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Effect of Slaughter-House Offal and Fish Levels on Production Performance in Mink and Blue Fox

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Abstract

The present study evaluates growth, fur properties, health condition and reproduction performance in mink (*Neovison vison*) and blue fox (*Vulpes lagopus*) during growing-furring and reproduction periods. Diets compared were: Diet A, which was composed of a high amount of slaughter-house offal but less fish products than normal, and diet B, which was composed of low amounts of slaughter-house offal but increased fish production content. Whelping succeeded better in animals on diet B than on diet A. The difference in whelping result between diets was 0.6 kits/mated female for mink ($P < 0.05$) and 0.4 kits/mated female for blue fox. At age 6 weeks, the difference was significant ($P < 0.05$) only in mink, *i.e.*, 0.8 kits/mated female. Calculated per whelped female, the difference was most pronounced in mink (0.6 kits; $P < 0.05$). The weights of vixens at 6 weeks were similar with diets A and B in both species. In mink and blue fox, the body weights of male and female kits were higher with diet B ($P < 0.05$). During the growing period, weight gain was better with diet B ($P < 0.05$). Final body weights were higher in males on diet B ($P < 0.05$). A similar tendency was found in females. In blue fox, the skin was significantly longer in animals on diet B ($P < 0.05$). Significant differences were not found in fur mass, cover or quality. In mink, skin length was similar in both diets. Significant differences were not found in fur properties between the diet groups. The conclusion is that diet B can be better recommended instead of diet A.

Keywords

Farmed Furbearers, Feed Ingredients, Growing, Reproduction, Fur Production

1. Introduction

The main ingredients in fur animal feed are products of the fish and slaughter industries. Typically their amounts

vary by year and season [1]-[4]. Different diets are often manufactured for farmed mink and foxes. The mink (*Neovison vison*) is a semi-aquatic mustelid (Family *Mustelidae*) whose living environment in the wild is associated with water systems such as streams, riverbanks, lake shores and marine shore marshes. The amount of aquatic food, e.g., invertebrates and fish, in its diet ranges from 30% to 70% [5] [6]. Thus, mink has adapted to substantial variations in the composition of feed. On fur farms today, fish products account for approximately 30% of total food supply. The other common furbearer on fur farms is blue fox, a colour type of the wild Arctic fox (*Alopex lagopus*). The composition of the diet of wild foxes typically varies even more than does that of mink [7] [8] [9]. In an Arctic habitat, foxes tend mainly to eat meat and food scraps whereas in a coastal area, their diet may comprise mainly even fish [10]. Foxes have therefore adapted to marked regional, annual and seasonal fluctuations in food availability and content.

Although farmed mink and blue fox have been fed fish and slaughter-house products for more than 50 years, we still lack sufficient understanding on the proper use of these specific ingredients [3] [9] [11] [12]. Previously, a study on effect of slaughterhouse offal and fish mixture on production performance of blue and silver foxes has been carried out [13]. Slaughterhouse diet did not contain fish and, correspondingly, fish diet did not contain slaughterhouse offal. There were no great differences between diets in the body weights of animals at pelting. Fur characteristics, on the other hand, were better in both species on fish mixture based diet [13]. In the present study, farmed mink and blue fox were fed with two different diets. Diet A comprised a high amount of slaughter-house offal but a lower amount of fish products than normal. Diet B comprised lower amounts of slaughter-house offal but increased fish product content. The aim was to clarify the effects of these two different diets on growth performance and fur properties in juveniles and on reproduction result in adults.

2. Material and Methods

2.1. Experimental Animals and Set-Up

The study was performed at the Fur Farming Research Station, Kannus (MTT) during two seasons: 1) the breeding period from March to June, and 2) the growing period from July to November. The use of experimental animals was evaluated and approved by the Animal Care Committee of MTT Agrifood Research Finland. The animals were standard coloured dark mink and blue fox. All animals were born in May. Only healthy animals free from plasmocytosis were used. Study groups were made genetically equal so that one kit from same litter was placed to each group. Experimental diet groups were: 1) Diet A, which was composed of a high amount of slaughter-house offal and a low amount of fish products; and 2) Diet B, which was composed of lower amounts of slaughter-house offal but increased fish product content (see **Table 1** and **Table 2**). The groups in the growing experiment were formed at weaning (9 July) and comprised kits selected from those born in the breeding experiment. N = 60 mink and N = 40 blue foxes of both sexes were used for the growing experiment. 48 mink and 70 blue foxes of both sexes were selected for the reproduction experiment. The general health of the animals was checked daily. Health evaluation was based on general appearance of animals, including consistence of faeces.

The animals were housed singly for the reproduction experiment and in pairs for the growing experiment. The mink cages were 70 cm long × 30 cm wide × 38 cm high. Each cage also contained a wooden nest box (22 cm wide × 30 cm long × 40 cm high) with ample bedding material (hay, straw). Daily routine treatments were conducted according to standard farming procedures [9]. The fox cages were 105 cm long × 115 cm wide × 70 cm high. Each cage had a wire-mesh platform (105 cm long × 25 cm wide) and a wooden block for chewing (diameter 7 cm, length 35 cm).

2.2. Diets and Feeding

Details of the raw materials and chemical compositions of the experimental diets are shown in **Table 1** and **Table 2**. Diets were the same throughout the study. Vitamins per kg of food were: retinol 1.05 mg; cholecalciferol 0.009 mg; alpha-tokopherol 40 mg; thiamine 15 mg; riboflavin 6 mg; cyanocobalamin 0.02 mg; pantothenic acid 5 mg; nicotine acid 10 mg; pyridoxine 3 mg; folic acid 0.3 mg; biotin 0.04 mg (**Table 1**). Furthermore, 1 kg mixture food contains: calcium 16.0%; phosphorus 11.0%; magnesium 4.0%; cobalt 40 mg; copper 150 mg; iron 6500 mg; manganese 3000 mg; zink 6000 mg.

Freshly mixed feed was supplied twice a day during July-mid-September. Thereafter, animals were fed once a

Table 1. Composition of experimental diets (%) with vitamin content[1].

Ingredients	Diet A	Diet B
Slaughterhouse offal	50.0	26.0
Fish offal[2]	-	15.0
Fish mixture[2]	15.0	16.0
Cooked barley	3.0	5.5
Soybean oil	0.5	2.1
Potato mass	-	0.5
Water	31.5	34.9

[1]Vitamins per kg of food: retinol 1.05 mg; cholecalciferol 0.009 mg; alpha-tokopherol 40 mg; thiamine 15 mg; riboflavin 6 mg; cyanocobalamin 0.02 mg; pantothenic acid 5 mg; nicotine acid 10 mg; pyridoxine 3 mg; folic acid 0.3 mg; biotin 0.04 mg; [2]Cod 50.0%, Baltic herring 50.0%.

Table 2. Chemical composition and calculated contents of metabolizable energy (ME) in experimental diets.

Variable	Diet A	Diet B
Dry matter (DM), %	31.6	28.6
In DM%, ash	11.7	10.8
Crude protein	47.3	45.0
Crude fat	22.8	19.4
Crude carbohydr.	18.2	24.8
ME (MJ/kg DM)	17.7	16.8
From ME%: protein	42.9	42.9
Fat	46.2	41.5
Carbohydr.	10.9	15.6

day. The feed was dispensed by a commercial feeding machine. Leftovers were collected the next day. Watering was automatic *ad libitum*. Daily feed portions were adjusted according to the animals' appetite and seasonal standards [12] [14]. The average amount of feed given to mink daily was 250 g/animal and to foxes 800 g/animal.

2.3. Breeding Experiment

Animals were mated according to normal mating routines [12] [15]. Before the breeding season, the testicles of breeding males were palpated to check normality. Mink females were mated according to the 1 + 8 system [1] [16]. Foxes were artificially inseminated according to normal farming practice. All vixens were primiparous. Conventional breeding boxes (60 cm long × 45 cm wide × 45 cm high) were placed inside the cages two weeks after the animals had mated. At whelping, the date of parturition and the number of live-born and stillborn kits were recorded. The whelping result was calculated at 1 day and 6 weeks. Vixens and kits were weighed at age 6 weeks with a Mettler SM 15 balance, accuracy ±1 g.

2.4. Growing Experiment

Initial and final body weights were measured with a Mettler SM 15 balance, accuracy ±1 g. Haemoglobin was measured in male mink in July and September [12] [17]. The animals were pelted according to the conventional pelting procedures used on farms. Mink were killed by engine-produced CO and foxes by electric shock. Fur properties were evaluated by the Finnish Fur Sales Co at the Fur Center, Vantaa. The fur characteristics evaluated were colour, mass, cover, overall impression and quality [9] [18] [19]. The scale ranged from 1 (poorest) to

10 (best). Carcass examinations were carried out by a veterinary surgeon immediately after pelting.

2.5. Statistics

Statistical analyses were performed by the General Linear Models (GLM) procedure of the Statistical Analysis System [19] using Tukey's studentized range (HSD) test and analysis of variance [9] [12]. The experimental factor in the study was the diet. Data are given as mean ± standard deviation (SD).

3. Results

3.1. Breeding Period

The appetite of the animals was good. No diarrhoea was found. In mink, daily feed consumption in April was 207 g/animal with diet A and 210 g/animal with diet B. The daily consumption values in May were 346 g and 355 g/animal, respectively. In June, mink females on diet A consumed 829 g/animal and those on diet B 854 g/animal daily. In blue fox, daily feed consumption in April was 264 g/animal with diet A and 243 g/animal with diet B. The daily feed intake values in May were 576 g and 456 g/animal, respectively ($P < 0.05$). In June, the average daily consumption of blue fox vixens on diets A and B was 1646 and 1636 g/animal, respectively. The animals' health was good.

Reproduction results are given in **Table 3**. Whelping performance tended to be better in animals receiving diet B. This held true for both species. In mink and blue fox, the whelping difference between diets at birth was 0.6 kits/mated female with diet A ($P < 0.05$) and 0.4 kits/mated female with diet B. At age 6 weeks the difference was clear only in mink, *i.e.*, 0.8 kits/mated female ($P < 0.05$). Calculated per whelped female, the difference was highest at 6 weeks in mink (0.6 kits; $P < 0.05$).

The body weights of vixens at age 6 weeks were similar for both species with diets A and B (**Table 4**). In both mink and blue fox, the body weights of male and female kits were higher with diet B.

3.2. Growing Period

Body weights and fur properties are shown in **Table 5** and **Table 6**. In both sexes, weight gain was better in animals on diet B ($P < 0.05$). Final body weights were higher in males on diet B ($P < 0.05$). A similar tendency was noted in females. In blue fox, the skin was also significantly longer in animals on diet B ($P < 0.05$). Significant

Table 3. Reproductive performance in mink and blue fox vixens. For diets see **Table 1**. Statistical significance between diets within species: $^{*}P < 0.05$.

	Blue fox		Mink	
Variable	Diet A	Diet B	Diet A	Diet B
Mated females, N	48	48	70	70
Whelped females, N	42	44	53	58
Barren females, N	6	4	16	12
Females lost kits, N				
At 1 day	2	3	-	-
At 6 weeks	5	4	4	1
Kits per mated female				
At 1 day	7.94 ± 3.0	8.35 ± 3.6	3.62 ± 2.4	4.23 ± 2.7*
At 6 weeks	6.67 ± 4.6	6.9 ± 4.4	3.05 ± 2.6	3.87 ± 2.5*
Kits per whelped female				
At 1 day	9.07 ± 3. 2	9.11 ± 3.3	4.71 ±2.2	5.10 ± 2.8
At 6 weeks	8.65 ± 3.2	8.38 ± 3.5	4.03 ± 2.5	4.67 ± 2.6*

Table 4. Body weights (g) of vixens and kits at age of 6 weeks. Statistical significance: $^{*}P < 0.05$. For diets see **Table 1**.

	Blue fox		Mink	
Variable	Diet A	Diet B	Diet A	Diet B
Vixens	5795.5 ± 552.5	5791.5 ± 593.9	897.8 ± 109.5	932.1 ± 125.4
Male kits	1081.0 ± 206.7	1267.9 ± 260.5*	240.6 ± 65.3	304.3 ± 72.2*
Female kits	1062.1 ± 186.8	1227.4 ± 226.0*	219.9 ± 60.1	282.5 ± 63.2*

Table 5. Body growth and fur properties in juvenile blue foxes. Initial body weights (BW) were measured on 9 July, final body weights were measured on 18 November. Data are given as mean ± SD. Fur properties were evaluated only in males. N = 40 animals. Statistical significance: $^{*}P < 0.05$.

Variable	Diet A	Diet B
Initial BW, kg		
Females	1.81 ± 0.32	1.55 ± 0.41
Males	1.87 ± 0.32	1.61 ± 0.3
Final BW, kg		
Females	10.04 ± 1.37	10.56 ± 1.39
Males	11.11 ± 1.44	11.84 ± 1.32*
Skin length, cm	66.0 ± 3.8	72.4 ± 3.0*
Fur mass	6.5 ± 1.7	6.0 ± 1.8
Cover	8.0 ± 1.1	7.5 ± 1.8
Fur quality	6.0 ± 1.6	5.6 ± 1.6

Table 6. Body growth, haemoglobin and fur properties in juvenile mink. Initial body weights (BW) were measured on 9 July, final body weights (BW) were measured on 18 November. Data are given as mean ± SD. Fur properties and haemoglobin were evaluated only in males. N = 60 animals. $^{*}P < 0.05$.

Variable	Diet A	Diet B
Initial BW, kg		
Females	543.0 ± 74.5	603.2 ± 72.9
Males	634.6 ± 106.6	789.0 ± 104.2
Final BW, kg		
Females	1192.6 ± 137.5	1292.3 ± 195.8
Males	1949.0 ± 321.5	2340.7 ± 280.4*
Haemoglobin g/l		
22 July	139.5 ± 8.6	127.0 ± 15.2
21 September	183.5 ± 9.0	182.7 ± 9.6
Skin length, cm	115.3 ± 3.6	115.1 ± 4.0
Fur mass	5.4 ± 2.0	6.5 ± 1.7
Cover	6.6 ± 1.5	7.3 ± 1.6
General impression	6.9 ± 1.6	7.5 ± 1.8
Colour	8.3 ± 1.1	8.2 ± 1.0
Fur quality	5.1 ± 2.1	6.2 ± 2.2

differences were not found in fur mass, cover or quality. In mink, skin length was similar in both diet groups. Nor were there any significant differences in fur properties between diets.

The health of all animals was good. Haemoglobin values did not differ significantly between the mink groups (**Table 6**). The appetite of all animals was also generally good. No diarrhoea was found in any of the animals. Carcass autopsies at pelting revealed slight hyperaemia in 9 colons of mink fed diet A and in 8 of those fed diet B. Correspondingly, slight hyperaemia was found in 9 foxes fed diet A and in 7 fed diet B.

The average feed consumption in mink on diet A was 35.3 kg and in those on diet B 37.2 kg/animal for the entire study period (9 July-18 November; $P < 0.05$). In foxes, the values were 105.9 and 104.7 kg/animal, respectively. The difference between diets is significant ($P < 0.05$) for mink but not for foxes.

4. Discussion

The first period of the present study comprised the breeding season, *i.e.*, from March to June. The animals were handled and mated according to normal farming practice. Thus, the results can be expected to apply well to commercial farming routines [3] [12] [20]. The reproduction results indicated that whelping was less successful in animals receiving diet A, *i.e.*, feed containing a high amount of slaughter-house offal and a low amount of fish. This result was even more pronounced in mink. In blue fox, on the other hand, diet also affected the growth of young kits. This was attributed to the marked weight difference between diet groups at age 6 weeks. The effect of diets was also reflected in the lower number of mated females in animals fed diet A.

The appetite of farm mink and blue fox is normally good during the growing-furring period [3] [9] [12], as was also demonstrated by our feed consumption data here. The higher feed consumption by animals on diet B most likely explains the greater body weight gain in mink receiving diet B. In blue fox, on the other hand, feed intake between diet groups did not differ significantly. Even so, foxes on diet B had higher final body weights. This tempts us to conclude that foxes can better utilize a diet with a lower amount of slaughter-house offal and a higher amount of fish products.

Diets of mink and blue fox may vary seasonally, annually and regionally in the wild [5] [6]. The blue fox is living in the arctic region [7] which means that content and availability of its diet typically varies more than in the mink [8]. Mink is a semi-aquatic animal that have used to a diet with a higher amount of fish than given here in diet A. Actually, 15% of fish in the diet is less than half the minimum amount reported in the wild [5] [6]. It, therefore, came as no surprise that a low amount of fish had a negative effect on the production performance of mink. In our previous study, a high amount of fish products in diets had a favourable effect on growth performance, fur properties and digestibility compared with the normal level [9].

Mink as a semi-aquatic mustelid-like carnivore is accustomed to eating several types of fish products but also meat [5]. A higher amount of slaughter-house offal as such is therefore unlikely to produce the adverse effect noted here: it was probably mainly due to the low amount of fish in diet A [3] [20]. Blue fox is also a carnivore but its diet in the wild normally comprises more meat than does that of mink [7] [8]. Here, differences in diets between the studied parameters were less pronounced in blue fox than in mink. This is attributed to the fact that the fox is physiologically more carnivorous than mink.

In blue fox males, the higher final body weight in animals on diet B was also seen as longer skin length at pelting. This result was expected as body weight markedly affects skin length in this species [9] [21]. The skin length of females was not measured. In mink, there is also often a clear correlation between skin length and body size [21]. The mink skins in the present study, however, were of the same order of magnitude despite diet and differences in final weights. It would seem that the diet of mink did not have an adverse effect on actual body growth, only on the fattening process.

The health status of the animals studied was generally good. Mortality was low in both mink and blue fox irrespective of their diet. The haemoglobin concentrations measured were also within the range of normal values [12] [17]. Furthermore, there were no alarming findings in autopsies. The slight hyperaemia found in the colon of both species is typical under farm conditions. These observations tempt us to conclude that both diets are suitable for mink when evaluated only from the animal welfare point of view. In terms of production, however, diet B was more suitable for both mink and blue fox.

5. Conclusion

Diet A was composed of a higher amount of slaughter-house offal but a low amount of fish products than nor-

mal. The study showed clearly that diet A is less suitable than diet B for both mink and blue fox. The same result was found during both the growing-furring and the reproduction periods.

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