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INCREASING THE EFFICIENCY OF AGRIBUSINESS: STRATEGIC GENE POOL MANAGEMENT AND TECHNOLOGICAL INNOVATIONS

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INTRODUCTION

It is now of great importance to further increase production and improve the quality and safety of agricultural products. In addition, in a market economy and European requirements, a competitive pig meat producer must supply the market with quality products that meet the requirements of European legislation [46, 47, 102]. Such prerequisites dictate further progress of Ukraine in the use of modern technologies in the pig industry. It is in the context of this aspect that the development of modern technologies raises a number of issues for scientists and practitioners, in particular: creating a sustainable feed base using innovative feedstuffs, deepening breeding work with the possibility of predicting the genetic potential of animals based on the use of DNA markers, solving the problem of ethical or humane treatment of pigs [47, 142].

One of the most important factors in increasing animal productivity is the creation of proper conditions for keeping and feeding animals, which makes scientists look for different approaches to the conditions of adaptation and comfortable stay of animals on the farm.

In this regard, there are, on the one hand, technological methods for improving pig meatiness based on elements of ethology, bioethics, feeding and housing [28, 46–48, 62, 102, 135, 162, 163]. On the other hand, there are molecular genetic methods for identifying animals with «desirable» genotypes based on DNA markers of meat productivity [8, 37, 56, 74, 121, 142, 204, 209].

Based on the above, in order to ensure further progress of the domestic pig industry, it is important to increase pig productivity using modern gene pool and innovative technological solutions, which is the purpose of our research.

SECTION 1.

<u>CURRENT STATE AND DEVELOPMENT TRENDS OF SWINE FARMING IN AGRIBUSINESS</u>

The pig industry in Ukraine has always been one of the main sources of income and prosperity for the state. In the history of Ukrainian pig production, there were times when pork accounted for 55–60 % of the total meat balance [24]. Looking at the historical aspect of the Ukrainian pig industry, we note that until 1914, pig production ranked fourth in the world in terms of production and sales of its own products [145]. In turn, our ancestors considered the pig to be a symbol of well–being and associated it with a «well–fed life» [82].

Of course, it is well known that the development of the pig industry is prioritized by the economic and biological characteristics of pigs, omnivorousness, early maturity, economical use of feed, a wide range of uses for slaughter products, their shelf life and the suitability of pork for making tasty and highly nutritious culinary products.

However, recently the pork market has become largely problematic, and the problem is primarily related to pork production. This situation was initiated by a number of negative factors, including economic destabilization in the country, a reduction in pig numbers and meat production, lower demand and reduced exports.

An analysis of the situation in the pork industry leads to the conclusion that the share of pork in the structure of meat production in Ukraine tends to decrease. Thus, in 2016, it amounted to 32.2 %, while in 2020 it dropped to 29.1 %. Unfortunately, this unfortunate situation is due to a number of factors, including the temporary occupation of the Autonomous Republic of Crimea and parts of Donetsk and Luhansk oblasts, the worsening epidemiological situation with the African swine fever virus (ASF), low purchasing power of the population due to the COVID–19 coronavirus pandemic, and, ultimately, the deterioration of the economic situation in the country as a whole.

According to the State Statistics Service of Ukraine [16], between 2015 and 2020, the number of pigs decreased by 19.1 % to 5.7 million heads (Table 1.1). At the same time, in 2016, there was a slight decline in the number of pigs compared to 2015 – 0.94 %, and then an intensive decline began 2020 inclusive, which has already crossed the «anti» mark of the historical minimum of 2004 – 6.4 million heads.

It should be noted that largest reduction in the number of pigs affected Luhansk, Rivne, Zhytomyr, and Mykolaiv regions, while Khmelnytsky, Ternopil, Ivano–Frankivsk, and Lviv regions experienced an increase of 7.8–16.5 %. It is important to note that the increase in the number of pigs in these regions was due to its growth in agricultural enterprises by 37.6–69.3 % [16, 120, 131, 133].

Table 1.1

Dynamics of pig population in Ukraine, thousand heads

Indicator	Year						2020 to 2015, %
	2015	2016	2017	2018	2019	2020	
Farms of all categories	7079,0	6669,1	6561,2	6140,0	6170,0	5730,0	80,9
Agricultural enterprises	3704,0	3565,9	3297,2	3216,0	3530,0	3300,0	89,1
Households	3375,0	3103,2	3264,0	2924,0	2640,0	2430,0	72,0

Regarding households, we note that the number of pigs decreased by 28 % in almost all regions of the country, but in Zhytomyr, Chernihiv, Kherson, Odesa, and Rivne regions it was up to 30 %, and in Luhansk and Donetsk regions it exceeded 50 % [16].

Summarizing the above, we state that the data of the table convincingly indicate «steady» reduction in the number of pigs in Ukrainian farms of all categories, which was caused by low purchase prices due to the low purchasing power of the domestic market and a rather high cost of domestic pork production. In addition, the occupation of the Autonomous Republic of Crimea and military operations in eastern Ukraine affected the number of pigs. Another factor behind the decline in pig numbers is the outbreak of ASF in Ukraine.

According to the joint FAO/EBRD technical assistance project: «Ukraine: ASF Risk Mitigation and Awareness Raising – Phase II Equipment Acquisition» [123], ASF has been registered in Ukraine since 2012 (Table 1.2) [124].

It has been established that the total loss of livestock since 2012, when ASF was first registered in Ukraine, has reached more than 185 thousand pigs, and the losses of specialized pig farms are estimated at more than UAH 500 million [49].

The largest volumes of pork production in all categories of farms in 2015–

2016 were observed in Donetsk region – 84.7–93.2 thousand tons, which accounted for 11.1–12.3 % of the total production, Kyiv region – 81.7–74.9 thousand tons and 10.7–9.9 %, and Lviv region – 65.3–66.8 thousand tons and 8.6–8.8 %, respectively (Fig. 1.1)

Table 1.2

Dynamics of ASF outbreaks in Ukraine from 2012 to 2020

Year	Total number of outbreaks, units.	Number of domestic pigs, heads	The number of wild pigs, heads	Number of infected objects*, units
2012	1	1	0	0
2013	4	3	1	0
2014	16	4	12	0
2015	40	34	5	1
2016	91	84	7	0
2017	163	119	38	6
2018	145	93	39	13
2019	53	35	11	7
2020	12	7	4	1

*Notes. *Infected object – the number of households, pig farms where signs of pig disease or suspicious animals are detected, expressed in absolute terms in kind.*

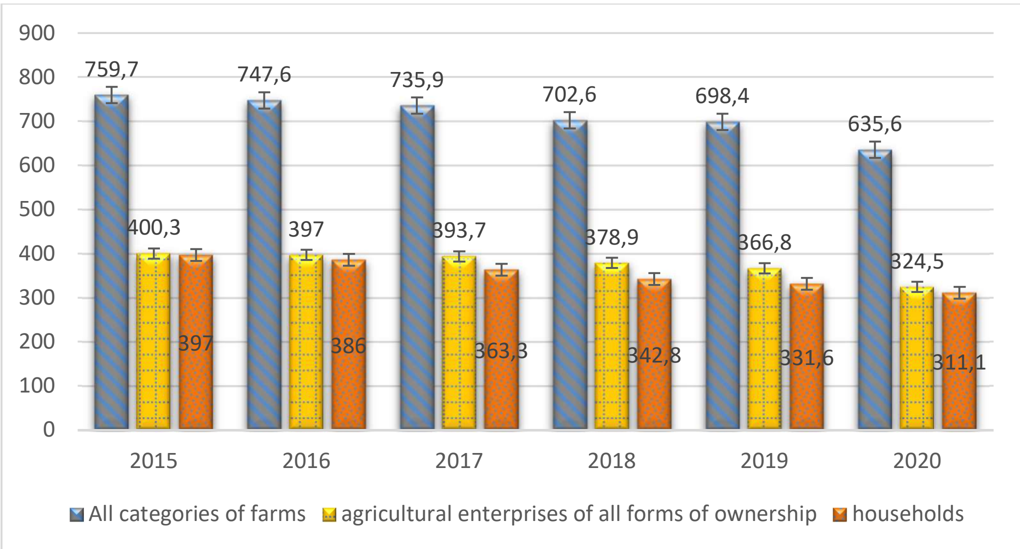


Fig. 1.1. **Dynamics of pork production in Ukraine, thousand tons**
(data exclude the temporarily occupied territory of the Autonomous Republic of Crimea, the city of Sevastopol and part of the temporarily occupied territories in Donetsk and Luhansk regions).

Regarding pork production from 2017 to 2020, looking at the chart below, we can say that this indicator was declining for all categories of farms. Thus, in 2017, pork production amounted to 735.9 thousand tons, in 2018 – 702.6 thousand tons, in 2019 – 698.4 thousand tons, in 2020 – 635.6 thousand tons.

Among agricultural enterprises of all forms of ownership, the largest pork production was in 2015 – 400.3 thousand tons, in 2016 – 397.0 tons, in 2017 – 393.7 thousand tons, in 2018 – 378.9 thousand tons, in 2019 – 366.8 thousand tons, in 2020 – 324.5 thousand tons. This digital data shows a steady decline in pork production at pig farms, regardless of ownership. However, it is worth noting that the largest volumes of pork production were recorded in Donetsk, Poltava and Kyiv regions.

According to a number of scientists [51, 73, 91, 112, 117, 132], the state of the pig industry largely depends on the level of feed supply. The dynamics of feed consumption per 1 kg of pig growth in the period from 2015 to 2020 is shown in Fig. 1.2.

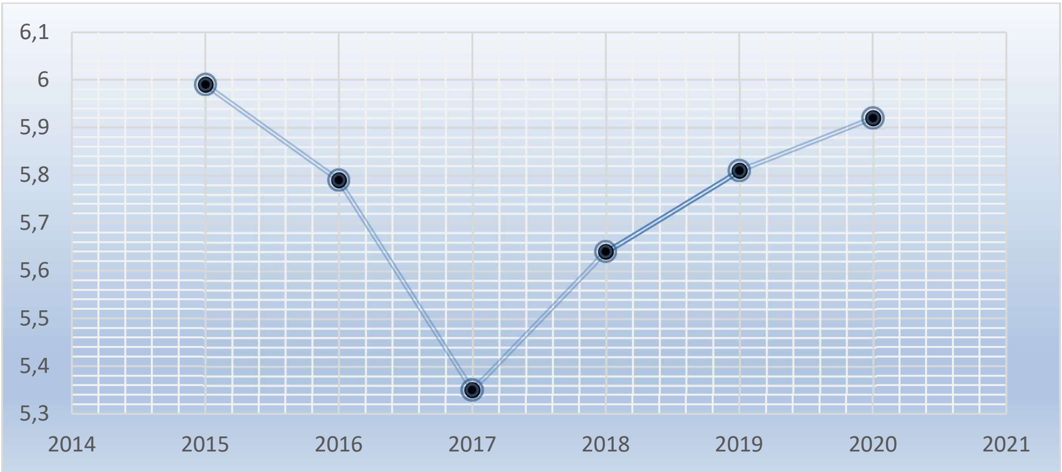


Fig. 1.2. **Dynamics of feed consumption quintal feed units per 1 kg of pig gain**

Visualization of the graphical representation of feed consumption per 1 quintal of pig gain shows that the largest amount of feed was consumed in 2015 – 5.99 c of feed units, and the smallest amount in 2017 – 5.35 quintal feed units, respectively, in 2016 and 2019 the amount of feed consumed for pig growth was almost identical – 5.79 quintal feed units and 5.81 quintal feed units, respectively. Such dynamics shows that 2015 and 2020 were obviously characterized by feed overconsumption per unit of production, which significantly increased its price.

According to the Ukrainian Pig Breeders Association, in 2020, the largest enterprises in the industry met the demand for pork with their products. Almost 50 % of industrial production in the market is accounted for by the top 30 pig breeding enterprises [4].

The top five largest producers are PJSC APK–Invest (286339 total pigs, 24702 breeding stock, 57931 live weight pigs sold), JV Niva Pereyaslavshchyny LLC (221813 total number of pigs, 14887 breeding stock, 38575 pigs sold for slaughter in live weight), Goodwell Ukraine LLC (187905 total number of pigs, 14095 heads of breeding stock, 37159 pigs sold for slaughter in live weight), LLC «SPE Globinsky Pig Complex» (154300 total number of pigs, 12500 heads of breeding stock, 34000 pigs sold for slaughter in live weight), Agroprodservice Enterprise Private (67500 total number of pigs, 8800 breeding stock, 18768 pigs sold for slaughter in live weight). It is worth noting that some of the companies from the above TOP–5 in the current difficult period of development of the pork market even increased production capacity and increased breeding stock, in particular, PJSC APK–Invest and JV Niva Pereyaslavshchyny [133].

Imports are an important component of the pork market (Table 1.3).

Table 1.3

Dynamics of the volume and prices of pig meat imported to Ukraine from around the world

Year	Volume and price	Products
		fresh, chilled and frozen pork
2015	volume, tons	3792.1
	price 1 t, USD U.S. DOLLARS	4111.1
2016	volume, tons	2956.6
	price 1 t, USD U.S. DOLLARS	3513.6
2017	volume, tons	3038.4
	price 1 t, USD U.S. DOLLARS	4340.2
2018	volume, tons	2340.0
	price 1 t, USD U.S. DOLLARS	4320.0
2019	volume, tons	2194.5
	price 1 t, USD U.S. DOLLARS	4185.0
2020	volume, tons	2510.0
	price 1 t, USD U.S. DOLLARS	4562.0

According to the table, in the period from 2015 to 2020, the volume of imports of fresh, chilled and frozen pork decreased from 3792.1 to 2510.0 tons, where the decrease rate for the specified period was 33.81 %. The decrease in pork imports to Ukraine was due to the increase in the cost of imported products and the devaluation of the national currency.

According to official electronic sources of Ukraine [133], the main suppliers of imported pork to Ukraine are: Poland – by 17.74 million dollars (42.39 %); Germany – by 7.27 million dollars (17.38 %); the Netherlands – by 5.65 million dollars (13.51 %); other countries of the world – by 11.18 million dollars (26.72 %).

According to *V. Khvorosyatnyi* and analysts of the Ukrainian Agrarian Association (UAA), after studying the internal structure of the meat market and finding out how many kilograms of meat per year (and what types) each Ukrainian consumes on average, three interesting trends were noticed [120]. The first is that the amount of meat consumed per year by one Ukrainian in 2017–2020 has hardly changed and fluctuates slightly: 2017 – 48.98 kg (4.08 kg per month), 2018 – 48.45 kg (4.04 kg, respectively), 2019 – 46.72 kg (3.8 kg per month), 2020 – 44.25 kg (3.2 kg per month).

The second is that the overall structure of annual consumption is also stable, dominated by the share of poultry. It makes up half of the diet of ordinary Ukrainians and its share is growing: In 2017, 24.34 kg per person (49.7 % of the total consumption for the year), in 2018 – 25.15 kg (51.9 %), in 2019 – 26.14 kg (55.9 %), in 2020 – 27.1 kg (61.2 %).

The third – three types of meat in the annual diet of Ukrainians have remained virtually unchanged in recent years. In addition to poultry, it includes: 2nd place – pork: 2017 – 13.8 kg (6.76 %), 2018 – 12.6 kg (6.10 %), 2019 – 13 kg (1.97 %), 2020 – 10.9 kg (2.43 %); 3rd place – beef: 2017 – 3.09 kg (6.3 %), 2018 – 5.4 kg (2.62 %), 2019 – 4.8 kg (0.73 %), 2020 – 3.6 kg (0.81 %), (Table 1.4).

Thus, the information provided in this section shows that pork imports have fallen significantly in recent years without an increase in exports, due to a catastrophic decline in the pig population (over 23 % in 5 years) and ineffective measures to prevent the spread of ASF. However, the demand for pork in Ukraine is traditionally high, which leads to further growth in prices for such products, which, in turn, together with a relatively short production cycle, encourages producers to increase the pace of pork production. In view of this, it is expected that the growth rate of pork prices will be somewhat lower, and the supply volume will remain within 300–330 thousand tons per year over the next three years. Therefore, scientists and practicing pig breeders face a priority task – to revive the domestic pig population with the transfer of the pig industry to industrial technology in order to obtain cheap, high–quality and competitive products.

Table 1.4

Dynamics of annual meat consumption by an average Ukrainian, kg

Type of meat	Year			
	2017	2018	2019	2020
Poultry meat, kg	24.34	25.15	26.14	27.1
Pork, kg	13.8	12.6	13	10.9
Beef, kg	3.09	5.4	4.8	3.6
Meat of other animal species, kg	7.75	5.3	2.78	2.78
Total, kg	48.98	48.45	46.72	44.25

Thus, the analysis of the above material gives grounds to note that the pig industry in Ukraine is in a difficult state, and the elimination of the negative trends that have developed requires the implementation of a number of measures:

1. Increasing pig productivity through the use of modern gene pool and innovative technological solutions;
2. Improving breeding and selection in the pig industry to obtain highly productive livestock;
3. Ensuring effective counteraction to the spread of the ASF virus at the state level and full compensation for losses incurred by pork producers;
4. State support for agricultural producers through the payment of subsidies to increase the efficiency of pork production;
5. Stimulating the operational analysis of the pig meat market conditions and price situation;
6. Stimulation of quality, assortment and guarantee of food safety for the population.

SECTION 2.
CHARACTERIZATION OF MODERN COMMERCIAL GENOTYPES OF LIVESTOCK FOR EFFICIENT PRODUCTION

The pig industry plays an important role in Ukrainian agriculture. Powerful pig complexes, livestock farms and private enterprises, trying to increase pig productivity, select the breed composition in such a way as to compete in the meat market, and therefore the specialists of a number of farms are faced with the following tasks obtaining the maximum number of piglets per sow per farrowing per year (most farms try to achieve about 32 piglets per sow per year); growing their own replacement stock, which makes it impossible to import replacement pigs from other farms. On the one hand, this helps to avoid the introduction of new diseases that are unique to the farm. On the other hand, genetics is constantly evolving and improving, so the introduction of new animals makes it possible to create a genetically complete livestock; obtaining animals with a high health status; obtaining a high–quality fattening animal in the shortest possible time, subject to a reduction in feed conversion, time from birth to slaughter.

Based on the above, the choice of genetics remains particularly relevant, especially for the maternal and paternal lines. The following sow breeds are most commonly used as maternal sows: Large White, Ukrainian Meat and Landrace, while purebred or crossbred pigs are used for the paternal line. The majority of purebreds are representatives of meat breeds such as Duroc, Piedmont, Hampshire, as well as specialized lines in maternal breeds such as Large White and Landrace.

Terminal boar – used as a parental form to produce full–fledged commercial pigs with the maximum effect of heterosis in terms of fattening and meat qualities. More often, they are two–breed: Duroc× Hampshire, Pietren×Duroc, Landrace× Duroc and other variations. However, three– and four–breed terminal boars are no less common. Currently, the most famous of them are: OptiMus Rattlerow Segers, MaxiMus Rattlerow Segers, Hypor Maxter, Hypor Magnus, Hypor Kanto, Maxgroo, DM, Titan, Tempo, Hemrock, Netzkar, Kantor, etc. However, the origin of such animals remains a commercial secret, and therefore their genetic basis is called commercial genotypes.

As T. A. Strizhak points out [125], a terminal boar is a male sire that has specific meat genetics and is intended for slaughter, not for breeding purposes and breeding new breeds. Terminal sires are used to pass on more masculine qualities (developed musculature) to their offspring, as opposed to sires with maternal qualities (high milk production, easy farrowing). The OptiMus Rattlerow Segers terminal boar is a synthetic boar obtained from a purebred Large White sow of English breeding (Rattlerow genetic company) by a nucleus of the paternal direction with high beef European boar lines according to the Rattlerow breeding program (Fig. 2.1).

Fig. 2.1. **The OptiMus terminal boar of the genetic company RA–SE Genetics NV (Belgium)**

The OptiMus animals are sires with high lean meat yield and growth rate, providing high rates of carcass weight gain. OptiMus boars are bred to produce «BETTERgen Muscle+», a single gene marker responsible for lean meat and carcass uniformity. The satisfactory percentage of lean meat in the carcass of fattening cattle is between 56 % and 58 %. The offspring have an ideal balance between the amount of meat and live weight gain, feed efficiency in terms of feed conversion, and complete stability to stressful situations. The absence of the haloton gene (stress gene) ensures excellent meat quality. The additional heterosis derived from this terminal boar provides advantages for natural and artificial insemination, resulting in improved viability and weaning rates. Targeted breeding of pigs using Genetec's IGF2 technology and the development of pure lines with stable heritable traits has resulted in the MaxiMus Rattlerow Segers synthetic boar with guaranteed genetic advantages (Fig. 2.2).

Fig. 2.2: **MaxiMus terminal boar of the genetic company RATTLEROW FARMS LTD (United Kingdom)**

The quality of the MaxiMus terminal boar is homozygous for «BETTERgen Muscle+», a gene responsible for better carcass uniformity. These terminal boars are known for their endurance and adaptability, and are characterized by good reproductive and meat qualities. In terms of performance, the MaxiMus terminal boar stands out for the following features: high average daily weight gain and a high percentage of lean meat yield of 57.2 % to 59.4 %. The high quality of meat in the carcass is ensured by the gene's resistance to stress. High growth of lean meat is also characteristic of this sire.

Hypor Maxter is the name of the terminal boar genetic line bred by the Canadian–French genetic company Hendric Genetec, as a result of improving the Pietrina breed since 1968 (Fig. 2.3).

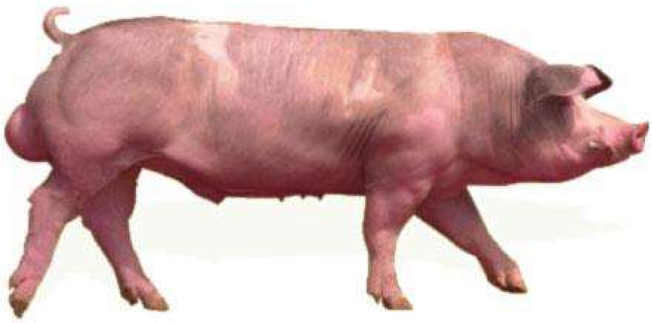


Fig. 2.3. **Hypor terminal gimbal genetic company Hendric Genetics (Netherlands)**

Representatives of the «Maxter» line are distinguished by the fact that their genes ensure maximum growth of fattening pigs and have the desired meat quality and carcass characteristics. The progeny of the «Maxter» boar, compared to the type animals, show greater growth potential without compromising lean meat yield and muscle eye area. In France, this boar has set a proven record, with its hybrid and Galaxy sows produced by France Hybrids already surpassing live weight gains of more than 1100 g per day. The results of the slaughter show that the area of the «muscle eye» is 62 mm, and the slaughter weight is 92 kg, the height of the ridge fat does not exceed 15 mm.

Maxter boars are negative for the stress gene. This is a very important indicator, as stress–negative pigs have a number of advantages over stress–positive pigs. The piglets are hardier than the stress–positive boars of the Pietrén breed. The meat quality of «Maxter» boar offspring is better, and PSE syndrome (pale, sour, exudative meat syndrome) is rarely seen. The animals are also characterized by a strong sexual instinct and high resistance to disease.

Hypor Magnus – animals of this line are characterized by high average daily uniform weight gain, which significantly increases the efficiency of pork production, have a high yield of lean meat from carcasses – 58.3 %, and have excellent adaptive properties (Fig. 2.4).

Fig. 2.4. **Hypor terminal boar genetic company Hendric Genetics (Netherlands)**

Hypor Kanto is the terminal boar for specialty farms producing high quality pork for premium overseas markets and growing quality–oriented domestic markets.

Animals of this line show the fastest growth – 950–1000 g per day among all terminal boars of this genetic company. The boars provide exceptional early maturity – 156 days to reach a live weight of 100 kg and a meat yield of 58.2 % without excess fat, which is an important factor in meeting the most demanding premium markets

Due to their strong constitution and high adaptive properties, high feed intake, and improved conversion, animals of this line are ideal for farms to increase production and marketing efficiency and to ensure consistency of carcass composition and meat quality (Fig. 2.5)

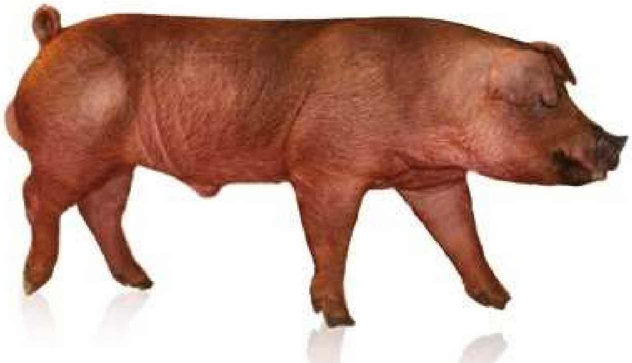


Fig. 2.5. **Hypor terminal gantry genetic company Hendric Genetics (Netherlands)**

In addition, the Maxgroo terminal line is widespread on the Ukrainian market, created specifically to ensure maximum growth rate, average daily gain and feed conversion of pigs raised for fattening (Fig. 2.6). The Maxgroo boar produces better slaughter pigs compared to other boars of terminal lines, which is confirmed by the results of independent tests. Market pigs produced by the Maxgroo boar are known for their strength and vitality. The boar of this line is ideal for the production of market pigs with a large slaughter weight, providing unsurpassed growth potential and carcass quality.

Hailin Maxgroo boars are specially selected from the general herd for buyers who plan to slaughter heavy pigs with low fat. Special attention is paid to the last criterion when selecting boars – P2 less than 8 mm at 110 kg.

Hermitage currently has one of the largest terminal boar breeding herds of more than 1,200 GGP sows that produce Maxgroo boars for Hermitage's artificial insemination stations around the world. With the help of embryo transfer technology, Maxgroo terminal lines with the highest indices can be introduced directly into the herds of buyers around the world. Animals of this line are characterized by the following indicators: maximum growth rate, excellent feed intake and feed conversion efficiency, maximum average daily gain, high leanness and carcass yield, maximum hybrid vigor and disease resistance, high progeny viability, excellent meat quality, and high health status.

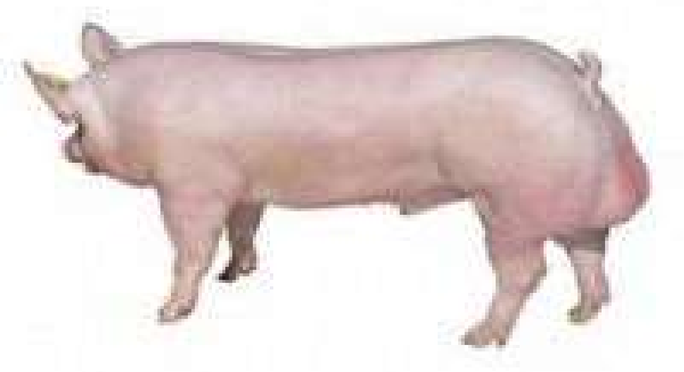


Fig. 2.6. **Maxgroo terminal gantry genetic company Hermitage Genetics (Scotland)**

PIC Ukraine – Genetic Company LLC, together with Hermitage Genetics and its production partner in Ukraine, Marlen–KD LLC, has started production of the DM terminal line. The DM meat line boar was bred by Hermitage Genetics by crossing the Top Drawer (Elite) boar Duroc and the Maxgroo sow. Boars of this line have an excellent meat constitution, as well as growth rates of lean meat. The main characteristics of boars of this line include: high viability of piglets, high growth rate of lean tissue, excellent meat quality and high percentage of lean meat and carcass yield, absence of stress gene, strength, stability and endurance, excellent sexual instinct, high health status (Fig. 2.7).

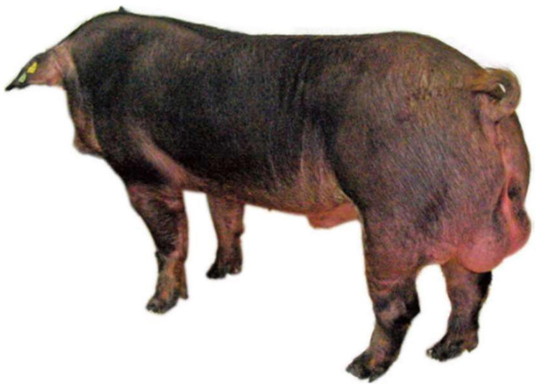


Fig. 2.7. **Terminal boar DM of a genetic company «Hermitage Genetics» (Scotland) and PIC (Ukraine)**

Thus, we note that the use of the genetic potential of terminal boars provides not only the obtaining of interbreed heterosis in fattening qualities, due to the maintenance of a high level of heterozygosity, but also the accelerated improvement of meat qualities due to their additive intermediate inheritance. All this can only work in full with optimal health prevention and appropriate feeding of animals, as well as compliance with microclimate parameters, taking into account the poor thermoregulation of the body of synthetic boars.

SECTION 3.
<u>STRATEGIC APPROACHES TO ENHANCING MEAT PRODUCTIVITY OF INDIVIDUALS</u>

Currently, both in the world and in Ukraine, there is a clear trend of replacing fat and meat and fatty pigs with meat–type animals [13, 14, 91, 94, 132]. Given this fact, at certain stages of pig production development, requirements are formed for the evaluation of animals in terms of quantity and quality of products, which, in turn, relates to meat traits of pigs. In this direction, industrial pig production solves a number of specific tasks: the use of new intensive pig genotypes with high fattening and meat qualities, ensuring optimal conditions for keeping animals, developing appropriate feeding standards and regimes, which together allows to produce pork with a sufficiently low fat content. At the same time, the issue of quality and safety of raw materials for entrepreneurs and the population remains relevant [5, 7, 10, 39].

It is well known that the meat productivity of pigs is assessed by quantitative and qualitative indicators. Quantitative indicators are live weight, live weight gain; carcass weight (carcass of a slaughtered animal without head, skin, internal organs, internal fat and limbs up to the wrist and hock joints); slaughter weight (carcass weight and internal fat); slaughter yield (ratio of slaughter weight to pre–slaughter weight, expressed as a percentage); pre–slaughter weight (weight of animals after a 24–hour hunger strike); fatness (characterized by muscle development and fat deposition at the root of the tail, under the skin in the groin area); payment for feed by weight gain (feed costs per 1 kg of weight gain). units per 1 kg of weight gain). Qualitative – the composition of the animal carcass by cuts, the ratio of muscle, fat, connective and bone tissue in the carcass, the chemical composition and caloric content of meat [9, 11, 22, 27].

Scientists are studying breed–specific features of growth and development of pigs of different combinations, developing effective methods for determining early prediction and improvement of meat productivity in order to control the processes of meat formation in postembryonic ontogeny and the effectiveness of selection to increase the meat content in the carcass [23, 25, 30, 53, 69, 70, 101].

According to *V. P. Rybalko, G. O. Birt, Y. G. Burgu* (2008), the meat productivity of pigs, and in particular the quality of their meat, is formed under the influence of the complex action of a number of ontogenetic and paratypic factors, the main of which are: breed, live weight and sex, which, to some extent, affect the productivity of animals during rearing and fattening [119].

The formative processes of pigs from birth to 12 months of age suggest that the most intensive growth of muscle tissue occurs during the suckling period, especially up to one month of age, but does not stop until 12 months of age [43, 70, 116].

It has been established that at different physiological stages of pig development, the rates of their formation are not identical. They largely depend on the intensity of metabolism in the body [14, 132]. The growth of tissues with age is uneven and is subject to biological laws. *M. D. Lyubetsky* [77] established the sequence of changes in the growth rate of individual organs and tissues of pigs, namely, that at birth bones and meat make up a significant proportion of the carcass (41 % and 52 %, respectively), and adipose tissue a small proportion 7 %. By 2 months of age, the yield of muscle tissue increases to 69 %, while bone decreases. By the age of 6 months, the amount of meat decreases to 52 %, bones – to 10.8 %, and the amount of fat increases to 37.1 %. By the age of 12 months, the yield of fat increases significantly 45 %.

Studies by I. B. Bankovska (2016) have shown that the meat productivity of pigs is determined mainly by genetic characteristics rather than technological factors [7, 23, 28]. It has also been established that live weight of pigs is a genetically determined trait, but it often depends on the conditions of feeding and housing. In addition, there is a relationship between pre–slaughter live weight and the content of meat and fat in the main parts of the carcass. Thus, as the live weight of animals increases, the amount of muscle, fat and bone tissue in the body of pigs is constantly increasing. However, it is worth noting that the growth of these tissues occurs with unequal intensity and the process of tissue formation can be changed by feeding and housing conditions [12]. For example, found that during the growth period of large white pigs from 1.2 to 140 kg, adipose tissue develops most intensively, as its mass at this stage of ontogeny increases 631 times, muscle tissue – 122 times, and bone tissue – 89 times. Due to the unequal growth rate, the ratio of muscle tissue to adipose tissue gradually decreases from 6.2 when slaughtering animals weighing 1.2 kg (at birth) to 1.2 when slaughtering 140 kg. Accordingly, as the live weight of pigs increases in the process of their development, the growth rate of muscle tissue gradually decreases, and fat tissue increases [28].

The above circumstances determine the meat productivity and quality of animal carcasses: the higher the proportion of lean meat in the pig carcass, the higher the meat productivity and meat quality. Regardless of the breed, muscle tissue forms faster than other body tissues during the embryonic and 4 months of the postembryonic period. In the following age periods, its growth rate slows down, and fatty tissue increases [12, 26, 27, 42, 57, 68].

The sex of pigs and castration also have a significant impact on the efficiency of feed absorption by animals, and, accordingly, on the quantitative and qualitative characteristics of meat. According to the results of *Bahelka J.* et al. (2007), *Boyle L.A., Bjorklund L*. (2007), sows have a 3.21 % higher meat yield than castrates, this difference increases with increasing carcass weight [28]. Researchers have found that the maximum content of muscle tissue belongs to the carcasses of wild boars – 59.1 %, followed by the carcasses of pigs – 58.8 %, and the carcasses of boars have 57.5 % of muscle tissue. An interesting fact is that pigs have better meat qualities because they have thinner bacon, more protein and less fat in the muscle tissue, and a greater amount of lean meat in the carcass. At the same time, wild boars have higher marbling and moisture retention capacity of meat [116, 143].

Currently, lean pork is in demand among the population, which is obtained by fattening young pigs to a live weight of 90–110 kg. However, fattening pigs to a live weight of 120–130 kg is more economically profitable than to a weight of100 kg. *Thus, V. M. Voloshchuk, V. M. Gyrya, V. I. Halak, V. I. Malik* (2013) proved that in young pigs with a pre–slaughter weight of 80–100 kg the slaughter yield is 70–75 %, 100–120 kg – 76–80 %, at150 kg and more – from 80 % and above [27]. It is worth noting that the chemical composition of meat changes with age: the content of intramuscular fat, protein and minerals in muscle tissue increases with age, while water decreases [44].

In addition to the above factors, the quality of pork is influenced by breed characteristics [13]. It was found that pigs of the Large White, Landrace, Myrhorod, and Wales breeds differ from each other and from their mixtures in terms of meat yield, fat, muscle eye area, fat thickness, and other indicators. According to the research data, it was found that the largest average fat thickness was observed in Myrhorod and Large White pigs (38.1 mm and 33.1 mm, respectively), and the highest meat content in the carcass was characteristic of Landrace and Wales pigs 62.2 % and 60.5 %, respectively.

Pig scientists have found that the content of muscle tissue in the carcass of Poltava–type pigs was 59.0–61.6 %, in Ukrainian Steppe White and Large Black pigs it ranged from 52.5 %–53.5 %, the content of fat in the carcass of the former was 26.6–29.5 %, in the latter – 35.3–36.4 %, the thickness of the fat was 29–32 and 35 %, respectively–41 mm [11, 44].

However, the use of pigs of specialized meat breeds and lines for pork production in crossbreeding and hybridization, and the use of fattening animals of different genotypes to the most optimal weight conditions can improve the meat quality of pigs by increasing their pre–slaughter weight [29, 91]. It was found that young pigs obtained by combining sows of the inbreed type of the Duroc breed of the Ukrainian Stepovyi selection with boars of the Landrace breed of the French selection maintained a high growth rate during fattening to a live weight of 140 kg [71, 75]. And when fattening pigs of the Duroc, Landrace and Ukrainian Steppe white breeds, differences in the formation of meatiness were noted. Therefore, the use of industrial crossbreeding and hybridization makes it possible to improve the fattening and meat qualities of pigs. In turn, the obtained hybrids are characterized by high average daily live weight gain, increased meat content in the carcass, a large weight of ham and the area of the «muscle eye», and lower feed costs per unit of gain [39, 76, 140]

The driving factor influencing the formation of the body and its vital activity in general is the feeding conditions [113, 115, 146]. It is believed that a reduced energy level in pig diets by 30 % compared to the original norms contributes to an increase in carcass meat yield by 5–6 % and a decrease in fat yield by 6–13 %. In turn, an increased energy level of 15 % to the norm increases fat yield by 3 % and reduces meat yield by 2 %. With a reduced energy level of 15–30 %, the area of the «muscle eye» increases by 6–13 %, the specific weight of the carcass by 1–3 %, but the thickness of the fat decreases by 3–12 % [26].

The analysis of the impact of various feeding factors on the quality of pork produced shows that the addition of the amino acid tryptophan to the diet increases the serotonin content in the blood, which reduces aggressiveness in pigs and reduces circulating cortisol concentrations and the risk of PSE pork. In addition, the introduction of an additional 2 % of leucine into the diet of fattening pigs increases the marbling of pork by 20–30 %, the content of intramuscular fat in the longest back muscle by 25–42 %, and in the short muscle by 18 %, without affecting the overall meat productivity of pigs [28, 33, 81, 134].

It is known that research on the normalization of pig digestion at different stages of ontogenesis is a priority, and therefore pig production technologies require solving a set of production problems to optimize feed formulations and feeding programs. In this aspect, research aimed at studying the effect of feed additives, functional feeds, herbal supplements, etc. on pig productivity is becoming increasingly relevant [31, 34, 52, 59, 60]. Since adequate feeding is a prerequisite for increasing individual pig productivity, and the latter determines the zootechnical and economic efficiency of animal husbandry, the need for various feed additives, such as Gepasorbex, Perfectin, Pro–Mac, Ultimade Acid, Liptoza Expert, determines their future meat productivity.

Researchers have found that the use of the water–soluble additive «Pro–Mac» in the diets of weaned piglets contributed to an increase in average daily gain by 15.2%, a decrease in feed costs per1 kg gain by 0.42 feed units, and a decrease in the cost per unit of gain by 3.7 % [62, 67]. In turn, the use of «Gepasorbex» improved the growth intensity of young pigs in growing by 8.2 %, increased feed conversion to 9.4 % and contributed to a decrease in the cost of 1 kg piglet live weight gain by 3.4 % [63, 65, 69, 122].

The introduction of a dry water–soluble concentrate of a biologically active feed additive – a feed phytobiotic based on Echinacea pallida – the system of feeding sows and gilts increases the fertility of sows by 3,0–9.0 %, nest weight at weaning at 30 days by 21.0–28.0 %, by 16.0 % ($p \leq 0.05$) the average daily gain of suckling piglets and their safety by 2.0–4.0 % compared to the control, net profit per sow from the sale of piglets by 24.0–33.0 %. The highest economic efficiency was observed when using a phytobiotic based on Echinacea pallida in the system of drinking of gestating sows and in the process of feeding suckling piglets during the pre–starter and starter periods [40].

The material described on this topic regarding the use of feed additives in pig production demonstrates the multidirectional nature of their positive impact on the physiological state and productivity of animals.

In the global practice of pork production, the search for new solutions to improve pig productivity is increasingly focused on the peculiarities of the «organism–environment» relationship, where inheritance takes place not at the level of traits, but at the level of a certain type of organism's response to living conditions. The productivity of animals is determined by genes that fully manifest themselves only under certain external factors. Therefore, in a changing environment, different genotypes are realized differently it is noteworthy that the influence of the share of housing conditions in the overall variability of pork quality indicators reaches almost 10 %. At the same time, the microclimate of the premises has a direct impact on the animal's body, which is manifested in changes in metabolism, heat and gas exchange, physicochemical properties of blood, body and skin temperature, i.e. in changes in the health of pigs, and, consequently, their productivity.

Numerous studies have shown that the optimal temperature in pig fattening rooms is +16–20°C at a relative humidity of 75 %. An increase in temperature above the zone of thermal neutrality, as a rule, leads to an increase in free moisture in the muscles of the carcass, the appearance of hyperthermia, and a decrease significantly inhibits the deposition of nitrogen in the body of pigs, causes a slowdown in growth processes, resulting in a decrease in the area of the «muscle eye» and the diameter of muscle fibers [92].

Regarding the way pigs are kept, studies have shown that pigs grow up to 16 % better in individual housing. However, the animals consume 13.4 % more feed per 1 kg of weight gain and increase fat up to 40 % more intensively. As for group housing, the best quality meat is produced by animals that are kept in the amount of four heads in a pen [92]. Many producers are of the opinion that young pigs should be kept in groups of 10–20 pigs for fattening. However, there are different technological systems where fattening stock of young pigs is kept in groups of 20 to 100 heads. The inconsistency of the results of group fattening of pigs, along with other reasons, may be due to different density of animals. The correlation coefficient between the density of fattening and the percentage of fat in carcasses was 0.74, which confirms the tendency to greater fat content of pig carcasses with increasing density of their placement in the machine [92, 131].

At present, in modern industrial pig farms, no more than 0.8 m^2 of space is allocated for one fattening head of young animals, which limits the motor activity of animals and negatively affects the quality of pig meat. A positive effect of free–range housing on meat quality was found: gilts that were provided with additional exercise during fattening had a larger diameter of muscle fibers – 47.26–54.22 vs. 42.17 mm [144].

The microclimate of the premises, clinical and physiological condition, behavior and productivity of animals are affected by the type of floor in piggeries, due to the fact that pigs lie on the floor for up to 20 hours a day, about 50 % of the total heat loss of the premises occurs through the floor. Therefore, the type of floor is an important factor for the rational use of heat generated by the body of animals and can be used cost–effectively in relation to increasing animal weight gain. According to the results of many studies, the way pigs are kept on different types of flooring affects the quality of fattening carcasses. However, an unambiguous conclusion has not yet been found. It is known that when fattening pigs on deep, unchanged straw bedding, the share of animal rest time is 55.4 %, while with traditional technology it is 70.4 %. In this regard, pigs fattened on deep litter have a significantly higher weight of paired carcasses than on the hard floor [12].

It is worth noting that in European countries and the United States, the practice of free–range pig feeding is used, where the weight gain of animals is lower than in intensive feeding, but the meat is of higher quality. Such products are in demand and are sold as «natural meat», «organic pork» or «bioproduct». To sell meat under this trademark, the conditions of fattening pigs must meet the following requirements: free access to exercise, box area of at least 0.4 m^2/head for piglets, 1.1 m^2/head – for animals with a live weight of 60–100 kg, no bars and fences inside the boxes, the duration of the suckling period is at least 7 weeks, prohibition of the use of growth stimulants, hormonal drugs, antibiotics, iron preparations, and to improve the welfare of pigs, no surgical removal of tails, tusks in piglets and castration without the use of analgesia and anesthesia are allowed, the share of roughage in the diet of fattening young animals should be at least 10 %. Of course, this system of growing requires additional costs, but due to the corresponding product prices, it allows you to get 22–25 % more profit. The high quality of meat produced by this technology and the growing consumer demand for a «natural product» are leading to increased interest in Ukraine in the organic pork production system [2].

An analysis of the main studies and publications shows that increasing the meat content of pig carcasses by targeted feeding is widely used in pig production practice. However, it should not be forgotten that the meat content in the carcass also depends on factors related to heredity breed or breeding, breeding qualities, etc. A significant reserve for increasing pork production is the increased pre–slaughter weight of animals. However, the issue of the optimal condition of pigs for slaughter remains unresolved. Studies have shown that fattening pigs to large weight conditions 120–130 kg leads to an increase in feed consumption per unit of weight gain, but if terminal boars of specialized synthetic lines are used as a parental form, it is possible to obtain high meat quality in the offspring [140].

Thus, the analysis of this information in this subsection allows us to conclude that the formation of pig productivity is influenced by many factors, including: breed, age, sex, feeding, housing, zooveterinary parameters and biosecurity of pig premises, which is the key to increasing individual pig productivity, zootechnical and economic efficiency of the pig industry.

SECTION 4.

LEVERAGING CTS AND MC4R GENE POLYMORPHISM FOR IMPROVED MEAT PRODUCTIVITY

Recently, the pig industry has begun to actively use marker–assisted selection (MAS) technologies, which involves genotyping individuals at loci that control economic traits and using the molecular information obtained to evaluate genotypes, select and select animals. A large number of candidate genes belonging to such loci (quantitative trait loci, QTL) have been identified that affect the reproductive, fattening, and meat quality of pigs. However, among them, not many genes and corresponding DNA markers are known that can be effectively used in practice in terms of their informativeness and strength of association with traits [132, 168, 243].

As we noted in the previous section, pig meat quality is a genetically determined trait that varies depending on the breed, live weight, age of the animals, and paratypic factors. Therefore, in order to meet consumer needs, pork producers should adopt new methods to improve the quality of meat of this animal species, allowing for the selection of animals with optimal genotypes. Therefore, pork producers are encouraged to analyze the genetic factors that determine the level of quantity and quality of pork. However, there are a number of problems regarding the speed of assessment of these indicators, since, from a practical point of view, they can be determined only after slaughtering animals [93].

The development of modern science allows the use of innovative methods for predicting the quantity and quality of meat using DNA markers. Today, several dozen major genes affecting pork quality have already been identified and are currently actively used abroad, and a number of them have been studied in Ukraine e.g., CTSS, CTSL, CTSF, CTSB, CTSK, IGF2 [8, 37, 217].

For example, the following DNA markers are used to predict the meat productivity of pigs: cathepsin L (CTS), F (CTS), melanocortin 4 receptor (MC4R), insulin–like growth factor–2 (IGF–2), a group of genes encoding fatty acid binding proteins (FABP), pituitary transcription factor–1 (POU1F1), etc.

It is worth noting that single nucleotide polymorphisms of these genes can be identified and used to establish links with physical and chemical meat quality traits in specific pig herds, which in turn can be used to select animals carrying the most desirable genotypes. Cathepsins (CTSS, CTSL, CTSB, CTSK, CTSF) are lysosomal proteinases with a wide range of functions that are synthesized in tissues and cell types [169]. These enzymes are usually synthesized as preprocathepsins, play an important role in the catabolic reactions of basic proteins, and are also involved in the processing and presentation of antigens that affect the immune response [244], the processing of hormones and proenzymes with a subsequent impact on the regulation of biochemical pathways. The high activity of skeletal muscle cathepsin in pigs is associated with known meat defects, namely excessive softness, stickiness, dark color, metallic taste caused by tyrosine crystals, and the formation of white films on the cut surface [220]. Cathepsins are also involved in the process of autolysis that occurs in the post–slaughter period in meat. Therefore, genes encoding these enzymes can be considered as promising candidate genes for improving meat quality. The gene for cathepsin F in pigs is localized in chromosome 2 (SSC2) p14–p17 and consists of 12 exons and 11 introns; the product of its expression is a protein containing 474 amino acid residues [210].

The single nucleotide polymorphism g.22 G>C of the CTSF gene is caused by a nucleotide substitution of G for C, which leads to the replacement of glutamic acid with aspartic acid in the polypeptide chain of the cathepsin F enzyme. In the works of *V. Russo* et al. (2004) emphasized the significant association of the g.22 G>C polymorphism of the cathepsin F gene (CTSF) with the average daily increase and thickness of of spinal fat [150]. The g.22CC genotype of the cathepsin F gene increased growth performance and reduced carcass fat [228].

Researchers from the University of Iowa (USA) have studied the effect of single nucleotide polymorphism of the CTSF gene on the quality of the so–called «Dry–Cured Hams» – a so–called pork product that is typical for the Mediterranean region, such as: Italy, Spain and Portugal [177]. The authors of the study showed a significant effect of genotype at the CTSF locus on intramuscular fat content and pH. In contrast, the works of Polish scientists have not found a significant effect of polymorphism on pig meat quality indicators [231].

Melanocortin receptors belong to the G–protein–coupled receptor family and are transmembrane proteins [79].

Five types of melanocortin receptors have been identified – MC1R, MC2R, MC3R, MC4R, MC5R – encoded by different genes and performing different functions [79, 95]. The level of development of meat productivity traits in pigs is determined by the melanocortin receptor 4 MC4R gene [79, 95, 207]. A mutation has been identified in this gene that causes pigs to consume more feed (up to 10 %), grow faster (6–8 %), and weigh more (6–10 %). Controlling this mutation can be used in targeted breeding to reduce or increase fat content [201].

The MC4R gene is expressed in various parts of the central nervous system, including the thalamus, hypothalamus, brain stem and cortex, and spinal cord. MC4R gene expression encodes the second type of neuronal melanocortin receptor–4, which is a transmembrane receptor with 7 transmembrane domains associated with G–proteins and located in the hypothalamic nuclei. The expression of MC4Rs in these structures of the nervous system indicates their possible involvement in the regulation of autonomic and neuroendocrine functions [189].

A functional feature of the MC4 receptor is the control of body weight and regulation of eating behavior. The mechanisms of this action have not been fully studied, but based on the available literature, it can be concluded that some features of this process are realized through the interaction of MC4 receptors with the leptin system [89, 233].

Thus, based on the above features, the MC4R gene can affect not only the reproductive qualities of pigs, but also its significant effect on average daily gain, feed intake, muscle growth, fat content and carcass length. In the vast majority of studies performed on purebred animals and synthetic pig lines, as well as on two–, three– and four–breed crosses, the following ratio of MC4R genotypes in terms of growth rate was observed – AA>GG. For fat thickness, the relationship AA>GG and AG>GG was established. Some studies found an inverse relationship (AA<GG) or no relationship between MC4R genotypes and the level of development of this trait.

Thus, we conclude that the effect of MC4R genotype is manifested depending on the breed of the studied groups of pigs [167, 178, 194, 207].

Based on the above information, we note that the study of the effect of cathepsin CTSF and melanocortin MC4R on the meat productivity of pigs of different breeds, breed combinations and synthetic lines kept in the base farm is an urgent task, which determined the vector of our further research.

SECTION 5.
INNOVATIVE STRATEGIES TO ENHANCE LIVESTOCK PRODUCTIVITY AND AGRIBUSINESS EFFICIENCY

5.1. Impact of feeder design on fattening efficiency of young stock.

5.1.1. Growth dynamics of young stock. Reducing the cost of pork is possible by reducing feed losses during feed distribution and consumption by animals, as well as by using dosed feeding of animals according to feed rations. The practice of operating pig farms in Ukraine shows a significant disorganization of technological processes of animal feeding. Further development of the pig industry should be based on the introduction of modern animal husbandry technologies and the creation of new, competitive feeding equipment. The experience of using modern feeding equipment shows that it is possible to reduce feed costs for obtaining1 kg pig growth by up to 30 % due to rational dosing and elimination of feed losses during distribution and consumption by animals [71, 142].

One of the main indicators of growth energy in pigs is their live weight at different periods of ontogeny. The level of genetic potential of animals for this trait is influenced by both genetic factors and paratypical ones.

In the scientific and economic experiment, the effect of the type of feeder hopper and feeding machine for feeding young animals during the fattening period from 30 kg of live weight to 100 and 120 kg on their growth energy was studied in the conditions of LLC «Tavrian Pigs», Kherson region. For this purpose, two groups of young animals of 40 animals were formed (10 heads of each of the studied combinations: (M×L)×D; (M×L)×P; (B×L)×D; (B×L)×P).

In accordance with generally accepted methods, experimental young animals were evaluated in terms of live weight, absolute, average daily, and relative weight gain [87, 130, 132]. According to the research methodology, control over the growth rate of pigs was carried out by individual weighing.

The young animals of the comparison groups were characterized by a fairly high growth rate. Studies have shown a certain dependence of the growth rate of young animals on the type of feeder used during the fattening period 30–120 kg. Age–related changes in the live weight of experimental young animals are characterized by its dynamics, which is presented in Table 5.1.

Fig. 5.1. **Bunker moonshine maker**

Fig. 5.2. **Feeding machine**

The use of different types of homebrewers for feeding compound feed to young pigs in fattening affected the indicators of live weight, so animals that consumed feed from feeding machines group II significantly outperformed analogues that received feed from bunker homebrewers group I.

Table 5.1

Age dynamics of live weight of experimental animals (kg), x ± Sd

Age, month	The number of animals in the group, heads	Group	
		I hopper feeder	II feeding machine
3	40	31.9 ± 0.89	32.1 ± 0.86
4	40	49.8 ± 0.26	53.1 ± 0.81***
5	40	76.3 ± 0.29	80.3 ± 0.71***
6	40	97.3 ± 0.18	103.7 ± 0.30***
7	35	117.8 ± 1.52	125.9 ± 1.23***

At the age of 4 months, animals of the second group outperformed their counterparts of the first experimental group by 6.6 % ($P > 0.999$). At 5 months of age, the young animals of the second experimental group were also characterized by a higher live weight of 80.3 kg, which is 4.0 kg more 5.2 % than the same indicator of the animals of the first group ($P > 0.999$).

The tendency of more intensive growth of pigs of the second experimental group was maintained during the further fattening period.

To assess the intensity of growth and, to a certain extent, development of pigs, indicators of absolute, relative and average daily gain are traditionally used. Differences in the change in live weight were confirmed by the level of absolute, average daily and relative gains (Table 5.2), since live weight is directly related to them.

The young animals of the second experimental group outperformed the first group in terms of absolute weight gain at all age periods, but the difference was not always significant. In the age interval of 3–4 months, the young animals of group II outperformed the analogues of group I by 3.1 kg, with a statistically significant difference ($P > 0.999$).

At the age of 5–6 months, the animals of the second experimental group had an absolute weight gain of 23.4 kg, which is 2.5 kg ($P > 0.999$) higher than the same indicator of the first group. In the age periods of 4–5 and 6–7 months, no significant difference in absolute gain was found.

Analyzing Table 5.2, according to the indicators of average daily weight gain in the age period of 3–4 months, we note that the values of the indicators in the context of experimental groups were quite high and ranged from 589–691 g, with a significant advantage of young pigs of the second group.

Table 5.2

Age dynamics of absolute, average daily and relative gains of young pigs depending on the type of feeder, x ± Sd

Indicator	Age, periods	Animal group	
		I	II
Absolute growth, kg	3–4	17.9±0.82	21.0±0.40***
	4–5	26.5±0.33	27.2±0.76
	5–6	20.9±0.30	23.4±0.62***
	6–7	20.5±1.50	22.2±1.25
Average daily weight gain, g	3–4	589±17.5	691±13.3***
	4–5	872±11.1	895±15.5
	5–6	691±10.0	770±10.4***
	6–7	674±10.0	730±11.8***
Relative growth, %	3–4	56.1±2.71	65.4±1,42**
	4–5	53.2±0.54	51.2±1.31
	5–6	27.5±0.37	29.1±0.78
	6–7	21.1±1.28	21.4±1.00

By the age of 5 months, no statistically significant difference in average daily weight gain was found between the experimental groups of animals. However, the tendency to outperform their peers in this indicator was shown by the young animals of the second group, which consumed feed from feeding machines. In particular, at the age interval of 5–6 months, they outnumbered the peers of the first group by 79 g 11.4 %, at the age of 6–7 months – by56 g 8.3 %, with a statistically significant difference (P > 0.999).

Analyzing the age dynamics of the average daily weight gain of animals of the experimental groups, it should be noted that the growth of average daily weight gain occurs up to five months of age and has the highest value in the age period of 4–5 months (872–895 g), and then gradually begins to decline, but still remaining at a relatively high level. Based on this, it is during these periods that special attention should be paid to proper feeding of animals, because it is during these periods that the highest live weight gains of fattening young animals are achieved, which makes it possible to identify the genetic potential of experimental animals.

Given that the absolute values of live weight gain by age periods of animals do not fully characterize the intensity of growth, we used the method of calculating relative growth (see Table 5.2). Evaluating the experimental groups by the relative growth rate, which characterizes the intensity of growth of the organism, it was found that for all groups the value was highest in the period of 3–4 months and ranged from 56.1–65.4 %.

Specific trends in the dynamics of relative growth were observed at different age periods. However, a statistically significant difference between the performance of the animals of the experimental groups was found only at the age of 3–4 months.

Thus, the results obtained are fully consistent with the general patterns of individual development of animals, which are characterized by a higher value of this indicator at the initial stages of development, and with age, its value tended to decrease [42, 132].

Consequently, animals that received feed during fattening from feeding machines had higher values of growth intensity indicators in contrast to their counterparts that consumed feed from bunker self–feeders.

5.1.2. Fattening performance of experimental young stock. The study of the patterns of individual growth opens up the possibility of its regulation in the process of growing and breeding animals. One of the most important characteristics of pig performance is early maturity. It is especially important during fattening, since the length of stay of young animals on fattening, feed consumption for growth are inversely proportional to early maturity [43, 69, 113]. The effectiveness of fattening depends on many factors, the main ones being feeding and housing conditions, breed, age and live weight of animals.

During the period of fattening to different weight conditions, differences in early maturity, feed consumption, and average daily live weight gain were observed between the experimental groups of animals. The results of fattening pigs to live weight100 kg are presented in Table 5.3.

Table 5.3

Fattening qualities of experimental young animals during fattening to live weight100 kg, n = 40, x ± Sd

Group	Age at live weight, days	Average daily weight gain in fattening, g	Feed consumption at 1 kg growth, feed units
I	186.3±2,41	717.3±12.93	3.49
II	177.6±1,70	785.3±10.20	3.22
± II to I	−8.7**	+68.0***	−0.27

The fattening qualities of the experimental pigs are quite high, which was achieved under the conditions of adequate feeding, as a prerequisite for intensive growth, development and health of pigs is biologically complete feeding according to diets well balanced in protein, amino acids, minerals and vitamins.

The use of feeding machines for feeding experimental young pigs (see Fig. 5.2) had a positive effect on early maturity, so the young pigs of the second experimental group reached live weight100 kg 8.7 days earlier (P > 0.999), in contrast to the analogues of the first group, which consumed feed from the bunker moonshine (see Fig. 5.1). Animals of group II were also characterized by higher average daily weight gain −785,3 g , which is by68 g more than in group I (P > 0.999).

One of the main indicators in the evaluation of young pigs for fattening qualities is feed costs per unit of live weight gain, because when assessing the cost of pork, the share of feed accounts for more than half of the costs. Feed costs per1 kg of gain in the context of experimental groups were relatively low, and the value of this indicator was 3.49 and 3.22 feed units, but lower in animals of group II.

With further fattening of animals until they reached live weight120 kg, a similar trend was established. Pigs that received feed during fattening from feeding machines had higher values of fattening qualities in contrast to their counterparts that consumed feed from bunker self–feeders (Table 5.4).

Table 5.4

Fattening qualities of experimental young animals during fattening to live weight120 kg, n = 35, x ± Sd

Group	Age at live weight, days	Average daily weight gain during fattening, g	Feed consumption at1 kg growth, feed units
I	216.1±3,18	706.5±10,62	3.75
II	204.7±2,60	771.5±8,46	3.51
± II to I	-11.4^{**}	$+65.0^{***}$	–0.24

Animals of the second group reached the specified live weight faster than young animals of the first group by 11.4 days (P > 0.99), with higher values of average daily gain – 771.5 g, which is by65 g (P > 0.999) more than the same indicator of animals of the first group.

The prolongation of the age of reaching a certain live weight led to an increase in feed consumption per unit of growth in young animals of the first experimental group. Thus, they spent 3.75 feed units per1 kg of growth, which is 0.24 feed units more compared to animals of group II.

Consequently, due to the design features of the feeding machines, the feed dosage was more accurately regulated, and less spillage of feed from the feed table was observed. During the operation of the feeding machines, there was no «hanging» of the feed in the feed bins of the feeders, due to the presence of «feed moisturizers», which had a positive effect on the uniformity of feed supply over time, which improved the productive qualities of young pigs during the fattening period.

5.2. Effects of the feed additive «Bio Plus 2B» on fattening and meat

quality of young stock

5.2.1. Fattening performance of experimental young stock. A promising reserve for increasing pork production is the use of enzymes and probiotic preparations, feed additives that normalize the microbial composition of the gastrointestinal tract and have the ability to restore and improve digestion, nutrient absorption, metabolic processes in the digestive tract and the body as a whole and increase its immunological resistance [103, 115].

Various feed additives are actively used in the production of mixed fodder, which significantly improve the consumption of basic diets, increase the digestibility and utilization of nutrients, purposefully change metabolic processes and prevent stressful conditions of animals [54].

Taking into account this information, the aim of the study was to determine the effectiveness of the probiotic preparation «Bio Plus 2B» produced by Biochem (ANNEX B) on the fattening and meat quality of young pigs (Table 5.5) in the conditions of LLC «Tavrianski Svini», Kherson region.

Table 5.5

Fattening qualities of experimental young animals, x ± Sd

Group	Age at live weight, days	Average daily weight gain in fattening, g	Feed consumption at1 kg growth, feed units
When fattening to a live weight of 100 kg, n = 40			
I	181.9±1.70	752.1±8.0	3.52
II	175.3±2.41	778.6±7.9	3.28
± II to I	–6.6*	+26.5*	–0.24
When fattening to a live weight of 120 kg, n = 35			
I	214.5±2.49	716.5±10,0	3.63
II	206.1±3.35	753.4±11,6	3.47
± II to I	–8.4*	+36.9*	–0.16

Experimental groups of 40 pigs were formed as follows: Group I during the fattening period 30–120 kg consumed the basic diet (BD) (ANNEX D); Group II was administered the probiotic «Bio Plus 2B» in a dose of 400 g/ton of feed to the basic diet, other technological factors were identical

Fattening qualities were evaluated by the age days of reaching a live weight of 100 and 120 kg, by average daily gain g and feed costs (feed units) per 1 kg of gain. When the animals reached a live weight of 100 and 120 kg, a control slaughter of 5 heads of each group was carried out to study meat and fat qualities in the conditions of the slaughterhouse of «Tavrian Pigs LLC».

When put on fattening, young animals of all groups had almost the same live weight at the age of 90 days after the equalization period (Group I – 32,8 kg; Group II – 33,0 kg).

Young pigs of group I, which consumed the main diet, were fed longer, the age of reaching live weight100 kg was 181.9 days, which is 6.6 days higher than analogues that consumed the probiotic product «Bio Plus 2B» in addition to the main diet (P > 0.95), live weight 120 kg these animals also reached a longer period, which was 214.5 days and thus exceeded the animals of group II by 8.4, at the first threshold of probability.

The presence of the probiotic «Bio Plus 2B» in the feed used for fattening young animals resulted in higher average daily growth, animals of the second group had a value of this indicator at the level of – 778,6 g, when fattening to live weight 100 kg, and when fattening to live weight 120 kg – 753,4 g , which is 26,5 g (P > 0.95) and (P > 0.95), respectively.0.95 and 36,9 g (P > 0.95) higher than the analogues of the first group, respectively. Higher average daily gains led to a decrease in feed costs per unit of gain in young animals of the second group.

Thus, the probiotic «Bio Plus 2B», which was introduced into the composition of feed for fattening young animals, helps to improve fattening qualities due to better feed digestibility. Higher average daily gain rates were obtained in pigs fed with400 g in the feed to the tone of the experimental preparation «Bio Plus 2B» produced by Biochem.

5.2.2. Meat quality assessment of experimental young organisms. The efficiency of pork meat production, along with reproductive and fattening traits, largely depends on the level of slaughter and meat qualities. This issue is of particular importance when using specialized meat breeds of foreign selection to improve the meat qualities of domestic pig breeds in the development of new inbred types and lines, or in the production of hybrid commercial young animals.

Diets containing probiotic feed additives have a positive effect on metabolic processes, which is reflected in meat productivity. Experimental data and production observations show that in conditions of intensive livestock farming, the addition of probiotics to the diet of animals increases their resistance to the effects of technological and biological stress factors, normalizes metabolism and provides a more complete disclosure of genetically determined productivity [52].

When the gilts reached the live weight of 100 kg and 120 kg, a control slaughter was carried out and the slaughter qualities of the animals of the experimental groups were determined (Table 5.6).

The difference in the growth rate of the carcass, head, legs and internal organs of pigs of different groups leads to differences in slaughter yield. When reaching the live weight of 100 kg, the slaughter yield of animals that consumed the probiotic product «Bio Plus 2B» in addition to the main diet was 2.8 % higher, with a statistically insignificant difference.

When fattening to live weight 120 kg, the advantage of animals of the second group over the analogues of the first group increased and amounted to 3.4 % (P > 0.95).

Table 5.6

Slaughter qualities of pigs, (n = 5), x ± Sd

Group	Slaughter house exit, %	Length of the half–carcass, cm	Thickness of the roast over 6–7 thoracic vertebrae, mm	Area of the «muscle eye», cm^2	Weight of the hind third of the half carcass, kg
When fattening to a live weight of 100 kg					
I	72.3±0.75	95.2±0.40	20.2±0.37	37.6±0.24	11.6±0.23
II	75.1±0.80	97.3±0.78	18.2±0.20	38.8±0.22	11.7±0.14
± II to I	+2.8	+2.1	–2.0**	+1.2*	+0.1
When fattening to a live weight of 120 kg					
I	71.1±0.80	102.5±0.29	24.0±0.21	40.2±0.38	13.4±0.23
II	74.5±0.44	103.2±0.45	21.6±0.31	42.7±0.30	13.7±0.23
± II to I	+3.4*	+1.7	–2.4**	+2.5**	+0.3

An important indicator of the meat quality of pigs is the length of the half–

carcass. In our studies, at the pre–slaughter live weight of young pigs 100 kg, the advantage of animals of the second group in this indicator was found, at 2,1 см (the difference is not statistically significant), when reaching the live weight 120 kg, no significant difference was found between the experimental groups.

Analyzing the thickness of the fat at the level of 6–7 thoracic vertebrae, it was found that animals treated with the probiotic preparation were less fatty when fattening to different weight conditions. Thus, when the live weight of 100 kg was reached, the thickness of the fat in animals of group II was –18,2 мм, at a live weight of120 kg –21,6 мм, which is 2.0 and 2,4 мм less ($P > 0.95$) than in animals of group I, respectively.

Absolute and relative changes in muscle and adipose tissue are reflected in changes in the area of the «muscle eye», which is a reliable criterion for assessing the meatiness of carcasses. According to the results of numerous studies, it was found that the area of the «muscle eye» positively correlates with the yield of meat in pig carcasses [39]. As a result of our own research, a probable effect of the probiotic preparation on the area of the «muscle eye» was established, so when fattening animals to a live weight of 100 kg, the value of this indicator in animals that consumed the experimental preparation was 38.8 cm^2, at 120 kg – 42.7 cm^2, which is 1.2 ($P > 0.95$) and 2.5 cm^2 ($P > 0.99$) higher than analogues that consumed only the main diet.

No significant difference was found in the weight of the hind third of the half–carcass in the experimental groups, but a tendency to a higher weight of ham in animals of the second group was found.

A more objective and accurate indicator characterizing the meat quality of pigs is the yield of individual carcass tissues. As a result of the analysis of the morphological composition of the carcass, it is possible to obtain deeper and more objective information about the meat and fat qualities of pigs [10, 13, 23, 92, 143]. In this regard, we carried out the deboning of right half–carcasses and determined their morphological structure (Table 5.7).

As a result of weighing, it was found that the carcasses of pigs of different groups at pre–slaughter weight of 100–120 kg differed in morphological composition. The use of the probiotic «Bio Plus 2B» produced by Biochem in the diet of experimental young pigs increased the content of meat in the carcass, when reaching a live weight of100 kg by 1.6 % ($P > 0.99$) and when reaching a live weight of 120 kg by 1.1 % ($P > 0.95$).

The analysis of the morphological composition of the carcasses of experimental young animals allowed us to conclude that the use of live spore cultures in the form of the preparation «Bio Plus 2B» in the feeding of young pigs had a positive effect on improving meat quality. Thus, the content of fat in the carcass during fattening to different weight conditions was lower in animals of the second group, at live weight100 kg – by 2.6 %, at live weight120 kg – by 2.2 % (P > 0.99).

Table 5.7

Morphological composition of carcasses of experimental young pigs, n = 5, x ± Sd

Group	Content in the carcass, %			Ratio of meat: lard
	meat	lard	bones	
When fattening to a live weight of 100 kg				
I	62.4±0.20	23.8±0.24	13.8±0.34	1 : 0.38
II	64.0±0.31	21.2±0.33	14.8±0.26	1 : 0.33
± II to I	+ 1.6**	– 2.6**	+ 1.0	– 0.05
When fattening to a live weight of 120 kg				
I	61.6±0.32	25.8±0.16	12.6±0.21	1 : 0.42
II	62.7±0.36	23.6±0.31	13.7±0.18	1 : 0.38
± II to I	+ 1.1*	– 2.2**	+ 1.1*	– 0.04

The highest content of bones in the carcass was observed in animals of the second experimental group, the value of this indicator was 14.8–13.7 % when fattening to a live weight of 100 and 120 kg.

After obtaining the results of the morphological composition of the carcass, using the values of meat and fat yield, the ratio of meat : fat was calculated. The highest value of this indicator was in the animals of the first group, where the meat yield was the lowest, when fattening to different weight conditions 1 : 0.38 at slaughter in100 kg and 1 : 0.42 at slaughter in 120 kg.

Thus, the established peculiarities of the dynamics of changes in the specific gravity of the main parts of the carcass give reason to believe that the most intensive formation of meat qualities occurs in animals that received a complex of live spore cultures before reaching live weight 120 kg.

The main trend in the development of pork production is not only further increase in meat content, but also simultaneous improvement of the quality of pork produced. The quality of pork meat products depends on the morphological composition of carcasses, as well as their physical and chemical properties and biological value. When assessing the quality of meat, such indicators as tenderness, juiciness, moisture retention capacity, intramuscular fat content, protein quality, color, pH, and others are taken into account.

The results of the physicochemical and chemical analysis of the longest back muscle at slaughter of young animals of the experimental groups at different weight conditions are given in Tables 5.8 and 5.9.

Analysis of the results of studies of the active acidity of muscle tissue of experimental animals showed that no violations of the carcass maturation process were detected. It should be noted that the pH value of meat of pigs of all groups and weight conditions was within the normal range and amounted to 5.40–5.44 units.

Table 5.8

Physicochemical parameters of pig meat, n = 5, x ± Sd

Group	Acidity, pH	Moisture retention capacity, %	Color intensity, units × 1000
When fattening to a live weight of 100 kg			
I	5.40±0.03	54.60±1.15	55.30±3.00
II	5.44±0.03	56.75±0.75	57.30±3.66
± II to I	+ 0.04	+ 2.15	+ 2.0
When fattening to a live weight of 120 kg			
I	5.41±0.03	54.56±1.13	57.23±3.25
II	5.44±0.02	54.95±1.13	59.22±2.98
± II to I	+ 0.03	+ 0.39	+ 1.99

Characterizing the results obtained, it should be noted that at a pre–slaughter weight of 100–120 kg the best indicators of moisture retention capacity of meat were in pigs of the second group – 56.75–54.95 %, but no statistically significant difference was found in relation to the indicators of the first group.

With an increase in pre–slaughter weight, the intensity of meat coloration increased, but no significant difference was observed between the experimental groups.

The qualitative assessment of meat and fat products should not be limited to the established ratio of the main tissues in carcasses. The nutritional value of slaughter products largely depends on the proportions of the main components:

water, protein, fat and ash.

At a pre–slaughter weight of 100–120 kg, no statistically significant differences in the content of both moisture and dry matter in the longest back muscle were found between the animals of the experimental groups.

Meat obtained from pigs that consumed the probiotic product «Bio Plus 2B» in addition to the main diet was inferior in fat content to meat from animals that received the main diet by 0.41 and 0.36 % ($P < 0.95$) when fattening to a live weight of 100 and120 kg, respectively.

Table 5.9

Chemical properties of pig meat, n = 5, x ± Sd

Group	Total moisture, %	Dry matter, %	Fat, %	Protein, %	Ash, %
When fattening to a live weight of 100 kg					
I	74.83±0.25	25.17±0.25	2.55±0.12	21.20±0.28	1.42±0.05
II	74.46±0.56	25.54±0.56	2.14±0.11	21.72±0.49	1.68±0.11
± II to I	– 0.37	+ 0.37	– 0.41*	+ 0.52	+ 0.26
When fattening to a live weight of 120 kg					
I	74.21±0.29	25.79±0.29	2.57±0.08	21.45±0.36	1.49±0.08
II	74.17±0.28	25.83±0.28	2.21±0.08	21.66±0.43	1.55±0.09
± II to I	– 0.04	+ 0.04	– 0.36*	+ 0.21	+ 0.06

There was no significant and statistically significant difference in the protein and ash content of meat between the I and II experimental groups, but the highest protein and ash content was found in meat obtained from animals of the II experimental group that consumed the probiotic «Bio Plus 2B».

According to the results of the research, it can be concluded that the quality of meat of pigs of the experimental groups meets the requirements of the standards and, depending on the presence of probiotics in the diet, has specific properties. Thus, the use of live spore cultures in the form of «Bio Plus 2B» has led to improvement of meat quality indicators, improvement of physicochemical and chemical properties of muscle tissue, which increase the taste and nutritional quality of meat.

5.2.3. Organoleptic and tasting evaluation of meat and lard products. One of the priority modern approaches to solving problems with the quality of agricultural products is the development, production and use of new biopharmaceuticals, which are complexes of various microorganisms – symbionts of the gastrointestinal tract of animals and biologically active additives [18, 31, 51].

Probiotics in animal husbandry are used to improve digestion, accelerate the adaptation of animals to high–energy diets, and increase feed efficiency and productivity [51, 136].

An important indicator of the quality of pig meat, after the use of certain additives, is its taste characteristics, which were evaluated by tasting, on a point scale in accordance with the recommendations. The longest back muscle was tasted in boiled form, as well as its broth, the data of which are presented in Table 5.10.

Table 5.10

Tasting evaluation of cooked meat and broth, x ± Sd

Indicator	Group	
	I	II
Tasting assessment of meat, points		
Appearance, color on the section	8.1±0.30	7.9±0.37
Flavor	7.2±0.24	8.0±0.32*
Taste	8.1±0.30	7.8±0.34
Consistency	7.6±0.27	7.4±0.28
Juiciness	7.8±0.26	7.5±0.28
Overall assessment	7.8±0.23	7.7±0.30
Tasting evaluation of the broth, points		
Appearance, color	7.8±0.33	7.7±0.24
Flavor	7.7±0.35	8.0±0.22
Taste	7.9±0.35	8.2±0.30
Breadth	7.8±0.26	7.6±0.37
Overall assessment	7.8±0.24	7.9±0.20

As a result of the organoleptic evaluation of the matured pork obtained from the experimental groups, it was found that the meat has a drying crust of pale pink color. The muscles in the cut are slightly moist; do not leave a wet spot on the filter paper, light pink in color, dense, elastic, when pressed with a finger, the resulting dimple quickly evens out. The smell is specific, characteristic of this type of fresh meat. The lard is pale pink in color, soft, elastic, and has no rancid odor.

Boiled meat of pigs of groups I and II has an excellent appearance, a very pleasant and strong smell, and tastes very tasty, with a delicate texture and very juicy.

In the context of the experimental groups, no significant and statistically significant difference was found, except for the indicator of the aroma of cooked meat, its value was higher in animals of group II – 8 points, which is 0.8 points more than in group I ($P < 0.95$). The overall assessment of the quality of cooked meat was quite high and amounted to 7.7–7.8 points out of 9 possible.

The evaluation of the organoleptic characteristics of the meat broth showed that it has an excellent appearance, a very pleasant and strong aroma, and a high richness, which determines its taste – it is very tasty. The overall broth quality score is also quite high and amounts to 7.8–7.9 points out of 9 possible. It should also be noted that no off–flavors or odors were observed after using the probiotic in the experimental group.

5.3. Influence of «Enrichment Materials» on behavior and productivity under industrial technologies.

Of great importance for the welfare of pigs is the enrichment of manipulative objects in confined housing systems that increase their motor, search, research and cognitive activity, play activity and, as a result, stabilize their intragroup hierarchy and significantly reduce aggressive behavior in terms of biting off tails and ears [156, 186, 205, 211, 230, 232].

Thus, the main objective of the study was to evaluate the effect of enrichment materials on piglet behavior, plasma cortisol levels and productivity, and plasma cortisol levels were chosen as a useful stress marker. A total of 180 fattening stock were used in the experiment, where the maternal form was a combination of the Large White breed with the Landrace breed, and the paternal form was the terminal boar «Maxter», which were kept in the conditions of the base farm of LLC «Tavrian Pigs», Kherson region. Fattening pigs were divided into two fattening periods: I fattening period «Grower» – animals weighing 30–60 kg, aged 77–110 days consumed 2.4–2.6 kg of feed per head per day, pigs were kept in cages on a concrete slotted floor with an area of 0.65 m^2/head; II period of fattening «Finisher» – animals with a live weight of 61–100 kg, aged 111–161 days consumed 2.8–3.0 kg of feed per head per day, kept in cages on a concrete slotted floor with an area of 0.85 m^2/head according to VNTP–APC – 02.05 «Pig enterprises (complexes, farms, small farms)» [20].

Feeding according to the fattening periods for the experimental groups of pigs was identical according to detailed feeding rates, taking into account the physiological characteristics of the animals and was carried out using bunker self–feeders with automated feed distribution, watering was carried out through automatic teat drinkers, ventilation was of the supply and exhaust type. The number of pigs in the cage was 30. The main diet (MD) was compound feed of our own production with the use of premixes produced by PC Alternative LLC (ANNEX D).

All experimental animals were divided into three groups based on the principle of analogs of 60 heads (2 pens × 30 heads) each: I – control group, animals were kept without the use of enrichment material; II – experimental group, animals were kept with straw bales (Fig. 5.3); III – experimental group, animals were kept with plastic bottles (2L) filled to 50 % of their capacity with grain (wheat), Fig. 5.4.

Fig. 5.3. **Enrichment material (straw bale) for pigs of the second experimental group**

During the experiment, the behavioral acts of pigs during fattening of three experimental groups were timed by video surveillance using Boblov KJ21 video recorders (with a resolution of 1280×720 (HD), 1920×1080 (Full HD), a lens with a viewing angle of 170 and a recording format using a motion sensor and night illumination.

Visual and video observations of the animals were carried out from 7 ^{00}am to

7^{00} am of the next day for three consecutive days with the determination of the duration (in minutes) of behavioral acts – rest, feed and water intake, movement, aggressive actions (fights, bites), exploratory (studying the object), interaction with the object, movement and games according to the method of *V. I. Velikzhanin* [19].

Fig. 5.4. **Enrichment material - plastic bottles half–filled with wheat grain for pigs of the third experimental group**

Observation of the behavior of pigs and blood sampling with its subsequent laboratory testing for the content of the hormone cortisol in the blood plasma was carried out on the 12th, 14th, 17th and 22nd week of life. For this purpose, 10 ml of blood was taken from the jugular vein of 10 piglets of the three experimental groups at 6^{00} am and 21^{00} pm. Based on the prerequisites for meeting the requirements of animal welfare, scientists and producers of the pig industry are interested in the advantages and disadvantages of using different types of enrichment materials indoors to reveal the natural behavior of pigs, eliminate mental suffering and, ultimately, increase the production performance of the industry as a whole.

Therefore, based on these motivational aspects, the final stage of the first scientific and economic experiment was to analyze the effectiveness of using different types of enrichment materials for pigs during the fattening period.

In the course of the experiment, it was found that changes in the main behavioral acts of piglets of the control and experimental groups were observed already at the 12th week of life (Table 5.11).

Table 5.11

Influence of the enrichment environment on the duration of behavioral acts of pigs of the first fattening period «Grower» depending on the week of life, min, x ± Sd

Behavioral act	Group, n = 60		
	I control	II experimental	III experimental
Week 12			
Recreation	740.1±11.30	802.5±8.66*	782.8±9.81
Feed and water intake	138.2±5.34	145.6±4.61	146.2±3.67
Movement	342.6±1.72	188.4±1.03***	194.4±1.08***
Study of the object	0	69.9±2.74	72.4±3.45
Interaction with the object	0	42.3±1.42	41.8±1.28
Games	6.2±0.81	24.8±1.56***	39.2±1.43***
Aggressive behavior (fighting, biting)	212.9±1,42	166.5±3.26***	163.2±2.74***
Week 14			
Recreation	751.3±17.47	799.6±15.52	795.0±14.85
Feed and water intake	141.7±6.90	141.9±7.48	142.4±8.16
Movement	312.8±16.23	315.2±14.65	320.6±13.46
Study of the object	0	74.2±3.46	78.2±4.29
Interaction with the object	0	52.3±8.62	55.7±9.24
Games	5.8±1.21	34.2±2.45**	36.7±2.84***
Aggressive behavior (fighting, biting)	228.4±3.80	17.2±1.56***	16.8±1.28***

It is worth noting that animals with access to the enrichment environment, especially pigs of the second experimental group, were characterized by a significantly longer rest period ($p < 0.05$) compared to piglets of the control group, less aggressiveness ($p < 0.05$), which was accompanied by a decrease in the duration of fights and bites, and, as expected, an increase in the duration of play behavior by almost 4–6 times. It should be noted that the piglets of the experimental groups in the presence of the manipulative material spent more time studying the new object and interacted with it for a longer period of time compared to their peers in the control group (no material).

At 14–th week of life, piglets with access to plastic bottles half–filled with wheat grains showed more active motor behavior due to an increase in the duration of time spent on play activity, which generally improves search and exploration activities, promotes positive experience or affiliative behavior in the group. It is also worth noting the fact that in the pigs of the experimental groups that were kept with an enrichment environment, cases of inter–individual aggression decreased almost thirteen times ($p < 0.001$).

Since an important manifestation of the reduction of aggressive behavior among animals that had free access to manipulative material is a significant decrease in the number of cases of harmful social behavior – biting tails and ears. Thus, among the animals of the control group, 24 cases of biting were recorded during the first stage of fattening, while among piglets that had the opportunity to transfer their aggression to straw blocks (group II), six such cases were recorded, and in experimental pigs of group III with plastic bottles filled with grain, 4 cases of harmful social behavior were recorded.

Both at 17(–th) and 22(–th) weeks of life (Table 5.12), it was noted that only differences in the duration of fights ($p < 0.001$) and play behavior ($p < 0.01$) remained significant between animals of different groups, while for the rest of the main behavioral acts, no significant difference was found between animals with access to the enrichment environment and those in the control group.

It should be noted that in pigs of the experimental groups, cases of intragroup aggression decreased from 7 to 12 times ($p < 0.001$), among animals of the control group during the second stage of fattening, 22 cases of biting were recorded, while among piglets that had the opportunity to transfer their aggression to straw blocks group II, 4 such cases were recorded, and in experimental pigs of the III group with plastic bottles filled with grain, 1 case of harmful social behavior was recorded.

Table 5.12

Influence of the enrichment environment on the duration of behavioral acts of pigs of the second fattening period «Finisher» depending on the week of life, min, x ± Sd

Behavioral act	Group, n = 60		
	I control	II experimental	III experimental

17th week			
Recreation	867.8±16.24	812.6±14.73	820.3±16.29
Feed and water intake	162.3±9.10	154.5±8.95	155.0±7.64
Movement	295.8±11.41	301.5±12.17	302.2±10.76
Study of the object	0	60.8±6.55	56.7±5.29
Interaction with the object	0	53.2±4.44	54.7±6.17
Games	2.4±0.36	42.8±7.68***	40.8±6.44***
Aggressive behavior (fighting, biting)	111.7±6.32	14.6±1.89***	10.3±0.67***
22th week			
Recreation	920.6±10.43	869.5±12.38	854.8±11.42
Feed and water intake	166.4±10.26	156.8±7.84	162.0±8.25
Movement	274.2±9.42	286.7±10.17	283.8±8.91
Study of the object	0	52.6±4.21	54.5±4.82
Interaction with the object	0	40.7±6.55	45.2±8.36
Games	2.1±0.31	20.4±4.18**	28.8±6.44**
Aggressive behavior (fighting, biting)	76.7±10.14	13.2±6.92***	10.9±5.96***
26th week			
Recreation	1069.8±11.42	972.0±12.18***	958.8±12.42***
Feed and water intake	160.4±7.69	156.4±7.28	164.2±8.14
Movement	192.2±8.24	215.4±9.32	206.2±8.69
Study of the object	0	39.8±4.78	42.6±5.16
Interaction with the object	0	30.6±2.62	38.9±3.16
Games	2.0±0.29	18.4±1.34***	22.6±2.12***
Aggressive behavior (fighting, biting)	15.6±3.42	7.4±1.26*	6.7±2.10*

Furthermore, we note that at 26 weeks, when the experimental animals reached 120 kg of live weight, behavioral indicators differed significantly from the previous ethological acts in the period from 17–22 weeks.

As a result of the experiment, an increase in the rest period was recorded, which is typical for pigs both in terms of age and live weight.

It should be noted that the animals of the first control group spent the most time on this behavioral act (rest) – almost 1070 minutes, which is 9.1 % significantly more than pigs of the second experimental group, which were kept using manipulative material in the form of straw blocks and 10.4 % significantly more than their peers of the third experimental group, which were kept using plastic bottles filled with grain. Regarding play behavior at this age, we note that games were recorded in animals of both experimental groups II and III and significantly exceeded the time of control pigs from 18 to 20 minutes.

However, it is worth noting that in animals that reach heavier weight conditions, play behavior is significantly reduced compared to earlier age periods.

Regarding aggressive behavior, we note that, compared to previous age periods, fights, bites and fights occurred, but only as a defense. The shortest time was recorded in animals kept with plastic bottles filled with half grain – pigs of the III experimental group – 6.7±2.10 min. During fattening to a live weight of 120 kg, 6 cases of biting were recorded in animals of the control group, while among pigs that were able to transfer their aggression to manipulative materials (experimental groups II, III), 2 cases of harmful social behavior were recorded. It should be noted that for the remaining behavioral acts during the period of 26 weeks, when the experimental animals reached a live weight of 120 kg, no significant difference was found between pigs that had access to the enrichment environment and those in the control group.

The animals of the control and experimental groups were characterized by significant differences in the concentration of cortisol in the blood plasma. On the 12th week of life (Fig. 5.5, 5.6), both in the morning and in the evening, animals of the three groups had cortisol levels in the blood plasma that were twice as high ($p < 0.001$) as the norm of the biological reference interval, which is obviously due to stressful events after the piglets were transferred from the growing room to a new room for the first fattening period and, as a result, their aggressive behavior and increased locomotor activity.

However, it is worth noting that the high cortisol content in these animals indicates, first of all, an adequate response of the hypothalamic–pituitary–adrenal system to the stressor, which is a manifestation of the general adaptation syndrome and is a natural way for the body to cope with stress.

Regarding the 14–22 weeks of life of experimental animals, it should be noted that the enrichment environment for pigs of both II and III experimental groups contributed to a significant decrease ($p < 0.001$) in the level of cortisol in the blood plasma relative to the normative value, regardless of the time of day.

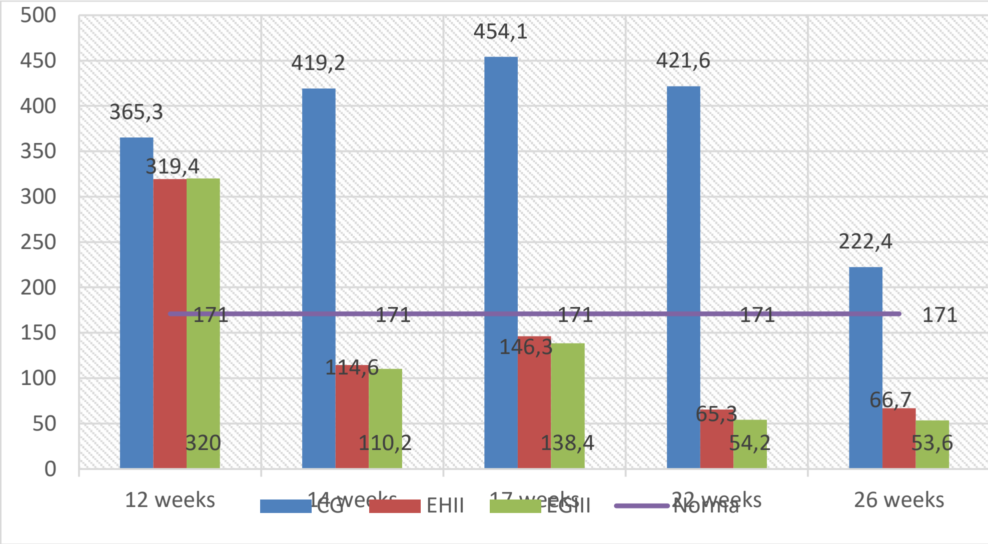


Fig. 5.5. **Effect of the enrichment medium on the concentration of cortisol in the plasma of pigs at 6^{00} am depending on the week of**

Notes: CG – control group I; EG II – experimental group II; EG III – experimental group III; Normal – normative value of 171 nmol/l.

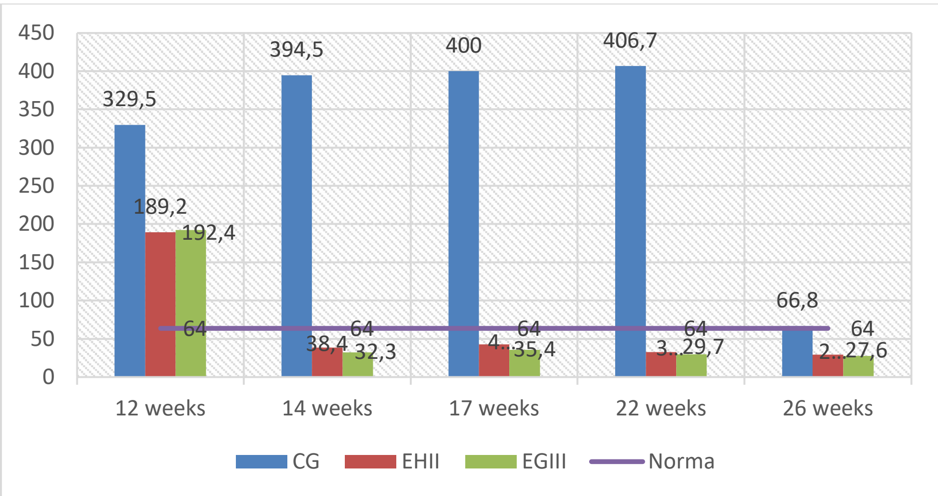


Fig. 5.6. **Effect of the enrichment medium on the concentration of cortisol in the plasma of pigs at 21^{00} pm depending on the week of life**

Notes: CG – control group I; EG II – experimental group II; EG III – experimental group III; Normal – normative value of 64 nmol/l.

The same cannot be said about the pigs of the control group, because their plasma cortisol levels significantly exceeded ($p < 0.001$) the norm, indicating the presence of a chronic stress condition in animals.

It should be noted that at 26 weeks, the level of cortisol in the blood plasma of pigs of the control group decreases by almost half, but is higher than normal, and in experimental young pigs of the II and III experimental groups remains within the range of 22 weeks.

Such a distribution of the hormone cortisol in the control and experimental groups indicates that pigs in the absence of an enrichment environment are in a state of chronic stress, which is confirmed by a higher content of cortisol in their plasma ($p < 0.001$), pronounced inter–individual aggressive behavior, which significantly destabilizes animal behavior and leads to the manifestation of abnormal forms of stereopathy (biting tails, ears), and significantly reduces the productivity and welfare of pigs and fattening.

In general, the change in behavioral indicators among animals of the control and experimental groups led to significant differences in their performance (Table 5.13). At the time of the experiment, piglets aged 11 weeks had a live weight of 33–34 kg, which meets the regulatory requirements. Among the piglets that had free access to the manipulative material, regardless of whether it was bales of straw or plastic bottles filled with grain, a significant increase in live weight ($p < 0.05$, $p < 0.01$, $p < 0.001$) was noted from 12 to 26 weeks, which was associated with a significant increase in their average daily gain ($p < 0.001$) compared to animals in the control group.

The result is that fattening pigs kept in boxes with enrichment facilities (experimental groups II, III) were less anxious and moved around, which ultimately had a positive effect on the intensity of their growth parameters. It is worth noting that enrichment facilities for the animals of the experimental groups contributed to a decrease in the culling of animals due to injuries (fights, contacts, attacks) and diseases.

Thus, in our experiment, it was found that pigs kept in the presence of an enrichment environment had significantly higher growth parameters by 3.5–7.0 % ($p < 0.05$; $p < 0.01$; $p < 0.001$) and lower culling due to fights, bruises, bites, injuries and diseases by 2.0–5.4 % compared to animals in the control group.

As welfare requirements are being met, scientists and producers in the pig industry will benefit from information on the advantages and disadvantages of using different types of enrichment materials indoors to reveal natural behavior of pigs, relieve them of mental suffering and, ultimately, improve the production performance of the industry as a whole.

Table 5.13

Influence of the enrichment environment on productive traits of pigs, x ± Sd

Feature	Group / Age n = 60		
	I control	II experimental	III experimental
11 weeks			
Live weight, kg	33.70±0.262	33.93±0.221	33.97±0.232
12 weeks			
Live weight, kg	37.93±0.229	38.83±0.237*	39.37±0.206**
Average daily weight gain, g	604.3±2.04	700.0±1.90***	771.4±2.02***
Rejections (injuries, illnesses), %	6.7	1.7	1.7
14 weeks			
Live weight, kg	47.93±0.254	49.20±0.228**	50.00±0.224***
Average daily weight gain, g	714.3±1.77	740.5±2.03***	759.5±2.05***
Culling out (injuries, illnesses), %	7.1	5.1	1.7
17 weeks			
Live weight, kg	64.80±0.274	67.30±0.282**	68.57±0.271***
Average daily weight gain, g	803.2±1.98	861.9±1.56***	884.1±1.51***
Rejections (injuries, illnesses), %	3.8	1.8	0
22 weeks			
Live weight, kg	94.70±0.298	98.27±0.274**	98.90±0.339***
Average daily weight gain, g	854.3±1.52	884.8±1.35***	866.7±1.79***
Culling (injuries, illnesses, etc.), %	2.0	0	0
26 weeks			
Live weight, kg	114.43±0.341	118.10±0.273***	119.00±0.209***
Average daily weight gain, g	704.8±14.42	708.3±13.27	717.9±23.31
Culling (injuries, illnesses, etc.), %	0	0	0

Therefore, based on these motivational aspects, we present the effectiveness of using different types of enrichment media for pigs during the fattening period (Table 5.14).

Table 5.14

Advantages and disadvantages of using different enrichment objects (manipulative materials) for pigs during fattening

№ s/n	Indicator	Baled straw	Bottles filled with grain
1	Imitation of natural behavior	×	×
2	Attractive sound effect	–	×
3	Mobility of the enrichment facility	–	×
4	Safety of the pig enrichment facility	×	×
5	Violation of the integrity of the enrichment facility	×	–
6	Possibility of clogging of the sewage system	–	×
7	Danger of mycotoxins and fungi	×	–
8	Low cost	×	×
9	Labor costs for the transfer	×	–

Notes: × – advantage; – negative effect / no effect.

It has been established that intensive industrial systems of pork production technology have a number of advantages: protection from predators, climate control, animal control, ease of cleaning and management [185]. The disadvantages of intensive systems include: low level of environmental stimulation, lack of opportunity for pigs to express their inherent behavior, such as rooting, lying down and exploring.

In order to improve the disadvantages of intensive housing systems, it is worth enriching the environment for pigs, in our case, straw bales and plastic bottles filled with 50 % wheat grain. Thus, environmental enrichment becomes necessary in intensive production systems to improve animal welfare while maintaining high pig productivity. However, different manipulative materials in their life cycle also have a number of advantages and disadvantages, so the issue of the efficiency of using a particular enrichment facility is quite relevant from the point of view of animal welfare.

Many research results indicate that the growth rate of pigs affects their fattening and meat quality [91, 132]. In this regard, we studied the effectiveness of enrichment facilities for improving the fattening qualities of young pigs (Table

5.15).

Table 5.15

Fattening qualities of young pigs depending on enrichment facilities, n = 60, x ± Sd

Group	Age of reaching a live weight of 100 kg, days	Average daily weight gain during fattening, g	Feed conversion, kg
live weight 100 kg			
I – control	160.4±0.65	810.9±6.67	3.14
II – experimental	156.2±0.51	849.1±5.42	3.00
III – experimental	155.7±0.83	850.5±8.76	3.00
+/– II to I	–4.2***	+38.2***	–0.14
+/– III to I	–4.7***	+39.6***	–0.14
live weight 120 kg			
I – control	190.1±0.56	780.6±4.69	3.59
II – experimental	184.8±0.42	808.8±3.56	3.46
III – experimental	183.5±0.31	812.6±3.04	3.45
+/– II to I	–5.3***	+28.2***	–0.13
+/– III to I	–6.6***	+32.0***	–0.14

The results of studies on the fattening qualities of young pigs of the experimental groups, depending on the enrichment objects, convincingly show that animals that used manipulative objects (enrichment materials): II and III experimental groups, respectively, reach a live weight of 100 kg 4.2 and 4.7 days earlier compared to their peers in the I control group, at $p < 0.001$. The values of average daily gains in pigs of the II and III experimental groups that used manipulative materials were significantly higher ($p < 0.001$) by 38.2 g and 39.6 g, respectively, with the same feed conversion of 3 kg, than the same indicator of animals of the I control group, where the feed conversion was 3.14 kg.

Regarding fattening indices when the experimental animals reached 120 kg of live weight, we note that the tendency for a probable excess ($p < 0.001$) of animals of experimental groups II and III in terms of average daily gain is 28.2 g and 32.0 g relative to young pigs that did not use manipulative materials.

The same trend was observed in the case of the age of 120 kg, where animals of the III and II experimental groups reached the expected live weight 6.6 and 5.3 days earlier than their peers in the control group.

Thus, based on the results of the study, we note that due to enrichment materials (straw bales, plastic bottles filled with grain), inter–individual aggression between animals decreased, search, cognitive and play activities increased without abnormal forms of stereopathy, which is confirmed by a reduced concentration of the hormone cortisol in the blood plasma and an increase in productive traits of pigs when they reach a live weight of both 100 kg and 120 kg. Therefore, the data of the study on the effect of environmental enrichment on pig welfare, productivity and their effectiveness in terms of simplicity and ease of use are useful for pork farmers in developing strategies for enriching pig farms with substrates or materials, which opens up ways to identify the natural behavior of pigs. However, we emphasize that our studies have established the fact that animals lose interest in monotonous enrichment objects after reaching a live weight of 100 kg, and therefore, in order to increase the cognitive, search and research behavior of pigs, we propose to rotate manipulative materials, which will obviously improve animal performance when they reach heavier weight conditions.

5.4. Enhancing productivity through the complex supplement «Gepasorbex».

5.4.1. Effects of «Gepasorbex» on fattening traits and nutrient levels in the blood serum of individuals. It is known that the use of intensively innovative technologies and pigs of high genetic potential to ensure productivity through the efficient use of feed resources, maximum animal preservation and prevention of various diseases is a feature of the modern pig industry. This fact places significant demands on the provision of high–quality and environmentally friendly feed, which is associated with its contamination with various toxins, heavy metals, pesticides, nitrates, etc.

Therefore, a number of studies are currently being conducted to find the most effective sorbents that will help get rid of mycotoxins and preserve vitamins in the body of animals. Due to the urgency of the problem, the goal was to determine the effectiveness of using the complex preparation «Gepasorbex» produced by «Vetservisproduct» in the diets of young pigs contaminated with mycotoxins to increase productivity and reduce feed costs.

The first stage of the research was devoted to the study of the effect of the complex supplement «Gepasorbex» on the fattening traits of pigs and the concentration of retinol, tocopherol and 25–hydroxycalciferol in their blood serum. In total, 90 heads of fattening young pigs were used in the experiment, where the maternal form was a combination of the breeds Large White × Landrace, and the paternal form was boars of the terminal line «Maxter», which were kept in the conditions of LLC «Tavrian Pigs», Kherson region.

Fattening was divided into two periods: I period of fattening «Grower» – animals with a live weight of 30–60 kg (12–17 weeks) consumed feed 2.4–2.6 kg per head per day using feed of the «Grower» type with nutritional value: crude protein – 180.25 g/kg; metabolic energy – 13.04 MJ/kg, pigs were placed on a concrete slotted floor with an area of 0.65 m^2/head according to VNTP–APC – 02.05 «Pig enterprises (complexes, farms, small farms)» [20]; II period of fattening «Finisher» – animals with a live weight of 61–120 kg (17–26 weeks) consumed 2.8–3.2 kg per head per day using feed of the «Finisher» type with a nutritional value: crude protein – 140.88–153.08 g/kg; metabolic energy – 12.90–13.14 MJ/kg, pigs were placed on a concrete slotted floor with an area of 0.85 m^2/head according to VNTP–APC – 02.05 «Pig enterprises (complexes, farms, small farms)» [20].

The main diet (MD) was compound feed of own production with the use of premixes produced by PC Alternative LLC (ANNEX D). The main feed used for feeding the pigs of the experimental groups according to laboratory studies was recognized as slightly toxic.

When pigs were transferred from the rearing to the fattening shop of the first period, the comparison period (CP) started at 11–12 weeks to equalize the animals and ensure the purity of the study. Further, all experimental animals were divided into three groups (according to the principle of analogs) according to generally accepted methods [87, 130] with 30 animals in each group: I – control group of pigs used the basic diet «Grower», «Finisher»; pigs of II – experimental group consumed the basic diet «Grower», «Finisher» with the addition of 0.15 % by weight of feed of a commercial analog of mycotoxin adsorbent; animals of III – experimental group used the basic diet «Grower», «Finisher» with the addition of 0.15 % by weight of feed of the complex preparation «Gepasorbex» (ANNEX E).

A significant difference in productive traits (live weight and average daily gain) of pigs of the control and experimental groups was observed at the age of 56 days, or 14 weeks (Table 5.16).

Table 5.16

Productive traits of experimental groups of pigs, x ± Sd

Feature	Group/Age, n = 30		
	I – control	II – experimental	III – experimental
12 weeks			
live weight, kg	35.50±0.717	35.03±0.812	35.83±0.649
14 weeks			
live weight, kg	45.80±0.637	46,23±0,768	47.73±0.629*
average daily weight gain, g	735.7±15.75	800,0±19,19**	850.0±12.04***a
17 weeks			
live weight, kg	62.87±0.610	64.20±0.791	66.50±0.645***a
average daily weight gain, g	812.7±15.64	855.6±10.33*	893.7±8.45***b
22 weeks			
live weight, kg	93.33±0.471	95.80±0.720**	98.43±0.544***b
average daily weight gain, g	870.5±11.92	902.86±9.55*	912.40±8.55**
26 weeks			
live weight, kg	113.97±0.367	118.13±0.412***	120.97±0.256*** b
average daily weight gain, g	736.9±9.45	797.6±15.35**	804.8±13.23***

*Notes: * – p < 0.05; ** – p < 0.01; *** – p < 0.001 (compared with animals of the control group – group I); a – p < 0.05; b – p < 0.01 (compared with animals of experimental group III with analogues of experimental group II).*

It should be noted that when put on fattening, all piglets had a live weight of 33–34 kg. Within 14 weeks, pigs of the III experimental group consuming the complex preparation «Gepasorbex» significantly exceeded the live weight of the control group by 1.93 kg ($p < 0.05$), and the average daily gain was observed in relation to the animals of both the control group by 114.3 g ($p < 0.001$) and the II experimental group consuming a commercial analogue of the mycotoxin adsorbent by 50 g ($p < 0.05$).

A similar trend was observed in the following age periods. Thus, at 17 weeks of age, animals of the III experimental group significantly dominated in terms of live weight over the analogues of the II experimental group by 2.3 kg ($p < 0.05$) and peers of the I control group by 3.63 kg ($p < 0.001$). The highest average daily weight gain was recorded in pigs that consumed the complex supplement «Gepasorbex» and significantly exceeded the studied indicator in pigs of the I control and II experimental groups by 9.1 % ($p < 0.001$) and 5.9 % ($p < 0.05$), respectively.

Regarding the 22th week of life of fattening young pigs, a probable advantage of animals of the II and III experimental groups in terms of live weight and average daily gain was established, by 2.47 kg ($p < 0.01$), 32.36 g ($p < 0.05$) and 5.1 kg ($p < 0.001$), 41.9 g ($p < 0.01$), respectively.

At the age of 26 weeks, in terms of live weight, animals of the III experimental group consuming the complex feed additive «Gepasorbex» dominated the peers of both the II experimental and I control groups by 2.67 kg ($p < 0.01$) and 7.00 kg ($p < 0.001$), respectively. In terms of average daily weight gain, pigs of the II and III experimental groups that consumed mycotoxin enterosorbents had higher values by 60.7 g ($p < 0.001$) and 67.9 g ($p < 0.001$), respectively, than their counterparts in the control group.

Thus, based on the above numerical data, we note that young pigs from experimental groups II and III showed better growth performance and significantly outperformed the control group in terms of live weight and average daily weight gain at all ages. The results described above allow us to conclude that pigs consuming mycotoxin adsorbent in the main diet (experimental groups II, III) have a significant positive effect on their growth performance.

It is worth noting that mycotoxin adsorbents differ from each other and, due to technological developments, are becoming more sophisticated and diverse in terms of adsorption properties, as well as have an indirect therapeutic effect from generation to generation. Feed sorbents have the ability to quickly bind a wide range of toxicants. Sorbents are stable at different pH values and are thermostable during feed pelletizing. The use of mycotoxin adsorbents as feed additives is beneficial for reducing the toxic effects of mycotoxins in pigs, which ensures more sustainable use of feed. There are many mechanisms by which adsorbents mitigate the toxic effects of mycotoxins in feed, one of which is adsorption, when the mycotoxin interacts with another molecule (adsorbent) and is not absorbed by the animal body. In the adsorbed form, the mycotoxin will be excreted with feces, and its toxic effect will be minimized in animals. The next mechanism is to use these agents to strengthen the immune function and gut health of the animal, such agents often include the use of prebiotics, probiotics, postbiotics, phytobiotics and synbiotics [192].

However, as noted by *Kihal et al.* [200], many feed additives with sorption properties bind vitamins, macro– and microelements. According to the results of studies by other authors, it has been proven that prolonged use of sorbents has been shown to reduce the content of vitamins A, D and E in the blood of animals and poultry. For example, *Schell T.C. et al.* [227]; *Reddy K.E. et al.* [223]; *Weaver A.C. et al.* [241] proved that aflotoxin B_1 had a detrimental effect on liver health and electrolyte balance in pigs, which led to deterioration of functions and changes in the structure of the liver and kidney architecture.

The productivity and resistance of pigs depends on providing them with a sufficient amount of nutrients and biologically active substances. The latter include vitamins A, D and E, which ensure the normal course of biochemical and physiological processes in the body, and have an impact on the growth and development of animals [199].

As a result of experimental studies, it was found that the content of vitamins in pigs of the control, II experimental group decreased compared to animals of the III experimental group (Table 5.17).

Based on the digital material, it was found that on day 48 of the experiment, the retinol content in the blood serum of pigs of the first fattening stage «Grower» in animals of the III experimental group that consumed the complex preparation «Gepasorbex» was within the biological reference interval, The same cannot be said about the content of this vitamin in pigs of the II experimental and I control groups, since their actual content was less than the minimum limit of the regulatory interval by 4.3 % and 6.8 %, respectively.

At the age of 22 weeks 88 days, II stage of fattening «Finisher», the retinol content in the blood serum of fattening young animals of the III experimental group significantly exceeded the vitamin *A* content of the control group by 16.75 μg/ml ($p < 0.001$) and was within the limits of the biological reference material.

It should be noted that at this age period, pigs of the II experimental group consuming a commercial analog of the mycotoxin adsorbent significantly exceeded the animals of the I control group by 6.16 μg/ml ($p < 0.05$) in terms of retinol content in the blood serum, but the concentration of the latter in the animals of the II experimental group was lower than the minimum threshold of the reference interval.

Table 5.17

Dynamics of vitamin content in blood serum of pigs, x ± Sd

Vitamin name	Group, n = 10 / vitamin content			Biological reference interval
	I control	II experimental	III experimental	
age of pigs – 12 weeks (48 days)				
Retinol (vitamin *A*), mcg/ml	25.16±1.28	25.84±1.39	27.12±1.65	27.0–30.0
Tocopherol (vitamin *E)*, µg/ml	3.76±0.52	4.28±0.39	5.71±0.96*	5.7–6.4
25–hydroxycholecal–ciferol (vitamin *D*), ng/ml	25.42±1.54	25.75±1.38	31.05±2.12*	30.0–32.0
age of pigs – 22 weeks (88 days)				
Retinol (vitamin *A*), µg/ml	36.13±1.82	42.29±1.67*	52.88±1.95***	50.0–60.0
Tocopherol (vitamin *E)*, µg/ml	5.02±0.37	5.64±0.29	6.62±0.54*	6.5–6.8
25–hydroxycholecal–ciferol (vitamin *D*), ng/ml	27.24±0.87	28.15±0.92	30.89±1.14*	30.0–32.0

Given that retinol, in addition to its antioxidant function, stimulates the growth of connective tissue «growth vitamin», weight gain is often reduced in the presence of its deficiency (see Table 5.16). It has been postulated that decreased levels of vitamin *A* in the liver are the result of *T–2* toxin consumption [176] and, as a result, decreased intestinal absorption of fat–soluble nutrients. In addition, *Hoehler D et al.* suggested [190] that mycotoxins, by stimulating lipid peroxidation of intestinal enterocytes, lead to damage that significantly contributes to impaired retinol absorption. In our study, this phenomenon was clearly observed in pigs of the control group.

In addition, aflatoxins in pigs' diets reduced serum tocopherol and retinol concentration compared to the control and pre–test values and reduced the concentration of tocopherol in the heart tissue, which was recorded with animals of the first control group in the experiment.

The concentration of tocopherol in pigs of the III experimental group at the age of 48 days significantly exceeded the similar vitamin in animals of the I control group by 1.95 μg/ml ($p < 0.05$) and was recorded at the level of the biological reference interval. A similar trend was observed at 12 weeks, where animals (experimental group III) using the complex enterosorbent «Gepasorbex» significantly exceeded pigs of the control group I by 1.6 μg/ml ($p < 0.05$) and were within the biological reference interval.

It is worth noting that the concentration of 25–hydroxycholecalciferol within the biological reference interval was recorded during the experiment in animals of the III experimental group both at 48 days and at 88 days and exceeded their peers of the I control group by 5.63 ng/ml ($p < 0.05$) and 3.65 ($p < 0.05$), respectively.

According to the research objective, we studied the fattening traits of pigs of the experimental groups in accordance with their purpose when the animals reached a live weight of 100 and 120 kg (Table 5.18).

The results of studies on the fattening qualities of young pigs of the experimental groups, depending on the feeding of feed additives of mycotoxin adsorbents, convincingly show that animals that used complex additives of mycotoxin enterosorbents: II and III experimental groups, respectively, 3.0 ($p < 0.01$) and 6.0 ($p < 0.001$) days earlier reach a live weight of 100 kg compared to their peers in the I control group. The values of average daily weight gain in pigs of the II and III experimental groups that used a commercial analog of the mycotoxin adsorbent and, in fact, the feed additive «Gepasorbex» were significantly higher ($p < 0,001$) by 41.5 g and 67.7 g, respectively, in terms of feed conversion for the second experimental group, which reached 2.94 kg, and for the third experimental group – 2.85 kg, than the same indicator of animals of the first control group, where the feed conversion was 3.39 kg.

Regarding fattening indices when the experimental animals reached 120 kg of live weight, the results of the study revealed that the tendency for a probable excess ($p < 0.001$) of animals of experimental groups II and III in terms of average daily gain was 47.3 g and 68.0 g relative to young pigs that did not use the addition of mycotoxin enterosorbent in the main diet.

Table 5.18

Fattening traits of young pigs, n= 30, x ± Sd

Purpose of the group	Age of reaching live weight 100	Average daily weight gain at fattening	Feed conversion,

	kg, days	facilities, g	kg
live weight 100 kg			
I – control	161.7±0.56	826.6±7.66	3.39
II – experimental	158.7±0.80	868.1±5.96	2.94
III – experimental	155.7±0.58	894.3±5.88	2.85
+/– II to I	–3.0**	+41.5***	–0.45
+/– III to I	–6.0***	+67.7***	–0.54
live weight 120 kg			
I – control	190.2±0.49	800.7±5.46	3.50
II – experimental	184.2±0.48	848.0±6.21	3.30
III – experimental	180.7±0.32	868.7±5.26	3.22
+/– II to I	–6.0***	+47.3***	–0.20
+/– III to I	–9.5***	+68.0***	–0.28

An identical numerical trend is noted in the case of the age of 120 kg live weight, where animals of the II and III experimental groups reach the expected live weight 6.0 and 9.5 days earlier than their peers in the control group. At the same time, they have significantly higher average daily weight gain compared to their counterparts in the control group by 47.3 g ($p < 0.001$) and 68.0 g ($p < 0.001$), respectively. Feed conversion at the lowest level was recorded in pigs of the III experimental group – 3.22 kg, which is 0.28 kg less than the same value in pigs of the I control group – 3.50 kg.

Thus, according to the results of the experiment, the complex action drug «Gepasorbex» is able to remove mycotoxins, endogenous and exogenous toxic substances of various nature without binding vitamins necessary for the vital activity of animals, including pigs, which subsequently has an impact on improving the fattening characteristics of pigs.

The experiment allowed us to draw attention to the effectiveness of the use of the complex preparation «Gepasorbex» produced by Vetservisproduct in the diets of fattening young animals in feeds contaminated with mycotoxins to increase pig productivity. Animals that consumed feed containing mycotoxin adsorbents showed an increase in live weight and their average daily weight gain relative to animals in the control group, earlier reached weight conditions of 100 and 120 kg with lower feed conversion, which significantly reduces the main cost item of farms in terms of pig production technologies – «Feed». In addition, due to the complex composition of Gepasorbex components that have undergone special multi–stage processing, the product has a selective binding effect, which allows vitamins in the feed to remain and be absorbed by the pig's body.

5.4.2. Impact of «Gepasorbex» on slaughter characteristics of organisms. The study of the slaughter qualities of experimental animals was carried out according to the relevant methodological recommendations of the Institute of Pig Production and Animal Production of the National Academy of Sciences of Ukraine [117, 128, 130]. To evaluate slaughter qualities, young animals were selected for slaughter from the groups of fattening young animals when the gilts reached a live weight of 100 and 120 kg in the amount of 10 heads of each weight condition in the conditions of LLC «Tavrian Pigs», Kherson region. Then a control slaughter was carried out with the subsequent determination of the slaughter qualities of animals of the I – control and II, III experimental groups. The control slaughter with carcass deboning was carried out according to generally accepted methods [6, 90, 130].

When the appropriate pre–slaughter weight was reached, after slaughtering the animals, the head was separated by a transverse incision perpendicular to the vertebrae between the occipital processes and the first cervical vertebra, the limbs – the front limbs along the lower border of the wrist joint, the hind limbs – along the lower border of the jump joint. The carcasses were weighed and cooled for 24 hours at a temperature of + 2 to 4°C.

The following indicators were taken into account during slaughter: pre–slaughter weight (after 24 hours of starvation); slaughter weight of a paired carcass with skin, without limbs, without head and internal fat; slaughter yield (slaughter weight expressed as a percentage of pre–slaughter weight); weight of a cooled carcass without internal fat; carcass length (from the anterior edge of the pubic fusion to the anterior edge of the first cervical vertebra); thickness of the ham (above the spinous processes between the sixth and seventh thoracic vertebrae, together with the thickness of the skin); area of the «muscle eye» (tracing the contour of the cross–section of the longest back muscle – m. longissimus dorsi, at the level between the first and second lumbar vertebrae); weight of the hind third of the half–carcass (between the last and penultimate lumbar vertebrae).

Based on the assessment of the slaughter qualities of the experimental groups of pigs (Table 5.19), it was found that when slaughtered with a live weight of both 100 kg and 120 kg, the highest value of the slaughter yield was characterized by pigs of the III experimental group and outperformed their peers of the I control group by 4.1 %, where the difference is statistically significant ($p < 0.001$) and 0.5 %, respectively.

Table 5.19

Slaughter qualities of young pigs depending on from feeding the complex feed additive «Gepasorbex», x ± Sd

The purpose of the group, n = 10	Downhole yield, %	Length of half carcass, cm	Thickness of slices, mm	Area of the «muscle eye», cm^2	Weight of the hind third of the half carcass, kg
pre–slaughter live weight 100 kg					
I – control	71.1±0.76	94.6±0.58	18.2±0.89	36.8±0.34	10.9±0.32
II – experimental	75.0±0.62	96.7±0.69	15.2±0.51	39.2±0.29	11.4±0.17
III – experimental	75.2±0.58	96.7±0.62	14.0±0.54	39.8±0.28	11.6±0.21
+/– II to I	+3.9***	+2.1*	–3.0**	+2.4***	+0.5
+/– III to I	+4.1***	+2.1*	–4.2***	+3.0***	+0.7
pre–slaughter live weight 120 kg					
I – control	75.8±0.52	102.6±1.07	26.2±0.74	42.9±1.02	14.3±0.14
II – experimental	76.2±0.58	103.1±1.25	19.1±0.62	43.4±0.98	14.7±0.16
III – experimental	76.3±0.56	103.6±1.49	18.0±0.55	44.1±1.03	14.8±0.17
+/– II to I	+0.4	+0.5	–7.1***	+0.5	+0.4
+/– III to I	+0.5	+1.0	–8.2***	+1.2	+0.5*

An equally important indicator of meat quality of pigs is the length of the half–carcass. In our studies, at a pre–slaughter live weight of 100 kg, animals of both the II and III experimental groups had the highest value of this indicator – 96.7 cm, which is 2.1 cm more than the same indicator of animals of the I control group ($p < 0.05$). It is worth noting that at a pre–slaughter live weight of 120 kg, the animals of the III experimental group dominated in terms of half–carcass length and outperformed the control group by 1.0 cm, but the difference is statistically insignificant.

The experimental animals of the III group, both at slaughter with a live weight of 100 kg and 120 kg, were characterized by a thinner backbone by 4.2 cm and

8.2 cm, respectively, compared to the animals of the I control group ($p < 0.001$).

It is worth noting that absolute and relative changes in muscle and adipose tissue are reflected in changes in the area of the «muscle eye», which is an important criterion for assessing the meatiness of carcasses. According to the results of numerous studies, it has been found that the area of the «muscle eye» positively correlates with the yield of meat in pig carcasses. In the course of research, it was found that when the live weight of 100 and 120 kg was reached, the area of the «muscle eye» ranged from 36.8–39.8 cm^2 and 42.9–44.1 cm^2 in the groups. The young animals of the III experimental group significantly exceeded the animals of the I control group by the value of this indicator by 3.0 cm^2 at a pre–slaughter live weight of 100 kg, at $p < 0.001$ and 1.2 cm at a pre–slaughter live weight of 120 kg.

Regarding the weight of the hind third of the half–carcass, no significant difference was found in the experimental groups, but a tendency to a higher weight of ham was found in animals of the II and III experimental groups, which during the fattening period used mycotoxin adsorbents both «Gepasorbex» and a commercial analog.

Thus, based on the above material, we note that the use of the mycotoxin adsorbent «Gepasorbex» in the diet of young pigs of the III experimental group resulted in their better slaughter qualities both at a live weight of 100 kg and 120 kg.

5.4.3. Influence of «Gepasorbex» on chemical properties of the longissimus dorsi muscle. Currently, there is a trend in the pig industry to increase meat yield with simultaneous improvement of pork quality. However, most animals with high meat yields have an increased moisture content and, as a result, flabbiness is recorded and the color intensity of meat raw materials decreases, which causes unprofitability of the entire meat processing industry of the country [126, 134, 137, 138].

From the carcasses of slaughtered animals of each of the three groups, 10 samples of the longest back muscle 400 g between the 9th–12th thoracic vertebrae were taken [78, 104–107, 126–129].

To determine the chemical composition of the longest back muscle (m. longissimus dorsi) in an independent laboratory of LLC «Expert Center Biolights» was determined by mass fraction, %: moisture – by drying to a constant mass of the analyzed sample with quartz sand at a temperature of 103 ± 2°C (DSTU *ISO* 1442:2005 (gravimetric)); protein – by the Kjeldahl method followed by photometric measurement of the degree of intensity of indophenol blue staining, which is proportional to the amount of ammonia in the mineralized material according to DSTU *ISO* 937:2005 (trimetric); fat – by extraction with petroleum ether on a Soxhlet device according to DSTU ISO 1443:2005 (gravimetric)); ash – by drying, charring and ashing the samples in a muffle furnace at a temperature of 550 ± 25 °C according to DSTU ISO 936:2008 «Meat and meat products. Method for determining the mass fraction of total ash». The performed research methodology is included in the scope of accreditation for compliance with DSTU ISO/IEC 17025:2017 [80].

Evaluation of slaughter products shows (Table 5.20) that the chemical properties of meat in animals depend on the purpose of the group in the experiment. The analysis of the research results allows us to note that the mass fraction of moisture in the meat of animals of all experimental groups was in the range of 63.75–68.25 % at a pre–slaughter weight of 100 kg and 63.21–67.70 % at a slaughter weight of 120 kg.

The value of the mass fraction of moisture was within the physiological norm, but we found a significant difference between the groups of pigs in this indicator. It should be noted that at a pre–slaughter weight of 100 kg and 120 kg, animals of both the II and III experimental groups had a significantly lower moisture content in meat – 65.43 % and 63.75 % and 65.12 % and 63.21 %, respectively, than young pigs of the I control group – 68.25 % at 100 kg and 67.70 – 120 kg, where the differences are statistically significant ($p < 0.001$).

The presence of adipose tissue in meat is known to increase its caloric value, contribute to tenderness and flavor. However, too much fat leads to a relative decrease in protein content, as the nutritional value decreases [109].

Table 5.20

Chemical composition of the longest muscle of the back of pigs (*m. longissimus dorsi*) depending on the feeding of the complex feed additive, n= 10, x ± Sd

Assignment of groups	Mass share, %			
	moisture	protein	fat	ashes
pre–slaughter live weight 100 kg				
I – control	68.25±0.389	19.08±0.331	11.65±0.473	1.02±0.029

II – experimental	65.43±0.291	19.36±0.326	14.09±0.494	1.12±0.037
III – experimental	63.75±0.382	21.92±0.390	13.05±0.362	1.28±0.022
+/– II to I	–2.82***	+0.28	+2.44***	+0.10*
+/– III to I	–4.50***	+2.84***	+1.40*	+0.26***
pre–slaughter live weight 120 kg				
I – control	67.70±0.504	18.90±0.327	12.22±0.272	1.18±0.033
II – experimental	65.12±0.419	19.00±0.368	14.72±0.312	1.16±0.029
III – experimental	63.21±0.480	21.75±0.340	13.65±0.278	1.39±0.027
+/– II to I	–2.58***	+0.10	+2.5***	–0.02
+/– III to I	–4.49***	+2.85***	+1.43***	+0.21***

The results of the analysis of the chemical composition of muscle tissue of experimental animals showed that the highest fat content in meat was recorded in pigs at a pre–slaughter live weight of 100 kg of the II experimental group at the level of 14.09 %, which significantly exceeded the value of the same indicator of the I control group by 2.44 % ($p < 0.001$). At a pre–slaughter live weight of 120 kg, pigs of the II experimental group also had the highest mass fraction of fat – 14.72 %, which significantly exceeded the peers of control group by 2.5 % ($p < 0.001$). It should be noted that in terms of the mass fraction of fat in meat, animals of the III experimental group that consumed the complex additive of mycotoxin adsorbent «Gepasorbex» occupied an intermediate position and the value of this indicator at a pre–slaughter live weight of both 100 and 120 kg was at the level of 13,05 % and 13.65 %, which indicates the obvious caloric content and tenderness of meat raw materials obtained from animals of this group while maintaining the mass fraction of protein, which affects the nutritional value of meat.

An essential component of meat is proteins, consisting of essential and nonessential amino acids [23]. Thus, when slaughtering animals with a live weight of 100 kg, a higher content of the mass fraction of protein was observed in young pigs of the III experimental group – 21.92 %±0.390, which significantly ($p < 0.001$) exceeded the same indicator of animals of I control group. A similar probable predominance of pigs of the III experimental group relative to control animals by the value of this indicator was observed in the slaughter of young animals at a live weight of 120 kg – by 2.85 %, where $p < 0.001$.

Regarding the mass fraction of ash, we note that in the meat of animals of all experimental groups, it ranged from 1.02–1.28 % at slaughter of 100 kg and slightly more than 1.16–1.39 % – at 120 kg. According to this indicator, a significant difference was found between the animals of the control group and their counterparts from the experimental groups at a pre–slaughter weight of 100 kg. Thus, it amounted to 0.10 % ($p < 0.05$) in the second experimental group, and 0.26 % ($p < 0.001$) in the third experimental group. At a pre–slaughter weight of 120 kg, a slightly different trend was observed. According to the ash content in the meat of pigs of the control group and their analogues from the experimental groups, a significant difference was found only in the animals of the III experimental group – 0.21 % ($p < 0.001$), and the animals of the II experimental group were 0.02 % inferior to the pigs of the control group, although the difference was not statistically significant. Thus, under the condition of increased moisture content and a lower percentage of dry matter in meat obtained from pigs of the first control group at slaughter of 100 kg, a lower ash content was noted – 1.02 %±0.029. At slaughter of 120 kg, a lower ash content of 1.16 %±0.029 was inherent in the animals of the second experimental group.

According to the results of the experiment, it was found that the meat of animals treated with the complex additive of mycotoxin adsorbent «Gepasorbex» (Vetservisproduct LLC) is characterized by a higher protein content and lower fat content compared to the meat of pigs of the II experimental and I control groups. With an increase in pre–slaughter live weight from 100 to 120 kg, the meat of animals of all experimental groups showed a tendency to increase the content of intramuscular fat due to a decrease in protein and moisture content. Thus, the chemical composition of the meat of the animals of the experimental groups, both at 100 kg and 120 kg slaughter, met the requirements for normal quality pork.

5.4.4. Effects of «Gepasorbex» on amino acid composition of muscle tissue of individuals. The functional property and nutritional value of muscle tissue is due to the presence of protein components in its composition. The special value of protein compounds lies in the ability to serve as a source material for the formation of important structural elements in the human body, in particular: blood proteins, enzymes, hormones, tissues, etc.

Due to its physiological characteristics, the human body is unable to synthesize a number of essential amino acids, including isoleucine, leucine, lysine, methionine, threonine, tryptophan, valine, and phenylalanine. These amino acids are indispensable for tissue synthesis and must be supplied as part of proteins. In turn, tyrosine can be partially replaced by phenylalanine, cystine by methionine, arginine and histidine are partially synthesized by the human body, so these amino acids, according to some authors, are considered conditionally essential amino acids [108, 110].

The amino acid composition in the muscle tissue of pigs at pre–slaughter live weight of 100 and 120 kg in the amount of 5 samples of each group was determined by ion–exchange chromatography PV.BLS 7.2–04/10 using an automatic amino acid analyzer T–339, Mikrotechna (Prague, Czech Republic) in an independent laboratory of LLC «Expert Center «Biolights»» with preliminary hydrolysis of muscle tissue proteins in an acidic environment. To assess the biological value of meat, the amino acid index, which reflects the ratio of the content of essential amino acids to their total amount, and the amino acid score (the basis for calculating this indicator is the determination of the percentage of each of the essential amino acids in food protein in relation to their content in protein, taken as «ideal») were determined according to a generally accepted formula.

In order to determine the fullness of the protein under study, along with the determination of the amino acid score, the limiting amino acid was also determined. An amino acid is considered limiting only if its amino acid score is less than 100 %.

To more fully determine the biological value of meat, we calculated the protein–quality index, which is determined by the ratio of the essential amino acid tryptophan to oxyproline (a nonessential amino acid).

Oxyproline was determined according to the current DSTU 50207–92 (*ISO* 3496–78). Tryptophan in meat was determined by the method of Spies and Chambers (1949), as modified by *Geller* (1958) [6, 105].

In pigs, the balance of amino acids in the body is individual, since protein, consisting of chains of amino acids, must be contained in the feed supplied to the animals from the diet. The experimental animals in our experiment either did not use or used different feed additives of mycotoxin adsorbents, so there are differences in the amino acid composition of pig meat of the experimental groups (Table 5.21).

Table 5.21

The content of essential amino acids at pre–slaughter live weight of 100 kg in the longest back muscle of pigs (m. longissimus dorsi), g/100 g, x ± SD

Amino acid	Assignment of groups, n = 5		
	I – control	II – experimental	III – experimental
Alanine	1.20±0.001	1.32±0.002***	1.35±0.003***
Arginine	1.19±0.001	1.22±0.002***	1.30±0.001***
Histidine	0.78±0.002	0.88±0.004***	0.92±0.002***
Glycine	0.86±0.001	0.94±0.003***	0.96±0.001***
Aspartic acid	1.21±0.004	1.23±0.005***	1.26±0.004***
Glutamic acid	1.52±0.007	1.78±0.011***	1.92±0.014***
Proline	0.83±0.001	0.86±0.002***	0.94±0.001***
Serine	0.84±0.002	0.88±0.002***	0.98±0.003***
Tyrosine	0.81±0.001	0.87±0.003***	0.93±0.002***
Cystine	0.78±0.002	0.76±0.008	0.87±0.004***
Total	10.02	10.74	11.43

Based on the results of the content of essential amino acids at a pre–slaughter live weight of 100 kg in the longest back muscle of pigs, it was found that the experimental groups of pigs that used mycotoxin adsorbents significantly ($p < 0.001$) prevailed in the value of essential amino acids in animals of the first control group. As a result, the maximum amount of nonessential amino acids per 100 g of muscle tissue of the longest back muscle was recorded in animals of the III experimental group – 11.43 g, the minimum – in pigs of the I control group at the level of 10.02 g and the intermediate position belongs to pigs of the II experimental group – 10.74 g.

Further, according to the results of the test protocol, we studied the content of essential amino acids at a pre–slaughter live weight of 100 kg in the longest muscle of the pig's back (Table 5.22).

As a result of the evaluation of the amino acid composition of proteins of the longest back muscle of pigs at slaughter of 100 kg, it was found that the maximum value of essential amino acids was in the animals of the III experimental group, which consumed a complex additive of mycotoxin adsorbent «Gepasorbex» – 9.11 g, and a lower amount of the same indicator is inherent in pigs of the I control group, where the total amount of essential amino acids is 6.84 g.

Thus, 100 g of muscle tissue protein obtained from the carcasses of pigs of the control group I contains 6.84 g of essential amino acids and 10.02 g of nonessential amino acids; in the meat of pigs of the II experimental group, which consumed a commercial analog of the mycotoxin adsorbent, essential amino acids – 7.55 g, and 10.74 g of substitutable amino acids; in the meat of the III experimental group, pigs fed with the complex additive «Gepasorbex», contains 9.11 g of essential amino acids, 11.43 g of substitutable amino acids.

Table 5.22

The content of essential amino acids at pre–slaughter live weight of 100 kg in the longest back muscle of pigs (*m. longissimus dorsi*), g/100 g, x ± SD

Amino acid	Assignment of groups, n = 5		
	I – control	II – experimental	III – experimental
Valine	1.24±0.004	1.28±0.003***	1.39±0.012***
Isoleucine	1.39±0.002	1.48±0.004***	1.55±0.003***
Leucine	1.13±0.015	1.14±0.014	1.26±0.017***
Lysine	1.34±0.003	1.46±0.002***	2.07±0.002***
Methionine	0.46±0.001	0.59±0.001***	0.84±0.002***
Threonine	0.59±0.003	0.78±0.001***	1.05±0.001***
Phenylalanine	0.69±0.002	0.82±0.002***	0.95±0.011***
Total	6.84	7.55	9.11

Regarding the amino acid index (the ratio of essential amino acids to nonessential amino acids), we note that the highest value was in pigs of the III experimental group at 79.70 %, a slightly lower value was recorded in the meat of animals of the II experimental group – 70.30 % and the lowest value was inherent in animals of the I control group – 68.26 % (Table 5.23).

Amino acids from feed are not fully absorbed in the body of animals. Only a part of them is absorbed in the small intestine and participates in metabolic processes, affecting productivity.

Table 5.23

Amino acid composition, ratio of essential to nonessential amino acids at pre–slaughter live weight of 100 kg in the longest back muscle of pigs (*m. longissimus dorsi*), g/100 g

Amino acid	Assignment of groups, n = 5		
	I – control	II – experimental	III – experimental

Irreplaceable	6.84	7.55	9.11
Replaceable	10.02	10.74	11.43
Total	16.86	18.29	20.54
Amino acid index, % (ratio of essential/replaceable)	68.26	70.30	79.70

The undigested part of amino acids is excreted in the feces, moving peristally to the large intestine. The digestibility of amino acids in the animal body depends on a large number of factors, including: the component composition of the feed, its production technology, the presence of mycotoxins that increase the amount of unassimilated amino acids, the presence of anti–nutrients, the health of the animal, etc.

The determination of the biological value of meat is associated with the balance of its amino acid composition, since the most complete and objective assessment of meat quality can be established only by determining the amino acid composition of muscle tissue proteins, as well as the ratio of essential and nonessential amino acids in it [32].

As noted by *Pron E.V., Danilova T.N., Donskikh T.V.* [116], the amino acid composition of meat proteins depends on the sex, age of pigs, weight condition, physiological state before slaughter, etc.

The results of the evaluation of the amino acid composition of muscle tissue proteins at 120 kg slaughter are presented in Table 5.24. It should be noted that in general, muscle tissue proteins of the experimental groups of young pigs are quite similar in their amino acid composition.

According to the data of Table 5.24, as a result of the assessment of the amino acid composition of muscle tissue proteins of the longest back muscle at 120 kg slaughter of pigs, the highest content of essential amino acids was recorded in pigs of the III experimental group – 10.41 g, the lowest content was observed in the meat of peers of the I control group – 9.18 g.

Table 5.24

Amino acid content at pre–slaughter live weight of 120 kg in the longest back muscle of pigs (m. longissimus dorsi), g/100 g, x ± SD

Amino acid	Assignment of groups, n = 5		
	I – control	II – experimental	III – experimental

Valine	1.19±0.002	1.23±0.003***	1.21±0.001***
Isoleucine	1.16±0.002	1.17±0.001**	1.19±0.002***
Leucine	1.73±0.017	1.70±0.014	1.74±0.015*
Lysine	2.42±0.003	2.44±0.002**	2.51±0.002***
Methionine	0.59±0.001	0.56±0.001	0.62±0.002***
Threonine	1.15±0.003	1.17±0.001***	1.16±0.001*
Phenylalanine	0.94±0.002	0.96±0.002***	0.98±0.001***
Total essential amino acids	**9.18**	**9.23**	**10.41**
Alanine	1.18±0.001	1.19±0.001*	1.22±0.001***
Arginine	1.67±0.001	1.63±0.004	1,78±0.006***
Histidine	1.16±0.002	1.18±0.003**	1.22±0.002***
Glycine	0.94±0.001	0.94±0.001	0.96±0.001**
Aspartic acid	2.31±0.004	2.31±0.005	2.31±0.004
Glutamic acid	3.57±0.007	3.61±0.005***	3.58±0.012*
Proline	0.72±0.001	0.73±0.002*	0.73±0.001*
Serine	0.89±0.002	0.89±0.002	0.90±0.001*
Tyrosine	0.74±0.001	0.79±0.003***	0.79±0.002***
Cystine	0.33±0.001	0.34±0.002*	0.34±0.002*
Total essential amino acids	**13.51**	**13.61**	**13.83**
Total amount of amino acids	22.69	22.84	24.24
Amino acid index, %	67.95	67.82	75.27

Determining the content of essential amino acids, the maximum amount of 13.83 g was obtained in the protein of pigs of the III experimental group, and the minimum amount was found in animals of the I control group – 13.51 g.

As a result of thorough research into the basics of healthy human nutrition, the FAO and WHO Joint Committee proposed a standard for the amino acid composition of a product that would best meet the needs of the human body [50]. To compare the amino acid composition of the meat protein of the test samples of the experimental groups with the reference, the so–called «ideal» protein, we calculated the amino acid score according to the generally accepted formula.

The content of essential amino acids in the studied protein of meat raw materials at slaughter in 100 kg of the experimental groups and in the "ideal" protein (mg/g) in terms of 100 g of protein is given in Table 5.25.

Table 5.25

Content of essential amino acids in protein, mg/g

Amino acid	The «ideal» protein according to FAO/WHO	Assignment of groups, n = 5		
		I control	II experimental	III experimental
Valine	50	50.6	51.0	53.7
Isoleucine	40	49.4	48.9	51.1
Leucine	70	71.8	71.6	71.2
Lysine	55	102.8	103.2	106.5
Methionine	35	36.6	37.3	38.2
Threonine	40	47.7	51.9	51.1
Phenylalanine	60	73.8	73.5	73.2

After the laboratory determination of the number of amino acids in the protein samples under study, the amino acid score and limiting acid were determined for each group of experimental animals. The calculation results are presented in Table 5.26.

In order to determine the fullness of the protein under study, along with the determination of the amino acid score, the limiting amino acid is also determined. An amino acid is considered limiting only if its amino acid score is less than 100 %.

Table 5.26

Amino acid score, %

Amino acid	Assignment of groups, n = 5		
	I – control	II – experimental	III – experimental
Valine	101.2	102.0	107.4
Isoleucine	123.5	122.3	127.8
Leucine	102.6	102.3	101.7
Lysine	186.9	187.6	193.6
Methionine	104.6	106.6	109.1
Threonine	119.3	129.8	127.8
Phenylalanine	123.0	122.5	122.0

The digital data in Table 5.26 convincingly show that the protein samples of all experimental groups do not contain a limiting amino acid, in other words, the amount of essential amino acids exceeds their content in the «ideal» protein. Therefore, we state that the meat protein in young animals of all experimental groups is complete.

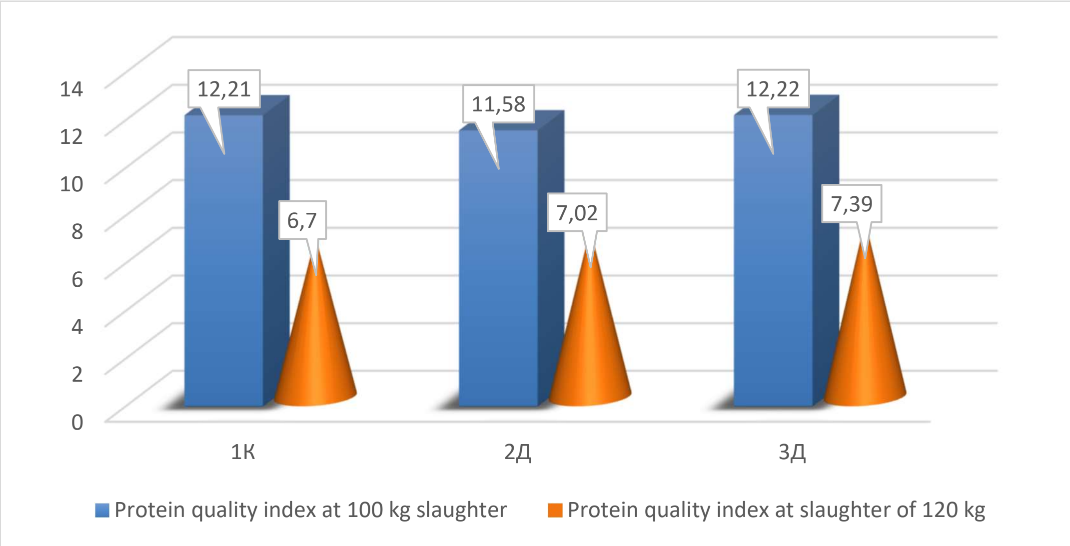


Fig. 5.7. **Protein–quality index of meat of experimental groups of pigs at slaughter of 100 and 120 kg**

Notes: 1C – pigs of the first control group; 2D – animals of the second experimental group; 3D – young pigs of the third experimental group.

For a more complete determination of the biological value of meat, it is worth calculating the protein–quality index, which is determined by the ratio of the essential amino acid tryptophan to oxyproline (a nonessential amino acid). Since the amount of oxyproline in muscle tissue determines the content of connective tissue proteins, the more of these proteins in meat, the lower its biological value. The results for the protein–quality indicator are shown in Fig. 5.7.

The maximum value of the protein–quality index at slaughter both at 100 kg and 120 kg is characterized by animals of the III experimental group – 12.22 and 7.39, respectively.

According to the general zootechnical requirements, the protein–quality index of meat of the experimental groups of pigs at slaughter with a live weight of 100 kg corresponds to high–quality pork. However, with age, the content of connective tissue increases, and therefore, when slaughtering experimental groups of pigs with a live weight of 120 kg, we observe a decrease in the protein–quality index of meat raw materials due to an increase in the content of the substitutable amino acid oxyproline and, accordingly, a decrease in the essential amino acid tryptophan.

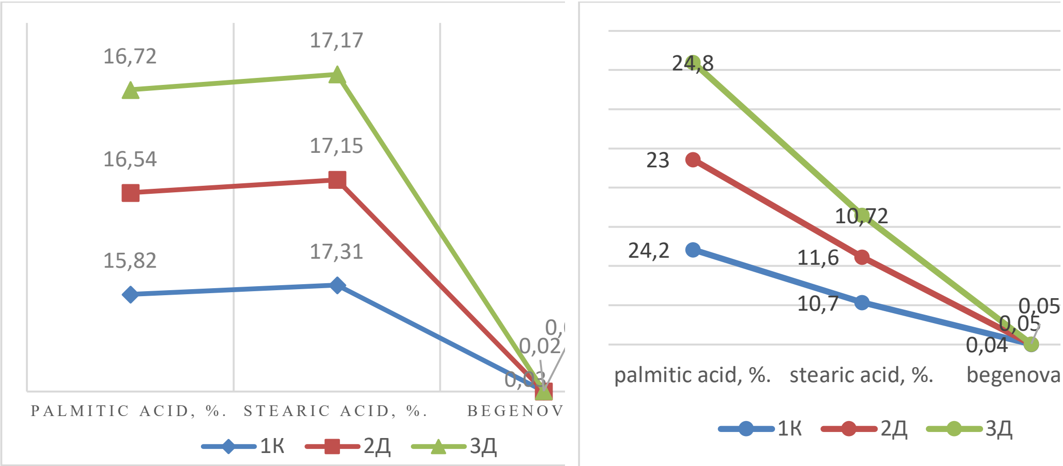
Thus, the above research results indicate that feeding pigs with mycotoxin adsorbent in the form of a complex feed additive «Gepasorbex» prevents the binding of vitamins, which, in turn, performing their coenzyme functions, affect the absorption of amino acids in the intestine and, as a result, promote their biosynthesis in muscle tissue. This justification is confirmed by the fact that the amino acid index (the ratio of essential amino acids to nonessential amino acids) is the highest in pigs of the III experimental group both at slaughter of 100 kg – 79.70 % and at slaughter of 120 kg – 75.27 %, and the protein–quality index (the ratio of tryptophan to oxyproline) is 12.22 and 7.39, respectively

Thus, it can be argued that animals consuming the «Gepasorbex» feed additive accumulate the most amino acids in their bodies.

5.4.5. Impact of «Gepasorbex» on fatty acid composition of meat of organisms. In order to fully biologically evaluate the meat of the experimental groups of pigs, it is necessary to analyze the fatty acid composition. The nutritional value of meat depends on the lipid composition of muscle tissue, since it is the lipids of meat that provide its specific taste, biological value and juiciness [3, 83, 84].

The fatty acid composition of the studied meat samples in the amount of 5 units of each group of pigs (I – control, II – experimental, III – experimental) at the pre–slaughter live weight of 100 kg and 120 kg was determined in an independent laboratory of LLC «Expert Center «Biolights» in accordance with DSTU *ISO* 5508 – 2001 «Fats and oils of animals and plants», DSTU *ISO* 5509–2002 «Analysis by gas chromatography of fatty acid methyl esters» [35, 36].

The results of the laboratory study on the content of saturated fatty acids in the meat of experimental animals at slaughter of 100 and 120 kg are shown in Fig. 5.8.



for slaughter of 100 kg with a slaughter weight of 120 kg

Fig. 5.8. **Dynamics of saturated fatty acids content in meat of experimental groups of pigs at different weight conditions**

Notes: 1C – animals of the first control group; 2D – pigs of the second experimental group; 3D fattening cattle of the third experimental group.

The digital data of the graphs on the change in the content of saturated fatty acids in the meat of the experimental groups of pigs at slaughter of the latter with a live weight of 100 and 120 kg indicates that the content of palmitic fatty acid in the meat of experimental pigs increases with age, its content varies at slaughter of 100 kg – 15.82–16.72 %, and at 120 kg – 23.0–24.8 %.

Regarding stearic acid, which serves as a storage of energy reserves, we note that its content at slaughter of 100 kg in the experimental groups of pigs was at the level of 17.15–17.31 %, and at slaughter of 120 kg the value of the indicator decreased slightly, which is obvious, and ranged from 10.70–11.60 %.

Since behenic acid is mainly found in plant products, the results of laboratory analysis in the meat of animals of the experimental groups revealed its insignificant amount, which corresponds to the normative indicators and ranged from 0.02–0.04 % – at slaughter of 100 kg and 0.04–0.05 % – at slaughter of 120 kg. With an increase in its amount in products of animal origin, the latter can increase the level of cholesterol in human blood [38].

Thus, our research has established that the total content of saturated fatty acids in animals of the III experimental group, which consumed a complex additive of mycotoxin adsorbent «Gepasorbex» at slaughter of 100 kg was within the physiological norm, but higher than in other experimental groups and amounted to

33.93 %, which is 0.22 % more than in animals of the II experimental group and 0.77% more than in control pigs. A similar trend persists at the slaughter of 120 kg pigs, which probably indicates a positive effect of the feed additive on the biosynthesis of lipids in the muscle tissue of the pig body.

The next step in determining the effect of the complex additive «Gepasorbex» on the fatty acid composition of pig meat was to study unsaturated fatty acids.

The results of the laboratory study on the content of unsaturated fatty acids in the meat of experimental animals at slaughter of 100 and 120 kg are shown in Fig. 5.9.

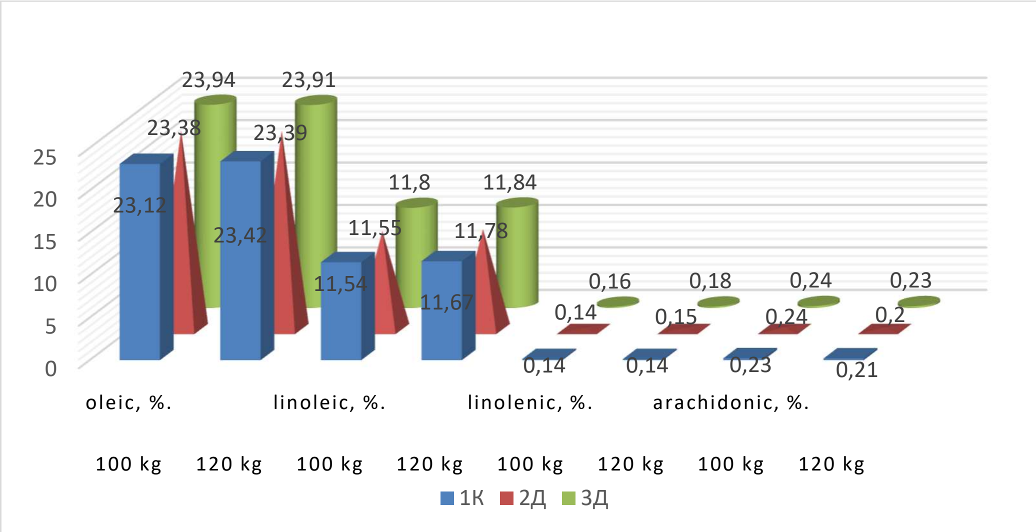


Fig. 5.9. **Dynamics of saturated fatty acids content in meat of experimental groups of pigs at different weight conditions**

Notes: 1C – animals of the first control group; 2D – pigs of the second experimental group; 3D fattening cattle of the third experimental group.

According to the figure, it was found that the highest content of unsaturated fatty acids in adipose tissue (within the physiological norm) was in young pigs of the III experimental group at slaughter of 100 kg – 36.14 % and slightly decreased at slaughter of 120 kg – 36.12 %, and the lowest in animals of the II experimental group – 35.25 % at slaughter of 100 kg and 35.39 % at slaughter of 120 kg.

Based on the analysis, we conclude that, in general, the content of linoleic, linolenic, and arachidonic acids in the first control and experimental groups is satisfactory both at slaughter of 100 kg and 120 kg. However, our experiment has shown that the fatty acid composition of meat from pigs that did not use mycotoxin adsorbents during feeding is unbalanced. It is proved that in order to obtain high–

quality balanced adipose tissue, it is necessary to organize the feeding of animals with feed additives that bind and remove mycotoxins from the intestine, as well as positively affect the biosynthesis of fatty acids in the pig's body.

5.4.6. Effects of «Gepasorbex» on macronutrient composition of meat of individuals. The composition of the meat of pigs of the experimental groups at slaughter of 100 and 120 kg was studied for the content of macronutrients, in particular calcium and phosphorus (calcium – by the trilonometric method; phosphorus – by the photometric method using an electrophotometer of the KFC–3 brand). The spectral analysis data are shown in Fig. 5.10.

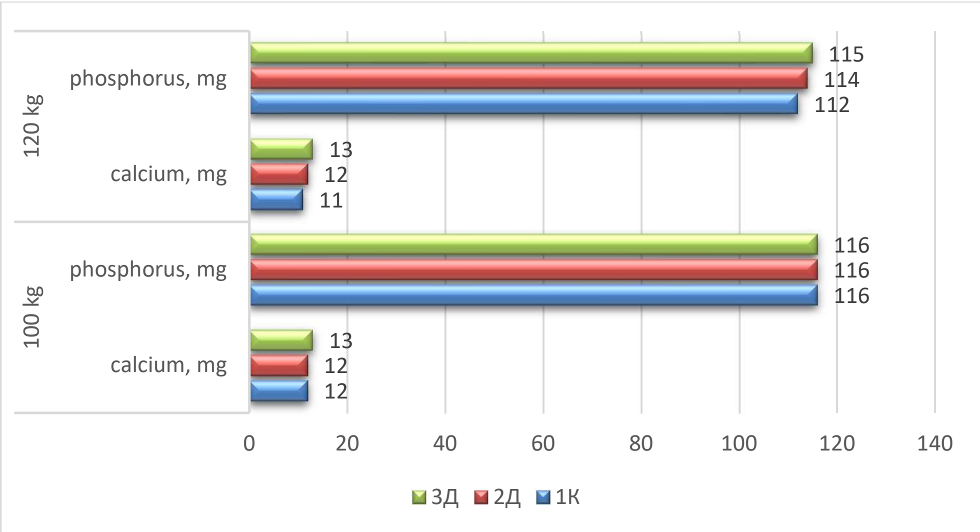


Fig. 5.10. **Calcium and phosphorus content in pig meat 100 g, mg**

Notes: 1C – animals of the first control group; 2D – pigs of the second experimental group; 3D fattening cattle of the third experimental group.

The analysis of the results shows that the meat of pigs from all three groups has a fairly good macronutrient composition in terms of the content of the minerals studied. The content of these nutrients in the meat of all groups was almost the same both at slaughter of 100 kg and 120 kg. For example, the calcium content varied within the groups at 100 kg slaughter – at the level of 12–13 mg, and 120 kg – 11–13 mg. As for phosphorus, the situation is as follows: 116 mg was typical for all experimental groups at 100 kg slaughter, 112–115 mg – at 120 kg.

Thus, as a result of the study, we conclude that complex feed additive of mycotoxin adsorbent «Gepasorbex» in a particular case did not affect the content of calcium and phosphorus in animal meat at slaughter of 100 kg, 120 kg.

5.4.7. Methodology for using «Gepasorbex» to boost young stock productivity. Methods of controlling mycotoxins are currently undergoing a significant evolution, which has resulted in the use of bentonites and aluminosilicates, which are active against only a few mycotoxins, to the use of modified glucomannans, which strongly and quickly adsorb almost all mycotoxins known to date. Due to the urgency of the problem, the purpose of the research was to study the effectiveness of using different doses of the complex drug «Gepasorbex» produced by Vetservisproduct in the diets of young pigs in fattening.

The well–known method of using the complex drug «Gepasorbex» as a sorbent of mycotoxins to increase the productivity of pigs of different technological groups is used in constant doses, despite the duration of use [63, 65, 206].

Thus, the drug «Gepasorbex» after 30 days of normative use at a dose of 1.2–2.0 kg/t is used in a reduced dose by 50 % – 0.6–1.0 kg/t, with an average level of contamination with mycotoxins of feed. Animals of the first control group consumed the basic diet during the fattening period; pigs of the second experimental group were administered the mycotoxin sorbent «Gepasorbex» in the basic diet at a dose of 1.2–2.0 kg/ton of feed (standard dose at an average level of contamination); young pigs of the third experimental group were administered the complex preparation «Gepasorbex» in the basic diet at a dose of 0.6–1.0 kg/ton of feed.

Thus, we emphasize that after 30 days of normative use, the normative dose was reduced by 50 %, and other technological factors of feeding and housing were identical for all experimental groups of pigs.

It is worth noting that the main feed was used to feed pigs in the experimental groups and was recognized as slightly toxic according to laboratory tests. The issue of profitability in livestock farming is key to developing new strategies for feeding farm animals. In a period of fluctuating raw material prices and purchase prices for animal products, producers must be provided with effective solutions to optimize costs and increase animal productivity.

The results of fattening young pigs of the experimental groups with the use of the complex preparation «Gepasorbex» are presented in Table 5.27.

It should be added that the young animals of all groups, when put on fattening, after the equalization period had almost the same live weight in the range of 33.6–34,6 kg at the age of 90 days. During the fattening period, the young animals of the experimental groups that consumed feed contaminated with mycotoxins, which contained mycotoxin sorbent or did not contain it, differed in the duration of their stay on fattening

Table 5.27

The results of fattening young pigs with the use of the complex preparation «Gepasorbex», x ± Sd

Indicator	Animal Group, n = 40		
	I	II	III
Assignment of groups	control	experimental	experimental
Dosage of the drug per 1 ton of feed, kg	–	1.2–2.0	0.6–1.0
Live weight of a piglet when put on fattening, kg	34.1 ±0.45	33.6 ±0.50	34.6 ±0.44
Age of reaching live weight 100 kg, days	187.6 ±3.22	178.6 ±1.90*	175.3 ±2.00**
Average daily weight gain during fattening, g	675.2 ±8.92	749.4 ±5.88***	766.7 ±6.15***
Feed conversion, kg	3.23	3.15	3.12
Preservation at fattening, %	92.5±1.00	97.5±0.89	95.0±0.88

The young pigs of group I, which consumed the main feed, were fed longer – 97.6 days, and thus were significantly inferior in this indicator to the experimental groups: animals of group II by 9 days ($p < 0.01$) and group III by 12.3 days ($p < 0.01$). This difference affected the overall age of reaching live weight100 kg, so young animals of the II and III experimental groups, which were fed with the complex preparation «Gepasorbex» at a dose of 1.2–2.0 and 0.6–1.0 %, reached live weight100 kg in 178.6 and 175.3 days, respectively.

The presence of sorbents in the feed used for fattening young animals led to higher average daily gains, respectively, animals of the second group had a value of this indicator at the level of 749,4 g, which is 11 % higher than the control group ($p < 0.001$) and animals of the third group –766,7 g , which is 13.6 % higher than the control. Higher average daily gains led to a decrease in feed conversion by young animals of the experimental groups.

Similar results were obtained when the animals of the experimental groups reached a live weight of 120 kg.

Thus, «Gepasorbex», which was introduced into the composition of feed (contaminated with mycotoxins) for fattening young animals, contributes to the improvement of fattening qualities. Higher average daily gain rates, while saving the drug itself, were obtained in pigs fed with 0.6–1,0 kg per ton of the complex drug «Gepasorbex» (after 30 days of standard use, the dose was reduced by 50 % (0.6–1.0 kg/ton), which is in contrast to the prototype where the standard introduction to the diet is 1.2–2.0 kg/ton, with an average level of mycotoxin contamination.

In order to increase productivity, prevent gastrointestinal diseases, increase the natural resistance of fattening young animals and increase the efficiency of pork production in industrial complexes, it is recommended to introduce the complex drug «Gepasorbex» in the composition of complete feed in the specified proportions. After 30 days of constant use of the drug, it is possible to reduce the standard dose of its administration without reducing productivity and therapeutic effect for fattening young pigs.

5.5. Enhancing productivity with the feed additive «Perfectin».

It has been proven that if phytogenic substances are included in the diet of animals in the right combination and dosage, the livestock producer receives significant benefits. First of all, phytogens control the state of intestinal microflora, preventing the occurrence of gastrointestinal disorders, which, in turn, smooths out immune stress in animals. In addition, phytogenic substances, due to their physical and chemical properties, can significantly change the sensory and olfactory characteristics of animal feed [54, 103, 146, 152]

This necessitates the search for optimal, natural growth stimulants for fattening pigs. The effect of the feed additive «Perfectin» produced by Vetpharm LLC, Ukraine (additional information – registration certificate AV–07088–04–17 dated 25.07.2017, ANNEX G) on the productive traits of pigs was studied

The aim of the research was to study the productivity of young pigs during the fattening period up to 100 and 120 kg depending on the feeding of this feed additive. To achieve this goal, 2 groups of experimental fattening pigs of 40 heads each were formed: pigs of the control group received the main diet – feed of own production using premixes produced by «PC Alternative» LLC; young pigs of the experimental group received the feed additive «Perfectin» in the form of a powder in the amount of 2 kg per ton of feed, in addition to the main diet. The study of fattening and slaughter qualities of experimental animals was carried out according to the relevant methodological recommendations of the Institute of Pig Production and Animal Production of the National Academy of Sciences of Ukraine [104–107, 126–129].

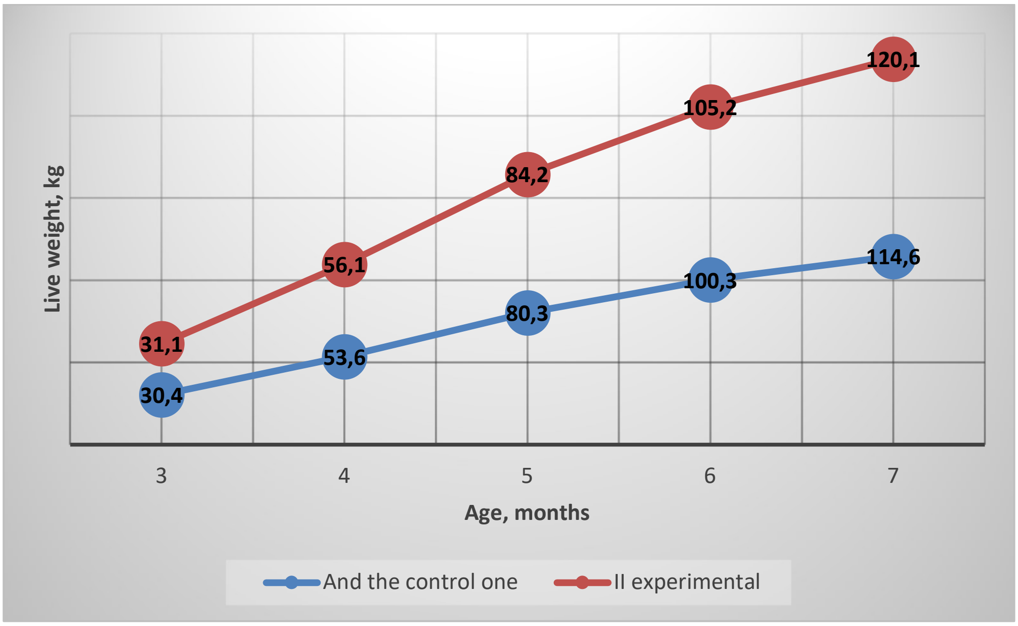


Fig. 5.11. **Dynamics of live weight of fattening pigs depending on from feeding the feed additive «Perfectin», kg**

The conducted studies have established (Fig. 5.11) that the use of the feed additive «Perfectin» in the specified amounts contributes to better growth of experimental young pigs in the age aspect. According to the results of the research, when put on fattening, the live weight of young pigs of both experimental groups was almost the same, the advantage in favor of the second experimental group was 0,7 kg, where the difference is not statistically significant.

At the age of 4 months, pigs of the II experimental group had an advantage in live weight – 56.1±0.28 kg and outperformed the peers of the I control group by this indicator at 2,5 kg, with $p < 0.001$.

A similar trend was observed at the age of 5 months, where a statistically significant difference in live weight in favor of pigs of the second experimental group was 3,9 kg ($p < 0.001$) compared to pigs of the first control group.

Regarding the six–month age period, we note that the animals of the second experimental group significantly exceeded the young pigs of the control group in terms of live weight at 7,2 kg ($p < 0.001$).

Live weight in pigs of the II experimental group at seven months of age dominated over the analogues of animals of the I control group with a significant difference of 6.2 kg at $p < 0.001$.

Thus, the results of age–related changes in live weight in the experimental groups of pigs give a clear vision that feeding the feed additive «Perfectin» contributes to an increase in live weight at the age of 4–7 months, as was the case with fattening young pigs of the second experimental group.

Since the growth rate of pigs at an early age affects their fattening and meat quality [23, 118, 141], the effectiveness of the feed additive «Perfectin» on improving the fattening traits of young pigs was investigated (Table 5.28).

The figures in the table show that animals in the second experimental group reached a live weight of 100 kg and 120 kg 9.3 and 4.7 days earlier, respectively, compared to their peers in the first control group, with $p < 0.01$.

According to the values of average daily gain on fattening, the young pigs of the II experimental group significantly exceeded the animals of the I control group by50 g at a live weight of 100 kg and 27.9 g at a live weight of 120 kg, where the difference is statistically significant ($p < 0.001$). Regarding the feed conversion rate, the advantage, as expected, belongs to the animals of the second experimental group – 3.16 kg vs. 3.32 kg at a live weight of 100 kg and 3.46 kg vs. 3.61 kg when the animals reached a live weight of 120 kg relative to the analogues of the first control group. It is postulated that feeding the feed additive «Perfectin» has a positive effect on increasing the fattening traits of young pigs.

Table 5.28

Fattening traits of young pigs depending on from feeding the feed additive «Perfectin», n = 40, x ± SD

Assignment of groups	Early maturity, days	Average daily weight gain during fattening, g	Feed conversion, kg
when reaching a live weight of 100 kg			
I – control	179.6±2.46	776.7±7.96	3.32
II – experimental	170.3±2.93	826.7±6.25	3.16
+/– II to I	-9.3^{**}	$+50.0^{***}$	–0.16
when reaching a live weight of 120 kg			
I – control	189.2±0.48	782.5±4.23	3.61
II – experimental	184.5±0.36	810.4±3.02	3.46
+/– II to I	-4.7^{**}	$+27.9^{***}$	–0.15

Then the pigs of the experimental groups were selected for slaughter to evaluate their slaughter traits [87, 130]. Evaluating the slaughter qualities of the experimental groups of pigs (Fig. 5.12), it was found that the highest value of slaughter yield was characterized by pigs of the II experimental group – 75.0±0.62 % and outperformed their peers of the I control group by 3.9 %, where the difference is statistically significant ($p < 0.01$).

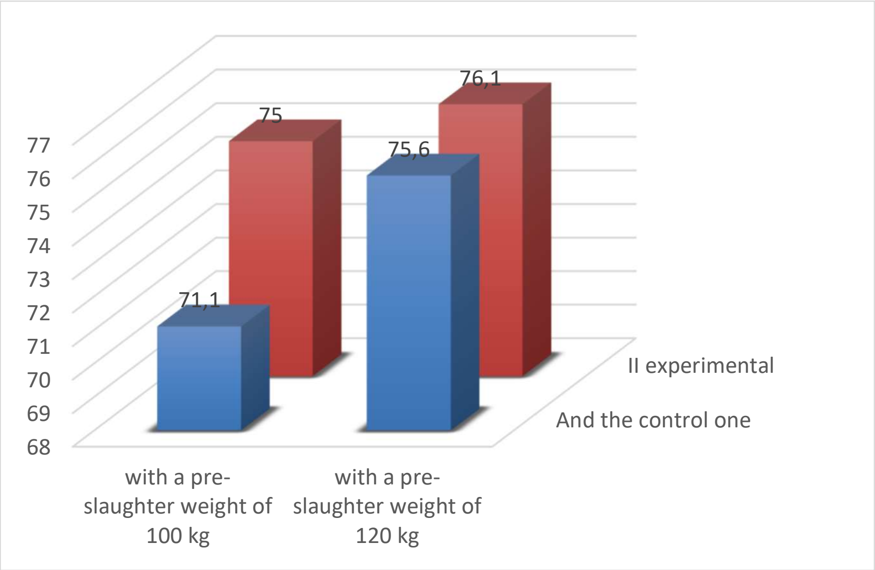


Fig. 5.12. **Slaughter yield of experimental groups of pigs by their pre–slaughter weight of 100 and 120 kg, %**

At a pre–slaughter weight of 120 kg, the advantage in slaughter yield was 0.5 % in pigs of the second experimental group (the difference is statistically insignificant).

Fig. 5.13. **Carcass length of the experimental groups of pigs according to their**

pre–slaughter weight of 100 and 120 kg, cm

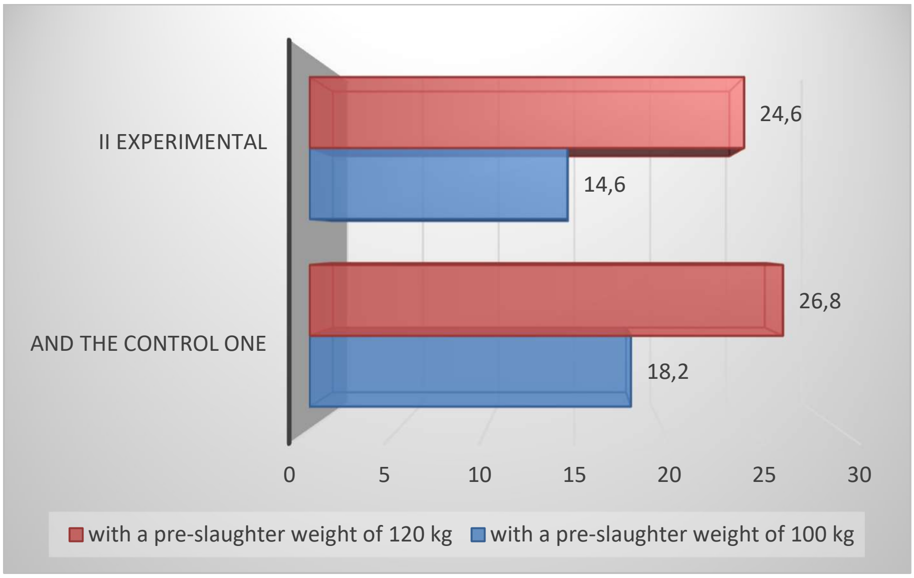


Fig. 5.14. **Fat thickness of the experimental groups of pigs according to their pre–slaughter weight of 100 and 120 kg, mm**

Based on the studies conducted, at a pre–slaughter live weight of 100 kg and 120 kg of young pigs, animals of the second experimental group had the highest value of this indicator – 96.7 cm and 104.2 cm, which is 2.1 and 1.1 cm more than the same indicator of animals of the first control group ($p < 0.05$), but in the second case the difference is statistically insignificant (Fig. 5.13).

Experimental animals of group II at a pre–slaughter weight of 100 kg were characterized by thinner fat compared to animals of the first control group by 3.6 % ($p < 0.01$).

Taking into account the global trend to increase the realizable live weight of pigs, we studied the effect of feeding the feed additive «Perfectin» on the thickness of the fat at a pre–slaughter live weight of 120 kg. According to the results (Fig. 5.14), animals of the second experimental group that consumed the additive showed a tendency to reduce the thickness of the fat by 2.2 mm compared to pigs of the first control group, the difference is not significant.

It is worth noting that absolute and relative changes in muscle and adipose tissue are reflected in changes in the area of the «muscle eye», which is an important criterion for assessing the meatiness of carcasses.

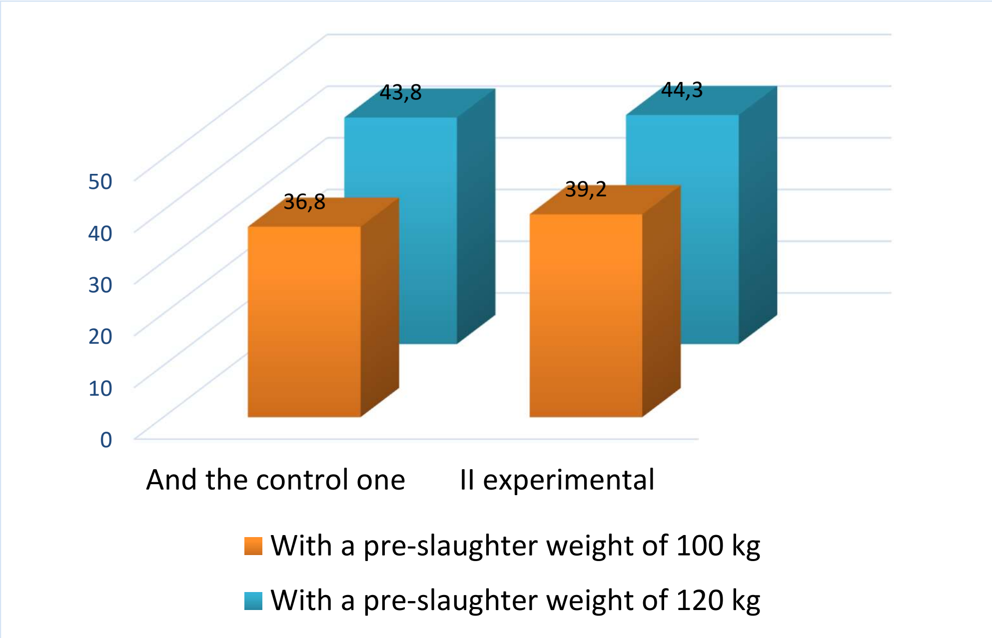


Fig. 5.15. **The area of the «muscle eye» of the experimental groups of pigs according to their pre–slaughter weight of 100 and 120 kg, cm²**

According to the results of numerous studies, it was found that the area of the «muscle eye» positively correlates with the yield of meat in pig carcasses. Thus, when reaching a live weight of 100 kg and 120 kg, the area of the «muscle eye» ranged from 36.8–39.2 cm^2 and 43.8–44.3 cm^2, respectively (Fig. 5.15). The young animals of the second experimental group significantly exceeded the animals of the first control group by the value of this indicator at a live weight of 100 kg by 2.4 cm^2, at $p < 0.001$, and at 120 kg – by 0.5 cm^2, where the difference is not significant.

Regarding the weight of the hind third of the half–carcass (Fig. 516), no significant difference was found in the experimental groups, but a tendency to a higher weight of ham was found in animals of the second experimental group, which consumed the feed additive «Perfectin» during the fattening period

Summarizing the above, we indicate that the use of the feed additive «Perfectin» in the diet of young pigs of the II experimental group resulted in their better growth, fattening and slaughter qualities.

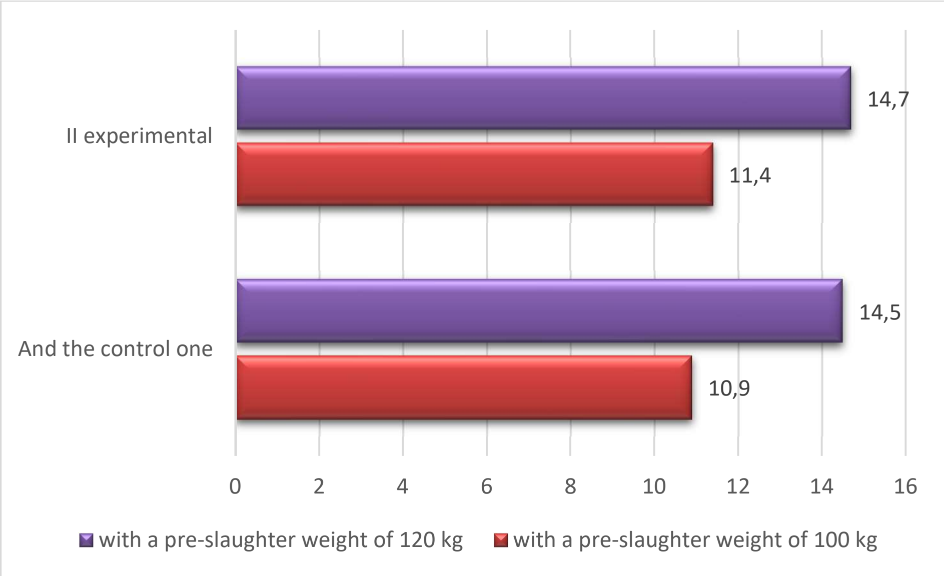


Fig. 5.16. **Weight of the hind third of the carcass of the experimental groups of pigs according to their pre–slaughter weight of 100 and 120 kg, kg**

It is worth noting that the meat productivity of pigs is determined by both quantitative (meat and fat yield) and qualitative indicators. The latter are based on the quantitative ratio, the degree of formation of muscle and adipose tissue, as well as the presence of highly balanced components in the diets of animals, in particular: premixes, probiotics and feed additives [23, 28]. Since the meat of pigs whose diets include various feed additives has a complex of histo–morphological features that determine its degree of maturity, pigs at the same age period produce meat raw materials of different histo–morphological composition

During the control slaughter of animals weighing 100 and 120 kg, muscle tissue samples of the longest back muscle were taken in the amount of 10 pieces from each group, 2×2×2 cm^3 in size, which were immediately fixed in a 10 % solution of neutral formalin for one day. Then, for further storage, the samples were transferred to a 5% solution of neutral formalin. Histological preparations and their analysis were performed according to generally accepted methods [1, 50, 97, 99, 137]. Sections of samples for the study were obtained on a freezing microtome MZ–2. The analysis of the obtained sections and their photographs were made on a fluorescence microscope «AxioImager.A1» (Carl Zeiss, Germany) using EC «Plan–Neofluar» lenses 20×0.50 and 40×0.75 under the conditions of «Expert Center «Biolights» LLC. The diameter of muscle fibers and the ratio of structural components of the tissue were determined according to the method of *M. S. Koziya* and *V. O. Ivanov* [97, 99].

Based on the studies, it was found that the histological structure of muscle tissue of pigs when they reach a pre–slaughter live weight of 100 and 120 kg differs depending on the feeding of the feed additive «Perfectin» (Table 5.29).

The analysis of the histological structure of the longest back muscle of pigs of the studied groups at a pre–slaughter live weight of 100 kg proved that feed additives along with genotype are powerful factors that form and determine the specificity of somatic muscles.

Table 5.29

Histological structure of the longest back muscle of the experimental groups of pigs depending on the feeding of the feed additive «Perfectin», x ± SD

Group, n = 10	Muscle fiber diameter, μm	The ratio of structural components of the fabric, %	
		parenchyma	stroma
at a pre–slaughter live weight of 100 kg			
I	34.1±0.41	72.5±0.53	27.5±0.43
II	35.3±0.32	74.1±0.45	25.9±0.54
+/– II to I	+1.2*	+1.6*	–1.6*
at a pre–slaughter live weight of 120 kg			
I	38.6±0.44	70.14±0.72	29.6±0.32*
II	37.2±0.38	75.2±0.58	24.8±0.27
+/– II to I	–1.4*	+4.8***	–4.8***

It should be noted that the animals of the second experimental group have a significant advantage in terms of muscle fiber diameter, where the difference is 1.2 μm and is statistically significant ($p < 0.05$).

Studies have shown that the actual growth of muscle tissue parenchyma decreases and amounts to 72.5 % in animals of the first control group, compared to young pigs of the second experimental group – 74.1 %, where the difference is statistically significant ($p < 0.05$), and the amount of stromal component in the longest muscle of pigs of the first control group increases due to the development of a network of collagen fibers and amounts to 27.5 %, which is significantly higher than the percentage of stroma of the longest muscle of pigs of the second experimental group by 1.6 % ($p < 0.05$).

The micrographs demonstrate a variety of muscle tissue structure in the experimental groups of pigs depending on the feeding of the feed additive «Perfectin». Thus, there is a pronounced dynamics due to changes in the thickness of muscle fibers in the direction of their thickening (Fig. 5.17, 5.18).

Fig. 5.17. **Transverse section of the longest back muscle of the control group I**

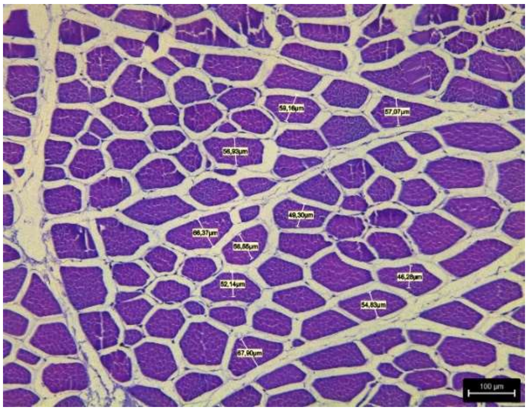


Fig. 5.18. **Transverse section of the longest back muscle of II experimental group**

At a pre–slaughter live weight of 120 kg, the following picture is observed (Fig. 5.19, 5.20): feeding «Perfectin» to pigs of the II experimental group promotes stimulation of skeletal muscle myocytes, which is clearly confirmed by the fact of increasing parenchyma by 4.8 % at $p < 0.001$, compared to control counterparts and their active growth due to acceleration of cellular metabolism, the so–called assimilating parenchyma.

This triggers the mechanism of utilization of previously accumulated nutrients. In addition, the drug «Perfectin» helps to dilate blood vessels and saturate muscle cells with oxygen. This, in turn, gives the meat a more intense color, and the fibers become more elastic.

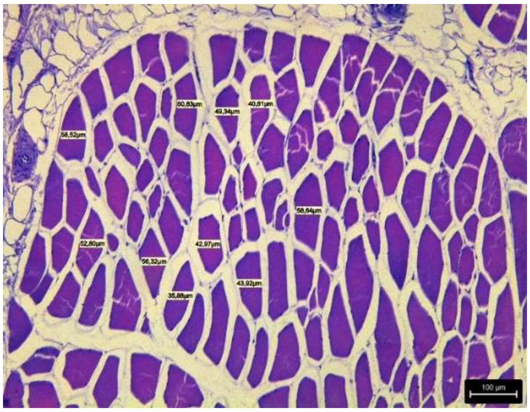


Fig. 5.19*.* **Transverse section of the longest back muscle of the control group I**

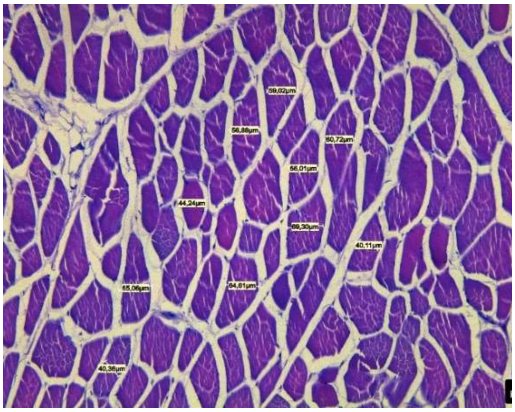


Fig. 5.20*.* **Transverse section of the longest back muscle of the second experimental group**

Regarding the thickness of muscle fibers, it should be noted that the dominant position in this indicator by 1.4 μm ($p < 0.05$) was in the animals of the first control group compared to the animals of the second experimental group. Obviously, the stromal component was also higher in pigs of the first control group by 4.8 % ($p < 0.001$) compared to their peers of the second experimental group.

Thus, based on the histological studies of the longest back muscle of pigs of the experimental groups, it was found that feeding the feed additive «Perfectin» promotes the growth of muscle fibers in animals, and the meat obtained from young pigs of the second experimental group is characterized as lean.

The results of the research allow us to assert that with the introduction of «Perfectin» per 1 ton of feed into the main diet of fattening young animals –2 kg , it is possible to increase the average daily gain at a live weight of 100 kg by 50.0 g, at a live weight of 120 kg – 27.9 g, reduce feed consumption at a live weight of 100 kg by 0.16 kg, at a live weight of 120 kg – 0.15 kg, resulting in a live weight of 100 kg and 120 kg being achieved 9.3 and 4.7 days earlier. With the use of the feed additive «Perfectin» due to better synthesis of muscle tissue, it is possible to increase meat qualities, in particular: slaughter yield at a live weight of 100 kg by 3.9%, at a live weight of 120 kg – 0.5 %, carcass length at a live weight of 100 kg at 2,1 см, at a live weight of 120 kg – 1.1 cm, muscle eye area at a live weight of 100 kg by 2.4 cm^2, at a live weight of 120 kg – 0.5 cm^2. In turn, the meat obtained from animals of the second experimental group (OR + «Perfectin») was characterized by better quality indicators and is characterized as lean.

5.6. Improving productivity through combined use of «Pro–Mac» and «Ultimade Acid» preparations.

Modern industrial pig farming is based on the principle of a technological conveyor aimed at maximizing benefits in the shortest possible time, and does not sufficiently take into account the natural balance of physiological needs and capabilities of a living organism. Thus, the stress load inherent in the very essence of modern technology of productive livestock breeding leads to a decrease in profitability, an increase in the cost of obtaining a unit of production, an increase in the cost price and causes significant economic damage. Prevention and elimination of the negative effects of stress on the body is an urgent task of animal husbandry [28, 131, 132].

Taking into account the relevance of this issue and the interest of practitioners, the aim was to study the influence of technological features of piglets during the growing and fattening period on their productive traits (live weight, average daily gain, preservation rate), taking into account the factor of complex use of «Pro–Mac» and «Ultimade Acid» (manufactured by Kanters Special Products BV, the Netherlands) in their feeding.

According to the manufacturer, the «Pro–Mac» stress corrector contains a complex of vitamins, amino acids, trace elements, herbal supplements and essential oils that have a multifaceted effect on almost all body systems, stimulating their activity. As a result, they provide a good start for young pigs and high growth energy during fattening, helping to effectively «launch» the digestive, immune, hormonal and nervous systems and maintain them under stressful conditions in industrial technology (for more information, see registration certificate AA–05695–04–15 of 25.02.2015, Annex K).

«Ultimade Acid» is a complex of organic acids: formic, propionic, lactic, sorbitolic, whose main function is to lower the pH of the stomach, stimulate enzyme formation, prevent the reproduction of E. coli and Salmonella, antifungal and antimycotoxic effects, activation of growth and development of small intestinal villi at all periods of cultivation (additional information – registration certificate AA–05696–04–15 dated 25.02.2015, Annex L).

In order to test the integrated use of heterogeneous drugs, a scientific and economic experiment was conducted on suckling piglets, piglets at the first stage of growing and fattening young pigs in the conditions of «Tavrianski Svini» LLC, Kherson region. The total number of pigs to be studied was 1761 heads. According to the research scheme, it was planned to evaluate the productive effect of «Pro–Mac» and «Ultimade Acid» both independently and in combination. The experimental pigs were divided into two groups: I – control group – pigs were reared according to the basic technology of using water–soluble additives «Pro–Mac» and "Ultimade Acid" during weaning, when transferred to growing and fattening, namely four days before weaning (transfer), «Pro–Mac» was administered through the feeding system and within seven days after weaning (transfer), «Ultimade Acid» was administered through the feeding system; II – experimental group – pigs were reared according to the basic technology, but for young animals simultaneously used the drugs «Pro–Mac» and "Ultimade Acid", which were introduced into the water supply system for piglets (farrowing shop) with the help of a mediator every other day in turn, four days before weaning (transfer) and seven days after weaning (transfer) of piglets (growing and fattening shop). The drugs were introduced into the water supply system using a Dozatron mediator at a dose of 1 liter per 1000 liters of drinking water.

Superstarter feeds and protein–mineral–vitamin supplements produced by PC Alternative LLC were used to feed suckling pigs and balance the diets of young animals during growing and fattening. Animal housing during the suckling period, growing and fattening had no significant design and technological features.

In experimental piglets from weaning to 90 days of age using «Pro–Mac» and «Ultimade Acid», the value of average daily gain, g and preservation, %, were studied according to generally accepted methods [87]. The study of fattening qualities early maturity, days, average daily gain, g, feed conversion, kg of experimental animals when they reached pre–slaughter live weight of 100 and 120 kg was carried out according to the relevant methodological recommendations of the Institute of pig production and animal production of the NAAS of Ukraine [104–107, 126–129]. To evaluate slaughter qualities, young animals were selected for slaughter from the groups of fattening young animals when they reached a live weight of 100 and 120 kg in the amount of 5 heads of each weight condition, and then a control slaughter was performed with further determination of the slaughter qualities of animals of the I – control and II – experimental groups. The control slaughter with deboning of carcasses was carried out according to generally accepted methods [117, 128, 130].

The quality of carcasses was assessed by their morphological composition by complete deboning and gutting of carcasses of each group of pigs, after their preliminary cooling to a temperature of +4°C for 24 hours. The percentage yield of muscle, adipose, and bone tissue was taken into account according to generally accepted zootechnical methods [130].

It is now well known that piglet weaning weight and growth rates in the first 7–10 days after weaning have a significant impact on feed efficiency throughout the piglet's life until slaughter. That is why, during this period, it is necessary to ensure high average daily weight gain and piglet health. The results of growing experimental piglets from weaning to 90 days of age using «Pro–Mac» and «Ultimade Acid» are presented in Table 5.30.

Table 5.30

Results of growing experimental groups of pigs, x ± Sd

Indicator	Group		± II to I
	I	II	
Number of goals at weaning (28 days), heads	890	890	–
Live weight of piglets at weaning, kg	8.12±0.32	8.08±0.30	–0.04
Number of goals at the age of 90 days, heads	823	858	+35
Live weight of piglets at the age of 90 days, kg	32.81±0.20	37.88±0.24	+5.07***
Average daily weight gain, g	405.00±5.3	489.00±4.5	+84.00***
Preservation, %	92.47±1.60	96.40±1.80	+3.93*

At weaning, the live weight of the piglets of the experimental groups was almost the same, the difference in favor of the piglets of group II was only 0.04 g (the difference is not statistically significant). When studying this issue and observing the behavior and condition of piglets of both experimental groups, it should be noted that piglets of group I established hierarchical relationships with each other for a long time, unlike piglets of group II. Therefore, we state that the animals of the second group have better nest fusion in the rearing area. During the period of stay of the experimental piglets in the growing area, we note a significant decrease in live weight in animals of group I by 5.07 kg compared to the experimental young animals of group II ($p < 0.001$).

It should be noted that animals of group I had a reduced feed intake; during the first days after transferring them to the growing area, unlike their counterparts of the second group, they consumed feed better. This fact also influenced the increase in average daily weight gain in piglets of group II, equal to 489 g, which is 84 g more than in young animals of group I ($p < 0.001$). In terms of the safety of young animals during growing, a higher rate was found in group II – 96.40 %, which is 3.93 % more than in group I ($p < 0.05$).

According to the results of the conducted research, it was found that the growth rate of pigs at an early age affects their fattening, slaughter and meat traits. In this regard, we studied the effectiveness of the use of feed additives «Pro–Mac» and «Ultimade Acid» in their complex application to improve the fattening traits of young pigs (Table 5.31).

Table 5.31

Fattening traits of experimental groups of pigs with the complex use of «Pro–Mac» and «Ultimade Acid», x ± Sd

Assignment of groups, n = 40	Early maturity, days	Average daily weight gain during fattening, g	Feed conversion, kg
when reaching a live weight of 100 kg			
I – control	165.3±1.50	813.4±8.26	3.30
II – experimental	160.7±1.68	859.4±7.88	2.93
+/– II to I	–4.6*	+46.0***	–0.37
when reaching a live weight of 120 kg			
I – control	190.5±1.48	808.6±6.40	3.48
II – experimental	185.2±1.32	848.9±7.21	3.26
+/– II to I	– 5.3**	+ 40.3***	– 0.22

The results of the studies presented in the table show that the animals of the second experimental group reach a live weight of 100 kg 4.6 days earlier ($p < 0.05$) and 5.3 days earlier ($p < 0.01$) than the analogues of the pigs of the first control group at a pre–slaughter weight of 120 kg.

It is worth noting that according to the values of average daily weight gain during fattening, young pigs of the II experimental group had a probable dominance over the animals of the I control group by 46.0 g at a live weight of

100 kg and 40.3 g at a live weight of 120 kg, where the difference is statistically significant ($p < 0.001$).

As for the feed conversion rate, the advantage, as expected, belongs to the animals of the second experimental group – 2.93 kg at a live weight of 100 kg and 3.26 kg when the animals reached a live weight of 120 kg, where the difference in the first case is (–0.37 kg), in the second – (–0.22 kg) relative to the analogues of the first control group

Based on the research, it was found that pigs that received the additional stress corrector «Pro–Mac» and «Ultimade Acid» in their complex feeding according to the scheme established in the technological card, significantly outperformed their counterparts (I control group), which were raised according to the basic technology, in terms of live weight, early maturity and average daily gain. Thus, it can be argued that the studied complex feed additives minimize technological stress phenomena, triggering the mechanism of general adaptation of pigs, stimulating digestive processes, increasing overall resistance and, as a result, increasing fattening traits of pigs.

Then the pigs of the experimental groups were selected for slaughter to evaluate their slaughter traits, the results of which are shown in Table 5.32. According to the given digital material on the slaughter traits of the experimental groups of pigs, it was found that the highest value of the slaughter yield was characterized by pigs of the II experimental group at a pre–slaughter live weight of both 100 kg and 120 kg and outperformed their peers of the I control group by 0.3 % (the difference is statistically insignificant) and 1.2 % ($p < 0.05$), respectively.

Regarding the length of the half–carcass, it should be noted that the animals released with these stress–correcting additives – the II control group had a statistically unlikely advantage in live weight of 100 kg – 1.1 cm, 120 kg – 1.5 cm relative to the analogues of pigs of the I control group.

In continuing the discussion of this topic, it should be noted that in animals of the second control group at slaughter of 100 kg, a significant decrease in the thickness of the fat by 1.3 mm ($p < 0.05$) is observed, and at slaughter of 120 kg – the thickness of the fat decreased to 1.5 mm ($p < 0.05$) relative to pigs of the control group, which did not have the ability to feed the specified complex additives that act as stress correctors.

The area of the «muscle eye» in pigs of the control group I at slaughter of 100 kg was 0.3 cm^2) smaller the difference was statistically insignificant, and at slaughter of 120 kg – 1.5 cm^2 smaller ($p < 0.05$) than in pigs of the experimental group II.

Table 5.32

Slaughter signs of experimental groups of pigs with the complex use of «Pro–Mac» and «Ultimade Acid», x ± Sd

Assignment of groups, n = 5	Downhole yield, %	Length of half carcass, cm	Thickness of slices, mm	Area of the «muscle eye», cm^2	Weight of the hind third of the half carcass, kg
pre–slaughter live weight 100 kg					
I–control	73.8±0.60	95.7±0.52	17.8±0.40	41.3±0.30	12.2±0.12
II – experimental	74.1±0.30	96.8±0.48	16.5±0.35	41.6±0.26	12.4±0.10
+/– II to I	+ 0.3	+ 1.1	– 1.3*	+ 0.3	+ 0.2
pre–slaughter live weight 120 kg					
I–control	75.2±0.34	101.1±1.14	21.8±0.34	43.3±0.45	14.5±0.31
II – experimental	76.4±0.47	102,6±1,18	20.3±0.66	44.8±0.58	14.8±0.29
+/– II to I	+ 1.2*	+1.5	– 1.5*	+1.5*	+ 0.3

At the same time, the advantage of the scales in terms of the weight of the hind third of the half–carcass at 100 kg slaughter by 0.2 kg, at 120 kg slaughter – 0.3 kg perfectly demonstrates the higher values in favor of animals of the second experimental group compared to control pigs.

A more accurate and objective indicator that characterizes the meat traits of pigs is the morphological composition of the carcass and the ratio of individual tissues in it. Based on this analysis, it is possible to obtain in–depth information about the meat and fat qualities of pigs and the impact of individual factors of technology and its components on them

In this regard, we carried out deboning of half–carcasses in the amount of 5 units from each group to determine their morphological composition. As a result of deboning, high carcass meat content was found in all weight categories studied. Thus, for a pre–slaughter live weight of 100 kg in terms of meat content in the carcass of pigs of the II experimental group exceeded the analogues of the I control group by 0.5 % (Table 5.33).

Table 5.33

Morphological composition of carcasses of experimental young with the complex use of «Pro–Mac» and «Ultimade Acid», x ± Sd

Assignment of groups, n = 5	Content in the carcass, %		
	meat	lard	bones
pre–slaughter live weight 100 kg			
I – control	64.8±0.30	22.2±0.29	13.0±0.11
II – experimental	65.3±0.35	21.8±0.30	12.9±0.18
+/– II to I	+0.5	–0.4	–0.1
pre–slaughter live weight 120 kg			
I – control	64.6±0.32	23.0±0.20	12.4±0.14
II – experimental	65.9±0.39	21.9±0.28	12.2±0.17
+/– II to I	+1.3*	–1.1**	–0.2

The absence of a statistically significant difference between the meat content in carcasses of pigs of the experimental groups was found. There was also a tendency to increase the weight of adipose tissue in the carcasses of pigs that were not fed with complex stress–correcting additives before reaching 100 kg of live weight, and therefore exceeded by 0.4 % the analogues of the second experimental group, where the difference is statistically unlikely. According to the bone content in pig carcasses, we note that a higher content of 0.1 % was recorded in animals of the first control group compared to the analogues of the experimental group the difference is statistically insignificant.

According to the results of the carcass weighing with a pre–slaughter live weight of 120 kg, the data obtained indicate a decrease in meat content in animals of the first control group relative to pigs of the second experimental group, where their advantage in this indicator was 1.3 % ($p < 0.05$).

The bone content in the carcass at slaughter of pigs with a live weight of 120 kg in animals of the first control group was not significantly higher – by 0.2 % compared to animals of the second experimental group, the difference is statistically insignificant. The proportion of adipose tissue was 1.1 % higher in pigs of the control group I ($p < 0.05$) compared to the analogues of the experimental group II.

Thus, the studies confirmed the expediency of the complex use of Pro–Mac and Ultimade Acid for suckling piglets (farrowing shop) four days before weaning and seven days after weaning (growing shop) with a frequency of one day in turn and for young pigs in fattening and slaughter at 100 and 120 kg to minimize technological stress. Thus, in piglets of the second experimental group, which were fed with complex stress–correcting additives during the first days after transferring them to the growing area, feed consumption improved, which led to an increase in average daily gain in piglets by 84 g and a safety index by 3.93 % compared to the control group.

Regarding the fattening period, it should be noted that the complex feeding of Pro–Mac and Ultimade Acid in animals of the second experimental group allowed young animals to reach 4.6 days ($p < 0.05$) and 5.3 days ($p < 0,01$) earlier than to reach pre–slaughter live weight of 100 kg and 120 kg with a probable dominance in terms of average daily gain of 46.0 g – at slaughter of 100 kg and 40.3 g – at slaughter of 120 kg relative to the control group. According to the data obtained, the influence of stress correctors affected the slaughter qualities and morphological composition of meat of the experimental groups of pigs.

5.7. Boosting productivity with the phytobiotic «Liptosa Expert».

One of the methods of increasing pig productivity is the use of productivity and preservation stimulants, while their safety remains in the center of attention. In this regard, the search for biologically active feed additives to replace antibiotics is of scientific and practical interest today [69, 92].

Taking into account this information, the aim was to study the effect of liquid and dry forms of phytobiotic (Liptosa Expert) manufactured by Lipidos Toledo S.A., Spain, supplier of LLC «Company «Agrotradekhim» (additional information – registration certificate AA–05457–04–14 dated 01.10.2014, ANNEX M) on the growth rate of mixed young pigs ((Large White × Landrace) × Maxter).

Two stages of research were conducted. The first stage was carried out on two groups of piglets that were weaned at the age of 21–28 days, 40 heads per group. The conditions of housing and feeding were the same in the two groups. The piglets of the control and experimental groups received the same complete pre–starter feed produced by PC Alternative LLC.

The difference was in the scheme of veterinary treatment of piglets during the weaning period. Thus, piglets of the control group received colistin sulfate with water at the rate of 6 mg/kg of live weight for 5 days during weaning. Piglets of the experimental group, instead of antibiotic therapy, received a liquid phytobiotic supplement «Liptosa Expert», consisting of plant extracts and medium–chain fatty acids at a dose of 0.7 l/t of drinking water. The phytobiotic was administered 3 days before weaning and 4 days after. During the experiment, the number of cases of enteritis (units), piglet survival, %, and live weight, kg, were determined [87, 130].

The second stage of research was conducted on 90 piglets of the same combination at the age of 45–65 days (starting period), which were divided into two groups: control and experimental.

The difference in piglet feeding was that the animals of the control group received complete feed with the addition of the antibiotic colistin sulfate and amoxicillin, and the piglets of the experimental group were fed the dry phytobiotic «Liptosa Expert». At the end of the experiment, the quantitative composition of the microflora of the large intestine of the experimental groups of pigs was studied in an independent laboratory of the Expert Center «Biolights» LLC. Microbiological examination of feces for the quantitative presence/absence of the following microbiota: Bifidobacterium spp., Lactobacillus spp., Escherichia coli, Candida spp. and Candida albicans, their identification and qualitative assessment of their concentration using MALDI–TOF MS [80, 88].

An identical third stage of research using the dry form of the phytobiotic «*Liptosa Expert*» was conducted for fattening pigs when they reached a pre–slaughter live weight of 100 and 120 kg at a dose of 1.5 kg per 1000 kg of feed. The parameters of live weight (kg) and average daily weight gain were studied according to generally accepted zootechnical methods [87, 130].

As a result of the first series of studies (Table 5.34), it was found that in the control group the safety of pigs was 2.5 % significantly lower than in the experimental group and amounted to 95.0% ($p < 0.05$).

The average live weight of piglets at the end of the experiment in the control group was 7.49 kg, while in the experimental group it was 7.55 kg, or 0.8 % higher.

It is also worth noting that the average daily live weight gain in the control group was 4.42% lower compared to the experimental group, where it was 162.9 g ($p < 0.05$). Obviously, this was due to the incidence of enteritis in the control group, which amounted to 10 % compared to 5 % in the experimental group.

Table 5.34

Productivity of experimental piglets (first series of studies), x ± Sd

Indicator	Group

	control	experimental
The number of piglets at the beginning of the experiment, heads	40	40
Number of piglets at the end of the experiment, heads	38	39
Preservation, %	95.0±1.00	97.5±0.80*
Live weight at the beginning of the experiment, kg	6.40±0.32	6.41±0.30
Live weight at the end of the experiment, kg	7.49±0.20	7.55±0.18
Average daily weight gain, g	155.7±2.7	162.9±2.3*
Number of piglets with enteritis, head	4	2
Cases of enteritis, %	10	5

Thus, the use of the liquid phytobiotic «Liptosa Expert» can be an alternative to the use of a standard antibiotic regimen.

During the second series of studies, we determined the effect of the dry phytobiotic «Liptosa Expert» on piglet growth performance during the starting period (Table 5.35), as well as the state of intestinal microflora (Fig. 5.21).

The results of the research show that the average live weight of piglets in the experimental group at the end of the experiment was 7 % higher than in the control group and amounted to 22.8 kg, the average daily live weight gain was also 12.4 % higher than in the control group and amounted to 590 g. At the same time, feed conversion was 4.3 % lower in the experimental group compared to the control.

At the end of the experiment, the quantitative composition of the microflora of the large intestine was studied. In particular, it was found that the number of beneficial microorganisms Bifidobacterium spp. in the intestines of the experimental group piglets exceeded the control group by thousands of times, and Lactobacillus spp. by 125 times.

Table 5.35

Productivity of experimental piglets (second series of studies), x ± Sd

Indicator	Group	
	control	experimental
Number, heads	45	45
Age of piglets at the beginning of the	45	45

experiment, days		
Age of piglets at the end of the experiment, days	65	65
Duration of the experiment, days	20	20
Average live weight of piglets at the beginning of the experiment, kg	10,8±0,26	11,0±0,24
Average live weight of piglets at the end of the experiment, kg	21,3±0,38	22,8±0,40**
Average daily weight gain, g	525±4,20	590±5,12***
Feed conversion, kg	1,40	1,34

The number of pathogenic *E. coli* microflora was 2.3 times lower in the intestines of piglets of the experimental group, and the number of Candida spp. and Candida albicans colonies was 152 times lower compared to the control.

One of the promising areas for increasing pig productivity under conditions of industrial technology and improving the quality of meat may be the use of a number of phytogenic additives that promote metabolic activation, improve the taste of feed, and their assimilation [59, 60, 94, 136, 139]. The use of phytobiological preparations in pig feeding can achieve a positive effect on the peristalsis of the digestive tract, stabilization of the intestinal microflora, reduction of toxin formation, stimulation of the immune system, regulation of inflammatory processes and, ultimately, increase in productivity [51, 174]. When studying the growth of young pigs, the most interesting for research is the dynamics of changes in live weight, which is a generally recognized complex indicator characterizing the level of development of the organism during ontogenesis.

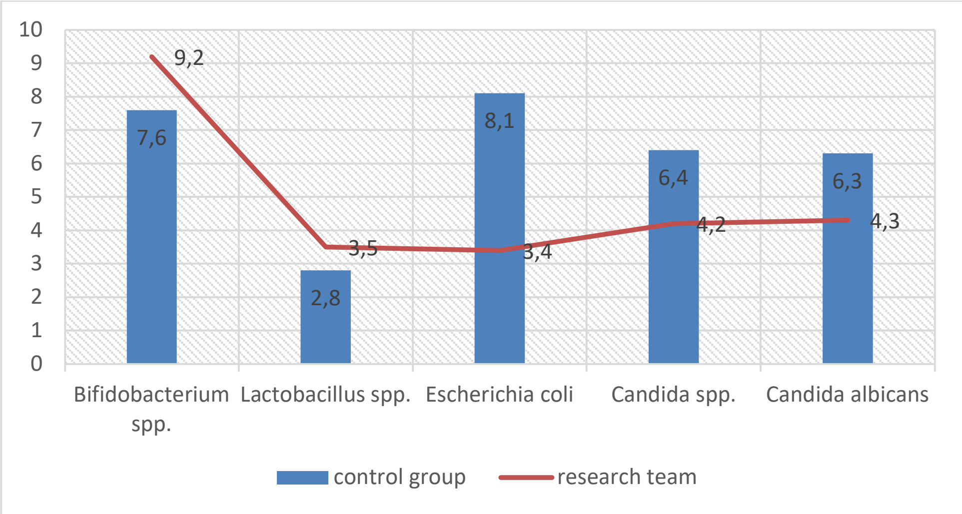
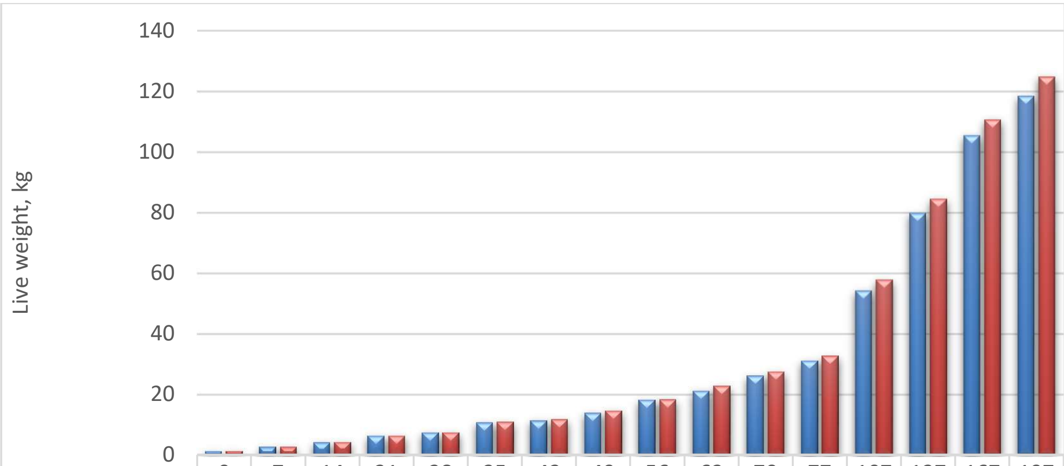


Fig. 5.21. **Quantitative composition of the microflora of the large intestine of experimental groups of pigs**

Notes: Bifidobacterium spp., Lactobacillus spp. – CFU/g × 10(5)*; Escherichia coli – CFU/g*× 10⁷*; Candida spp*.

The results of the research showed that the phytobiotic «Liptosa Expert» had a positive effect on the growth of pigs at different ages, starting from birth and reaching a live weight of 120 kg (Fig. 5.22).



	0	7	14	21	28	35	42	49	56	63	70	77	107	137	167	197
control	1,36	2,72	4,27	6,4	7,49	10,8	11,46	14	18,28	21,3	26,23	31,24	54,29	79,85	105,4	118,4
experimental	1,35	2,73	4,3	6,41	7,55	11	11,87	14,71	18,41	22,8	27,57	32,76	57,85	84,51	110,6	124,8

Fig. 5.22. **Comparative indicators of live weight gain in pigs of experimental groups in the age aspect, kg**

By the end of the suckling period, the live weight of piglets of the experimental group exceeded that of the control group by 0.79 %, but the difference was statistically insignificant. During the growing period at the age of 63 days, a significant difference in live weight between the animals of the experimental and control groups was recorded, which amounted to 1.5 kg (6.58 %; $p < 0.05$). By the end of the growing period, a significant difference in this indicator remained and at the age of 77 days it reached 1.52 kg (4.64 %; $p < 0.01$). During the fattening period, the excess of live weight of animals of the experimental groups compared to the control at the age of 107 days was 3.56 kg (6.15 %; $p < 0.001$), at 137 days – 4.66 kg (5.51 %; $p < 0.001$), at 167 days – 5.22 kg (4.71 %; $p < 0.001$) and 197 days – 6.42 kg (5.14 %; $p < 0.001$).

The analysis of the data obtained on the assessment of growth intensity in terms of average daily weight gain of young pigs confirmed the established pattern (Fig. 3.19). The average daily gain in live weight of piglets of the experimental group during the suckling period exceeded that of control animals: at 7 days – by 2.8 g (1.42 %), at 14 days – by 2.9 g (1.29 %), at 28 days – by 7.2 g (4.42 %), but the difference was statistically insignificant.

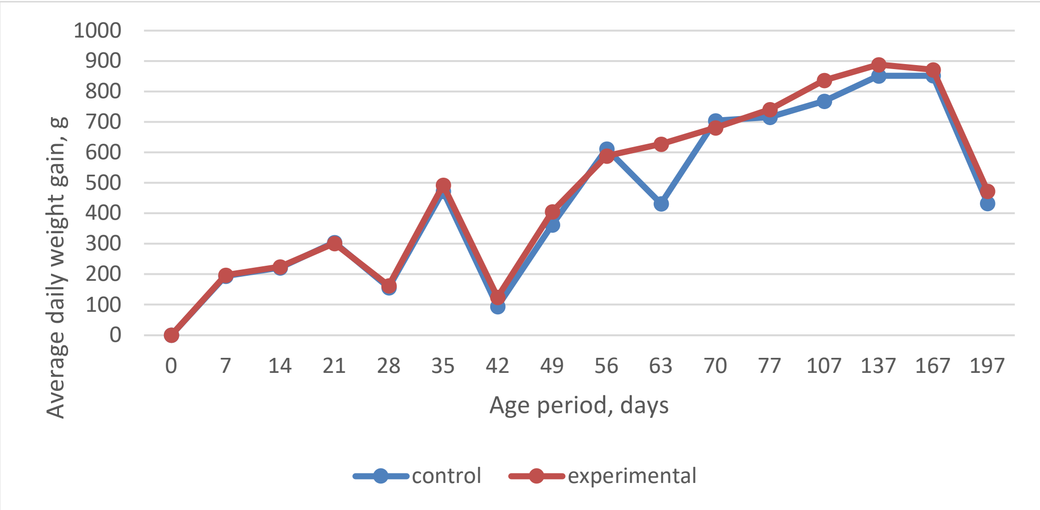


Fig. 5.23. **Average daily weight gain of pigs of experimental groups in age aspect, g**

Starting from day 35, the average daily live weight gain of piglets of the experimental group significantly exceeded the control by 20.1 g (4.1 %; $p < 0.05$). At the end of the growing period at the age of 77 days, the average daily weight gain of piglets of the experimental group exceeded that of the control group by 25.7 g (3.47 %; $p < 0.01$). The most significant difference in average daily weight gain was observed directly during the fattening period, where the excess relative to the control group in the experimental group was 107 days – 68.0 g (8.13 %; $p < 0.001$), 137 days – 36.7 g (4.13 %; $p < 0.01$), 167 days – 18.7 g (2.15 %; $p < 0.05$), 197 days – 40.0 g (8.46 %; $p < 0.01$).

The study of meat productivity of pigs with the use of «Liptosa Expert» phytobiotic in their diet is of scientific and practical interest. In this regard, at the end of the experiment, a control slaughter of the experimental groups of animals was carried out. The results of the control slaughter showed that the investigated phytobiotic had no positive effect on the pre–slaughter and slaughter weight of pigs and, as a result, slaughter yield.

Thus, the use of the phytobiotic «Liptosa Expert» supplied by «Agrotradekhim» LLC during weaning, growing and fattening can be an effective method of replacing the use of antibiotics and growth stimulants, which leads to an increase in the safety of piglets in the suckling period, an increase in average daily live weight gain and the development of beneficial microflora in the intestines of pigs. However, the studied phytobiotic supplement did not show a positive effect on the formation of meat qualities of the experimental groups of pigs, and therefore requires further study.

5.8. Genetic influence of CTSF and MC4R Genes on fattening and meat traits.

5.8.1. Genetic structure of purebred populations and terminal lines by CTSF and MC4R genes. Genotyping of the main herd of purebred pigs of the Large White, Landrace breeds and synthetic lines «Maxter» and «Maxgroo» for the CTSF and MC4R genes was carried out. To establish the association of genotypes of young pigs by CTSF and MC4R genes with their fattening and meat qualities. The total number of heads was 82.

Molecular genetic testing was performed in the genetics laboratory of the Institute of Pig Production and Animal Production of the National Academy of Sciences of Ukraine. DNA was extracted from blood serum using the Chelex–100 ion exchange resin kit [37, 240]. DNA typing was performed using polymerase chain reaction (PCR) and restriction fragment length polymorphism (RFLP) technology. The structure of PCR primers, conditions of PCR, corresponding restriction enzymes, PCR–RFLP patterns and different alleles for each locus are presented in Table 5.36.

For PCR–PCR analysis, amplification reagent kits from Helicon were used. DNA restriction was performed using enzymes from Fermentas (Lithuania, Vilnius) according to the manufacturer's instructions.

Table 5.36

PCR amplification conditions, PCR–PCR gene allele patterns

Gene	Primer structure for PCR	PCR*	PCR–PCR patterns of different alleles
CTSF	F:5'–AGGGAGGGCTGGAGA–CGGAGTA–3' R:5' –TCATTCTGGCTCAGCTCCAC–3'	118/58/2.0	PCR–PCR (RsaI): g.22G allele 118 bp; g.22C allele 97 + 21 bp.
MC4R	F:5 '–TACCCTGACCATCTTGATTG–3' R: 5 '–ATAGCAACAGATGATCTCTTT–3'	220/60/2.5	PCR–PCR (TaqI): c.1426 A allele 220 bp; c.1426 G allele 150 + 70 bp.

*Note: * – PCR product size (bp)/ annealing temperature, °C/[$MgCl_2$, mM].*

For restriction analysis, TaqI endonuclease (Fermentas, Lithuania, Vilnius) was used. PCR products and DNA fragments after restriction were separated in a 2 % agarose gel. DNA staining in the gel was performed in ethidium bromide solution (0.5 μg/ml). Restriction fragments were analyzed by electrophoresis in a 2 % agarose gel. Visualization was performed by staining the agarose gel with ethidium bromide followed by viewing in ultraviolet light under a transilluminator. Photographs were taken with a Canon EOS 250D 18–55 DC digital camera.

As a result of the research, it was found that the CTSF gene in animals of all test breeds and lines is polymorphic. However, among the animals of the Large White breed and the terminal lines «Maxter» and «Maxgroo» carriers of all possible genotypes were found, while among the Landrace pigs no individuals with the $CTSF^{GG}$ genotype were found (Table 5.37).

Certain peculiarities in the distribution of frequencies of genotypes of this gene were also revealed among the animals of the studied breeds. Among the boars of the «Maxter» terminal line, a larger proportion of individuals carrying the $CTSF^{GG}$ genotype was found, with the highest frequency of 0.588.

It should be noted that among the animals of the Large White breed, its frequency was the lowest – 0.250. Thus, the frequency of the $CTSF^{G}$ allele was highest in pigs of the «Maxter» terminal line – 0.706, and the lowest in Landrace animals – 0.067.

Table 5.37

Frequency of genotypes and alleles of *the CTSF* gene in pigs of different breeds and lines

Breed, line	Genotype			Zero	
	CTSF	$CTSF^{GC}$	$CTSF^{GG}$	$CTSF^{C}$	$CTSF^{G}$
Great White, n = 40	0.350	0.400	0.250	0.550	0.450
Landrace, n = 15	0.867	0.133	0.000	0.933	0.067
«Maxter», n = 17	0.177	0.235	0.588	0.294	0.706
«Maxgroo», n = 10	0.200	0.400	0.400	0.400	0.600

According to the results of genotyping of breeds by the CTSF gene, a deficit of heterozygotes was found among animals of the «Maxter» and «Maxgroo» terminal lines and the Large White breed, as evidenced by high positive values of the fixation index (0.433, 0.167 and 0.192, respectively) (Table 5.38).

Table 5.38

Assessment of genetic diversity of experimental animals by the CTSF gene

Indicator	Breed, lineage			
	large white (n = 40)	landrace (n = 15)	«Maxter» (n = 17)	«Maxgroo» (n = 10)
Effective number of alleles	1.980	1.142	1.710	1.923
Actual heterozygosity	0.400	0.133	0.235	0.400
Expected heterozygosity	0.495	0.124	0.415	0.480
Fixation index	0.192	–0.073	0.433	0.167

Whereas for the Landrace breed, the difference between actual and expected heterozygosity is insignificant.

Regarding the MC4R gene, it was found that in animals of the «Maxter» and «Maxgroo» terminal lines and the Large White breed it was polymorphic, while in animals of the Landrace breed it is characterized by a monomorphic state – $MC4R^{GG}$ (Table 5.39). At the same time, certain differences were found in the frequencies of different genotypes of this gene in animals of the «Maxter» terminal line compared to other breeds and lines. Thus, in animals of the «Maxte»r terminal line, the most common genotype was MC4R 0.588, while in Large White pigs, carriers of the heterozygous genotype predominated, with a share of 0.500. A high proportion of heterozygotes – $MC4R^{AG}$ was also noted among the studied boars of the terminal line «Maxgroo» – 0.400. The highest frequency of the MC4R allele was found in the terminal boars of «Maxter» – 0.706.

Table 5.39

Frequency of MC4R gene genotypes and alleles in pigs of different breeds and lines

Breed, lineage	Genotype			Zero	
	$MC4R^{AA}$	$MC4R^{AG}$	$MC4R^{GG}$	$MC4R^{A}$	$MC4R^{G}$
Large white, n = 40	0.350	0.500	0.150	0.600	0.400
Landrace, n = 15	0.000	0.000	1.000	0.000	1.000
«Maxter», n = 17	0.588	0.235	0.177	0.706	0.294
«Maxgro», n = 10	0.300	0.400	0.300	0.500	0.500

According to the distribution of genotype frequencies, according to the results of the analysis of molecular variability (ANOVA), all pig populations differed significantly from each other (Fst = 0.379, p = 0.001).

Experimental boars–sires of the terminal line «Maxgroo» were characterized by higher genetic diversity in terms of the effective number of MC4R gene alleles than representatives of other breeds and lines (Table 5.40). Boars of the terminal line «Maxter» are characterized by a significant predominance of expected heterozygosity over the actual one, which indicates a deficit of heterozygotes in the population. This is also evidenced by the high value of the fixation index Fis = 0.433. A similar situation was noted with regard to the genetic structure of the sample of boars of the terminal line «Maxgroo», in which the deficit of heterozygotes is 0.200.

However, in the population of large white pigs, there is practically no deviation from the state of genetic equilibrium. Obviously, this is the result of the influence of artificial selection pressure on the population, namely, the selection and breeding work in the herd. No statistically significant deviations of the distribution of genotype frequencies of both studied genes from the state of genetic equilibrium of Hardy–Weinberg were found.

Table 5.40

Assessment of genetic diversity of animals of the studied breeds and lines

by the MC4R gene

Indicator	Breed, lineage			
	Large white n = 40	landrace n = 15	«Maxter» n = 17	«Maxgroo» n = 10
Effective number of alleles	1.923	1.000	1.710	2.000
Actual heterozygosity	0.500	0.000	0.235	0.400
Expected heterozygosity	0.480	0.000	0.415	0.500
Fixation index	–0.042	–	0.433	0.200

Thus, the animals of the Maxter and Maxgroo terminal lines and the Large White and Landrace breeds differ in the frequencies of MC4R and CTSF gene genotypes. Thus, only in Landrace animals the MC4R gene is characterized by a monomorphic state – $MC4R^{GG}$. For pigs of the Large White breed and the «Maxter» terminal line, a high level of inbreeding is characteristic. Therefore, the population of animals of the «Maxter» line has a deficit of heterozygotes for both studied genes, the fixation index in both cases is 0.433, and the population of the Large White breed has a positive value of the fixation index for the CTSF gene.

The revealed features of the genetic structure of the studied pig breeds and lines became the basis for further elucidation of the degree of association of genotypes for the MC4R and CTSF genes with productive traits of animals.

To obtain experimental fattening stock of all possible genotypes by the CTSF gene, we obtained half–blood (LW×L) homozygous pigs with the genotype – $CTSF^{SS}$, which were subsequently mated with boars of the terminal lines «Maxter» and «Maxgroo» with genotypes $CTSF^{CC}$ (to obtain three–breed young animals with the genotype $CTSF^{CC}$) and $CTSF^{GG}$ (to obtain three–breed young animals heterozygous for the gene $CTSF^{GC}$).

To obtain fattening young animals of the studied combinations of all possible genotypes for the MC4R gene, we obtained half–blood (LW×L) homozygous pigs with the genotype $MC4R^{GG}$, which were subsequently mated with boars of the terminal lines «Maxter» and «Maxgroo» with genotypes $MC4R^{GG}$ (to obtain three–breed young animals with the genotype $MC4R^{GG}$) and $MC4R^{AA}$ (to obtain three–breed young animals heterozygous for the MC4R gene).

5.8.2. Effects of CTSF and MC4R genotypes on fattening performance of

young stock.

When evaluating the effect of genotypes of young pigs of different origin by the cathepsin *F* gene on their fattening traits (Table 5.41), it was found that animals with the $CTSF^{GC}$ genotype, regardless of their origin, showed a tendency to more intensive growth, which was manifested in the shortest duration of fattening to a live weight of 100 kg. The lowest among all experimental groups this indicator was found in young animals of the combination (LW × L) × «Maxgroo» – 158.4 days.

The highest average daily weight gain during fattening in all experimental groups was also characteristic of animals carrying the genotype $CTSF^{GC}$. However, the degree of their superiority over their counterparts in animals of different origins had its own characteristics. Thus, among the experimental young animals of the combination (LW × L) × «Maxter» and (LW × L) × «Maxgroo», animals with the $CTSF^{GC}$ genotype outweighed their homozygous $CTSL^{CC}$ counterparts by 27.8 g and 39.1 g, ($p < 0.05$; $p < 0.01$).

In addition, the animals of the combination (LW × L) × «Maxter» and (LW × L) × «Maxgroo» with the $CTSL^{GC}$ genotype had a lower feed conversion of 2.97 and 3.06 kg, respectively.

Table 5.41

Fattening traits of young pigs with different genotypes by the CTSF gene, n = 20, x ± Sd

Pedigree	Genotype	Age of reaching a live weight of 100 kg, days	Average daily weight gain, g	Feed conversion, kg
(LW × L) × «Maxter»	CC	169.0±2.60	817.1±10.24	3.13
	GC	164.6±3.18	844.9±9.30*	3.06
(LW × L) × «Maxgroo»	CC	163.3±3.70	868.8±12.40	3.01
	GC	158.4±2.92	907.9±10.30**	2.97

As a result of the evaluation of fattening traits of young pigs with different genotypes for the melanocortin receptor gene, it was found that, regardless of breed and lineage, higher growth intensity and, therefore, a shorter age of reaching a live weight of 100 kg was inherent in heterozygous $MC4R^{AG}$ animals (Table 5.42).

In particular, the young animals of the combination (LW × L) × «Maxter» reached a live weight of 100 kg in 159.2 days, which is 8.1 days ($p < 0.01$) less than the same indicator of their peers with the $MC4R^{GG}$ genotype.

A similar trend was found for young animals obtained as a result of combining VB × L sows with boars of the terminal line «Maxgroo» – heterozygous individuals reached a live weight of 100 kg faster than their homozygous counterparts by 5.3 days ($p < 0.05$).

Table 5.42

Fattening traits of young pigs with different genotypes for the MC4R gene
n = 20, x ± Sd

Pedigree	Genotype	Age of reaching a live weight of 100 kg, days	Average daily weight gain, g	Feed conversion, kg
(LW × L) × «Maxter»	AG	159.2±2.24	903.3±10.21	2.97
	GG	167.3±2.18**	815.1±9.61***	3.17
(LW × L) × «Maxgroo»	AG	157.7±1.88	929.9±9.25	2.95
	GG	163.0±2.01*	858.3±9.90***	3.05

Heterozygous young animals of all studied combinations were characterized by lower feed conversion. The lowest values of this trait were found in young animals derived from the genotype (LW × L) × «Maxgroo» – 2.95 kg.

Thus, based on the above research results, it was found that young animals heterozygous for the cathepsin F gene $CTSF^{GC}$ and heterozygous for the melanocortin gene $MC4R^{AG}$ were characterized by higher fattening traits.

5.8.3. Influence of CTSF and MC4R genotypes on meat quality traits of young organisms.

5.8.3.1. slaughter characteristics across different genotypes of organisms.

When evaluating the slaughter traits of young animals of different origin, it was found that the genotype of animals for the cathepsin F gene does not have a clear, unambiguous effect on slaughter yield (Table 5.43). Thus, among the animals of the combination (LW × L) × «Maxter» and (LW × L) × «Maxgroo», heterozygous individuals were characterized by a higher slaughter yield – 73.4 % and 74.0 %, respectively, with a statistically significant difference ($p < 0.001$; $p < 0.01$).

There were no significant differences between animals with different genotypes in all study groups in terms of carcass length and fat thickness. There was no unambiguous dependence on genotype for the studied gene and the area of the «muscle eye». Among the animals of the combination of (LW × L) × «Maxter» and (LW × L) × «Maxgroo», the highest value of this trait was observed in heterozygous individuals, although this difference is statistically significant only when using boars of the terminal line «Maxgroo».

Table 5.43

Slaughter traits of pigs with different genotypes for the *CTSF* gene, n = 5, x ± Sd

Pedigree	Genotype	Downhole yield, %	Length of the half–carcass, cm	Thickness of the roast over 6–7 thoracic vertebrae, mm	Area of the «muscle eye», cm²	Weight of the hind third of the half carcass, kg
(LW × L) × «Maxter»	CC	72.0±0.18	96.2±0.30	17.0±0.47	39.8±0.28	11.6±0.09
	GC	73.4±0.20***	96.8±0.42	16.6±0.50	40.0±0.30	12.4±0.11***
(LW × L) × «Maxgroo»	CC	73.2±0.23	96.6±0.35	16.2±0.52	40.2±0.30	12.3±0.10
	GC	74.0±0.20**	97.2±0.28	16.0±0.58	41.6±0.22***	12.6±0.08**

The weight of the hind third of the half–carcass in animals of all study groups was the highest in heterozygous animals $CTSF^{GC}$. Moreover, their superiority over analogs is statistically significant ($p < 0.001$; $p < 0.01$).

When assessing the slaughter qualities of young pigs with different genotypes by the melanocortin gene, it was found that most of the taken into account traits have higher values in animals with the $MC4R^{GG}$ genotype (Table 5.44).

In terms of slaughter yield, a statistically significant difference between homo– and heterozygous individuals was found only among animals of the combination (LW × L) × «Maxgroo» – by 0.5 %, this indicator was higher in young animals with the $MC4R^{GG}$ genotype – 74.0 % ($p < 0.05$).

There was no statistically significant difference between homo– and heterozygous individuals in terms of half–carcass length in the young of any of the studied combinations. However, there was a tendency for homozygous animals to prevail over their heterozygous counterparts.

In general, for all the studied combinations, animals with the $MC4R^{GG}$ genotype were characterized by a smaller thickness of the cuttings – 16.0–16.3 mm. In heterozygous individuals, this indicator ranged from 16.0–17.2 mm.

Table 5.44

Slaughter traits of pigs with different genotypes for the MC4R gene, *n* = 5, x ± Sd

Pedigree	Genotype	Downhole yield, %	The length of the half–carcass, cm	Thickness of the roast over 6–7 thoracic vertebrae, mm	Area of the «muscle eye», cm²	Weight of the hind third of the half carcass, kg
(LW × L) × «Maxter»	*AG*	73.1±0.22	96.0±0.21	17.2±0.22	38.4±0.31	11.9±0.15
	GG	73.5±0.17	96.2±0.30	16.3±0.10***	39.5±0.24**	12.1±0.21
(LW × L) × «Maxgroo»	*AG*	73.5±0.16	95.4±0.34	16.8±0.30	39.0±0.25	12.0±0.20
	GG	74.0±0.18*	96.3±0.42	16.0±0.23*	39.9±0.16**	12.6±0.18*

It was established that a statistically significant advantage of homozygous individuals over their heterozygous counterparts occurs in both cases of young animals obtained from half–breed sows LW × L mated with boars – sires of the terminal lines «Maxter» and «Maxgroo». Thus, young animals with the $MC4R^{GG}$ genotype of the combination (LW× L) × «Maxter» outweighed their heterozygous counterparts by 0.9 mm ($p < 0.01$), and animals of the combination (LW × L) × «Maxgroo» – by 0.9 mm ($p < 0.01$).

In the young of the studied combinations, a statistically significant advantage of animals with the homozygous $MC4R^{GG}$ genotype in terms of the area of the «muscle cell» over heterozygous counterparts was found. Thus, this indicator in homozygous animals of the combination (LW × L) × «Maxter» was 39.5 cm², which is 1.1 cm² ($p < 0.01$) more than in heterozygous individuals. The advantage of homozygotes from the (LW × L) × «Maxgroo» combinations was 0.9 cm² ($p < 0.01$).

Higher values of the weight of the hind third of the half–carcass were also found in animals with the $MC4R^{GG}$ genotype, but they statistically significantly outperformed their heterozygous counterparts only in the case where the parental form was the terminal line of boars «Maxgroo», namely in the group of young animals (LW × L) × «Maxgroo», this difference was 0.6 kg ($p < 0.05$).

Thus, in general, the positive effect of the cathepsin F gene in the heterozygous state $CTSF^{GC}$ and the melanocortin receptor gene in the homozygous state by the $MC4R^{G}$ allele on the manifestation of most signs of slaughter qualities of pigs, regardless of their breed, was established.

5.8.3.2. Morphological composition of carcasses of experimental young stock.

Quantitative and qualitative indicators of pig meatiness are genetically determined. Studies [9] have shown that under optimal conditions of keeping and feeding, pig meatiness is determined by genetic characteristics by 63.7 % and only by 36.3 % by other paratypic factors. A more accurate conclusion about the productivity of pigs can be made on the basis of data on the quantity and quality of meat products obtained from them. An objective indicator of meat productivity is the morphological composition of the pig carcass.

Weighing showed that carcasses of pigs with different genotypes for the gene of cathepsin F and melanocortin had certain differences in morphological composition. Thus, when evaluating carcasses obtained from young animals with different genotypes for the cathepsin F gene, it was found that, regardless of the breed of animals, heterozygous individuals $CTSF^{GC}$ tend to prevail in meat content in carcasses (Table 5.45).

In general, for all the studied combinations, the meat content in carcasses was 63.5–64.9 %. In contrast, in heterozygous animals, this figure ranged from 64.3–64.9 %. However, there was no statistically significant difference between homo– and heterozygous genotypes.

The content of fat in the carcasses of animals with the $CTSF^{CC}$ genotype was 22.0 %, and in their heterozygous counterparts – in the range of 21.1–21.8 %, the difference between animals for this indicator was within the statistical error. A similar trend was observed in the bone content of carcasses.

Table 5.45

Morphological composition of carcasses of experimental young pigs with different genotypes for the CTSF gene, n = 5, x ± SD

Pedigree	Genotype	Content in the carcass, %		
		meat	lard	bones
(LW × L) ×	CC	63.5±0.36	22.0±0.58	14.5±0.35

«Maxter»	GC	64.3±0.42	21.8±0.60	13.9±0.37
(LW × L) × «Maxgroo»	CC	64.1±0.35	22.0±0.49	14.0±0.36
	GC	64.9±0.41	21.1±0.52	14.0±0.41

Instead, in the carcasses of animals with different genotypes for the melanocortin gene, statistically significant differences in the content of meat and lard were found (Table 5.46). Thus, the meat content in the carcasses of animals carrying the homozygous $MC4R^{GG}$ genotype, which belonged to combinations obtained as a result of mating half–breed sows with boars of the terminal line «Maxgroo», significantly exceeded the same indicator of heterozygous animals of the corresponding breed.

Table 5.46

Morphological composition of carcasses of experimental young pigs with different genotypes for the MC4R gene, n = 5, x ± SD

Pedigree	Genotype	Content in the carcass, %		
		meat	lard	bones
(LW × L) × «Maxter»	AG	63,6±0,25	22,5±0,23	13,9±0,17
	GG	64,4±0,23	22,1±0,17	13,5±0,10
(LW × L) × «Maxgroo»	AG	64,3±0,18	21,9±0,26	13,8±0,23
	GG	64,9±0,20*	21,2±0,17*	13,9±0,19

In particular, the difference between the carcasses of animals with homo– and heterozygous genotypes of the experimental combinations was 0.8 (the difference is not statistically significant) and 0.6 % ($p < 0.05$).

The opposite trend was observed in the content of fat in carcasses – carcasses of animals of the combinations (LW × L) × «Maxter» and (LW × L) × «Maxgroo» with the homozygous genotype $MC4R^{GG}$ were inferior to their heterozygous counterparts by 0.4 % and 0.7 %, respectively ($p < 0.05$).

According to the bone content, no significant difference was found in the experimental genotypes, the value of this indicator was in the range of 13.5–13.9 %.

Thus, we can state that the melanocortin gene is more informative when used as a marker of the morphological composition of carcasses. It was found that the carcasses of animals in which it was homozygous for the $MC4R^{G}$ allele are characterized by a higher meat content with a lower fat content. However, it is also necessary to take into account the specificity of this association in animals of different breeds.

5.8.3.3 Quality metrics of meat and fat of experimental young stock.

The quality of pork is genetically determined and varies depending on breed, live weight, age of animals, and environmental conditions. In order to meet new consumer requirements, it is important for producers of commercial pork to adopt new methods to improve its quality, allowing them to select animals with optimal genotypes. To this end, it is desirable to analyze the genetic factors that determine the level of quantity and quality of pork. However, there are a number of problems regarding the speed of assessment of these indicators. In practice, they can be determined only after slaughter.

The development of modern science allows the use of innovative methods for predicting the quantity and quality of meat using DNA markers. Today, several dozen major genes affecting the quality of pork have been identified and are currently being actively used abroad, and a number of them have been studied in Ukraine [93, 121]. Currently, the main trend in the development of modern pig production is not only further increase of meat content, but also simultaneous improvement of the quality of produced pork. In most animals with high meat yields, there is an increase in water content, flabbiness, and a decrease in color intensity. This deterioration in meat quality causes significant economic damage to farms.

When evaluating the physicochemical properties of meat of pigs with different genotypes for the CTSF gene, we found no statistically significant difference between the indicators of active acidity, moisture retention capacity and color intensity of meat obtained from homozygous and heterozygous animals (Table 5.47).

Table 5.47

Physicochemical parameters of pig meat with different genotypes by the CTSF gene, *n* = 5, x ± Sd

Pedigree	Genotype	Acidity, pH	Moisture retention capacity, %	Color intensity, (units × 1000)
(LW × L) × «Maxter»	CC	5.40±0.028	55.8±0.89	56.8±0.45
	GC	5.41±0.032	54.3±0.92	56.2±0.35

(LW × L) × «Maxgroo»	CC	5.41±0.021	55.6±1.21	56.0±0.60
	GC	5.42±0.018	54.9±1.01	55.8±0.67

The acidity of the meat was 5.40–5.42 units, which is a typical value for meat of normal quality. The moisture retention capacity ranged from 54.3–55.8 %. The results obtained indicate that the genotype of animals by the cathepsin gene is not associated with the presence of meat defects and does not determine changes in its physicochemical properties.

Also, there was no significant difference between the physicochemical parameters of pig meat obtained from homo– and heterozygous animals for the MC4R gene (Table 5.48).

Thus, no dependence of the physicochemical properties of pig meat on the allelic state of the cathepsin F and melanocortin genes was found.

Table 5.48

Physicochemical parameters of pig meat with different genotypes by MC4R gene, n = 5, x ± Sd

Pedigree	Genotype	Acidity, *pH*	Moisture retention capacity, %	Color intensity, (units × 1000)
(LW × L) × «Maxter»	AG	5.40±0.020	54.1±1.25	55.9±0.71
	GG	5.43±0.021	55.0±0.95	55.7±0.69
(LW × L) × «Maxgroo»	AG	5.40±0.021	54.6±1.18	55.7±0.68
	GG	5.40±0.019	55.0±1.00	55.8±0.70

As a result of the analysis of the chemical composition of meat obtained from pigs with different genotypes for the CTSF gene, it was found that meat obtained from homozygous animals has a slightly higher moisture content compared to meat from animals with the $CTSF^{GC}$ genotype (Table 5.49).

As for fat content, no general trend was found at all. In animals derived from sows (LW×L) with boars of the terminal lines «Maxter» and «Maxgroo», heterozygous individuals tended to prevail. However, no statistically significant difference was found in any of the studied parameters.

According to the results of the analysis of chemical properties of meat of pigs with different genotypes for the MC4R gene, it was found that pork from homozygous animals contained more moisture compared to meat from heterozygous animals (Table 5.50). In particular, among the animals of the combination (LW × L) × «Maxgroo», this advantage was 2.5 % ($p < 0.05$). Among the animals of other combinations, this advantage was not statistically significant.

In terms of fat content, a statistically significant difference was observed between meat obtained from animals with different genotypes of the combination (LW× L) × «Maxter». The content of this substance was 0.4 % higher in heterozygous individuals ($p < 0.05$).

Table 5.49

Chemical properties of meat of pigs with different genotypes by the CTSF gene, n = 5, x ± Sd

Pedigree	Genotype	Total moisture, %	Dry matter, %	Fat, %	Protein, %	Ash, %
(LW × L) × «Maxter»	CC	75.0±0.25	25.0±0.25	2,3±0.11	22.1±0.23	1.5±0.21
	GC	74.7±0.17	25.3±0.17	2.6±0.09	21.4±0.18	1.7±0.13
(LW × L) × «Maxgroo»	CC	75.2±0.23	24.8±0.23	2.1±0.06	21.8±0.15	1.6±0.09
	GC	74.9±0.22	25.1±0.22	2.4±0.10	21.7±0.21	1.8±0.10

In terms of protein and ash content, there was no difference between meat obtained from animals with different genotypes for the MC4R gene.

Thus, the positive effect of the cathepsin F gene in the heterozygous state $CTSF^{GC}$ and the melanocortin receptor gene in the homozygous state by the $MC4R^{G}$ allele on the manifestation of most signs of slaughter qualities of pigs, regardless of their breed, was established. It is worth noting that we did not establish the dependence of the chemical composition of the meat of pigs of the studied combinations on their genotype for cathepsin and melanocortin genes.

Table 5.50

Chemical properties of meat of pigs with different genotypes by MC4R gene, n = 5, x ± Sd

Pedigree	Genotype	Total moisture, %	Dry matter, %	Fat, %	Protein, %	Ash, %
(LW × L) ×	*AG*	73.3±0.32	26.7±0.32	2.7±0.11	21.4±0.15	1.6±0.18

«Maxter»	*GG*	74.0±0.59	26.0±0.59	2.3±0.15*	21.6±0.17	1.7±0.21
(LW × L) × «Maxgroo»	*AG*	73.5±0.55	26.5±0.85	2.1±0.13	21.8±0.10	1.6±0.15
	GG	75.0±0.63*	25.0±0.93	1.9±0.11	22.0±0.11	1.7±0.20

5.9. Performance analysis of purebred and crossbred young stock under varying weight conditions.

5.9.1. Early maturity and feed efficiency in experimental young stock.

The growth and development of animals occurs through a complex interaction of the hereditary basis of the organism with specific environmental conditions and is an important factor for the realization of the genetic potential of animal productivity [132, 141].

To study the fattening and meat qualities of pigs at different weight conditions, 30 heads of pigs of each combination were selected on the principle of analogues. Fattening and meat qualities were studied according to the scheme given in Table 5.51.

Table 5.51

Scheme of the experiment to study fattening, and meat and fatty qualities

Animal group	Purpose of the group	Genotype		Live weight, kg		
				100	120	140
		sows	boars	number of pigs on fattening, head		
I	Control	DUSS	DUSS	30	27	24
II	Experimental	LW	DUSS	30	27	24
III	Experimental	DUSS	LW	30	27	24
IV	Experimental	L	DUSS	30	27	24
V	Experimental	DUSS	L	30	27	24

According to the research methodology, the growth of pigs was monitored by individual weighing. Young pigs of comparative genotypes were characterized by high growth energy. Our studies indicate a certain specificity of growth of young animals depending on the breed, breed and age. Age–related changes in live weight of gilts are characterized by the dynamics of live weight of experimental young animals, which is presented in Table 5.52.

Table 5.52

Dynamics of live weight of experimental animals, kg, x ± Sd

Age, month	Group				
	I	II	III	IV	V
1	6.5±0.18	6.8±0.24	5.6±0.30	6.3±0.20	6.2±0.22
2	19.1±0.28	20.3±0.26**	19.0±0.30	20.2±0.28**	21.8±0.24***
3	29.3±0.24	30.4±0.26**	31.5±0.24***	32.1±0.26***	33.1±0.20***
4	51.8±0.22	53.6±0.24***	55.8±0.26***	56.1±0.28***	59.4±0.26***
5	78.1±0.24	80.3±0.21***	81.7±0.25***	82.2±0.26***	87.3±0.23***
6	97.8±0.19	100.3±0.18***	104.2±0.20***	106.5±0.28***	112.9±0.23***
7	120.8±0.22	123.1±0.26***	125.7±0.28***	128.5±0.17***	135.1±0.17***
8	141.5±0.16	138.6±0.21	142.2±0.24*	147.4±0.18***	156.3±0.15***

The table shows that the animals of the experimental groups had slightly better live weight than their purebred counterparts of the Ukrainian Duroc breed of the control group.

No significant difference was found between the experimental and control groups in terms of live weight at one month of age, but piglets of the combination VB(ZS)× DUSS – 6,8 kg , where the maternal basis was a large white breed of foreign selection and the paternal basis was a pig of the intra–breed type of the Duroc breed of Ukrainian selection «Stepovyi», were characterized by the lowest live weight of piglets of the III experimental group – 5.6 kg.

The live weight of animals at two months of age was highest in animals of the V experimental group (DUSS × L(FS)), which significantly exceeded the animals of the control group by 2,7 kg (P > 0.999).

The animals of experimental groups II and IV also significantly exceeded the live weight of the animals of the control group I)at 1,2 kg and 1,1 kg, respectively (P > 0.99).

At three months of age, the highest live weight was characterized by animals of the combination, where the maternal form was the intrabreed type of the Ukrainian breed Duroc «Stepovoy», and the paternal form was the French breed Landrace –33,1 kg , which is3,8 kg more (P > 0.999) than in purebred analogues of the intrabreed type «Stepovoy».

The tendency of more intensive growth of pigs of the II, III, IV and V experimental groups is maintained during the further fattening period.

Thus, at 4 months of age, the live weight of experimental young animals of group II was 53,6 kg , of young animals of group III – 55,8 kg , of group IV 56,1 kg , of group V –59,4 kg , which is more than purebred animals (I) of the control group by 1,8 kg (P > 0.999); 4,0 kg (P > 0.999); 4,3 kg (P > 0.999); 7,6 kg (P > 0.999), respectively. At five months of age, the tendency for higher live weight in animals of the II, III, IV and V experimental groups is maintained. The young animals of these groups exceeded the analogues of the control group by 2.2 kg (P > 0.999); 3.6 kg (P > 0.999); 4.1 kg (P > 0.999); 9.2 kg (P > 0.999), respectively.

At the age of 6 months in the context of the control and experimental groups, animals of the III, IV and V experimental groups were characterized by higher live weight indicators, their live weight was: 104.2 kg 106.5 kg 112.9 kg , respectively, and exceeded the analogues of the intra–breed type "Stepovoy" by 6.5 %, 8.9 %, 15.4% (P > 0.999). A similar trend was observed at seven months of age. As for the eight–month age, the highest live weight during this period was characterized by young pigs of the V experimental group –156,3 kg, and exceeded the analogues of the control group by 10.5% (P > 0.999). The lowest live weight at the age of 8 months was in animals of the II experimental group – 138,6 kg and was 2.0 % lower than in the control group.

Differences in live weight were confirmed by the level of absolute, average daily and relative gains (Table 5.53), as live weight is directly related to them.

The young animals of experimental groups II, III, IV, and V outperformed the control group in terms of absolute weight gain at 1–2, 3–4, and 5–6 months.

Namely, at the age of 1–2 months, the highest value of the absolute growth rate was characterized by gilts – V of the experimental group, where the paternal form was the Landrace breed of French selection, and the maternal form was the intrabreed type of the Duroc breed of Ukrainian selection «Stepovoy» and they exceeded the control animals at 3.0 kg at P > 0.999.

The animals of the II and III experimental groups also exceeded the analogues of the large white breed, but no significant difference was found.

Table 5.53

Age dynamics of absolute, average daily and relative growth of young pigs, x ± Sd

Indicator	Age, month	Animal group				
		I	II	III	IV	V
Absolute increase	1–2	12.6 ±0.32	13.5 ±0.65	13.4 ±0.52	13.9 ±0.32**	15.6 ±0.61***

	2–3	10.2 ±0.54	10.1 ±0.32	12.5 ±0.46**	11,9 ±0.60*	11.3 ±0.52
	3–4	22.5 ±0.60	23.2 ±0.50	24.3 ±0.54*	24.0 ±0.64	26.3 ±0.46***
	4–5	26.3 ±0.65	26.7 ±0.81	25.9 ±0.64	26.1 ±0.32	27.9 ±0.54*
	5–6	19.7 ±0.82	20.0 ±0.56	22.5 ±0.46**	24.3 ±0.32***	25.6 ±0.50***
	6–7	23.0 ±0.46	22.8 ±0.56	21.5 ±0.54	22.0 ±0.56	22.2 ±0.52
	7–8	20.7 ±0.50	15.5 ±0.65	16.5 ±0.55	18.9 ±0.36	21.2 ±0.46
Average daily weight gain, g	1–2	414.5 ±8.77	444.1 ±9.10*	440.8 ±12.04	457.2 ±13.00**	513.2 ±11.00***
	2–3	335.5 ±9.04	332.2 ±10.04	411.2 ±11.49***	391.4 ±12.12***	371.7 ±10.44**
	3–4	740.1 ±12.44	763.2 ±11.80	799.3 ±9.59***	789.5 ±11.45**	865.1 ±9.50***
	4–5	865.1 ±15.18	878.3 ±14.44	852.0 ±17.68	858.6 ±14.21	917.8 ±13.21**
	5–6	648.0 ±11.80	657.9 ±10.00	740.1 ±17.98***	799.3 ±16.42***	842.1 ±12.40***
	6–7	756.6 ±10.84	750.0 ±9.40	707.2 ±16.21	723.7 ±15.04	730.3 ±16.42
	7–8	680.9 ±9.80	509.9 ±9.00	542.8 ±15.01	621.7 ±14.00	697.4 ±15.04
Relative growth, %	1–2	98.4	99.6	108.9	104.9	111.4
	2–3	42.1	39.8	49.5	45.5	41.2
	3–4	55.5	55.2	55.7	54.4	56.9
	4–5	40.5	39.9	37.7	37.7	38.0
	5–6	22.4	22.1	24.2	25.8	25.6
	6–7	21.0	20.4	18.7	18.7	17.9
	7–8	15.8	11.8	12.3	13.7	14.6

At the age of 2–3 months, the advantage in terms of absolute weight gain was in favor of the III, IV and V experimental groups and compared to the control group was: 2.3 kg ($P > 0.99$); 1.7 kg ($P > 0.95$) and 1.1 kg ($P < 0.95$), respectively. At the age of 3–4 months, gilts of all experimental groups outweighed their counterparts of the control group by 0.7–3.8 kg.

At the age of 4–5 months, the situation changed, and purebred animals of the intrabreed type of the Duroc breed of the Ukrainian selection «Stepovyi» outperformed their counterparts of the mixtures of the III and IV experimental groups.

In the period of 5–6 months, animals of the V experimental group were characterized by a higher value of absolute growth.

In the period of 6–7 months, the advantage was on the side of animals of the control group I, they exceeded the pigs of the experimental groups (II, III, IV, V) in terms of absolute growth by 0.2 kg; 1.5 kg; 1.0 kg and 0.8 kg, respectively, in all cases the difference is not statistically significant.

At the age of 7–8 months, a similar trend was observed, but the young animals of the V experimental group outperformed the purebred Duroc animals in terms of absolute gain at 0.5 kg, but the difference was not significant.

In terms of average daily weight gain, the best values during the entire age period were characterized by the pigs of the experimental groups.

In the period of 1–2 months, the highest average daily gain was observed in animals of the V experimental group, where the paternal form was the Landrace breed of French selection, and the maternal form was DUSS – 513.2 g , which is by 98.7 g (23.8 %) higher than the value of this indicator in the control group. Animals of the II, III and IV experimental groups at this age exceeded the analogues of the Duroc breed of Ukrainian selection by 29.6 g ($P > 0.95$); 26.3 g the difference is not statistically significant; 42.7 g ($P > 0.99$), respectively.

In the period of 2–3 months, the animals of the III experimental group had higher average daily gains – 411.2 g, where the maternal basis was the intrabreed type of the Ukrainian breed of duroc «Stepovyi», and the paternal basis was the large white breed of foreign selection. The lowest value of average daily weight gain in this period of time was observed in animals of the second experimental group, but it was also at a fairly high level – 332.2 g.

The young animals obtained from direct and reciprocal crossing of the intrabreed type of the Ukrainian breed Duroc «Stepovyi» and the French breed Landrace (IV and V) were characterized by the following values of average daily growth: 391.4 g and 371.7 g, respectively, and exceeded the purebred analogues of DUSS I by 55.9 g ($P > 0.999$) and 36.2 g ($P > 0.99$).

In the following age periods, when studying the average daily weight gain, a tendency to increase the weight gain in domestic animals was established.

In the age period of 3–4, 4–5, 5–6, 7–8 months, the highest average daily weight gain was observed in animals of the V experimental group, where the maternal basis is the intrabreed type of the Duroc breed, and the paternal basis is Landrace. At the age of 6–7 months, the animals of the control group were characterized by the highest average daily weight gain – 756.6 g.

Analyzing the average daily growth of all groups, it should be noted that it was highest at 3–4 and 4–5 months of age, and slightly decreased at 5–6 months of age.

Based on this, it should be noted that it is during these periods that special attention should be paid to proper feeding of animals, because it is during these periods that the highest live weight gains of fattening young animals are achieved, which makes it possible to identify the genetic potential of these pig genotypes.

Evaluating the experimental groups in terms of relative growth rate, which characterizes the intensity of growth of the organism, it was found that for all groups the value was highest in the period of 1–2 months and ranged from 98.4–111.4 %, the highest value of the indicator was characterized by animals of the combination DUSS× L, which exceeded the control group by 13.2 %.

In the age period of 2–3 months, the best in this indicator were animals of the III experimental group – 49.5 %, which exceeded the control group by 17.6 %. At the age of 3–4, 4–5 months, the advantage was on the side of animals of the V experimental group.

At the age of 5–6 months, the advantage was on the side of the animals of the experimental groups, and the highest relative gain was characterized by animals L × DUSS. At 6–7 and 7–8 months of age, the highest value of relative gain was characterized by purebred young animals of the control group I and amounted to 21.0 % and 15.8 %, respectively, of the age periods.

One of the main signs of pig productivity is early maturity. This is especially important during fattening or growing. Since the length of stay of young animals for fattening, growing, feed and growth costs is inversely proportional to early maturity.

The effectiveness of fattening depends on many factors, the main ones being feeding and housing conditions, breed, age and live weight of the animals.

Numerous studies by domestic and foreign scientists have shown that under the same feeding and housing conditions, the fattening qualities of pigs of different breeds and crossbreed combinations do not manifest themselves in the same way [7, 23, 43, 57, 92, 113, 141].

To study the fattening qualities of pigs obtained by purebred breeding and crossbreeding, the experimental animals were put on control fattening at 3 months of age, with an average live weight of 29.31–33.22 kg.

During the fattening period, there were differences between the experimental groups of animals in terms of early maturity, feed consumption, and average daily live weight gain. The results of fattening pigs at different weight conditions are presented in Table 5.54.

Table 5.54

Fattening qualities of young animals, x ± Sd

Group	Age at live weight, days	Average daily weight gain during fattening, g	Feed costs for1 kg growth, feed units
When reaching live weight100 kg, n = 30			
I	185.3±1.93	744.2±5.36	3.52
II	182.5±2.52	769.9±7.96**	3.46
III	177.1±2.81*	789.2±7.29***	3.33
IV	174.3±2.46***	801.6±6.25***	3.25
V	167.7±2.27***	875.6±6.17***	3.16
When reaching live weight120 kg, n = 27			
I	210.1±1.58	757.1±6.77	4.00
II	208.4±4.04	770.4±9.99	3.91
III	205.1±3.33	770.9±10.34	3.87
IV	200.2±4.32*	794.8±9.64**	3.76
V	194.3±2.32***	843.5±8.79***	3.58
When reaching live weight140 kg, n = 24			
I	235.7±3.32	761.3±9.32	4.20
II	245.2±3.81	715.8±10.32	4.50
III	240.0±3.93	724.8±10.32	4.38
IV	227.6±4.13	781.8±11.23	4.23
V	218.3±3.15***	841.6±10.74***	4.08

The table shows that the fattening qualities of all combinations are high, which was achieved under conditions of adequate feeding, as a prerequisite for intensive growth, development and health of pigs is biologically complete feeding according to diets well balanced in protein, amino acids, minerals and vitamins.

Fattening pigs reached live weight 100 kg in 167.7–185.3 days with average daily gain of 744.2–875.6 g, spending 3.16–3.52 feed units for 1 kg gain.

Comparing the main indicators in the context of control and experimental groups, we believe that the breeding animals, where the paternal form was the Landrace breed of French selection, and the maternal form was the intrabreed type of the Ukrainian breed duroc «Stepovyi» group V, were characterized by the best fattening indicators.

Namely, they reached live weight100 kg earlier by 17.6 days with higher average daily gains, by 131.4 g and consumed less feed by 1 kg, an increase of 11.4 % compared to purebred counterparts of the control group. The experimental animals of the IV group also outperformed the control group by 11 days in terms of age at live weight 100 kg, by 11 days in terms of average daily gain by 57.4 g, and by 0.27 feed units.

The experimental genotypes obtained from reciprocal crossing of intrabreed type pigs of the Ukrainian breed Duroc «Stepovyi» and foreign large white breeding (groups II and III) outperformed the control group in terms of average daily gain by 25.7 and 45 g , while consuming less feed by 0.06 and 0.19 feed units and the age of reaching live weight 100 kg was 3 and 8 days shorter, respectively.

When fattening young animals to live weight 120 kg, a similar trend was observed, the experimental genotypes significantly outperformed the control group in all major fattening parameters.

It is characteristic to note that the experimental genotypes retained high growth intensity even when fattening to live weight 140 kg. When animals reached live weight140 kg, the trend that took place during fattening to 100–120 kg changed slightly. The growth intensity of animals of the II and III experimental groups decreased, they reached the live weight of 140 kg 10 and 5 days later than the control group, had lower average daily gains by 45.5 and 36.5 g and, accordingly, higher feed costs by 0.30 and 0.18 feed units.

The lowest age of achievement of live weight 140 kg was characterized by animals of the V experimental group (DUSS× L) – 218.3 days, which is 17 days less than control animals. The young animals of this combination were characterized by the highest average daily gain – 841.6 g and lower feed costs – 4.08 feed units.

Analyzing the fattening qualities of young pigs of different genotypes, it was found that crossing contributed to the improvement of all fattening qualities of breeding stock without exception, since the intensity of live weight gain led to an increase in absolute, average daily gain and to a decrease in the age of reaching live weight of 100, 120,140 kg and feed costs per1 kg gain.

Fattening pigs of the intrabreed type of the Duroc breed of the Ukrainian selection «Stepovyi» under various combinations in conditions of full feeding to live weight100 kg contributed to a high level of average daily gain – 744.2–875.6 g. This trend continued when fattening to heavier weight conditions of 120–140 kg.

It was found that the highest fattening performance in three variants of fattening was obtained from a combination of intra–breed sows of the Duroc breed with boars of the Landrace breed. The expediency of fattening pigs of this combination to high weight conditions was noted, as they clearly retained high growth intensity when fattening to live weight 140 kg.

5.9.2. Slaughter, meat, and fat quality of experimental young stock.

The efficiency of pork meat production, along with reproductive and fattening traits, largely depends on the level of slaughter and meat qualities. This issue is of particular importance when using specialized meat breeds of foreign selection to improve the meat qualities of domestic pig breeds in the development of new intrabreed types and lines, or in the production of hybrid commercial young animals.

A general indicator of the slaughter qualities of animals is the slaughter yield, which is influenced by many factors: breed, breeding, productivity direction, etc. [132, 141].

When slaughtering pigs, the highest slaughter yield is obtained, on average 25 % more than other farm animals. The highest slaughter yield, which is noted in the specialized literature, is 88–90 %. The number of bones in pig carcasses is 2.5 times less. When slaughtering pigs, the highest yield of edible slaughter products is obtained [70, 75, 141].

When the gilts reached 100, 120,140 kg live weight, a control slaughter was performed, and the slaughter yield in the control and experimental groups is shown in Table 5.55.

Thus, the results of the experiment indicate that the slaughter and meat and fat qualities of pigs of the experimental genotypes were at a high level. In all weight conditions, the highest value of slaughter yield was in animals of group I (DUSS × DUSS) – 75.10–71.69 % and group V (DUSS × L) – 75.00–71.00 %, which is consistent with the studies of a number of authors [81, 112, 132, 141].

An important indicator of meat quality of pigs is the length of the carcass, but in our studies there was no significant difference in this indicator in all weight conditions.

Table 5.55

Slaughter qualities of pigs of different genotypes, x ± Sd

Group	Slaughterhouse exit, %	Length of the half–carcass, cm	The thickness of the bacon, mm	Area of the «muscle eye», cm^2	Weight of the hind third of the half carcass, kg
Pre–slaughter weight 100 kg, n = 3					
I	75.10±0.69	95.77±0.46	23.30±0.46	39.10±0.28	11.15±0.11
II	71.20±0.77*	94.61±0.68	24,80±0.88	37.30±0.37*	10.81±0.22
III	73.00±0.80	95.63±0.91	25.70±0.86	36.90±0.41**	10.67±0.21
IV	74.83±0.71	96.24±0.66	24.30±0.63	38.60±0.34	10.98±0.18
V	75.00±0.77	96.44±0.64	24.70±0.68	38.90±0.28	11.10±0.14
Pre–slaughter weight120 kg, n = 3					
I	75,08 ±0,44	98,03 ±0,88	26,40±0,71	42,08±0,42	12,69±0,19
II	70,25±0,51**	97,18±1,01	28,80±0,74	40,54±0,59	11,90±0,25
III	72,25±0,57*	96,94±0,96	30,00±0,70*	39,81±0,58*	11,83±0,27
IV	74,00±0,61	98,45±0,86	27,10±0,70	41,70±0,44	12,13±0,21
V	74,42±0,67	99,56±0,83	27,80±0,68	41,86±0,51	12,35±0,23
Pre–slaughter weight140 kg, n = 3					
I	71,64±0,43	118,40±0,61	30,80±0,54	49,63±0,23	14,07±0,38
II	68,43±0,67*	116,00±0,80	32,40±0,66	47,13±0,34**	13,58±0,60
III	69,71±0,45*	115,40±0,76*	33,70±0,71*	46,89±0,40**	13,44±0,73
IV	70,21±0,47	120,10±0,55	32,40±0,48	48,58±0,31	14,20±0,40
V	71,00±0,44	121,60±0,61*	32,10±0,51	49,14±0,28	14,30±0,31

In addition to live weight at slaughter140 kg, where animals V (DUSS × L) of the experimental group outperformed animals of the control group by 3.2 см (P > 0.95). However, there was a tendency for a longer carcass in the crossbred young of the experimental group V, where the paternal form was the Landrace breed of French selection and the maternal form was the Duroc breed of Ukrainian selection.

Since the longer carcass of Landrace pigs is their breed feature, they clearly transmit this quality to offspring when crossbred. This indicator in animals of group V at slaughter at 100, 120, 140 kg was 96.44 cm, 99.56 cm, and 121.60 см, respectively.

Regarding the thickness of the fat at the level of 6–7 thoracic vertebrae in all weight conditions, a pattern of increase in this indicator in crossbred animals obtained from reciprocal crossing of intrabreed type pigs of the Duroc and Large White breeds (II, III) was revealed in contrast to animals of the control group.

Absolute and relative changes in muscle and adipose tissue are reflected in changes in the area of the «muscle eye», which is a reliable criterion for assessing the meatiness of carcasses. According to numerous studies, the area of the «muscle eye» positively correlates with the yield of meat in pig carcasses.

A common pattern for pigs of all experimental groups was that the area of the «muscle eye» increases with the growth and increase in live weight of animals. It should be noted that the growth rate of this trait remains at a high level when animals reach live weight 140 kg.

Thus, when slaughtered with a live weight of 100 kg, the highest indicator of the area of the «muscle eye» was characterized by animals of the control group – 39.10 cm^2 and prevailed over animals of the II, III experimental groups by 4.6 % ($P > 0.95$) and 5.6 % ($P > 0.99$), respectively. When the live weight120 kg was reached, no significant difference was found between the groups. And when the live weight of 140 kg was reached, the area of the «muscle eye» ranged from 47.13–49.63 cm^2 by group.

In terms of the weight of the hind third of the half–carcass, no significant difference was found in the experimental groups in all weight categories, but a tendency to a greater weight of ham in animals of the control group was found, indicating a change in the intensity of the development of the organism, its early maturity. In the study of fattening and meat qualities, the evaluation index was used to summarize the fattening and meat qualities (Table 5.56).

In all growth periods, the highest value of the complex index of fattening and meat qualities was observed in animals of the V experimental group in the range of 211.9–203.6. When animals reached a live weight of 100–140 kg, the lowest value of this index was characterized by animals of the II experimental group.

It should be noted that of all the economically useful traits of pigs, meat qualities have the highest coefficient of inheritance and they develop independently [132].

Table 5.56

Comprehensive index of fattening and meat qualities, x ± Sd

The value of the index	Group				
	I	II	III	IV	V
Pre–slaughter weight 100 kg					
I(1)	180.1 ±1.23	186.3 ±2.10	190.9 ±1.66	193.9 ±3.20	211.9 ±1.16
Pre–slaughter weight 120 kg					
I(2)	183.2 ±2.20	186.4 ±4.40	186.5 ±2.56	192.3 ±2.10	204.1 ±3.50
Pre–slaughter weight 140 kg					
I(3)	184.2 ±1.25	173.2 ±2.00	175.4 ±2.30	189.2 ±2.60	203.6 ±2.20

The final conclusion about the productivity of pigs of different breeds can be made on the basis of data on the quantity and quality of meat products obtained from them. The criterion for assessing the quality of pork includes a number of indicators, such as the quality of the carcass itself, its morphological and chemical composition, physical properties, etc. [129, 141].

A more objective indicator of meat productivity is the morphological composition of the pig carcass. With an increase in pre–slaughter weight, there are changes in the ratio of individual tissues: muscle, fat and bone.

Numerous studies have established that under the same feeding and housing conditions there are significant interbreed differences in the morphological composition of the carcass. Carcass weighing showed that the groups differed in morphological composition (Table 5.57).

Studies have shown a pattern of changes in the ratio of tissues with age, a decrease in meat yield and an increase in fat, but different genotypes have their own intensity of change in this ratio.

Analyzing the data in the table, it should be noted that all experimental groups had good meat quality and were characterized by high meat content and low fat content in all weight conditions.

Differences in the intensity of muscle tissue growth in relation to adipose tissue are especially pronounced in animals of the III experimental group (DUSS× LW) at pre–slaughter weight 100 kg. Therefore, the lowest relative content of muscle tissue in animals of this group was 61.00 %, but the yield of lard was the highest – 25.12 %.

Table 5.57

Morphological composition of the carcass of experimental young pigs, x ± Sd

Group	Content in the carcass, %			Ratio of meat : lard
	meat	fat	bones	
Pre–slaughter weight 100 kg, n = 3				
I	63.90±0.21	23.79±0.30	12.31±0.20	1 : 0.37
II	62.20±0.28**	24.32±0.34	13.48±0.25*	1 : 0.39
III	61.00±0.30**	25.12±0.38	13.88±0.34*	1 : 0.41
IV	63.18±0.30	23.00±0.24	13.82±0.38*	1 : 0.38
V	64.12±0.36	23.32±0.21	12.56±0.28	1 : 0.36
Pre–slaughter weight 120 kg, n = 3				
I	60.24±0.28	26.33±0.24	13.43±0.22	1 : 0.44
II	57.06±0.36**	29.89±0.37**	13.05±0.31	1 : 0.52
III	57.89±0.21**	28.84±0.39**	13.57±0.35	1 : 0.50
IV	60.78±0.30	25.81±0.28	13.41±0.27	1 : 0.42
V	60.80±0.32	26.00±0.20	13.20±0.24	1 : 0.43
Pre–slaughter weight 140 kg, n = 3				
I	56.14±0.36	29.30±0.24	14.56±0.21	1 : 0.52
II	53.81±0.24***	31.98±0.34***	14.21±0.37	1 : 0.59
III	54.60±0.21***	31.18±0.39**	14.22±0.31	1 : 0.57
IV	56.31±0.28*	29.85±0.27**	13.84±0.27	1 : 0.53
V	57.53±0.32	28.18±0.30	14.29±0.23	1 : 0.49

When slaughtered, 120 kg had the highest meat yield of 60.80 % and the lowest fat yield of 20.00 %, animals with the paternal form of the Landrace breed of French selection and the maternal form of the intra–breed type of the Duroc breed, but no significant difference was found compared to the control group.

The same trend was observed at 140 kg slaughter. In all weight conditions, the lowest yield of meat and the highest yield of fat were characterized by crossbred animals of the II and III experimental groups.

Thus, the analysis of the morphological composition of carcasses shows that the relative meat yield at slaughter of 100–140 kg was different and depended on the genotype of animals and amounted to 64.12–53.81 % in the groups. In terms of meat yield from the carcass, the best were purebred animals of the inbred type of the Duroc breed of the Ukrainian selection «Stepovyi» (I control group), crossbred young animals of the combination DUSS × L, they had a relative meat yield of 100–140 kg at slaughter of 63.90–56.14 % and 64.12–57.53 %, respectively.

5.9.3. Internal organ development in experimental organisms.

The growth and development of pigs, productivity and body type are closely related to their interior, morphological and biological characteristics of the organism. It is known that the circulatory, respiratory, excretory and other organs are chains of a single system and changes in one of them lead to changes in other related organs and systems [42, 81, 141].

When studying the formation of pig meatiness, it is important to study the growth of individual organs. Numerous studies have established that the growth rate of the main tissues that are components of meat productivity coincides in time with the growth rate of all animal organs. Also, the growth and development of internal organs is significantly influenced by a number of factors: different combinations of breeds and lines, feeding levels and feeding types [42, 77, 132, 141].

The absolute weight of the internal organs of pigs of the experimental groups at different weight conditions is given in Table 5.58.

The obtained results give grounds to characterize the peculiarities of metabolic processes in the organisms of experimental animals. The data in the table indicate that as the live weight of pig’s increases, the absolute weight of the internal organs of young animals of all groups increases.

The most intensive growth is in the liver, which is both an organ and an endocrine gland directly involved in the digestive process. Organs such as the spleen, heart and lungs are characterized by slower growth compared to the growth rate of the animal's live weight as a whole.

Pigs of the IV and V experimental groups obtained from reciprocal crosses of the intrabreed type of the Duroc breed of the Ukrainian Stepovyi selection and Landrace of the French selection, regardless of pre–slaughter weight, have a higher absolute weight of the heart, lungs, liver, spleen and kidneys compared to analogues of the other groups.

The better development of internal organs of these genotypes indicates their more active activity, which leads to increased metabolism and, as a result, higher meat productivity of pigs of these combinations.

Table 5.58

Changes in the absolute weight of internal organs of experimental pigs, g, x ± Sd

Group	Internal organs, g				
	lungs	heart	liver	spleen	kidneys
Pre–slaughter weight 100 kg, n = 3					
I	764±16.92	300±13.22	2095±19.12	208±11.84	320±13.12
II	716±16.24	327±13.58	2180±20.06*	179±11.46	323±13.21
III	735±16.58	320±13.46	2181±20.10*	187±11.68	329±13.34
IV	810±17.32	343±13.96	2115±19.93	264±12.07*	336±13.42
V	798±17.14	365±14.02*	2174±20.02*	277±12.13*	348±13.57
Pre–slaughter weight 120 kg, n = 3					
I	806±17.19	356±13.89	2320±21.04	230±12.35	391±13.63
II	744±16.81	379±14.46	2370±21.28	226±12.27	398±13.79
III	775±16.92	372±14.11	2373±21.34	228±12.31	401±13.81
IV	857±17.36	386±14.58	2390±21.46	313±12.72**	412±13.95
V	850±17.28	402±14.76	2394±21.52	318±12.83**	417±14.01
Pre–slaughter weight 140 kg, n = 3					
I	842±17.62	420±15.04	2412±22.00	252±12.42	408±13.93
II	805±17.21	417±14.92	24,28±22.17	265±12.58	414±14.04
III	812±17.24	422±15.12	2432±22.28	257±12.52	423±14.14
IV	900±18.00	446±15.23	2444±22.41	331±12.91*	428±14.25
V	886±17.73	452±15.35	2440±22.36	336±13.06*	436±14.36

Young pigs of the control group I at a live weight of 100, 120 and 140 kg exceeded pigs of the experimental groups II and III by 6.7 %, 8.3 %, 4.6 % and 3.9 %, 4.0 %, 3.7 %, respectively. However, the crossbred animals of the IV and V experimental groups had an advantage of 4.4–6.9 % in this indicator over the purebred control animals at different pre–slaughter weights.

As for the heart weight, the studied genotypes of groups II and III occupied an intermediate position between the control animals and the other groups.

However, the pigs of the following combinations (L × DUSS; DUSS × L) in different weight conditions exceeded the animals of the intrabreed type of the Duroc breed of the Ukrainian selection «Stepovyi». Thus, at slaughter at 100 kg, pigs of the V experimental group had the highest absolute heart weight – 365 g and outweighed control animals by 21.7 % (P > 0.95).

By liver weight at live weight 100 kg pigs of II, III, V experimental groups significantly outnumbered animals of the Duroc breed of Ukrainian selection by 4.0 %, 4.1 %, 3.8 %, respectively, at ($P > 0.95$). A similar trend was observed in the following weight periods.

The young animals of the IV and V experimental groups at slaughter in100 kg significantly exceeded the control pigs by 26.9 % and 33.2 %, respectively, in terms of absolute spleen weight in both cases, the difference is statistically significant. This difference is especially clearly observed in this indicator between purebred animals and young animals obtained from reciprocal crossing of intrabreed pigs of the Duroc breed of Ukrainian selection and Landrace of French selection, when they reached a live weight of 120 and 140 kg.

The kidney weights of all studied genotypes were higher than those of control pigs. For example, at a live weight of 100 kg pigs of groups II, III, IV, V had an advantage in kidney weight over the control by 0.9 %, 2.8 %, 5.0 %, 8.7 %, respectively in all cases the difference is not statistically significant, at slaughter in 120 kg – respectively 1.8 %, 2.6 %, 5.4 %, 6.6 % ($P < 0.95$), at the pre–slaughter weight of 140 kg – respectively 1.5 %, 3.7 %, 4.9 %, 6.9 % ($P < 0.95$).

Thus, based on a comparative study of the weight of internal organs in the dynamics of growth, it can be concluded that intensive formation of internal organs occurred in young animals of the experimental groups (II, III, IV, V), which, in turn, indicates a higher level of metabolic processes in young animals of the experimental genotypes and indicates a better use of nutrients in the diet.

5.9.4. Histological analysis of muscle tissue in experimental groups. Meat productivity of pigs is determined primarily by heredity, age, feeding and housing conditions. Recently, the demand for lean pork has been growing, so much attention should be paid not only to quantitative (meat yield, fat, etc.) but also to qualitative traits [44, 141].

Muscle tissue makes up more than 40 % of animal body weight and, depending on its structure, performs important physiological functions in the body [33]. The main histomorphologic and functional element of striated tissue is the muscle fiber, a multinucleated cell 10 to 100 microns thick and up to12 см or more in length. The surface of the muscle fiber is covered with an elastic membrane, the sarcolemma [105].

The quality of meat is influenced by the size of muscle fibers, the amount and location of adipose tissue. The plasma of muscle cells contains complete proteins, and connective tissue contains incomplete proteins, the amount, properties, and location of which determine the tenderness of meat [126–128, 141].

It has been established that muscle fibers become thicker and coarser with age. Particularly significant thickening is observed at a later stage of ontogeny (4.5–5.5 months). Thus, for the period from 3.5 to 4.5 months of age changes in fiber thickness amounted to 9–12 %, and from 4.5 to 5.5 months of age, this figure increases to 27–28 %. A detailed analysis of the fiber thickness of the longest back muscle revealed that in animals of 3.5 months of age, muscle fibers up to 30 microns thick accounted for 22.1 % of the total, in pigs at 4.5 months – 18.4 and at 5.5 months – only 6 %. At the same time, fibers with a maximum thickness (100 microns) in 3.5, 4.5, 5.5 month old animals were 1.1 %, 4.4 %, and 6.0 %, respectively. These data indicate that in pigs from 3.5 to 5.5 months of age there is an intensive increase in muscle tissue [126, 141].

Micrometry data when animals reach live weight100 kg indicate a significant variation in the diameter of muscle fibers (from 6.6 to 112.3 microns). The largest number of small muscle fibers is found in the muscle tissue of pigs of the Large White 36.29 %, Myrhorod 31.70 % and Landrace× Large White 29.30 % breeds. The number of large muscle fibers is higher in pigs of meat breeds: Landrace 16.3 % and Pitren 14.3 % [42, 119, 141].

The analysis of histological preparations of purebred and mixed–breed animals shows that muscle fibers are organized into first–order bundles and differ not only in diameter but also in shape and location. While in purebred pigs there are relatively few small–diameter muscle fibers and they are located in one or two groups in the middle of the bundle, in the muscle tissue of domestic animals there are much more small muscle fibers and groups in the middle of the bundles are more numerous; along with smaller muscle fibers, large–diameter fibers are much more common in these animals, which are mainly located along the periphery of the bundles [5, 126, 137, 141].

Pork has a high nutritional value and is used to produce a wide range of meat products. The digestibility of pork meat reaches 95 %, and that of bacon – 98 %. Compared to beef and lamb, it contains less water and more dry matter. The high content of complete, easily digestible protein and essential amino acids, and a relatively low percentage of inferior proteins, such as collagen and elastin, distinguish pork from other types of meat. The presence of adipose tissue gives pork meat its caloric content, tenderness and flavor [91, 104, 138, 141].

Breed differences in pork quality are based on the quantitative ratio and degree of formation of muscle and adipose tissue. Meat of fatty pigs already by 5–6 months of age is characterized by a set of histomorphological features that determine its maturity, and meat and bacon pigs – by 6–7 months of age [81]. Therefore, animals of different productivity directions at the same age period produce pork of different histomorphological composition.

Taking into account the fact that muscle tissue contains activators and energy substances that help animals grow meat and characterize its quality, histological studies are of particular relevance [23, 30, 64].

Many scientists are studying the histological structure of muscle tissue [126, 137, 138, 141], as intensive selection for early maturity results in some deterioration in meat quality.

The analysis of literature sources allows us to conclude that of all the indicators that are directly related to the growth of muscle tissue and animals themselves, as well as the increase in their meat productivity, the increase in the size of muscle fibers is the most important. This indicator, in turn, is an objective criterion for the yield of lean meat in the carcass [6].

According to the analysis of literature sources, the problem of studying the histological features of the structure of muscle and adipose tissue in pigs of different genotypes, taking into account their level of fattening and meat productivity, has not been studied sufficiently at present [141].

Therefore, the research involved the study of the histological structure of muscle tissue of pigs of the intra–breed type of the Duroc breed of the Ukrainian selection «Stepovyi» in various combinations. The main task of the research was to determine the thickness of muscle fibers, as well as the ratio of structural components of tissues of pigs of experimental groups at different weight conditions, as well as to determine the optimal time of slaughter of pigs, based on the analysis of the histological structure of muscle tissue as one of the indicators characterizing the technological properties of meat.

The dynamics of muscle tissue development of the longest back muscle of pigs at pre–slaughter weights of 100, 120,140 kg shows that groups of pigs differed in histological structure (Table 5.59).

Table 5.59

Dynamics of the development of the longest back muscle tissue of the

experimental groups, x ± Sd

Group	Genotype	Muscle fiber diameter, microns	The ratio of structural components of the fabric, %	
			parenchyma	stroma
live weight 100 kg, n = 3				
I	DUSS × DUSS	24.5±0.41	85.2±2.71	14.8±1.20
II	DUSS × LW	33.4±0.50*	78.6±2.69	21.4±1.27
III	LW × DUSS	36.9±0.49***	76.2±1.83*	23.8±1.19
IV	DUSS × L	16.2±0.22**	89.2±2.77	10.8±1.11
V	L × DUSS	17.7±0.21*	88.4±1.87	11.6±1.10
live weight 120 kg, n = 3				
I	DUSS × DUSS	30.6±0.44	82.0±2.73	18.0±1.17
II	DUSS × LW	46.1±0.63***	76.1±2.66*	23.9±1.32*
III	LW × DUSS	48.0±0.58***	74.3±1.80**	23.7±1.21**
IV	DUSS × L	20.7±0.19*	87.7±1.92	12.3±0.12
V	L × DUSS	22.8±0.25**	86.2±1.79	13.8±1.13
live weight 140 kg, n = 3				
I	DUSS × DUSS	33.0±0.37	77.8±1.83	22.2±1.30
II	DUSS × LW	55.2±0.48**	74.8±2.62	25.2±1.24
III	LW × DUSS	56.9±0.52**	73.1±1.78	26.9±0.98
IV	DUSS × L	23.6±0.30*	86.4±2.04*	13.6±1.17*
V	L × DUSS	24.8±0.22*	85.6±1.91*	14.4±1.32*

The obtained results of histological studies showed that when the pigs reached the live weight of 100 kg II, III experimental groups in terms of muscle fiber thickness significantly outperformed the animals of the control group by 26.6 % ($P > 0.95$) and 33.6 % ($P > 0.999$), respectively. This indicates that the genotypes of the experimental groups in the interfascicular layer have a greater number of fat cell precursors in the stage of formation compared to the control group. The muscle fascicles of these groups are predominantly spherical or elliptical in cross–section, and are well vascularized. The diameter of the muscle fibers ranges from 35–41 microns, with insignificant variability.

The opposite trend is observed in young animals of the IV and V experimental groups obtained from reciprocal combinations of intrabreed type pigs of the Duroc breed of the Ukrainian Stepovyi selection and Landrace of the French selection, which are significantly inferior in terms of muscle fiber diameter to their analogues – purebred animals of the control group.

The muscle fascicles of these genotypes are lanceolate in shape, with well–formed strands of collagen fibers in the intervals between them. The shape of the muscle fiber cross–sections is predominantly penta–hexagonal, with nuclei located near the sarcolemma. The average value of myocyte diameters ranges from 18–21 µm, with significant variability.

However, in terms of the ratio of parenchyma, the gilts of these groups exceed the control pigs by 4.5 and 3.6 %, respectively, due to the presence of a small amount of connective tissue between their muscle fibers. When animals reach live weight120 kg, a similar pattern is observed.

Thus, in the II and III experimental groups, a significant growth of muscle fibers was observed, which exceeded the control pigs by 33.6–36.0 % (P > 0.999). In these combinations, a significant number of muscle cells in cross–section have an irregular elliptical shape, which indicates the activation of growth processes and intense coloration corresponds to an increase in the number of specific contractile proteins. In the same groups, unlike the control group, the connective tissue in the interfascicular layer increases significantly due to the presence of a large number of mature fat cell precursors.

Regarding the IV and V groups of combinations L × DUSS and DUSS × L, it should be noted that the growth of muscle fibers is characterized by low intensity, the average diameter ranges from 23–25 µm compared to control animals – 33–35 µm. However, the amount of collagen in the interfascicular layer increases and single mature adipocytes precursors of fat cells are observed.

An even more significant increase in diameter is observed in animals of such combinations: LW × DUSS; DUSS × LW at a live weight of 140 kg. They are superior to purebred animals of the inbred type of the Duroc breed of the Ukrainian selection «Stepovyi» by 40 % (P > 0.99) and 42 % (P > 0.99), respectively. The amount of collagen in these groups is insignificant, but there is an intensive formation of the vascular network with adipose tissue adjacent to it.

In the following experimental groups (IV and V), a weak growth of muscle fibers is noticeable, which are quite tightly adjacent to each other. The young pigs of the control group outperformed the pigs of these groups in terms of muscle fiber thickness by 22.8 % (P > 0.95) and 18.9 % (P > 0.95), respectively. In these groups, the amount of collagen in the interfascicular layer increases; adipose tissue is negligible.

The analysis of the histological structure of the longest back muscle showed that there was a breed specificity in the formation of muscle fibers in the experimental groups. Upon reaching a live weight of 100–120 kg in animals of the control group, the actual growth of muscle tissue parenchyma loses its intensity and the amount of stromal component increases due to the development of a network of collagen fibers. Therefore, the meat obtained from purebred young animals of the intrabreed type of the Duroc breed of the Ukrainian selection «Stepovyi» is characterized as lean or with a moderate degree of fat content.

At a pre–slaughter weight of 100–140 kg, animals of such combinations as LW × DUSS; DUSS × LW increase the amount of stroma, mainly due to adipose tissue. Meat obtained from these genotypes is characterized by tenderness and juiciness.

Upon reaching a live weight of 100–120 kg in pigs of the IV and V groups of combinations: L × DUSS and DUSS × L, an increase in the parenchymal component of muscle tissue is observed, and when the live weight of 140 kg is reached, the growth activity of the muscle component is somewhat weakened. Therefore, in order to increase the muscle mass of these genotypes, it is recommended to use them for further fattening.

5.9.5. Meat and fat quality indicators of young stock across weight conditions.

The main trend in the development of pig production is not only further increase in meat content, but also simultaneous improvement of the quality of produced pork [132].

In recent years, in order to improve the meat quality of pigs in our country, crossbreeding of large white breed sows with boars of meat breeds and lines of domestic and foreign selection has been widely used, and therefore control over the quality of pork is an urgent issue, since breeding pigs for rapid growth and increased meatiness leads to a decrease in meat quality [10, 23, 29, 141].

Most animals with high meat yields show an increase in water content, flabbiness, and decreased color intensity [33, 39, 44, 91]. This deterioration in meat quality causes significant damage to farms. Significant economic losses have been reported in the production of bacon and canning of meat with high humidity [104, 116, 141].

The quality of pork meat products depends on the morphological composition of the carcasses, as well as their physical and chemical properties and biological value. When assessing the quality of meat, indicators such as tenderness, juiciness, moisture retention capacity, intramuscular fat content, protein quality, color, pH, and others are taken into account.

According to domestic and foreign literature, the quality of meat and lard products is significantly influenced by the breed and combination of breeds during crossbreeding, age of animals, feeding level, fatness, as well as a number of genetic and phenotypic factors [5, 10, 14, 23, 141].

The Institute of Pig Production and Agroindustrial Production of the National Academy of Agrarian Sciences of Ukraine summarized the data of long–term studies on the influence of breed on the physicochemical parameters of meat quality, its protein and amino acid composition, as well as on the physicochemical parameters and fatty acid composition of pig fat. The determination of the chemical composition of the longest back muscle of 18 domestic breeds did not reveal significant interbreed differences in the content of dry matter, protein, fat, and ash. Muscle tissue contained an average of 24.58% dry matter (amplitude of fluctuations by breed – 23.97–25.82 %), protein – 21.59 % (21.08–22.12 %), fat – 2.39 % (1.65–2.87 %), ash – 1.09 % (1.06–1.13 %).

The quality of carcasses is influenced not only by the ratio of meat to fat, but also by the fatty acid composition of back fat and its physicochemical properties. The high nutritional value of lard depends on the fatty acid composition and the ratio of saturated and unsaturated acids [23–25, 27, 30, 141].

The quality of meat is assessed by the consumer based on such indicators as color, moisture content, juiciness, texture and tenderness, taste and smell. To assess the nutritional value of meat, the content of essential amino acids, minerals, vitamins and fatty acids that the human body cannot synthesize are also taken into account.

In our studies, the results of physicochemical and chemical analysis of the longest back muscle during slaughter of pigs of different experimental genotypes and different pre–slaughter weights are presented in Tables 5.60, 5.61.

Active acidity is considered to be the main indicator in assessing meat quality. Its level characterizes the degree of intensity of biochemical processes in the carcass and is closely related to the formation of taste and technological properties of meat.

Table 5.60

Physicochemical parameters of pig meat, x ± Sd

Group	Acidity, pH	Moisture retention capacity, %	Color intensity, E× 1000
Pre–slaughter weight 100 kg			
I	5.55±0.07	54.81±1.91	51.00±3.66
II	5.60±0.11	56.13±1.54	54.20±3.12
III	5.61±0.15	56.00±1.65	55.60±4.46
IV	5.49±0.03	53.01±2.69	50.40±3.19
V	5.51±0.05	51.48±1.74	50.60±2.79
Pre–slaughter weight 120 kg			
I	5.57±0.12	51.50±2.45	56.00±4.44
II	5.62±0.06	54.24±1.15	59.80±5.62
III	5.60±0.16	55.10±1.04	57.40±2.50
IV	5.55±0.04	48.70±1.74	53.00±4.46
V	5.58±0.08	50.83±1.31	54.20±3.80
Pre–slaughter weight 140 kg			
I	5.60±0.05	52.34±1.87	64.80±5.89
II	5.73±0.04	53.78±1.23	67.00±2.00
III	5.75±0.03*	54.18±1.93	69.60±2.04
IV	5.61±0.05	49.81±1.27	62.50±4.94
V	5.69±0.06	49.43± 0.78	63.00±6.47

Analysis of the results of studies of the active acidity of muscle tissue of experimental animals showed that no violations of the carcass maturation process were detected. It should be noted that the pH value of meat of pigs of all groups and weight conditions was within normal limits.

Table 5.61

Chemical properties of pig meat, x ± Sd

Group	General moisture, %	Dry matter, %	Fat, %	Protein, %	Ash, %
Pre–slaughter weight 100 kg					
I	73.42±0.42	26.58±0.35	2.54±0.31	22,18±0,38	1.86±0.05

II	74.24±0.41	25.76±0.51	2.83±0.27	21.35±0.82	1.58±0.10
III	73.94±0.22	26.06±0.52	2.64±0.35	21.87±0.35	1.55±0.08
IV	72.89±0.68	27.11±0.45	2.50±0.19	22.78±0.41	1.83±0.04
V	73.10±0.67	26.90±0.38	2.48±0.15	22.42±0.35	2.00±0.04
Pre–slaughter weight 120 kg					
I	72.74±0.52	27.26±0.38	3.32±0.65	21.75±0.38	2.19±0.04
II	73.35±0.41	26.65±0.45	3.61±0.29	21.24±0.44	1.80±0.12
III	73.00±0.32	27.00±0.58	4.11±0.31	20.95±0.65	1.94±0.08
IV	72.14±0.54	27.86±0.61	3.10±0.47	22.61±0.57	2.15±0.05
V	72.52±0.36	27.48±0.52	3.00±0.28	22.36±0.52	2.12±0.10
Pre–slaughter weight 140 kg					
I	73.32±0.36	27.68±0.35	3.84±0.35	21.59±0.44	2.25±0.08
II	73.10±0.26	26.90±0.48	4.16±0.67	21.18±0.65	1.56±0.12
III	72.92±0.44	27.08±0.67	4.25±0.54	21.00±0.57	1.83±0.06
IV	71.89±0.56	28.11±0.64	3.43±0.48	22.47±0.64	2.21±0.10
V	72.15±0.40	27.85±0.52	3.38±0.39	22.19±0.58	2.28±0.07

The lowest pH value was characterized by animals of the IV experimental group, where the maternal form is the Landrace breed of French selection, and the paternal form is the intra–breed type of the Duroc breed of Ukrainian selection «Stepovyi». It was relatively higher in pigs obtained from reciprocal crossing of the intrabreed type of the Ukrainian breed duroc «Stepovyi» and the large white breed of foreign selection – II, III experimental groups.

Thus, when animals reached the live weight of140 kg, pigs of the III experimental group significantly exceeded the control by 2.7 % ($P > 0.95$).

An important qualitative factor in the culinary properties of pork is its ability to retain sufficient moisture. Meat that contains enough bound water is juicier, has a more delicate texture, better flavor and taste.

In the context of the control and experimental groups, the result in terms of moisture content corresponded to the indicators of normal pork quality – from 51.48 to 56.13 % when slaughtered in100 kg, from 48.70–55.10 % when slaughtered in120 kg and from 49.43–54.18 % – in140 kg. However, there is a certain tendency to reduce this indicator in animals characterized by increased meatiness.

An equally important indicator that characterizes both the presentation and technological properties of meat and the intensity of oxidative processes in the pig's body is its color. It is no coincidence that meat color is used as a quality indicator on the global market.

The analysis of the results for this indicator between the experimental and control groups did not reveal a significant difference.

The value of the color intensity index at different weight conditions ranged from 50.40 to 69.60. Fattening pigs to a live weight of 140 kg increased the intensity of coloration of muscle tissue of animals of all experimental groups.

The analysis of the data in Table 5.61 shows that the test groups practically did not differ in the content of total moisture in the longest muscle of the back.

Studies have confirmed the pattern of increasing the content of dry matter in muscle tissue mainly due to an increase in intramuscular fat content.

Thus, with age, in the process of increasing the weight of pigs, there is a decrease in the content of hygroscopic moisture, a slight decrease in protein content and an increase in fat content.

The nutritional value of meat largely depends on its fat content, which gives meat products excellent taste and increases their energy value. The highest fat content at slaughter at 100, 120,140 kg , was in the meat of pigs of the II and III experimental groups – 2.83, 2.64 %; 3.61, 4.11 % and 4.16, 4.25 %, respectively, and the lowest in the young animals of the V experimental group (DUSS × L) – 2.48 %, 3.00 % and 3.385, respectively.

No significant and statistically significant difference was found in the protein content of meat between the control and experimental groups, but the highest protein content was characterized by meat obtained from animals of the IV and V experimental groups, which exceeded the control group at slaughter of 100 kg: by 2.7 and 1.1 %; in 120 kg – 3.9 and 2.8 %; in 140 kg – 4.1 and 2.8 %, respectively. Thus, it should be noted that the fat and protein content is determined by the breed factor.

Table 5.62

Physicochemical parameters of pig fat, x ± Sd

Group	General moisture, %	Dry matter, %	Fat, %	Cell membranes, %	Iodine number
Pre–slaughter weight 100 kg					
I	8.51±0.31	91.49±0.38	89.10±0.18	2.39±0.90	56.90

II	8.14±0.22	91.86±0.42	89.45±0.22	2.41±0.87	57.60
III	7.87±0.25	92.13±0.58	90.13±0.27*	2.00±0.42	57.76
IV	6.94±0.41	93.06±0.51	91.16±0.41*	1.90±0.57	59.36
V	7.34±0.35	92.66±0.42	90.77±0.22**	1.89±0.45	58.76
Pre–slaughter weight 120 kg					
I	7.63±0.38	92.37±0.24	90.24±0.19	2.13±0.22	58.24
II	7.36±0.56	92.64±0.28	90.09±0.28	2.55±0.62	57.53
III	7.14±0.49	92.89±0.31	90.46±0.15	2.43±0.45	57.96
IV	6.21±0.42	93.80±0.33*	92.02±0.31**	1.78±0.15	58.87
V	7.14±0.23	92.86±0.29	90.86±0.24	2.00±0.39	59.14
Pre–slaughter weight 140 kg					
I	6.91±0.54	93.09±0.24	90.81±0.22	2.28±0.32	57.89
II	6.58±0.42	93.42±0.36	90.78±0.28	2.64±0.60	57.90
III	6.68±0.68	93.32±0.29	90.80±0.31	2.52±0.49	58.12
IV	6.16±0.62	93.84±0.42	91.72±0.48	2.12±0.38	58.72
V	6.31±0.58	93.69±0.31	91.48±0.40	2.21±0.51	58.64

When slaughtering animals with a live weight of 100 and 140 kg, the highest ash content was observed in animals obtained from reciprocal crosses of the intrabreed type of the Duroc breed of the Ukrainian Stepovyi selection and Landrace of the French selection and exceeded the pigs of the control group by 7.5 and 1.3 %, respectively, the difference is not statistically significant.

When the gilts of the experimental groups reached a live weight of 120 kg, purebred young animals of the first control group (DUSS × DUSS) had the highest ash content in meat compared to the experimental groups, which was 2.19 %.

According to the results of the research, it can be concluded that the quality of meat of pigs of all experimental groups meets the requirements of the standards and, depending on the combination and pre–slaughter weight, has specific properties. Thus, crossbreeding and fattening to a live weight of 120–140 kg influenced the improvement of meat quality indicators, the improvement of physicochemical and chemical properties of muscle tissue moisture retention capacity, color intensity, intramuscular fat content, which increase the taste and nutritional quality of meat in general.

There were some differences between animals of different combinations in the physical and chemical properties of adipose tissue. Changes in the chemical composition and physical properties of pig fat of the experimental groups depending on the weight condition are shown in Table 5.62. The fat of slaughtered experimental animals of all groups was characterized by high quality indicators.

With age, the fat content in the adipose tissue of animals of all experimental groups increases and the moisture content decreases. The backbone of purebred pigs of the control group I in all weight periods exceeded the rest of the experimental groups in terms of total moisture content.

The dry matter content of animals of the IV experimental group was slightly higher. Thus, when slaughtered with a live weight of 100 kg, pigs of this combination (L × DUSS) exceeded the control group by 1.7 % (the difference is not statistically significant);120 kg – by 1.5 % (P > 0.95); 140 kg – by 0.8 % (P < 0.95).

In terms of fat content at pre–slaughter weight100 kg, animals of the III, IV, V experimental groups exceeded young pigs of the control group by 1.1 % (P > 0.95), 2.3 % (P > 0.95) and 1.9 % (P > 0.99), respectively. When reaching the live weight of120 kg only gilts of the IV experimental group, this indicator significantly exceeded the animals of the control group by 2 % (P > 0.95).

When slaughtering animals with a live weight of 140 kg, pigs of the control group exceeded the fat content of young animals obtained from reciprocal crossing of the intrabreed type of the Duroc breed of the Ukrainian selection «Stepovyi» and Landrace of the French selection (IV, V groups) by 1 % and 0.7 %, respectively, but no statistically significant difference was found.

According to the iodine number, which reflects the content of unsaturated fatty acids in lard and the quality of lard, all experimental genotypes were characterized by high values of this indicator.

Based on the physicochemical parameters, it was found that the fat of pigs of all experimental groups is of dense consistency with good digestibility.

Thus, the analysis of qualitative characteristics allows us to conclude that the meat and lard of pigs of the experimental groups is characterized by good quality, no significant difference in the studied indicators between animals of different genotypes when fattening to a live weight of 100–140 kg was found.

5.9.6. Hematological parameters of organisms of different genotypes.

The possibility and probability of early assessment of the productive qualities of animals of different combinations is of both theoretical and practical importance, which is carried out by determining the interior features [42, 58, 141, 143].

The genetic determination of different growth intensity and productivity of individual animals of different pig breeds is associated with complex and diverse metabolic processes, which are reflected in the morphological and biochemical parameters of the blood, which is relatively constant, but at the same time one of the most labile systems in the body [132]. Even minor changes in metabolism are reflected in the blood. It is impossible to determine the degree of productivity of animals only by their exterior, without taking into account interior features [42].

A number of authors point out that the activity of homopoiesis, the intensity of redox processes in the pig's body are influenced by both genotypic (breed, type of constitution, type of productivity) and paratypic (feeding, housing conditions) factors [23, 91, 141, 143].

In turn, the morphological composition of the blood is closely related to the general vital activity of the organism and can be used as an indicator of animal adaptation to certain environmental conditions [42]. Many authors have shown a link between live weight gain and the morphological composition of red blood cells [141].

Periods of the most active growth are characterized by a higher content of these blood cells [132]. Therefore, it is of practical interest to study the degree of genetic difference in blood morphological parameters when combining different genotypes in the process of their growth, which can explain the increased growth energy of young animals of mixed origin, obtained as a result of these combinations.

To determine the interior characteristics of young animals of different genotypes when the experimental pigs reached 2, 4, 6 months of age, blood samples were taken from the same animals (5 heads from each group) in the morning from 8 to 10 o'clock, before feeding. The morphological and biochemical status of pig blood was determined by conventional methods: the number of red and white blood cells by counting in the Goryaev chamber under a microscope; hemoglobin content – using a Sali hemometer; total protein content in the blood serum – by refractometric method on a photoelectrocalorimeter KFC–2; the amount of albumin and globulins – by the nephelometric method; the activity of the enzymes aspartate and alanine aminotransferases by the Reitman–Frenkel method [141]. The data on the morphological composition of the blood of pigs of experimental groups in the age aspect are given in Table 5.63.

Table 5.63

Age–related changes in the morphological composition of blood of pigs of

different genotypes, x ± Sd

Indicator	Age, m	Animal Group, n = 5				
		I	II	III	IV	V
Hemoglobin, g/%	2	9.89 ±0.138	9.38 ±0.117	8.27 ±0.061	8.92 ±0.083	8.98 ±0.076
	4	10,77 ±0.124	11.00 ±0.158	9.18 ±0.012	10.84 ±0.135	11.40 ±0.098**
	6	11.14 ±0.168	10.70 ±0.145	10.10 ±0.139	11.27 ±0.171	11.36 ±0.169
Red blood cells, mln/mm^3	2	7.61 ±0.093	7.14 ±0.082	7.32 ±0.113	7.77 ±0.078	7.83 ±0.125
	4	7.57 ±0.098	7.33 ±0.108	7.35 ±0.116	7.65 ±0.081	7.91 ±0.089*
	6	7.71 ±0.136	7.41 ±0.111	7.30 ±0.097	7.81 ±0.148	7.90 ±0.137
White cells, mln/mm^3	2	19.21 ±0.268	18.48 ±0.196	18.61 ±0.211	20.04 ±0.301	19.21 ±0.316
	4	18.72 ±0.212	18.56 ±0.324	18.70 ±0.273	19.84 ±0.198**	19.36 ±0.185
	6	13.37 ±0.158	14.82 ±0.216	14.40 ±0,182	15.22 ±0,169***	15.00 ±0,134

The study of the morphological composition of the blood of pigs of different genotypes in the process of their growth allowed to compare their quantitative and qualitative composition. The results of the study showed that purebred young pigs of the combination: DUSS × DUSS (I) had the highest hemoglobin content at 2 months of age and exceeded the experimental groups by 5.4 %, 19.6 %, 10.9 %, 10.1 %, respectively. However, the mixed breed young animals of group V, where the paternal form is Landrace of French selection and the maternal intrabreed type of the Duroc breed of Ukrainian selection in the following age periods exceeded the control at 4 and 6 months of age in terms of hemoglobin content by 6 % (P > 0.99) and 1.9 % (difference is not statistically significant), respectively.

This indicates that in piglets of this combination, the maturity to salting is reduced, and redox processes in them are maintained at a high level for a longer time.

In terms of red blood cell content at 2, 4, 6 months of age, the advantage was on the side of pigs of the V experimental group, which outperformed the control group by 2.9 % ($P < 0.95$), 4.5 % ($P > 0.95$) and 2.5 % ($P < 0.95$), respectively.

The analysis of the leukocyte content showed that at 2 months of age, the leukocyte content was higher in pigs of the experimental group IV and exceeded the control animals by 4.3 % ($P < 0.95$). At the age of 4 and 6 months, the situation did not change; the higher leukocyte count was in animals of experimental group IV with a high degree of probability.

Analyzing the data on the morphological composition of blood in the age aspect in the context of the control and experimental groups, the advantage remains on the side of IV and V experimental groups, and this indicates an increased level of metabolic processes associated with the formation of muscle tissue, and explains the increased growth energy of young animals of these groups.

An important indicator that characterizes the metabolic rate and physiological status of the organism is the protein composition of blood serum [42]. It has been found that in crossbred and hybrid animals, as more potentially early maturing genotypes, a more intense increase and higher values of total protein content by 6.0...8.0 % and its fractions: albumin and globulins are observed [23, 25, 43, 91, 141].

Similar phenomena are observed in purebred pigs that differ in early maturity: in faster maturing pigs, the serum protein content increases faster, and growth is accompanied by more intense protein deposition in the body [91]. Regarding the change in these indicators with age, in pigs, their increase is observed up to a certain age (6–14 months) and up to certain limits depending on maturity and growth energy, followed by a slight decrease or stabilization [42, 141].

Blood enzymes are considered to be a reliable marker of early prediction of animal productive qualities. It has been established that the level of activity of some enzymes is controlled by heredity and their activity is higher in early maturing animals, which is confirmed by correlations with productive traits and is reflected in the works of domestic and foreign scientists [23, 132, 141].

In general, it should be noted that meat genotypes of pigs are characterized by higher rates of protein–enzyme metabolism than universal breeds. Thus, transamylase activity is highest during the period of active growth of muscle tissue. Studies have shown that the highest AST activity is observed in pigs at four months of age, especially for pigs of meat genotypes. At an older age, the formation of adipose tissue and a decrease in muscle tissue formation begin, which leads to a decrease in the activity of aminotransferases in subsequent age periods [91, 141].

The data of the results of our studies of the biochemical composition of the blood of the experimental groups are given in Table 5.64, which indicate that at 2 months of age, young animals of experimental group V had the highest value – 6.96 g/% of total protein in the blood serum. At 4 months of age, the animals of experimental groups IV and V were characterized by a high value of this indicator and exceeded the control group in protein content by 7 % ($P > 0.99$) and 3.7 % ($P > 0.95$), respectively.

In the same age group, animals of the II and III experimental groups were inferior to the control by 1.2 % ($P < 0.95$) and 4.3 % ($P > 0.95$), respectively. Animals of the first control group were characterized by a high level of total protein at the age of 6 months – 7.84 g/%.

Some genotypic differences in the ratio of albumin and globulin fractions of total protein in experimental animals were found.

At the age of 2, 4 months, young animals of the IV and V experimental groups were characterized by higher albumin content with a high degree of reliability compared to control animals. At the age of 6 months, the advantage was on the side of the local young of the III experimental group, where the maternal form is the intrabreed type of the Ukrainian breed duroc «Stepovyi», and the paternal form is the foreign breed Large White.

A similar trend was observed in the globulin content at 2 months of age. However, at 6 months of age, the highest globulin level was observed in the control group – 4.84 g/%.

As a result of the studies, it was found that, compared to purebred animals, almost all crossbred groups had increased protein metabolism. It was found that at 4 months of age, pigs have high levels of serum enzyme activity, which corresponds to the period of intensive synthesis of muscle tissue.

AST activity in gilts of the experimental groups, especially IV and V, was 7.4–36.6 % higher for all age periods compared to purebred animals.

The increased activity of transamylases in the blood serum of pigs of these groups is due to the influence of animals of French origin, selected for high growth intensity, which is explained by the manifestation of a higher intensity of metabolic processes in the tissues and organs of these animals. The ALT activity at 2 months of age was the highest – 0.47 mmol/hourly in gilts of the IV experimental group, which exceeded the control pigs by 27.7 % (P > 0.99). A similar trend was observed at 4 months of age. However, at the age of 6 months, the highest activity of this enzyme was observed in the gilts of the V experimental group – 0.96 mmol/hhl.

For a more detailed study of enzyme activity, the Ritis index is used, which indicates the ratio of AST to ALT enzymes, expressed in units. The ALT enzyme is involved in the process of amino acid transamination, which, with the help of the AST enzyme, synthesizes specific tissue proteins, i.e. builds muscle tissue in the pig's body. Based on this, this index is important in studying the degree of intensity of oxidative processes, the level of metabolism, which determine the level of productivity of pigs and allows for more economical consumption of essential amino acids [42, 141].

Thus, the highest value of the Ritis index in pigs of the experimental groups is at 4 months of age and is 1.17–1.41 units. This can be explained by the fact that it was during this period that the highest AST activity was observed, indicating a period of active muscle growth and a period of intensive protein synthesis in the body of young pigs. At 6 months of age, the activity of aminotransferases decreases, so the Ritis index has slightly lower values compared to the previous age period, so the formation of muscle tissue in pigs slows down and fatty tissue increases.

Table 5.64

Biochemical composition of blood of experimental groups, x ± Sd

Indicator	Age, m	Animal group				
		I	II	III	IV	V
Total protein, g/%	2	6.18 ±0,105	5.90 ±0.087	6.19 ±0.093	6.88 ±0.128*	6.96 ±0,098**
	4	7.45 ±0,057	7.36 ±0.085	7.14 ±0.069	7.73 ±0.081*	7.97 ±0.095**
	6	7.84 ±0,073	7.13 ±0,067	7.32 ±0.103	7.40 ±0.091	7,24 ±0.080
Albumin, g/%	2	2,43 ±0,031	2,22 ±0,043	2,35 ±0,028	2,78 ±0,039***	2,84 ±0,021***
	4	2,78 ±0,017	2,81 ±0,030	2,79 ±0,049	3,02 ±0,041***	3,12 ±0,036***
	6	3,00 ±0,051	2,96 ±0,047	3,12 ±0,039	3,00 ±0,040	2,98 ±0,036
Globulins, g/%	2	3,75 ±0,059	3,78 ±0,041	3,84 ±0,063	4,10 ±0,070**	4,12 ±0,051**
	4	4,67 ±0,075	4,55 ±0,065	4,35 ±0,048	4,71 ±0,051	4,85 ±0,083
	6	4,84 ±0,054	4,17 ±0,047	4,20 ±0,065	4,40 ±0,081	4,26 ±0,068

Protein ratio (albumin/globulins)	2	0,65 ±0,019	0,59 ±0,004	0,61 ±0,007	0,68 ±0,009	0,69 ±0,012
	4	0,60 ±0,008	0,62 ±0,009	0,64 ±0,007	0,64 ±0,006	0,64 ±0,006
	6	0,62 ±0,008	0,71 ±0,007	0,74 ±0,009	0,68 ±0,006	0,70 ±0,011
AST, mmol/hchl	2	0,30 ±0,006	0,34 ±0,008	0,32 ±0,007	0,41 ±0,018**	0,40 ±0,011**
	4	0,84 ±0,010	0,86 ±0,017	0,80 ±0,021	0,92 ±0,031	0,96 ±0,009***
	6	0,67 ±0,009	0,70 ±0,008	0,67 ±0,006	0,71 ±0,015	0,72 ±0,022
ALT, mmol/hl	2	0,36 ±0,005	0,44 ±0,009	0,42 ±0,007	0,47 ±0,011**	0,46 ±0,015**
	4	0,72 ±0,019	0,62 ±0,011	0,60 ±0,010	0,74 ±0,024	0,68 ±0,021
	6	0,84 ±0,013	0,72 ±0,009	0,70 ±0,007	0,84 ±0,008	0,96 ±0,009
Ritis index (AST/ALT), units.	2	0,83	0,77	0,76	0,87	0,87
	4	1,17	1,39	1,33	1,24	1,41
	6	0,80	0,97	0,96	0,84	0,75

Thus, based on the hematological studies, it can be concluded that in terms of almost all the main morphological and biochemical parameters of blood at different ages, the animals of experimental groups IV and V exceeded their peers. These data indicate the high reactivity of the organism of animals of these groups, which contributes to the identification of genetic potential in experimental animals.

5.10. Developing a program to optimize meat productivity of livestock.

The results of our own research and their discussion provide the basis for the development of a practical program for increasing the meat productivity of pigs in industrial production. It consists of a set of interconnected measures, taking into account innovative technological solutions, technological and breeding operations and techniques, which are presented in Table 5.65.

The program consists of technological and informational blocks, the implementation of which makes it possible to increase the productivity of fattening young pigs and bring pork production to an innovative, cost–effective level in enterprises of various sizes and forms of management.

Table 5.65

Program for increasing the meat productivity of young pigs* at using

modern gene pool and innovative technological solutions

№ s/n	Complex technological solutions	Expected result
1.	The use of «enrichment materials» in the form of straw bales and plastic bottles 2L 50 % filled with wheat, corn, barley, etc. per machine (20–30 heads) with their renewal on a weekly basis.	1. A significant decrease in the number of cases of harmful social behavior (biting tails and ears, fighting) and an increase in playful, exploratory behavior, which is confirmed by a lower level of cortisol in the blood plasma. 2. Reduction of culling percentage during the fattening period by 13.8–15.8 %. 3. Higher growth parameters by 3.5–7.0 %.
2.	Addition of 0.15 % by weight of the complex preparation «Gepasorbex» to feed contaminated with mycotoxins (medium degree).	1. Stopping the negative effects of mycotoxins, endogenous and exogenous toxic substances of various natures without binding vitamins *A*, *D* and *E*. 2. Increase in live weight by 2.67–5.1 kg and average daily weight gain by 41.9–60.7 g at weight conditions of 100–120 kg, respectively 3. Increase in downhole yield by 0.5–4.1 %. 4. Increase in the mass fraction of protein in meat by 2.85 %. 5. The highest amino acid index is 79.70% at 100 kg slaughter; at 120 kg slaughter – 75.27 %. 6. The highest protein–quality index is 12.22 and 7.39 units.
3.	Introduction of the feed additive «Perfectin» to the recipe of feed in the amount of 2 kg per 1000 kg of feed.	1. Reduction of the age of slaughtering conditions by 9.3 days, feed consumption per 1 kg of weight gain by 5.1 %, increase in average daily weight gain by 6.0 %. 2. Increase in slaughter yield by

		3.9 %, decrease in fat thickness by 19.8 %, increase in the area of the «muscle eye» by 6.1 %. 3. Promotes the growth of muscle fibers in the later periods of fattening. The meat is characterized as lean.
4.	Complex use of «Pro–Mac» (stress corrector) and «Ultimade Acid» (organic acid complex). The drugs are introduced into the water supply system using a Dozatron mediator at a dose of 1 liter per 1000 liters of drinking water 4 days before and 7 days after changing the diet, regrouping, weighing and other technological manipulations.	1. Reducing the age of reaching slaughter conditions of 100–120 kg by 4.6–5.3 days, feed consumption per 1 kg of weight gain by 0.37–0.22 kg, increasing the average daily weight gain by 46.0–40.3 g. 2. Increase in slaughter yield by 0.3–1.2 %, decrease in the thickness of the speck by 1.3–1.5 mm, increase in the area of the «muscle eye» by 0.3–1.5 cm^2. 3. Increase in meat yield from the carcass by 0.5–1.3 %.
5.	The use of a dry form of the phytobiotic «Liptosa Expert», introduction into the feed formulation in the amount of 1.5 kg per 1000 kg of feed.	1. Increase in live weight by 5.14–6.15 % and average daily weight gain by 8.13–8.46 %. 2. It is an effective method of replacing the use of antibiotics and growth stimulants, which leads to an increase in the preservation and development of beneficial microflora in the intestines of pigs.
6.	Apply selection aimed at obtaining animals with $CTSF^{GC}$ and $MC4R^{AG}$ genotypes in combinations sows (LW×L) with boars of the terminal lines «Maxter» and «Maxgroo».	1. Increase in slaughter yield by 0.4–1.4 %, increase in the area of the «muscle eye» by 0.2–1.4 cm^2, increase in the weight of the hind ham by 0.3–0.6 kg. 2. Increase in meat yield from the carcass by 0.6–0.8 %.

Notes. * – fattening young pigs at the age of 77–190 days.

5.11. Economic efficiency of research outcomes in agribusiness.

The level of efficiency of the pig industry depends on the use of a promising gene pool with high reproductive, fattening and meat qualities in purebred breeding and crossbreeding. It is also largely influenced by product quality indicators.

Increasing the economic efficiency of pork production is possible by increasing its production while reducing labor and material costs per 1 kg of live weight gain, i.e. by ensuring the intensification of the industry.

High efficiency can be achieved both by reducing the cost of pork and by increasing the selling price of meat, which depends on its quality. The weight of pigs at the end of fattening is an important indicator of pork production intensity. The amount of weight affects the quantitative level of pork production, its quality indicators and production costs.

The main criteria for determining the optimal final live weight for fattening should be the following: the possibility of obtaining high gains as long as possible, feed efficiency, yield of meat and fat products and their quality, and production cost. These indicators are subject to change with increasing age and weight of animals. Average daily weight gain and feed consumption per 1 kg of weight gain are interrelated. Pigs that have a high growth rate and produce higher gains use feed more efficiently, have a lower proportion of maintenance feed, and consume less nutrients per unit of production.

Regardless of the productivity direction, with increasing age and weight of fattening pigs, feed costs per unit of gain increase and feed costs per unit of slaughter weight decrease. When calculating feed costs per slaughter weight, meat and fat yield, fattening to higher weight conditions is also effective.

Table 5.66 shows the indicators of economic efficiency of using different types of self–storage units for young animals for fattening to live weight 100 kg.

Table 5.66

Economic efficiency of the use of homebrewers for young pigs

Indicator	Type of feeder		+/– feeding machine to the bunker feeders
	bunker	feeding machine	
Cost of the feeder*, UAH	6000.0	7800.0	+1800
Number of pigs, goal	80	80	–
Number of feeders, pcs	2	2	–

Live weight of young animals when put on fattening (age 90 days), kg	31.9	32.1	+0.2
Age of reaching live weight 100 kg, days	186.3	177.6	–8.7
Duration of fattening, days	96.3	87.6	–8.7
Feed costs for1 kg growth, feed units	3.49	3.22	–0.27
The increase in live weight at fattening per 1 head, c	0.681	0.679	–0.002
Live weight gain on fattening, kg	54.48	54.32	–0.16
Cost of 1 kg of live weight gain, UAH	2275.35	2158.57	–116.78
Average selling price per 1 kg of live weight gain*, UAH	2750.0	2750.0	–
Cost of live weight gain, UAH thousand	123.96	117.25	–6.71
Revenue from the sale of live weight gain, UAH thousand	149.82	149.38	–0.44
Additional costs for feeders, UAH thousand	–	3.6	–
Net profit on sales, UAH thousand	25.86	28.53	+2.67
Profitability level, %	20.86	24.33	+3.47

Note: * – at average market prices in 2015.

If feeding machines are used to feed mixed fodder to 80 heads of young cattle during the fattening period, an additional UAH 3.6 thousand is spent compared to the use of bunker self–made machines.

However, during the fattening period, animals that consumed feed from feed machines reached live weight faster 100 kg, by 8.7 days with lower feed costs by 0.27 feed units compared to their counterparts that received feed from bunker moonshine machines. Higher growth intensity led to a decrease in the cost of 1 c of growth by 116.78 UAH.

At the same selling price of 2750.0 UAH, as well as taking into account the additional costs of feeders, but with higher productivity, it is advisable to use feeding machines for feeding compound feed to young animals during the fattening period. Based on 80 heads of young cattle, the use of feeding machines leads to an additional net profit of 2.67 thousand UAH, with a higher profitability of 3.47 %

compared to the use of bunker self–made milkers.

Table 5.67 shows the indicators of economic efficiency of the use of the probiotic preparation «Bio Plus 2B» in fattening young animals to live weight 100 kg.

The use of live spore cultures «Bio Plus 2B» in the diets of young pigs – group II, led to an increase in growth intensity, due to which the animals reached live weight100 kg in 6.6 days with less feed consumption – by 0.24 feed units, compared to young pigs receiving the main diet – group I.

The shorter fattening period and lower feed costs contributed to a reduction in the cost of one centner of gain. Even spending an additional UAH 2.29 thousand on the probiotic product «Bio Plus 2B» during the period of fattening to live weight 100 kg in the II group, it became possible, due to increased productivity, to obtain a higher value of net profit – UAH 28.09 thousand per 80 heads of young animals, which is UAH 3.23 thousand higher than the same indicator of the I group. In the second group of animals that consumed the probiotic «Bio Plus 2B» in addition to the main diet, the level of profitability was 3.79 % higher than in the first group and amounted to 24 %.

Taking into account the studies conducted, we note that the use of modern probiotics «Bio Plus 2B» and their impact on improving production, economic and economic indicators undeniably prove the justified need for their use in pig feeding technology.

The level of efficiency of the pig industry depends on the use of a modern gene pool with high fattening and meat traits in purebred breeding and crossbreeding under optimal feeding and housing conditions.

It is also largely influenced by product quality indicators. If we take into account the high growth rate of young pigs, it becomes obvious how much even a small difference in performance ultimately affects the economic efficiency of pork production [23, 25, 28, 71, 101].

Based on the studies conducted on the impact of «enrichment materials» in the conditions of industrial technology of the base farm on the behavior and productive traits of fattening young pigs, the economic efficiency of the impact of the enrichment environment on the productivity of fattening young pigs at different weight conditions was calculated, which is shown in Table 5.68.

Table 5.67

Economic efficiency of using the probiotic «Bio Plus 2B»

Indicator	Group		+/– group II to the first group
	I (OR)	II (OR + 400 g/ton «Bio Plus 2B»	
Number of pigs, heads	80	80	–
Live weight of young animals when put on fattening (age 90 days), kg	32.8	33.0	+0.2
Age of reaching live weight 100 kg, days	181.9	175.3	–6.6
Duration of fattening, days	91.9	85.3	–6.6
Feed costs for1 kg growth, feed units	3.52	3.28	–0.24
The increase in live weight at fattening per 1 head, c	0.672	0.67	–0.002
Live weight gain on fattening, kg	53.76	53.6	–0.16
Cost of 1 kg of live weight gain, UAH	2287.7	2183.27	–104.43
Average selling price per 1 kg of live weight gain*, UAH	2750.0	2750.0	–
Cost of live weight gain, UAH thousand	122.99	117.02	–5.96
Revenue from the sale of live weight gain, UAH thousand	147.84	147.40	–0.44
Additional costs for probiotics, UAH thousand	–	2,29	2,29
Net profit on sales, UAH thousand	24.85	28.09	+3.23
Profitability level, %	20.21	24.00	+3.79

Note: * – at average market prices in 2015.

Table 5.68

Economic efficiency of the influence of enrichment environment on the productivity of fattening pigs at different weight conditions

Indicator	Weight condition, kg	Group		
		I control[a]	II experimental[b]	III experimental[c]
Number of gilts at the beginning of fattening, heads	–	60	60	60
Live weight of a piglet at the age of 11 weeks, kg	–	37.93	38.83	39,37
Age of reaching weight condition, days	100	160,4	156,2	155,7
	120	190,1	184,8	183,5

Feed conversion, kg	100	3,14	3,00	3,00
	120	3,59	3,46	3,45
Duration of fattening, days	100	83,4	79,2	78,7
	120	113,1	107,8	106,5
Absolute weight gain during the fattening period, kg	100	62,07	61,17	60,63
	120	82,07	81,17	80,63
The number of young animals at the end of fattening, head	100	49	57	58
	120	49	57	58
Live weight gain during fattening, kg	100	30,41	34,87	35,17
	120	40,21	46,27	46,77
Additional costs for the enrichment environment, UAH	100	–	400,00	292,00
	120	–	560,00	408,80
Cost of 1 kg of live weight gain, UAH	100	4003,53	3859,91	3839,48
	120	4160,86	4026,47	4000,40
Average selling price per 1 of live weight gain, UAH[d]	100	4500,0	4500,0	4500,0
	120	4750,0	4750	4750,0
Cost of live weight gain of young animals, UAH thousand	100	121,76	134,98	135,31
	120	167,33	186,85	187,49
Revenue from the sale of live weight gain of young animals, UAH thousand	100	136,86	156,90	158,24
	120	191,02	219,77	222,14
Net profit on sales, UAH thousand	100	15,10	21,92	22,94
	120	23,69	32,92	34,65
Profitability level, %	100	12,40	16,24	16,95
	120	14,16	17,62	18,48

Notes: [a] – without the use of enrichment material; [(b)] – using straw bales; [(c)] – using plastic bottles (2L) filled with grain (wheat) to 50% of their capacity; [d] – at average market prices 2021.

It was found that young pigs that had access to «enrichment materials» during fattening – II and III experimental groups were characterized by higher rates of fattening traits at weight conditions of 100 and 120 kg compared to animals raised using traditional technology – group I (control).

Reduction of the fattening period, reduction of feed costs, higher preservation and higher average daily weight gain in young animals of the II and III experimental groups influenced the reduction of the cost of growth compared to the control (group I) by 143.63 and 164.05 UAH at a live weight of 100 kg and 134.39 and 160.46 UAH at a weight of 120 kg.

So, taking into account the cost and selling prices per kilogram of live weight gain, we note that the use of «enrichment materials» is cost–effective, does not incur significant additional costs additional costs in group II for the period of fattening up to 120 kg – 560 UAH, in group III – 408.8 UAH per 60 heads, since the net profit and profitability of young pigs of groups II and III are higher than those of group I (control) by 6.82 and 7.84 thousand UAH. UAH and 3.84 and 4.55 % at the weight condition of 100 kg and respectively by 9.22 and 10.96 thousand UAH and 3.46 and 4.32 % at the weight condition of 120 kg.

It should be noted that fattening young pigs to higher weight conditions in the context of all experimental groups has higher profitability.

The experimental studies revealed an increase in the productive qualities of young pigs (LW×L) × «Maxter» when using the complex feed additive «Gepasorbex» produced by Vetservisproduct in the diets of mixed fodder contaminated with mycotoxins. The positive result of the use of the feed additive naturally influenced the indicators of economic efficiency of pig production (Table 5.69).

The use of the complex feed additive «Gepasorbex» – group III in the diets of fattening young pigs led to an increase in growth intensity, due to which animals reached a live weight of 100 kg 3 and 6 days earlier at lower feed costs – by 0.45 and 0,54 kg and 6 and 9.5 days earlier reached a live weight of 120 kg at lower feed costs – by 0.2 and 0.28 kg, compared to young animals receiving only the basic diet – group I (control) and group II, which consumed the basic diet with a commercial analog of mycotoxin sorbent.

The shorter duration of fattening and lower feed costs contributed to a reduction in the cost of one centner of gain (experimental groups II and III).

Table 5.69

Economic efficiency of the effect of «Gepasorbex» additive on the productivity of fattening pigs at different weight conditions

Indicator	Weight condition, kg	Group		
		I control[a]	II experimental[b]	III experimental[c]
The number of pigs on fattening, heads	–	30	30	30
Live weight of a piglet at the age of 12 weeks, kg	–	35,5	35,03	35,83
Age of reaching weight condition, days	100	161,7	158,7	155,7
	120	190,2	184,2	180,7

Feed conversion, kg	100	3,39	2,94	2,85
	120	3,50	3,30	3,22
Duration of fattening, days	100	77,7	74,7	71,7
	120	106,2	100,2	96,7
Absolute weight gain during the fattening period, kg	100	64,5	64,97	64,17
	120	84,5	84,97	84,17
Live weight gain during fattening, kg	100	19,35	19,49	19,25
	120	25,35	25,49	25,25
Additional costs for mycotoxin sorbent, UAH	100	–	687,64	658,38
	120	–	1009,44	975,70
Cost of 1 kg of live weight gain, UAH	100	4354,66	4006,08	3903,60
	120	4214,75	4065,10	3973,70
Average selling price per 1 of live weight gain, UAH[d]	100	4500,0	4500,0	4500,0
	120	4750,0	4750,0	4750,0
Cost of live weight gain of young animals, UAH thousand	100	84,26	78,77	75,81
	120	106,84	104,63	101,32
Revenue from the sale of live weight gain of young animals, UAH thousand	100	87,08	87,71	86,63
	120	120,41	121,08	119,94
Net profit on sales, UAH thousand	100	2,81	8,94	10,82
	120	13,57	16,45	18,63
Profitability level, %	100	3,34	11,35	14,28
	120	12,70	15,72	18,38

Notes: [a] – the basic rations «Grower» and «Finisher» were used; [b] – the basic rations «Grower» and «Finisher» were consumed with the addition of 0.15 % by weight of feed of a commercial analogue of mycotoxin adsorbent; [c] – the basic rations «Grower» and «Finisher» were used with the addition of 0.15 % by weight of feed of the complex drug «Gepasorbex»; [d] – at average market prices in 2021.

Even spending additionally on sorbents of mycotoxins during the fattening period to a live weight of 100 and 120 kg – 687.64 and 1009.44 UAH in group II and 658.38 and 975.7 UAH in group III, it became possible, due to increased productivity, to obtain a higher value of net profit per 30 heads of young animals, which is 6.13 and 8.01 thousand UAH. UAH and 2.88 and 5.06 thousand UAH higher than the same indicator of the first group at weight conditions of 100 and 120 kg.

In the third group of experimental animals, which consumed the complex feed additive «Gepasorbex» in addition to the main diet, the highest level of profitability was observed at weight conditions of 100 and 120 kg by 5.06 and 2.18 % and 10.94 and 2.93 %, respectively, compared to analogues of groups I and II, at lower additional costs for the feed additive.

The study of the economic efficiency of the effect of the complex feed additive

«Gepasorbex» on the slaughter traits of young pigs at different weight conditions is presented in Table 5.70. The lower value of the cost of live weight gain directly affected the cost of carcass, because the cost of slaughter was the same for young pigs of all experimental groups.

The use of the complex feed additive «Gepasorbex» (group III) in the diets of fattening young pigs led to an increase in the slaughter yield and, as a result, to obtain heavier carcasses – 75.39 and 92.3 kg at a pre–slaughter weight of 100 and 120 kg, respectively, which is higher than the index of analogues of groups I and II by 3.83 and 0.13 kg; 0.86 and 0.46 kg.

The calculations of economic efficiency confirm the data on the feasibility and higher profitability of selling animals in slaughter weight compared to selling them in live weight. Thus, in the context of experimental groups, it was found that due to the sale of animals in slaughter weight, it is possible to increase the profitability index at weight conditions of 100 kg and 120 kg for group II by 3.89 % and 38.78 % and group III by 4.08 % and 40.33 %, respectively. Regarding Group I, we note that it is more profitable to sell animals of 100 kg in live weight, and only when the live weight reaches 120 kg is it more profitable to sell them in slaughter weight, which increases this indicator by 35.85 %.

Thus, in comparing the obtained data on the economic efficiency of the effect of the complex feed additive «Gepasorbex» on the slaughter traits of young pigs at different weight conditions, we note a significant advantage of the III group (OR + 0.15% of the feed additive «Gepasorbex») over the analogues of the I and II groups.

Table 5.70

Economic efficiency of the effect of the additive «Gepasorbex» on the slaughter traits of young pigs at different weight conditions (per 1 head)

Indicator	Weight condition, kg	Group		
		I control[a]	II experimental[b]	III experimental[c]
Carcass weight, kg	100	71,56	75,26	75,39
	120	91,44	91,84	92,3
Sales price per kg of meat and lard products, UAH[d]	100	70,0	70,0	70,0
	120	78,0	78,0	78,0
Cost of meat and lard products from 1 carcass, UAH	100	5009,2	5268,2	5277,3
	120	7132,32	7163,52	7199,4

Cost price of meat and lard products per carcass, UAH	100	4955,13	4571,69	4458,96
	120	4801,22	4636,60	4536,07
Net profit on sales of meat and lard products per 1 head, UAH	100	54,07	696,51	818,34
	120	2331,10	2526,92	2663,33
Level of profitability in the sale of meat and lard products, %.	100	1,09	15,24	18,35
	120	48,55	54,50	58,71

Notes: [a] – Grower and Finisher basic rations were used; [b] – «Grower» and «Finisher» basic rations were consumed with the addition of 0.15 % by weight of feed of a commercial analogue of mycotoxin adsorbent; [c] – «Grower» and «Finisher» basic rations were used with the addition of 0.15 % by weight of feed of the complex drug «Gepasorbex»; [d] – at average market prices in 2021.

The calculation of the economic efficiency of the influence of genotype by CTSF and MC4R genes on the slaughter traits of young pigs at a weight condition of 100 kg (per 1 head) is presented in Table 5.71. Higher slaughter yield was characterized by heterozygous individuals $CTSF^{GC}$ of the genotypes (BW × L) × «Maxter» and (BW × L) × «Maxgroo» and, as a result, heavier carcasses after slaughter – 73.75 kg and 74.19 kg, respectively. Taking into account the higher indicators of fattening and slaughter traits of heterozygous young animals for the cathepsin F gene $CTSF^{GC}$, we note higher values of the level of profitability of meat and lard products sales – 13.23 % and 18.85 %, which is 1.91 % and 2.24 % higher than in homozygous analogues.

According to the obtained calculations of the economic efficiency of the influence of genotype on the MC4R gene on the slaughter traits of young pigs, it was found that lower animal cost indicators during rearing and sufficiently high slaughter traits led to higher indicators of profitability in $MC4R^{AG}$ heterozygotes, both in animals of the combination (BW × L) × «Maxter» at the level of 16.64 % and in animals of the combination (BW × L) × «Maxgroo» at the level of 18.51 %, which, in turn, exceeded the analogues in the homozygous state for the $MC4R^{G}$ allele by 1.31 % and 2.59 %, respectively.

Table 5.71

Economic efficiency of the influence of genotype by *CTSF* and *MC4R* genes on slaughter traits of young pigs at a weight condition of 100 kg (per 1 head)

Indicator	Genotype by *CTSF* cathepsin gene				Genotype by melanocortin *MC4R* gene			
	(LW × L) × «*Maxter*»		(LW × L) × «*Maxgro*»		(W × L) × «*Maxter*»		(W × L) × «*Maxgro*»	
	CC	*GC*	*CC*	*GC*	*AG*	*GG*	*AG*	*GG*
Carcass weight, kg	72,60	73,75	73,66	74,19	73,68	74,31	74,68	74,69
Sales price per kg of meat and lard products, UAH[a]	70,0	70,0	70,0	70,0	70,0	70,0	70,0	70,0
Cost of meat and lard products from 1 carcass, UAH	5081,83	5162,66	5156,28	5192,95	5157,94	5201,60	5227,32	5228,17
Cost price of meat and lard products per carcass, UAH	4565,0	4559,5	4422,0	4369,2	4422,0	4510,0	4411,0	4510,0
Net profit on sales of meat and lard products per 1 head, UAH	516,83	603,16	734,28	823,75	735,94	691,59	816,32	718,17
Level of profitability in the sale of meat and lard products, %	11,32	13,23	16,61	18,85	16,64	15,33	18,51	15,92

Note: [a] – at average market prices in 2021.

5.12. Economic efficiency of the use of the complex food additive «Gepasorbex» based on active plant components in industrial pigpricing

Modern industrial pig farming is one of the key livestock industries that provide the population with high–quality animal products. Today, it is one of the few livestock sectors that can increase revenues to regional and state budgets and create enough jobs in rural areas in a short time. In the context of intensive production, important tasks are to increase animal productivity, improve the digestibility of feed nutrients, reduce morbidity and minimize the negative impact of stress factors on the pig's body.

One of the promising areas in the technology of feeding pigs of different technological groups is the use of functional feed additives, in particular, based on natural active ingredients (milk thistle, etc.), which contribute to the normalization of metabolic processes and increase productive performance.

At the current stage of development of the pig industry, feed additives with hepatoprotective, sorption and immunomodulatory properties are gaining more and more attention. They help reduce the impact of toxic substances, improve the functional state of the liver and normalize intestinal microbiocenosis, which in turn has a positive effect on the growth and development of animals. The complex feed additive «Gepasorbex» is based on active plant components and has a pronounced sorption capacity, which helps to detoxify the body and improve the overall health of animals.

Even taking into account numerous studies in the field of the use of feed additives in animal husbandry, the issue of their effectiveness in industrial pig production remains relevant. It is important to investigate the effect of the complex feed additive «Gepasorbex» on productive traits, in particular reproductive traits, live weight dynamics, feed conversion, average daily gain, etc., as well as economic efficiency.

Thus, the aim of this study is to evaluate the effectiveness of the use of the complex feed additive «Gepasorbex» in industrial pig production and to determine its effect on pig productivity, their physiological state and economic feasibility of use in production conditions.

The key factor in profitable pig production is to ensure high reproductive capacity of the main pig population, the safety of young pigs and their efficient rearing to the level of marketable products. The full disclosure of the genetic potential of pigs is possible only under conditions of proper maintenance, feeding and high adaptability of their organism.

As noted by *Krasnikov S. V., Reshetnichenko O. P., et al*. [5, 6], animals must be provided with proper care to obtain quality products to be supplied to domestic and foreign markets. One of the serious risks to the health and productivity of pigs is mycotoxins, which adversely affect the functioning of the body's major systems. An effective means of combating them are sorbents that bind toxins and remove them from the body without harming the animals. Modern sorbents not only neutralize mycotoxins, but also perform a preventive function, contributing to the normalization of the immune system, intestinal microflora, metabolism and improved appetite. This, in turn, has a positive effect on the quality of the final product. Thus, the use of sorbents is an important factor in increasing pig productivity and ensuring the safety of livestock products [19, 20, 27, 31, 35, 36].

According to profitability in livestock farming is a determining factor in the development of new approaches to farm animal feeding. Given the volatility of raw material prices and fluctuations in the purchase price of animal products, producers need to implement effective solutions that will help optimize costs and increase animal productivity.

Today, functional feed additives are increasingly being developed on the basis of active plant components. Supplements based on milk thistle (*Carduus marianus L.*, genus *Silybum Adans L.*, family *Asteraceae*), a plant that is a popular herbal hepatoprotector, have proven to be the most effective. The ripe fruits of this plant are a source of the active substance silymarin, which is a component of many medicines. Its action is aimed at neutralizing toxic compounds that enter the body from the environment or are formed in it, even before they penetrate into hepatocytes. In addition, silymarin is able to stimulate the synthesis of its own phospholipids, which contribute to the restoration of cell membranes. Clinical studies of hepatoprotectors confirm that milk thistle has antioxidant, anti–inflammatory properties and prevents the development of connective tissue in the liver. Its positive effect covers not only the liver but also the entire gastrointestinal tract. The most effective form of use is the powder, which acts at the micro level to cleanse liver cells. All parts of the plant – leaves, roots, and seeds – have medicinal properties. The seeds contain fats, essential oil, vitamin *K*, resins, mucilage, tyramine, flavonoids, as well as a complex of macro– and microelements that enhance its therapeutic effect.

Given the relevance of the issue, the goal was to determine the effectiveness of the use of the complex feed additive «Gepasorbex» and its effect on the productive traits of sows and fattening young pigs under conditions of industrial technology for the production of pig products

Experimental studies were conducted as part of two scientific and economic experiments. In the first experiment, the effect of the complex additive «Gepasorbex» on the fattening and meat traits of young pigs was studied in the conditions of LLC «Tavrian Pigs» in the Kherson region. The productive traits of 90 heads of fattening young pigs were studied, where the maternal form was a combination of the breed's Large White × Landrace, and the paternal form was boars of the terminal line «Maxter». Fattening was divided into two periods: I period of fattening «Grower» – animals with a live weight of 30–60 kg (12–17 weeks) consumed 2.4–2.6 kg per head per day using feed of the «Grower» type with nutritional value: crude protein – 180.25 g/kg; metabolic energy – 13.04 MJ/kg, pigs were placed on a concrete slotted floor with an area of 0.65 m^2/head according to VNTP–APC – 02.05 «Pig enterprises (complexes, farms, small farms)»; II period of fattening «Finisher» – animals with a live weight of 61–120 kg (17–26 weeks) consumed 2.8–3.2 kg of feed per head per day using feed of the «Finisher» type with nutritional value crude protein – 140.88–153.08 g/kg; metabolizable energy – 12.90–13.14 MJ/kg [13], pigs were housed on a concrete slotted floor with an area of 0.85 m^2/head according to VNTP–APC – 02.05 «Pig enterprises (complexes, farms, small farms)». The main diet (MD) was compound feed of own production with the use of premixes produced by PC Alternative LLC. When pigs were transferred from the growing room to the fattening room of the first period, the equalization period (EQP) started at 11–12 weeks to equalize the animals and ensure the purity of the research. Further, all experimental animals were divided into three groups (according to the principle of analogs) according to generally accepted methods [7, 11, 22] with 30 animals in each group: I – control group of pigs used the basic diet "Grower", "Finisher"; pigs of II – experimental group consumed the basic diet «Grower», «Finisher» with the addition of 0.by weight of feed of a commercial analog of mycotoxin adsorbent; animals of III – experimental group used the basic diet «Grower», «Finisher» with the addition of 0.15% by weight of feed of the complex preparation «Gepasorbex».

The composition of1 kg feed additive «Gepasorbex» (Vetservisproduct LLC, Ukraine) contains the following active ingredients, %: silicon dioxide – 60.2–70.8;

aluminum oxide – 8–12; magnesium carbonate – 1.0–2.5; titanium dioxide – 0.8–0.15; selenium – 0.32–0.35; clinker – 4.2–4.5; active feed yeast – 8–10; milk thistle – 18–20 % (registration certificate AV–08268–04–19 from 04.03.2019 p.).

Composition of the feed additive «Commercial analog»: silicon dioxide SiO_2, kaolinite clay, magnesium silicate, inactivated yeast (Saccaromyces cerevisiae), sugar kelp, wild chicory and calendula extracts, dry matter – 954.0 g.

The main feed used for feeding the pigs of the experimental groups according to laboratory studies Expert Center «Biolights» LLC was recognized as slightly toxic for aflatoxin, ochratoxin and zearalenone. The experiment studied fattening performance according to the methods.

At the age of 12, 14, 17, 22, 26 weeks, live weight (kg) and average daily gain (g) were determined; the following fattening traits of pigs, in particular: age of reaching live weight (days), average daily gain (g), feed conversion (kg) were determined in experimental groups of pigs when they reached 100 and 120 kg, respectively, according to generally accepted methods.

Scientific and economic experiments (second stage) to study the effectiveness of the use of the supplement «Gepasorbex» based on biologically active compounds of plant and mineral origin for the prevention of metabolic disorders, mycotoxicosis in gestating and lactating sows and its effect on reproductive traits were conducted in the conditions of the private rental enterprise «Victoria» in the Bashtanka district of the Mykolaiv region. We studied 192 nests of suckling sows in the farrowing shop with 2798 heads of suckling piglets for two adjacent farrowings (breed: two–breed sows of the Large White× Landrace (PIC, UK) and boars of the *Maxter* terminal line (FRANCE HYBRIDES, France); two–breed sows of the Large White× Landrace and boars of *the* PIC 337 terminal line (PIC, UK).

Sows were kept according to their physiological condition in the respective technological groups. The gilts and sows were kept on a concrete slotted floor in accordance with regulatory requirements. The gilts were kept in groups of 12 with a floor area of 1.8 m^2/head. When transferred to the reproduction shop to the sow section, the animals were kept in individual pens (2350×650 mm) for 30 days before establishing/confirming pregnancy by ultrasound diagnostics and consumed 2.8–3.1 kg of feed per head per day using the «Sows and Gestation Sows» type of feed with the following nutritional value: crude protein – 144.9 g/kg; metabolic energy – 2914.7 Kcal/kg. After establishing fertility, sows were transferred to the farrowing sow area, where they were kept in group pens with a standard area per animal of 2.1 m^2, fed 2.5–2.7 kg of feed per head per day using the «Single and Farrowing Sows» type of feed.

5 days before the expected farrowing date, gestating sows were transferred to the farrowing shop to the suckling sow section, where they were kept fixed in pens (2400 mm long, 1800 mm wide with a total area of 4.32 m^2). Sows consumed feed at will during the suckling period (excluding farrowing day – 1.0 kg/head) using feed of the «Lactating sows» type with the following nutritional value: crude protein – 165.6 g/kg; metabolic energy – 2962.7 Kcal/kg. Suckling piglets were fed from 7 days to weaning with starter feed in the form of granules from home–made fermenters, nutritional value: crude protein – 185.0 g/kg; metabolic energy – 325.0 Kcal/kg. The duration of the suckling period was 28 days. After weaning, the sows returned to the sow paddock and consumed feed of the «Lactating sows» type until insemination.

The main diet (MD) was compound feed of own production with the use of premixes and protein–mineral–vitamin additives produced by Tsekhave LLC Ukraine in the appropriate composition «Single and farrowing sows», %: wheat – 34.0; barley – 45.0; sunflower meal – 14.5; soybean meal – 3.0; Tsekhavit Sow Supporos premix – 3.5; Lactating sows, %: wheat – 43.5; barley – 30.0; sunflower meal – 10.0; soybean meal – 11.5; Tsekhavit Sow Lactation premix – 5.0.

When pigs were transferred from the repair shop to the reproduction shop to the sow section, the comparison period (CP) started from 33–35 weeks of age to equalize the animals and ensure the purity of the study. Further, all experimental animals were divided into three groups according to the principle of analogs according to generally accepted methods, 24 animals in each group: I – the control group of sows used the main diet «Single and farrowing sows», «Lactating sows»; sows of the II experimental group were fed the basic diet «Single and pregnant sows», «Lactating sows» with the addition of 0.15 % by weight of feed of the complex preparation «Gepasorbex», and sows of the III experimental group consumed the basic diet «Single and pregnant sows», «Lactating sows» with the addition of 0.by weight of feed of a commercial analog.

Reproductive traits of sows were determined by the following indicators: total number of piglets at birth (heads), multiplicity (heads).), the proportion of stillborn piglets (%), the weight of the nest of piglets at birth and weaning (28 days); live weight of each piglet at birth (large–fecundity) and weaning (28 days) (kg), the number of piglets in the nest at weaning (heads), the average daily growth of suckling piglets (g), and the safety of the litter (%). In order to summarize the reproductive traits of sows of experimental groups, an evaluation index was calculated for a limited number of traits (Lash–Molna in the modification of *M. D. Berezovsky*). After weaning the sows, the percentage of sows that came into heat and were inseminated within 7 days was determined (%).

All veterinary treatments were identical for the pigs of the experimental groups in accordance with the adopted scheme on the farm.

The microclimate of the room in which the experimental animals were kept was maintained by a negative ventilation system consisting of an axial exhaust fan located on the ceiling of the room and inlet valves located in the walls of the building. The operation of which was coordinated with the help of microprocessors for maintaining microclimate parameters. Manure was removed from the room using a vacuum–self–flow system of periodic action, which included baths for the entire area of the machines and a system of pipelines through which manure was removed to intermediate manure collectors outside the room.

The conditions of feeding, watering, housing, care, and prevention of animals in the experiment were in accordance with the national legislation «Requirements for the welfare of farm animals during their keeping» (Law of Ukraine «On Veterinary Medicine», 2021).

The economic efficiency of the research results was determined according to the «Methodology for determining the economic efficiency of scientific research in pig production». The experimental data were processed by the method of variation statistics using computer equipment and application software packages.

Improvement of reproductive performance in «first farrowing» sows, as well as in sows of the second and subsequent farrowing, can be achieved in production conditions by continuously adding complex feed additives enriched with bioactive substances of plant and mineral origin to the diet of idle, pregnant and lactating sows, in particular, «Gepasorbex» (Table 5.72).

The use of the complex feed additive «Gepasorbex» in the diets of gestating and lactating sows of the first reproductive cycle helps to improve appetite, reduce weight loss and optimize metabolism, which has a positive effect on their reproductive traits. The inclusion of 0.15 % the additive in the diet increased the overall estimated index of sows and reduced unproductive days of the reproductive cycle by 1.71–5.0 days, which confirms its technological effectiveness. Based on the results of the first farrowing, the same sows were selected for the second reproduction cycle. According to the results of insemination and control of pregnancy on day 25–28 by ultrasound diagnostics, it was found that the fertility rate of sows of group I was 79, group II – 91 and group III – 87.5 %.

The results of ultrasound diagnostics of pregnancy fully corresponded to the actual data of farrowing of sows. It was found that regular consumption of the diet with the complex additive «Gepasorbex» during the first reproductive cycle contributes to an increase in fertility in the next reproductive cycle.

Sows on the second cycle of reproduction were characterized by higher reproductive traits. Thus, the index of multiplicity of sows of group II was higher – 12.86 gilts, and exceeded the control by 1.12 gilts ($p < 0.01$).

Experimental sows that consumed feed with low mycotoxin content in different physiological periods (group I) without the use of sorbents were characterized by an increased proportion of stillbirths at the second farrowing – 9, which is 1.45 and 2 more than in groups III and II, respectively.

According to scientists and practitioners [19, 27, 31, 36], even small doses of mycotoxins have a cumulative effect, and their presence in the animal's body can have a negative impact for a long time, regardless of the fact that the feed no longer contains hazardous substances.

The index of large fertility did not have a significant difference by farrowing cycles, but tended to increase.

The index of conditional milk yield of sows in the second cycle of reproduction in the II and III experimental groups was 68.06 kg and 60.66 kg, which exceeds the control values by 8.56 kg and 1.16 kg, respectively ($p < 0.001$). The analysis of the experimental groups shows a stable tendency to increase the conditional milk yield of sows when using the feed additive «Gepasorbex» (group II).

Nest weight at weaning is a key indicator of sow productivity, as it reflects not only fertility, but also their ability to feed their offspring, ensuring intensive growth and safety of piglets. Higher live weight and number of piglets at weaning in the sows of the experimental groups contributed to an increase in nest weight. Piglets of the control group had lower average daily weight gain during two reproduction cycles, which was largely due to insufficient sow milk production.

The absence of mycotoxin sorbents in the diet and the use of low–toxic feeds negatively affected the growth and development of piglets, reducing their average daily weight gain to 190.39 g, which is 58.03 and 33.59 g ($p < 0.001$) less than in piglets of the II and III experimental groups. At the same time, piglets of group II exceeded their peers of group III by 24.44 g ($p < 0.001$).

The serial number of farrowing also influenced the safety performance. According to the results of the assessment of the reproductive qualities of the second farrowing, sows had lower values of the safety index, probably due to increased multiplicity. The uteruses of the second experimental group were characterized by higher safety – 89.

When determining the generalized index of reproductive traits, it was found that it was higher in sows of group II – 44.38 points; the uteruses of the control group had a score of 39.14 points, which was significantly inferior to them by 5.24 points ($p < 0.01$). Animals of the III experimental group had an index value of 40.84 points and were significantly inferior to the analogues of the II experimental group.

On the basis of the conducted studies, the economic efficiency of the use of the complex feed additive «Gepasorbex» and its effect on the reproductive traits of sows and piglets' productivity before weaning were evaluated (Table 5.73).

Sows treated with the complex feed additive «Gepasorbex» (group II) showed higher reproductive traits compared to the control group (group I) and those that consumed a commercial analog (group III). In the same group (II), increased fertility was recorded – 12.86 goals. Due to the improvement of reproductive traits and increased growth energy of piglets using the supplement «Gepasorbex», higher values of live weight gain by the time of weaning were achieved: Group II – 85.12 kg, Group III (commercial analog) – 71.05 kg, which exceeds the control by 25.91 and 11.84 kg, respectively.

Table 5.72

Reproductive traits of sows, $\overline{X} \pm S_{\overline{X}}$

Indicator	Group					
	I–control		II experimental		III experimental	
	Serial number of the farrowing					
	1	2	1	2	1	2
n	24	19	24	22	24	21
Total number of piglets at birth, head	10,92±0,216	13,00±0,192	12,04±0,353**	13.91±0.314^{aa}	11,63±0,239*	12,95±0,164
Multiplicity, head	9,79±0,134	11,74±0,164	11,13±0,337***	12.86±0.291^{bb}	10,58±0,216**	12,05±0,164^{1}
Share of stillborn piglets, %.	9,88±0,913	9,55±1,117	7,59±0,719*	7,46±0,690	8,70±1,337	8,10±1,278
Nest weight of piglets at birth, kg	12,17±1,283	17,36±0,223	15,38±0,379^{**a}	18.65±0.381^{aa}	14,19±0,292*	17,68±0,271^{1}
Large–fruited, kg	1,43±0,016	1,48±0,014	1,39±0,020	1,45±0,017	1,41±0,016	1,47±0,016
Milk yield, kg	49,42 ±1,162	59,50±1,224	58,33±1,684***	68.06±1.371^{cc}	55,66±0,995***	60,66±0,999^{3}
The number of piglets at weaning at the age of 28 days, head	8,71±0,141	10,37±0,170	10,04±0,221***	11.41±0.233^{cc}	9,54±0,134***	10,48±0,123^{2}
Average live weight of one piglet at weaning, kg	6,81±0,083	7,19±0,101	7,75±0,156***	8.91±0.157^{cc}	7,50±0,127***	8.19±0.129^{cc2}
Live weight of a nest of piglets at weaning, kg	59,28±1,182	74,45±1,273	77,40±1,559^{***b}	89.58±1.774^{cc}	71,48±1,297***	78,47±1,861^{3}
Average daily gain of piglets in the suckling period, g	179,42±2,925	190,39±3,320	212,04±4,894***	248.42±5.043^{cc}	203,13±4,166**	223.98±4.242^{cc3}
Piglet safety, %	89,11±1,361	88,56±1,460	90,92±1,450	89,13±1,700	90,56±1,204	87,12±0,892
Index, points	33,49±0,383	39,14±1,460	38,63±0,685^{***a}	44.38±0.628^{bb}	36,78±0,448***	40,84±0,453^{3}

Notes (hereinafter): * – $p < 0.05$; ** – $p < 0.01$; *** – $p < 0.001$ (for sows of the first farrowing when comparing experimental groups to the control). ^{a} – $p < 0.05$; ^{b} – $p < 0.01$; ^{c} – $p < 0.001$ (for sows of the first farrowing when comparing II and III experimental groups). ^{aa} – $p < 0.05$; ^{bb} – $p < 0.01$; ^{cc} – $p < 0.001$ (for sows of the second farrowing when comparing experimental groups to control). ^{1} – $p < 0.05$; ^{2} – $p < 0.01$; ^{3} – $p < 0.001$ (for sows of the second farrowing when comparing experimental groups II and III).

Higher weight gain and a larger number of piglets at weaning contributed to a reduction in production costs, which amounted to 110.69–116.21 UAH/kg. Even taking into account the additional costs of purchasing feed additives «Gepasorbex» and its commercial analog, the net profit from the sale of live weight of piglets in group II amounted to 7.60 thousand UAH, and in group III – 14.21 thousand UAH, which exceeds the control group by 2.83 thousand UAH and 1.18 thousand UAH, respectively.

Table 5.73

Economic efficiency of the use of feed additive «Gepasorbex» on productive traits of sows (per 1 sow)

Indicator	Group		
	I[a]	II[b]	III[c]
Multiplicity, head	11.74	12.86	12.05
Number of additional piglets, head	–	1,1	0,3
The number of piglets at weaning at 28 days, head	10.37	11.41	10.48
Number of additional piglets obtained at weaning at 28 days, head	–	1,0	0,11
Live weight of piglets at weaning, kg	7.19	8.91	8.19
Cost of 1 kg of feed additive, UAH[d]	–	100.0	105.0
Additional costs for feed additive, UAH	–	72.95	76.65
Piglet live weight gain, kg	59.21	85.12	71.05
Cost of 1 kg of piglet live weight gain, UAH[d]	119.4	110.69	116.21
Realized price per kg of live weight gain, UAH[d]	200.0	200.0	200.0
Cost of piglet live weight gain, UAH thousand	7.07	9.42	8.26
Sales price of piglet live weight gain, thousand UAH	11.84	17.02	14.21
Net profit on sales, UAH thousand	4,77	7,60	5,95
Profitability level, %	67.50	80.68	72.10

Notes: [a] – the basic diet «Single and Gestating Sows», «Lactating Sows» was used; [b] – the basic diet «Single and Gestating Sows», «Lactating Sows» was consumed with the addition of 0.15 % by weight of feed of the complex preparation «Gepasorbex»; [c] – the basic diet «Single and pregnant sows», «Lactating sows» with the addition of 0.15 % by weight of feed of a commercial analog of mycotoxin adsorbent; [d] – at average market prices in 2023.

The highest level of profitability of suckling piglets was recorded when using the feed additive «Gepasorbex» at a dose of 1.5 kg/t – 80.68 %. The use of a commercial analog in the same amount reduced this figure by 8, to 72.10 %. The absence of mycotoxin sorbents in sow diets led to a lower level of profitability – 67.50 %.

As part of the second scientific and economic experiment to study the effectiveness of the use of the complex feed additive «Gepasorbex» and its effect on the productive traits of fattening young pigs, a significant difference was found in the productive traits live weight and average daily gain of pigs of the control and experimental groups at the age of 56 days, or 14 weeks.

At the beginning of fattening, all piglets had a live weight of 33–34 kg. After 14 weeks, pigs of the III experimental group receiving «Gepasorbex» exceeded the control group by 1.93 kg in live weight ($p < 0.05$). In terms of average daily weight gain, they had a 114.3 g advantage over the control group ($p < 0.001$) and a 50 g advantage over the second experimental group, which consumed a commercial analog ($p < 0.05$).

A similar trend continued in the following age periods. At 17 weeks of age, pigs of the III experimental group exceeded the II group by 2.3 kg ($p < 0.05$) and the control group by 3.63 kg ($p < 0.001$) in live weight. The highest average daily weight gain was observed in animals treated with the «Gepasorbex» supplement, exceeding the indicators of the control and II experimental groups by 9.1 % ($p < 0.001$) and 5.9 % ($p < 0.05$), respectively.

At the age of 22 weeks, a probable advantage of young animals of the II and III experimental groups in terms of live weight and average daily gain was established, by 2.47 kg ($p < 0.01$), 32.36 g ($p < 0.05$) and 5.1 kg ($p < 0.001$), 41.9 g ($p < 0.01$), respectively.

At 26 weeks of age, pigs of group III receiving the complex supplement «Gepasorbex» had a 2.67 kg advantage in live weight over their peers from group II ($p < 0.01$) and 7.00 kg advantage over the control group ($p < 0.001$). In terms of average daily weight gain, animals of groups II and III that consumed mycotoxin enterosorbents showed higher values by 60.7 g ($p < 0.001$) and 67.9 g ($p < 0.001$), respectively, compared to the control group.

Thus, the pigs of the experimental groups (II and III) had a higher growth rate and exceeded the control in terms of live weight and average daily gain at all stages of rearing. This confirms the effectiveness of adding mycotoxin adsorbent to the diet.

The study of the fattening qualities of young pigs depending on the feeding of feed additives–adsorbents of mycotoxins showed that animals of the II and III experimental groups receiving complex enterosorbents reached a live weight of 100 kg faster than their peers from the control group – respectively 3.0 ($p < 0.01$) and 6.0 ($p < 0.001$) days earlier (Table 5.74).

Pigs of the II and III experimental groups treated with a commercial analog of the mycotoxin adsorbent and the feed additive «Gepasorbex» had significantly higher average daily weight gain ($p < 0.001$) – by 41.5 g and 67.7 g, respectively. The feed conversion in animals of group II was 2.94 kg, and in pigs of group III – 2.85 kg, which was significantly more efficient, compared to control animals, in which this figure reached 3.39 kg.

Table 5.74

Fattening traits of young pigs, n = 30, $\overline{X} \pm S_{\overline{X}}$

Group	Age of reaching a live weight of 100 kg, days	Average daily weight gain during fattening, g	Feed conversion, kg
live weight 100 kg			
I – control	161.7±0.56	826.6±7.66	3.39
II – experimental	$158.7±0.80^{**}$	$868.1±5.96^{***}$	2.94
III – experimental	$155.7±0.58^{***}$	$894.3±5.88^{***}$	2.85
live weight 120 kg			
I – control	190.2±0.49	800.7±5.46	3.50
II – experimental	$184.2±0.48^{***}$	$848.0±6.21^{***}$	3.30
III – experimental	$180.7±0.32^{***}$	$868.7±5.26^{***}$	3.22

The study of fattening indices when the experimental animals reached 120 kg of live weight confirmed a significant ($p < 0.001$) increase in the average daily weight gain in pigs of the II and III experimental groups by 47.3 g and 68.0 g, respectively, compared to animals that did not receive mycotoxin enterosorbent in the diet.

Animals of the II and III experimental groups reached a live weight of 120 kg faster than their counterparts in the control group – 6.0 and 9.5 days earlier, respectively. At the same time, their average daily weight gain was significantly higher by 47.3 g ($p < 0.001$) and 68.0 g ($p < 0.001$), respectively. The lowest feed conversion was recorded in pigs of the III experimental group – 3.22 kg, which is 0.28 kg less than in the control group (3.50 kg).

Evaluation of slaughter qualities showed that pigs of the third experimental group had the highest slaughter yield both at a live weight of 100 kg and 120 kg, exceeding analogues from the control group by 4.1 % ($p < 0.001$) and 0.5 %, respectively.

Carcass length is an important indicator of meat quality. At a live weight of 100 kg, pigs of the II and III experimental groups showed the maximum values of this indicator – 96.7 cm, which is 2.1 cm more than in the control group ($p < 0.05$). At a weight of 120 kg, the animals of the III group outweighed the control counterparts by 1.0 cm, but this difference was statistically insignificant.

Animals of the third experimental group had thinner fat at slaughter both at a live weight of 100 kg and 120 kg – by 4.2 cm and 8.2 cm, respectively, compared to the control group ($p < 0.001$).

Changes in the ratio of muscle to adipose tissue are reflected in the area of the «muscle eye» which is a key indicator of carcass meatiness. Studies by a number of authors [4, 21, 25] confirm the positive correlation of this parameter with meat yield. It was found that at a live weight of 100 and 120 kg, the area of the «muscle eye» varied between 36.8–39.8 cm^2 and 42.9–44.1 cm^2, respectively. The pigs of the III experimental group had significantly higher values, exceeding the analogues of the control group by 3.0 cm^2 ($p < 0.001$) at 100 kg and by 1.2 cm^2 at 120 kg.

In the experimental groups, no significant difference was found in the weight of the hind third of the half–carcass, but a tendency to increase the weight of ham was found in animals of the II and III experimental groups, which were fed mycotoxin adsorbents both «Gepasorbex» and a commercial analog in the main diet during the fattening period.

So, the use of a complex feed additive based on active plant components «Gepasorbex» in the diet of young pigs of the III experimental group contributed to the improvement of slaughter qualities, both at a live weight of 100 kg and 120 kg.

Experimental studies have shown that the addition of the complex feed additive «Gepasorbex» produced by Vetservisproduct to the diet of young pigs (LW × L)×«Maxter» contributed to the improvement of their productive qualities, even when feeding with feed contaminated with mycotoxins. The use of this additive had a positive impact on the economic efficiency of pig production.

The addition of the complex feed additive «Gepasorbex» (group III) to the diet of fattening young pigs helped to accelerate growth. Due to this, the animals reached a live weight of 100 kg 3 and 6 days earlier, while consuming 0.45 and 0.54 kg less feed. Similarly, the live weight of 120 kg was reached 6 and 9.5 days faster with a decrease in feed consumption by 0.2 and 0.28 kg compared to the young animals of the control group I, which received only the basic diet, and group II, which consumed the basic diet with a commercial analog of the mycotoxin sorbent.

Table 5.75

Economic efficiency of the use of the feed additive «Gepasorbex» in fattening pigs to different weight conditions

Indicator	Weight condition, kg	Group		
		I[a]	II[b]	III[c]
The number of pigs on fattening, head	–	30	30	30
Live weight gain during fattening, kg	100	19.35	19.49	19.25
	120	25.35	25.49	25.25
Additional costs for mycotoxin sorbent, UAH	100	–	687.64	658.38
	120	–	1009.44	975.70
Cost of 1 kg of live weight gain, UAH	100	4354.66	4006.08	3903.60
	120	4214.75	4065.10	3973.70
Average selling price per 1 of live weight gain, UAH[d]	100	4500.0	4500.0	4500.0
	120	4750.0	4750.0	4750.0
Cost of live weight gain of young animals, UAH thousand	100	84.26	78.77	75.81
	120	106.84	104.63	101.32
Revenue from the sale of live weight gain of young animals, UAH thousand	100	87.08	87.71	86.63
	120	120.41	121.08	119.94
Net profit on sales, UAH thousand	100	2.81	8.94	10.82
	120	13.57	16.45	18.63
Profitability level, %	100	3.34	11.35	14.28
	120	12.70	15.72	18.38

Notes: [a] – the basic rations «Grower» and «Finisher» were used; [b] – the basic rations «Grower» and «Finisher» were consumed with the addition of 0.15 % by weight of feed of a commercial analog of mycotoxin adsorbent; [c] – the basic rations «Grower» and «Finisher» were used with the addition of 0.15 % by weight of feed of the complex preparation «Gepasorbex»; [d] – at average market prices in 2021.

The shorter duration of fattening and lower feed costs contributed to a reduction in the cost per cent of weight gain (experimental groups II and III). Even spending additionally on sorbents of mycotoxins during the period of fattening to live weight of 100 and 120 kg – 687.64 and 1009.44 UAH in group II and 658.38 and 975.7 UAH in group III, it became possible, due to increased productivity, to obtain a higher value of net profit per 30 heads of young animals, which is 6.13 and 8.01 thousand UAH. UAH and 2.88 and 5.06 thousand UAH higher than the same indicator of the first group at weight conditions of 100 and 120 kg.

In experimental animals of group III, which in addition to the main diet received a complex feed additive «Gepasorbex» based on active plant components, at weight conditions of 100 and 120 kg, the highest level of profitability was recorded – by 5.06 and 2, as well as 10.94 and 2 higher, respectively, compared to analogues of groups I and II, at lower additional costs for the feed additive.

Studies of the economic efficiency of the effect of the feed additive «Gepasorbex» on the slaughter performance of young pigs at different weight conditions (Table 5.76) show that the lower cost of live weight gain directly affected the reduction in the cost of carcass, since the cost of slaughter activities was the same for all experimental groups.

The addition of the complex feed additive «Gepasorbex» (group III) to the diet of fattening young pigs contributed to an increase in slaughter yield, which led to the formation of heavier carcasses – 75.39 kg at a pre–slaughter weight of 100 kg and 92.3 kg at a weight of 120 kg. These figures exceeded the values of the analogues of groups I and II by 3.83 and 0.13 kg; 0.86 and 0.46 kg, respectively.

The calculations of economic efficiency confirm the data on the feasibility and higher profitability of selling animals in slaughter weight compared to selling them in live weight. Thus, in the context of experimental groups, it was found that due to the sale of animals in slaughter weight, it is possible to increase the profitability index at weight conditions of 100 kg and 120 kg for group II by 3.and 38.and group III by 4.and 40, respectively.

Regarding Group I, we note that it is more profitable to sell animals of 100 kg in live weight, and only when the live weight reaches 120 kg is it more profitable to sell them in slaughter weight, which increases this indicator by 35.85 %.

Table 5.76

Economic efficiency of the effect of the feed additive «Gepasorbex» on the slaughter traits of young pigs at different weight conditions (per 1 head)

Indicator	Weight condition, kg	Group		
		I[a]	II[b]	III[c]

Carcass weight, kg	100	71.56	75.26	75.39
	120	91.44	91.84	92.3
Sales price per kg of meat and lard products, UAH[d]	100	70.0	70.0	70.0
	120	78.0	78.0	78.0
Cost of meat and lard products from 1 carcass, UAH	100	5009.2	5268.2	5277.3
	120	7132.32	7163.52	7199.4
Cost price of meat and lard products per carcass, UAH	100	4955.13	4571.69	4458.96
	120	4801.22	4636.60	4536.07
Net profit on sales of meat and lard products per 1 head, UAH	100	54.07	696.51	818.34
	120	2331.10	2526.92	2663.33
Level of profitability in sales of meat and lard products, %	100	1.09	15.24	18.35
	120	48.55	54.50	58.71

Notes: [a] – the basic rations «Grower» and «Finisher» were used; [b] – the basic rations «Grower» and «Finisher» were consumed with the addition of 0.15 % by weight of feed of a commercial analog of mycotoxin adsorbent; [c] – the basic rations «Grower» and «Finisher» were used with the addition of 0.15 % by weight of feed of the complex preparation «Gepasorbex»; [d] – at average market prices in 2021.

Thus, in comparing the obtained data on the economic efficiency of the effect of the complex feed additive «Gepasorbex» on the slaughter traits of young pigs at different weight conditions, we note a significant advantage of the III group (OR + 0.15 % of the feed additive «Gepasorbex») over the analogues of the I and II groups.

Thus, the use of the complex feed additive «Gepasorbex» (0.15 % by weight of feed) for sows of the first and second farrowing cycles improves reproductive performance, which is confirmed by the estimated total index: in group II it was 38.63–44.38 points, in group III (commercial analog) – 36.78–40.84 points, while in the control group – 33.49–39.14 points. The use of the additive «Gepasorbex» allowed to reduce the number of unproductive days in the reproductive cycle of sows by 1.71–5.0 days compared to the control and commercial analog, which indicates its technological and economic efficiency. The addition of the complex drug «Gepasorbex» to the diet of sows helps to create optimal conditions for feeding, neutralizing the negative effects of feed factors (mycotoxins, toxins, anti–

nutrients). This provides favorable conditions for the development of fetuses, which, in turn, contributes to increased growth energy of piglets, their greater safety during farrowing and at further stages of ontogeny. At the current market price for piglet live weight, pig production remains a fully profitable industry. The introduction of modern technological solutions, including the use of the «Gepasorbex» feed additive, helps to further increase profitability. The highest level of profitability of suckling piglets was recorded when this feed additive was included in the diet of single, gestating and suckling sows, which amounted to 80. The experiment proved the effectiveness of using the complex preparation «Gepasorbex» produced by Vetservisproduct in the diets of fattening young pigs in feed contaminated with mycotoxins to increase pig productivity. Pigs of the II and III experimental groups receiving feed with the addition of mycotoxin adsorbents showed a statistically significant increase in live weight by 2.3–4.2 kg and 3.6–7.0 kg, as well as higher average daily weight gain by 41.5–47.3 g and 67.7–68.0 g. They reached weight conditions faster: 100 kg – 3 and 6 days earlier, 120 kg – 6 and 9.5 days earlier, compared to the control group, while they had better feed conversion by 0.2–0.45 kg and 0.28–0.54 kg, respectively. It was established that the inclusion of the feed additive «Gepasorbex» in the diet of young pigs of the III experimental group contributed to a significant improvement in slaughter performance: at a pre–slaughter weight of 100 and 120 kg, the slaughter yield increased by 0.5–4.1%, the length of the half–carcass – by 1.0–2.1 cm, the area of the «muscle eye» – by 1.2–3.0 cm^2, the weight of the hind third of the half–carcass – by 0.5–0.7 kg. At the same time, the thickness of the fat decreased by 4.2–8.2 mm compared to the pigs of the control group. Reduced fattening time and reduced feed costs in groups II and III contributed to a reduction in the cost of growth. Despite the additional costs of mycotoxin sorbents (658.38–1009.44 UAH), the increase in productivity allowed for a higher net profit: in group II – by 6.13–8.01 thousand UAH, in group III – by 2.88–5.06 thousand UAH more than in the control group. Pigs of group III, which received the complex feed additive «Gepasorbex», had the highest level of profitability: at a weight of 100 and 120 kg – by 5.06–10.and 2.18–2.more than in groups I and II, at lower additional costs. It was proved that the use of the complex additive «Gepasorbex» in the sale of animals in slaughter weight increased the profitability index at weight conditions of 100 and 120 kg by 4.and 40., respectively.

Prospects for further research are to improve the complex feed additive and study its effect on the productive traits of pigs of different technological groups.

GLOSSARY AND DICTIONARY OF TERMS AND CONCEPTS

Absolute gain is an indicator that characterizes the increase in pig weight in ontogeny. It is determined by the difference between the final and initial live weight for certain periods of growing and is measured in kilograms or grams.

Agalactia is the absence of milk in sows due to mammary gland dysfunction without clinical signs of disease.

Adaptation is the adaptation of pigs to new environmental conditions (climate, housing, feeding).

Acclimatization is the adaptation of pigs to new climatic conditions while maintaining economically useful qualities, primarily reproductive ones.

Albumin is a simple protein; it is a component of animal tissues, egg white, milk, and blood serum, and is obtained in crystalline form when dried.

Anaerobic processes are processes that take place without oxygen.

Fertility is the number of live piglets born by a sow per farrowing.

Protein–vitamin–mineral supplement (PVMS) is a mixture of protein–rich concentrated feed with added vitamins, minerals, trace elements and antibiotics.

Pig boning is a comprehensive assessment of animals for breeding and productive qualities, which is carried out in all farms regardless of their organizational and legal forms and forms of ownership that have breeding pigs.

A vagina (artificial) is a device for obtaining sperm from sires of various designs and sizes

Gross output is the total of all types of products obtained from pig production over a certain period of time, expressed in terms of value. Its volume depends on pig productivity, the size and structure of the herd, labor productivity and other factors

Fatness is a state of the body characterized by the degree of muscle development and the ratio of muscle and adipose tissue; it is determined visually and by palpation.

Large–fecundity (kg) – is determined by the average live weight of one piglet in a litter at birth.

Genotype × environment interaction is the reaction of different genotypes to environmental conditions and the assessment of the breeding values of animals under these conditions. Different genotypes react differently to different environmental conditions, which complicates breeding and selection work

Pig breeding is a system that includes a set of measures aimed at creating comfortable conditions for feeding and housing young animals to identify their genetic traits.

Feed consumption (feed units) is the ability of pigs to digest feed. This indicator is calculated by dividing the sum of feed units contained in the consumed feed by the gross live weight gain during the fattening period.

Fattening stock are animals intended for slaughter for meat.

Fattening properties are a set of traits that characterize the results of fattening (average daily gain, age of slaughter weight and feed consumption per unit of gain).

Pig fattening is the intensive feeding of pigs aimed at obtaining the highest quantity and best quality of products and raw materials from them.

Weaning is the separation of young animals from their mothers at the end of the suckling period.

Reproduction is the restoration of the herd population by replacing retired animals with new ones.

Reproductive capacity is the genetically determined ability of animals to reproduce offspring.

Reproductive cycle is the period that includes pregnancy, the productive period, and the interval between weaning and fertilization.

Reproductive qualities are a group of traits (fertility, multiplicity, viability) that characterize reproductive capacity.

Age at live weight100 kg is the difference in days between the date of reaching live weight100 kg and the date of birth.

Pig age is the period of time from birth to aging and death of pigs. The age is determined based on the data on birth, marking of pigs.

Probability is an indicator that indicates the degree of probability of the difference obtained between the compared groups of animals.

Internal fat is fat removed from the stomach, intestines, kidneys, and groin.

An intra–breed type is a more or less homogeneous, sufficiently consolidated group of animals of a certain breed that has specific exterior and constitutional features, is adapted to certain natural and economic conditions of breeding, and has characteristic signs of productivity.

The moisture–holding capacity of meat is the property of muscle tissue proteins to retain water.

Hemoglobin is a red iron–containing respiratory pigment in the blood found in red blood cells. It transports oxygen from the respiratory system to the tissues and carries back some carbon dioxide from the tissues to the respiratory system.

A **gene** is an elementary unit of heredity that is part of a deoxyribonucleic acid molecule. The main function of a gene is to program the synthesis of enzymes and other proteins.

Genealogical lineage and family are groups of animals within a breed united by a common origin and name.

Genetic polymorphism is the simultaneous presence in a population of several different hereditary forms of the same locus that are in equilibrium for a number of generations.

Genetic potential for productivity is the maximum productivity of animals, which is determined by heredity and manifests itself in optimal feeding and housing conditions.

Gene pool is a set of breeds or types and lines within a breed that characterizes their genetic diversity.

Genotype is a set of all the genes of an organism that determine the basis of breeding work. The interaction of the genotype with the environment determines the phenotypic manifestation of traits.

Heterozygosity is an animal condition in which homologous chromosomes have different alleles of one or more genes. In animal breeding, heterozygosity is created by selection, but it can also occur as a result of mutation.

Heterosis is the property of hybrids from crossing breeds, types, lines or species to exceed the average performance of parental forms for one trait or set of traits.

Hybrid – offspring obtained from crossing different species of animals or from breeds, types or lines that have been selected and tested for compatibility.

Hybridization is the crossing of animals of different species, specialized breeds, types and lines to create new breeds or produce commercial hybrids. It is divided into inter–breed, breed–line and inter–line hybridization.

Hypodynamia is a weakening and decrease in muscle activity due to limited physical activity (sedentary behavior).

Glycogen is an animal starch that is formed from blood sugars in the liver, muscles, and other organs as the main reserve carbohydrate in the animal body.

Glycolysis is a complex enzymatic process of anaerobic breakdown of carbohydrates in the body of animals, which results in the formation of lactic acid.

Globulins are a very common group of animal and plant proteins in nature that are part of the cytoplasm, blood plasma and lymph, determining the buffering and immune properties of the body.

Glucose is a hydrocarbon of the monosaccharide group; it is a valuable nutrient for all organisms; it is a component of sucrose, fiber, starch, glycogen, glycosides and is central to their carbohydrate metabolism.

Feeders are special equipment for feeding animals; there are stationary, semi–stationary, portable, mobile and automatic feeders.

Homozygosity is the genetic structure of a zygote or genotype when homologous chromosomes have the same gene shape.

Disinfectants – means of destroying pathogens, including chlorine–containing compounds, oxidizers, phenols, salts of heavy metals, alkalis, acids and gaseous substances.

Deoxyribonucleic acid (DNA) is a high molecular weight biologically active compound that is an integral part of every cell in the body, which plays an important biological role by storing and transmitting genetic information about the structure, development and individual characteristics of each living organism.

The length of the bacon half (cm) is measured with a centimeter tape, in a hanging vertical position, along the cut from the previous edge of the pubic bone to the middle of the first rib.

The length of the chilled carcass (cm) is measured with a centimeter tape, in a hanging vertical position, in the middle of the cut from the previous edge of the pubic bone to the anterior surface of the first cervical vertebra (atlas).

Body length – is determined at the established age periods by measuring with a measuring tape from the occipital crest to the root of the tail.

Meat ripening is a set of changes in meat properties caused by the development of autolysis, which results in a delicate texture and juiciness, as well as a specific aroma and taste.

The industry's profitability is the excess of product value over production costs.

Economic evaluation of pig production is the determination of the cost of funds and labor per unit of pig production and the determination of the feasibility of these costs.

Exterior is the external structure of an animal in relation to its biological characteristics and economic value.

Elever is a specialized farm for growing and evaluating sires.

Feed utilization efficiency is the consumption of feed (feed units or kilograms of feed) per unit of animal weight gain.

Live weight is an indicator of the development of blue, determined by weighing at any age.

Adipose tissue is a type of connective tissue in an animal body that consists of cells almost entirely filled with fat droplets.

Pig slaughter is a technological process of killing pigs.

Slaughter yield, % is the percentage of carcass, head, leg and internal fat to the live weight of the animal before slaughter. Depending on the weight of the animals and their fatness, the slaughter yield of pigs is 70–85 %, i.e. in pigs weighing 80–100 kg it reaches 70–75 %, 150–180 kg – 80–82 %, and in well–fed pigs – 83–85 %.

Slaughter animals are farm animals intended for slaughter for the purpose of obtaining meat and meat products.

Fertilization is the process of fusion of male and female germ cells (gametes), which is the basis of reproduction.

Zootechnical accounting – records of productivity and product quality, origin, weight, mating, offspring, and other data of various technological groups of pigs.

Hierarchy is a system of relationships between animals of different sexes and ages in a group that determines their behavior.

Immunity is the ability of an organism to protect its integrity and biological identity. There are active, passive, species, acquired, and other types of immunity.

The intensification of the pig industry is a process of consistently increasing the quantity and quality of products, reducing costs and increasing labor productivity in their production.

Interior is defined as a set of internal histological, biochemical and physiological indicators of an organism in relation to its constitution and direction of productivity.

Quarantine is a system of measures aimed at preventing the spread of infectious diseases.

Quantitative traits are traits characterized by continuous variability and polygenic inheritance. Modern animal breeding is mainly based on these traits.

Boars under test are boars from the first mating until the end of their evaluation by weaning weight, after which they are transferred to the main boars or culled.

Compound feed is a dry feed mixture (loose or in pellets) balanced in all nutrients.

The constitution of animals a set of anatomical and physiological features of the organism as a whole, determined by heredity and conditions of individual development associated with the nature of productivity and the ability of the organism to respond appropriately to external stimuli.

Sperm concentration is the number of sperm in 1 ml, which is determined using a Goryaev camera, an optical standard, a photoelectrocalorimeter.

Feed unit – a unit of measurement of feed nutrition, which is equivalent to the nutritional value of medium quality oats (in kg, and more recently in metabolizable energy, in mJ).

A feed ration is a set of the required amount of feed that an animal consumes over a certain period of time.

Locus is the location of the corresponding gene and its alleles on a genetic or cytological map.

Meat productivity is one of the main economically useful traits of farm animals, which depends on the hereditary characteristics of the organism, species, breed, growing and feeding conditions, age, sex, fatness, etc.

Meat is a highly valuable product that includes muscle, connective, adipose, bone, and cartilage tissue, and their quantity and ratio depend on the species, sex, breed, fatness, and conditions of animal husbandry.

Marbling of meat is a marble–like appearance of meat on a cut, caused by the placement of fatty veins between muscle fibers and bundles.

Nest weight at weaning is the total live weight of piglets in the weighed individually.

The weight of the hind third of the half–carcass (ham), kg – which is separated by a transverse cut between the penultimate and last lumbar vertebrae.

Mycotoxicosis is a disease of animals that occurs as a result of eating feed contaminated with toxic fungi or their products.

Microclimate is a set of physical, chemical and mechanical factors of the indoor environment that affect the animal body.

A microtome is a device that makes sections of tissue or organs for microscopic examination.

Microflora is a set of different types of microorganisms that inhabit a particular environment (air, water, animal rumen, etc.).

Mineral nutritional value of feed is the ability of feed to meet the mineral requirements of animals.

Myogen is a group of soluble muscle proteins.

Myoglobin is a complex muscle protein of the chromoprotein group.

Myosin is the most important muscle protein, which is the main component of myofibrils.

Myofibers are the contractile filaments of striated muscle fibers and the cytoplasm of smooth muscle cells.

Morphological composition of the carcass – the ratio of different tissues in the carcass: muscle, fat and bone.

Moozing is an economic event that involves the stay and movement of animals in the open air

The tenderness of meat is an organoleptic indicator of the effort required to break down the product when chewed.

Semen volume is the volume of filtered ejaculate measured in a measuring cylinder or graduated beaker heated to the temperature of native semen.

Metabolizable energy is the energy of feed that is converted into physiological and biochemical energy in the animal body and is measured in MJ.

Herd turnover – planned or actual changes in the composition of age and sex groups of animals during a certain calendar period in accordance with the objectives of the farm and the natural conditions of herd reproduction.

Operator is the main category of employees of livestock complexes engaged in the production of livestock products.

Lighting is the creation of illumination of the surface of objects indoors using the light energy of the sun or an artificial light source.

Insemination is the convergence of gametes that precedes fertilization in animals.

The main boars and sows are adult animals of the breeding herd, which are used to produce breeding stock and fattening stock;

Assessment by intrinsic performance – assessment of the hereditary qualities of a breeding animal in terms of productivity and development (phenotype).

A **steamed carcass** is a fresh carcass after primary processing of an animal that can retain body heat (33–34 °C) for 2–3 hours.

Mating is the fertilization of females by natural or artificial means.

Bedding is a material (peat, straw, sawdust, dry leaves, etc.) that is laid on the floor in livestock buildings.

Breeding (genetic) value is the value of breeding animals based on their actual or expected impact on the quality of offspring.

A **breeding farm** is a farm that breeds and raises breeding animals for sale and reproduction of its own herd.

A **breeding plant is** the highest category of breeding farms whose main task is to improve and reproduce existing and develop new highly productive genotypes.

Breeding stock are purebred or mixed–breed sows and boars from birth to the first mating (insemination), which come from breeding animals with known origins and are intended for reproduction of the herd.

Breeding records are individual registration of data on the breeding value of animals by breeding entities in order to obtain systematized data necessary for breeding.

A breeding **reproducer** is a breeding farm that breeds breeding animals from breeding plants and raises breeding stock for commercial farms.

A **sire** is a sexually mature male used in breeding to reproduce a herd.

The area of the «muscle cell», cm², is measured on the transverse section of the longest back muscle, between the last thoracic and first lumbar vertebrae, with a planimeter along its contour, transferred from the carcass to a transparent film (tracing paper), or by multiplying the width of the «muscle cell» by the height and a coefficient of 0.8.

Complete feeding is the degree to which the feed meets the nutrient requirements of the animals.

Completeness of feed – the presence in the feed of all the nutrients necessary for the animal's body.

Feed intake is a quantitative characteristic of feed consumption until the need is met.

Polymorphism is the existence of two or more groups of individuals with sharply different qualities within one animal species.

A crossbreed is an animal obtained by mating animals of different breeds or breeding mixtures «in–house».

A breed is a collection of animals of the same species that was formed under the influence of human activity, characterized by a common origin of traits, and the ability to change progressively in the future.

Premixes are enrichment mixtures of biologically active substances of microbiological and chemical synthesis used to increase the nutritional value of feed.

Profit is the monetary expression of the realized part of the net profit of livestock farming, which remains after covering all the costs of production and sale of products. The off spring of animals.

Live weight gain is an increase in the live weight of animals over a certain period of time.

Labor productivity is the ability of a particular labor to produce a certain amount of material goods per unit of working time.

Animal productivity is the amount of product of the desired quality obtained over a certain period and the ability of animals to perform certain work.

Procholost is the repeated hunting of animals after insemination.

Diet – a set and amount of fodder for an animal for a certain period of time.

Resistance is the body's natural resistance to the effects of physical, chemical and biological factors that cause a pathological condition.

Herd repair is the systematic replacement of animals culled due to old age, illness, or low productivity with younger and more productive ones.

Repair boars are boars from selection (or purchase) for rearing to the first mating, intended to replace culled boars and expand the main herd.

Replacement pigs are pigs from selection (or purchase) for rearing to first farrowing, intended to replace culled sows and to expand the main herd.

Profitability is the profitability of production of a particular product and the livestock industry as a whole.

Profitability level is the ratio of the profit received from the sale of products to the total cost of production as a percentage.

Reproduction is the ability of an animal organism to reproduce its own kind, which ensures the continuity and continuity of life.

Carcass cutting is the division of an animal carcass into parts (cuts) according to their nutritional value for the sale of meat.

Splitting is the appearance of individuals of different genotypes in the offspring or the genetically determined appearance of a phenotypic trait.

Sperm motility is determined by eye on a ten–point scale. Each point is equal to 10 % of spermatozoa that have a straightforward forward motion.

Sows under test are sows from the time of first pregnancy until weaning, after which they are transferred to the main sows or culled.

Light coefficient is an indicator of measuring lighting in rooms, which is determined by the ratio of the area of the glazed surface of windows (without frames) to the floor area.

A breeding and hybrid center is an enterprise that includes a research laboratory and an industrial complex designed to test specialized breeds, types and lines for productivity and combinability and to create and reproduce progenitor and parental forms intended for use in the hybridization system.

Average daily gain is an indicator of the intensity of weight growth of young animals per day during the relevant growing period. It is calculated by dividing the absolute gain by the number of days of rearing and is measured in grams.

Early maturity, days, *is* the ability of pigs of cultivated breeds to reach live weight100 kg at the age of 5–6 months after birth.

The cost of pig production is the part of the value that represents the monetary value of the means of production consumed and labor costs.

Specialization in pig production is a form of social division of labor in the industry.

Stress is a state of tension in the body, its physiological protective reactions to the effects of various adverse factors.

Stress resistance is the ability of animals to adapt to changed conditions without reducing productivity.

Stress sensitivity is the level of animal response to stress factors.

Diet structure – the ratio of different feeds (roughage, juicy, concentrated) in the feed ration, expressed as a percentage.

Crossbreeding is the mating of animals belonging to different genetic groups (breeds, lines) to combine the genetic material of different cells in one cell.

Industrial crossbreeding is a breeding system based on crossing breeds, types and lines to produce fattening young stock.

Reciprocal crossbreeding is the crossing of animals of two lines, types or breeds, in which each line, type or breed is used once as a maternal and once as a paternal form in order to study their influence on the quality of offspring.

Three–breed crossbreeding is the crossing of mixed two–breed animals with a third breed and the use of mixed young animals for fattening.

Technology for agricultural production can be defined as a system of interrelated measures and techniques for the rational management of the industry, which ensures optimal biological, technological and organizational conditions for production in order to obtain the required quantity of products of the required quality at the optimal cost of labor and funds.

Fat thickness – determined when the animals reach the live weight100 kg at the level of the 6–7th thoracic vertebrae, retreating5 см to the right or left of the line of spinous processes of the thoracic vertebrae.

The thickness of the half–carcass fat is determined during the control slaughter of pigs without taking into account the thickness of the skin over the spinous processes between the sixth and seventh thoracic vertebrae of the cooled half–carcass.

Carcass is an industrial, economic and commercial name for the body of slaughtered animals without skin, head, legs, tail, internal organs and internal fat.

Conditional milk yield of sows – determined by the live weight of a nest of piglets at 21 days of age, at the time when the largest amount of milk is produced.

Farm animal husbandry is a system of organizational and economic measures aimed at ensuring comfortable living conditions for animals and increasing their productivity with minimal labor and money.

A cyclogram is a graphical model of production that reflects the time characteristics of the technological process, i.e. it allows you to visually represent the progress of the production process with closer accuracy and plan and control it on many grounds.

Artificial insemination of pigs is a set of measures to ensure fertilization of females without mating with sires.

The quality of livestock products is a set and correlation of properties that determine the ability of products to meet certain human food needs and industrial requirements for raw materials.

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ANNEX

ANNEX A

Technical characteristics of the bunker moonshine

The number of animals that can consume feed at the same time, heads.	up to 20
Number of feeding places	4
Number of dispensers	4
Live weight of animals, kg	25–180
Hopper volume, l	280
Hopper height, cm	100
Hopper length, cm	126
Hopper depth, cm	38
Feed table width, cm	31
Feed table height, cm	23

The self–bunker type feeder for four feeding places is designed for feeding pigs from 25 to180 kg dry feed

The feed is fed through a metering unit mounted directly above the trough. The feed is fed into the dispenser through an automatic feed conveyor from the storage hopper.

The body of the pig feeders is made of polypropylene GOST 16338–85, the fittings are made of stainless steel.

Manufactured by *Polnet* (Poland).

ANNEX B
Technical characteristics of the feeding machine

The number of animals that can consume feed at the same time, head.	30–50
Live weight of animals, kg	20–120
Hopper volume, l	95
Hopper filling height, cm	125
Maximum hopper diameter, cm	57
Minimum hopper diameter, cm	14
Feed table width, cm	70
Feed table depth, cm	50
Feed table height, cm	12

The feeding machine is designed for feeding pigs from 20 to120 kg with bulk and granular feed.

The downpipe and metal profiles are made of stainless steel. The pig feeder is equipped with two sprinklers. The feeder is equipped with three configurations of the feed discharge system, which allows adjustment depending on the type of animals served.

The feeder hopper is made of plastic (Germany), resistant to UV rays, the feeding table is made of stainless steel with a smooth and flat surface.

Manufactured by *Polnet* (Poland).

ANNEX B

ДЕРЖАВНА ВЕТЕРИНАРНА ТА ФІТОСАНІТАРНА СЛУЖБА УКРАЇНИ

STATE VETERINARY AND PHYTOSANITARY SERVICE OF UKRAINE

РЕЄСТРАЦІЙНЕ ПОСВІДЧЕННЯ
REGISTRATION CERTIFICATE

Відповідно до Закону України "Про ветеринарну медицину", постанови Кабінету Міністрів України від 21.11.2007 р. № 1349 "Про затвердження положень про державну реєстрацію ветеринарних препаратів, кормових добавок, преміксів та готових кормів" та на підставі експертного висновку від 29.07.2015 № 4102-К/06, рекомендацій Державної фармакологічної комісії ветеринарної медицини, наказу Державної ветеринарної та фітосанітарної служби України від 05.08.2015 р. № 2022 зареєстровано:

препарат *БіоПлюс 2Б*

форма *Порошок*

Власник реєстраційного посвідчення:

Хр. Хансен Чех Репаблік с.р.о.
с.р. 215, 69301 Старовіце, Чеська Республіка

зареєстровано в Україні за № ***АА-06060-04-15*** від ***05.08.2015***

Виробник:

Біохем Цузатцштоффе Хандельс- унд Продукцьонсгезельшафт мбХ
Кюстермейерштрассе, 16, м. Лоне, 49393, Німеччина

При будь-якій зміні в реєстраційному досьє власник посвідчення (виробник) повинен повідомити орган реєстрації.

Обов'язкові додатки:
- коротка характеристика препарату (додаток 1);
- етикетка (додаток 2);

Реєстраційне посвідчення дійсне до ***04.08.2020***

Це посвідчення не є зобов'язанням щодо закупівлі даного препарату

ДЕРЖАВНА ВЕТЕРИНАРНА ТА ФІТОСАНІТАРНА СЛУЖБА УКРАЇНИ Ідентифікаційний код 37472261

Заступник Голови Державної ветеринарної та фітосанітарної служби України
Заступник Головного державного інспектора ветеринарної медицини України
Deputy Chief of State Veterinary and Phytosanitary Service of Ukraine
Deputy Chief State Inspector of Veterinary Medicine of Ukraine

О. М. Вержиховський

Continued from Annex C

Додаток 1
до реєстраційного посвідчення АА-06060-04-15
05.08.2015

Коротка характеристика

1. Назва
БіоПлюс 2Б
2. Якісний і кількісний склад
1 г містить:
Bacillus licheniformis (DSM 5749) - не менше 1,6 x 10^9 КУО;
Bacillus subtilis (DSM 5750) - не менше 1,6 x 10^9 КУО.
Допоміжна речовина: кальцію карбонат.
3. Фармацевтична форма
Порошок.
4. Фармакологічна дія
Штами бактерій *Bacillus licheniformis та Bacillus subtilis* сприяють пригніченню патогенної та умовно-патогенної мікрофлори кишечнику, що призводить до зменшення захворювань на діарею, проявляють імуномоделюючу дію - відновлюють імунний статус, збільшують продукування ендогенного інтерферону, посилюють функціональну активність макрофагальних клітин та підвищують фагоцитарну активність лейкоцитів крові (моноцитів та нейтрофілів).
5.1. Вид тварин
Велика рогата худоба, свині, птиця, кролі.
5.2. Показання до застосування
Для профілактики захворювань травного каналу, стабілізації мікрофлори кишечнику, а також для покращення конверсії корму, збільшення приростів та покращення продуктивності телят, поросят, свиней на відгодівлі, свиноматок, індичок, бройлерів та батьківськоого поголів'я бройлерів, курей-несучок, кролів.
5.3. Протипоказання
Відсутні.
5.4. Особливі застереження при застосуванні
Відсутні.
5.5. Застосування під час вагітності і лактації, несучості
Не регламентується.
5.6. Взаємодія з іншими засобами та інші форми взаємодії
Синергічна дія при одночасному застосуванні добавки з кормовими ферментами та підкислювачами.
5.7. Дози і способи введення тваринам різного віку
Вносять у корми шляхом рівномірного змішування з розрахунку:
телята, поросята, свиноматки, свині на відгодівлі, бройлери, кури-несучки, батьківське поголів'я, індички, кролі - 400 г/т.
5.8. Спеціальні застереження для осіб і обслуговуючого персоналу
Згідно з існуючими нормативними документами.
6. Фармацевтичні особливості
6.1. Термін придатності
24 місяці.
6.2. Особливі застереження щодо зберігання
Сухе темне місце за температури до 25 ^{0}C.
6.3. Природа і склад контейнера первинного упакування
Багатошарові крафт-мішки з поліетиленовими вкладками по 5, 10 та 25 кг та біг-беги по 500 та 1000 кг.
7. Назва та місцезнаходження власника реєстраційного посвідчення:
Хр. Хансен Чех Репаблік с.р.о.
с.р. 215, 69301 Старовіце
Чеська Республіка

Continued from Annex C

8. Назва та місцезнаходження виробника (виробників)
Біохем Цузатцштоффе Хандельс- унд Продукцьонсгезельшафт мбХ
Кюстермейєрштрассе, 16, м. Лоне, 49393
Німеччина
Телефон: +49 4442 92890, Факс: +49 4442 928928, E-mail: Ukraine@biochem.net.

9. Додаткова інформація

Continued from Annex C

Додаток 2
до реєстраційного посвідчення АА-06060-04-15
05.08.2015

БіоПлюс 2Б

Склад:
1 г містить:
Bacillus licheniformis (DSM 5749) - не менше 1,6 x 10^9 КУО;
Bacillus subtilis (DSM 5750) - не менше 1,6 x 10^9 КУО.
Допоміжна речовина: кальцію карбонат.

Застосування:
Для профілактики захворювань травного каналу, стабілізації мікрофлори кишечнику, а також для покращення конверсії корму, збільшення приростів та покращення продуктивності телят, поросят, свиней на відгодівлі, свиноматок, індичок, бройлерів та батьківському поголів'ї бройлерів, несучок, кролів.

Дозування:
Вносять у корми шляхом рівномірного змішування з розрахунку:
телята, поросята, свиноматки, свині на відгодівлі, бройлери, несучки, батьківське поголів'я, індички, кролі - 400 г/т.

Умови зберігання:
Сухе прохолодне місце за температури до 25 °С.

Р.п. №:
Термін придатності: 24 місяці.

Дата виробництва:
Серія №:

Вага нетто: _ кг*

Власник реєстраційного посвідчення:
Хр. Хансен Чех Репаблік с.р.о.,
с.р. 215, 69301 Старовіце
Чеська Республіка

Biochem
Feed Safety for Food Safety

Виробник:
Біохем Цузатцштоффе Хандельс-
унд Продукцьонсгезельшафт мбХ
Кюстермейєрштрассе, 16, м. Лоне, 49393
Німеччина,
Телефон: +49 4442 92890, факс: +49 4442 928928
Online: www.biochem.net / Approval No.: αDE NI 4 00076

*5, 10, 25, 500, 1000

1

ANNEX D

Composition of mixed fodder for feeding pigs of different technological groups, %

Component	Young animals on fattening with live weight, kg		
	30–60	60–100	100–120
Wheat	32,00	24,00	16,55
Barley	12,10	24,00	28,00
Corn	17,38	19,00	20,30
Bran	8,00	12,00	17,20
Soybean cake	24,30	11,6	7,45
Sunflower cake	3,22	6,90	8,00
Premix	3,00	2,50	2,50
Total	100	100	100

Nutritional value of 1 kg of feed

Component	Fattening period		
	30–60 kg	60–100 kg	100–120 kg
Feed units	1,18	1,09	1,04
Metabolic energy, MJ	13,04	12,90	13,14
Crude protein, g	180,25	153,08	140,88
Crude fiber, g	50,80	53,38	54,31
Crude fat, g	32,15	39,95	40,55
Lysine, g	10,25	8,72	7,77
Methionine, g	3,18	2,33	2,33
Methionine + cystine, g	6,11	4,87	4,57
Threonine, g	6,89	5,61	3,67
Tryptophan, g	2,54	2,10	2,30
Calcium, g	7,58	6,43	5,20
Phosphorus (total), g	6,77	6,31	6,44
Phosphorus (total), g	3,11	2,81	2,14
Sodium, g	1,75	1,73	1,60
Magnesium, g	1,80	1,80	1,40
Iron, mg	80,00	60,00	59,00
Manganese, mg	25,00	20,00	23,10
Zinc, mg	90,00	70,00	66,00
Copper, mg	20,00	10,00	10,00
Iodine, mg	0,38	0,38	0,31
Selenium, mg	0,19	0,19	0,22
Cobalt, mg	0,47	0,47	0,32
A, thousand, ME	7000	3000	3000
D, thousand, MO	1000	600	600
E, mg	15,00	5,00	5,00
K, mg	1,00	0,00	0,00
B_1, mg	0,75	0,50	0,50
B_2, mg	3,75	2,00	2,10
B_3, mg	10,50	3,60	3,64
B_5, mg	15,00	7,00	6,55

B_6, mg	1,00	0,60	0,60
B_{12}, mg	0,02	0,02	0,02
B_c, mg	0,00	0,00	0,00
H, mg	0,05	0,00	0,00
C, mg	0,00	0,00	0,00
Choline chloride, mg	100,00	0,00	0,00

ANNEX E

ДЕРЖАВНА СЛУЖБА УКРАЇНИ
З ПИТАНЬ БЕЗПЕЧНОСТІ
ХАРЧОВИХ ПРОДУКТІВ ТА
ЗАХИСТУ СПОЖИВАЧІВ

THE STATE SERVICE OF UKRAINE
ON FOOD SAFETY AND
CONSUMER PROTECTION

РЕЄСТРАЦІЙНЕ ПОСВІДЧЕННЯ
REGISTRATION CERTIFICATE

Відповідно до Закону України «Про ветеринарну медицину», постанови Кабінету Міністрів України від 21.11.2007 р. № 1349 «Про затвердження положень про державну реєстрацію ветеринарних препаратів, кормових добавок, преміксів та готових кормів» та на підставі експертного висновку 13.02.2019 № 389-К/06, рекомендацій Державної фармакологічної комісії ветеринарної медицини, наказу Державної служби України з питань безпечності харчових продуктів та захисту споживачів 04.03.2019 № 135 зареєстровано:

продукт *ГЕПАСОРБЕКС*

форма *Порошок*

Власник реєстраційного посвідчення:
ТОВ «ВЕТСЕРВІСПРОДУКТ»
08132 Київська обл., Києво-Святошинський р-н, м. Вишневе, вул. Київська, 6-Г, УКРАЇНА

зареєстровано в Україні за № ***АВ-08268-04-19*** від ***04.03.2019***

Виробник:
ТОВ «ВЕТСЕРВІСПРОДУКТ»
08132 Київська обл., Києво-Святошинський р-н, м. Вишневе, вул. Київська, 6-Г, УКРАЇНА

При будь-якій зміні в реєстраційному досьє власник посвідчення (виробник) повинен повідомити орган реєстрації.

Обов'язкові додатки:
- коротка характеристика продукту (додаток 1);
- етикетка (додаток 2).

Реєстраційне посвідчення дійсне до: ***03.03.2024***

Це посвідчення не є зобов'язанням щодо закупівлі даного продукту.

Директор Департаменту безпечності харчових продуктів та ветеринарної медицини
Director of Department for Food Safety and Veterinary Medicine
Б. І. Кобаль

Додаток 1
до реєстраційного посвідчення АВ-08268-04-19

Коротка характеристика продукту

1. Назва
ГЕПАСОРБЕКС
2. Склад
В 1 кг кормової добавки міститься :

Назва складника	Одиниці виміру	Вміст
Бентоніт:		
- Кремнію діоксид	%	60,2-70,8
- Алюмінію оксид	%	8-12
- Магнію карбонат	%	1-2,5
- Титану діоксид	%	0,8-0,15
- Селен	%	0,32-0,35
- Кліноплеоліт	%	4,2-4,5
Дріжджі активні кормові	%	8-10
Розторопша плямиста подрібнена	%	18-20

3. Форма випуску
Порошок сірого кольору із специфічним запахом.
4. Фармакологічна властивості
Кормова добавка має сукупні властивості окремих компонентів.

Кормова добавка поглинає/зменшує/інактиває вміст мікотоксинів (афлатоксин, охратоксин, зеараленон, вомітоксин /ДОН/, фумонізин, Т-2 та інші) в кормах, попереджає їх всмоктування у кишечнику тварин, пом`якшує наслідки мікотоксикозів. Покращує гігієну корму, внаслідок чого знижується надходження патогенної та умовно-патогенної мікрофлори при споживанні корму. Надає виражений ефект імуностимулятора, пребіотика, а також гепатопротектору.

Компонент добавки розторопша плямиста містить силімарин, жирні олії, ефірні олії, флавоноїди, сапоніни, органічні кислоти та інші біологічно активні речовини, які сприяють зміцненню клітинних мембран, збільшення продукування жовчі, стимулювання синтезу білка і нейтралізації токсинів різного походження, посилюють секрецію залоз і моторику кишечника, зміцнють імунну систему. Компоненти кормової добавки сприяють нормалізації функціонування шлунково-кишкового тракту, нормалізації функціонування печінки, регенерації печінкової тканини.

5. Клінічні особливості
5.1.Вид тварин
Свині, птиця, врх.
5.2. Покази до застосування
Профілактика мікотоксикозів та інших токсикозів різної етіології.
5.3. Протипоказання
Не встановлені.
5.4. Особливості застереження при використанні
Немає.
5.5. Застосування під час вагітності, лактації, несучості
Застережень немає.
5.6. Взаємодія з іншими засобами та інші форми взаємодії
Не встановлено.
5.7. Дози та способи введення тваринам різного віку

Змішувати з кормом із розрахунку :
Птиця - 0,5 - 2 кг на тонну корму.
Свиноматки, молодняк свиней, свині на відгодівлі – від 0,5 до 3 кг на тонну корму.
ВРХ – від 0,5 до 3 кг на тонну корму.
Комбікорми, кормосуміші, монокорм – 0,5 – 3 кг на тонну

5.8. Спеціальні застереження для осіб та обслуговуючого персоналу

Немає.

5.9. Спеціальні застереження для осіб та обслуговуючого персоналу

Дотримуватись основних правил гігієни та безпеки, що прийняті при роботі з ветеринарними препаратами.

6. Фармацевтичні особливості

6.1. Термін придатності

24 місяці.

6.2. Особливі застереження щодо зберігання

Сухе, провітрюване приміщення, при температурі від 5 до 20ºС.

6.3. Природа і склад контейнера первинного упакування

Мішки по 1, 5, 10, 20, 25 кг

6.4. Особливі заходи безпеки при поводженні з невикористаним продуктом або його залишками

Невикористаний продукт повинен бути утилізований у відповідності з національними вимогами.

7. Назва та адреса власника реєстраційного посвідчення

ТОВ «ВЕТСЕРВІСПРОДУКТ»,
08132 Київська обл., Києво-Святошинський р-н, м. Вишневе, вул. Київська, 6-Г
Телефон: +380683858435
Факс:
E-mail: Vetserviceproduct@gmail.com

8. Назва та адреса виробника

ТОВ «ВЕТСЕРВІСПРОДУКТ»,
08132, Україна, Київська обл., Києво-святошинський р-н м. Вишневе, вул. Київська 6-Г
Телефон: +380683858435
Факс:
E-mail: Vetserviceproduct@gmail.com

ANNEX G

ДЕРЖАВНА СЛУЖБА УКРАЇНИ
З ПИТАНЬ БЕЗПЕЧНОСТІ
ХАРЧОВИХ ПРОДУКТІВ ТА
ЗАХИСТУ СПОЖИВАЧІВ

THE STATE SERVICE OF UKRAINE
ON FOOD SAFETY AND
CONSUMER PROTECTION

РЕЄСТРАЦІЙНЕ ПОСВІДЧЕННЯ
REGISTRATION CERTIFICATE

Відповідно до Закону України "Про ветеринарну медицину", постанови Кабінету Міністрів України від 21.11.2007 р. № 1349 "Про затвердження положень про державну реєстрацію ветеринарних препаратів, кормових добавок, преміксів та готових кормів" та на підставі експертного висновку від 14.07.2017 № 2344-К/06, рекомендацій Державної фармакологічної комісії ветеринарної медицини, наказу Державної служби України з питань безпечності харчових продуктів та захисту споживачів від 25.07.2017 р. № 604 зареєстровано:

продукт ***ПЕРФЕКТИН***

форма ***Порошок для перорального застосування***

Власник реєстраційного посвідчення:

ТОВ "ВЕТФАРМ"
16500 Чернігівська обл., Бахмацький район, м. Бахмач, вул. Соборності, 27, Україна

зареєстровано в Україні за № ***AB-07088-04-17*** від ***25.07.2017***

Виробник:
ТОВ "ВЕТФАРМ"
16500 Чернігівська обл., Бахмацький район, м. Бахмач, вул. Соборності, 27, Україна

При будь-якій зміні в реєстраційному досьє власник посвідчення (виробник) повинен повідомити орган реєстрації.

Обов'язкові додатки:
- коротка характеристика (додаток 1);
- етикетка (додаток 2);

Реєстраційне посвідчення дійсне до ***24.07.2022***

Це посвідчення не є зобов'язанням щодо закупівлі даного продукту

Директор Департаменту безпечності харчових продуктів та ветеринарії
Director of Department for Food Safety and Veterinary

Б. І. Кобаль

Додаток 1
до реєстраційного посвідчення АВ-07088-04-17
25.07.2017

Коротка характеристика препарату

1.Назва препарату:
ПЕРФЕКТИН
2.Склад
1 кг кормової добавки містить: Spirulina (Arthrospira) platensis – 100 г, антиоксидант (SMART 66) – 100 г, гідроалюмосилікат – q.s. (до 1 кг).
3.Форма випуску
Порошок для перорального застосування.
4.Фармакологічні властивості
Підвищує рівень та активність токоферолу. сприяє нормалізації обміну речовин, кращому засвоєнню корму, зміцненню природної резистентності організму, особливо при бактеріальних і паразитарних інфекціях, стресах і фізичному навантаженні; сприяє підвищенню продуктивності та збереження поголів'я сільськогосподарських тварин, в тому числі птахів і хутрових звірів; збільшує міцність яєчної шкаралупи; оберігає від передчасної линьки сільськогосподарську птицю і розкльову яєць.

Стимулює приріст м'язової тканини та покращує коефіцієнт конверсії корму у свиней, великої рогатої худоби, птиці та інших тварин. Покращує репродуктивні функції, підвищує якість сперми – збільшує кількість та активність сперміїв.

Синтетичний антиоксидант, стабілізатор вітамінів А, Д, Е, рослинних і тваринних жирів, активує імунітет, регулює рівень тироксину, трийодтироніну, фолікулостимулюючого та лютеїнізуючого гормонів в крові, зменшує період відгодівлі, підвищує органолептичні показники м'яса. Перфектин є інгібітором перекисного окислення ліпідів – підтримує функціональність печінки та нормалізує роботу інших внутрішніх органів. Ініціює обмін ферментів глюкоза-6-фосфатагенази та супероксиддисмутази в сироватці крові – стабілізує структуру клітини, діє як антиоксидант на вільні радикали, попереджуючи руйнацію клітин і тканин організму.

За використання сільськогосподарській птиці (яйценосні кури, індички, качки, гуси) Перфектин сприяє збільшенню фактичної кількості яйцеклітин та пригнічує виникнення атрезії фолікулів. У період несучості, протягом всього періоду згодовування корму, збагаченого Перфектином, у курей-несучок підвищується яєчна продуктивність та подовжується період яйцекладки; покращується товщина і цілісність яєчної шкаралупи та збільшується вага яєць; покращується синтез протеїнів білка та одиниці ХАУ, підвищується індекс жовтка та його питома вага за зниження вмісту холестерину.

5. Клінічні особливості:
5.1 Вид тварин
Свині, птахи, велика рогата худоба, дрібна рогата худоба, хутрові звірі.
5.2 Показання до застосування
Перфектин застосовують тваринам у вигляді кормової добавки. Кормова добавка покращує коефіцієнт конверсії кормів, прискорює приріст ваги (збільшення м'язової тканини), нормалізує роботу печінки та репродуктивних органів.
5.3 Протипоказання
Немає
5.4 Побічна дія
Побічних дій та ускладнень після використання кормової добавки не виявлено
5.5 Особливі застереження при використанні
Звертати особливу увагу на ретельне змішування кормової добавки з кормом.
5.6 Використання під час вагітності та лактації
Кормова добавка не токсична, протипоказань до застосування не встановлено.
Не рекомендовано використовувати глибокотільним, глибокопоросним та тваринам в перші тижні після осіменіння.
5.7 Взаємодія з іншими засобами та інші форми взаємодії
Не описані.

Продовження додатку 1
до реєстраційного посвідчення АВ-07088-04-17
25. 07. 2017

5.8 Дози і способи введення тваринам різного віку
Дозування із розрахунку на 1 тонну корму:

Курчата-бройлери з 30-ти денного віку	4 кг
Кури-несучки	2 кг
Поросята	1 кг
Свиноматки та кнурі-плідники	1,5 – 2 кг
Телята до 6 місяців	4 кг
Худоба на відгодівлі	3,5 кг
Лактуючі корови	1-2 кг
Хутрові звірі	10 кг

5.9 Передозування (симптоми, невідкладні заходи, антидоти)

Передозування Перфектином малоймовірне.

5.10 Спеціальні застереження

Після закінчення маніпуляцій руки рекомендується ретельно промити водою з милом. Продукцію від тварин, які отримували кормову добавку, дозволено використовувати без будь-яких обмежень.

6. Фармацевтичні особливості:

6.1 Форми несумісності:

Не описані.

6.2 Термін придатності

Гарантійний термін придатності 24 міс. з дати виготовлення зазначеної на упаковці, в суміші з комбікормом – 3 місяці.

6.3 Особливі заходи зберігання

У сухому темному недоступному для дітей та тварин місці, окремо від продуктів харчування і отрутохімікатів, при температурі від 5°C до 25°C.

6.4 Природа і склад контейнера первинного упакування

Кормову добавку фасують у паперові або поліетиленові пакети по 100, 250, 500, 1000, 5000, 10000, 25000 г.

6.5 Особливі заходи безпеки при поводженні з невикористаним продуктом або із його залишками

Не використана кормова добавка, після закінчення терміну придатності, знищується методом утилізації.

7. Назва та місцезнаходження власника реєстраційного посвідчення та виробника

ТОВ «ВЕТФАРМ»
16500 Чернігівська обл.,
Бахмацький район, місто Бахмач,
вул. Соборності, 27, Україна.

ANNEX K

ДЕРЖАВНА ВЕТЕРИНАРНА ТА ФІТОСАНІТАРНА СЛУЖБА УКРАЇНИ

STATE VETERINARY AND PHYTOSANITARY SERVICE OF UKRAINE

РЕЄСТРАЦІЙНЕ ПОСВІДЧЕННЯ
REGISTRATION CERTIFICATE

Відповідно до Закону України "Про ветеринарну медицину", постанови Кабінету Міністрів України від 21.11.2007 р. № 1349 "Про затвердження положень про державну реєстрацію ветеринарних препаратів, кормових добавок, преміксів та готових кормів" та на підставі експертного висновку від 18.02.2015 № 524-К/06, рекомендацій Державної фармакологічної комісії ветеринарної медицини, наказу Державної ветеринарної та фітосанітарної служби України від 25.02.2015 р. № 303 зареєстровано:

препарат ***ПРО-МАК***

форма ***Розчин для перорального застосування***

Власник реєстраційного посвідчення:
Кантерс Спешл Продактс Б.В.
Де Статер 32, 5737 РВ Лішаут, Королівство Нідерландів

зареєстровано в Україні за № ***АА-05695-04-15*** від ***25.02.2015***

Виробник:
Кантерс Спешл Продактс Б.В.
Де Статер 32, 5737 РВ Лішаут, Королівство Нідерландів

При будь-якій зміні в реєстраційному досьє власник посвідчення (виробник) повинен повідомити орган реєстрації.

Обов'язкові додатки:
- коротка характеристика препарату (додаток 1);
- етикетка (додаток 2);

Реєстраційне посвідчення дійсне до ***24.02.2020***

Це посвідчення не є зобов'язанням щодо закупівлі даного препарату

Заступник Голови Державної ветеринарної та фітосанітарної служби України
Заступник Головного державного інспектора ветеринарної медицини України
Deputy Chief of State Veterinary and Phytosanitary Service of Ukraine
Deputy Chief State Inspector of Veterinary Medicine of Ukraine

ДЕРЖАВНА ВЕТЕРИНАРНА ТА ФІТОСАНІТАРНА СЛУЖБА УКРАЇНИ

В.В. Бадницький

Continued from Annex K
to the registration certificate AA–05695–04–15
dated February 25, 2015.

Brief description of the product

1. Title.

PRO–MAC

2. Ingredients One kilogram contains:

Components	Units of measurement	Quantity.
Ants k–o	g	249±20
Dairy products	g	152±10
Ethanol	g	89±5
Glucose	g	76±4
Choline chloride	g	75±4
L–Lysine	g	13,5±1
Acetic acid	g	9,9±0,5
Magnesium hexahydrate chloride	g	8,3±0,5
L–Threonine	g	7,9±0,5
DL–Methionine	g	6,8±0,5
Citric acid monohydrate	g	5±0,5
Ammonium formate	g	4,4±0,25
Zinc chloride	g	2,8±0,25
Propionic acid	g	2,6±0,25
L–Tryptophan	g	1,7±0,25
Monopropylene glycol	g	1,5±0,25
Polyethylene glycol	g	1,5±0,25
Midi Helat	g	1,5±0,25
Phosphorus content	g	1,3±0,25
Vitamin B3	g	1±0,1
Vitamin B5	g	0,8±0,1
Magnesium tetrahydrate chloride	g	0,8±0,1
Copper chloride dehydrate	g	0,5±0,1
Vitamin B1	mg	300±5
Calcium chloride	mg	280±5
Zinc chelate	mg	260±5
Sorbinic acid	mg	250±5
Vitamin B6	mg	250±5
Sodium iodite	mg	15±0,5
Vitamin B2	mg	8±0,5
Sodium selenite	mg	5±0,5

Vitamin B11	mg	2±0,25
Vitamin B12	μg	530±25
Demineralized water up to 1 kg		

3. Form of issue

The solution for oral administration is green–brown in color.

4. Pharmacological properties

The components of the drug have a multifaceted effect on almost all body systems, stimulating their activity, resulting in normalization of animal vital functions, increased vitality, and increased resistance.

Pro–Mac has an attractive odor and taste for pigs, increases the appetite of animals; as a result, water and feed consumption increases, absorption and digestibility of nutrients improves.

Pro–Mac provides a good start for young animals, helping to effectively "launch" the digestive, immune, hormonal, and nervous systems. In adult animals, the drug normalizes and stimulates the reproductive system, contributing to more successful fertilization of sows, improving the quality of boar sperm. It effectively prevents and reduces the effects of stress in all age groups of animals.

5. Clinical features

5.1 Type of animal

Pigs and poultry.

5.2 Indications for use

Normalization of animal vital activity, increase of their vitality; strengthening of resistance, improvement of appetite and feed intake. Stimulation of the digestive, immune, hormonal and nervous systems. Reducing the effects of stress

5.3 Contraindications

Do not use in combination with other supplements or drugs.

5.4 Special precautions for use

Generally accepted sanitary and hygienic rules must be followed.

5.5 Use during pregnancy and lactation

There are no restrictions.

5.6 Interaction with other tools and other forms of interaction

Unknown.

5.7 Doses and routes of administration for animals of different ages

Piglets (weaning) after weaning and before transfer to fattening: 0.5–1.0 liters per 1000 liters of drinking water 6 days a week.

Piglets at the beginning of the fattening period:

1 liter of Pro–Mac per 1000 liters of drinking water for the first 5–10 days. In specific situations: 1 liter of Pro–Mac per 1000 liters of drinking water for 10 days.

Sows before farrowing: 3–10 ml per sow per day for 14 days before farrowing. In specific situations: 1 liter of additive per 1000 liters of drinking water for 10 days.

Pro–Mac can be added to liquid feed at the rate of calculation:

– growing piglets, fattening piglets, sows: 5–10 ml of Pro–Mac per animal per day.

For poultry, the additive is used in accordance with the recommendations given in the table:

Groups of poultry	Period of use (number of days)	Dosage
Broiler chickens	0–3	1 l/1000 l of water
	4–6	0.5 l/1000 l of water
Breeding poultry	0–5	1 l/1000 l of water
	6–10	1 l/1000 l of water
	11–12	0.5 l/1000 l of water
Transfer of repair young stock to a productive herd (18 weeks)	first 5 days	1 l/1000 l of water
	the next two days	0.5 l/1000 l of water
	next 5 days	0.25 l/1000 l of water
Peak performance period	first 4 days	1 l/1000 l of water
	the next two days	0.5 l/1000 l of water

5.8 Overdose (symptoms, emergency measures, antidotes)

Follow the recommendations for use.

5.9 Special precautions for persons and personnel

Adhere to generally accepted sanitary and hygienic standards and rules.

6. Pharmaceutical features

6.1 Expiration date

24 months

6.2 Special storage measures

Store the premix in the manufacturer's container away from heat supply elements, in a place protected from light, out of the reach of children and animals, separately from food and feed, at a temperature of 5º to 25ºC.

6.3 Nature and composition of the primary packaging container

Polyethylene canisters of 5, 10, 250 and 1100 kg.

6.4 Special precautions for handling unused product or residues

The product residues are neutralized with a 5% solution of caustic alkali, an aqueous suspension of slaked or bleached lime (suspension in water 1:3). The neutralized product residues are poured into a pit at least 0.5 m deep, located away from water sources, reservoirs, and rivers.

7. Name and location of the registration certificate holder

Canter's Special Products B.V.	Kanters Special Products BV
De Stater 3,	De Stater 3,
5737 Lishaut	5737 RV Lieshout
Netherlands	The Netherlands

ANNEX L

ДЕРЖАВНА ВЕТЕРИНАРНА ТА ФІТОСАНІТАРНА СЛУЖБА УКРАЇНИ

STATE VETERINARY AND PHYTOSANITARY SERVICE OF UKRAINE

РЕЄСТРАЦІЙНЕ ПОСВІДЧЕННЯ
REGISTRATION CERTIFICATE

Відповідно до Закону України "Про ветеринарну медицину", постанови Кабінету Міністрів України від 21.11.2007 р. № 1349 "Про затвердження положень про державну реєстрацію ветеринарних препаратів, кормових добавок, преміксів та готових кормів" та на підставі експертного висновку від 18.02.2015 № 525-К/06, рекомендацій Державної фармакологічної комісії ветеринарної медицини, наказу Державної ветеринарної та фітосанітарної служби України від 25.02.2015 р. № 303 зареєстровано:

препарат ***УЛЬТІМЕЙД АЦІД***

форма ***Розчин для перорального застосування***

Власник реєстраційного посвідчення:

Кантерс Спешл Продактс Б.В.
Де Статер 32, 5737 РВ Лішаут, Королівство Нідерландів

зареєстровано в Україні за № ***АА-05696-04-15*** від ***25.02.2015***

Виробник:
Кантерс Спешл Продактс Б.В.
Де Статер 32, 5737 РВ Лішаут, Королівство Нідерландів

При будь-якій зміні в реєстраційному досьє власник посвідчення (виробник) повинен повідомити орган реєстрації.

Обов'язкові додатки:
- коротка характеристика препарату (додаток 1);
- етикетка (додаток 2);

Реєстраційне посвідчення дійсне до ***24.02.2020***

Це посвідчення не є зобов'язанням щодо закупівлі даного препарату

Заступник Голови Державної ветеринарної та фітосанітарної служби України
Заступник Головного державного інспектора ветеринарної медицини України
Deputy Chief of State Veterinary and Phytosanitary Service of Ukraine
Deputy Chief State Inspector of Veterinary Medicine of Ukraine

В.В. Бащинський

Continued from Annex L

ANNEX 1

to the registration certificate AA–05696–04–15

dated February 25, 2015.

Brief description of the product

1. Title.

ULTIMATE ACID

2. Composition.

One kilogram contains:

Components	Units of measurement	Quantity.
Formic acid	g	255±10
Ammonium formate	g	75±5
Copper chelate	g	62±4
Ethanol	g	57±4
Acetic acid	g	45±3
Propionic acid	g	45±3
Lactic acid	g	36±3
Zinc chelate	g	12,5±1
Sorbic acid	g	4,8±0,25
Sodium dihydrogen phosphate	g	0,34±0,05
Demineralized water up to 1 kg		

3. Form of issue

Blue solution for oral administration.

4. Pharmacological properties

ULTIMAID ACID is a multifunctional feed additive, a new generation "acidifier", a synergistic combination of organic acids and chelated zinc and copper compounds. In the intestinal tract, it lowers pH, inhibits the growth of pathogenic bacteria, molds and yeasts, thereby creating conditions for the development of "beneficial" microflora, improves digestion, and stimulates the activity of digestive enzymes

5. Clinical features

5.1 Type of animal

Poultry, pigs.

5.2 Indications for use

Prevention of gastrointestinal diseases and dysbiosis, salmonellosis, dysentery and colibacillosis, swine edema; after vaccinations and other stresses, water sanitation and maintaining the cleanliness of the drinking system.

5.3 Contraindications

Do not drink in combination with other supplements or drugs.

5.4 Special precautions for use

Generally accepted sanitary and hygienic rules must be followed.

5.5 Use during pregnancy and lactation

There are no restrictions.

5.6 Interaction with other tools and other forms of interaction

Unknown.

5.7 Doses and routes of administration for animals of different ages

For pigs of different age groups: mix with drinking water at a dose of 0.5–1 liter per 1000 liters of water. In case of disease exacerbation, the dosage can be increased to 1.5 liters per 1000 liters of water.

Poultry: by watering at the rate of 0.5–1 liter per 1000 liters of water. If necessary, the dosage can be increased to 1.5 liters per ton of water.

Broiler chickens		
Age	Course	Objective
From birth to the 4th week of cultivation	Daily	Prevention of disorders of phosphorus–calcium metabolism and its consequences
Period of dietary changes	3–5 days in a row	Prevention of possible negative effects of feed stress
Other growing periods	2–3 days in a row	Stimulation of digestive processes, increase of general resistance, enhancement of immune response to vaccination, ensuring high sanitary water quality
Repairing young stock		
From week 10 (egg crosses), from week 15 (meat crosses)	three days in a row	Stimulation of the development of reproductive organs
Period of transfer to the adult herd	10–14 days in a row	Prevention of possible negative effects of transportation, post–vaccination and feed stress. Strengthening the immune response to vaccination.
Keeping commercial layers and adult poultry of the family flock		
Peak performance period	Daily	Prevention of phosphorus–calcium metabolism disorders and its consequences – shell quality, limb weakness. Increasing resistance and preventing intestinal diseases
After the 40th week	Three days in a row	Stimulation of the reproductive organs, prevention of phosphorus–calcium metabolism disorders and intestinal diseases

5.8 Overdose (symptoms, emergency measures, antidotes)

Follow the recommendations for use.

5.9 Special precautions for persons and personnel

Adhere to generally accepted sanitary and hygienic standards and rules.

6. Pharmaceutical features

6.1 Expiration date

24 months

6.2 Special storage measures

Store the premix in the manufacturer's container away from heat supply elements, in a place protected from light, out of the reach of children and animals, separately from food and feed, at a temperature of 5º to 25ºC.

6.3 Nature and composition of the primary packaging container

Polyethylene canisters of 20, 250 and 1100 liters.

6.4 Special precautions for handling unused product or residues

The product residues are neutralized with a 5% solution of caustic alkali, an aqueous suspension of slaked or bleached lime (suspension in water 1:3). The neutralized product residues are poured into a pit at least 0.5 m deep, located away from water sources, reservoirs, and rivers.

7. Name and location of the registration certificate holder

Canter's Special Products B.V.	Kanters Special Products BV
De Stater 3,	De Stater 3,
5737 Lishaut	5737 RV Lieshout
Netherlands	The Netherlands

ANNEX M

ДЕРЖАВНА ВЕТЕРИНАРНА ТА ФІТОСАНІТАРНА СЛУЖБА УКРАЇНИ

STATE VETERINARY AND PHYTOSANITARY SERVICE OF UKRAINE

РЕЄСТРАЦІЙНЕ ПОСВІДЧЕННЯ
REGISTRATION CERTIFICATE

Відповідно до Закону України "Про ветеринарну медицину", постанови Кабінету Міністрів України від 21.11.2007 р. № 1349 "Про затвердження положень про державну реєстрацію ветеринарних препаратів, кормових добавок, преміксів та готових кормів" та на підставі експертного висновку від 24.09.2014 № 3750-К/06, рекомендацій Державної фармакологічної комісії ветеринарної медицини, наказу Державної ветеринарної та фітосанітарної служби України від 01.10.2014 р. № 2851 зареєстровано:

препарат *Ліптоза Експерт*

форма *Порошок*

Власник реєстраційного посвідчення:

Ліпідос Толедо С.А. (Ліптоза)
Сан Ромуалдо 12-14, 3-ий поверх, офіс 1, 28037 Мадрид, Іспанія

зареєстровано в Україні за № *АА-05457-04-14* від *01.10.2014*

Виробник:
Ліпідос Толедо С. А. (Ліптоза)
С/ Хуан де ла Сієрва с/н 45600 Талавера де ла Рейна, Іспанія

При будь-якій зміні в реєстраційному досьє власник посвідчення (виробник) повинен повідомити орган реєстрації.

Обов'язкові додатки:
- коротка характеристика препарату (додаток 1);
- етикетка (додаток 2);

Реєстраційне посвідчення дійсне до *30.09.2019*

Це посвідчення не є зобов'язанням щодо закупівлі даного препарату

Заступник Голови Державної ветеринарної та фітосанітарної служби України
Заступник Головного державного інспектора ветеринарної медицини України
Deputy Chief of State Veterinary and Phytosanitary Service of Ukraine
Deputy Chief State Inspector of Veterinary Medicine of Ukraine

В.В. Башинський

Додаток № 1
до реєстраційного посвідчення
№ АА-05457-04-14
Від 01.10.2014

Коротка характеристика на кормову добавку

1. Назва кормової добавки

Ліптоза Експерт

2. Якісний та кількісний склад

1 кг містить:

Кислоту мурашину	– 50 000 мг;
Кислоту молочну	– 20 000 мг;
Кислоту пропіонову	- 22 000 мг;
Кислоту каприлову	- 50 000 мг;
Кальцію форміат	– 187 000 мг;
Амонію пропіонат	– 7 000 мг;
Ефірні масла :	
Орегано, Кориці, Гвоздики	– 50 000 мг;
Кремнію діоксид осаджений	– 70 000 мг;
Сепіоліт	– 541.000 мг.

Алюмосилікат магнію, кремнезем -до 1 кг.

3. Фармацевтична форма

Порошок.

4. Фармакологічні властивості

Комплекс органічних кислот та їх солей, що входить до складу кормової добавки, підвищує кислотність шлункового соку, посилює секрецію ферментів шлунку, підшлункової залози і кишечнику, покращує гідроліз поживних речовин, стимулює ріст ворсинок кишечнику, що сприяє пристінковому травленню та збільшує абсорбцію поживних речовин. Органічні кислоти та їх солі (кальцію форміат, амонію пропіонат) знижують величину pH вмістимого кишечнику, створюючи цим оптимальні умови для розвитку пропіоново- і молочнокислих бактерій, гальмують розмноження умовно-патогенних бактерій та грибів у кишечнику, завдяки чому профілактують розвиток ентероколітів.

5. Клінічні особливості

5.0 Вид тварин

Коні, велика рогата худоба, свині, вівці, кози, птиця, собаки, коти, риби.

5.1 Показання до застосування

Застосовують для оптимізації процесів травлення у свійських тварин і птиці, підвищенню резистентність тварин, покращенню росту і продуктивність, зниженню собівартість продукції, профілактиці захворювань травного каналу, підвищенню збереженості поголів'я.

5.2 Протипоказання

Відсутні.

5.3 Побічна дія

Відсутня.

5.4 Особливості застереження при використанні

Немає.

5.5 Застосування під час вагітності і лактації

Згідно дозування.

5.6 Взаємодія з іншими засобами та інші форми взаємодії

Ліптоза Експерт сумісна з усіма інгредієнтами кормів, іншими кормовими добавками та лікарськими засобами.

Продукцію тваринництва і птахівництва, після застосування добавки, можна використовувати в харчових цілях без обмежень.

Додаток № 1
до реєстраційного посвідчення
№ АА-05457-04-14
Від 01.10.2014

5.7 Дози і способи введення тваринам різного віку

Вносять у готові корми з розрахунку:

Птиця:

бройлери віком до 21 доби	- 2-3 кг /т;
бройлери віком від 21 доби і до забою	- 1-3 кг /т;
несучки та племінне поголів'я у перші 5 тижнів вирощування	- 2-3 кг /т;
індики	- 1-3 кг /т.

Свині:

поросята віком до 30 діб	- 2 кг /т;
поросята віком від 30 і до 70 діб	- 1-2 кг /т;
свиноматки	- 1-2 кг /т;
свині на відгодівлі	- 1-3 кг /т.
Інші види	- 0,5-2 кг/т.

5.8 Спеціальні застереження для осіб і обслуговуючого персоналу

При роботі з Ліптозою Експерт слід дотримуватися загальних правил особистої гігієни.

Не допускати контакту з очима, дихальною системою та шкірою.

6. Фармацевтичні особливості

6.1 Термін придатності

18 місяців.

6.2 Особливі заходи безпеки при зберіганні

Сухе, темне місце при температурі від 10 до 35°C.

Після першого відкриття (використання) – зберігати протягом 10 діб. Мішки не повинні зберігатися на підлозі або під стінами. Тримайте мішки закритими на стелажі.

6.3 Природа і склад контейнера первинного упакування

Багатошарові паперові мішки з поліетиленової вкладкою по 25 та 1000 кг.

6.4 Особливі заходи безпеки при поводженні з невикористаним засобом або з його залишками

Відкриті невикористані мішки з кормовою добавкою необхідно утилізувати відповідно до вимог місцевого законодавства.

7. Назва та місцезнаходження власника реєстраційного посвідчення

Ліпідос Толедо С.А. (Ліптоза)	LIPIDOS TOLEDO S.A. (LIPTOSA)
Сан Ромуалдо 12-14, 3-й поверх, офіс 1, 28037, Мадрид, Іспанія	San Romualdo 12-14, 3rd floor, office 1. 28037, Madrid, Spain

8. Назва та місцезнаходження виробника

Ліпідос Толедо С.А. (Ліптоза).	LIPIDOS TOLEDO,S.A.
С/ Хуан де ла Сієрва с/н 45600	Location: C/. Juan de la Cierva s/n. 45600
Талавера де ла Рейна,	Talavera de la Reina,
Іспанія	Spain

Continued from Annex M

Ліптоза Експерт

Склад:
1 кг містить:

Кислоту мурашину	– 50 000 мг;
Кислоту молочну	– 20 000 мг;
Кислоту пропіонову	– 22 000 мг;
Кислоту каприлову	- 50 000 мг;
Кальцію форміат	– 187 000 мг;
Амонію пропіонат	– 7 000 мг;
Ефірна масла:	– 50 000 мг;
Орегано, Кориці, Гвоздики	
Кремнію діоксид осаджений	– 70 000 мг;
Сепіоліт	– 541.000 мг.

Алюмосилікат магнію, кремнезем -до 1 кг.

Застосування:
Оптимізація процесів травлення у свійських тварин і птиці, підвищення резистентності тварин, покращення росту і продуктивності, зниження собівартості продукції, профілактика захворювань травного каналу, підвищення збереженості поголів'я свиней та птиці.

Дозування:
Вносять у готові корми з розрахунку:

Птиця:	
бройлери віком до 21 доби	- 2-3 кг /т;
бройлери віком від 21 доби і до забою	- 1-3 кг /т;
несучки та племінне поголів'я у перші 5 тижнів вирощування	- 2-3 кг /т;
індики	- 1-3 кг /т.
Свині:	
поросята віком до 30 діб	- 2 кг /т;
поросята віком від 30 і до 70 діб	- 1-2 кг /т;
свиноматки	- 1-2 кг /т;
свині на відгодівлі	- 1-3 кг /т.
Інші види	- 0,5-2 кг/т.

Серія:

Дата виробництва:

Термін придатності: 18 місяців

Вага нетто: кг*

Р.П. №

Власник реєстраційного посвідчення: Ліпідос Толедо С.А. (Ліптоза), Сан Ромуалдо 12-14, 3-й поверх, офіс 1, 28037, Мадрид, Іспанія
Виробник: Ліпідос Толедо С.А. (Ліптоза), С/ Хуан де лаСієрва с/н 45600, Талавера де лаРейна, Іспанія

*** 25 та 1000 кг**

ANNEX H

УКРАЇНА

ПАТЕНТ

НА КОРИСНУ МОДЕЛЬ

№ 129160

СПОСІБ ЗБІЛЬШЕННЯ ПРОДУКТИВНОСТІ МОЛОДНЯКУ СВИНЕЙ ПРИ КОМПЛЕКСНОМУ ВИКОРИСТАННІ ПРЕПАРАТІВ "ПРО-МАК" ТА "УЛЬТІМЕЙД АЦІД"

Видано відповідно до Закону України "Про охорону прав на винаходи і корисні моделі".

Зареєстровано в Державному реєстрі патентів України на корисні моделі **25.10.2018.**

Заступник міністра економічного розвитку і торгівлі України М.І. Тітарчук

МІНІСТЕРСТВО ЕКОНОМІЧНОГО РОЗВИТКУ І ТОРГІВЛІ УКРАЇНИ
ІДЕНТИФІКАЦІЙНИЙ КОД 37508596

Continued from Annex H

УКРАЇНА (19) **UA** (11) **129160** (13) **U**

(51) МПК (2018.01)
A23K 20/00
G01N 33/48 (2006.01)
A61K 31/375 (2006.01)
A61P 31/04 (2006.01)

МІНІСТЕРСТВО ЕКОНОМІЧНОГО РОЗВИТКУ І ТОРГІВЛІ УКРАЇНИ

(12) ОПИС ДО ПАТЕНТУ НА КОРИСНУ МОДЕЛЬ

(21) Номер заявки: **u 2018 03780**
(22) Дата подання заявки: **10.04.2018**
(24) Дата, з якої є чинними права на корисну модель: **25.10.2018**
(46) Публікація відомостей про видачу патенту: **25.10.2018, Бюл.№ 20**

(72) Винахідник(и):
Лихач Вадим Ярославович (UA),
Лихач Анна Василівна (UA),
Фаустов Ростислав Вікторович (UA),
Леньков Леонід Григорович (UA),
Задорожній В'ячеслав Вікторович (UA)

(73) Власник(и):
МИКОЛАЇВСЬКИЙ НАЦІОНАЛЬНИЙ АГРАРНИЙ УНІВЕРСИТЕТ,
вул. Георгія Гонгадзе, 9, м. Миколаїв, 54000 (UA)

(54) СПОСІБ ЗБІЛЬШЕННЯ ПРОДУКТИВНОСТІ МОЛОДНЯКУ СВИНЕЙ ПРИ КОМПЛЕКСНОМУ ВИКОРИСТАННІ ПРЕПАРАТІВ "ПРО-МАК" ТА "УЛЬТІМЕЙД АЦІД"

(57) Реферат:

Спосіб збільшення продуктивності молодняку свиней при комплексному використанні препаратів "Про-мак" та "Ультімейд ацід", що базується на застосуванні водорозчинних добавок "Про-Мак" та "Ультімейд Ацід", причому застосовують препарати з періодичністю через добу по черзі.

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Корисна модель належить до тваринництва і може бути застосована у свинарстві, зокрема у годівлі та напуванні молодняку свиней.

Відомий спосіб застосування препарату "Про-Мак" як стрес-коректора та стимулятора росту для підвищення продуктивності поросят [1].

Недоліком цього прототипу є те, що автори пропонують використовувати його як монодобавку в раціонах годівлі та напуванні молодняку свиней.

Відомий спосіб застосування препарату "Ультімейд Ацід" як найефективнішого засобу для підкислення питної води [2, 3].

Недоліком цього прототипу є те, що автори пропонують використовувати його як монодобавку у водонапуванні молодняку свиней.

Задача корисної моделі - це застосування комплексного використання препаратів "Про-Мак" і "Ультімейд Ацід" у водонапуванні молодняку свиней, завдяки поєднанню позитивної дії обох препаратів на продуктивність підсисних поросят і показники росту молодняку на дорощуванні.

Задача корисної моделі вирішується тим що застосовують препарати "Про-Мак" і "Ультімейд Ацід" з періодичністю через добу по черзі; які уводять в систему водопостачання, для підсисних поросят, за допомогою медикатора періодичністю через добу, за чотири дня до моменту відлучення та сім днів після відлучення поросят.

Корисну модель можливо використовувати для збільшення продуктивності молодняку свиней.

Приклад 1

поєднанні з "Ультімейд Ацід" (комплекс органічних кислот: мурашиної, пропіонової, молочної, оцтової, сорбіонової).

Компоненти, що входять до складу препарату "Про-Мак" багатогранно діють практично на всі системи організму, стимулюючи їх діяльність. "Про-Мак" забезпечує добрий старт для молодняку свиней, допомагаючи ефективному "запуску" травної, імунної, гормональної та нервової систем.

Основною функцією "Ультімейд Ацід" є зниження pH шлунка, стимуляція ферментоутворення, профілактика розмноження E. coli та Salmonella, протигрибковий та протимікотоксичний ефекти, активація росту й розвитку ворсинок тонкого відділу кишечнику.

З метою перевірки комплексного застосування різнорідних препаратів було проведено науково-господарський дослід на підсисних поросятах та поросятах на першому етапі дорощування в умовах товариства з обмеженою відповідальністю (ТОВ) "Таврійські свині" м. Скадовськ Херсонської області.

Для дослідження були використані результати вирощування поросят від відлучення (28 днів) і досягнення ними віку 90 днів. Загальна кількість голів для дослідження складала - 1780 голів. Схемою досліджень передбачалося оцінка продуктивної дії препаратів "Про-Мак" та "Ультімейд Ацід" як самостійно, так і у поєднанні.

Піддослідний молодняк був розділений на дві групи: І контрольна група - поросята вирощувалися за базовою технологією застосування водорозчинних добавок "Про-Мак" та "Ультімейд Ацід" в період відлучення та при переведенні на дорощування, а саме за чотири дні до відлучення через систему водонапування уводили препарат "Про-Мак" та протягом семи днів після відлучення поросят через систему водонапування уводили препарат "Ультімейд Ацід"; II дослідна група - поросята вирощувалися за базовою технологією, але для молодняку одночасно застосовуються препарати "Про-Мак" і "Ультімейд Ацід", які уводяться в систему водопостачання для поросят (цех опоросу) за допомогою медикатора періодичністю через добу по черзі, за чотири дня до моменту відлучення та сім днів після відлучення поросят (цех дорощування).

Препарати вводили в систему водонапування за допомогою медикатора "Dozatron" у дозі 100 мл на 100 л води. Для підгодівлі підсисних поросят та балансування раціонів молодняку на дорощуванні використовувалися суперстартерні комбікорми та білково-мінерально-вітамінні добавки компанії ТОВ "АгроВеткорм" (м. Дніпро). Утримання тварин в підсисний період та в період дорощування, в розрізі контрольної та дослідної групи, не мало визначних конструктивних та технологічних особливостей.

Оцінка продуктивності свиней здійснювалася відповідно до загальних методик [4].

Результати вирощування піддослідних поросят від відлучення до 90-денного віку за використання препаратів "Про-Мак" і "Ультімейд Ацід" представлені у таблиці.

Таблиця

Результати вирощування піддослідних поросят, $\overline{X} \pm S_{\overline{x}}$

Показник	Група		±II до I
	I	II	
Кількість голів при відлученні (28 днів), гол.	890	890	
Жива маса поросяти при відлученні, кг	8,12±0,32	8,08±0,30	-0,04
Кількість голів у віці 90 днів, гол.	823	858	+35
Жива маса поросяти у віці 90 днів, кг	32,81±0,20	37,88±0,24	+5,07***
Середньодобовий приріст, г	405±5,3	489±4,5	+84***
Збереженість, %	92,47±1,60	96,40±1,80	+3,93*

Примітки: * - P>0,95; *** - P>0,999.

При відлученні жива маса поросят піддослідних груп була майже однаковою, різниця на користь поросят II групи становила лише 0,04 г (різниця статистично не вірогідна).

При вивченні даного питання й спостерігаючи за поведінкою та станом поросят обох піддослідних груп, необхідно відмітити, що поросята I групи більш тривалий час встановлювали ієрархічні відносини між собою, на відміну від поросят II групи. Виходячи з цього констатуємо, що у тварин другої групи краще відбувається злиття гнізд на дільниці дорощування.

За період перебування піддослідних поросят на дорощуванні відмічаємо вірогідне зниження показників живої маси у тварин I групи на 5,07 кг у порівнянні з піддослідним молодняком II групи (P>0,999).

Відмічаємо, що у тварин I дослідної групи знижувалося споживання корму, протягом перших днів після переведення їх на дільницю дорощування, на відміну від своїх аналогів другої групи, які достатньо краще споживали корми. Даний факт відзначився і на збільшенні середньодобових приростів у поросят II групи, який дорівнював - 489 г, що на 84 г більше, ніж у молодняку I групи (P>0,999).

За показником збереженості молодняку в період дорощування встановлена вища збереженість у II групи - 96,40 %, що на 3,93 % більше за аналогів I групи (P>0,95).

Таким чином, проведені дослідження підтвердили доцільність комплексного застосування препаратів "Про-Мак" і "Ультімейд Ацід" для підсисних поросят (цех опоросу) за чотири дня до моменту відлучення та сім днів після відлучення поросят (цех дорощування) з періодичністю через добу по черзі. Доведено, що комплексне застосування обох препаратів є більш ефективнішим.

Економічна ефективність використання даного способу комплексного використання препаратів "Про-Мак" та "Ультімейд Ацід" становить 12,05 грн в розрахунку на одну голову.

Джерела інформації:

1. "Про-Мак" - інформація про препарат. [Електронний ресурс] - Режим доступу: https://www.kanters.nl/over-kanters/

2. "Ультімейт Ацід" - інформація про препарат. [Електронний ресурс] - Режим доступу: https://www.kanters.nl/over-kanters/

3. Крюкова Л. Підкислювач: використання у свинарстві / Л. Крюкова, Д. Крюков // Тваринництво та ветеринарія.-2017. - № 9 (17). - С. 22-24.

4. Методологія та організація наукових досліджень у тваринництві: посіб. / [І. І. Ібатуллін, О. М. Жукорський, М. І. Бащенко та ін.]. - К.: Аграрна наука, 2017.-328 с.

ФОРМУЛА КОРИСНОЇ МОДЕЛІ

1. Спосіб збільшення продуктивності молодняку свиней при комплексному використанні препаратів "Про-мак" та "Ультімейд ацід", що базується на застосуванні водорозчинних добавок "Про-Мак" та "Ультімейд Ацід", який **відрізняється** тим, що застосовують препарати з періодичністю через добу по черзі.

2. Спосіб за п. 1, який **відрізняється** тим, що препарати вводять у дозі 100 мл препарату на 100 л води, в систему водопостачання за чотири дні до моменту відлучення підсисних поросят та сім днів після відлучення.

Комп'ютерна верстка О. Рябко

Міністерство економічного розвитку і торгівлі України, вул. М. Грушевського, 12/2, м. Київ, 01008, Україна

ДП "Український інститут інтелектуальної власності", вул. Глазунова, 1, м. Київ – 42, 01601

ANNEX P

УКРАЇНА

ПАТЕНТ

НА КОРИСНУ МОДЕЛЬ

№ 137758

СПОСІБ ВИКОРИСТАННЯ КОМПЛЕКСНОГО ПРЕПАРАТУ "ГЕПАСОРБЕКС" ДЛЯ ЗБІЛЬШЕННЯ ПРОДУКТИВНОСТІ МОЛОДНЯКУ СВИНЕЙ

Видано відповідно до Закону України "Про охорону прав на винаходи і корисні моделі".

Зареєстровано в Державному реєстрі патентів України на корисні моделі **11.11.2019.**

Заступник Міністра розвитку економіки, торгівлі та сільського господарства України — Д.О. Романович

УКРАЇНА (19) **UA** (11) **137758** (13) **U**

(51) МПК
A23K 20/20 (2016.01)
A01K 67/02 (2006.01)

МІНІСТЕРСТВО РОЗВИТКУ ЕКОНОМІКИ, ТОРГІВЛІ ТА СІЛЬСЬКОГО ГОСПОДАРСТВА УКРАЇНИ

(12) ОПИС ДО ПАТЕНТУ НА КОРИСНУ МОДЕЛЬ

(21) Номер заявки: **u 2019 03249**
(22) Дата подання заявки: **01.04.2019**
(24) Дата, з якої є чинними права на корисну модель: **11.11.2019**
(46) Публікація відомостей про видачу патенту: **11.11.2019, Бюл.№ 21**

(72) Винахідник(и):
Лихач Вадим Ярославович (UA),
Лихач Анна Василівна (UA),
Задорожній В'ячеслав Вікторович (UA),
Фаустов Ростислав Вікторович (UA),
Луговий Сергій Іванович (UA)

(73) Власник(и):
МИКОЛАЇВСЬКИЙ НАЦІОНАЛЬНИЙ АГРАРНИЙ УНІВЕРСИТЕТ,
вул. Георгія Гонгадзе, 9, м. Миколаїв, 54020 (UA)

(54) СПОСІБ ВИКОРИСТАННЯ КОМПЛЕКСНОГО ПРЕПАРАТУ "ГЕПАСОРБЕКС" ДЛЯ ЗБІЛЬШЕННЯ ПРОДУКТИВНОСТІ МОЛОДНЯКУ СВИНЕЙ

(57) Реферат:

Спосіб використання комплексного препарату "Гепасорбекс" для збільшення продуктивності молодняку свиней, при якому препарат після 30 днів нормативного використання у дозі 1,2-2,0 кг/т застосовують у зменшеній на 50 % дозі - 0,6-1,0 кг/т, при середньому рівні контамінації мікотоксинами комбікормів.

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Корисна модель належить до тваринництва і може бути застосована у свинарстві, зокрема у годівлі молодняку свиней.

Відомий спосіб застосування комплексного препарату "Гепасорбекс" як сорбента мікотоксинів для підвищення продуктивності свиней різних технологічних груп, при якому препарат використовується в постійних дозах, незважаючи на тривалість використання [1].

Недоліком цього способу є те, що пропонується використовувати препарат в постійних дозах, незважаючи на тривалість використання, а саме "Гепасорбекс" уводять в комбікорми в процесі їх виготовлення на комбікормових заводах або до складу комбікорму чи подрібненого зернофуражу - перед застосуванням тваринам. Дозу визначає спеціаліст ветеринарної медицини залежно від інтенсивності контамінації корму конкретним видом мікотоксину.

Задача корисної моделі - це збільшення продуктивності молодняку свиней та зменшення витрат кормів.

Поставлена задача вирішується тим, що препарат "Гепасорбекс" після 30 днів нормативного використання у дозі 1,2-2,0 кг/т застосовують у зменшеній на 50 % дозі - 0,6-1,0 кг/т, при середньому рівні контамінації мікотоксинами комбікормів.

Приклад

Методи боротьби з мікотоксинами в даний час зазнають значної еволюції, в результаті якої пройдено шлях від використання бентонітів і алюмосилікатів, активних відносно лише одного-двох мікотоксинів, до застосування модифікованих глюкоманнанів, міцно і швидко адсорбуючих практично всі відомі на сьогоднішній день мікотоксини. У зв'язку з актуальністю проблеми, визначають ефективність використання в раціонах годівлі молодняку на відгодівлі різних доз комплексного препарату "Гепасорбекс" виробництва компанії "ВетСервісПродукт".

Дослідження були проведенні в умовах ТОВ "Таврійські свині" м. Скадовськ Херсонської області на поголів'ї помісного молодняку свиней ((українська м'ясна (УМ) × ландрас (Л) × п'єтрен (П)).

Піддослідні групи були сформовані таким чином:

I (контрольна група) - протягом періоду відгодівлі споживали основний раціон (ОР);

II (дослідна група) - до основного раціону вводили сорбент мікотоксинів "Гепасорбекс" в дозі 1200-2000 г/тонну комбікорму (нормативна доза при середньому рівні контамінації);

III (дослідна група) - до основного раціону вводили комплексний препарат "Гепасорбекс" в дозі 600-1000 г/тонну комбікорму.

Після 30 днів нормативного використання зменшили нормативну дозу на 50 %, а інші технологічні фактори годівлі та утримання були ідентичними.

Склад 1 кг кормової добавки "Гепасорбекс" містить наступні активні компоненти (%): кремнію диоксид - 64,2-74,8; алюмінію оксид - 14-18; магнію карбонат - 1,0-2,5; титану діоксид - 0,8-0,15; селен - 0,32-0,35; кліноплеоліт - 4,2-4,5; сухі пивні дріжджі - 8-10.

Композиція гідрофільних каркасних алюмосилікатів і лужних силікатів та їх лужноземельних елементів в харчовому каналі тварин на молекулярному рівні адсорбує переважну більшість (75-98 %) наявних в кормі мікотоксинів, що перешкоджає можливості їх всмоктування стінками шлунково-кишкового каналу та забезпечує подальше виведення з організму у складі фекальних мас. Біологічно активні речовин, які містяться в адсорбенті, в поєднанні зі сполукою селену сповільнюють процеси окислення і сприяють зменшенню токсичного навантаження на організм від решток, не зв'язаних мікотоксинами. Під їх впливом поступово відновлюються детоксикаційна діяльність печінки і загальний імунний статус організму.

Основний комбікорм, який використовувався для годівлі свиней піддослідних груп згідно з лабораторними дослідженнями, був визнаним як слаботоксичний. В досліді вивчались відгодівельні показники за загальноприйнятими методиками.

Питання рентабельності у тваринництві є ключовим для розробки нових стратегій у годівлі сільськогосподарських тварин. У період коливання цін на сировину та закупівельних цін на продукцію тваринного походження виробники мають бути забезпечені ефективними рішеннями для оптимізації витрат та підвищення продуктивності тварин.

Результати відгодівлі помісного молодняку свиней піддослідних груп за умови використання комплексного препарату "Гепасорбекс" представлено у таблиці. Молодняк усіх груп при постановці на відгодівлю після зрівняльного періоду мав практично однакову живу масу в межах 33,6-34,6 кг у віці 90 днів. За період відгодівлі молодняк піддослідних груп, що споживав комбікорм, контамінований мікотоксинами, до складу якого вводився або був відсутнім сорбент мікотоксинів, різнився за тривалістю перебування на відгодівлі.

Таблиця

Результати відгодівлі молодняку свиней
за використання комплексного препарату "Гепасорбекс", $\overline{X} \pm S_{\overline{X}}$

Показник	Група тварин		
	I	II	III
Призначення груп	контрольна	дослідна	дослідна
Дозування введення препарату на 1 т комбікорму, кг	-	1,2-2,0	0,6-1,0
Кількість голів при постановці на відгодівлю (90 днів), гол.	40	40	40
Жива маса поросяти при постановці на відгодівлю, кг	34,1±0,45	33,6±0,50	34,6±0,44
Кількість голів при досягненні живої маси 100 кг, гол.	37	39	38
Тривалість відгодівлі, днів	97,6±1,85	88,6±1,60**	85,3±1,71**
Вік досягнення живої маси 100 кг, днів	187,6±3,22	178,6±1,90*	175,3±2,00**
Абсолютний приріст на відгодівлі, кг	65,9±1,22	66,4±1,89	65,4±1,92
Середньодобовий приріст на відгодівлі, г	675,2±8,92	749,4±5,88***	766,7±6,15***
Витрати корму на 1 кг приросту, корм. од.	3,23	3,15	3,12
Збереженість на відгодівлі, %	92,5±1,00	97,5±0,89	95,0±0,88

Примітки: * P>0,95; ** P>0,99; *** P>0,999.

Молодняк свиней I групи, який споживав основний комбікорм, триваліше відгодовувався - 97,6 днів, і тим самим вірогідно поступався за цим показником дослідним групам: тваринам II групи на 9 днів (P>0,99) та III групи на 12,3 дня (P>0,99). Ця різниця вплинула на загальний вік досягнення живої маси 100 кг, так, молодняк II та III піддослідної груп, до складу комбікорму яких вводився комплексний препарат "Гепасорбекс" у дозі 1,2-2,0 і 0,6-1,0 кг/т, досягав живої маси 100 кг за 178,6; 175,3 днів відповідно.

Присутність у комбікормі, який використовувався для відгодівельного молодняку, сорбентів зумовило вищі середньодобові прирости, відповідно тварини другої групи мали значення даного показника на рівні - 749,4 г, що на 11 % переважали контрольну групу (P>0,999), та тварин третьої групи - 766,7 г, що на 13,6 % вище за показник контролю. Вищі середньодобові прирости зумовили зменшення витрат кормів на одиницю приросту у молодняку дослідних груп.

Таким чином, "Гепасорбекс", який уводився до складу комбікормів (контамінованих мікотоксинами) для відгодівельного молодняку, сприяє покращенню відгодівельних якостей. Більш високі показники середньодобових приростів, при заощаджені самого препарату, були отримані у свиней, до комбікорму яких вводили 0,6-1,0 кг на тонну комплексного препарату "Гепасорбекс" (після 30 днів нормативного використання було зменшено дозу на 50 % - 0,6-1,0 кг/т), що відрізняється від найближчого аналога, де нормативне уведення до складу раціону складає 1,2-2,0 кг/т при середньому рівні контамінації мікотоксинами.

Для збільшення продуктивності, профілактики шлунково-кишкових захворювань, підвищення природної резистентності відгодівельного молодняку та збільшення ефективності виробництва свинини в умовах промислових комплексів рекомендується до складу повнораціонних комбікормів вводити комплексний препарат "Гепасорбекс" у вказаних пропорціях. Після 30-денного постійного використання препарату можливе зменшення нормативної дози його ведення, без зниження продуктивності та терапевтичного ефекту для відгодівельного молодняку свиней.

Економічна ефективність використання даного способу застосування комплексного препарату "Гепасорбекс" становить 23,0 грн. в розрахунку на одну голову відгодівельного молодняку за весь період відгодівлі.

Джерело інформації:

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ФОРМУЛА КОРИСНОЇ МОДЕЛІ

Спосіб використання комплексного препарату "Гепасорбекс" для збільшення продуктивності молодняку свиней, який **відрізняється** тим, що препарат "Гепасорбекс" після 30 днів нормативного використання у дозі 1,2-2,0 кг/т застосовують у зменшеній на 50 % дозі - 0,6-1,0 кг/т, при середньому рівні контамінації мікотоксинами комбікормів.

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ANNEX P

УКРАЇНА

СВІДОЦТВО

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Стаття "Використання кормової добавки при годівлі сільськогосподарських тварин "ГЕПАСОРБЕКС - ГЕПАТОПРОТЕКТОР ТА ДЕАКТИВАТОР МІКОТОКСИНІВ" ВІД ТОВ "ВЕТСЕРВІСПРОДУКТ"

(вид, назва твору)

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