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# ADAPTIVE CAPACITIES OF REPLACEMENT HYBRID DOE RABBITS TO INDUSTRIAL HOUSING CONDITIONS OF AGROTECHNOPARK

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A B S T R A C T

Industrial rabbit breeding is currently a high-potential livestock industry. Rabbits are characterized by large litter and early maturity. Increasing meat production of industrial breeding rabbits will meet domestic market needs, create industry conditions, and thus increase profits. To study rabbit adaptation, two groups of replacement doe rabbits were kept in a two-tier, two-sided all-metal mesh battery and in cages for the outdoor keeping of rabbits, for 30% of the core herd. The density of keeping replacement young animals was 4-5 animals in a cage; doe rabbits selected for replacement were born from doe rabbits with large litters and much milk which had grown at least 90% of their baby rabbits. Experimental groups received a diet of granulated compound feeds for rabbits. Veterinary hygiene conditions were the same. All females left for herd replacement were evaluated by live weight, body type, and density of hair on their legs. Replacement doe rabbits had an average live weight of 3.5 kg, body type and density of hair met the requirements for hybrids. This study recommends replacing obsolete cages for keeping rabbits with industrial-type cages that will facilitate work with breeding and replacement rabbits, as well as increase output products for the room with the same area. Laboratory of rabbit breeding of "Agrotechnopark" Academic and Research Innovation Center meets the requirements for modern livestock buildings concerning conditions of keeping, zoological hygiene, feeding, bacterial contamination, and accordingly has the potential for additional purchases of rabbits to expand the base.

**Disciplinary**: Animal Sciences, Zootechnics, Biological Science; Agriculture Business.



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# 1. INTRODUCTION

For industrial breeding in Russian farms, rabbits have several competitive advantages over other types of farm animals: high fertility, the ability to have up to 8 litters from one doe rabbit during a production year, early maturity, dietary properties of rabbit meat, lack of competition in rabbit meat market (Sysoev, 1985; Zdanovich, 2018; Zdanovich, 2019; Lesnyak and Dobudko, 2006; Trubchaninova, 2014a, 2014b; Plotnikov, 1989).

The quantitative and qualitative composition of rabbit products largely depends on pedigree features, hereditary traits, environmental factors, and intensive economic use of animals (Sysoev, 1990; Plotnikov, 1984; Roussky, 2017; Nigmatullin, 2014).

Many specialists in this industry, to obtain rabbit meat, work with domestic rabbits with high early maturity, and increased body weight. Many rabbit breeders often use rabbits of domestic Serebristy breed with high maturity and large live weight.

In the course of mastering industrial technology, it turned out that rabbits as productive animals were poorly studied. Rabbits are studied more from the point of biology and medicine than as an object of agriculture. This to a large extent can explain the ups and downs of rabbit breeding development in our country. These multiple ups and downs show an insufficient level of knowledge, and meanwhile, using genetic potential is one of the important reserves for rabbit breeding. Stockbreeding and selection for heterosis should be of importance (Dobudko, 2018; Kornienko, 2019; Trubchaninova, 2014c, 2014d; Zdanovich, 2017; Koschayev et al., 2019).

Therefore, the study of the adaptation features of rabbits during the conversion of breeding into industrial one makes allows significant increases in the productions of rabbit products without additional capital investments and improving the quality of rabbit breeding products.

The purpose of this research is to study the adaptive abilities of hybrid rabbits to the industrial housing system based on the rabbit farm of Belgorod State Agricultural University named after V. Gorin. The following tasks were set for achieving this goal:

- to study the technique of artificial insemination of replacement hybrid doe rabbits, the main indicators of the reproductive ability of rabbits,
- to study the intensity of growth and development of rabbits by age and their productive qualities,
- to study sanitary and hygienic conditions of raising, to perform bacterial and microbiological assessment of technological equipment, feeding,
- to perform bacterial and microbiological assessment of rabbits' slaughter products in order to study the environmental cleanness for heavy metals in meat.

# 2. RESULTS OF EXPERIMENTAL STUDIES

## 2.1 MATERIALS AND METHODS

This study was conducted in the conditions of the rabbit breeding laboratory of "Agrotechnopark" Academic and Research Innovation Center of Belgorod State Agricultural University. The object of scientific research was replacement young rabbits kept in a two-tier, two-sided all-metal mesh battery and in cages for the external keeping of rabbits. For this purpose, replacement doe rabbits were divided into two groups which amounted to 30% of core herd. The density of keeping replacement young animals was 4-5 animals in a cage; doe rabbits selected for replacement were born from doe rabbits with large litters and much milk which had grown at least 90% of their baby rabbits. All rabbits were healthy, viable, with a live weight of 1-1.2 kg. At 3-3.5 months of age, the re-selection of replacement animals was carried out. Females were kept 2-3 animals per cage. Young rabbits were estimated by live weight, general body build, and hair thickness. Upon reaching puberty and weight of 3.5 kg, replacement doe rabbits were mated, then after 12 days, they were checked for pregnancy. Fertilized does were joined to the core herd. In autumn, checked doe rabbits which rose 6-8 ready to be separated baby rabbits were joined to the core stock.

Experimental groups received a ration made from granulated compound feeds for rabbits produced by Biorhythm company; as well as the rest of the rabbit stock in the laboratory, except for males who additionally received dry forage of good quality. Zoological hygiene conditions of housing were the same.

In terms of reproductive capacity, reproductive features were of particular importance: pregnancy of doe rabbits (its duration), multiple pregnancies, and parameters of milk production. We studied the parameters of quantity and quality of obtained and reared baby rabbits in different litters, and also the live weight of litter before separating and the uniformity of litter of one doe rabbit from kindling to kindling. Milk production and early maturity were the basic parameters for the assessment.

Data were processed according to the method of N.A. Plokhinsky (1978). Difference in values was considered significant * - $P < 0.05$, ** - $P < 0.01$, *** - $P < 0.001$.

## 2.2 ORGANIZATION OF RABBITS FEEDING

The total duration of the experiment was 6 months. Rabbits were fed and watered ad libitum. During the experiment, dry food was used for the entire livestock in the conditions of the rabbit breeding laboratory. The contract was concluded with OOO Biorhythm. Biorhythm company was established in 2009, the company's activities are aimed at providing high-quality compound feedings produced following their own recipes using feed additives corresponding to a certain period of keeping animals and birds.

Compound feedings were put into feeders for replacement young animals – daily, for lactating doe rabbits and young animals – once every 2 days when feeding ad libitum. Feeding was in the form of granules of 3.2 mm, with a shelf life of 4 months from the day they were produced, non-toxic, with humidity 10.6%, without any genetically modified products, developed according to GOST R52812-2007 (Table 1).

**Table 1**: Recipe for compound feed PZK-91 (2359)

| Feeding components | Value |
|---|---|
| Wheat | 34.98% |
| Grass flour | 24.91% |
| Oilcake | 10.80% |
| Soybean meal | 6.90% |
| Corn | 10.0% |
| Feed chalk | 2.00% |
| Sunflower oil | 0.50% |
| Sodium chloride | 0.12% |

It should be noted that when feeding replacement young animals, the provision of full-value diets should be constant: until rabbits reach a weight of 4.5 kg at the age of 165 days with an average daily gain of 20 g during the growing period, as it was observed in our experiment. Compound feeding fully complies with the standard parameters for feeding rabbits.

The provision of animals with mineral and vitamin complexes is of great importance when raising rabbits for herd replacement.

From trace elements in rabbits' diet, most often there is a lack of iron, copper, zinc, and manganese. The composition of feeding used by us showed no deficiency in these mineral substances. The need for energy and nutrients is of particular importance for young rabbits. Rabbits cannot synthesize protein from inorganic nitrogenous substances and get it only from plants or feed of animal origin. Optimal fiber level in rabbit diets is also important, so, the studies of animal feed meeting 100% of rabbit needs in nutrients were conducted in the microbiological laboratory of Belgorod State Agricultural University (Table 2).

**Table 2**: Level of protein and fiber in the feeding used in laboratory

| Name | Parameters, % | |
|---|---|---|
| | Crude protein | Crude fiber |
| KS-PZK-91 compound feed for rabbits | 15.90 | 14.4 |

The desired level for high productivity is the following: crude protein 16-18%, crude fiber 12-15%. It fully complies with crude protein and crude fiber in the tested feeding sample.

Currently, in the framework of an acute issue of environmental pollution by industrial waste, there is a danger of increasing their content in plants and, consequently, in food products and feeding of plant origin. Highly toxic substances such as mercury (Hg), lead (Pb), cadmium (Cd), arsenic (As) and others pose the greatest danger to human health. Therefore, it was decided to conduct a study of the compound feed sample for the presence of toxic elements (Table 3).

**Table 3**: Toxic elements in KS-PZK-91 compound feed

| Cd | Pb | Hg | As |
|---|---|---|---|
| 0.048 | 0.093 | Not found | 0.030 |

An indicator of environmental safety of products is developed and recommended threshold limit value (TLV) of toxins: lead 0.5 mg/kg, arsenic 0.1 mg/kg, cadmium 0.05 mg/kg, mercury 0.03 mg/kg. (Kaplin, 2006). These heavy metals are dangerous toxins: cadmium is the strongest poison transported by blood; the main targets are liver and kidneys. Lead, a toxic metal, affects the hematopoietic and nervous system causing anemia, gastrointestinal disorders, etc. Arsenic is used in agriculture: herbicides, fungicides, various preservatives – all of them contain arsenic. Mercury compounds getting into the body cause both acute and chronic poisoning. Data specified in Table 3 showed that KS-PZK-91 compound feed supplied according to the contract by Biorhythm company has the concentration of heavy metals within limited values; our study revealed no mercury in it.

The feed is a key link in any technological map for the production of livestock products. Together with feed, toxic or pathogenic microorganisms can get into an animal's body, so we considered it necessary to conduct a study of animal feeds that make up 100% of animals' diet for several pathogens.

Data in Table 4 showed that there are no bacteria in compound feeds by Biorhythm company, so, the risk of infection of rabbits is reduced and consequently, clean carcasses can be obtained.

**Table 4**: KS-PZK-91 feed mix

| Parameters | Results; units of measurement | Reference document for study method |
|---|---|---|
| Enteropathogenic E. coli | Not found in 50.0 | Rules for bacteriological research of feeds No. 11 approved by the Ministry of Agriculture of the USSR on 10.06.1975. |
| Salmonella | Not found in 50.0 | |

## 2.3 FEATURES OF RABBIT HOUSING

It is a known fact that the state of health, productive qualities, reproductive ability, growth, and development of young animals depend to a large extent on the conditions of housing and care for animals. In the conditions of the rabbit breeding laboratory, rabbits live in a house with an adjustable microclimate. One of the important stages of rabbit farm modernization is the replacement of KSK-1 cages for rabbits with cages of an industrial sample (two-tier, double-sided all-metal mesh battery). This formed the basis for assessing the adaptation of young animals to new conditions. Two cages of the industrial design were mounted in a rabbit house, for replacement doe rabbits of experimental group 1; 2 animals in each cage, the whole group amounted to 18 animals. Experimental group 2 was kept in KSK-1 cages that were in operation for several years. Feeding and drinking conditions were the same, and all animals were in the same zoological hygiene conditions.

Hygiene issues are very important in rabbit breeding, especially when animals are bred in enclosed spaces with a high concentration of livestock. Microclimate, air environment, and technological factors are of great importance. Rabbits are kept in a room with an artificially formed microclimate that has a directed effect on them. Air is the most important element of the biosphere; temperature conditions, humidity, atmospheric pressure, air velocity, light exposure, gas concentration are vitally important. Animals were relatively easy to adapt to various environmental factors and can maintain constant body physiological functions. Rabbits most often react on increased ammonia concentrations which irritate the airways and open port of infection. Basic microclimate parameters are shown in Table 5.

**Table 5**: Parameters of microclimate in rabbit house during the experiment

| Parameters | Core herd | | |
|---|---|---|---|
| | At the level of the reticular floor of the cage | At the level of the animal in the cage | At the level of the top door |
| Temperature, $C^0$ | 14 | 15.5 | 15 |
| Relative humidity, % | 75 | 75 | 75 |
| Air velocity, m/s | 0.3 | 0.3 | 0.3 |
| Ammonia concentration, mg/$m^3$ | 3-5 | 3-5 | 3-5 |
| Hydrogen sulfide concentration, mg/$m^3$ | 0 | 0 | 0 |
| $CO_2$ concentration,% | 0.04 | 0.03 | 0.03 |
| Lighting at the level of animal, lux | - | 100 | - |
| Daylight hours, h | 15 | | |

Analysis of data in Table 6 revealed that the premises of the rabbit farm correspond to standard basic parameters for microclimate. Average temperatures in Celcius during the experiment were defined based on the readings of the thermograph, relative humidity was determined by the readings of M-16-A hygrograph with weekly recording systems, ammonia content was defined using UG-2 universal gas analyzer, and lighting level was measured with the help of Yu-17 light meter.

Microclimate in rabbit breeding rooms should be optimal and ensure the normal functioning of all organs and systems of rabbits. Any disturbances of microclimate – excessive heat, moisture, increased level of harmful gases in the air, as well as microbes and dust – lead to a sharp decrease in the resistance of rabbit organism and, as a result, to the rapid spread of infections. Atmospheric air contains by volume: nitrogen 78.09%, oxygen 20.95, argon 0.93, carbon dioxide 0.03%, inert gases in a small amount (carbon monoxide, methane, ozone, sulfur dioxide, ammonia, etc). Harmful gases accumulate in the air of rabbit houses which are the result of their living and decomposition of their excrements: carbon dioxide, ammonia, hydrogen sulfide, etc.

Lighting is also within normal for rabbits, as the room was fully equipped with incandescent lamps which have a significant effect on the reproductive function of checked young doe rabbits. The lighting system is still under reconstruction; energy-saving lamps for industrial premises are expected. Ventilation in rabbit house is natural, two fans are also mounted according to the principle of air suction, but in summer, at high ambient temperatures, artificial ventilation moves hot air from natural ventilation shafts what increases room temperature, so the fans are turned on in the morning and in the evening. Rooms are constantly monitored for drafts; they are unacceptable even in warm premises.

Assessment of bacterial contamination at the rabbit farm (Methodological guidelines for quality control of disinfection of the objects subject to veterinary supervision (approved by the Main Veterinary Directorate of the USSR State Agro-Industrial Committee on May 16, 1988, No. 432-3)) revealed that no bacteria of Escherichia coli group (BECG) were found on drinking bowls, but they were found, after growing cycle, on the feeders in the number of cages (appendix); this is not an abnormality of the growing regime and is explained by having several rabbits in the limited space of cage. BECG presence also shows that cages need to be disinfected, and it is regularly carried out in the laboratory during the technological gap between rabbit growing cycles. Treatment is carried out using burning the cages with a gas burner, such processing is the most effective. Before burning, the whole cage is thoroughly cleaned and wiped. Disinfection takes a few minutes.

In our research, we considered it necessary to study, among other things, the insemination of technological equipment of rabbit-breeding premises for the presence of salmonous bacteria; for it, we made washings from eight different feeders and drinking bowls in rabbit house (Table 6).

**Table 6**: Washings of rabbit farm cage equipment

| Defined parameters | Results | Reference document |
|---|---|---|
| Feeders | No salmonella | Guidelines for quality control of disinfection of the objects subject to veterinary supervision (approved by the Main Veterinary Directorate of the USSR State Agro-Industrial Committee on May 16, 1988, No. 432-3) |
| Drinking bowls | No salmonella | |

Salmonella bacteria are fairly stable: they can live for a long time in dust, dried feces, manure, soil, water, and animal feeds while maintaining virulence. Biothermal disposal of manure leads to Salmonella inactivation only after three weeks. The main condition is obligatory compliance with sanitary and hygienic rules and standards of keeping and feeding animals; the team of “Agrotechnopark” Academic and Research Innovation Center emphasized these problems.

## 2.4 HERD REPLACEMENT ORGANIZATION

Young animals were separated on the 45$^{th}$ day of raising; young animals for replacement were taken from each litter and had a live weight of at least 500 g at 1 month of age. They were divided according to the sex: doe rabbits for replacement, male rabbits for fattening. In cages of industrial design and in KK-1 cages there were replacement doe rabbits, 4 animals per cage, up to 3 months of age, then they were separated by 2 animals. In total, the number of doe rabbits participating in the experiment was 36, 18 animals in each group. All young animals obtained from doe rabbits of the core herd were marked using a tattoo earmarker. Growth and development of replacement young animals were monitored by monthly weighing and individual examination. Table 7 shows a comparison of changes in the live weight of rabbits.

**Table 7**: Changes in the live weight of rabbits during their growth, g.

| Age, days | Group 1 | Group 2 |
|---|---|---|
| At birth | 75.77±0.2 | 77.88±0.27 |
| 30 | 965.17±5.2 | 1,001.3±7.20 |
| 60 | 1,844±5.42 | 2,010.7±17.81 |
| 90 | 2,200±16.71 | 2,250±17.71 |
| 120 | 3,200±17.82 | 3,210±17.90 |

For an investigation of changes in live weight, all doe rabbits left for herd replacement were evaluated by live weight, body build, and density of hair on the legs. Replacement doe rabbits had an average live weight of 3.5 kg body type and density of hair met the requirements for hybrids.

The livability of replacement livestock in experimental groups corresponded to zootechnical standards and was somewhat higher in the first group of doe rabbits kept in the cages of industrial design (Table 8).

**Table 8**: The survival rates of rabbit livestock, %.

| Days | Groups 1 | Groups 2 |
|---|---|---|
| 30 | 100 | 100 |
| 60 | 99 | 97 |
| 90 | 98 | 97 |
| 120 | 98 | 96 |

The percentage of rabbit mortality in all experimental groups does not exceed established standards. But there was an increase in livestock livability in the first experimental group kept in the cages of industrial design.

Daily average gains in live weight in rabbits of experimental groups during the fattening period averaged 20 g what is typical for meat and fur-producing rabbits. Replacement doe rabbits were mated after reaching puberty and a live weight of 3.5 kg. The laboratory purchased all components for teaching students artificial insemination. Therefore, we considered it reasonable to carry out mating by artificial insemination.

Assessment of readiness of doe rabbits for mating was assessed by the condition of their external organs, Table 9.

**Table 9**: Readiness of doe rabbits for mating

| Experimental groups | Form of the vaginal opening | Color of the vaginal opening |
|---|---|---|
| Group 1 | Swollen, folds sharply pronounced, no angle | Red with deep red tone |
| Group 2 | Rounded, swollen, folds sharply pronounced, no angle | Deep red |

Based on our observations and the data specified in Table 10, it can be seen that all the females in experimental groups were ready for mating and had the shape and color of the vaginal opening characteristic of females at the stage of heat.

Assessment of fresh sperm was carried out according to the method of Milovanov (1962). Only healthy males of strong body type, tested for the quality of offspring and with good sexual reflexes, were selected for taking seminal material.

Doe rabbits in heat were determined by the state of their genitals according to the method of Nigmatullin (2007). A definite increase in the percentage of pregnant doe rabbits was revealed as their readiness for mating increased. Also, their fertility and the number of separated young animals by 45 days increased.

**Table 10**: Parameters of working with doe rabbits

| Parameters | Group 1 | Group 2 |
|---|---|---|
| Mated doe rabbits | 17 | 16 |
| Of them fertilized | 15 | 14 |
| % of pregnant doe rabbits | 88 | 87 |
| Fertility per 1 doe rabbit, pcs | 8.50±0.33 | 8.01±0.30 |

Results of studies revealed that in the conditions of this farm, the fertility of doe rabbits after artificial insemination was fairly high.

Every loss of baby rabbits is undesirable. Results of summarized data on kindlings show that a decrease in stillborn rabbits is observed with fertility from 1-5 per litter. High fertility is typical for doe rabbits who gave a significant number of baby rabbits during their first kindling, Table 11.

**Table 11**: Productivity of doe rabbits

| Parameters | Group 1 | Group 2 |
|---|---|---|
| Duration of pregnancy, days | 31.4±0.56 | 31.0.44 |
| Fertility, pcs | 8.8±0.31* | 8.5±0.35* |
| Live weight of litter at birth, g: | 550±0.31* | 512±21* |
| Separated baby rabbits for 1 doe rabbit in 45 days, pcs | 8.1±0.15* | 8.0±0.14* |
| Live weight of 1 animal, g in 45 days | 1,300±23 | 1,453±31 |
| Live weight of 1 animal, g in 60 days | 1,505±31* | 1,647±29 |

Maternal qualities are assessed by the output of separated baby rabbits. In our research, we studied the maternal qualities of doe rabbits and the livability of baby rabbits up to 60 days of age. The main parameter of the reproductive capacity of rabbits is the percentage of offspring livability. According to the total number of baby rabbits left by the doe rabbit, significant differences were obtained for the second and third groups ($P < 0.001$) and ($P < 0.01$), respectively, see Table 12.

**Table 12**: Basic parameters of the reproductive capacity of doe rabbits

| Parameters | Group 1 | Group 2 |
|---|---|---|
| The livability of young animals in 21 days,% | 97.7±0.15 | 98.2±0.24 |
| Mortality up to 4 months of age,% | 1.3±0.33 | 1.1±0.28 |
| The livability of young rabbits up to 60 days of age, % | 95.6±0.22 | 97.0±0.55 |

Rabbit growth curve after birth was characterized by the following parameters: the live weight of baby rabbits by 6$^{th}$ day increased 2 times, by the 10$^{th}$ day – 3 times, by the 20$^{th}$ day – 5-6 times, by the 30$^{th}$ day – 9-10 times. Baby rabbits grow more intensively up to 4 months of age. By this time they reached 85% of the size and 65% of the live weight of adult rabbits which corresponds to zootechnical standards. Table 13 shows changes in body weight of rabbits.

**Table 13**: Age-related changes in live weight of rabbits of experimental and control groups, g

| Age, days | Groups | |
|---|---|---|
| | 1 | 2 |
| 30 | 1,262±19.08 | 1,360±18.07 |
| 60 | 1,709±21.81 | 2,100±18.46 |

Comparing age-related changes in the live weight of rabbits with established standards, we can conclude that changes in live weight were positive, with the leadership of experimental group 2. The average daily weight gain in rabbits of experimental groups during the fattening period was 45.2 g. Rabbits were reared up to 75 days of age (broiler raising). Type of body build is associated with such economically important parameters as early maturity, meatness, quality of hair, vitality, and resistance to diseases. The type of body build in rabbits is determined by appearance and blockiness index. Table 14 shown exterior parameters and type of body build of rabbits.

**Table 14**: Exterior parameters (average) and type of body build.

| Groups | Body length, cm | Chest girth, cm | Index of blockiness, % | Body build |
|---|---|---|---|---|
| 1 | 57 | 36 | 63.2 | mesosome |
| 2 | 56 | 35 | 62.5 | mesosome |

Body development was assessed by linear parameters, i.e. by measurement of chest circumference behind shoulder blades and torso length with tape, to the accuracy of 0.5 cm. The blockiness index in experimental groups 1 and 2 was 63.2% and 62.5% what was 1.4% and 0.7% respectively higher than in the control group and corresponded to an intermediate, mesosome type of body build. Animals of this type are characterized by a compact, proportional body.

Hair is dense, thick, pure white, with a thin fur lining, the skin is thin, dense (Figure 1).

**Figure 1**: Exterior assessment of rabbits.

## 2.5 MICROBIOLOGICAL TESTS

Before slaughtering rabbits for microbiological studies of carcasses, we evaluated meat productivity using carcasses, bloodless during slaughtering, without skin, head, limbs, and internal organs. Internal fat was not removed. Rabbit meat is of fine fiber structure, with uniform thin layers of adipose tissue that makes the meat marbling. There was insignificant subcutaneous fat on the carcass surface. The color of the carcasses was pale pink.

In the course of our study, we paid special attention to the microbiological parameters of rabbit carcasses. Five carcasses were taken to our university microbiological laboratory for microbiological parameters and toxicity tests. Microbiological research methods reveal the degree of product contamination with microorganisms and allow defining upcoming changes in the quality of the product, its damage, see Table 15.

**Table 15**: Microbiological studies of rabbit meat (fresh chilled)

| Parameters | Results; units of measurement | References for test method |
|---|---|---|
| Quantity of mesophilic aerobic and facultative anaerobic microorganisms, CFU per 1.0 | 8 CFU/g | GOST 10444.15 |
| Coliform bacterias | Not found in 1.0 | GOST 31747 |
| Pathogenic incl. salmonella | Not found in 25.0 | GOST 31659 |
| L.monocytogenes | Not found in 25.0 | GOST 32031 |

It should be noted that, according to microbiological tests, rabbit carcasses showed negative results for such important parameters as the presence of BECG, salmonella, L.monocytogenes. Tests for these bacteria show the purity of the product. The presence of these bacteria indicates the general sanitary state of production including equipment cleanliness.

In our research, we considered it appropriate to test rabbit meat for toxic elements (Table 16).

**Table 16**: Toxic elements in rabbit meat (general sample), mg/kg

| Cd | Pb | Hg | As |
|---|---|---|---|
| 0.01 | 0.081 | Not found | 0.024 |

According to TLV, it was found that the level of toxic elements in the carcasses produced in a rabbit breeding laboratory is several times lower than threshold limit values, and no mercury was detected. All this indicates the environmental safety of the product.

## 2.6 EFFICIENCY OF RABBIT PRODUCTS OUTPUT

The final stages performed in the conditions of a rabbit farm, calculating the economic efficiency of rabbit raising, parameters of production costs, sale prices, live weight of rabbits, and the number of animals raised during the study period were taken into account, see Table 17.

**Table 17**: Cost-effectiveness.

| Parameter | Groups | |
|---|---|---|
| | 1 | 2 |
| Live weight of 1 animal in 60 days, kg | 1.505 | 1.647 |
| Number of grown baby rabbits | 288 | 236 |
| Total weight of sale, kg | 817.2 | 763.2 |
| Cost of production, for 1 animal, RUR | 300 | 300 |
| Sale price, RUR | 450 | 450 |
| Expected income, thousand RUR | 245.2 | 228.9 |

For successful rabbit raising, the intended raising of young animals is necessary which includes strict observance of the standards for raising rabbits in the conditions of rabbit house. Upon the minimum number of kindlings per year – 2, income will amount to 1.76 thousand RUR per one doe rabbit. Consequently, with average values of slaughter yield and sale prices, keeping rabbits in rabbit house and raising using complete feeds is cost-effective with an income of 23.0 thousand RUR.

## 3. CONCLUSION

Based on these studies and their results, recommendations were made on the reasonability of replacing obsolete KSK-1 cages for keeping rabbits with industrial-type cages. Rabbit breeding laboratory of “Agrotechnopark” Academic and Research Innovation Center fully complies with the requirements for modern livestock premises in terms of housing conditions, zoological hygiene parameters, feed, and accordingly has the potential for additional purchases of rabbit breeds to expand the established base.

Feed base, level of bacterial contamination of rabbit carcasses, presence of toxic elements fully complies with the standards. At average values of slaughter yield and sale prices, keeping rabbits in rabbit house and raising using complete feeds is cost-effective with the minimum income of 23.0 thousand RUR. (This indicator is not reflected in Table 17.)

## 4. AVAILABILITY OF DATA AND MATERIAL

Information can be made available by contacting the corresponding author.

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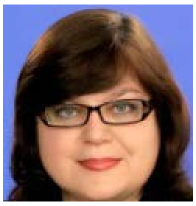

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