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Short Communication

INFLUENCE OF THE HOUSING SYSTEM ON SPERM PRODUCTIVITY AND REPRODUCTIVE CAPACITY OF RABBITS

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The influence of the housing system on sperm productivity and reproductive capacity of rabbits was studied. Indicators like ejaculate volume, sperm density, activity, and concentration, as well as the percentage of fertility were measured for silver breed rabbits of three coloured lines housed in aggregates "Rabbitax-8" and in a modular rabbit house developed by Mykolayiv National Agrarian University. The highest male sperm productivity and reproductive capacity were found for rabbits housed in aggregates "Rabbitax-8".

Keywords: *ejaculate volume, sperm density, sperm activity, sperm concentration, fertility.*

Rabbit breeding is a very progressive part of animal husbandry in many countries around the world. Most rabbit farms use artificial insemination as a form of advanced technology. Thus, a high-quality sire is the most important condition of herd reproduction.

Many domestic and foreign scientists, in particular, V. S. Andreieva (1980), V. V. Myros (2008), V. Y. Liubetskyi (2015), Yu. I. Masalovych (2015) and others have been engaged in artificial insemination research in rabbit breeding. The use of artificial insemination in rabbit breeding has a number of advantages over conventional mating, as in other livestock industries.

Environmental factors are very important in sire breeding (feeding, keeping, etc.). Currently, Ukraine uses various technologies for rabbit breeding. Therefore, the aim of our research was to study the impact of advanced rabbit housing systems in the country on sperm productivity and reproductive capacity of sires.

To achieve this goal, the following tasks were raised: assessment of qualitative and quantitative sperm and fertility indicators of silver breed rabbits of different coloured lines when housed in aggregates "Rabbitax-8" and in a modular rabbit house, experimentally developed by Mykolayiv National Agrarian University specialists.

The research was conducted in the most favourable period for rabbit breeding — March to June. Two groups of animals aged 10–12 months were used for research. The feeding conditions of the animals were identical — high-grade ration of granulated feed brand "Kremix". The coloured lines of rabbits (light silver, silver, dark silver) of the Silver breed were studied.

The first group, which contained 9 males and 30 females, was kept in the aggregates "Rabbitax-8" (Fig. 1), in the conditions of farm "Kirichenko L.V.", and the second was kept in a modular rabbit house (Fig. 2), in the conditions of the training, research and production rabbit farm of Mykolayiv National Agrarian University.

In each group three subgroups of different coloured lines, consisting of three males and 30 females (light silver, silver, dark silver), were formed. To determine the qualitative

Fig. 1. Aggregate "Rabbitax-8".

Fig. 2. Modular rabbit house.

and quantitative indicators of male sperm, microscopic research methods were used according to generally accepted techniques. Ejaculate volume, its density, sperm activity and concentration were assessed. The percentage of insemination was determined for each coloured line in different housing systems. Freshly taken semen was examined. Ejaculate volume was measured using a calibration scale marked on a beaker, and concentration and density were determined using a M-photoelectrocalorimeter.

Sperm activity was determined by counting semen with rectilinear translational motion using a microscope at a magnification of 400 times on a Morozov table (t = +38–40 °C) on a ten-point scale, one point of which was equal to 10% of semen with rectilinear translational motion.

If during the study under the microscope almost all spermatozoids moved forward, the sperm was evaluated at 10 points (the highest score). A sign of this assessment was the rapid vortex-like movement of spermatozoids. With a slightly slower vortex motion, a score of 9–8 points was given, etc.

Mating of female was done in a natural way. The male fertilised a female two times in the morning and two times in the evening for two consecutive days and then for two days the male rested.

Table 1. Characteristics of rabbit sperm

Coloured line	Housing system	
	I experimental (aggregate "Rabbitax-8")	II experimental (modular rabbit house)
	$(\bar{X} \pm S_{\bar{x}})$	$(\bar{X} \pm S_{\bar{x}})$
Indicators of male ejaculate volume in experimental groups, ml		
light silver	0.54 ± 0.004***	0.51 ± 0.009***
silver	0.77 ± 0.008	0.74 ± 0.005
dark silver	0.94 ± 0.003***	0.91 ± 0.007***
Indicators of male sperm activity in experimental groups, points		
light silver	8.28 ± 0.355	7.18 ± 0.255^{3}
silver	8.32 ± 0.421	7.24 ± 0.547^{3}
dark silver	8.74 ± 0.254*	$7.66 \pm 0.569^{*,3}$
Indicators of male sperm concentration in experimental groups, bln/1ml		
light silver	0.11 ± 0.012***	$0.06 \pm 0.018^{**,3}$
silver	0.14 ± 0.011	0.07 ± 0.015^{3}
dark silver	0.15 ± 0.017**	$0.08 \pm 0.014^{**,3}$
Indicators of rabbit fertilisation in experimental groups,%		
light silver	79.2 ± 1.24***	$70.8 \pm 1.22^{***,3}$
silver	80.5 ± 2.25	75.2 ± 2.87^{3}
dark silver	90.0 ± 2.85***	$80.4 \pm 2.95^{***,3}$

The difference between groups of rabbits from different housing systems was considered significant at probability: $^{1}p < 0.05$; $^{2}p < 0.01$; $^{3}p < 0.001$; between coloured lines: $^{*}p < 0.05$ $^{**}p < 0.01$; $^{***}p < 0.001$ (average silver – control).

Statistical research methods were used to process results in order to assess their reliability. The influence of housing systems on sperm productivity and reproductive qualities was determined by analysis of variance. We accepted the housing system as a factor influencing sperm productivity (factor A).

Male semen was examined before fertilisation of females. Sperm from males was obtained in an artificial vagina by placing an infertile female into the cage of a rabbit (male) for mating.

Values of ejaculate volume, and of sperm activity and concentration, after rabbit fertilisation in experimental rabbit groups are given in the Table 1. A statistical difference between groups of rabbits from different housing systems was considered significant at probaility values: $^{1}p < 0.05$; $^{2}p < 0.01$; $^{3}p < 0.001$; and between coloured lines: $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$ (average silver — control).

We found that the volume of rabbit ejaculate in the experimental groups ranged from 0.51 to 0.94 ml. Analysis of the data showed no significant differences were observed between experimental groups 1 and 2. The rabbits produced the same volume of ejaculate in both systems. However, the difference between the coloured lines was significant ($p < 0.001$). Rabbits of the dark silver line when, kept in aggregates and modules, produced the largest volume of ejaculate — 0.94 and 0.91 ml, respectively. The smallest volume of ejaculate was observed for males of the light silver coloured line.

The greatest sperm activity was inherent for males kept in the aggregates “Rabbitax-8”, where values in the range of 8.28–8.74 points were recorded. A significant lower difference ($p < 0.001$) was observed for the second experimental group (7.18–7.66 points). The difference in sperm activity between the coloured lines was not significant. Rabbits of the second experimental group were kept in a modular rabbit house with constant microclimate values. This may explain the decrease in sperm activity by one score, but it was sufficiently high for reproduction.

The highest sperm concentration was observed for rabbits housed in aggregates “Rabbitax-8”. Its value is twice as high as that of the rabbits of the second experimental group. There is also a tendency for an increase in sperm concentration with darker silver rabbit colour. Ejaculate of the rabbits in experimental groups was found to be thick and medium. Males kept in the aggregates (scores 8 and 7) had dense ejaculate, and males kept in the module had medium ejaculate — score 5.

Analysing the qualitative and quantitative indicators of rabbit sperm in different housing systems, it was observed that there was an advantage of keeping rabbits in the aggregates, as these rabbits had the indicator value for activity, concentration and density. The volume of ejaculate showed a significant difference.

The best fertilisation was found for male semen of rabbits with housed aggregates “Rabbitax-8”. Male fertility was determined by the fertility rate of ten females in two adjacent rounds of mating (from March to June). At each round the group of females was different.

The number of pathological forms of sperm was determined by counting germ cells with abnormalities in the structure of the glans (asymmetric, shortened, pointed, round, flattened, pear-shaped, elongated, and isolated), cervix (thickened, broken, and deflected back), body (thickened, bent, and broken) and tail (isolated, bent, twisted, broken, and folded) under a microscope. To determine the percentage of abnormal sperm, a thin smear of tested sperm was made on a clean non-fat slide; then it was dried, fixed in 96% alcohol for 5 minutes, washed with water, stained with ink, washed with water again and dried. After drying, the smear was examined under a microscope at a magnification of 600 times. Spermatozoids were counted in several fields of view with a total number of not less than 500. Normal and pathological forms of spermatozoids were counted separately. Counts of normal sperm were in the range of 79.2–90.0%. Fertility rates differed between experimental groups and coloured lines. The best fertilisation rates were found for males of the dark silver group kept in the aggregates — 90.0%. The lowest were found for the group of light silver rabbits housed in the module — 70.8%.

The results for detection of pathological forms of sperms are shown in Table 2. The number of live sperm in the rabbit ejaculates of the experimental groups was in the range of

Table 2. The number of pathological forms of sperm, (%), ($(\bar{X} \pm S_{\bar{X}})$)

Pathological forms	Housing system / Coloured line					
	I experimental (aggregate “Rabbitax-8”)			II experimental (modular rabbit house)		
	light silver	silver	dark silver	light silver	silver	dark silver
asymmetric	0.7 ± 0.05	0.6 ± 0.11	0.3 ± 0.04	1.8 ± 0.13***	0.9 ± 0.11**	0.8 ± 0.04**
shortened	0.4 ± 0.04	0.4 ± 0.09	0.2 ± 0.11	1.7 ± 0.11***	0.8 ± 0.09***	0.7 ± 0.11***
pointed	0.8 ± 0.03	0.7 ± 0.06	0.4 ± 0.08	1.0 ± 0.22*	1.7 ± 0.06***	0.8 ± 0.08***
round	1.1 ± 0.07	0.9 ± 0.08	0.7 ± 0.06	1.5 ± 0.15*	1.2 ± 0.11*	0.8 ± 0.06
flattened	1.5 ± 0.03	1.1 ± 0.05	0.5 ± 0.05	2.0 ± 0.24*	1.4 ± 0.06*	1.4 ± 0.05***
pear-shaped	1.0 ± 0.07	1.0 ± 0.07	0.5 ± 0.08	1.6 ± 0.33***	1.5 ± 0.12***	1.5 ± 0.08***
elongated	1.7 ± 0.08	1.5 ± 0.06	0.5 ± 0.07	2.0 ± 0.34*	1.7 ± 0.12*	1.5 ± 0.07***
isolated	2.2 ± 0.11	2.0 ± 0.13	1.1 ± 0.05	2.0 ± 0.21	2.2 ± 0.13	1.4 ± 0.05*
thickened	1.5 ± 0.12	1.1 ± 0.08	0.4 ± 0.09	1.4 ± 0.31	1.3 ± 0.11*	1.4 ± 0.09***
broken	1.0 ± 0.22	1.0 ± 0.23	0.7 ± 0.11	1.5 ± 0.32**	1.2 ± 0.13	1.1 ± 0.11*
deflected back	1.7 ± 0.32	1.5 ± 0.13	0.5 ± 0.07	2.0 ± 0.34	1.7 ± 0.15	1.5 ± 0.07***
thickened	1.3 ± 0.18	1.0 ±0.24	0.5 ± 0.08	1.5 ±0.22	1.3 ± 0.22*	1.5 ± 0.08***
bent	1.1 ± 0.34	1.0 ± 0.09	0.3 ± 0.06	1.4 ± 0.32*	1.2 ± 0.21	0.5 ± 0.06
broken	1.0 ± 0.33	0.8 ± 0.07	0.5 ± 0.12	1.0 ± 0.07	1.0 ± 0.16	1.5 ± 0.12***
isolated	1.2 ± 0.54	1.0 ± 0.28	0.6 ± 0.08	1.7 ± 0.43*	1.3 ± 0.18*	0.8 ± 0.08
bent	1.1 ± 0.08	0.7 ± 0.06	0.3 ± 0.03	1.0 ± 0.07	1.2 ± 0.12**	0.5 ± 0.03*
twisted	1.2 ± 0.32	1.0 ± 0.28	0.3 ± 0.03	1.0 ± 0.08*	1.2 ± 0.13*	0.6 ± 0.03***
broken	1.4 ± 0.44	1.1 ± 0.08	0.4 ± 0.05	1.0 ± 0.07**	1.3 ± 0.17*	0.6 ± 0.05***
folded	0.9 ± 0.12	0.8 ± 0.04	0.3 ± 0.03	1.0 ± 0.09	1.2 ± 0.11***	0.7 ± 0.03***

$^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$

Table 3. Influence of the housing system on sperm productivity and reproductive qualities of males, % of variance explained

Factors of influence	Feature				
	ejaculate volume	activity	concentration	density	fertility
Housing system (Factor A)	41.3**	74.4***	68.2***	68.5***	75.2***
Random exposure	58.7	25.6	31.8	31.5	24.8
General	100.0	100.0	100.0	100.0	100.0

$^{**}p < 0.01$; $^{***}p < 0.001$

85–90%, and pathological forms of sperm were in the range of 10–15%, and no significant differences were found. Therefore, the fertilisation of rabbits was not significantly affected by these factors. Analysis of variance statistics for effect of the housing system on sperm productivity and male reproductive qualities are given in Table 3. Analysis of variance revealed a fairly high effect of the housing system on activity, concentration, density and fertility — proportion of variance explained = 74.4; 68.2; 68.5; 75.2%.

Thus, our research proved the influence of the housing system on qualitative and quantitative indicators of rabbit sperm. The indicator values were best for males which were housed in aggregates “Rabbitax-8”. Rabbits that were kept in the module house had slightly lower rates, but they were not lower than allowed for reproduction of rabbits.

The modular rabbit house maintains a constant microclimate throughout the year, which might explain the average sperm productivity of rabbits, as they are kept in aggregates during the most favourable period of reproduction when there was an improvement in rabbit sperm productivity, but this theme requires further study.

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TURĒŠANAS APSTĀKĻU IETEKME UZ TRUŠU SPERMAS PRODUKTIVITĀTI UN REPRODUKTĪVO JAUDU

Trušiem, kuri tika turēti mājoklī “Rabbitax-8”, kas izstrādāts Nikolajevas Nacionālā lauksaimniecības universitātē (Ukraina), novērota augsta spermas produktivitāte un reproduktīvā jauda.