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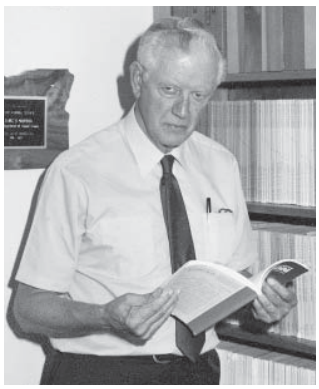
We in the mink industry certainly have many reasons to be grateful to Bob Zimbal who is one of the pillars of our business. Most recently, Bob and his good wife are hosting the joint meeting of Canada Mink Breeders and the American Mink Council in Madison, Wisconsin and are including a tour of their ranch operations in Sheboygan Falls. The meeting included an interesting session on equipment and supplies put on by North American Fur Auction at their Stoughton facility. It will include discussions on proper pelt handling – a most important part of our business.

Another person who has been helpful to me and is as dedicated to the mink industry as the Zimbals' are, is Wilhehm Weiss, who is located at the Danish Fur Breeders' Research Center in Holstebro, in Denmark. Dr. Weiss kindly sends various reports from his station to me and I relay some of them to you in our newsletters. I notice that some of the research direction at Holstebro are changing, and they are working with mink behavior and ways to make their lives more comfortable and enjoyable. They have investigated putting shelves and tubes in the cages in places where the animals can rest, and the results are most interesting. They found that the shelves were used more than the tubes, and more by the female mink than the males. The diameter of the tubes and that of the next box openings was the same: 11 centimeters (about 4 3/8 inches) and the mink pulled the tubes into the nest boxes. They suggested that the tube's diameter might be a little greater to prevent this practice. This would leave more open space in the nest box and not impair its insulation.



Dr. Jim Oldfi eld

I wish you all a productive furring season and hope that the present spell of hot weather will not be damaging.

Respectfully,

J. E. Oldfield

MINK DISEASE: BASIC RESEARCH

Research is commonly divided into applied and basic. This classification is somewhat hazy; what is usually meant is that applied research is concerned with a problem of a practical nature, such as the development of a vaccine or a new drug. Generally, basic or fundamental research is done to find out why something happens. It is the kind of research that discovers new principles.

The rancher might question the value of basic research. Why do "ivory tower" scientists worry about why something happens when I need a cure for Aleutian disease and cheaper sources of protein? Forget the principles and get on with the job!

It is true that research workers have been able to get desirable results without determining why they got them. But later, when something goes wrong, there are no answers. Our experience with living panleukopenia virus used as an oral vaccine is but one example. When Dr. Burger and I put the virus directly into the stomach of mink with a tube, the mink were immune when later challenged with virulent mink virus enteritis virus. However, when Dr. Hartsough mixed our panleukopenia virus with regular mink rations and fed them in the usual manner, the results of the mink virus enteritis challenge were a bit different – 145 out of 150 challenged mink died of the mink disease.

In 1943 the first large-scale immunization program using a variant influenza virus as an intranasal spray was reported. This finding was largely overlooked until poultry pathologists decided to bathe the nation's flocks in virus. Indeed, Newcastle disease vaccines have been sprayed, dusted, added to the drinking water and dropped into the chicken's eyes. Of course, this put my co-workers and me on the trail of a spray vaccine for distemper. It worked well in the laboratory, using a controlled fine spray when
the mink were confined to tight nest boxes but under practical ranch conditions, we could only immunize 75% of the mink.

Fortunately, I have a good example as to how basic research contributed to the control of Aleutian disease. We received a grant from the Mink Farmers' Research Foundation to learn about Aleutian disease. And with due credit to your organization, there were no strings attached in that you wanted the problem solved "yesterday." To learn why the mink were dying, my co-workers discovered that all mink affected with Aleutian disease had increased serum gamma globulin (hypergammaglobulinemia).

With this basic finding Dr. Jim Henson, a transplanted Texan, ran a dozen or so simple laboratory tests to detect this abnormal globulin level. Finally, he noticed that a commonly used iodine solution would cause a noticeable reaction with the serum of affected mink on a glass plate. It is obvious that this practical field test would not have been possible without knowing the fundamental principles concerning the nature of the disease. Thus, there is a need for both basic and applied research in fur animal diseases, for they tend to complement one another.

This column can be summed up by quoting from a paper by Sir MacFarlane Burnet, Nobel Prize winner in medicine. "There are two excellent justifications for fundamental research. It is the only attack that is likely to open up unexpected new approaches to the practical problems, and it satisfies that almost mystic desire to do something toward seeing the universe 'all in one piece.' Also, for a variety of reasons which someone might find it interesting to analyze, most scientists worth their salt seem to get more straight-forward fun out of basic research than out of anything else."

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Washington State University

GENOTYPE-ENVIRONMENT INTERACTION OF MINK

Introduction

Genotype-environment interaction means that a character measured in two environments is to be regarded not as one but as two traits. The genetic correlation expresses the genetic similarity in the two environments. If the genetic correlation is close to one, then the character is determined by almost the same genes in the two environments. If it is close to zero, the character is determined by different sets of genes. Genotype-environment interaction can be tested for by selecting for a trait in a line in one of the environments and by selecting for the same trait in another line in the other environments and then afterwards testing each line in each environment.

The existence of genotype-environment interaction is well documented in many experiments and species, e.g. in pigs (Cameron and Curran, 1995), in poultry (Sørensen, 1986), and in mice (Hetzel and Nicholas, 1986; McPhee and Trappett, 1987; Nielsen and Andersen, 1987). In this experiment, the presence of genotype-environment interaction was investigated in mink when selecting and testing for November weight on ad libitum and weekly restricted feeding. A line selected for low feed conversion on ad libitum feeding was tested in the two environments as well.

Materials and Methods

Animals: In 2003, three lines (FF, AL, RF) each with 100 females were established for the experiment. In 2004 after normal selection in the AL-line, 10 males and 50 females with the lowest feed conversion rate were used to establish the FE-line. In 2005, the FE-line was increased to 100 females. Mink in the Al- and FE-line were selected for high November weight and low feed conversion rate on ad libitum feeding, while the RF-line was selected for high November weight on restricted feeding. Line FF was a farm fed control line. In 2003, recordings were obtained from 376, 354 and 366 animals in the FF-, AL-, and RF-line. 476, 422, 455, and 242 recordings were obtained in 2004 and 516, 274, 414, and 384 recordings were obtained in 2005 in the FF-, AL-, RF-, and FE-line. In 2006, the AL-, RF- and FE-line were tested on both ad libitum and restricted feeding. Mink in these lines were assigned randomly to either ad libitum or restricted feeding, so that an equal distribution of genotypes on the two diets was obtained for each line. The number of mink from the three selection lines tested on each diet is given in Table 1.

Feeding and weight:

At weaning, the mink were placed in male + female pairs. The first weighing was performed in late June or early July. The test feeding was commenced within a week and at the same day for all lines. A standard feed kitchen diet was used. Line FF was farm fed. Line AL and line FE were fed ad libitum. Line RF was kept under a restrictive feeding regime and fed 90% of the amount of feed offered to the FF-line. Management of individual feed allowance at cage level was controlled by a computerized feeding machine regulated by a Palm Pilot (Møller et al., 2004). The feeding machine was used for feeding line FF and RF as well. Individual weights were recorded every three weeks from the time the animals were set out in pairs until pelting. Eight weights were recorded for each animal.

Model: November weight in the lines on ad libitum and restricted feeding in generation 4 in 2006 was analyzed for each sex using model 1.

$$Yijk = \mu + Ii + fj + Ii\,fj + kn + eijk \quad (1)$$

Yijk is the observation on the kth mink in line I on test feed j;
μ is the overall mean;
Ii is the fixed effect on line (AL, RF, FE);
fj is the fixed effect of test feed (ad libitum, restrictive);
Ii fj is an interaction term
kn is the random effect of litter n of the animal
eijk is the random error term.

The genetic correlation (rG) is estimated as:

$$rG2 = CRA \times CRR / RA \times RR \quad (2)$$

RA and RR are the responses, and CRA and CRR the correlated responses for November weight on *ad libitum* and restrictive feeding.

Results and Discussion

November weight (mean of sexes) in the lines in 2003, 2004 and 2005 is shown in Fig. 1. The results for the FF-line show that environmental factors cause a decrease in November weight in 2004 and 2005. The difference between the average of November weight in the two sexes in the AL-, RF- and FE-line and the average of November weight in the FF-line is given in Table 2. In 2003, the difference is due to different feeding in the lines. This is shown as E in Fig. 1. In 2004 and 2005 the differences reflect both the effect of different feeding and selection in the AL-, RF- and FE-line. This is shown as G+E in 2005 in fig. 1.

Table 2. Difference (g) between November weight (mean of sexes) in the selection lines (AL, RF, FE) and the control line (FF) in 2003, 2004 and 2005.

Line / Year	2003	2004	2005
AL-FF	214	452	576
RF-FF	-176	-93	275
FE-FF		271	311

The response in November weight in 2005 corrected for the effect of the different feeding is 362 g for the AL-line, 451 g for the RF-line and 97 g for the FE-line. Thus response to selection is obtained in all selection lines. The response in the FE-line is as expected smaller than the response in the AL-line due to the way the line was established and as the improvement in the FE-line is obtained as a correlated response to selection for low feed conversion.

In 2006, the AL-, RF- and FE-line were tested on both ad libitum and restricted feeding. The results are shown for both sexes in Figure 2. A significant interaction was found between selection line and feeding level for males (P<0.005), but not for females (P=0.58). Overall, the results indicate genotype-environment interaction.

The results for the average of sexes are given in

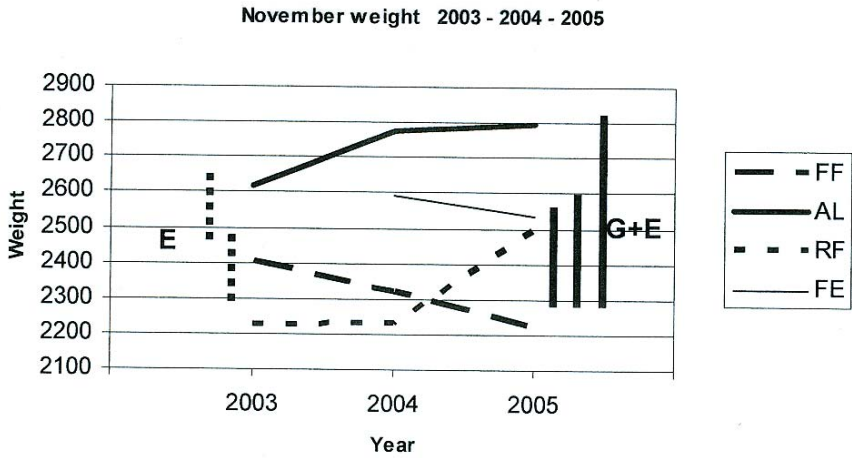

Fig. 1. November weight (mean of sexes) in the AL-, RF-, FE- and FF-line in 2003, 2004 and 2005. E is the environmental differences between the AL- and RF-line and the FF-line. G+E is the genetic and environmental difference between the AL-, RF- and FE-line and the FF-line.

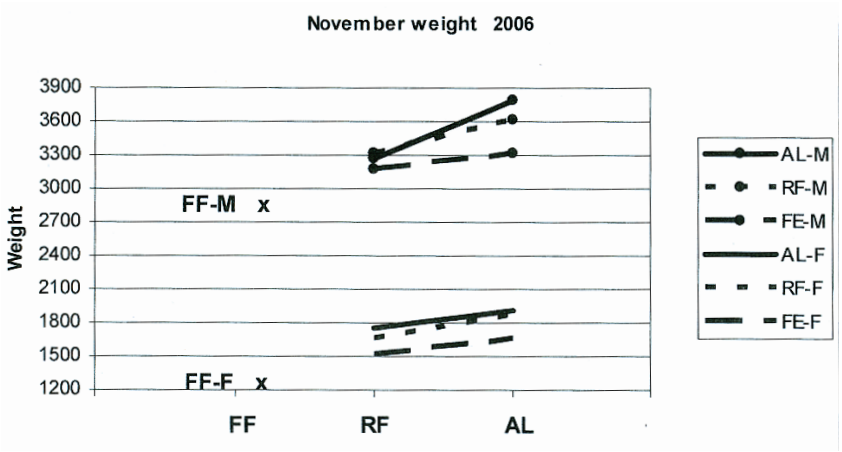

Fig. 2. November weight in the AL-, RF- and FE-line on ad libitum (AL) and restricted feeding (RF) and in the FF-line on farm feeding (FF) for male (M) and female (F) mink in 2006.

Figure 3. Based on responses and correlated responses for the mean of sexes, the genetic correlation between November weight on ad libitum and on restricted feeding is estimated at 0.92. This indicates that November weight on the two diets is not entirely the same character. This estimate is larger than similar estimates found in other experiments where selection is performed for growth rate on ad libitum and restricted feeding. Thus, Cameron and Curran (1995) found a genetic correlation of 0.49 for pigs. Hetzel and Nicholas (1986) and McPhee and Trappett (1987) found genetic correlations to be 0.28 and 0.54 in mice. The restricted feeding amounted to 75% of the ad libitum feeding in the experiment with pigs. In the experiments with mice, it was 83% (Hetzel and Nicholas, 1986) and 80% (McPhee and Trappett, 1987). In the present experiment the mink on restricted feeding obtained 80-85% of the ad libitum intake. A larger reduction in feed intake or more generations of selection may explain the smaller estimates obtained in pigs and mice.

November weight is reduced on restricted feeding in all lines. The reduction in November weight is larger in the AL-line (337 g) than in the RF-line (251 g) as expected with genotype-environment interaction. The smallest reduction is obtained in the FE-line (142 g). The average performance on ad libitum feeding for the AL-, RF- and FE-line was 2682, g, 2614 g and 2410 g. The highest average November weight was obtained by selection on ad libitum feeding.. However, it was only slightly better than the average performance obtained when selecting on restricted feeding. The change in correlated traits such as reproduction and body composition traits in the lines remains to be investigated.

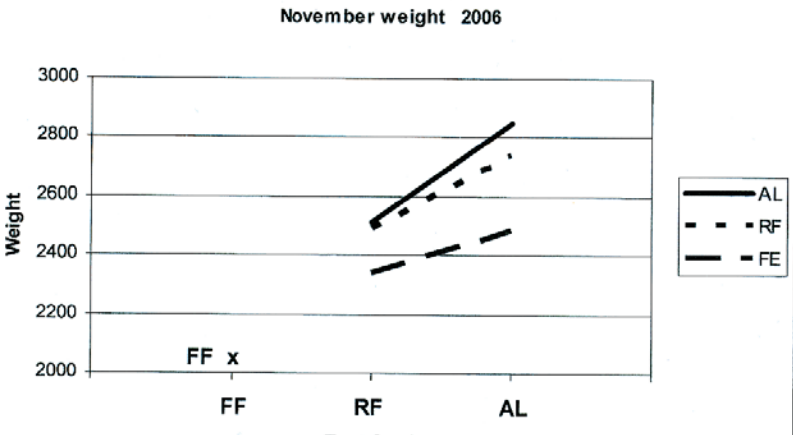

Fig. 3. November weight (mean of sexes) in AL-, RF- and FE-line on ad libitum (AL) and restricted feeding (RF) and in the FF-line on farm feeding (FF) in 2006.

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EFFECT OF EXCESS DIETARY SULFUR-CONTAINING AMINO ACIDS ON DIGESTIBILITY IN MINK

Introduction

The sulfur-containing amino acids (SAA) methionine (Met) and cysteine (Cys) deserve special attention in fur animal nutrition due to their important role in supporting body growth and in particular hair growth. Met is an essential amino acid; in fact, the first limiting amino acid in conventional fur animal feed. Met is a precursor for Cys, but the dietary Met requirement is often considered together with Cys, since Cys partly replaces Met in some functions such as a component in structural proteins (hair) and as a major constituent for glutathione and taurine. Dietary Cys can therefore contribute as much as about half of the total SAA requirement. Several studies have provided documentation of the dietary protein and SAA requirement during the growing-furring period in mink (Skrede, 1981; Glem-Hansen, 1982; Bøsting and Clausen, 1996; Damgaard et al., 1998) and blue foxes (Dahlman et al., 2002). Thus, dietary Met content should be emphasized in practical fur animal feed production, and DL-Met is often supplemented when using low dietary protein levels or when using high levels of ingredients with low content of SAA. Furthermore, it has been shown that dietary cysteine supplementation can improve iron absorption in mink (Skrede, 1988). In blue foxes, Dahlman et al. (2002b) showed that supplementation of Met increased nutrient digestibility when using suboptimal protein levels in the growth period. Our study aimed at revealing if excess dietary SAA gives enhanced nutrient digestibility in adult and growing mink.

Materials and Methods

Diets

The basal diet contained (g/kg): cod scraps; 250, fishmeal; 30, salmon scraps; 20, poultry bi-products; 150, meat-and-bone meal; 100, slaughterhouse by-

products; 120, precooked wheat/oats; 100, vitamin/mineral mix; 2, water; 228. The proximate composition of the basal diet was (%): Dry matter (DM); 35, ash; 5.2, crude protein; 16.9, fat; 6.0, and carbohydrates (by difference); 7.0. The metabolisable energy (ME) content was 5500 kJ/kg feed (15 700 kJ/kg DM). The ME originating from protein, fat and carbohydrates was 47, 38 and 15%, respectively. The hygienic standard of the diet was within recommendations of the Norwegian Fur Breeders' Association and pH of the diet was 5.5. Analyses of dry matter (DM), ash, crude protein (CP), crude fat (CF) of feed and faeces were carried out by standard procedures at the Norwegian Fur Breeders' Association Laboratory, Oslo. Crude carbohydrates (CHO) were calculated by difference. Amino acid analyses of feed were carried out at the Department of Animal and Aquacultural Sciences, Ås.

Animals

Two digestibility experiments were carried out with mink of standard brown genotype; one with adult males and one with ten-week-old males. Six adult animals were given each of the four diets, starting with the basal diet April 28 and ending with the last diet May 19. The experiment with ten-week-old mink was carried in the period July 21-27 with 24 animals, and comprised six animals on each diet. The diets were given to the animals for seven days, of which the four last days was the collection period fur urine and faeces. The animals were kept in metabolic cages for accurate measurement of feed and drinking water consumption, and collection and separation of faeces and urine. The feed allowance was 200 g/day corresponding to approximately 1000 kJ ME/day. Mean body weights of the adult mink and the growing mink on the first day of the experiment were 2542 g (s.d. 297) and 1210 g (s.d. 72), respectively.

Statistical analyses

Analysis of variance was applied by the GLM procedure of SAS (SAS Institute, 2002). Fixed effects of diet and age were applied in the model. The Is-means/pdiff statement was used to test differences between single diet

Results and Discussion

The digestibility experiments were carried out without problems and the diets were consumed close to 100%. Previous studies carried out at the department with excess supplements of SAA in diets for mink have in some cases indicated reduced feed intake, probably because of unpleasant odor or taste of the added sulfur-containing amino acids. Generally, the experiment showed that increasing SAA supplementation resulted in higher digestibility values for most nutrients, except for fat. On the highest SAA level (0.4 Met + 0.2 Cys) the effect was clearcut; the digestibility values being

	Basal diet	+0.2% Met	+0.4% Met	+0.4% Met +0.2% Cys
g/kg feed Met+Cys	3.19 + 1.62	4.46 + 1.60	6.02 + 1.44	6.46 + 2.80
g/kg DM Met+Cys	9.42 + 4.77	13.16 + 4.72	17.74 + 4.24	19.04 + 8.27
g/kg DM Sum SAA	14.19	17.88	21.98	27.31
mmol/kg DM Sum SAA	102.6	127.3	154.1	196.1
g/16 g N Sum SAA	2.85	3.59	4.41	5.48
g/MJ Sum SAA	0.87	1.10	1.36	1.68
g/kg BW/175d g/kg BW/175d	0.48 0.83	0.61 1.05	0.75 1.29	0.93 1.61

Table 1. Analysed concentration of sulfur-containing amino acids (SAA) in the experimental diets (n=1).

significantly increased compared with the basal diet for DM, CP, ash and CHO (Table 2). The increased digestibility for CP with higher inclusion of SAA could partly be due to higher digestibility of supplemented crystalline SAA than for the protein-bound AA in the basal diet. However, an additional positive effect of SAA on protein nitrogen (N) digestibility was evident, since crystalline SAA accounted for no more than 0.7, 1.3 and 1.7% of total N in three experimental diets, respectively. In blue foxes Dahlman et al. (2002b) found increased digestibility of CP, CF, CHO and DM when adding Met to a low-protein diet (15% of ME from protein). The increase in digestibility was most pronounced for CF, CHO and DM. Dahlman et al. (2002b) proposed that the enhanced digestibility due to Met supplementation might be caused by increased activation of digestive enzymes. Studies with humans have shown that as much as 30-44% of dietary SAA is metabolized by gut tissue, indicating that SAA is essential for normal gut function and a first site of SAA conversion (Shoveller et al., 2005). Dietary Met is transmethylated to homocysteine which may be transsulfurated to cysteine. Dietary Cys is likely to play a key role in the intestinal epithelial antioxidant function as precursor for glutathione. Yet, the fate of the SAA metabolized by the gut tissue is mainly unknown (Shoveller et al., 2005).

Supplementary cysteine has been shown to improve iron absorption in mink, whereas the dipeptide cystine hade no effect (Skrede, 1988). Studies on Se absorption in dogs indicate that both Met and Cys may enhance mineral absorption (Reasbeck et al., 1985). The mechanism for the improved absorption of minerals is not clear, but some SAA-mineral chelates may prevent poorly absorbable mineral complexes to be formed in the diet or during the digestive processes in the gastrointestinal tract.

The important role of SAA for gut tissue integrity and the positive effect on mineral absorption might be the reasons for the increased nutrient digestibility found in the present study. The positive effect on ash digestibility was significant when cysteine was supplemented, indicating increased mineral absorption.

The effect of age was only significant for CF digestibility and DM digestibility (Table 2). For other nutrients the digestibility values were similar in kits and adult animals, thus indicating minor age differences in digestive capacity with the experimental diets used in the present study.

In conclusion, the results of the study show that excess dietary SAA can improve nutrient digestibility in mink. This effect should give even more focus on the dietary SAA in fur animal nutrition.

	Basal diet	+0.2% Met	+0.4% Met	+0.4% Met +0.2% Cys	Age Adult old	10 weeks	P-value diet	P-value age	Pooled SEM
DM	65.0c	65.4c	66.9b	68.1a	67.1	65.7	<0.0001	<0.0001	0.39
CP	78.3c	78.8bc	79.6 ab	80.5a	79.8	78.8	0.001	0.01	0.38
CF	96.2	96.5	95.9	98.4	93.9	0.19	0.19	<0.0001	0.26
Ash	7.7 c	9.8c	12.6bc	17.3a	12.3	11.4	<0.0001	0.48	0.86
CHO	54.1b	53.7b	56.5a	57.0a	55.5	55.1	0.001	0.59	0.65

Table 2. Digestibility (%) of dry matter (DM), crude protein (CP), crude fat (CF), ash and carbohydrates (CHO).

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