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## NURSING ANEMIA IN MINK

By

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Research work on the etiology of nutritional disorders in lactating mink has so far been carried out only to a limited extent. Nutritional diseases occurring in lactating females are described by American workers as "Nursing sickness".

Lack of appetite, emaciation and anemia are mentioned as symptoms (*Hartsough & Gorham*, 1961). Anemia in young mink kits (3—5 weeks old) is described by *Momberg-Jørgensen* (1952). Anemia arising in weaned mink kits as a result of feeding with certain kinds of raw fish is described by *Helgebostad* (1957), *Helgebostad & Martinsons* (1958) and *Stout & al.* (1960). This form of anemia appears to certain extent to be an hereditary condition.

### MATERIAL AND METHODS

The experiments, which were started in the beginning of December 1959, and ended on July 1st 1960, included 85 female mink and 273 mink kits divided into four groups. The animals in all groups were fed a basal diet of the following percentage composition: Ground wheat meal 12.5, sugar 3.1, skim-milk powder 3.1, tallow fat 3.1, arachis oil 0.6, brewers yeast 3.1. The animals received daily doses of: Thiamin 0.2 mg, riboflavin 0.2 mg, pyridoxine 0.1 mg, folic acid 0.017 mg, biotin 0.01 mg, Ca-pantothenat 0.7 mg, niacin 0.8 mg, inositol 5.0 mg, cholin 25.0 mg, vitamins A 1500 I.U., D 200 I.U. and E 4—6 mg, ascorbic acid 5 mg and 0.25 g common salt. In addition to this basal diet, one group of animals (gr. 4) was fed slaughter offal (tripe with connecting spleen) in amounts corresponding to 74 %, while the three other groups were fed gutted coalfish (*Gadus virens*)

74.5 %. The first one of the three groups got raw gutted coalfish + 4  $\mu$ g. vit. B<sub>12</sub>, the second got raw gutted coalfish + 4  $\mu$ g. vit. B<sub>12</sub> + 0.05 g. Fe SO<sub>4</sub> · 7 H<sub>2</sub>O and the third group was given *boiled* gutted coalfish + 4  $\mu$ g. vit. B<sub>12</sub> + 0.05 g. Fe SO<sub>4</sub> · 7 H<sub>2</sub>O, daily.

Before mating, the females were weighed every three weeks and later once in the middle of the lactation period (on May 27th). The young ones were weighed when 3, 5 and 7 weeks old. For determination of hemoglobin and hematocrite values, blood samples were drawn from the tail-end of the animals. Hemoglobin was determined as chlorhemin in a Bausch & Lomb spectro-photometer according to *Cohen & Smith*, 1919. Hematocrite values were measured with van Allan micro-pipettes which were moistened on the inside with heparin and centrifuged for 15 minutes at 2500 rev/min. The reported values present volumes of packed bloodcells as percentage of the total volume.

## RESULTS

The female mink were distributed among the various groups as evenly as possible. They were all weighed on March 3rd. No significant difference was observed in the weight of animals belonging to the four groups before mating (see Table 1), but at the next weighing on May 27th, i.e. in the middle of the lactation period, a significant difference was observed. Females belonging to the group fed with *raw* coalfish had lost weight, while females of the groups receiving either *boiled* coalfish (gr. 3) or tripe had gained weight. The differences in weight of animals belonging to the various groups on May 27th are highly significant (Table 1). Determination of hemoglobin and hematocrite values in the females was carried out simultaneously with the weighing. A close relationship between hemoglobin and hematocrite values on the one hand and recorded weight on the other, was observed in animals belonging to the various groups. The animals fed raw coalfish (gr. 1) showed low hemoglobin values. Addition of Fe to the diet (gr. 2) resulted in increase of the hemoglobin level from 12.53 g per cent for the raw coalfish + vit. B<sub>12</sub> fed group to 14.39 g. per cent for the raw coalfish + vit. B<sub>12</sub> + Fe fed group (see Table 1). Feeding with boiled coalfish and vit. B<sub>12</sub> + Fe (gr. 3) resulted in high hemoglobin levels with values up to 18 g. per cent, which was also the hemoglobin values of the group fed with tripe instead of coalfish. The latter

Table 1.\*)  
Hemoglobin and hematocrite values and live weight for female mink.  
Mean values and standard error.

Group	1	2	3	4	Total
Hb. 27/5	12.53 ± 0.80	14.39 ± 0.51	18.00 ± 0.49	18.05 ± 0.50 <sup>4)</sup>	15.29
Htcr. 27/5	41.5 ± 2.62	46.3 ± 2.95	57.3 ± 1.18	57.8 ± 1.49 <sup>4)</sup>	49.38
Weight g 3/3	814 ± 30 <sup>1)</sup>	878 ± 35	858 ± 46 <sup>3)</sup>	820 ± 34 <sup>5)</sup>	843
Weight g 27/5	737 ± 27	798 ± 18 <sup>2)</sup>	896 ± 44	865 ± 42	813
Weight difference	— 77	— 80	+ 38	+ 45	— 30
Number of females	15	15	9	12	51

1) = 14 females, 2) = 13 females, 3) = 8 females, 4) = 11 females, 5) = 10 females

*Analysis of variance.*

Hemoglobin

Item	df	Mean squares	F-test
Between	3	98.57	19.29
Within	46	5.11	F > P 99.9
Total	49	10.83	

Hematocrite

Item	df	Mean squares	F-test
Between	3	807.03	10.28
Within	46	78.54	F > P 99.9
Total	49	123.14	

Weight 3/3-60 before mating.

Item	df	Mean squares	F-test
Between	3	15261	0.981
Within	43	15558	P 50 < F < P 75
Total	46	15539	

Weight 27/5-60 in the lactation period.

Item	df	Mean squares	F-test
Between	3	64'894	4.934
Within	45	13'152	F > P 99.5
Total	48	16'386	

\*) The statistical evaluation is carried out according to the methods given by *Snedecor* (1955).

Table 2.  
Hemoglobin and hematocrite values and weight of litters and kits.  
Mean values and standard error.

Group	1	2	3	4	Total
Hb. 22/6-24/6.	5.81±0.28	7.50±0.23	12.64±0.26	12.74±0.33	9.31±0.39
Htcr. 22/6-24/6.	18.9 ±1.04	23.5 ±0.84	41.4 ±0.98	38.6 ±1.21	29.6 ±1.27
Number of kits	15	23	17	11	66

*Analysis of variance.*

Hemoglobin

Item	df	Mean squares	F-test	
Between	3	191.95	F = 161.30	Highly significant difference between groups.
Within	62	1.19	F>P 99.9	
Total	65	9.99		

Hematocrite

Between	3	194.00	120.05	Highly significant difference between groups.
Within	62	16.16	F>P 99.9	
Total	65	105.38		

Weight of litters and kits 21 days old.

Group	Average number of kits	Litterweight of groups	Calcul. litterweight	Observed - calcul.	z	Weight per kit	Rank z	Number of litters
1	3.64	320±37	373	— 53	— 1.43	88	2	14
2	4.00	326±37	416	— 90	— 2.43	82	1	14
3	4.44	614±46	468	+ 146	+ 3.17	138	4	9
4	4.31	507±38	453	+ 54	+ 1.42	118	3	13
Total	4.06	423±19				104		50

*Analysis of covariance for litterweight and littersize kits 21 days old.*

Cause	df	S(y — y) <sup>2</sup>	df	S <sup>2</sup> y · x	b	r
Total	49	904'481	48	18843	118	0.799
Between	3					
Within	46	511'545	45	11367	108	0.845

Significance test

for adjusted values                      392'936                      3                      130979

Regressionline:

Total = 423 ± 118 (x —  $\bar{x}$ )

Total    S<sup>2</sup>x = 2.34            Sx = 1.53

„        S<sup>2</sup>y = 51039            Sy = 226

„        cov. = 276.3

F = 130979/ 11367 = 11.52    F > P 99.9

Highly significant difference between  
calculated litterweights of various groups.

x = littersize

y = litterweight

Between groups.

S<sup>2</sup>x = 2.40            Sx = 1.55

S<sup>2</sup>y = 39178            Sy = 198

cov. = 259.3

group got bonemeal as a source of minerals but received no addition of tallow fat, vit. B<sub>12</sub> or Fe.

The same results observed among the adult females of the various groups were also proved for kits coming from the same mothers (Table 2). Hemoglobin and hematocrite values were lowest in the kits coming from mothers fed with raw coalfish, somewhat higher in kits where Fe had been added to the same maternal diet, whereas kits belonging to mothers fed with boiled coalfish showed blood values equally high as for those coming from mothers fed with tripe (Table 2). Blood samples for analyses were drawn on June 22nd—24th, before weaning, while the kits were 7 weeks old. Clinical examination of the kittens revealed anemia characterized by palenes of the mucous membranes and the hairless parts of the paws and the nose (Fig. 1). The kittens were small, and their fur became rough and dull. The kittens were weighed when 3, 5 and 7 weeks old. Table 2 shows a significant difference between weights of kits belonging to the various groups, already at an age of 3 weeks. This difference is also marked at the two later weighings. Statistical evaluation reveals: for kits 5 weeks old:  $F = 5.91 F > P 99.9$  and for kits 7 weeks old:  $F = 3.07 P 97.5 < F < P 99. *$ )

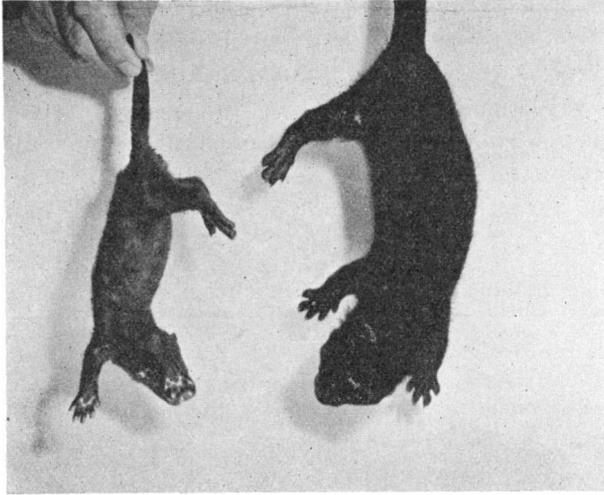
The young ones of the group fed with raw coalfish grew very slowly compared to the rate of growth of those coming from mothers who had been fed boiled coalfish or tripe (Fig. 1).

Pronounced anemia and lowered weight were the most characteristic signs of the effect induced by feeding raw coalfish. This easily explain the high rate of mortality within these groups. The moribund kittens were completely emaciated and grossly anemic. Cannibalism was observed amongst animals in these groups, the females eating their young ones particularly in the course of their first week of life. Cannibalism also occurred among the kittens when they had reached the age of 5—6 weeks. It started with the young ones sucking each others' ears, then biting through the skin and gradually eating until the victim died (Fig. 2).

In group 1, comprising animals which were fed with raw coalfish, the average number of kittens at parturition was 3.7 per litter. At weaning, this figure had dropped to 2.3, corresponding to a mortality of 1.4 per litter. Addition of iron to the raw coalfish-diet in group 2 resulted in a higher number of kits per litter

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\*)  $P =$  the percentage point of the F-distribution.



**Fig. 1.** Kit to be left group 2 fed raw coalfish, 49 d. old, small, emaciated, pale foot pads. Kit to the right group 3 fed boiled coalfish, 53 d. old, normal size, black fur.



**Fig. 2.** Kit group 1 fed raw coalfish, killed 7 weeks old by his littermate. The fur-coat is rough and dull.

and a lower rate of mortality than in group 1 which received no supplement of iron. Animals in group 4, which got tripe, showed the highest average number of kits per litter at birth, viz. 5.71. Mortality was considerably lower in this group than in the raw coalfish group. The lowest observed mortality occurred in group 3, where the animals were fed boiled coalfish, but here the size of the litters was relatively small (see Table 3).

Table 3.  
Mean and mean deviation of number of kits per litter.

Group	1		2		3		4	
	No. of litters	Mean values						
Littersize at birth		3.70±1.90		4.93±1.67		4.50±1.80		5.71±1.43
Littersize at weaning	20	2.30±1.84	15	3.47±1.64	10	4.00±1.80	14	4.50±1.07
Number of kits dead		1.40		1.46		0.50		1.21

Several cases of light underfur were observed among 8 weeks old kits receiving raw coalfish (Fig. 3).

Eight barren female mink which were fed raw coalfish showed normal blood values (groups 1 and 2).

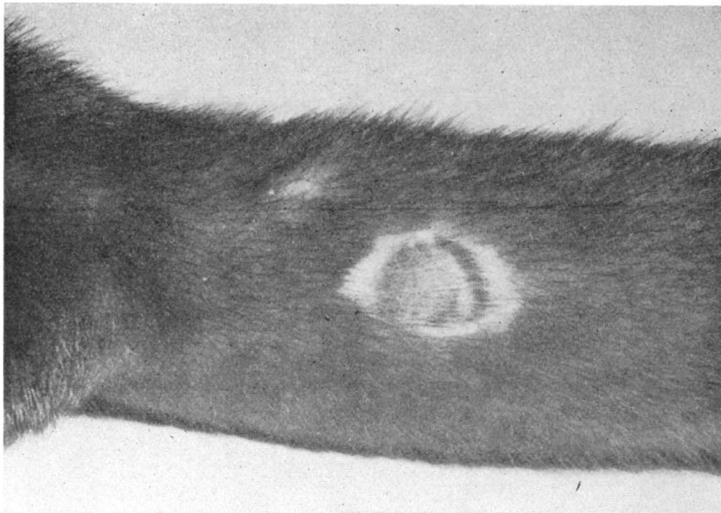


Fig. 3. Light underfur of minkkit 8 weeks old, fed raw coalfish, group 1.

## DISCUSSION

Anemia developed in roughly 30 % of the kits as the result of feeding special sorts of raw fish like coalfish, whiting and haddock to standard mink during the period from July to December (*Helgebostad* 1957, *Helgebostad & Martinsons* 1958). Certain families of mink are more prone to get anemia than others when being fed with raw hake and raw coalfish (*Stout* 1960, own observations).

During the period of lactation, the stress to the animals appears to be so strong that a greater number of them, irrespective of heritage, may develop anemia when being fed with raw coalfish. Addition of vitamins of the B complex, including folic acid and vit. B<sub>12</sub>, could not prevent anemia. Iron has a certain curative effect during the pregnancy and lactation periods both for the females and the kittens, but later in the summer, the addition of iron to the diet appears to have no positive effect on the kittens. Parenteral administration of Fe, however, helps to cure anemia both in the mothers and their offspring (*Helgebostad & Martinsons* 1958, *Stout & al.* 1960).

Decreased live weight of the females and poor growth and high mortality among the kits are signs which accompany the anemic condition. The detrimental effect was eliminated in the cases where boiled coalfish were fed. There was no anemia, low mortality and good growth gain among kits whose mothers received boiled fish. The etiology of metabolic disturbances involved in the raw fish producing form of anemia seems to be rather complicated. There is good reason to take into account more than one factor. Addition of iron to the raw coalfish diet fed to mink gives a certain positive effect during the period of pregnancy and lactation.

Boiling of the fish is the most efficient measure, indicating that there is in raw coalfish an anemic factor which is inactivated or disappears by boiling. Boiled fish as the main source of dietary protein supplemented with Fe and known vitamins, however, does not give the best result as the animals thus fed, show a relatively high number of empty and barren females.

This problem is submitted to further studies.

Analysis of the coalfish used in our diets gave the following percentages: protein 18.8, fat 0.5, minerals 3.6, dry matter 22.9.

## REFERENCES

- Cohen & Smith*: J. biol. Chem. 1919, 39, 484.  
*Hartsough, G. R. & J. Gorham*: Blue Book Fur Farming, Milwaukee 1961, pp. 124.  
*Helgebostad, A.*: Norsk Pelsdyrblad 1957, 6, 114.  
*Helgebostad, A. & E. Martinsons*: Nature 1958, 181, 1660.  
*Helgebostad, A. & E. Martinsons*: 8. Nord. Vet.-möte, Helsingfors 1958. Berättelse, pp. 264.  
*Momberg-Jørgensen, H. C.*: Pelsdyrsygdomme. København 1951, pp. 105.  
*Snedecor, G. W.*: Statistical methods applied to experiments in agriculture and biology, 4th ed. Ames. Iowa State College Press, 1955.  
*Stout, F. M., J. E. Oldfield and J. Adair*: J. Nutr. 1960, 70, 421.  
*Stout, F. M., J. E. Oldfield and J. Adair*: J. Nutr. 1960, 72, 46.

## SUMMARY

Nursing anemia in mink has been induced experimentally through feeding with raw coalfish. The experiments were carried out during the period from December to the end of June, involving 85 females and 273 kittens, divided into four groups which were given the same basal diet. Animals which were fed with raw coalfish in addition to the basal diet, developed a high degree of anemia, which also manifested itself by the extremely low values of hemoglobin and hematocrite which were recorded.

The anemia was partly checked when Fe was added to the diet. Only when boiled coalfish was used, did the blood values reach the same level as that of the control group which was fed with tripe in addition to the basal diet. The females of the group receiving raw coalfish lost weight and their litters grew poorly and showed a high rate of mortality. Female mink fed with boiled coalfish or tripe gained in weight during the lactation period. Their kits showed good growth and mortality was low.

A statistical evaluation of the recorded values for hemoglobin, hematocrite and live weights in the experimental animals revealed highly significant difference between the various groups.

## ZUSAMMENFASSUNG

*Säuglingsanämie beim Nerz.*

Säuglingsanämie beim Nerz wurde experimentell durch Fütterung mit rohem Kohlfisch hervorgerufen. Der Versuch wurde in der Zeit vom Dezember bis zum 1. Juli ausgeführt und umfasste 85 erwachsene Weibchen und 273 Welpen, auf vier Gruppen mit dem gleichen Grundfutter verteilt. Bei den Tieren der Gruppe 1, die Grundfutter und rohen Kohlfisch erhielten, entwickelte sich eine ausgeprägte Anämie sowohl bei den erwachsenen Weibchen als auch bei den Welpen. Durch Zuschuss von Eisensulfat besserte sich die Anämie etwas. Erst bei Verfütterung gekochten Kohlfisches lagen die Blutwerte bei den

Tieren auf dem gleichen Niveau wie bei den Nerzen der Kontrollgruppe, die mit Grundfutter und Schlachtabfall gefüttert worden waren. In der Gruppe roher Kohlfisch zeigten die erwachsenen Weibchen Abnahme des Gewichts, die Welpen schlechtes Wachstum und grosse Mortalität. Bei Fütterung mit gekochtem Fisch oder Schlachtabfall nahmen die erwachsenen Weibchen in der Laktationsperiode an Gewicht zu, die Welpen zeigten gutes Wachstum, und die Mortalität war gering. Die gefundenen Werte zeigten einen stark signifikanten Unterschied zwischen den Gruppen.

#### SAMMENDRAG

##### *Nursing anemia in mink.*

Nursing anemia in mink er fremkalt eksperimentelt ved foring med rå sei. Forsøket ble utført i tiden desember til 1. juli og omfattet 85 tisper og 273 hvalper, fordelt på fire grupper, hvor dyrene fikk samme grunnfor. Hos dyrene i gruppe 1 som fikk grunnfor og rå sei, utviklet det seg en utpreget anemi både hos tisper og hvalper. Ved å gi tilskudd av jernsulfat, bedret anemien seg noe. Først når man nyttet kokt sei, lå blodverdiene hos dyrene på samme nivå som i kontrollgruppen, hvor det ble foret med grunnfor og slakteavfall. I gruppen rå sei gikk tispene ned i vekt, hvalpene vokste dårlig, og det var stor hvalpedødlighet. Hvor det ble foret med kokt fisk eller slakteavfall, øket tispene i vekt i laktasjonsperioden, hvalpene hadde god vekst, og det var liten dødlighet. De fundne verdier viste høy signifikant forskjell gruppene i mellom.

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