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KIDNEY STONES IN MINK AFTER FEEDING ON FISH SILAGE

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Introduction

Preservation of fish for fur animals is usually done by cold storage. This is relatively expensive, and the refrigerative capacity is not always sufficient. Therefore, it may become necessary to preserve fish by ensiling. The preservatives could consist of acids such as hydrochloric acid, sulphuric acid, phosphoric acid, acetic acid or formic acid, or preservation could take place through lactic acid fermentation. The Heggedal Experimental Farm has been working on ensiling fish. In 1942-43, experiments were carried out with silver and blue fox. 25% of the protein in the feed consisted of herring ensiled with AIV acid or formic acid (Fyrileiv and Helgebostad).

Condensed milk preserved in phosphoric acid was tested as well. Subsequently, many scientists have studied fish silage as feed for fur animals (Jensen & Jorgensen 1975, Losnegard, Tertnes, Boge & Loftsgaard 1974, Froysedal 1977). These experiments involved the eventual harmful effects of inorganic acids and alkalies used as preservatives.

Experiments were conducted with feeding fish silage to young mink during the growth period extending from July 1 to the beginning of December. 100 young minks were involved, divided into five groups with an equal number of males and females in each group. The control group was fed a feed with the following composition:

Table 1

Fôrets sammensetning i prosent og næringsinnhold.
(The composition in percent and nutritional content of the feed.)

Sløyet sei	(gutted coalfish)	64
Fiskemel	(fishmeal)	16
Tørrmelk	(dried sk.milk)	2
Talg	(tallow)	4
Sukker	(sugar)	1,2
Hvetegrop	(whole weat)	12,8

Vitamins were administered at the following daily doses per animal : Vitamin A 1,500 IU, vitamin D 150 IU, vitamin E 3 mg, thiamin 0.5 mg, riboflavin 0.4 mg, Ca-pantothenate 1.4 mg, nicotinic acid 1.7 mg, pyridoxine 0.3 mg, folinic acid 0.034 mg, biotin 0.01 mg, inositol 5 mg, and paraminobensoic acid 10 mg.

Prosent av energien fra: (percent of energy from:)		
Protein	(protein)	54
Fett	(fat)	24
Karbohydrater	(carbohydrates)	22
Beregnet askeinnhold våt basis	(ash content)	7,65

In the experimental groups, gutted pollack was replaced with an equal amount of fish silage. The fish silages were manufactured by the following method :

4.5 l AIV acid, 2 l formic acid (87 %), and 2 kg caustic lye were added to 100 kg portions of ground pollack. Caustic lye was dissolved in water prior to being mixed very well with the ground pollack. A fifth group received cooked pollack instead of raw.

To make the animals accustomed to these portions, they received during the first 14 days half a ration of the experimental feed, while the other half consisted of their standard feed. The feed of the AIV group was neutralized with 40 g $CaCO_3$ per kg silage and that of the basic group with 15 ml AIV acid per kg silage a few hours before feeding.

Results

The control groups that received gutted raw or cooked pollack ate their feed, but their growth was not optimal. The feces were thin and partially slimy. The young mink of the formic acid group did not approve of their feed. Their appetite was poor, and the experiment had to be interrupted after 3 weeks. The AIV group and the animals receiving the basic preserved feed had a satisfactory appetite during the first month of the experiment. In August/September their feed intake became uneven, and some feed was left uneaten. Their growth was much below that of the control group. The young mink drank a lot of water.

As no supplementary iron was given, the hemoglobin level of the young was lower than normal in all groups (Table 2), especially in the group receiving raw unpreserved pollack, two young of which group exhibited white underfur. In the other groups, fur quality was medium. One mink of the

AIV group and two of the basic group died during the last month of the experimental period. All three had kidney stones. At the end of the experiment, the animals were put to death, and their carcasses were investigated for occurrence of kidney stones.

The carcasses were small but in a good normal condition. The kidneys, ureters, urethras, and vesicae of 34 animals of the two silage groups were examined. Kidney stones partly lying in the renal pelvis were found. Otherwise, the macroscopic finds were negative.

The stones, which were small with uneven surfaces and a yellowish-white to brown color, were analytically shown to consist of triphosphate ($MgNH_4PO_4.6H_2O$).

Sections from these kidneys were histologically very similar to those of the two silage groups. Especially in the main section, there were distensions and evidence of epithelial cells and degenerative nuclear changes. The changes were the most distinct in the pars recta of the main section where cellular walls were in some areas indistinct and the tubules almost filled with sparsely eosinophile, fine-grained, or often homogeneous-looking cytoplasmatic masses. The nuclei were either pycnotic, lacking, or present in large numbers and collected in clumps indicating distinct proliferation but without signs of organized regeneration of the epithelia.

Deposits of calcium-like masses were found in different quantities in all animals. In HE-dyed sections, they exhibited a bluish color.

The deposits were found in the tubules and interstitially between the tubules. Mostly, they were localized in the marrow, but also found in the neck. Deposits were found in the adventitia of very many animals, especially in the major arterial branches such as the interlobular arteries. Deposits in the blood vessels were somewhat more homogeneous than the other deposits and exhibited a less intense blue color. Preparations from an animal fed acid

feed and one fed basic feed were examined by dying with the von Kossa method for calcium. Deposits in the renal center reacted positiv ely, while deposits in the adventitia of the bigger arteries of the neck gave no reaction.

Table 2

Antall dyr i forsøk, vekter, tisper, hanner, hemoglobin (Hb) og pelskvalitet.
(Number of animals, weights, females, males, hemoglobin (Hb) und fur quality).

Gruppe (Group)	Antall dyr	Gjennomsn.vekter, g 7/2 ♀	7/2 ♂	28/10 ♀	28/10 ♂	Hb, g/100 ml	Pelskvalitet totalinntrykk (Fur quality)
Rå, sløyet sei (Raw gutted coalfish)	20	550	630	1065	1510	16,3	4,7
Kokt, sløyet sei (Boiled, gutted coalfish)	20	517	640	935	1550	17,0	5,0
AIV-ensilasje (AIV-ensilage)	20	504	724	850	1225	16,5	4,6
Basisk ensilasje (Basic ensilage)	20	526	688	780	1120	17,0	4,4

Some individual animals of both groups showed scar-like stripes in the neck with connective tissue neoplasms in the interstitia as well as some occurrence of nephrons. It can be stated in brief that acute and chronic nephrotic changes with kidney stone deposits were observed.

Discussion

Silage constituted about 50 % of the protein in the experimental feed. In quantities as big as this, the silage had a negative effect on the appetite, especially the formic acid silage which made the group practically go on

a hunger strike so that the experiment had to be interrupted. Due to the reduced appetite, the growth was poor.

Poulsen & Jorgensen (1976) have demonstrated that a feed consisting of fish preserved with sulphuric acid or hydrochloric acid results in acidosis in mink. The risk of acidosis was high if pH in the feed was 5 or below 5. The risk of acidosis was reduced through neutralization of the feed with $\frac{1}{2}$ % $CaCO_3$. Occurrence of kidney stones is not mentioned.

In the present experiments, feeding great quantities of fish silage for about 5 months resulted in kidney tissue injuries (nephrosis) and deposits of kidney stones. The animals needed a lot of water to drink. When the acid and basic groups of the ensiled feeds are neutralized with $CaCO_3$ and AIV acid respectively, new salt compounds are formed and the ash content increases noticeably. This obviously led to an additional load on the kidneys and contributed to the kidney injuries and stones observed.

No kidney stones were found in blue fox and silver fox, when herring preserved with AIV constituted about 25 % of the feed protein in the growth period (Fyrileiv & Helgebostad 1942). The acid silage was manufactured and neutralized by a method similar to that used in the present mink experiments.

Occurrence of kidney stones has been described in connection with avitaminosis A and B_6 (Helgebostad 1954, Braulich 1974) and hypervitaminosis D (Helgebostad 1977). The daily doses of vitamins A, D, and B_6 lie, in the present experiments, within the optimal boundaries for fur animals. The same dosage has been used in other experimental studies of different feeds for mink without subsequent formation of stones in the urogenital system.

The risk of acidosis and kidney injuries with stone deposits in the kidneys indicates that silage preserved with inorganic acids must be used with caution as a feed for mink. Neutralization of the feed with $CaCO_3$ makes

the risk of acidosis smaller, but the possibility of kidney stone deposits is present.

In the winter, the addition of acid silage to the feed makes it more porous which means that the feed freezes to a hard, hardly edible mass.

Summary

Feeding experiments have been carried out with standard mink on a diet where 50 percent of the protein came from fish ensilage. AIV acid (H_2SO_4, HCl) or NaOH was used for preserving. Before feeding the ensilages were neutralized with $CaCO_3$ in the AIV group and AIV acid in the basic group.

The high presentage of fish ensilage in the feed had a negative influence on the appetite. The pups did not grow very well.

During the experimental period from weaning to pelting time the animals got kidney damages (nephrose), and small kidney concrements were seen in both groups. Analyses of the concrements showed that they were containing triple phosphate ($MgNH_4PO_4 6H_2O$)

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