

## Sazer-Fredin index – an effective method of assessing young pigs for feeding and meat qualities

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### Article info

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The purpose of the work was to investigate the fattening and meat quality of young pigs of different intrabreed differentiation according to the Sazer-Fredin index and, based on the obtained data, to calculate the economic efficiency of the results of the experiment. The research was carried out in the Dnipropetrovsk region and the animal husbandry laboratory of the State Institution “Institute of Grain Crops of the National Academy of Sciences”. The assessment of young pigs of the large white breed in terms of fattening and meat qualities was carried out considering the following indicators: average daily gain in live weight during the period of control fattening, g; the age of reaching 100 kg live weight, days; thickness of fat at the level of 6–7 thoracic vertebrae, mm; length of the cooled carcass, cm; the length of the bacon half of the chilled half-carcass, see. Control fattening of young pigs was carried out in farm conditions, according to M. D. Berezovsky and I. V. Khatka's method (2005). It was established that the young pigs of the large white breed of the controlled population belong to the elite class by the age of reaching a live weight of 100 kg, the Thickness of the lard at the level of 6–7 thoracic vertebrae, and the length of the chilled carcass. Taking into account the intrabreed differentiation according to the Sazer-Fredin index, it was established that the young pigs of experimental group I prevailed over peers of II in terms of the average daily gain of live weight during the period of control fattening by 4.23 %, the age of reaching a live weight of 100 kg – 1.83 %, the Thickness of lard by the level of 6–7 thoracic vertebrae – 14.47 mm and the length of the chilled carcass – 0.31 %. The leading indicators of the average daily increase in live weight during the period of control fattening and the length of the chilled carcass and the minimum values of the age of reaching the live weight of 100 kg and the Thickness of lard at the level of 6–7 thoracic vertebrae were found in young pigs of group I-b. The criterion for selecting highly productive animals according to the Sazer-Fredin index is young pigs with a variability of the specified mathematical model from +0.089 to +0.591 points. The pairwise correlation coefficient between young pigs' fattening and meat qualities and the Sazer-Fredin index ranges from -0.413 ( $t_r=2.93$ ) to +0.248 ( $t_r=1.66$ ). The maximum increase in additional production was obtained from young pigs of the first experimental group according to the Sazer-Fredin index (+1.47 %). The value of additional products obtained from young pigs of the specified group provided that the sales price for 1 kg of live weight of young pigs at the time of the study was UAH 67.4. is + UAH 101.93/head.

**Keywords:** young pigs, breed, fattening and meat qualities, mathematical model, index, correlation, economic efficiency.

## Індекс Сазера-Фредіна – ефективний метод оцінки молодняку свиней за відгодівельними і м'ясними якостями

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Метою роботи було дослідити відгодівельні і м'ясні якості молодняку свиней різної внутріпородної диференціації за індексом Сазера-Фредіна, на основі одержаних даних розрахувати економічну ефективність результатів експерименту. Дослідження проведено у Дніпропетровській області та лабораторії тваринництва Державної установи «Інститут зернових культур НААН». Оцінку молодняку свиней великої білої породи за відгодівельними і м'ясними якостями проводили з огляду на такі показники: середньодобовий приріст живої маси за період контрольної відгодівлі, г; вік досягнення живої маси 100 кг, діб; товщина шпигу на рівні 6–7 грудних хребців, мм; довжина охолодженої туші, см; довжина беконної половини охолодженої півтуші, см. Контрольну відгодівлю молодняку свиней великої білої породи проводили в умовах господарства за методикою М. Д. Березовського, І. В. Хатька (2005). Установлено, що молодняк свиней великої білої породи підконтрольної популяції за віком досягнення живої маси 100 кг, товщиною шпигу на рівні 6–7 грудних хребців і довжиною охолодженої туші належать до класу еліта. З огляду на внутріпородну диференціацію за індексом Сазера-Фредіна встановлено, що молодняк свиней I піддослідної групи переважав ровесників II за середньодобовим приростом живої маси за період контрольної відгодівлі на 4,23 %, віком досягнення живої маси 100 кг – 1,83 %, товщиною шпигу на рівні 6–7 грудних хребців – 14,47 мм і довжиною охолодженої туші – 0,31 %. Максимальні показники середньодобового приросту живої маси за період контрольної відгодівлі і довжини охолодженої туші та мінімальні значення віку досягнення живої маси 100 кг і товщини шпигу на рівні 6–7 грудних хребців виявлено у молодняку свиней групи I-b. Критерієм відбору високопродуктивних тварин за індексом Сазера-Фредіна є молодняк свиней з варіабельністю зазначеної математичної моделі від +0,089 до +0,591 балів. Коефіцієнт парної кореляції між відгодівельними і м'ясними якостями молодняку свиней та індексом Сазера-Фредіна коливається в межах від -0,413 ( $t_r=2,93$ ) до +0,248 ( $t_r=1,66$ ). Максимальну прибавку додаткової продукції одержано від молодняку свиней I піддослідної групи за індексом Сазера-Фредіна (+1,47 %). Вартість додаткової продукції, яку одержано від молодняку свиней зазначеної групи, за умови, що ціна реалізації за 1 кг живої маси молодняку свиней на час проведення дослідження дорівнювала 67,4 грн, становить +101,93 грн/гол.

**Ключові слова:** молодняк свиней, порода, відгодівельні і м'ясні якості, математична модель, індекс, кореляція, економічна ефективність.

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## Introduction

According to the current Instructions on the grading of pigs [1], boars and sows are evaluated for fattening and meat qualities of their offspring according to the following indicators: age of reaching 100 kg live weight (days), feed consumption per 1 kg of growth (feed unit), the Thickness of lard at the level of 6–7 thoracic vertebrae (mm) and length of the chilled carcass (cm). For animals of the 1st group of breeds of the elite class, the age of reaching a live weight of 100 kg is 190 days or less, feed consumption per 1 kg of gain is 3.9 and fewer feed units, fat Thickness at the level of 6–7 thoracic vertebrae is 31 millimeters and less, length chilled carcass – 93 or more centimeters.

Numerous studies testify to the effectiveness of innovative methods of assessing the breeding value of pigs and the selection of highly productive animals, as well as the significant influence of foreign breeding pigs on the phenotypic manifestation of economically critical quantitative traits [2–7].

Thus, according to V. I. Khalak and others [8], in young pigs of the large white breed, the age of reaching a live weight of 100 kg is 172.7±1.11 days (Cv=4.12 %), the Thickness of lard at the level of 6–7 thoracic vertebrae is 21.41±0.294 mm (Cv=8.79 %), the length of the chilled carcass is 96.4±0.59 cm (Cv=2.22 %), the length of the bacon half of the carcass is 80.8±0.89 cm (Cv = 4.00 %).

Research by M. D. Berezovsky and others [9] showed that in young pigs of the large white breed, the age of reaching a live weight of 100 kg is 192 days, the consumption of feed per 1 kg of growth is 3.72 feed units, the Thickness of lard at the level of 6–7 thoracic vertebrae is 25.1 mm. The use of sows of the large white breed in combination with boars of the landrace breed contributed to a decrease in the age of reaching a live weight of 100 kg of their offspring by 8.8 days, feed consumption per 1 kg of gain – by 0.21 feed units, fat Thickness at the level of 6–7 thoracic vertebrae – by 2.5 millimeters.

The results of the research of Balatsky V. M. and others [10, 11] determined the genetic structure of pigs of predominantly white, Poltava meat, large black, and Mirgorod pori pigs according to the cathepsin F gene (CTSF g.22 G>C SNP) in controlled populations and established the main population parameters. In all breeds, the genetic marker was characterized by polymorphism with a predominance of the g.22C allele frequency. The level of informativeness of CTSF g.22 G>C SNP was found to be at the optimal level for associative analysis (PIC= 0.358–0.375), which allows searching for connections of the marker with pig productivity traits in controlled subpopulations. In a subpopulation of pigs of the large white breed of Ukrainian selection, an analysis of the relationship of the genetic marker CTSF g.22 G>C SNP with indicators of animal productivity: the age of reaching a live weight of 100 kg, the Thickness of lard at the level of the 6–7th rib, 10th rib, in the area of the sacrum and average daily weight gain and selection index. The authors established a tendency towards the association of the indicated genetic marker with the age at which the animals reached a live weight of 100 kg (p=0.07).

The relevance of the chosen research direction is evidenced by the works of domestic and foreign scientists,

namely: V. I. Rossokha, E. K. Oliinychenko, O. A. Boyko, O. A. Zaderikhina [12], R. L. Susol, I. Ye. Tkachenko [13], O. M. Tsereniuk [14], O. M. Khramkova [15], M. A. Khvatova [16], R. L. Susol [17], L. P. Gryshina, O. H. Fesenko [18], P. A. Vashchenko [19], Z. M. Ciepielewski, W. Stojek, A. Borman, D. Myślińska, P. Pałczyńska, M. Kamyczek [20], A. M. Maslyuk [21], V. M. Girya, M. V. Voloshchuk, N. M. Pogribna [22], O. I. Dudka, I. M. Karvatska [23], M. A. Khvatova [24].

## The aim of the study

The purpose of the work is to investigate the fattening and meat qualities of young pigs of different intrabreed differentiation according to the Sazer-Fredin index, based on the data obtained, to calculate the economic efficiency of the results of the experiment.

## Materials and methods

The experimental part of the research was carried out in the agricultural formations of the Dnipropetrovsk region (Ltd “Druzhba-Kaznacheivka”) and the animal husbandry laboratory of the State Institution “Institute of Grain Crops of the National Academy of Sciences”.

The object of research was young pigs of the large white breed. The animals were evaluated for fattening and meat qualities taking into account the following indicators: average daily gain of live weight during the period of control fattening, g, age of reaching a live weight of 100 kg, days, fat Thickness at the level of 6–7 thoracic vertebrae, mm, length of the chilled carcass, cm [25].

The age of reaching a live weight of 100 kg (1, 2), the Sazer-Fredin index (3) was calculated according to the following formulas:

if the live weight of the animal is 85–99 kg:

$$D_{100} = \left[ (100 \text{ kg} - M_0) \div \frac{M_0 - M_{pw}}{D_0 - D_{pw}} \right] + D_0, \quad (1)$$

if the live weight of the animal is 101–115 kg:

$$D_{100} = D_0 - \left[ (M_0 - 100 \text{ kg}) \div \frac{M_0 - M_{pw}}{D_0 - D_{pw}} \right] + D_0, \quad (2)$$

where:  $D_{100}$  – age of reaching a live weight of 100 kg, days;  $D_0$  – the age at last weighing, days;  $D_{pw}$  – age of previous weighing, days;  $M_0$  – live weight at the last weighing, kg;  $M_{pw}$  – live weight at preliminary weighing, kg [1];

$$I = \frac{1}{\sigma_g} \times \Delta G_1 - \frac{1}{\sigma_f} \times \Delta F_1 \quad (3)$$

where:  $I$  – Sazer-Fredin index, points;  $\Delta G_1$  – growth rate in deviations from the average;  $\Delta F_1$  – Thickness of lard in deviations from the average;  $\sigma_g$  – phenotypic standard deviation of growth rate;  $\sigma_f$  – phenotypic standard deviation of fat Thickness [26];

The “T-factor” index (4) was calculated according to the method Hazei L. N., Kline E. A. [27]:

$T = \text{Thickness of lard at the level of 6-7 thoracic vertebrae (mm)} / \text{length of the chilled carcass (cm)}$  (4)

The strength of correlations between features was determined by the Chaddock scale [28] (Table 1).

**Table 1**  
Chaddock's scale for grading the strength of correlation

The value of the correlation coefficient	Strength of correlation
0.1-0.3	Weak
0.3-0.5	Noticeable
0.5-0.7	Noticeable
0.7-0.9	High
0.9-0.99	Very high

The cost of additional products [29] and biometric processing of the received data [30] was carried out according to generally accepted methods.

**Table 2**  
Indicators of the variability of fattening and meat qualities of young pigs of the large white breed, n=44

Indicators, units of measurement	Biometric Indicator	
	$\sigma \pm S_{\sigma}$	$Cv \pm Sc_v, \%$
Average daily gain of live weight during the period of control fattening, g	37.73±4.022	4.84±0.515
Age of reaching 100 kg live weight, days	5.25±0.559	2.96±0.315
The Thickness of the lard at the level of 6-7 thoracic vertebrae, mm	2.16±0.230	10.45±1.114
Length of the cooled carcass, cm	1.64±0.174	1.71±0.182
The length of the bacon half of the cooled carcass, cm	3.03±0.323	3.54±0.377

The results of the study of the fattening and meat qualities of young pigs of the large white breed of different

## Results and discussion

It was established that the average daily increase in live weight of young pigs of the experimental group (n=44) during the period of control fattening is 779.4±5.68 g, the age of reaching 100 kg live weight is 177.3±0.79 days, the Thickness of lard is at 6–7 thoracic vertebrae – 20.7±0.32 mm, the length of the chilled carcass – 96.5±0.31 cm, the length of the bacon half of the chilled carcass 85.5±0.58 cm. The Sazer-Fredin index ranges from -1.006 to +1.880, and the “T-factor” index – varies from 0.183 to 0.252 points.

The coefficient of variation of fattening and meat qualities in young pigs of the controlled population ranges from 1.71 to 10.45 % (Table 2).

intrabreed differentiation according to the Sazer-Fredin index are shown in Table 3.

**Table 3**  
Feeding and meat qualities of young pigs of the large white breed of different intrabreed differentiation according to the Sazer–Fredin index

Indicators, units of measurement	Biometric Indicator	Sazer–Fredin index gradations	
		+0.089 – +1.880	-1.006 – -0.175
		group	
		I	II
	<i>n</i>	28	16
Average daily gain of live weight during the period of control fattening, g	$X \pm Sx$	791.1±6.78	757.6±7.74
	$\sigma \pm X_{\sigma}$	35.91±4.800	30.98±5.483
	$Cv \pm Sc_v, \%$	4.53±0.605	4.08±0.722
Age of reaching 100 kg live weight, days	$X \pm Sx$	176.1±0.90	179.4±1.17
	$\sigma \pm X_{\sigma}$	4.80±0.641	5.51±0.975
	$Cv \pm Sc_v, \%$	2.72±0.363	3.07±0.543
The Thickness of the lard at the level of 6-7 thoracic vertebrae, mm	$X \pm Sx$	19.5±0.33	22.8±0.22
	$\sigma \pm X_{\sigma}$	1.75±0.193	0.91±0.161
	$Cv \pm Sc_v, \%$	8.97±1.199	3.99±0.706
Sazer-Fredin index, point	$X \pm Sx$	0.632±0.098	-0.550±0.086
	$\sigma \pm X_{\sigma}$	0.52±0.068	0.34±0.061
	$Cv \pm Sc_v, \%$	82.2±10.989	61.81±10.939
	<i>n</i>	18	9
Length of the cooled carcass, cm.	$X \pm Sx$	96.7±0.36	96.3±0.64
	$\sigma \pm X_{\sigma}$	1.77±0.295	1.93±0.455
	$Cv \pm Sc_v, \%$	1.83±0.305	2.01±0.474
The length of the half bacon of the cooled carcass, cm.	$X \pm Sx$	85.7±0.77	85.1±0.87
	$\sigma \pm X_{\sigma}$	3.26±0.543	2.61±0.615
	$Cv \pm Sc_v, \%$	3.80±0.633	3.06±0.721
Index “T-factor” points	$X \pm Sx$	0.207±0.0031	0.237±0.0036
	$\sigma \pm X_{\sigma}$	0.01±0.0016	0.01±0.0023
	$Cv \pm Sc_v, \%$	4.83±0.805	4.21±0.992

It was established that the young pigs of experimental group I prevailed over peers of II in terms of average daily gain in live weight during the period of control fattening by 33.5 g (td=3.25; P<0.01), the age of reaching a live

weight of 100 kg – 3.3 days (td=2.24; P<0.05), the length of the cooled carcass is 0.4 cm (td=0.54; P>0.05). The difference between the animals of the I and II groups in terms of the length of the bacon half of the chilled carcass

is 0.6 cm (td=0.51; P>0.05), the Thickness of the lard at the level of 6–7 thoracic vertebrae is 3.3 mm (td=8.68; P<0.001), Sazer-Fredin index – 1.182 points (td=9.09; P<0.001). The maximum value of the "T-factor" index was found in the animals of the II sub-experimental group; compared to peers of the first experimental group, the

difference in this indicator is equal to 0.03 points (td=6.38; P<0.001).

The intrabreed differentiation of young pigs according to the Sazer-Fredin index indicates a significant difference between the groups in terms of the leading indicators of fattening and meat qualities (table 4).

**Table 4**

Fattening and meat quality of young pigs of the large white breed of different intrabreed differentiation according to the Sazer-Fredin index within the I (I-a, I-b) and II (II-a, II-b) experimental groups

Indicators, measurement units	Biometric indicators	Sazer-Fredin index gradations			
		+0,849 – +1,880	+0,089 – +0,591	-1,006 – -0,833	-0,298 – -0,175
		group			
		I-a	I-b	II-a	II-b
	n	9	19	8	8
1	$X \pm Sx$	789.9±13.90	792.9±7.80	772.4±12.14	742.8±6.84
	$\sigma \pm X_{\sigma}$	41.71±9.837	34.03±5.524	34.36±8.590	19.36±4.840
	$Cv \pm Sc_v, \%$	5.28±1.245	4.29±0.696	4.44±1.11	2.60±0.650
2	$X \pm Sx$	176.7±1.59	175.8±1.12	177.9±2.04	181.7±1.82
	$\sigma \pm X_{\sigma}$	4.77±1.125	4.91±0.797	5.78±1.445	5.15±1.287
	$Cv \pm Sc_v, \%$	2.69±0.634	2.79±0.452	3.24±0.810	2.83±0.707
3	$X \pm Sx$	20.6±0.33	19.0±0.41	22.0±0.11	23.6±0.18
	$\sigma \pm X_{\sigma}$	1.00±0.235	1.80±0.292	1.00±0.250	0.51±0.127
	$Cv \pm Sc_v, \%$	4.85±1.143	9.47±1.537	4.54±1.135	2.16±0.540
4	$X \pm Sx$	1.330±0.0885	0.302±0.0205	0.882±0.0212	0.218±0.0167
	$\sigma \pm X_{\sigma}$	0.26±0.061	0.13±0.021	0.06±9.015	0.04±0.010
	$Cv \pm Sc_v, \%$	19.54±4.608	43.04±6.987	7.31±1.827	18.34±4.585
	n	8	10	4	5
5	$X \pm Sx$	96.7±0.64	96.6±0.42	96.5±1.50	96.2±0.37
	$\sigma \pm X_{\sigma}$	1.83±0.457	1.34±0.299	3.00±1.063	0.83±0.262
	$Cv \pm Sc_v, \%$	1.89±0.472	1.38±0.308	3.10±1.099	0.86±0.272
6	$X \pm Sx$	87.0±1.48	84.7±0.61	85.2±1.93	85.0±0.70
	$\sigma \pm X_{\sigma}$	4.20±1.050	1.94±0.434	3.86±1.014	1.58±0.500
	$Cv \pm Sc_v, \%$	4.82±1.205	2.29±0.512	4.53±1.606	1.85±0.585
7	$X \pm Sx$	0.213±0.0044	0.202±0.0040	0.228±0.0034	0.245±0.0030
	$\sigma \pm X_{\sigma}$	0.01±0.002	0.01±0.002	0.006±0.0015	0.006±0.0018
	$Cv \pm Sc_v, \%$	4.69±1.172	4.95±1.107	2.63±0.657	2.44±0.772

Note: 1 – an average daily gain of live weight during the period of control fattening, kg; 2 – age of reaching 100 kg live weight, days; 3 – fat Thickness at the level of 6–7 thoracic vertebrae, mm; 4 – Sazer-Fredin index, point; 5 – length of the cooled carcass, cm; 6 – length of the bacon half of the cooled carcass, cm; 7 – "T-factor" index, score.

Thus, the animals of the experimental group I-b prevailed over the peers of II-b in terms of the average daily increase in live weight during the period of control fattening by 50.1 g (td=4.83; P<0.001), the age of reaching a live weight of 100 kg – 5.9 days (td=2.76; P<0.01), the Thickness of lard at the level of 6–7 thoracic vertebrae - 4.6 mm (td=10.45; P<0.001), the length of the chilled carcass – 0.4 cm (td=0.72; P>0.05). The difference between the animals of the specified groups in terms of the length of the bacon half of the chilled carcass is 0.3 cm (td=0.32; P>0.05), the Sazer-Fredin index is 0.084 points (td=3.23; P<0.001), the index "T-factor" – 0.043 points (td=8.60; P<0.001).

A similar pattern was also established between young pigs of experimental groups I-a and II-a.

The coefficient of variation of the leading indicators of fattening and meat qualities of young pigs of the experimental groups ranges from 0.86 (the length of the chilled carcass in the animals of the II-b experimental group) to 9.47 % (the Thickness of lard at the level of 6–7 thoracic vertebrae in the animals of the experimental group I-b).

The results of calculations of the pairwise correlation coefficient between the fattening and meat qualities of young pigs and evaluation indices are shown in Table 5.

**Table 5**

Coefficients of paired correlation between fattening and meat qualities of young pigs and evaluation indices

Indicator (feature)	Biometric indicators			Strength of correlation	
	x	y	r±Sr		
Sazer-Fredin index points		1	0.248±0.1495	1.66	Weak
		2	-0.122±0.1532	0.80	Weak
		3	-0.333±0.1455*	2.29	Moderate
		4	0.085±0.1537	0.55	-
		5	0.234±0.1500	1.56	Weak
		6	-0.413±0.1405**	2.94	Moderate

Note: 1 – an average daily gain of live weight during the period of control fattening, kg; 2 – age of reaching 100 kg live weight, days; 3 – fat Thickness at the level of 6–7 thoracic vertebrae, mm; 4 – length of the cooled carcass, cm; 5 – length of the bacon half of the cooled carcass, cm; 6 – "T-factor" index, score; \* – P<0.05; \*\* – P<0.01.



The pairwise correlation coefficient between young pigs' fattening and meat qualities and evaluation indices ranges from -0.413 ( $t_r=2.93$ ) to +0.248 ( $t_r=1.66$ ).

Reliable correlation coefficients were established according to the following pairs of signs: Sazer-Fredin index  $\times$  fat thickness at the level of 6–7 thoracic

vertebrae ( $r=-0.333$ ), Sazer-Fredin index  $\times$  "T-factor" index ( $r=-0.413$ ).

The results of the calculation of the economic efficiency of the use of young pigs in the experimental groups are shown in Table 6.

**Table 6**

Economic efficiency of research results

Group	n	Average daily gain of live weight during the period of control fattening, g	Increase in additional products, %	Cost of additional products, hryvnias/head*
General selection	44	779.4 $\pm$ 5.68	–	–
II	16	757.6 $\pm$ 7.74	-2.79	-197.09
I	28	791.1 $\pm$ 6.78	+1.47	+101.93

Note: \* – the sale price of young pigs to the processing enterprises of the region at the time of the study was 67.4 UAH / kg.

It was established that the maximum increase in additional production was obtained from young pigs of the first experimental group (+1.47 %). The value of additional products obtained from young pigs of the specified group provided that the sales price for 1 kg of live weight of young pigs at the time of the study was UAH 67.4. is + UAH 101.93/head.

## Conclusions

1. It was established that the young pigs of the large white breed of the controlled population belong to the elite class by the age of reaching a live weight of 100 kg, the Thickness of the lard at the level of 6–7 thoracic vertebrae and the length of the chilled carcass.

2. Taking into account the intrabreed differentiation according to the Sazer-Fredin index, it was established that the young pigs of experimental group I prevailed over the peers of II in terms of the average daily increase in live weight during the period of control fattening by 4.23 %, the age of reaching a live weight of 100 kg – 1.83 %, thickness lard at the level of 6–7 thoracic vertebrae – 14.47 mm and the length of the chilled carcass – 0.31 %.

3. The leading indicators of the average daily increase in live weight during the period of control fattening and the length of the chilled carcass and the minimum values of the age of reaching the live weight of 100 kg and the Thickness of lard at the level of 6–7 thoracic vertebrae were found in young pigs of group I-b. The criterion for selecting highly productive animals according to the Sazer-Fredin index is young pigs with a variability of the specified mathematical model from +0.089 to +0.591 points.

4. The pairwise correlation coefficient between fattening and meat quality of young pigs and the Sazer-Fredin index ranges from -0.413 ( $t_r=2.93$ ) to +0.248 ( $t_r=1.66$ ).

5. The maximum increase in additional production was obtained from young pigs of the first experimental group according to the Sazer-Fredin index (+1.47 %). The value of additional products obtained from young pigs of the specified group provided that the sales price for 1 kg of live weight of young pigs at the time of the study was UAH 67.4. is + UAH 101.93 /head.

## Conflict of interest

The authors state that there is no conflict of interest.

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