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REVIEW ARTICLE

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ENVIRONMENTAL AND GENETIC FACTORS INFLUENCING THE REARING PERFORMANCE IN MINK (*NEOVISON VISON*)

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ABSTRACT

The aim of this study was to indicate the relationship between various genetic and environmental factors and the results of kits rearing. Among the factors determining the degree of rearing of young kits, genetic factors should be mentioned, especially the color of the mink, and the environmental factors include: duration of labor, age of mothers, mating and laying time, length of pregnancy, litter size, nutrition, body condition the female and her milk yield, indoor microclimate, bacterial and viral diseases, or the care provided by the farm staff. As a result of the analysis, it can be concluded that the number of reared mink babies is influenced by both the color variety and a number of environmental factors, and the mink farmer's task is to get to know all these aspects and treat them comprehensively. The mink breeding should be carried out in such a way that the animal welfare is as good as possible, so that the females give birth to the healthiest and strongest litters.

Key words: number of mink reared, mink mortality, color variety, mink reproduction

INTRODUCTION

The American mink, or actually the farm mink, *Neovison vison*, is the main source of very valuable pelts, the properties of which make them outstanding from the pelts of various other species of fur animals. Mink fur is dense, warm and healthy. This is why mink is the most popular fur animal farmed in Poland [Ludwiczak and Stanisz 2019]. As a result of breeding work carried out on farms, the fertility of mink is significantly higher compared to free-living animals. The appropriate condition of females in the breeding herd is not only the number of young born, which in mink can vary from 3 to even a dozen in a litter, but most of all the number of weaned offspring, which is an indicator of both the dam's body condition and the quality of care (farmer). The number of kits reared is considered to be the percentage of kits by the time of slaughter, which is counted in relation to the overall litter size. The female of the breeding herd should produce 4 young per year on average within 3–4 years of breeding life, and this number of the young should be raised until weaning [Felska-Błaszczyk et al. 2010a]. The litter size is a criterion for the selection of a female on many farms in Poland. It is very strict, e.g. if the female does not give birth to at least 6 kits in the first year and does not raise them until weaning, she is subject to culling. Socha and Markiewicz [2002] state that the average number of weaned kits per litter in Poland varies between 2.2 and 5.9 individuals.

According to Felska-Błaszczyk et al. [2010a] and Bielański et al. [2003], the main causes of deaths in the rearing of kits is lactation inhibition, caused by inadequate nutrition, as well as poor living conditions. According to Schou and Malmkvist [2017], the majority (77.0%) of deaths in live born animals in the first week occur on the day of birth and on the following day (days 0 and 1). The increased number of kits at birth has led to a decrease in the body weight of kits, which often increased the death rates during the rearing period [Schou and Malmkvist 2017]. Increased fertility of females also resulted in the occurrence of more frequent health problems, especially in the highly prolific females, in the form of nursing sickness. This problem has led to the fact that mink farmers are not currently striving to achieve as many litters as possible at any cost, even at the cost of the health and life of the animals. On the contary,

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farmers tend to improve the rearing conditions, so that as many young as possible survive the rearing period. The point is that it is the mortality of the young during their nursing represents the final measurable effect of reproduction carried out on the farm, not the fertility of the dams [Felska-Błaszczyk et al. 2008, Dziadosz et al. 2010, Święcicka et al. 2016]. The aim is for females to raise all the young that they gave birth to, which is primarily related to the improvement of welfare in the period of nursing the young.

The factors determining the rearing success include both the genetic factors, especially the color variant, and the environmental ones, such as duration of labor, age of mothers, mating and laying time, length of pregnancy, litter size, nutrition, body condition of the female and her milk yield, indoor microclimate, bacterial and viral diseases, or the care provided by the farm staff.

Therefore, the aim of this study is to show the relationship between various genetic and environmental factors and the results of rearing.

Genetic factors and rearing performance

The genetic factors influencing the results of kits rearing include, first of all, the color variety of the breeders. The mink breeding began about a hundred years ago and during that time many color varieties were obtained, about 200. This diversity of color variants is reflected not only in the color of the coat, but also in different reproductive parameters. The most popular color variety is the standard mink [Święcicka et al. 2016], most similar to free-living animals. It is a variety used to derive many mutations of mink [Baranowski and Żuk 2020]. The most popular mutational color varieties include mink: palomino, silverblue, black cross, pearl, pastel, white (Hedlund and Regal), and sapphire [Wacławik et al. 2020].

Novel color varieties have been obtaibned, which are more or less fertile than the standard and which raise the young better or worse. And so, for example, according to Święcicka et al. [2016] the percentage of kits weaned from the litter ranges as follows: for the standard from 79.4% to 90.6%, for pastel from 85.4% to 95.7%, for platinum from 52.9% to 100%, for palomino from 62.6% to 94.3%, for black cross from 65.3% to 95.9%, for the Hedlund white from 76.8% to 99%, and for sapphire from 42.5% to 96.4%. The authors performed an analysis over a period of 15 years and found that only in the standard variety, the percentage of rearing young from the litter did not decrease and was at a constant level, and for other color varieties this percentage decreased over the years, which was surprising, because it would seem that over the years of breeding, the awareness and knowledge of farmers about animal welfare should increase the percentage of reared young. In order to explain this, it is also necessary to examine the female fertility in the same period. Well, it was found that mink litters in this long-term period were getting larger and this was the reason for the decrease in the percentage of reared young. The hypothesis was confirmed that the larger the litter, the smaller the kits and the lower the chance of survival until weaning.

These results also show a different tendency that occurs depending on the color variety, namely in mutational varieties the rearing of mink is poorer than in standard varieties, i.e. those that are genetically and phenotypically most similar to a free-living mink. Standard mink is the basic color variety of mink [Bielański et al. 2005]. Other types, the so-called mutational colors, are derived by crossing individual original color varieties with each other and crossing these varieties with the standard variety. In the studies by Felska-Błaszczyk et al. [2010a] the highest number of reared young was also obtained from black standard mink, 6.10 individuals on average, while the least young were reared by females of the mutation sapphire cultivar, 5.31 individuals. Dziadosz et al. [2010] found that standard black mink obtained the best rearing results for kits, and the lowest rearing results were achieved by mutation females – white regal and cross sapphire. In the above studies, the highest mortality was found in sapphire mink, 20.22%, and the lowest mortality in the standard black variety, 17.81%.

The research by Kołodziejczyk and Socha [2012], carried out on the effect of crossing a palomino mink with a standard mink on reproductive results, revealed that a 50% admixture of standard mink genes to a palomino mink increases its fertility and the number of reared mink compared to the results achieved by "purebred" mink palomino and palomino mink with 25% admixture of standard mink genes.

In the studies by Socha and Kołodziejczyk [2006] it was found that the average number of reared young in a litter in cv. Palomino was 4.9 and in cv. Standard 4.6. Similar results of rearing kits for the standard variety were obtained by Felska-Błaszczyk et al. [2012]. Other color varieties may have higher results for the rearing of kits. And so, for example, the silverblue variety is considered one of the largest color varieties and at the same time one of the most fertile. According to Felska-Błaszczyk et al. [2012], mink of this variety breed an average of more than 6 kits per litter, compared to other mutation varieties such as the sapphire mink, which rears approximately 4.9 individuals.

Environmental factors and the results of kits rearing

The mortality of the kits during the rearing period consists of many factors, including the following: the birth of dead or weak kits, too low birth weight, which usually occurs with large litters; insufficient maternal care, which is also associated with too low milk yield, inflammation of the mammary gland (mastitis), and the very common so-called "wet nest" syndrome associated with diarrhea [Hunter 2008]. Most of the losses of kits (from 60% to 70%) occur within the first seven days of birth [Ludwiczak and Stanisz 2019]. Schneider and Hunter [1993] found that 91% of kits fall within the first three days after birth. This was confirmed by Schou and Malmkvist [2017], who reported that in the first three days after birth, there are the highest number of falls of kits, as much as 93%. The overall mortality of young mink during the rearing period ranges from 13 to even 27% [Schneider and Hunter 1993, Lagerkvist et al. 1994].

Selected environmental factors influencing the size of kits rearing will be described below.

Labor period

Prolonged labor causes kits to become hypoxic and therefore they are born weaker, which increases their mortality. Normal delivery should last from 5 to 6 hours [Malmkvist et al. 2007]. A similar labor time has been reported by Malmkvist and Palme [2008], who found that the average mink labor lasts about 6 hours and 28.3 minutes. Houbak and Malmkvist [2008], who conducted similar observations, found that offspring mortality was higher in females with longer total birth times (deliveries lasting from 2 hours and 10 minutes to 10 hours and 10 minutes) compared to females with low kit mortality (births lasting from 1 hour and 2 minutes to 5 hours and 15 minutes).

Seremak et al. [2019], who observed the duration of labor from 1 hour and 3 minutes to 4 hours and 32 minutes, and the average duration of labor in pearl mink was 3h 23 minutes. According to the above authors, the female left the nest an average of 8 times during childbirth, staying outside it, on average, about 18 minutes. The time intervals between the birth of subsequent kits ranged from 16 to 52 minutes.

Date of mating, date of delivery and length of pregnancy

According to some authors, the number of offspring weaned from one litter is influenced by the date of delivery. For example, Socha and Kołodziejczyk [2006] found that females who gave birth before April 25 raised more young than those who gave birth later. The date of delivery is very closely related to the length of pregnancy, which has a direct relationship with the date of mating. Socha and Markiewicz [2002] studied the influence of the date of the first mating and the date of birth, on the number of born and the number of reared kits, and found that the highest average number of born and reared kits was observed in females mated at the first date (until March 5). Slightly lower values were reached by mating at the third date (mating between March 10 and 15), and slightly lower values at the second date (mating between March 6 and 9). Definitely the lowest values, both in terms of the number of born and reared kits, were found for females that were first mated at the latest date, after March 16. Based on the above observations, it can be concluded that mink should be mated in the first half of March.

Socha and Markiewicz [2002] found that females who gave birth the earliest (before April 25) raised the most young, and females who gave birth the latest raised the least. When analyzing the date of the first mating and the date of littering, it can be noticed that the earliest indoor minks have longer gestation, and the indoor minks have the shortest pregnancies. The duration of a mink pregnancy can vary considerably, from 36 to even more than 80 days. Most often it is 45–55 days and largely depends on the mating date as shown above. According to Socha and Markiewicz [2002] and Felska-Błaszczyk et al. [2008] the most positive for the birth of large and strong litters are the so-called average duration of pregnancy. The research of Sulik and Felska [2000] showed that females on days 53–54 of pregnancy gave birth to the most numerous litters. Similar results were achieved by Święcicka [2013], who stated that the highest percentage of falls of young kits was observed in mothers with longer pregnancies, over 65 days, and in mothers with the shortest pregnancies, below 45 days. Felska-Błaszczyk et al. [2012] report slightly different results, and found that the largest number of born and weaned young from one litter was achieved by females with pregnancies up to 44 days.

Female body weight – body condition

The feeding of mink on farms in the autumn is very intensive and energetic, so that the animals during the slaughtering period were as large as possible, and those selected for the breeding stock had fat reserves for the winter period. Such nutrition, often with an addition of free fat in the ration, causes that mink in winter are maximally fat. The selected breeders should be brought to the so-called reproductive condition, which means a short-term feeding with limited ration, with reduced energy diet. Unfortunately, not all females achieve the appropriate breeding condition, as some of them are too lean and some are too obese, which means that they achieve poorer reproductive performance, including nursing. For example, Tinggaard et al. [2012] found that females that were too obese gave birth to fewer litters than females in the appropriate body condition. Similarly, Lagerkvist et al. [1994] report that females selected for large sizes obtained fewer litters and the young from such litters had a higher mortality.

As stated by Rouvinen-Watt [2003], the abnormal body condition of female breeding mink during mating and pregnancy, and during the feeding of the young, predisposes them to lactation anemia. In the conducted own research, it was found that the highest indices of the litter size, the number of live-born kits in the litter and the number of reared mink from the litter were recorded in females with an optimal body condition [Felska-Błaszczyk and Seremak 2020].

Dam's age

According to Felska-Błaszczyk et al. [2010a], a female breeding mink produces 12 to 15 reared offspring during three years of breeding life. In the fourth year the fertility decreases by over 10%, in the fifth year by almost 26%, and in the sixth year by 35%. Due to such a rapid decrease in fertility, females are usually culled from breeding after the third year of breeding life. The mortality of the young during the rearing period also depends on the age of the females. In young, one-year-old females, mortality is higher than in older females, aged 2 to 5 years [Lagerkvist et al. 1993]. In the studies by Felska-Błaszczyk et al. [2010a], where the results of reproduction of three color varieties of breeding mink (black standard, sapphire and black standard NAP) were analyzed, from the first to the third year of reproductive use, it was found that female one-year-old obtained the largest number of reared young from one litter (nearly 6) and the lowest mortality of young, amounting to less than 18%. Two- and three-year-old females were rearing fewer kits, slightly more than 5.2. At the same time, three-year-old females achieved the highest mortality rate of the kits, over 22%. Similar results were achieved by Dziadosz et al. [2010], who also found the highest reproductive results in various color varieties of mink, including the number of reared young, in the first year of reproductive age. Socha and Kolodziejczyk [2006] obtained different results, who stated that the largest number of born and reared young in the litter in the second and third years of breeding use of females.

Litter size

Schou and Malmkvist [2017] found that the viability of mink kits is primarily influenced by litter size – greater total litter size at birth was associated with a higher risk of kit death and a reduced growth rate of surviving kits. The number of live minkeys in the litters had the opposite effect, since the minks in the large live litters had a reduced risk of death, and those with a large average litter size on days 1 to 7 had an increased growth rate. In larger litters, the body weight of kits is usually lower than in smaller litters, and Schneider and Hunter [1993] report that it is the body weight of nordic kits at birth that is the greatest determinant of survival of kits. They reported that the mean weight of kits that died within the first day after birth (7.9 g) was significantly lower than the mean birth weight of healthy kits (10.7 g). Also Seremak et al. [2013] found that, as a rule, very large litters show a very low survival rate to weaning, because the young are much smaller and the female has limited grooming abilities.

The analyzes carried out on Polish farms show that the average size of the litter in the nest ranges from 6.5 to 7 young, although much larger litters, 14–18 young ones appear quite often [Sulik and Felska 2000, Felska-Błaszczyk et al. 2010a, Seremak et al. 2011]. The reproductive possibilities of mink are enormous, as evidenced by the litter born on a farm in Poland in 2007, the size of 23 kits, which unfortunately died within two days of giving birth because they were too small and weak [Felska-Błaszczyk et al. 2010b]. Too large litters, over 9 kits, apart from poor survival of kits due to their too small size, cause another serious disease in females, called nursing sickness. Highly fertile females need a lot of energy to produce a large amount of very fatty milk, which, with the slightest nutritional errors, causes them to experience exhaustion during or just after lactation, often leading to the death of the female [Rouvinen-Watt 2003]. It also leads to an increase in the mortality of the young. Schneider et al. [1992] found that nursing diseases resulting from large mink litters can lead to more than 50% of female mortality.

Seremak et al. [2013] pointed to the existence of a close relationship between large litters and increased mortality of kits. The authors found that many litters – with ten or eleven young – are not raised and often 2 to 6 young are left in them. A very interesting observation of the authors was also the fact that the young from single litters had a high mortality. The above analysis allowed for the conclusion that the litters with the size from 2 to 9 young are the most favorable for rearing.

In order to reduce the mortality of young kits in large litters during the rearing period with dams, Clausen and Larsen [2015] recommend partial earlier weaning of the young from their mothers, at 42 days of age. These authors found that keeping the entire litter with the mothers longer, up to 56 days of age, increased the number of mink bites, increased their mortality and decreased their growth rate. In contrast, partial weaning of large litters at 42 days of age reduced the number of bitten young mink, as well as reduced their mortality and increased the growth rate, especially of males.

Nutrition

Nutrition errors lead to as much as 70% of losses in fur farming [Wrzecionkowska 2013]. In order for the female to be able to raise her offspring, care should be taken to properly balance the food ration and maintain proper feed hygiene, both during pregnancy, which will allow for the birth of a strong litter, and during the rearing of kits [Seremak et al. 2016a]. The consequence, resulting from inadequate animal nutrition, are reproductive disorders, perinatal diseases, and diseases of the rearing period of kits and diseases related to metabolism. According to Wilson et al. [2015], more than 10% of the total number of deaths of mink kits is starvation, most likely caused by a lack of mother's milk or too large litters.

Newborn young minks do not have their own energy reserves, they are completely dependent on mother's milk during the first 20–25 days of life [Tauson et al. 1998]. The period of lactation and rearing of the young requires a large amount of energy from the female, which results in the female's increased demand for protein and energy in the feed [Nowakowicz-Dębek et al. 2018]. According to Mustonen et al. [2005], the mink has a relatively poor adaptation to food deprivation because it is unable to rapidly use subcutaneous fat as the main fuel during metabolism. Instead, it has to derive some of its energy needs from the breakdown of the body's proteins, which causes the body to become exhausted and collapse very quickly, especially in mink babies. It was found that the low supply of metabolic energy from protein (14%) in the diet of females during the last 16 days of pregnancy led to a lower birth weight of kits, compared to young ones born of females who received an adequate amount of metabolic energy from protein in the same period. (29%) [Matthisen et al. 2012]. In the above studies, young males after weaning were also divided into two groups and received a dose with a lower supply of metabolic energy from protein (18%) and an adequate amount of metabolic energy from protein (32%). The males whose mothers received a lower amount of protein energy in the last 16 days of pregnancy, and who received the appropriate amount of this energy after weaning, showed changes in protein metabolism by reducing protein oxidation. The above experience clearly shows how important it is to feed female mink during pregnancy. This is confirmed by subsequent studies by Matthisen et al. [2010], who found that uterine malnutrition can induce changes in the phenotype of an individual and in hepatic homeostasis in female mink even in subsequent generations.

According to Szeleszczuk [2001], poor quality of food is primarily responsible for the deaths of young mink in the final period of rearing. This fact was confirmed by Bis-Wencel et al. [2006], who in the group fed with dietary fodder supplemented with antioxidant and preservative obtained, on average, 0.8 more young weaned compared to the group of mink, which did not receive such additives in the feed. The experiment of Bis-Wencel et al. [2006] clearly shows that for mink it is insufficient to balance the rations only in terms of basic nutrients, such as protein, fat and carbohydrates. Currently, various types of feed additives are used in their nutrition. This group includes probiotic and prebiotic preparations that are increasingly used. Seremak et al. [2016b] found that feeding mink with fodder with the addition of inactive yeast *Saccharomyces cerevisiae* and with the addition of inactive yeast *Saccharomyces cerevisiae* and stillage (DDGS) has a positive effect on the weight gain of young mink during the rearing period. Similarly favorable results on the weight gain of young mink using a probiotic preparation were recorded in our own research [Felska-Błaszczyk et al. 2016].

Indoor microclimate for mink

Schou and Malmkvist [2017] found that litters that grew up in warmer nests had lower mortality, which was primarily due to hypothermia and higher growth rates in the first week of kits' life. The mortality rate of live born mink kits in the first week has been reported to range from 14% to 40% [Martino and Villar 1990, Malmkvist and Palme 2008 and 2015] depending, among other things, on the availability of nesting material.

Due to the fact that the kits are born naked, blind and deaf, with a weight of approx. 9–12 g in the initial period of kits rearing, the problem is to maintain the appropriate temperature in the nests, because the kits do not have a developed mechanism of thermoregulation and are exposed to rapid body cooling, due to the relatively large surface area of the body in relation to the volume [Brown and Lasiewski 1972, Harri et al. 1991]. In connection with the above, when the nest is inadequately protected against cold, large losses in the offspring may occur. Thermoregulation of kits develops gradually and depends primarily on increasing their body weight, isolating the nest and the behavior of the mother [Rouvinen-Watt and Harri 2001]. Their survival strategy is based on the ability to withstand hypothermia and adequate nutrition and warmth provided by the mother. Functional homeopathy does not develop in young minks until about 6 weeks of age [Tauson et al. 2006]. Until then, maternal care plays a key role in the survival of the kits. If the female is out of the nest for too long, the young are unable to maintain high temperature, which increases their risk of dying from hypothermia and starvation [Martino and Villar 1990, Harjunpää and Rouvinen-Watt 2004, Tauson et al. 2006].

The American mink is a monoestral species, with the mating period in March and the period of delivery end of April – beginning of May. The female gives birth to kits in nest boxes, where special wire inserts are installed before the littering period, and the whole is insulated with various insulating materials. Under the climatic conditions of Poland, there are often, both in April and May, very cold nights, with temperatures below 3°C, which results in large losses of the offspring, especially in the first days of life of the kits [Malmkvist et al. 2007]. Breeding mink females start building a nest from January until the beginning of the birthing season in April [Malmkvist and

Palme 2015, Schou and Malmkvist 2018, Schou et al. 2018]. Building nests by females before giving birth depends largely on the outside temperature. In winter and early spring, when it is cool outside, females are more motivated to build. As the temperature rises (up to about 25°C), minks are less involved in building nests, moreover, they spend less time in the nest with the young. This leads to the conclusion that temperature is an important factor influencing the maternal instinct between the female and the young [Schou and Malmkvist 2018, Schou et al. 2018].

The material for lining the nest boxes can be: straw, wood shavings, sawdust, hay and sheep wool. A common criterion for choosing an insulating material is low price, which means that the selected material does not always fulfill its role properly. Appropriate insulation material in the nests during the rearing of the young is crucial for the survival of the litter [Malmkvist and Palme 2008, Malmkvist et al. 2016]. In their work, Cambell et al. [2017] investigated the possibility of using two materials to insulate mink nests – wood shavings and chopped oat straw. They compared the mortality of the young from nests insulated with these materials and their body weight at the age of 3 weeks. They found no significant differences in both parameters, however, the kits from straw-insulated nests were characterized by slightly lower mortality and higher body weight. They noticed that both tested parameters were influenced by the temperature in the nest and the relative humidity of the air. They also found that sawdust influences higher dustiness in the nest box compared to straw, which also has a negative impact on the survival of the young. In their work, Sønderup et al. [2009] proved that wheat straw used as a nest lining material shows a higher litter survival rate compared to wood chips and chopped barley straw. By contrast, Cambell et al. [2017] found no differences between wood chips and chopped oat straw in terms of litter survival or body weight at 3 weeks of age.

Lund and Malmkvist [2012] studied the relationship between the amount of building material administered and the mortality of the young. For this purpose, they used 105 breeding mink females, divided into 4 groups: non-pregnant females, pregnant females with access to one nesting material, pregnant females with access to three materials and pregnant females with access to one material but transferred to a climate-controlled room. The fourth group was analyzed only to determine the time of nest construction. The climate data in the nest showed that females with access to the three materials have slightly higher temperature in the nests and lower temperature and relative humidity than those with access to only one material. As expected, non-pregnant females had lower temperature and higher humidity in the nests than the other groups. A good and warm nest is an essential element when the mother is outside the nest.

In other studies, Schou and Malmkvist [2017] examined the effect of nest temperature on the growth rate and survival of minkres and found that it had little effect on the mortality of kits – young in nests with higher temperatures grew slightly better than those from nests with lower temperatures. However, they found that it is the composition of the bedding used to insulate mink nests that has a significant impact on the development and survival of the young and the size of the litter (females with large litters had less success in caring than females with small litters). They confirmed their results in other studies by examining the effect of litter size and temperature on the mortality and growth of farmed mink [Schou and Malmkvist 2017]. The results indicated that temperature is not the only cause of death of the kits. Mainly, the size of the litters should be taken into account, as well as ensuring the appropriate welfare of females, which will increase the early survival of the young.

Choosing the right material for lining the nest can have a positive effect on increasing the survival efficiency of kits on breeding farms and reduce economic losses incurred on the purchase of bedding. Straw is an easily available and inexpensive material, and its use has a positive effect on the rearing of kits, which is confirmed by the above studies.

Interesting research on the influence of the microclimate of mink housing on the results of their reproduction was carried out by Święcicka [2013], who concluded that an increase in air temperature to about 16–17°C and a decrease in relative air humidity to about 65% significantly accelerated the time of lambing, showing the average length of pregnancy lasting about 47 days, which increased the size of the litter and the number of reared kits from the litter.

Bacterial, viral and other diseases

Among the main epizootic factors that cause deaths of mink kits (from birth to four months of age) on American farms, Wilson et al. [2015] mention, inter alia, Aleutian disease which caused 13.5% of falls, viral enteritis causing 10.6% of falls, fatty liver causing 9.6% of falls, epizootic gastroenteritis in mink causing 8.7% of falls and pneumonia caused by the bacterium *Pseudomonas aeruginosa* – 7.7% of the falls, and bacterial enteritis, which is also the cause of approximately 7.7% of the deaths of young mink. Already in 1983, Bøtner and Jørgensen [1983] found that the Aleutian disease virus was responsible for a very high mortality among young mink, amounting to over 70% of individuals in a litter, and Farid and Rupasinghe [2017] report that Aleutian disease is now present in all countries where there is a mink farm.

Another disease that occurs in mink in the early stages of the growth of young animals is bacterial cystitis and urolithiasis [Mundbjerg et al. 2020]. Mundbjerg et al.

[2021] report that bacterial cystitis is a serious problem on Danish farms, and the daily mortality of young mink in June and July may range from 0.3 to 0.7%. Mundbjerg et al. [2020] found that cystitis and/or urolithiasis were associated with the fall of 33% of mink kits in 2015 and 2017. The bacterial factor most frequently isolated in postmortem swabs from mink bladder with a postmortem diagnosis of urolithiasis and cystitis was *Staphylococcus delphini* group A. According to the above authors, urinary diseases, including cystitis and urolithiasis were the most common postmortem diagnosis of mink kits during the growth and was associated with group A *Staphylococcus delphini*. Unfortunately, there are no reports on this subject on Polish mink farms, but animal farmers have repeatedly reported the occurrence of bladder stones after carrying out an autopsy of dead young mink. In order to combat the inflammation of the bladder, Danish farmers use antibacterial treatment with the use of the antibiotics Sulfadiazine and Amoxicillin, which reduce the mortality of young mink.

Diarrhea of various ethology is observed in young mink in the pre-weaning period. One of the main causes is mink astrovirus (MiAstV). According to Barsøe et al. [2021], it is the cause of 68% of diarrhea among young mink during the period of rearing with mothers, especially in May.

Mink farmers, aware of the fact that it is necessary to prevent the appearance of diseases caused by viruses and bacteria, use various forms of biosecurity on farms in order to ensure biological safety [Compo et al. 2017]. They use, for example, personal protective equipment, strict control of the access of a limited number of people to animals, disinfection of feed containers, disinfection of feed wagons, deratisation, use of antimicrobials in feed or water.

Care by the farm staff

Herbut [2009] points to the strong human impact on the environment and the welfare of farm animals. The author divided the human impact into indirect, which consists in ensuring adequate animal welfare (buildings, feed, indoor climate, housing technology, etc.), and direct, consisting in direct contact with animals. People directly related to handling animals should be gentle and familiar with the ethology of animals [Herbut 2009]. Unfortunately, on many farms of livestock, not only fur animals, this aspect is underestimated and people who take care of animals do not have the appropriate qualifications. Cases of bad treatment of animals are reported more and more frequently on television, in the press or on the Internet. Over the years, the so-called The "human factor" is gaining importance in terms of improving the welfare of farm animals. Seremak et al. [2011] demonstrated it in their work on the impact of the quality of mink service on the obtained reproductive parameters, including the number of mink reared. The authors found a difference of several percent in the number of females that destroyed kits litters and in the number of reared young depending on the team of employees who took care of the animals. This work proved how important the "human factor". Similarly, Szeleszczuk [2001] reported that a certain percentage of losses in animal breeding may be related to errors in the handling of animals by farm workers, which were related to stress due to improper capture of animals, which may cause physical damage, or related to stress caused by by the noise.

CONCLUSIONS

In the light of the above analysis, a conclusion can be drawn that the results of mink rearing are influenced by many different factors and the mink farmer's task is to get to know all these aspects and treat them comprehensively. The mink breeding should be carried out in such a way that the animal welfare is as good as possible, so that the females give birth to the healthiest and strongest litters. The above presented analysis does not exhaust the discussed topic – the influence of various factors on the rearing of kits. For example, the aspect of the behavior of females during the rearing of norchats was not discussed at all, and as it was shown by Zieliński et al. [2019] the character of the female (whether she is, for example, timid, aggressive or curious, is very important for the number of born and reared young.) The above authors stated that timid females build nests and care for the young best.

The individual factors have been briefly presented, as each of the factors discussed could be used to write a separate study. As a result of many years of observations of mink breeding, the author of the study noticed many favorable changes in the breeding of this species of fur animals. The farmers themselves stated that the requirements for the litter size could not be raised, as this meant that a lot of young were born, but they were weak and the female had a problem with feeding the entire litter. On the other hand, more and more attention is paid to meeting animal welfare requirements so that the born kits are strong and healthy, which can be achieved taking into account all the above genetic and environmental factors.

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WPŁYW CZYNNIKÓW ŚRODOWISKOWYCH I GENETYCZNYCH NA WYNIKI ODCHOWU NORCZĄT (*NEOVISON VISON*)

STRESZCZENIE

Celem niniejszego opracowania było wskazanie relacji pomiędzy różnymi czynnikami genetycznymi i środowiskowymi a wynikami odchowu norcząt. Spośród czynników decydujących o stopniu odchowu młodych norcząt należy wymienić czynniki genetyczne, a tu przede wszystkim odmianę barwną norek, a spośród czynników środowiskowych należy wymienić: długość trwania porodu, wiek matek, termin krycia i wykotu, długość ciąży, wielkość miotu, żywienie, kondycja ciała samicy i jej mleczność, mikroklimat pomieszczeń, choroby bakteryjne i wirusowe, czy też opieka sprawowana przez pracowników fermy. W wyniku przeprowadzonej analizy można stwierdzić, że na liczbę odchowanych norcząt ma wpływ zarówno odmiana barwna, jak i szereg czynników środowiskowych, a zadaniem hodowcy norek jest poznanie wszystkich tych aspektów oraz traktowanie ich kompleksowo. Należy tak prowadzić hodowlę norek, aby dobrostan zwierząt był jak najlepszy, tak, aby samice rodziły mioty jak najzdrowsze i najsilniejsze.

Słowa kluczowe: liczba odchowanych norek, śmiertelność norcząt, odmiana barwna, rozród norek

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