

Application of probiotic supplementation in the nutrition of farm American mink (*Neovison vison*)

Badania nad zastosowaniem probiotyku w żywieniu fermowej norki amerykańskiej (*Neovison vison*)

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Abstract

The study focused on an analysis of body weight, fur quality and selected blood biochemical indices in farm mink fed a diet with an addition of probiotics containing effective microorganisms. The feeding trial was conducted in 2013 on a population of Silverblue mink. The experimental group was offered the probiotics supplement with their daily ration. The control group did not receive a probiotic supplement. Body weight gains, blood AST and ALT content and the quality of fur were analyzed. The probiotic supplement positively and statistically significantly influenced the body weight gains of the mink, particularly in males. The supplement had a beneficial effect also in terms of pelt quality, since the animals fed the probiotic yielded pelts in the highest class of quality.

Keywords: blood biochemical parameters, fur-bearing animals, nutrition, probiotics, quality of fur

Streszczenie

Celem pracy była analiza masy ciała, jakości okrywy włosowej oraz wybranych wskaźników biochemicznych krwi nerek hodowlanych żywionych mieszanką paszową z dodatkiem preparatu probiotycznego zawierającego efektywne mikroorganizmy. Badania prowadzono w roku 2013 na dwóch grupach nerek odmiany silverblue. Grupa eksperymentalna otrzymywała do paszy stosowanej

codziennie dodatek preparatu probiotycznego. Grupa kontrolna natomiast nie otrzymywała dodatku probiotyku. Analizowano przyrosty masy ciała, zawartość AspAT oraz ALAT w surowicy krwi oraz jakość okrywy włosowej. Zastosowany w paszy dodatek probiotyku wpłynął korzystnie na przyrosty masy ciała nerek, przede wszystkim samców, co zostało potwierdzone statystycznie. Stwierdzono także korzystny efekt w postaci poprawy jakości skór, gdyż u zwierząt żywionych preparatem probiotycznym pojawiły się skóry w najlepszej klasie jakościowej.

Słowa kluczowe: jakość okrywy włosowej, probiotyk, składniki biochemiczne krwi, zwierzęta futerkowe, żywienie

Introduction

The American mink is one of the most commonly farmed fur-bearing animal. Intensive management and large production scale of farms require applying various feed supplements as growth promoters (Śliżewska et al., 2006). The animal is a typical carnivore; the proportion of meat in the ration is about 80%. A short gastrointestinal tract and a quick rate of gastric emptying results in the fact the various feed additives are sought in order to improve digestibility of feed components, which would eventually lead to a higher live weight. Increased body weight gains during the period prior to slaughter entails larger body sizes and, in consequence, larger pelts.

Probiotics, which are used among dietary supplements on fur-animal farms, are composed of specific, strictly defined microorganisms. These improve the animal's gut microbiota composition (Gugolek et al., 2004; Lorek et al., 2000), thereby protecting against outbursts of pathogenic bacteria. Their activity range is wide; probiotics improve digestibility of feed, primarily proteins, whose high level in the diet is required in the nutrition of the carnivores (Ahlstrøm et al., 2006). In addition, probiotics enhance the body's immunity, since they eliminate undesirable microorganisms. They consist of a wide variety of beneficial microorganisms that have the ability to mitigate pathogenic microorganisms.

The use of probiotics in carnivorous fur animals nutrition is on the rise, although some breeders are extremely skeptical towards this supplementation, especially when it comes to mink. The gastrointestinal tract in mink is very short in relation to body length, like 5:1. Although the gastrointestinal tracts of red and Arctic foxes are shorter than in mink, probiotics are increasingly being used in their nutrition (Li et al., 2002). Gastric emptying time in the mink is very short, from 1 to 21 hours. Therefore, in order to function properly, the probiotic microorganisms must have a short generation span (Gugolek, 2002). It seems thus reasonable to check whether probiotics should be used in mink nutrition.

The aim of this study was to analyze body weight gains, fur quality, and blood biochemical indices in farmed mink fed a diet supplemented with probiotic.

Materials and methods

Animals and measurements

The studies were carried out on a mink farm located in north-western Poland in 2013. The feeding trial involved young, directly weaned Silverblue mink of both sexes. The 2-month-old animals (80 males and 80 females) were randomly assigned to two equal groups, (each $n = 80$, 40 males and 40 females) experimental and control. The experimental group animals were fed a feed supplemented with the probiotic in the dose $5 \text{ L} \cdot \text{t}^{-1}$. The probiotic contained $5 \times 10^6 \text{ CFU} \cdot \text{ml}^{-1}$ of alive *Lactobacillus casei* and *Lactobacillus plantarum*, $5 \times 10^3 \text{ CFU} \cdot \text{ml}^{-1}$ alive yeast *Saccharomyces cerevisiae*, and sugar cane molasses. The control group was fed identical feed without the probiotic. The supplementation trial was carried out from the moment of weaning (10 February) until slaughter of the animals for pelt (end November). Table 1 presents chemical composition of the feed with and without the probiotic supplement. The feed was a mixture of mainly poultry offals and fish waste. The same diet was applied throughout the experiment.

Table 1. Nutrient composition in both feed mixtures

Tabela 1. Składniki pokarmowe w poszczególnych mieszankach paszowych

| Feed | Dry matter [%] | Ash [%] | Crude protein [%] | Crude fiber [%] | Crude fat [%] | Nitrogen-free extract [%] |
|------------------------------|----------------|---------|-------------------|-----------------|---------------|---------------------------|
| with probiotic supplement | 34.08 | 2.96 | 12.07 | 1.40 | 10.09 | 7.55 |
| without probiotic supplement | 35.47 | 3.19 | 12.40 | 1.50 | 10.78 | 7.59 |

All the studied animals ($n = 160$) were first weighed the day prior to the onset of the trial (9 July). Next, body weight measurements were repeated in four-week intervals, in August, September, and October. Body weight was measured using a digital scale with precision to 5 g. In August and October, blood was drawn from 30 mink of either sex in each group (experimental and control). A blood sample of 1 ml was collected from a rear-paw claw, according to the procedure of testing for Aleutian disease (Larsen, 2013).

The measurements and evaluations included body weight gains, serum alanine transaminase (ALT) and aspartate transaminase (AST) activity levels, AST/ALT ratio, as well as the quality of resulting fur, which was based on grading scrutiny carried out by independent fur auction brokers (Saga Furs). In November, before slaughter, the animals were graded for fur quality, and sorted into eleven classes, the first of which was worst in terms of fur quality, and the eleventh – best. The activity of ALT and AST were determined using a Roche bio-assay (without pyridoxal phosphate activation). The method approved by IFCC.

Statistical analysis

Statistical data analysis was carried out using STATISTICA 10.0 PL package. Descriptive statistics included the arithmetic mean and coefficient of variation (V%). To determine the significance of differences between the means within the parameters, one-way ANOVA with Tukey's post-hoc test were performed.

Results

Table 2 shows the statistical analysis of body weight gains in the studied mink. Due to the fact that the American mink exhibits a clear sexual dimorphism in body weight, and this was not the subject of this study, there are differences marked in Table 2 in body weight of both sexes.

Table 2. Mink body weight

Tabela 2. Masa ciała norek

| Group | Sex | Initial BW at age 8 weeks [g] | Body weight by month/age [g] | | | | | | Weight gain [g] | |
|-----------|---------|---|------------------------------|------|-----------------------|------|---------------------|------|---------------------|------|
| | | | August 12 weeks | | September 16 weeks | | October 20 weeks | | Mean [g] | V% |
| | | | Mean [g] | V% | Mean [g] | V% | Mean [g] | V% | | |
| Probiotic | females | 870.7 | 1213.7 | 11.8 | 1455.5 | 12.1 | 1593.5 | 12.2 | 719.3 | 22.4 |
| | males | 1214.4 | 1990.7 | 12.5 | 2727.6 | 10.6 | 3076.2 ^a | 11.2 | 1848.8 ^b | 14.4 |
| | total | 1038.4 | 1597.4 | 27.5 | 2083.7 | 32.8 | 2316.3 | 34.3 | 1270.0 | 47.9 |
| Control | females | 895.3 | 1247.6 | 13.4 | 1473.8 | 14.5 | 1596.8 | 14.9 | 701.5 | 23.6 |
| | males | 1213.6 | 1987.4 | 10.1 | 2672.9 | 10.4 | 2959.5 ^a | 10.2 | 1740.1 ^b | 14.0 |
| | total | 1062.7 | 1632.9 | 25.4 | 2104.9 | 30.9 | 2306.5 | 31.9 | 1248.7 | 44.9 |

^a, ^b – differences significant in columns at $P \leq 0.05$.

The effect of the probiotic supplementation on body weight gains was higher in males than in females. Males had a very equal initial body weight; at the end of the first month of the trial, however, probiotic-fed male mink had a higher body weight as compared with the control. After three months, the differences were statistically significant ($P \leq 0.05$). In October the treated males were 4% larger than the control animals. Over the entire trial period, body weight gains in probiotic-fed males exceeded by 6.25% ($P \leq 0.05$) the parameter attained by the males of the control

group. There were no significant differences, however, in body weight gains in females during the period under study.

Females did not respond that distinctly to the supplementation; however, also females revealed that the probiotic had a positive effect on the final live weight, since the probiotic-fed females, which finally attained 719.3 g in live weight, were by 2.5% heavier compared to the control females (their final body weight averaged 701.5 g).

Table 3 presents the statistics on serum ALT and AST levels and the AST/ALT ratio. It was found that sex had a significant effect (at $P \leq 0.05$) for serum AST level in September, and the addition of probiotics on ALT level in August ($P \leq 0.01$). It was also found that the supplement had a significant impact ($P \leq 0.01$) on the AST/ALT ratio in August.

Table 3. Serum ALT and AST levels, AST/ALT ratio
Tabela 3. Wartość aktywności enzymów ALAT i AspAT w surowicy

| Parameter | Sex | August | | | | October | | | |
|---|---------|--------------------|------|--------------------|------|--------------------|------|---------|------|
| | | Probiotic | | Control | | Probiotic | | Control | |
| | | mean | V% | mean | V% | mean | V% | mean | V% |
| AspAT [U ^{*l} ⁻¹] | females | 91.0 | 7.9 | 90.8 ^a | 11.1 | 124.8 ^b | 23.6 | 115.2 | 15.1 |
| | males | 68.8 ^{Aa} | 13.8 | 110.0 ^A | 25.5 | 89.2 ^b | 10.6 | 106.4 | 18.4 |
| | mean | 79.9 | 17.7 | 100.4 | 22.2 | 107.0 | 26.1 | 110.8 | 16.3 |
| ALAT [U ^{*l} ⁻¹] | females | 115.2 | 10.2 | 99.0 | 15.8 | 146.5 | 11.5 | 145.0 | 24.9 |
| | males | 98.2 | 4.3 | 114.2 | 15.1 | 149.2 | 8.5 | 142.2 | 18.9 |
| | mean | 106.7 | 11.5 | 106.6 | 16.4 | 148.0 | 9.3 | 143.6 | 20.9 |
| AST/ALT ratio | females | 0.79 ^c | 11.4 | 0.92 ^B | 8.0 | 0.80 | 27.3 | 0.83 | 28.4 |
| | males | 0.7B ^C | 17.1 | 0.95 ^{Cc} | 10.4 | 0.60 | 14.6 | 0.75 | 9.8 |
| | mean | 0.74 | 14.9 | 0.93 | 8.9 | 0.68 | 26.4 | 0.79 | 21.5 |

^{A, B, C} – differences significant in columns at $P \leq 0.01$,

^{a, b, c} – differences significant in columns at $P \leq 0.05$.

AST/ALT ratio is used to diagnose the hepatic damage. Its levels below 0.9 U^*l^{-1} indicate a hepatic parenchymal disease (Kokot and Kokot, 1997), and the physiological level of the ratio in mink should not fall below 1.0 U^*l^{-1} (Bis-Wencel et al., 2006). Normal values of AST/ALT ratio were found only in the control mink in

August. Values below $0.9 \text{ U} \cdot \text{l}^{-1}$ occurred in mink from the group fed with the probiotic in two months, whereas in the control group in September.

Figure 1 depicts the results of fur quality grading. There were no significant differences in the assignment to the quality classes after administration of probiotics. It is worth noting that in the group fed with probiotic-supplemented feed, there were individuals that had the best quality of fur, and none of the control-group mink has achieved the highest score for fur quality.

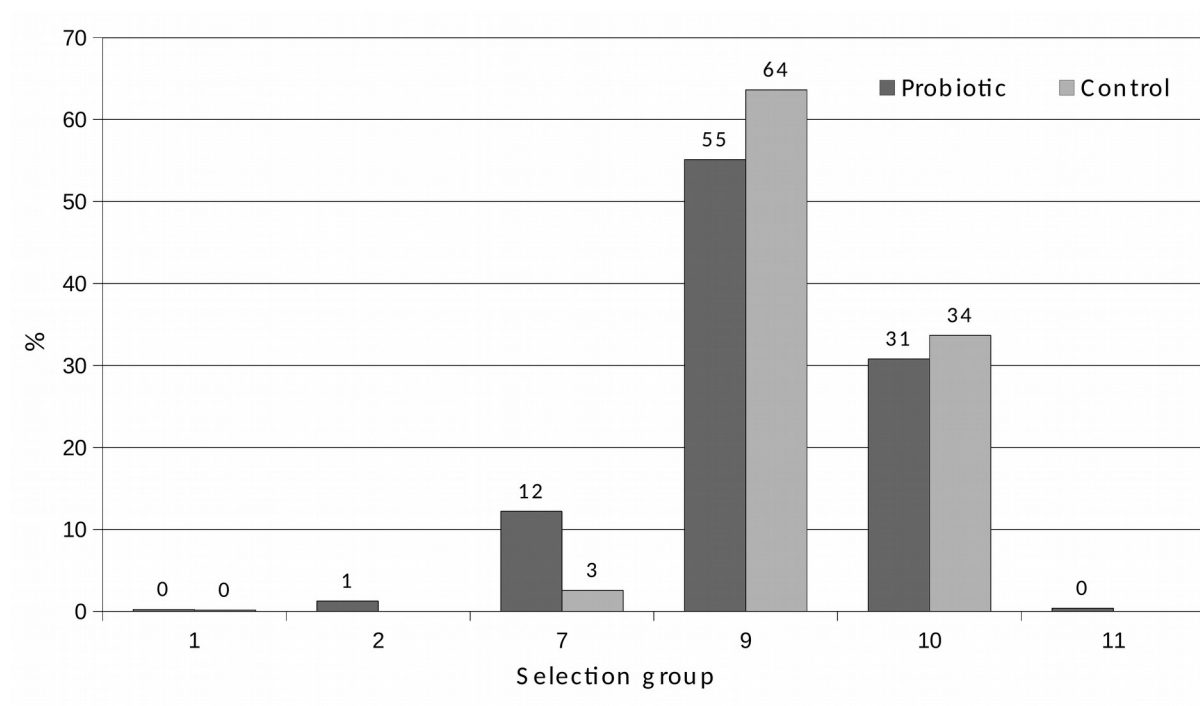


Figure 1. Fur quality of the studied mink

Rysunek 1. Jakość okrywy włosowej w analizowanych grupach norek

Discussion

Probiotics dietary supplementation in mink, applied from weaning until slaughter, resulted in increased body weight gains. Similar results were reported by other authors (Gugolek et al., 2004; Li et al., 2002; Lorek et al., 2001), who studied arctic foxes that attained higher body weight gains after probiotic supplementation. Probiotics added to the diet also resulted in an increased use of carbohydrates energy and higher nitrogen retention (Lorek et al., 1998). Application of a probiotic based on *Bacillus subtilis* or *Enterococcus faecium* in blue fox nutrition resulted in improved daily weight gains, increased nutrient digestibility and nitrogen retention, but also improved to the score attained for fur quality (Jungang et al., 2014).

The gastrointestinal tract in farm mink is relatively shorter compared to the wild forms of the species, due to farm feeding a feed processed into pulp (Gugolek et al., 2013). Those who are – because of that short digestive tract – skeptic to probiotic application in farm mink nutrition should accept the fact that retention of food passing

through the digestive tract of the farm American mink is longer compared to the wild mink, which was showed by Gugolek et al. (2013). These authors also found that farm mink have higher parameters of nutrient digestibility compared to mink living in the natural environment. Pedersen and Jørgensen (1992) analyzed the colonization of the mink gastrointestinal tract by lactic acid bacteria, *Enterococcus faecium*. These authors found high counts of bacteria in the digestive tract of mink even 4 days after discontinuation of probiotics supplementation. The positive effect of lactic acid bacteria on the reproductive performance of mink and fox blue was observed by Tauson (1984), who found an increase in the sizes of litters produced by females fed a diet supplemented with strains of lactic acid bacteria; also the mortality rate was lower.

According to Liu et al. (2013), there is no need for the feeding of mink of probiotic bacteria, since they do not improve animal growth and digestibility of nutrients; however, there are not many reports like this in the literature. McCartney (2011) observed, on the other hand, a very positive effect of probiotic nutrition of mink. The author found that probiotics used in the feed reduce stress the animals suffer under intensive management, reduce nuisance odors, improve the formation of stool and prevent constipation and, most importantly, improve the quality of fur, and above all its glitter.

One of the probiotic organisms is yeast. It was found that an addition of yeast to feed resulted in higher feed intake in arctic foxes; consequently, the animals attained higher body weight and better quality coat (Przysiecki et al., 2010). The increased weight gain observed in the experimental mink group in this study may be due to the presence of yeast *Saccharomyces cerevisiae*, as suggested by Przysiecki et al. (2010).

It was found in this study that the analyzed probiotic had a positive effects primarily on the body size, which translates to the size of the skin.

However, the composition of bacteria present in the studied formulation, i.e. yeast *Saccharomyces cerevisiae*, *Lactobacillus casei* and *Lactobacillus plantarum* should be considered. The latter two bacterial species have not been well described in terms of nutrition of fur-bearing carnivores. Most commonly used are strains of *Lactobacillus acidophilus*, *Enterococcus faecium*, and *Bifidobacterium bifidum*. AST/ALT ratio included in this analysis is used to evaluate serum transaminases, which include aspartate aminotransferase (AST) and alanine aminotransferase (ALAT). This indicator helps in the diagnosis of hepatic and biliary tract diseases (Arthi et al., 2011). The presented trial revealed a disturbing level of this ratio in the animals treated with the probiotic, since it dropped below 0.9.

Conclusions

The dietary probiotic supplementation applied in farm mink nutrition had a positive effect on body weight, particularly in males. Another beneficial effect was an improvement of pelt quality, since the animals fed a probiotic preparation appeared in the best class of fur quality.

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