Henderson C. R. Estimates of varience and co varience components. Biometrics. 1953. № 9. R. 226-229

5. Mrode R. A. Linear models for the prediction of animal breeding values / R.A. Mrode. 2055, 2nd ed. CABI Publishing. 332 p.

6. Macedo F. L., Christensen O. F., Astruc J. M., Aguilar I., Masuda Y., Legarra A. Bias and accuracy of dairy sheep evaluations using BLUP and ssGBLUP with metafounders and unknown parent groups. Genet Sel Evol (2020) 52:47.

7. Gonchar O.F., Shevchenko E. A. Zastosyvannya metodiv genomnoi selecii pri doslidzenni kroliv novozelandskoi biloi porodi. Efektivne krolivnictvo ta zvirivnictvo. 2018. V. 4. S. 46-54.

8. Shevchenko E. A. Perspektivi vikoristannya DNK markeriv d krolivnictvi / Tezi dopovidey molodyh vchenix ta aspirantiv. Kyiv, 2011. S.10.

9. Gavrish O. M. Efektivnist vikoristannya indeksnoi ocinki v systemi dobory ta vikoristanni pleminnogo pogolivya kroliv porody poltavske sriblo. Efektivne krolivnictvo ta zvirivnictvo. 2020. V. 6. S. 38-46.

10. Instrukciya z bonityvannya kroliv - Ofic. Vid. Chynniy vid 25.09.2003 № 351 K., 2003. 86 s.

11. Honchar O.F., Shevchenko Ye.A. Assessment of the influence genotype factors on the meat productivity of the rabbits of poltavaska silver BreedScientific journal "Effective Rabbit Breeding and Animal Husbandry". 2018. vy`p. 4. S. 26-36.

12. Shevchenko E., Berezovsky O., Kopylova K., Kopylov K. Using DNA markers in selective breeding with different kinds of Ukraine farm animals. Zhyvotnovъdny Nauky (Journal of animal science). 2013. T.50. № 4. R. 73-79

13. Christensen O. F., Lund M.S. Genomic prediction when some animals are not genotyped. Genet. Sel. Evol. 2010; 42:2

14. BLUPF90 Family of Programs. [Elektronnyi resurs]. – Rezhym dostupu: http://nce.ads.uga.edu/wiki/doku.php

15. Misztal I., Lourenco D., Aguilar I., Legarra A., Vitezica Z. Manual for BLUPF90 Family of Programs. University of Georgia; Athens, GA, USA: 2015.

Література

1. Textbook animal breeding: Animal Breeding and Genetics for BSc Students. Kor Oldenbroek, Liesbeth van der Waaij. Center for Resources and Animal Breeding and Genomics Group, Wageningen University and Research Centre, 2014, 311 p.

2. Шевченко Є. А., К. В. Копилов Геномна та BLUP оцінка кролів новозеландської білої породи різної лінійної приналежності. *Біологія тварин*. 2014. Том 16, № 1. С. 6-12.

3. Henderson C. R. Estimates of changes in herd environment. *Journal dairy science*. 1949. № 8. P. 706-709

4. Henderson C. R. Estimates of varience and co varience components. *Biometrics*. 1953. № 9. P. 226-229

5. R. A. Mrode Linear models for the prediction of animal breeding values / R.A. Mrode. 2055, 2nd ed. CABI Publishing., 332 p.

6. Macedo F. L., Christensen O. F., Astruc J. M., Aguilar I., Masuda Y., Legarra A. Bias and accuracy of dairy sheep evaluations using BLUP and ssGBLUP with metafounders and unknown parent groups. Genet Sel Evol (2020) 52:47.

7. Гончар О.Ф., Шевченко Є. А. Застосування методів геномної селекції при дослідженні кролів новозеландської білої породи. *Ефективне кролівництво і звірівництво*. 2018. Вип. 4. С. 46-54.

8. Шевченко Є. А. Перспективи використання ДНК маркерів в кролівництві / Тези доповідей молодих вчених та аспірантів. Київ, 2011. S.10.

9. Гавриш О. М. Ефективність використання індексної оцінки в системі добору та використанні племінного поголів'я кролів породи полтавське срібло. *Ефективне кролівництво і звірівництво*. 2020. Вип. 6. С. 38-46.

10. Інструкція з бонітування кролів –Офіц. вид., чинний від 25.09.2003 № 351 –К., 2003. –86 с.

11. Гончар О.Ф., Шевченко Є.А. Assessment of the influence genotype factors on the meat productivity of the rabbits of poltavaska silver Breed . Збірник наукових праць “Ефективне кролівництво і звірівництво”. 2018. вип. 4. С. 26-36.
12. Shevchenko E., Berezovsky O., Kopylova K., Kopylov K. Using DNA markers in selective breeding with different kinds of Ukraine farm animals. *Животновъдни Науки (Journal of animal science).* 2013 T.50, № 4 . P. 73-79
13. Christensen O. F., Lund M.S. Genomic prediction when some animals are not genotyped. Genet. Sel. Evol. 2010; 42:2
14. BLUPF90 Family of Programs. [Електронний ресурс]. – Режим доступу: http://nce.ads.uga.edu/wiki/doku.php
15. Misztal I., Lourenco D., Aguilar I., Legarra A., Vitezica Z. Manual for BLUPF90 Family of Programs. University of Georgia; Athens, GA, USA: 2015

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ВИКОРИСТАННЯ РІЗНИХ МЕТОДІВ BLUP В ІНДЕКСНІЙ ОЦІНЦІ КРОЛІВ ПОРОДИ ПОЛТАВСЬКЕ СРІБЛО

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У роботі була проведена комплексна BLUP AM оцінка племінної цінності кролів породи полтавське срібло за генами міостатину та прогестеронового рецептора із врахуванням паратипових факторів. Виконано детальний аналіз компонентів відтворювальної здатності кролематок породи полтавське срібло та розглянуто найбільш перспективні з них, з погляду селекції. При складанні лінійних моделей за BLUP Animal Model запропоновано оцінювати репродуктивні ознаки кролів за показниками кількість народжених кроленят (без урахування мертвонароджених) у віці 40 днів та значення середньодобових приростів. Розроблений селекційний індекс для оцінки відтворювальної здатності кролематок, що включає BLUP AM - оцінки репродуктивних та материнських ознак. Значення селекційного індексу кролематок породи полтавське срібло за відтворювальною здатністю знаходилися в межах від -0,035 до +0,140. При відборі тварин доцільно використовувати значення селекційного індексу з урахуванням віку та порядкового номера лактації, а для покращення відтворювальної здатності значення BLUP AM – оцінок за окремими ознаками.

***Ключові слова**: кролики, племінна цінність, найкращий неупереджений лінійний прогноз, геномний найкращий неупереджений лінійний прогноз*