ТВАРИННИЦТВО

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REPRODUCTIVE QUALITIES OF RABBITS DEPENDING ON PARATYPIC FACTORS DURING THEIR MAINTENANCE

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Experimental studies were conducted on the population of rabbits of the Poltava Silver breed on the basis of the experimental rabbit farm of the Cherkasy Research Station of Bioresources of NAAS. The fertilization ability of rabbit sperm and the features of embryonic and postembryonic development of young animals depending on the season were studied. To assess the main indicators of the microclimate, an Electronic microclimate analyzer "EMA-5" was used. It was established that the concentration of carbon dioxide in the room was within the permissible limits - 970 ppm in winter, 982 ppm - in spring and 1210 ppm - in summer. Atmospheric pressure in all seasons was at the level of 751-754 mm Hg. st. The average daily illumination in the room was 47.5 Lx in winter, 81.5 Lx in spring and 87.8 Lx - in summer, that is, it corresponded to the permissible parameters. The exception was the winter season, during which the average daily light levels were 26.9% lower than the minimum permissible value. The reproductive qualities of rabbits using artificial insemination technology were experimentally studied. In addition, the individual development of the resulting offspring under conditions of maintenance in a capital production facility. Studies of sperm productivity indicators of males and reproductive ability of females depending on paratypic factors showed their seasonal variability. In particular, according to these indicators, the highest sperm productivity of males was observed in the winter period, and the reproductive ability of females was in the spring. The lowest sperm productivity of males was in the summer - during the period of high air temperatures, and the lowest reproductive ability of females - in winter when kept in a capital rabbits without heating. In the process of research, a clear pattern was revealed regarding the gradual decrease in the vast majority of sperm productivity indicators of males and an increase in the reproductive ability of females from winter to summer. The analysis of variance showed a significant influence of the season on the vast majority of the studied indicators – both on the sperm productivity of males and on the reproductive ability of females. Therefore, to increase the production

efficiency of industrial farms with a flow system of meat production, it is necessary to plan the reproduction of the herd, taking into account the seasonal variability of the indicators of the reproductive qualities of animals. This applies to the sperm productivity of males in the summer, in particular, it is recommended to increase the volume of insemination of rabbits by at least 10%. In addition, to improve the reproductive ability of females in winter, it is necessary to provide equipment for heating the queen cell of the required power, according to the calculation of the heat balance. To improve the industrial technology of keeping rabbits, it is necessary to additionally study the reproductive qualities of males and females, depending on the season, taking into account the regulatory parameters of the microclimate when kept in cages in a closed room and fed with complete granular feed.
Key words: *rabbits, microclimate, season, sperm productivity, reproductive ability.*

Introduction. Modern rabbit farming is increasingly adopting innovative technologies for meat production, largely due to the intensification of young animal growth. At the same time, new early-maturing rabbit genotypes are being introduced and kept in metal cages made of galvanized mesh under controlled microclimatic conditions within closed facilities [1, 13].

Currently, 39 industrial-type rabbit farms are operating in Ukraine, all with a full production cycle and equipped with modern animal husbandry technologies [5]. Under such intensive conditions, the profitability of rabbit farming relies on maintaining optimal feeding regimes and achieving high reproductive performance in breeding stock [6, 10].

Improving the reproductive traits of both males and females positively influences the production cost and market competitiveness of rabbit meat. Artificial insemination plays a key role in this process, as it reduces the spread of venereal diseases and enables more efficient use of the genetic potential of top-performing male breeders [2].

To gain a deeper understanding of reproductive performance under artificial insemination, researchers also examine the individual development of offspring. According to G.A. Schmidt, one of the most critical periods of animal ontogenesis is the embryonic stage, which in rabbits is divided into three subperiods: the early (embryonic) stage (1 – 12 days after fertilization), the pre-fetal (middle) stage (13 – 18 days), and the fetal (late) stage (19 – 30 days). At 13.5 days of gestation, the average weight of pre-fetuses is about 0.12 g, and by 19.5 days, fetuses weigh around 2.8 g and measure approximately 0.7 cm in length. A distinctive feature of rabbits is their exceptionally rapid intrauterine growth, which surpasses that of most other livestock species.

In recent years, under industrial conditions involving artificial insemination, the influence of seasonality on reproductive function has become increasingly significant, directly affecting the rhythm and volume of rabbit meat production [16, 18].

A preliminary analysis of the literature reveals insufficient and often contradictory information regarding reproductive performance in rabbit farming, particularly concerning the influence of individual paratypic factors such as seasonal variation.

In this context, further investigation into the reproductive performance of male and female rabbits across different seasons is necessary, taking into account microclimatic factors under cage housing in enclosed facilities and feeding with complete pelleted feed.

Objective of the study **-** To evaluate sperm fertilizing capacity as well as the embryonic and post-embryonic development of young rabbits depending on the season.

The purpose of the study is to study the fertilizing ability of sperm, embryonic and postembryonic development of young animals depending on the season.

Materials and methods. The research was conducted on a population of Poltava Silver rabbits breed on the basis of an experimental rabbit farm of the Cherkasy Experimental Station of Bioresources, as well as using special equipment SpermVision (Minitube) of SPE "Progress" taking into account world experience and using generally accepted methods. The research methods and deadlines were strictly adhered to. When conducting experimental work, the current DSTU and instructions for conducting research were adhered to, as well as technological regulations and regulatory documentation [8, 14].

The final requirements were specified in the process of work.

Indicators of economically useful traits of rabbits were calculated according to the data of primary zootechnical accounting – according to generally accepted methods of biometric analysis analyzer "EMA-5" was used, developed by employees of the Cherkasy Experimental Station of Bioresources of NAAS [15, 19].

In particular, the following were measured monthly: temperature, relative humidity and atmospheric pressure, as well as illumination and carbon dioxide concentration. Measurements were carried out in an automated mode every 10 minutes throughout the day using measuring units.

The obtained microclimate indicators were compared with the standards and hygienic requirements stipulated by the relevant Departmental standards for technoogical design (VNTP-APK 05.07), and were further systematized by seasons of the year - winter, spring, summer.

When studying the reproductive performance [2, 9] of male rabbits during the season of the year, before insemination of female rabbits, sperm was collected, mainly from the second ejaculate during the first month of the next season (with the exception of winter - in December of the previous year) from 5 fertile males, after which, after dilution with a diluent, 10 females were artificially artificially inseminated (after the first calving and older).

At the same time, sperm was evaluated: by ejaculate volume, sperm motility and their concentration in the ejaculate, and the total number of active sperm in the ejaculate was also calculated.

The degree of dilution was also taken into account - based on 50-70 million motile sperm in a sperm dose. The volume of the ejaculate was measured using a graduated sperm receiver, the the concentration of sperm - using standard methods in a counting chamber.

Greasier motility and sperm motility were assessed using Sperm Vision (Minitube) special equipment. In addition, males were also evaluated for sperm fertilizing ability [3, 10, 20].

The study of embryogenesis of female fetuses was carried out at the beginning of the fertile period at 20 days of age using a special ultrasound scanner "Ultrascan 45" by counting the number of "fetuses". Based on this, the survival of the newborn litter was determined (number of diagnosed fetuses/number of viable newborn rabbits).

The technical capabilities of the scanner did not allow for the study of embryogenesis at the age of 10 days of the embryonic period.

The litter of young animals was weighed in the nest at birth, at 10 and 20 days of age, and at weaning at 30 days, taking into account the number of rabbits in the nest, and the average live weight of rabbits was determined. At the same time, the survival of the litter during the suckling period was also taken into account (number of rabbits in the nest at weaning/number of viable litters born in the nest) [12].

The research materials were processed by biometric methods on a computer using the “Statistica 8” software. Based on the results of data processing, the arithmetic mean M), its error (m), coefficient of variation (Cv), and probability level (p) were determined.

Results of research. Analysis of the data on the average air temperature in the room for keeping rabbits without heating in winter shows that it was 4.8°C above zero (with an external temperature of 2.3°C). This indicator is significantly below the permissible norm (Table 1).

Table 1. Main indicators of the microclimate of the rabbitry by season

Indicator	Normative value1	Winter		Spring		Summer	
		outside	in the middle	outside	in the middle	outside	in the middle
Air temperature, °C	12-25	2,3	4,8	10,4	12,9	23,0	22,4
Relative air humidity, %	45-75	83,1	86,9	67,0	78,0	64,0	60,2
Atmospheric pressure, mm Hg.	760,0	753,0	753,0	754,0	754,0	751,0	751,0
Carbon dioxide (CO_2) level, ppm	till 2500	-	970	-	982		1210
	no less 65	-	47,5	-	81,5		87,8

With the arrival of spring, the temperature accordingly increased and was within 12.9°C in the rabbit's cage and 10.4°C outside. In summer, this indicator indoors averaged 22.4°C.

In 2020, the average monthly outdoor temperature in the summer period was more stable than in the past: in June, 23.4°C; in July, 22.9°C; and in August, 22.6°C.

As in the previous year, during this period, the experimental males and females, as well as the rest of the livestock, were in a somewhat depressed state, during which the overall need for water for drinking increased and the amount of feed consumed

Studies of the air microclimate in the rabbit hutch also showed that the maximum permissible parameters of relative humidity were exceeded both in winter by 11.9% and in spring by 3.0%, which indicates some shortcomings in the operation of the supply and exhaust ventilation system. Carbon dioxide in the room was within the permissible limits – 970 ppm in winter, 982 ppm in spring, and 1210 ppm in summer. about some shortcomings in the operation of the supply and exhaust ventilation system. However, with warming in summer, there was a tendency for this indicator to decrease and stabilize at the level of 60.2%.

Concentration: when analyzing atmospheric pressure, it was found that in all seasons it was actually at the level of 751-754 mm Hg. Analysis of the illumination index of the rabbitry showed that its average daily value was 47.5 Lk in winter, 81.5 Lk in spring, and 87.8 Lk in summer; that is, in most cases it met the permissible standards, except for winter.

Analysis of sperm productivity indicators of males showed its variability by season (Table 2).

Table 2. Male sperm productivity indicators depending on the season, (n=15)

Indicator	Winter		Spring		Summer	
	M ± m	Cv, %	M ± m	Cv, %	M ± m	Cv, %
Ejaculate, ml	1,3 ±0,07	21,15	1,3 ± 0,02	7,13	1,2 ± 0,03	9,40
Sperm concentration, million/ml	448,0± 14,55	12,58	398,7± 13,16*	12,79	351,3± 8,67***	9,55
Sperm motility, scores	7,6 ± 0,13	6,67	7,4 ±0,13	6,85	7,3 ± 0,13	6,65
Total number of active sperm in ejaculate, million	438,6± 26,54	23,43	393,1± 16,59	16,34	313,5± 4,87***	6,02
Degree of dilution of sperm	7,0±0,37	20,20	6,5±0,31	18,17	5,3±0,12***	8,69
Fertilizing ability, %	82,0	x	88,0	x	78,0	x

Note: Here and below the probability level* $p<0,05$;** $p < 0,01$; *** $p < 0,001$.

However, when measuring the volume of ejaculate sperm, no significant difference was found, although there was a tendency for its slight decrease in the summer. When determining the concentration of sperm in the ejaculate, it was significantly highest ($p<0.001$) in the winter (448.0 million/ml) and the lowest in the summer (351.3 million/ml); the difference was 21.58% (the winter period was taken as 100%). A seasonal pattern of a gradual decrease in this indicator from winter to summer was observed.

When assessing sperm motility in ejaculate, in the vast majority of cases, the highest indicator was observed in winter (7.6 points) and the lowest in summer (6.8 points), although the difference was not significant (10.53%). A tendency of a gradual seasonal decrease in this indicator from winter to summer was revealed.

When determining the total number of active sperm in the ejaculate, seasonal variability was also found (gradual decrease from winter to summer). This indicator was probably highest ($p<0.001$) in winter (438.6 million) and lowest in summer (313.5 million); the difference was 28.52%.

Considering the quality of the sperm, the degree of dilution was also changed before insemination of the females, seasonally decreasing it from winter to summer. This indicator was probably the highest ($p<0.001$) in winter (7.0) and the lowest in summer (5.3); the difference was 24.29%.

A study of the fertilizing ability of male sperm by season showed that this indicator was highest in spring (88%) and lowest in summer (78%); the difference reached 10%. In winter, 82% of females were fertilized. Thus, the conducted studies were on females. Thus, studies of male sperm productivity have mainly shown probable seasonal variability in most indicators.

The indicators of the reproductive ability of females depending on the season are given in Table 3.

Ultrasound research of embryogenesis of fetuses at the age of 20 days showed that the number of newborn viable rabbits from the number of detected fetuses (embryo preservation of the litter) was 95.2% in winter, 98.6% in spring, and 97.2% in summer; that is, it was highest in spring and lowest in winter, although the range of variability was insignificant – at the level of 1.4-3.4%.

Analysis of the multi-fertility of female rabbits showed that this indicator was probably the highest ($p<0.001$) in spring and summer (7.1 and 7.0 heads, respectively), and the lowest in winter (5.9 heads); the largest difference was 20.34% (the winter period was taken as 100%). In a similar comparison, it was larger in spring (61.8 g), smaller in summer (61.2 g), and the lowest in winter (59.9 g); the largest difference was 3.17%. As for the mass of the nest, the indicator of large-fruitedness was probably the highest ($p<0.05$) in spring (61.8 g), smaller in summer (61.2 g), and the lowest in winter (59.9 g); the largest difference was 3.17%. As for the mass of the nest, it was the lowest in winter (350.4 g) and the highest in spring (434.6 g); in summer, it was 425.6 g. The largest probable difference was 24.03% ($p<0.001$).

At 10 days of age, the largest number of rabbits in the nest was in spring (6.9 heads), and the smallest in winter (5.8 heads). In summer, this figure was at the level of 6.7 heads; the largest probable difference was 18.97% ($p<0.001$). The highest average live weight of 1 head of young was observed in spring (134.6 g), somewhat lower in summer (134.5 g), and the lowest in winter (131.3 g) the largest unexpected difference was 2.51%.

Table 3. Reproductive ability of females by season, (n=39-44)

Indicator	Winter (n=41)		Spring (n=44)		Summer (n=39)	
	M ± m	Cv, %	M ± m	Cv, %	M ± m	Cv, %
Ultrasound of fetuses	6,2±0,10	10,61	7,2±0,11***	9,74	7,2±0,08***	6,83
Embryo preservation, %	95,2	x	98,6	x	97,2	x
Multiplication, head.	5,9±0,15	16,43	7,1±0,14***	13,09	7,0±0,11***	9,58
Large-fruited, g	59,9±0,63	6,73	61,8± 0,54*	5,79	61,2±0,59	5,98
Nest mass, g	350,4±6,35	11,60	434,6±7,08***	10,81	425,6±5,32 ***	7,81
At the age of 10 days:						
number of rabbits, head.	5,8± 0,14	15,03	6,9± 0,13***	12,22	6,7± 0,09***	8,50
average live weight of 1 head, g	131,3±1,16	5,68	134,6±1,32	6,51	134,5±1,26	5,84
mass of the nest, g	760,6±17,40	14,65	923,5±15,51**	11,14	898,2±10,78 ***	7,49
At the age of 20 days:						
number of rabbits, head.	5,7±0,14	15,46	6,7±0,12 ***	11,54	6,6±0,10***	9,02
average live weight of 1 head, g	288,8±4,87	10,80	301,8±5,05	11,10	306,3±5,63*	11,49
mass of the nest, g	1648,7±54,72	21,25	2010,9±44,24 ***	14,59	2019,7±49,38***	15,27
At the age of 30 days:						
number of rabbits	5,6±0,13	15,25	6,6±0,12***	11,76	6,5±0,10***	9,29
average live weight of 1 head, g	531,5±5,93	7,14	533,9±12,23	15,19	560,3±4,89***	5,45
mass of the nest, g	2998,8±84,16	17,97	3532,3±97,69 ***	18,35	3615,6±55,21***	9,54
Milkiness, g	2596,6±84,16	17,97	3152,5±81,76 ***	17,20	3188,1±96,96***	18,59
Survival of off spring, %	94,9	x	93,0	x	92,9	x

In this case, the largest living mass of the nest was preserved in the spring (923.5 g), and the smallest was the nest (760.6 g); the small one was 898.2 g (the highest potential difference was 21.42%).

Similar investigations were carried out in the 20th century. Thus, in general, the greatest number of rabbits at the nest is in the spring (6.7 heads), and the fewest in the winter (5.7 heads). In the summer, this show was on the level of 6.6 heads. The greatest difference was 17.54% ($p<0.001$). Young animals were growing –

306.3 g, smaller in spring (301.8 g), and smaller in winter (288.8 g); a significant difference was due to the increase of -6.06% (p<0.05).

With the same number of important indicators at the age of 30 days (after weaning from the female), the largest number of rabbits in the nest was in spring (6.6 heads), and the smallest was in winter (5.6 heads). The entry point for this indicator was 6.5 heads; the largest difference was 17.86% (p<0.001). In this world, the average live weight is 1 head. For young animals, this figure was 560.3 g, for young animals in spring (533.9 g), and for smaller animals – 3615.6 g. In spring, this indicator was 3532.3 g, and in winter – the lowest (2998.8 g); the largest probable difference was 20.56% (p < 0.001).

As experience has shown, one of the most important factors in a rabbit female's productivity is her milk production. Our research has shown that this indicator is most likely to be found in the summer (3188.1 g) and lowest in winter (2596.6 g); the difference was 22.78% (p < 0.001). In the spring, the milk yield of the female was 3152.5 g.

Analysis of the saving of young animals during the period from breeding is clear that this indicator has an insignificant increase in longevity at the time of birth (1.9-2.0%) and is equal to: autumn - 94.9%, spring - 93.0%, and summer - 92.9%.

Thus, during the research, the females mainly identified the seasonal abundance for most of the most important indicators. As a rule, the highest productivity of the rabbit was especially in the winter and significantly lower in the spring and summer periods.

A one-way analysis of variance was carried out to determine the frequency of the indicators of sperm productivity in males due to the emergence of the period of death (Table 4), which indicated that the effect was likely to manifest itself on sperm concentration in the ejaculate (42%, p<0.001), the number of active sperm in the ejaculate (36%, p<0.001), and the level of sperm diluted (32%, p<0.001).

Table 4. Partially based on indicators of sperm productivity of males

Indicator	Impact shar	F	p
Ejaculate volume	0,06	1,35	0,271
Sperm concentration in ejaculate	0,42	15,24	0,001
Sperm motility in ejaculate	0,05	1,15	0,326
Total number of active sperm in the ejaculate	0,36	11,99	0,001
Degree of dilution family	0,32	10,00	0,001

A one-way analysis of variance was conducted to determine the proportion of variability in the indicators of female reproductive ability due to the influence of the season, which showed that the effect on the vast majority of its indicators was likely to be manifested: multiparity – 27% (p<0.001); nest weight at birth – 47% (p<0.001); at the age of 10 days: number of heads in the nest – 27% (p<0.001); nest weight – 36% (p<0.001); at the age of 30 days (weaning of rabbits): number of heads in the nest – 26% (p<0.001); average live weight of rabbits – 5% (p<0.05); nest weight – 21% (p<0.001); milkiness – 18% (p<0.001), table 5.

Table 5. The proportion of the influence of the season on the reproductive ability of females

Indicator	Share of influence	F	p
Multi Fertility	0,27	22,52	0,001
Number of rabbits, heads	0,05	2,97	0,072
Nest weight at birth	0,47	52,68	0,001
At the age of 10 days:			
the number of heads	0,27	22,59	0,001
average live weight of 1 head.	0,03	2,09	0,034
mass of the nest	0,36	33,71	0,001
At the age of 20 days:			
the number of heads	0,27	21,71	0,001
average live weight of 1 head.	0,05	3,19	0,045
mass of the nest	0,24	18,45	0,001
At the age of 30 days:			
the number of heads	0,26	20,74	0,001
average live weight of 1 head.	0,05	3,31	0,040
mass of the nest	0,21	16,29	0,001
Milkiness	0,18	12,83	0,001

Conclusions. The study of indicators of sperm productivity of males and reproductive ability of females depending on paratypic factors showed their seasonal variability. According to the studied indicators, the highest sperm productivity of males was observed in the winter period, and the reproductive ability of females – in the spring.

The lowest sperm productivity of males was in the summer period – during the period of high air temperatures – and the lowest reproductive ability of females was in the winter, when animals were kept in a capital unheated rabbit.

A clear trend towards a gradual decrease in the vast majority of the studied indicators of sperm productivity of males and an increase in the reproductive ability of females from winter to the onset of summer was revealed

In industrial farms with a flow system of meat production, herd reproduction planning must be carried out, taking into account seasonal variability of indicators.

In industrial farms with a flow system of meat production, herd reproduction planning must be carried out, taking into account seasonal variability of indicators. For the sperm productivity of males – especially in summer (it is recommended to increase the volume of insemination of rabbits by at least 10%) – and the reproductive ability of females in winter (providing a heating system for the female cell).

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ВІДТВОРНІ ЯКОСТІ КРОЛІВ У ЗАЛЕЖНОСТІ ВІД ПАРАТИПОВИХ ФАКТОРІВ ПРИ ЇХ УТРИМАННІ

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Експериментальні дослідження проводились на поголів'ї кролів породи полтавське срібло на базі експериментальної кролеферми Черкаської дослідної станції біоресурсів. Досліджено запліднювальну здатність сперми кролів, особливості ембріонального та постембріонального розвитку молодняку, залежно від пори року. Для оцінки основних показників мікроклімату використовували електронний аналізатор мікроклімату «ЕМА-5». Встановлено, що концентрація вуглекислого газу в приміщенні знаходилася в допустимих нормами межах – 970 ppm взимку, 982 ppm – весною та 1210 ppm – влітку. Атмосферний тиск в усі пори року знаходився на рівні 751-754 мм рт. ст. Середньодобовий показник освітленості в приміщенні дорівнював 47,5 Лк взимку, 81,5 Лк – весною та 87,8 Лк – влітку, тобто, відповідав допустимим параметрам. Виняток становила зимова пора року, впродовж якої середньодобові показники освітленості були меншими від мінімально допустимого значення на 26,9 %. Експериментально досліджено відтворні якості кролів за технології штучного осіменіння. Крім цього, індивідуальний розвиток отриманого приплоду за умов утримання в капітальному виробничому приміщенні. Дослідження показників спермопродуктивності самців та відтворної здатності самиць залежно від паратипових факторів засвідчили їхню сезонну мінливість. Зокрема, за цими показниками найвища спермопродуктивність самців спостерігалась у зимовий період, а відтворна здатність самиць – весною. Найнижча спермопродуктивність самців була влітку – упродовж періоду високих температур повітря, а найнижча відтворна здатність самиць – взимку за утримання в капітальному крільчатнику без опалювання. У процесі досліджень виявлена чітка закономірність щодо поступового зниження переважної більшості показників спермопродуктивності самців і підвищення відтворної здатності самиць від зимової до літньої пори року. Проведений дисперсійний аналіз засвідчив вірогідний вплив пори року на переважну більшість досліджуваних показників - як на спермопродуктивність самців, так і на відтворну здатність самиць. Тому для підвищення ефективності виробництва промислових господарств з потоковою системою виробництва м'яса, потрібно планувати відтворення стада з урахуванням сезонної мінливості показників відтворних якостей тварин. Це стосується спермопродуктивності самців влітку, зокрема, рекомендується збільшити обсяги осіменіння кролиць щонайменше на 10%. Крім того, для покращення відтворної здатності самиць взимку, потрібно забезпечити нормативні показники освітленості приміщення та обладнання для опалювання маточника необхідної потужності, згідно розрахунку нульового теплового балансу. Для удосконалення промислової технології утримання кролів необхідно додатково дослідити відтворні якості самців і самиць, залежно від пори року, з урахуванням нормативних параметрів мікроклімату, за кліткового утримання в закритому приміщенні та годівлі повнораціонним гранульованим комбікормом.

Ключові слова: *кролі, мікроклімат, пора року, спермопродуктивність, відтворна здатність.*