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Effect of Evening Primrose Oil as Food Supplement on Reproduction in the Mink

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Tauson, A.-H., M. Neil and M. Forsberg: Effect of Evening Primrose Oil as Food Supplement on Reproduction in the Mink. Acta vet. scand. 1991, 32, 337-344. – The effects of addition of evening primrose oil (EPO) to a mink diet in the breeding season on the reproductive performance and kit and female performance during the lactation period were investigated in an experiment with 4 groups of male and female mink. Matings were carried out so that control males were mated to both control and supplemented females. Similarly, supplemented males mated both control and supplemented females. Reproductive results were evaluated both on a group basis and as an effect of male or female treatment, respectively. After males supplemented with EPO, there was a tendency for reduced rate of stillborn kits and kit losses during the first 21 days of life. These effects could not be explained physiologically. Female treatment did not affect reproductive performance, but there was a tendency for lower weight losses during lactation for EPO-supplemented females. Kit performance during the lactation period was independent of experimental treatment.

reproductive performance; kit performance; lactation period; gamma linolenic acid.

Introduction

Mink are seasonal breeders with 1 reproductive period per year. In the northern hemisphere the breeding season starts in early March and ends in late March or early April. During this period females remain in heat until mated (*Elofsson et al.* 1989). If mated early in the breeding season, they may be remated once or possibly twice with an interval of 7-10 days between matings (*Hansson* 1947, *Venge* 1973). Ovulation is induced by mating and occurs 33-72 h after mating (*Enders* 1952). Implantation is delayed until the corpora lutea are activated by the luteal factor prolactin (*Papke et al.* 1980, *Murphy et al.* 1981, *Martinet et al.* 1983). This is followed by an increase in plasma progesterone level starting about 40 days (*Møller* 1973), or in females mated once not until 32 days, before parturition (*Einarsson* 1985). After peaking 15-30 days prior to parturition (*Møller* 1973), plasma progesterone decreases to basal levels at the time of parturition, which occurs 30±3 days after implantation.

The rate of embryonic and foetal losses may amount to about 50% (*Hansson* 1947). In more recent work, losses between implantation and parturition were of the order of 15-25% (*Tauson et al.* 1988). Further, early postnatal kit mortality in mink may amount to 10-15% (*Henriksen & Hansen* 1985).

Thus, an improved reproductive performance in the mink might be achieved by decreasing embryonic, foetal and early postnatal kit losses.

Dietary factors influence the reproductive

results and kit survival. In practice, the fat level is not limiting, but addition of fat to a diet which was extremely low in fat, reduced the barren frequency from 50% to 15% (*Friend & Crampton* 1961). The chemical quality of the fat may influence early kit mortality. Feeding a diet with rancid fat resulted in a kit mortality of about 30% (*Jarosz & Barteczko* 1976). However, there is no data on effect of fatty acid composition, e.g. level of essential fatty acids (EFA), on the reproductive performance in the mink. It has been shown in several species that EFA, of which there are precursors of prostaglandins, exert a profound effect on reproduction. Abnormal spermatogenesis, lack of oestrus, abortions and uterine inertia during parturition have been observed in experimental animals during EFA-deprivation studies (*Horrobin* 1981). Dihomogammalinoleic acid (DGLA), arachidonic acid (AA) and eicosapentaenoic acid (EPA) are prostaglandin precursors (*Horrobin* 1981). It is not known if the mink is similar to the cat in lacking the ability to convert linoleic acid to gammalinoleic acid (GLA) and DGLA, which are precursors to AA (*Morris & Rogers* 1989) and thus requires an ample dietary supply of prostaglandin precursors.

Evening primrose oil (EPO) is high in GLA, which can be converted to DGLA, the precursor of the 1-series of prostaglandins. Alternatively, DGLA can undergo desaturation to AA, the precursor of the 2-series (*Horrobin* 1981).

Foetal mortality in moderately zinc deficient rats has been reduced as an effect of supplementation with EPO (*Cunnane* 1982). Earlier, *Cunnane et al.* (1979) suggested that an important effect of zinc deficiency might be via reduced prostaglandin production, which thus may be counteracted by dietary addition of EFA. Further, treatment with EPO has had a positive effect on the premenstrual syndrome in women and possibly also an improved cyclicity was achieved (*Brush* 1983, *Horrobin* 1983).

Thus, EPO might improve the reproductive results by improved cyclicity of cyclic animals and by reduced foetal mortality. Dietary addition of EPO to a blue fox diet resulted in a tendency to decreased barren frequency but increased rate of abortions as an effect of male and female treatment. Further, a tendency to increased litter size was found as an effect of male treatment (*Tauson et al.* 1991). Due to the specific traits of reproduction of the mink, this species was considered an interesting experimental model. Further, the possibility of a physiological disability to convert linoleic acid to the prostaglandin precursors makes the mink very well suited for investigations into the effects of dietary EPO supplementation. In addition, an improved reproductive result may be of great economic importance. Therefore, the effect of dietary supplementation of a mink diet with EPO throughout the breeding season was evaluated at the Department of Animal Nutrition and Management, Funbo-Lövsta Research Station, Uppsala, during 1987.

Materials and Methods

The experiment was carried out with 4 groups each of 6 male and 29 female mink of the pastel colour type. The animals were weighed and grouped according to live weight, age and previous reproductive performance in late January. Per group, 3 males and 15 females were yearlings and the rest were 2-4 yeard old. Of each sex, 2 groups were fed the control diet and the other 2 groups were supplemented with EPO. The females fed the control diet were mated to males fed the control diet (group 1) or the supplemented diet (groups 2). Similarly, the females fed the supplemented diet were ma-

ted to males fed the control diet (groups 3) or to males fed the supplemented diet (group 4). The experimental feeding started on February 16 and was terminated at the end of the mating season (late March) for the males and at weaning when the kits were 6 weeks old (late June) for the females.

The composition of the control diet is given in Table 1. Supplementation with EPO (Efamol Ltd, Guildford, Surrey, UK) was 1.5 g per male and day and 0.75 g per female and day from the start of the experiment until May 1 when whelpings had started. From then on and until weaning the level was 0.4% EPO in the diet. The EPO contained no added vitamin E.

From the start of the experiment and until March 5 the females were fed 150 g per animal and day, which is about 20% below the energy requirement. From March 5 the females were flushed by increasing the ration size to 275 g daily (*Tauson* 1985, 1988a). When the females were mated, the ration size was reduced to a level at which the animals were kept in energy balance. The males were fed 275 g daily throughout the experiment. From whelping and until weaning the ration size was adjusted according to the number of kits in each group and their age. Feed remains were collected daily on a group basis and weighed.

Matings started on March 9 and were carried out within the group combinations described above. Females mated before March 16 were tried for a 2nd mating 8-10 days after the 1st mating, and if remated, tried for a 3rd mating the day after the 2nd mating. Females mated from March 16 onwards were tried for remating the day after the 1st mating.

The adult animals were weighed in late January and late February and the females were weighed on March 5. At parturition, the date and the number of live and stillborn kits were recorded. Litters born Monday to Friday were weighed, together with their mothers. When the kits were 21 and 42 days of age, female and individual kits were weighed. The kits were weaned at 42 days of age by removing the female.

Samples for chemical analyses of the control diet were taken once a week and analysed for dry matter (DM), ash, crude protein (CP),

Table 1. Composition of the control diet and results of chemical analyses (%).

	Period	
	February-April	May-June
Feedstuffs		
Cod offal	36	28
Baltic herring	8	12
Filleting scrap of ditto	8	12
Slaughter-house offal	10	12
Poultry waste	10	10
Potato protein	2	1
Extruded cereal mixture	4	2
Potato mash powder	3	2
Wheat bran	1	-
Steamed rolled oats + oats meal	2	3
Dextrose	-	0.5
Vitamin mixture[a]	0.4	0.7
Water	ad 100	ad 100
Chemical composition		
Dry matter	29.8	28.1
Ash	3.2	2.9
Crude protein	14.7	13.5
Crude fat	5.5	6.4
Carbohydrate	6.4	5.3
ME, MJ/kg[b]	5.09	5.10
ME, MJ/kg DM	17.09	18.17
Percentage of calculated ME from		
Protein	46	43
Fat	38	44
Carbohydrate	16	13

ME = Metabolizable energy
MJ = Megajoule

[a] Containg (per kg): vit. A: IE 1.500.000; vit. D_3: IE 150.000; vit. E: mg 7.000; vit. B_1: mg 700; vit. B_2: mg 800; vit. B_6: mg 800; vit. B_{12}: mg 2.5; calcium-pantothenate: mg 625; biotin: mg 10; folic acid: mg 45; niacin: mg 1.750.

[b] Calculated as described by *Tauson & Aldén* (1984).

and fat (*Anon* 1971). Carbohydrate was calculated by difference.

Barren females were killed and the number of implantation sites was recorded. The ovaries were sectioned for evaluating the number of corpora lutea (CL).

Statistical analyses were carried out according to the GLM-procedure of SAS (SAS Institute Inc., 1982). For female live weights in January and for the reproductive parameters the effects of group of male or female treatment, respectively, were tested. For female live weights in late February and early March the effect of weight in January was included in the model and from parturition to weaning also effect of litter size was tested. For individual kit weights a model comprising effect of female treatment, effect of random female within treatment and litter size, and effects of random kits within females was used. Treatment was tested against female effect, thus using female within group and litter size as an error term. Results presented are given as LS-means.

Results

The diets were readily consumed by the animals, and feed remains were of the same amount in all groups. The chemical composition of the control diet (Table 1) was in accordance with the Scandinavian standards (*Rimeslåtten 1964*). The supplemented diet had a chemical composition that was very similar to the control diet.

Male live weights increased from late January to late February. Female live weights were independent of group but weight in January significantly affected live weights during the rest of the experiment and 42 days after parturition also litter size affected female weights. There was a tendency for females on the EPO-supplemented diet to lose less weight in the lactation period than the non-supplemented females did (Table 2).

Two females, 1 in group 2 and one in group 3, remained unmated. Reproductive results on a group basis (Table 3) were not significantly different except for date of whelping, which was somewhat later in groups 2 and 4 than in groups 1 and 3. Overall reproductive results were good and only 4 females, 2 each in groups 3 and 4, were barren. Of these, all had CL and all but 1 (in group 4) had implantation sites. Litter size was high in all groups and the rate of stillborn kits was normal, possibly with the exception of group 1.

Table 2. Mean live weights of adult animals (g) from the start of the experiment until weaning of the kits.

	Group				P-value; effect of		
	1 Control ♂ Control ♀	2 Treatment ♂ Control ♀	3 Control ♂ Treatment ♀	4 Treatment ♂ Treatment ♀	Group	Weight in January	Litter size
Males							
January	2143	2160	2161	2163			
February	2354	2200	2240	2274			
Females							
January	1001	1006	993	1001	0.99	-	-
February	1016	1037	1019	1011	0.45	*<0.001**	-
March	953	960	955	991	0.12	*<0.001*	-
At parturition	1109	1139	1147	1169	0.52	*<0.001*	0.43
21 days *post partum*	1037	1055	1094	1068	0.21	*<0.001*	0.85
42 days *post partum*	868	926	936	951	0.08	*<0.001*	*<0.001*

* Statistically significant. effect.

Table 3. Female reproductive results on a group basis.

	Group				Effect of Group (P-value)
	1 Control ♂ Control ♀	2 Treatment ♂ Control ♀	3 Control ♂ Treatment ♀	4 Treatment ♂ Treatment ♀	
Date of first mating, March	11.6	11.9	11.2	11.3	0.68
No. matings/female	2.4	2.2	2.3	2.3	0.84
Barren females, %	0	0	7[a]	7	0.25
Average date of whelping, May	3.4	4.0	2.3	4.3	*0.02*[c]
Length of gestation, days	46.5	46.6	46.1	46.8	0.87
Kits/mated female at parturition[b]	6.4	7.0	6.3	5.9	0.33
Litter size at parturition[b]	6.4	7.0	6.8	6.3	0.53
Stillborn, kits, %	10	3	5	5	0.25
Kit losses, 0-21 days, %	6	6	13	5	0.22

[a] One female dead on May 5 excluded.
[b] Live and stillborn kits.
[c] Figures in italics indicate statistically significant differences.

Table 4. Reproductive results as an effect of male and female feeding with and without dietary addition of evening primrose oil.

	Males			Females		
	Control ♂	Treatment ♂	P-value	Control ♀	Treatment ♀	P-value
Date of first mating, March	11.4	11.6	0.59	11.7	11.2	0.30
No. matings per female	2.3	2.3	0.65	2.3	2.3	0.83
Average date of whelping, May	2.9	4.1	*0.009**	3.7	3.4	0.51
Length of gestation, days	46.3	46.7	0.53	46.6	46.5	0.85
Litter size at parturition	6.5	6.7	0.73	6.6	6.6	0.89
Stillborn kits, %	8	4	0.10	6	5	0.64
Kit losses, 0-21 days, %	11	5	0.10	8	9	0.70

* Statistically significant treatment effect.

Kit losses from parturition to 21 days after birth were low (groups 1, 2 and 4) to normal (group 3).

Male treatment influenced average date of whelping (Table 4) but gestation length was not affected. Litter size was independent of male treatment but there was a tendency for reduced rate of stillborn kits and kit losses after mating to EPO-fed males. Female treatment had no effect on reproductive results, however.

Kit live weights at 21 and 42 days of age (Table 5) were unaffected by treatment. Kit weights were relatively high in all groups.

Table 5. Kit mean live weights (g) as an effect of female treatment with dietary addition of evening primrose oil.

	Kit liveweight		P-value
	Control ♀	Treatment ♀	
At 21 days of age			
♂♂	120	121	0.33
♀♀	108	110	0.07
At 42 days of age			
♂♂	360	357	0.41
♀♀	321	325	0.06

Discussion

Positive effects of EPO supplementation on reproductive performance could not be documented in this experiment. However, the reproductive results were good on average and therefore possible treatment effects could be expected to be limited. The recorded tendencies for reduced rates of stillborn kits and kit losses after EPO-supplemented males are small and are difficult to explain from a physiological point of view. In an earlier investigation on blue foxes, a tendency for improved litter sizes was found as an effect of EPO treatment (*Tauson & Forsberg* 1991). Moreover, the rate of abortions was higher for EPO-treated blue foxes whereas barren frequency was higher in the female treatment groups resulting in a similar rate of females without litters in both groups. The reason for this might have been that most females were pregnant but the EPO-treated females maintained pregnancy longer than the control group. The discrepancy between the results of the investigations on mink and blue foxes might partly be dependent on different levels of performance of these 2 species, in which reproductive failures are more frequent in the blue fox than in the mink. In the blue fox experiment, the EPO used contained vitamin E, which was not the case in the present experiment, and this might also have affected the results. Further, the composition of the diets differed between the blue fox and the mink experiment. In the mink experiment the level of polyunsaturated fatty acids (PUFA) was higher than in the blue fox experiment, mainly due to a higher content of fish and fish offal providing mainly long-chain n-3 fatty acids, which may have some essentiality for warm-blooded animals (*Opstvedt* 1984) and thus partly cover the requirement of EFA. From the design of the present investigation a possible disability of the mink to convert linoleic acid to the prostaglandin precursors GLA, DGLA and AA similar to that in cats (*Morris & Rogers* 1989) could not be evaluated, but the results do not support such a hypothesis.

The dose levels used in these 2 experiments have been established with reference to other species (*Eneroth* 1986) and therefore might not have been the most suitable for the mink and the blue fox. The level of addition could not be expected to increase the energy concentration of the diet to such a degree that kit and female performance during laction was improved (*Tauson* 1988b), but there was a tendency for lower weight losses in the EPO-treated females during lactation, whereas kit performance was not affected.

Based on the results of this investigation, feed supplementation with EPO in mink diets during the breeding season did not influence reproductive performance and kit growth rate. If further investigations should be carried out, they ought to be focused on specific effects on male reproduction and possible interaction effects between EPO and vitamin E.

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Sammanfattning

Inverkan av jättenattljusolja som fodertillsats på reproduktionsresultat hos mink.

Inverkan av tillsats av jättenattljusolja till en foderblanding för mink under reproduktionsperioden på reproduktionsresultat, valptillväxt och honornas viktutveckling under laktationsperioden har undersökts i ett försök med 4 grupper av mink. Kontrollhanar parades med såväl kontrollhonor som supplementerade honor. På motsvarande sätt parade supplementerade hanar både kontrollhonor och supplementerade honor. Reproduktionsresultaten utvärderades såväl gruppvis som i relation till hanarnas resp. honornas försöksbehandling. Det fanns en tendens till sänkt frekvens valpar registrerade som dödfödda och valpförluster de 21 första levnadsdygnen efter supplementerade hanar. Dessa effekter kunde ej förklaras fysiologiskt. Honornas försöksbehandling inverkade ej på reproduktionsresultatet, men det fanns en tendens till mindre viktförluster under digivningsperioden för supplementerade honor. Valptillväxten under försöksperioden var oberoende av försöksbehandlingen.

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