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**Effect of antioxidant supplemented-diet for blue fox
on chosen reproductive and performance parameters**

Wpływ dodatku przeciwutleniacza do karmy lisów polarnych
na parametry rozrodu i produktywności

Summary. The investigations included adult female blue foxes and their offspring at a fox farm. The diet for carnivorous fur animals was improved with a synthetic antioxidant to protect feed components. The influence of a chosen antioxidant on some reproductive traits and performance parameters was determined.

The antioxidant dose introduced to a feed (Rendox) proved to benefit the animal health status. The females from the basic herd that received the antioxidant showed higher reproductive parameters as well as higher body weight at slaughter. Besides, the animals were positively scored at the licence (conformation) evaluation as compared to the females from the control group.

Key words: nutrition, antioxidant, reproduction, performance, fox

INTRODUCTION

The domestication process of non-companion fur carnivores has proceeded for nearly a hundred years and it still faces numerous questions of ethics. Besides, the comprehensive set of standards concerning animal welfare administered by the international organizations as well as requirements from the ecological and antifur movements appear to be extremely stringent as well [Niedźwiadek *et al.* 1996].

It was found that the animals maintained under the optimum housing and management conditions as regards their behavioral, mental state and physical health are characterized by higher reproductive parameters [Bakken 1994]. On the contrary, the ill-treated individuals with life-safety violation, showing physiological signs of stress do not reach good-quality reproductive traits.

Stress responsiveness reduction is possible through selective breeding of animals and gentle handling procedures [Bakken *et al.* 1994]. The studies conducted by Hansen [1998] revealed that blue fox females of calm temperament rear more numerous litters compared to the non-selected ones. The same holds true for common fox females.

According to the current European regulations, a weaned fox cub should have access to an elevated resting platform so that it could rest and observe the surrounding from up there. Besides, the European Fur Commission recommends providing animals with special chewy stuff for biting [The welfare... 2001].

In order to maximize profits of fur manufacturers, there have been carried out special selective one-sided breeding programs designed to obtain big-sized skins and this direction leads to reduction of the reproduction utilization period length. The breeders, however, implement the latest research findings concerning improvement of the animal living conditions, e.g. cage size, their additional equipment or air composition monitoring. It is attributed to the tough market competition on the one hand where only the producers of best quality fur pelts count and the national and European Union legislation on the other. It is noteworthy that these strict EU laws are superior to the national ones.

Successful animal management – rearing and breeding practices – at a fur farm is strongly related to a large number of contributing factors that form three major groups of issues, i.e. animal welfare, a crucial environmental factor – nutrition and the veterinary care and zootechnical procedures employed.

The objective of the present research was to determine the effect of a chosen antioxidant supplement to the diet for Arctic fox (*Alopex lagopus*) on some reproductive parameters and performance.

MATERIAL AND METHODS

The investigations included the adult polar fox females and their offspring maintained in a selected fur farm in the Podkarpackie region.

The experimental group (group D) was constituted by mature dams (20 animals) and their offspring at an equal sex ratio (10 animals of each sex), whereas the control group (group K) comprised the adult females (20 units) and their offspring at an equal sex ratio (10 animals of each sex).

The animals from groups D and K (both juvenile and adult) received the feedstuff of the same formulation and energy level (Tab. 1).

Feed ration level for females at the pre-mating period was established individually, subject to animal body condition. To satisfy the nutritional requirements of the animal at different developmental stages, the animal diet composition was supplemented with minerals and vitamins adding vitamin-mineral premix Guyfox rich in vitamin E, B and Fe.

Throughout the research period in both groups, dietary preservative sodium pyrosulfite (E223) was used at the rate of 0.2–0.3% per 1 ton of ready feedstuff at spring-summer season and 0.1–0.15% at autumn-winter period.

The animals from the experimental group (D) were supplied with a preservative-supplemented feedstuff (like in group K) and additional antioxidant Rendox at the amount of 200–250 ml per 1 ton of poultry-meat feed stored in the refrigerated state.

Table 1. Nutritional value of dietary unit of blue foxes
 Tabela 1. Wartość pokarmowa dawki żywieniowej lisów polarnych

Feed Pasza	Raw material % in dose Udział surowca w dawce, %			
	1 XII–1 V	2 V–15 VII	16 VII–30 IX	1 X – slaughter (1 X – do uboju)
Plaice, cod – 10% (post filleting offals) Flądra, dorsz – 10% (odpadki pofiletowe)	47	30	5	55
Greaves Skwarki	5	5	-	-
Poultry offals mixed Odpady drobiowe mieszane	13	30	55	-
Soybean-fish meal or meat-bone meal (50%) Mączka sojowo-rybna lub mięsno-kostna (50%)	6	5	10	11
Animal fat Tłuszcz zwierzęcy	-	-	2	4
Cereals (wheat-dry ground grain) Zboże (pszenica-śruta sucha)	10	11	12	13
Wheat bran Otręby pszenne	1	1	1	1
Water Woda	18	18	15	16
EM kcal/kg EM kcal/kg	1220	1360	1700	1830
EM kcal/kg % in a dose of Procent udziału EM kcal/kg w dawce				
– protein – białka	50.0	43.0	31.0	28.2
– fat – tłuszczu	33.4	40.8	54.6	57.3
– carbohydrates węglowodanów	16.6	16.2	14.4	14.4

The animals from both groups under investigation were provided with feed ad libitum and had free access to water.

Evaluation of animal performance in both groups (K and D) was performed through determination of the following parameters: percentage of mated/barren females, per cent of cub-killing dams (infanticidal behaviour), average size of litter at birth and weaning and number of pups per statistical female.

Measurements of fox body weight (groups K and D) were made at cub weaning period (VIII), intensive growth and hair coat maturity (X) and finally, at slaughter (XI).

The licence evaluation carried out by the assessor officially recognized by the National Animal Breeding Centre included body size, conformation, colour type, fur colour purity and hair coat quality.

The obtained results were analyzed statistically calculating the arithmetic means (\bar{x}) and standard deviation (SD). The statistical significances for the studied parameters were calculated using the variance analysis for double and triple cross-classification at weight restrictions. There were assumed two significance levels, i.e. $p \leq 0.01$ and $p \leq 0.05$, while the numbers denoted with the same letters differed statistically significant.

RESULTS AND DISCUSSION

Blue foxes are characterized by high fertility and prolificacy. Therefore, any negligence resulting in the impaired animal welfare state, disease incidence or reproductive problems contribute to lower profitability of fox farm breeding. As for the monoestrus animals, including Arctic fox, the situation is particularly disadvantageous as a lack of offspring greatly increases barren female farming costs in a given productive year. Production efficiency depends largely on the increased number of newborn and reared pups [Socha 1994, Socha *et al.* 2004].

Table 2. Chosen reproductive parameters of blue foxes
Tabela 2. Wybrane wskaźniki rozrodu u lisów polarnych

Parameters Parametry	Group K Grupa K	Group D Grupa D
% mated female foxes % samic pokrytych	100	100
% infertile females % samic jałowych	50 a	33.3 a
% females killing cubs % samic niszczących szczenięta	25 a	16.7 a
Average litter size at birth (unit) Średnia wielkość miotu przy urodzeniu (szt.)	5.75 a	6.5 a
Average litter size at weaning (unit) Średnia wielkość miotu przy odsadzeniu (szt.)	3.5 a	4.75 a
Number of cubs per statistical female (unit) Liczba szczeniąt od statystycznej samicy (szt.)	1.75 a	3.2 a

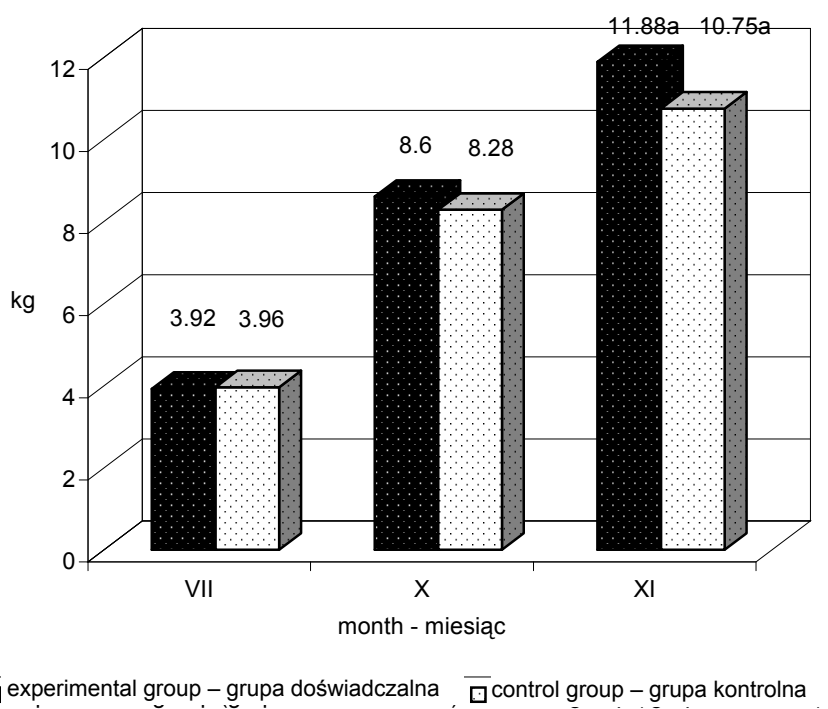
a – differ significantly at $p \leq 0.05$

a – różnią się istotnie statystycznie przy $p \leq 0,05$

Besides, animal age and origin prove to be determinant factors. In most fur farms, selection is performed after the first or second year of animal utilization. The studies by Socha *et al.* [1999] revealed that as for common silver foxes the highest reproductive performance was reported for the 4-year old vixens, described as half-import, that is one of the parents was imported. Similarly, a number of newborn pups is not a decisive factor concerning the number of reared offspring, despite the high correlation between these parameters observed in various species of fur animals [Socha and Adamska 2001]. Studying the reproduction-related issues, it should be noted that the current situation necessitates further

improvements in the animal nutrition management, like infection rate reduction or more efficient insemination techniques. That may be achieved with widely understood environmental factors. Therefore, it may be concluded that the research on the optimum systems to be employed in the carnivorous fur animal farming, including foxes, together with nutritional studies are justifiable from the economic standpoint as well [Śmielewska-Łoś 2002].

According to established experience and scientific knowledge, traditional feeding regimes of animals prior to reproduction season at high temperature causes their excessive obesity which in turn, delays the reproductive period in the consecutive year as well as decreases reproduction parameters. The research proved that introduction of a restricted feeding strategy (full ration every second day and half a ration every day) benefited female and male body weight losses and accelerated the reproductive readiness by approximately 7 days. Besides, the experimental group D obtained a higher percentage of mated females and lower of barren ones [Zoń *et al.* 1996]. The mean values of the analyzed parameters are summarized in Table 2.



a – differ significantly at $p \leq 0.05$

a – różnią się istotnie statystycznie przy $p \leq 0,05$

Fig. 1. Comparison of body weight measurements of blue foxes (*Alopex lagopus*)

Rys. 1. Zestawienie pomiarów masy ciała lisów polarnych (*Alopex lagopus*)

Higher reproductive indices were established for the dams from group D. The present studies showed that the females fed an antioxidant-supplemented diet had a higher

index of litter size at birth and weaning. These animals were also observed to have a lower share of barren and cub-killing vixens. The values were statistically significant. The present research results demonstrated lower parameters as compared to those reported by Kopczewski *et al.* [2001].

Here it is important to point out that according to the data provided by the Polish Association of Fur Animal Breeders and Producers, the year 2005 was considered as extremely disadvantageous for fur animal performance. At that time in numerous objects, there was recorded a high mortality rate among juveniles for no identified cause, as well as a high level of dam barrenness.

Table 3. Licence evaluation of blue foxes
Tabela 3. Ocena licencyjna lisów polarnych

Score parameters Parametry oceny	Score (min-max) Ocena	Group K Grupa K		Group D Grupa D	
		♀	♂	♀	♂
Size and shape Wielkość i budowa	0–6	6.00±0.00	6.00±0.00	6.00±0.00	6.00±0.00
Colour type Typ barwny	0–3	3.00±0.00	3.00±0.00	3.00±0.00	3.00±0.00
Fur colour purity Czystość barwy okrywy włosowej	0–3	2.75±0.43	3.00±0.58	2.22±0.45	2.33±1.15
Fur quality Jakość okrywy włosowej	0–8	6.00±0.00	6.00±0.58	5.80±0.84	6.33±1.15
Total score Łączna ocena	20	15.25±4.76	19.00±1.00a	17.00±0.71	17.67±2.31a

a – differ significantly at $p \leq 0.05$

a – różnią się istotnie statystycznie przy $p \leq 0,05$

During the study period, body weight measurements were performed three times (Fig. 1). The cub body weights in both groups recorded at first measurement series were at the same level, whereas those taken in October (second series) showed a slight difference in favor of animals from group D. The statistically significant differences between body weights of both groups were noted in November, that is the third measurement series. The foxes from the group fed the antioxidant-supplemented diet obtained the average body weight about 12 kg, while the control animals were lighter by about 1.5 kg on average.

Comparing the present research results with others [Nowakowicz-Dębek 2006], slightly higher body weights were noted, especially in group D, which may be attributed to a beneficial impact of the antioxidant.

The data summarized in Table 3 concern animal conformation and qualitative evaluation of hair coat. It was found that animals of both sexes had the top scores for size and shape as well as color type. Comparing the total scores obtained by males and females of the analyzed groups, higher results were reported for the females from the experimental group and the males from the control. However, the average licence evaluation results for the animals from K and D groups indicate some higher scores for

the individuals from the group with antioxidant dietary supplement. Similar results were reported by Gugolek *et al.* [1999] employing a preparation promoting nutrient digestibility and at the same time reducing putrefaction process in the digestive system. The data is also consistent with the licence evaluation scores carried out by Nowakowicz-Dębek [2006].

CONCLUSIONS

The females from the basic herd fed the antioxidant-supplemented diet showed higher reproductive parameters, higher body weight at slaughter as well as higher scores at licence evaluation compared to the dams from the control group.

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Streszczenie. Badaniami objęto dorosłe samice lisów polarnych oraz ich potomstwo w wytypowanej fermie. Do karmy podawanej mięsożernym zwierzętom futerkowym wprowadzono syntetyczny przeciwutleniacz, by zabezpieczyć jej komponenty. Określono wpływ dodatku wybranego przeciwutleniacza na wybrane parametry rozrodu i produktyjności.

Zastosowana dawka przeciwutleniacza (Rendox) wpłynęła korzystnie na stan zdrowia zwierząt. Samice stada podstawowego otrzymujące w karmie przeciwutleniacz charakteryzowały się lepszymi wskaźnikami rozrodu, wyższą masą ciała przy uboju i uzyskiwały wyższą punktację w ocenie licencyjnej w porównaniu z samicami z grupy kontrolnej.

Słowa kluczowe: żywienie, przeciwutleniacz, rozród, produktyjność, lisy