Effect of Fish Meal Level on Growth, Food Digestibility and Fur Properties of Farmed Mink (*Mustela vison*)

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Abstract. Our study sought to determine the effects of normal vs high fish meal levels in the diet on the growing-furring process and apparent food digestibility of farmed male mink (*Mustela vison*). The subjects were two groups of juvenile dark mink born in May and weaned in August. The experiment started after weaning with two diet groups: (1) normal level of fish meal (NOR), i.e. 4.5% of diet, and (2) high level of fish meal (HIGH), i.e. 10.0% of diet. We found that the mink on the high fishmeal (HIGH) diet consumed slightly more fresh food than the mink on the normal fishmeal diet (NOR) (total consumption 30.6 kg vs 28.1 kg). The mink in the NOR group ingested almost the same amount of food as dry matter and energy as the mink in the HIGH group. On October 22, the body weights of the HIGH group animals were significantly higher than those of the NOR animals. At the final weighing on December 3 (at pelting), a tendency for the body weights of NOR mink was noted to be lower than those of HIGH mink. Skin length was significantly shorter in NOR than in HIGH mink. The number of white wool skins (i.e. fur defect) was higher in NOR than in HIGH mink (4 vs 2 skins). Statistically significant differences in other fur variables were not found between the groups. The apparent digestibility of protein, fat and organic matter was significantly better in HIGH than in NOR mink. Our findings tempt us to conclude that the proportion of fish products, at least those of fishmeal, can be increased in the diet of farm-raised juvenile mink.

Keywords: farm-raised mink, feeding, fish products, diet, growing-furring period

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Abstrak. Penelitian bertujuan untuk menentukan pengaruh taraf tepung ikan secara normal vs. tinggi dalam ransum terhadap proses pertumbuhan dan kecernaan pakan pada *mink* (*Mustela vison*) yang diternakan. Subyek yang digunakan adalah dua kelompok *mink* berwarna gelap dewasa yang lahir bulan Mei dan disapih bulan Agustus. Percobaan dimulai setelah penyapihan dengan dua kelompok ransum: (1) ransum dengan taraf tepung ikan normal (NOR), yaitu 4.5%; dan (2) ransum dengan taraf tepung ikan tinggi (HIGH), yaitu 10.0%. Hasil menunjukan bahwa konsumsi pakan *mink* yang diberi pakan HIGH sedikit lebih tinggi dibanding NOR (konsumsi total 30.6 kg vs 28.1 kg). *Mink* pada kelompok NOR mencerna bahan kering dan energi dalam jumlah yang hampir sama dengan kelompok HIGH. Pada tanggal 22 Oktober, bobot badan *mink* pada kelompok HIGH secara nyata lebih tinggi daripada kelompok NOR. Pada penimbangan terakhir (3 Desember, saat *pelting*), kelompok NOR memiliki bobot badan yang lebih rendah dibandingkan kelompok HIGH. Panjang kulit secara lebih rendah pada kelompok NOR dibanding HIGH. Jumlah kulit bulu berwarna putih, yang merupakan bulu cacat, lebih banyak pada kelompok NOR dibanding HIGH (4 vs 2 kulit). Peubah bulu yang lain secara statistik tidak ada perbedaan yang nyata di antara dua kelompok *mink*. Kecernaan protein, lemak dan bahan organik lebih tinggi pada *mink* kelompok HIGH dibandingkan dengan NOR. Dapat disimpulkan bahwa bahan berupa produk ikan, paling tidak dalam bentuk tepung ikan, dalam pakan *mink* dewasa yang diternakan dapat ditingkatkan proporsinya.

Kata kunci: *mink* yang diternakan, pemberian pakan, produk ikan, ransum, periode pertumbuhan

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Introduction

Mink (*Mustela vison*) is a semi-aquatic mustelid (Family mustelidae) whose living habits in the wild are typically associated with various water system types such as streams, riverbanks, lake shores and marine shore marshes. However, the mink's commitment to an aquatic lifestyle varies. Its diet includes aquatic invertebrates and fish, the proportion of which may range from about 30 to 70%, depending on the season and habitat (Gerell, 1967; Dunstone and Birks, 1987). Most often the wild mink enters water to dive or swim when searching for food (Dunstone, 1978).

The composition of mink diet on farms has varied seasonally and yearly since mink farming began in the 1920s. Today, fish or fish products typically account for approximately 35-40% of the mink's total food supply. Thus, the fish content of the diet is now about half of the maximum the mink would eat in the wild. The current proportion of fish in the diet has changed little over the years (Berg, 1986). Various types of fish, fish products and fish oil have been tested on farmed mink, mostly with encouraging results (Skrede, 1978; 1979; Ahlstrom and Skrede, 1993; Rouvinen et al., 1996; Damgaard et al., 2000). These studies reveal that the mink lives well on various fish products as would be expected from its original feeding habits. Pure fish oil with a high fish fat content may, however, have an adverse effect on the welfare of mink (Tauson and Neil, 1991). More research is needed into the subject of high amounts of fish and fish products *per se.* Particular attention should be paid to the potential advantages of a high level of fishmeal on mink during their autumn growth. The expectation is that fishmeal, which contains less fat than fish oil, may be more suitable for mink.

We set out to establish the effect of a high vs normal fishmeal level on the body weight gain, food digestibility and fur properties of farmed mink during their growing-furring period. The amount of fish products in the diet is far lower than the estimated maximum. Our primary hypothesis was that the mink, as a semi-aquatic fish-eating mammal, is used to even high amounts of fish products in its diet. We, therefore, presumed that an increased level of fish products in the form of fishmeal would be not only useable but also advantageous to the growing-furring process and digestibility.

Materials and Methods

Experimental animals and set-up

The study was carried out at the Fur Farming Research Station, Kannus (MTT) during August-December. Litters were born in May. The use of experimental animals was evaluated and approved by the Animal Care Committee of MTT Agrifood Research Finland. The animals, dark male mink, were divided into two experimental groups after weaning: (1) normal level of fish meal (NOR), and (2) high level of fish meal (HIGH). There were 40 kits per group; all tested negative for plasmacytosis. They were housed singly in wire-mesh cages measuring 70 cm long x 30 cm wide x 38 cm high. Each cage also contained a wooden nest box (22 cm wide x 30 cm long x 40 cm high) with ample bedding material (hay, straw). Both experimental groups were genetically equal, one male kit from a single litter being taken into each of the groups.

Their daily routine treatments were conducted according to standard farming procedures (Korhonen and Niemelä, 1998).

Feed and diets

The feed was manufactured daily by the Fur Farming Research Station, Kannus (MTT). The raw materials and chemical compositions of the experimental diets are given in detail in Tables 1 and 2. The daily amounts of experimental raw materials were weighed with a balance, accuracy ± 10 g (Neigungswage Bauart FO, Dayton Vaaka, Finland and Josef Florenz AG, Austria) and mixed with a Stephan mixer (Stephan Universal machine, type UM 44, revolution speed 1500/3000 r/min, A. Stephan u. Söhne GmbH & Co, Germany). The feed samples for chemical analyses were collected during one week in August and October, and were analysed at the Feed Laboratory of the Finnish Fur Breeders' Association, Vaasa.

Freshly mixed feed was supplied twice a day during August-September, and thereafter once a day. Watering was automatic ad libitum. Daily feed portions were adjusted according to the animals' appetite and the seasonal standards of the Finnish Fur Breeders' Association (Berg, 1986). In practice, the feed allowance exceeded the animals' consumption. Feed consumption per produced skin is given in Table 3.

Weighing and fur evaluation

The animals were weighed every 4 weeks and at pelting with a Mettler SM 15 balance, accuracy ± 1 g. The animals were pelted on December 3 according to the conventional pelting procedures used on farms. The fur properties were evaluated by the Finish Fur Sales Co. at the Fur Center, Vantaa. The fur characteristics evaluated were colour shade, mass, cover, overall impression and quality. The scale ranged from 1 (poorest) to 10 (best). Fur defects were also evaluated.

Digestibility

Six dark male minks from both groups were studied for digestibility of diets. The digestibility experiment was performed by the AIA indicator method in digestibility cages, with 0.5 silicate (Celite 545) serving as an inert indicator. The experiment consisted of a 5-day preliminary period and a 7-day actual collection period. The animals received 275 g of fresh feed daily. Individual feed and faeces samples were taken before and during the collection period for detailed analyses. The samples were analysed at the laboratory of the Fur Farming Research Station, Kannus (MTT).

The apparent digestibility was determined according to the following equation:

$$\text{Apparent digestibility} = \frac{a-b}{a} \times 100$$

In which a=nutrient in feed/indicator in feed, b=nutrient in faeces/indicator in faeces. The metabolizable energy (ME) content of the diets was calculated using the factors 18.8 (protein), 38.9 (fat) and 17.2 (carbohydrates) per gram apparent digestibility nutrient (Tauson, 1988).

Statistics

Statistical analyses were performed by the General Linear Models (GLM) procedure of the Statistical Analysis System (SAS Institute Inc. 1988) using Tukey's Studentized range (HSD) test and analysis of variance.

Table 1. The composition of diets

Ingredient (%)	NOR	HIGH
Slaughterhouse offal	20.0	20.0
Fish mixture[1]	35.0	35.0
Cereal[2]	10.0	10.0
Meat feather meal	3.5	-
Soybean mean	2.5	-
Maize gluten	1.0	-
Fish meal	4.5	10.0
Soybean oil	2.0	2.0
Fish oil	1.5	-
Vitamins[3]	1.0	1.0
Minerals [4]	0.3	0.3
Water	18.7	21.7

NOR: normal level of fish meal, i.e. 4.5% of diet, HIGH: high level of fish meal, i.e. 10.0% of diet.
[1]Cod offal 50.0%, Baltic herring 50.0%; [2]Cooked barley and wheat; [3]1 kg mixture contains: calcium 16.0%; phosphorus 11.0%; magnesium 4.0%; cobalt 40 mg; copper 150 mg; iron 6500 mg; manganese 3000 mg; and zink 6000 mg.

Table 2. Chemical composition, and calculated contents of metabolizable energy in the diets

	NOR		HIGH	
Period	Aug-Sept	Oct-Dec	Aug-Sept	Oct-Dec
Dry matter (DM), %	37.7	37.7	34.7	35.5
In DM, %: Ash	8.6	8.5	10.8	10.5
Crude protein	36.2	34.8	44.1	38.9
Crude fat	26.7	28.9	23.5	25.0
Crude carbohydr.	28.6	27.8	21.7	25.6
ME (MJ/kg DM)	18.7	19.2	17.8	17.9
From ME, %: protein	32.8	30.8	39.7	34.8
fat	51.1	53.9	47.4	50.1
carbohydr.	16.1	15.3	12.9	15.1

NOR: normal level of fish meal, i.e. 4.5% of diet, HIGH: high level of fish meal, i.e. 10.0% of diet.

Table 3. The amount of feed and energy intake per animal, the body weights (BW) and fur properties given as mean ± standard deviation (SD)

Variable	NOR	HIGH
Eaten from given feed, %	88.0	95.0
Total feed consumption, kg	28.1	30.6
Total dry matter intake, kg	10.6	10.8
Metabolizable energy intake, MJ	201	192
BW on Aug 8	1526±188	1559±179
BW on Sept 24	1807±307	1857±212
BW on Oct 22	2031±355	2231±238**
BW on Dec 3	2205±444	2350±241*
Skin length, cm	70.6±5.2	74.1±3.0**
Colour shade	8.4±0.9	8.4±0.9
Mass	7.5±1.8	6.7±1.5
Cover	7.8±1.6	7.4±1.7
Quality	7.6±1.6	7.5±1.2
Overall impression	6.6±1.7	6.0±1.5
No. of white wool skins	4	2

NOR: normal level of fish meal, i.e. 4.5% of diet, HIGH: high level of fish meal, i.e. 10.0% of diet.
Significance: ** :P<0.01, * = P<0.1.

Results and Discussion

Feed consumption and growth

Three mink in the NOR and two in the HIGH group died before pelting. The reasons for their death are unknown.

Total feed consumption per group is shown in Table 3. The mink on a high fishmeal diet (HIGH) consumed slightly more fresh food than did the mink on a normal fishmeal diet (NOR). The mink in the NOR group ingested almost as much food as dry matter and energy as did the mink in the HIGH group.

The body weights of animals at the first two weighing (August 20, September 24) did not differ significantly between the groups (Table 3). On October 22, however, the body weights of the HIGH group animals were significantly ($P<0.01$) higher than those of the NOR animals. Furthermore, at the final weighing on December 3 a tendency ($P<0.1$) was found in the body weights of NOR mink to be lower than those of the HIGH mink (Table 3). The total body weight gain between the first weighing (August 20) and pelting (December 3) was significantly ($P<0.05$) higher in the HIGH than in the NOR animals.

Fur properties

Skin length was significantly ($P<0.01$) shorter in NOR than in HIGH mink (Table 3). The number of white wool skins (i.e. fur defect) was higher in NOR than in HIGH mink (4 vs 2 skins). No statistically significant difference in colour shade, mass, cover, quality or overall impression was found between the groups (Table 3).

Apparent digestibility

The results of the digestibility experiment are summarized in Table 4. The digestibility of both diets was comparable to that of the normal farm diet of mink. The apparent digestibility of protein, fat and organic matter was significantly ($p<0.05$) better in HIGH than in NOR mink.

The mink has adapted both physiologically and behaviourally to the exploitation of both terrestrial and aquatic prey in the wild. The proportions of these two food types depend on the availability of prey and its ease of capture (Dunstone, 1978). The results of our study showed that the farmed male mink did well with a higher amount of fishmeal in the diet than that of traditional use. Furthermore, a higher amount of fishmeal was found to improve the digestibility of food. This is not surprising as we know that the most important factor governing fat digestibility is fatty acid composition (Austreng et al., 1979; Ahlstrom & Skrede, 1995). Likewise, amino acid composition affects the digestibility of protein. The fat and protein composition of fish and fishmeal is typically good and thus beneficial for digestibility as clearly shown by the findings of the present study.

The appetite of farm mink is normally good during the growing-furring period, as also demonstrated by our feed consumption data. Furthermore, the higher feed consumption shown by the HIGH group mink reveals that feed palatability was better in the HIGH than in the NOR diet. Moreover, mink on the HIGH diet ate more when their intake was calculated not only as fresh feed but also as dry matter from the feed and energy. This finding is the most likely explanation for the HIGH diet mink being heavier than the NOR diet mink. A better growth rate and bigger body

size also produced larger skins, as seen from fur properties. Larger skins typically fetch better prices than smaller ones at auctions.

Fur properties and defects play a key role in estimating the effects of diet on farmed mink. The better the fur, the greater is the profit for the farmer. Good quality fur is also a general indication of good animal welfare and health. The occurrence of white wool skins is considered a fur defect and may often be due to an insufficient amount of certain ingredients or minerals in the diet. In our study, the number of skins with white wool was lower in mink on HIGH diets than in those on NOR diets. This finding suggests that high fishmeal *per se* had a beneficial effect on skin and fur. However, no statistically significant differences in other variables describing the properties of fur were found between the groups.

Farm animals may suffer when deprived of resources that exist in the wild. Recent debate on the welfare of farmed mink has raised the question of whether mink on farms need a permanent water pool where they can engage in fish-hunting behaviour (Korhonen and Niemelä, 2002; Vinke et al., 2008). This view is based on the lifestyle of mink, semi-aquatic animals, which have a clear commitment to living and hunting in water. Our present findings cannot be used to resolve the issue of the necessity of hunting and diving for farmed mink. Our results do show, however, that aquatic prey in the form of fishmeal as used here was advantageous to mink. Mink enjoy eating fish products and are used to high amounts of aquatic prey as part of their natural food.

The higher amount of fishmeal did not have any adverse effects on mink that we are tempted to recommend a higher amount of fish meal than that currently used be added to the daily farm mink diet during the growing-furring period. Further experiments with even higher amounts of fish and fish products than those used here should be made in the future.

Conclusions

A 5.5% higher content of fish meal than that normally used was found to have a favourable effect on the growth and skin length of mink and on the digestibility of food during the growing-furring period. The proportion of fish products, at least those of fishmeal, can be increased in the diet of juvenile farm-raised male mink.

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