Fur Animal Research

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Bob Langenfeld

Susan Morelli

It is always sad to lose members of our fur industry, and we regret the passing last month of Bob Langenfeld who was an industry leader for many of his 88 years. Bob was actively innovative in the mink feed and pelt processing businesses and served as a valued consultant all over the world.

We record also the loss of Susan Morelli, of Tigard, Oregon, beloved wife of our President and CEO, Joe Morelli.

Our Secretary, Dr. John Easley reminds us to be on the lookout for nursing sickness in our mink females after they whelp. He notes that the larger than usual kit crop, plus cooler weather, puts a lot of stress on them. John adds that the "sticky kit" problem is more prevalent in larger litters, too.

John Pagel writes that the Kettle Moraine Mink Breeders' Association is celebrating its 60th anniversary this July and expresses industry-wide gratitude to the many people who have contributed to the organization's success. John says that he feels the pelt sales have gone reasonably well, despite the tough economic conditions, which is good news.

I wish you the best of luck raising your kit crop.

Respectfully,

J. E. Oldfield

DIET PROTEIN IN MINK GESTATION

Danish workers have investigated the needs for protein and amino acids during the mink gestation period and amino acids during the mink gestation period (April 4-26) and the importance of this feed for milk production and early kit growth.

Materials and Methods

In the investigations both years we used 6 groups of each 135 brown female mink. The females were fed feed kitchen feed until April 6. From April 6 the feed protein content in 2006 was changed in five groups (Table 1) so that the MEp varied from 20 to 52%. In

2007 (Table 2) the Mep in five groups changed from 24 to 40. After April 26 all groups were fed 30 MEp. Day 28 in the nursing period the protein content was increased to 45 MEp to ensure the kits requirement of protein. The control group each year was fed 52 MEp in the whole period. Only females giving birth from April 26 to May 5 were used in the statistical calculations.

Table 1. Investigation plan in 2006

Group	Energy distribution		
	6/4 to 26/4	26/4 to day 28	Day 28 to day 42
P52_6	52:38:10	30:50:20	45:40:15
P44_6	44:42:14		
P36_6	36:46:18		
P28_6	28:50:22		
P20_6	20:54:26		
P52_52_6	52:38:10	52:38:10	52:38:10

The feed changed from April 26 to April 30 and from May 26 to May 30.

Table 2. Investigation plan in 2007

Group	Energy distribution		
	6/4 to 26/4	26/4 to day 28	Day 28 to day 42
P40_7	40:44:16	30:50:20	45:40:15
P36_7	36:46:18		
P32_7	32:48:20		
P28_7	28:50:22		
P24_7	24:52:24		
P52_52_7	52:38:10	52:38:10	52:38:10

The feed changed from April 26 to April 30 and from May 26 to May 30.

Feed formulas are seen in table 3 and 4. Analysed amino acid content is shown in table 5. In April 2006 amino acids are below present recommendations (Sandbøl and Lassén, 2006) in P20_6, in P28_6 only methionine and histidine is too low. In April 2007 many of the amino acids are below present recommendations, in group P24_7 and in P28_7 only threonine is a little too low.

Table 3. Feed ingredients in the nursing period 2006.

	P52_6 April, P 5 2 _ 5 2 _ 6 whole period	P 4 4 _ 6 April	P 3 6 _ 6 April	P 2 8 _ 6 April	P 2 0 _ 6 April	Birth to day 28	Day 28 to day 42
Fish offal, <3% fat	25.0	19.9	14.6	6.0	0	15.0	18.2
Industrial fish, 8-12% fat	32.0	25.0	18.0	8.6	0	30.0	30.0
Poultry offal, Farmfood	20.0	21.0	23.0	24.0	22.9	20.0	20.0
Slaughter offal	0	2.8	5.5	8.0	10.1		
Barley, heat treated	2.55	4.30	6.42	8.89	11.8	8.55	4.40
Wheat, heat treated	2.55	4.30	6.42	8.89	11.8	8.55	4.40
Fish meal, whole meal	2.46	2.00	1.50	0.60	0	2.50	2.50
Haemoglobin meal	3.00	2.50	1.80	1.20	0.21	1.92	2.50
Potato protein	3.0	3.30	3.20	3.50	3.24	1.18	2.50
Corn gluten meal	3.00	2.60	1.80	1.20	0.15	0.59	2.50
Soya protein (Protao)	0	0.8	1.6	2.5	3.0		
Soya oil	0.22	1.52	2.89	4.73	6.77	3.97	0.78
Pork fat	0.11	0.76	1.45	2.36	3.39	1.99	0.39
L-methionine				0.023	0.128		
Vitamins/Minerals	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Water	5.9	8.9	11.6	19.3	26.2	4.9	11.6
Planned: Energy content: Kcal/100g MJ/kg MJ/kg dry matter Dry matter, % Energy distribution Ash, %	152 6.4 17.7 36 52:38:10 3.26	169 7.1 18.2 38.9 44:42:14 2.92	186 7.8 18.6 41.9 36:46:18 2.57	206 8.6 19.2 44.9 28:50:22 1.96	226 9.5 19.8 47.8 20:54:26 1.44	212 8.9 19.3 46 30:50:20 2.84	158 6.6 17.9 37 45:40:15 2.92
Analysed: Energy content: Kcal/100g MJ/kg MJ/kg dry matter Dry matter, % Energy distribution Ash, %	146 6.1 17.6 35 53:37:10 3.1	165 6.9 18.0 38 44:41:15 2.8	170 7.1 18.4 39 37:45:18 2.5	184 7.7 18.9 41 29:49:22 1.9	192 8.0 19.4 41 21:52:27 1.3	184 7.7 18.9 41 31:49:20 2.8	145 6.1 17.4 35 49:38:13 3.4

In May and June sodium chloride was added up to a total of 0.42 g/100 kcal.

Table 4. Feed ingredients in the nursing period 2006.

	P40_7 April	P36_7 April	P32_7 April	P28_7 April	P24_7 April	P52_7 whole period	Birth to day 28	Day 28 to day 42
Fish offal, <3% fat	15.0	11.8	8.5	5.2	2.00	24.9	12.0	18.0
Industrial fish, 8-12% fat	32.0	25.0	18.0	8.6	3.50	32.0	30.3	30.0
Poultry offal, Farmfood	20.0	20.0	20.0	20.5	20.0	20.0	20.0	20.5
Slaughter offal	3.70	5.02	6.25	7.50	8.8	0		
Barley, heat treated	5.39	6.60	7.78	9.15	10.6	2.63	8.01	4.47
Wheat, heat treated	5.39	6.60	7.78	9.15	10.6	2.63	8.01	4.47
Fish meal, whole meal	2.08	2.08	1.61	1.24	0.10	2.46	2.11	2.45
Haemoglobin meal	2.90	2.80	2.70	2.51	2.40	3.00	1.44	2.50
Potato protein	2.90	2.80	2.70	2.60	2.39	3.00	2.00	2.50
Corn gluten meal	2.30	2.00	1.70	1.00	0.98	3.00	0.65	2.50
Soya protein (Protao)	1.40	1.80	1.90	2.26	2.64	0		
Soya oil	2.31	3.19	4.04	4.97	6.05	0.126	3.41	0.65
Pork fat	1.16	1.60	2.02	2.48	3.03	0.063	1.70	0.33
L-methionine			0.027	0.081	0.099			
Vitamins/Minerals	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Water	15.2	17.5	20.7	23.6	26.6	5.89	10.2	11.4
Planned:	176	188	197	207	219	151	197	157
Energy content:	7.38	7.88	8.25	8.69	9.17	6.32	8.26	6.58
Kcal/100g	18.5	18.9	19.1	19.4	19.7	17.6	19.2	17.8
MJ/kg	40	42	43.2	44.8	46.5	36	43	37
MJ/kg dry matter	40:44:16	36:46:18	32:48:20	28:50:22	24:52:24	52:38:10	30:50:20	45:40:15
Dry matter, %	2.63	2.44	2.17	1.92	1.59	3.26	2.63	2.91
Energy distribution								
Ash, %								
Analysed:	174	190	196	206	220	150	187	147
Energy content:	7.3	8.0	8.2	8.6	9.2	6.3	7.8	6.2
Kcal/100g	18.5	19.0	19.3	19.5	19.8	17.6	19.3	17.4
MJ/kg	39	42	43	44	47	36	41	36
MJ/kg dry matter	41:44:15	36:48:16	33:48:19	29:50:21	25:52:23	53:38:9	31.5:50:18.5	46:40:1=4
Dry matter, %	2.6	2.6	2.0	1.9	1.6	3.5	2.6	3.4
Energy distribution								
Ash, %								

In May and June sodium chloride was added up to a total of 0.42 g/100 kcal.

Table 5. Analysed and recommended amino acid content in the feed in April (g digestible amino acids / MJ)

	P52_..		P44_6	P40_7	P36_6	P36_7	P32_7	P28_6	P28_7	P24_7	P20_6	Recommended*
	2006	2007	2006	2007	2006	2007	2007	2006	2007	2007	2006	
met	0.68	0.69	0.51	0.46	0.44	0.42	0.42	0.34	0.40	0.34	0.34	0.38
cys	0.28	0.29	0.29	0.24	0.23	0.21	0.21	0.20	0.19	0.17	0.17	0.17
lys	2.09	1.95	1.65	1.44	1.32	1.29	1.17	0.98	1.03	0.84	0.69	0.84
thr	1.25	1.14	0.98	0.84	0.79	0.76	0.69	0.62	0.60	0.51	0.47	0.60
trp	0.29	0.30	0.23	0.23	0.21	0.21	0.19	0.17	0.18	0.15	0.13	0.17
his	0.85	0.76	0.70	0.61	0.55	0.56	0.50	0.41	0.45	0.37	0.28	0.43
phe	1.59	1.48	1.33	1.19	1.02	1.08	1.00	0.82	0.88	0.76	0.62	0.53
tyr	1.19	0.98	0.97	0.79	0.75	0.77	0.68	0.61	0.58	0.49	0.48	0.45
leu	3.01	2.62	2.47	2.09	1.90	1.89	1.70	1.46	1.48	1.24	1.02	1.41
ile	1.33	1.15	1.07	0..92	0.89	0.81	0.75	0.72	0.66	0.56	0.57	0.60
val	1.98	1.89	1.58	1.46	1.26	1.32	1.21	0.98	1.07	0.91	0.73	0.74
arg	1.72	1.75	1.39	1.22	1.17	1.08	1.04	0.92	0.92	0.79	0.73	0.88

Table 5 (continued). Analysed and recommended amino acid content in the investigation feed in May and June (g digestible amino acids / MJ).

	Feed in May		Recommended *	Feed in June		Recommended *
	2006	2007	May	2006	2007	June
met	0.40	0.40	0.38	0.57	0.55	0.53
cys	0.19	0.19	0.17	0.24	0.35	0.17
lys	1.24	1.19	0.84	1.68	1.78	1.46
thr	0.70	0.68	0.60	0.95	1.05	0.79
trp	0.19	0.19	0.17	0.24	0.28	0.19
his	0.50	0.45	0.43	0.76	0.76	0.62
phe	0.90	0.90	0.53	1.22	1.44	0.98
tyr	0.61	0.66	0.45	0.87	1.00	0.67
leu	1.54	1.56	1.41	2.34	2.47	1.70
ile	0.76	0.77	0.60	1.00	1.10	0.81
val	1.16	1.14	0.74	1.52	1.74	1.22
arg	1.03	1.01	0.88	1.43	1.46	1.27

* Amino acid recommendations from Sandbøl & Lassén (2006). The control group both years was above recommended in all periods.

The females in 2007 were body scored after a scale developed by Rouvinen and Armstrong (Clausen, 2006) April 7 and the day after birth, and in 2007 they were body scored December 20 and the day after birth. The females were weighed in January and February before the start of the trial period, and day 28 and 42 after birth

(2006), respectively (2007 not shown since the results were not ready at time of delivery of the paper). The kits were counted at birth and counted and weighed on day 28 and 42 after birth (2006), respectively (2007). In 2006 all barren females were euthanized on July 10, and investigated for implantation zones by The Veterinary Institute, DTU.

Results and Discussion

Feed

2006

The feed analyses corresponded to the planned values (Table 3), except for the investigation groups in June where the content of fat was lower than planned. The recommended content of essential amino acids (Sandbøl & Lassén, 2006) was kept in May and June for all groups (Table 5). In April the content of most essential amino acids in P20_6 was lower than recommended. In P28_6 the content was a little lower for methionine and histidine. The analysed values corresponded well to the planned values.

2007

The feed analyses corresponded to the planned values (Table 4). The recommended content of essential amino acids (Sandbøl & Lassén, 2006) was kept in May and June for all groups (Table 5). In April the content of some of the essential amino acids in P24_7 was lower than recommended, in other groups the recommendations were fulfilled. The analysed values corresponded well to the planned values.

Females

2006

The investigation period started April 6, so differences in female weight through the winter period (not shown) must be due to coincidence. On days 28 and 42 in the nursing period there were no differences in female weight between the groups in spite of different feeding in the gestation period. The percent of barren females was highest in P20_6 (Table 6) without significant difference. Investigation for implantation zones showed that from 27% (P44_6) to 54% (P28_6) of the barren females had been pregnant. 36 MEp or more in the gestation period gave the greatest number of live borne kits per litter at birth (Table 7), 28 MEp and 20 MEp gave fewer live borne kits and 20 MEp gave the greatest number of dead kits per litter at birth. P52_6 had 2 kits more per litter than P20_6 through the whole nursing period and 0.6 to 0.7 kits more than P28_6. P28_6 had the highest weight during the winter period (not shown) and P28_6 and P20_6 had the highest body score at birth. This can be of importance for the number of kits at birth because fat females give birth to fewer live borne kits (Clausen et al., 2007; Baekgaard et al., 2007). There was no difference in the frequency of greasy kits or number of females with nursing sickness between the groups (Table 6).

Group	% barren females	Number of litters	Body score at birth	% greasy kits	Number of females with nursing sickness
P52_6	14.7	94	2.8 (0.4) C	8.6	3
P44_6	9.3	107	2.9 (0.5) BC	5.7	4
P36_6	14.2	103	2.9 (0.5) ABC	8.8	3
P28_6	12.9	101	3.0 (0.4) A	9.0	3
P20_6	21.9	85	3.0 (0.6) AB	3.7	1
P52_52_6	11.5	98	2.9 (0.4) BC	7.2	3
P-value	NS		0.03	NS	NS

Table 6. Percent of barren females, number of litters, body score, greasy kits and nursing sickness 2006. NS indicates that there is no significant difference between the groups. Different letters indicate that there is significant difference between groups.

2007

The investigations period started April 6. Differences in female weight through the winter period (not shown) must be due to coincidence. Day 28 there were no differences between groups. The percent of barren females were highest in groups P24_7 and P28_7 (Table 8) without any significant difference between groups. There was no significant difference in body score at birth (Table 8). In the gestation period 40% of MEp and more gave most live borne kits per litter at birth (Table 9). 36 MEp (p=0.056) and below gave fewer live borne kits and 32 MEp and less increased the number of dead borne kits per litter at birth. Comparing with the results from 2006 it seems that feed in the gestation period should contain at least 40 MEp to get the greatest possible number of live borne kits at birth. 32 MEp and less increased the number of dead borne kits at birth. The recommended amount of amino acids in the gestation period should be reconsidered according to Table 5

Table 7. Kits per litter at birth, day 28 and day 42 in 2006

Group	Number of litters	Live borne kits at birth	Dead kits at birth	Kits per litter day 28	Kits per litter day 42
P52_6	94	7.19 (2.68) A	0.27 (0.66) A	6.62 (2.54) A	6.36 (2.63) A
P44_6	107	6.80 (2.39) AB	0.36 (0.66) A	6.38 (2.40) A	6.07 (2.36) A
P36_6	103	6.89 (2.58) AB	0.44 (0.99) A	6.36 (2.62) AB	6.06 (2.63) A
P28_6	101	6.49 (2.27) B	0.50 (1.07) A	5.86 (2.35) B	5.75 (2.39) A
P20_6	85	5.19 (2.68) C	0.80 (1.28) B	4.52 (2.76) C	4.36 (2.76) B
P52_52_6	98	6.91 (2.27) AB	0.48 (1.05) A	6.73 (2.26) A	6.37 (2.19) A
P-value		<0.0001	0.008	<0.0001	<0.0001

Different letters indicate that there is significant difference between groups.

Table 8. Percent of barren females, number of litters and body score 2007.

Group	% barren females	Number of litters	Body score at birth
P40_7	7.8	118	3.0 (0.4)
P36_7	10.0	107	3.0 (0.3)
P32_7	7.9	116	3.0 (0.3)
P28_7	14.4	101	3.1 (0.3)
P24_7	17.5	99	3.0 (0.3)
P52_52_7	9.2	108	3.0 (0.4)
	NS		NS

NS indicates that there is no significant difference between the groups.

Table 9. Kits per litter at birth and day 28 in 2007.

Hold	Number of litters	Live borne kits at birth	Dead kits at birth	Kits per litter day 28
P40_7	118	7.02 (2.29) A	0.55 (1.04) C	6.64 (2.28) A
P36_7	107	6.58 (2.16) AB §	0.51 (1.07) C	6.31 (2.43) A
P32_7	116	5.97 (2.37) BC	0.71 (1.21) BC	5.51 (2.54) B
P28_7	101	5.45 (2.28) C	0.86 (1.27) AB	4.79 (2.46) C
P24_7	99	4.72 (2.58) D	0.99 (1.41) A	4.03 (2.80) D
P52_52_7	108	6.95 (2.38) A	0.48 (0.91) C	6.71 (2.33) A
		<0.0001	0.002	<0.0001

Different letters indicate that there is significant difference between groups. § P-value between P40_7 and P367 is 0.056.

Kits

2006

A lower number of kits per litter normally increase the kit body weight. This seems to be the case for group P28_6 which had the kits with the highest body weight at day 28 (Table 10). Kits from group P20_6 had the same weight at day 28 as in the other groups, but there were 2 kits less per litter than in group P52_6 and P52_52_6 (Table 10). So it seems that females fed 20 MEp from April 6 to April 26 had low milk production.

From day 28 the kits started to eat and at Day 42 there were no significant difference between groups. The weight increase from day 28 to 42 was not significantly different between groups (p=0.10 for male kits).

Table 10. Kit body weight in 2006.

Group	Number of litters	Kit body weight day 28, g		Kit body weight day 42, g	
		Male kits	Female kits	Male kits	Female kits
P52_6	94	176 (40) AB	162 (37) AB	338 (86)	298 (65)
P44_6	107	178 (35) AB	163 (30) AB	336 (63)	295 (59)
P36_6	103	171 (38) BC	158 (33) BC	338 (71)	300 (57)
P28_6	101	185 (35) A	170 (30) A	353 (64)	314 (55)
P20_6	85	177 (32) C	163 (32) C	344 (71)	310 (58)
		0.03	0.05	NS	NS

NS indicates that there is no significant difference between the groups.
Different letters indicate that there is significant difference between groups.

2007

There was no difference between groups in kit body weight at day 28 (Table 11). In P24_7 the kits had the highest body weight, but there were 2.7 kits less per litter than in group P52_7 (Table 9). Comparing with the results from 2006 it seems that the amount of protein to the females in the gestation period is important for the later milk production from birth to day 28, measured as increase in kit body weight.

Conclusion

In the gestation period from April 6 to April 26 the females should have at least 40 percent of the metabolisable energy from protein (MEp) to achieve the greatest number of live borne kits at birth. 32 MEp or less increase the number of dead kits at birth, and 20 MEp reduce milk production. The recommended amount of amino acids in the gestation period should be reconsidered. The frequency of barren females was highest when protein was low but there was no significant difference.

Table 11. Kit body weight in 2007.

Group	Number of litters	Kit body weight, day 28 g	
		Male kits	Female kits
P40_7	118	192 (34)	176 (29)
P36_7	107	195 (33)	177 (28)
P32_7	116	200 (34)	181 (30)
P28_7	101	200 (36)	178 (31)
P24_7	99	204 (31)	189 (31)
		NS	NS

NS indicates that there is no significant difference between the groups.

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MINK VIRUS ENTERITIS

Anyone who studies infectious diseases is always interested in the first case in an outbreak. When, where and how was the first mink infected with mink virus enteritis?

Since mink virus enteritis has been observed in the field and studied in the laboratory for over 50 years, we thought it might be useful to comment on certain aspects of the malady even though we lack adequate experimentation. A virtue of a good speculation is that it can be proved wrong. At least it should create intellectual conflict among one's contemporaries.

Early History

Although there may be previous reports, our earliest source of published information are the minutes of the Dominion Council of Canadian Fur Breeders that was held in Fort William, Ontario, July 1950. The following is part of a discussion by a rancher from that area.

In the summer of 1947, a nephew of Mr. Schoales lost 16 of 150 mink kittens. The following summer, Schoales lost 700 of 1700 animals on his ranch. His lucid description of affected feces signalized the disease as we recognize it today. The first thing that happens is a softness - not exactly a diarrhea. The droppings are usually grey and then turn yellow. The animals will lay down a deposit more than that of a hen. It is sometimes pink and sometimes nearly white and sometimes like cheese which is the size of the intestine. It may be followed by a splash or two of mucus." While he did not mention abrupt loss of appetite, which is typical of the disease, the late Dr. Rendle Bowness observed sudden anorexia and dehydration in affected animals when he visited the area in late August of 1947. Dr. Bowness necropsied about 1,000 mink from 20 different ranches and observed lesions that are consistent with present descriptions. Recovered animals were apparently immune to further attack.

The malady was first diagnosed in the Kitchener Waterdown area of Ontario in 1949, in Wisconsin in 1950 and in Manitoba in 1954. For an unknown reason, mink virus enteritis was confined, for a few years, to two or three ranches in North Central Wisconsin before spreading elsewhere. At the present time, the disease has been diagnosed in major mink producing areas of the world.

Origin of Mink Virus Enteritis

The malady is so easily recognized in its typical form that we postulate that the Fort William area was the site of the first outbreak. Furthermore, this outbreak can probably be pinpointed to the summer of 1947.

We are indebted to Dr. Bowness for providing a resume of his early observations. "I had been in contact with the Fort William ranchers on an annual or semiannual basis from 1938, which was nine years previous to the recognized outbreak. The cause of the losses that occurred during this time was easily identified. It is my opinion that virus enteritis did not exist in epidemic proportions prior to 1947 and its spread after that time was primarily due to carriers. Furthermore, I think that the original Fort William outbreak was much more violent than later outbreaks in other areas."

If this was the first area of disease, the central perplexing question arises: what was the source of the virus on the ranch belonging to the nephew of Mr. Schoales?

The First Case?

It is highly likely that the female panleukopenia virus – a real killer of cats and raccoons – mutated

into a new virus that we now call mink virus enteritis. That the virus mutation occurred on Mr. Schoales' farm might not be true but it makes a good story.

There is always a good chance for exposure of the cat virus to farm raised mink. Hardly a ranch in the world does not have cats on its premises and the feline panleukopenia virus is frequently present. It is a stable virus and, unlike distemper, it can contaminate barns and feed equipment for at least a year.

For an example of the exposure of panleukopenia virus to mink, the feces of panleukopenia-infected cats could contaminate the mink nest box hay stored in a barn. Of course, there is always the possibility that infected cats could contaminate the mink food directly with their feces.

The Canadian investigators at the Ontario Veterinary College deserve a great deal of credit for first showing that Fort William Disease was caused by a new virus that they named mink virus enteritis. Furthermore, Frank Schofield and Gordon Wills related this mink enteritis to feline panleukopenia and provided the first vaccines for control of mink virus enteritis.

Summary

Most researchers feel that mink virus enteritis is so characteristic in its present form that the malady as reported in 1947 in Fort William, Ontario was actually the first outbreak of a new mink disease. The actual source of this virus that has now spread throughout the mink-raising world will probably never be known.

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SODIUM-BISULFATE, AMMONIUM CHLORIDE, BENZOIC AND ADIPIC ACID IN THE FEED FOR 28-56 DAY OLD MINK KITS

Abstract

The effect of ammonium chloride, Na-bisulfate, benzoic acid and adipic acid on urinary pH, in the early growth period of mink kits were tested. Further, the validity of feed base excess (BE) as a predictor of urinary pH, where acids are used as additives, was evaluated.

The results showed that 0.5% Na-bisulfate or 0.2% ammonium chloride were the best of the investigated additives in reducing urinary pH, without reducing early kit growth significantly. 0.34% adipic acid also reduced urinary pH, whereas 0.1% benzoic acid had no effect compared to the control group. Urinary pH could not be predicted by calculating feed BE in this investigation.

Background

Urinary disorders can be a problem on mink farms. Especially in June/July cystitis is seen in rapidly-growing male kits. These kits have a large feed intake and accordingly large excretion of waste substance in the urine. The problems mostly stop when fish silage is used in the feed. The mineral acids added in the feed will be excreted in the urine and as a result of this the urinary pH drops, possible crystals dissolve and the bacterial growth is reduced. A urinary pH between 6.0 and 6.6 is generally recommended.

However, in the period where the kits start to eat by themselves and until it is used in the feed there might be some problems.

Methionine in cat feed lowers the urinary pH. Addition of DL-methionine and L-cystine in mink feed have also proven an increased reduction in the urinary pH with increasing inclusion in the feed and Ahlstrom found a significant correlation between surplus of base in the urine (base excess (BE)) and the urinary pH. Clausen and Wamberg have also shown a correlation between BE and urinary pH.

Addition of ammonium chloride also lowers the urinary pH but if it is added every day in too large quantities it reduces the feed intake.

Mink Virus Enteritis. After an incubation period of four to eight days, the mink refuse to eat. When the feces are examined, one can notice a glob of thick, sticky, slimy mucus on the surface of an otherwise normal pile of feces. This mucus may be clear, creamy, greenish or pinkish in color. Occasionally, a pinkish-gray cast (slug) may be found mixed with the mucus.

Phosphoric acid has been used in mink feed in the USA in a period of years. 2.5% phosphoric acid (75%) on the basis of dry matter (ca. 1% in wet feed) has been an effective urinary acidifier. However, because of phosphorus pollution the usage may be limited in the future.

Addition of other acids which do not give a negative palatability could be interesting. Na-bisulfate ($NaHSO_4$) is used in cat feed and it has also been tested in mink feed with good results. For cats given dry pellets 0.9% Na-bisulfate lowered the urinary pH to the same level as in mink given 1% Na-bisulfate (from dry matter) equivalent to 0.4% in wet feed. In studies on farms in the USA 0.6% in wet feed (1.5% dry matter) was used, 0.9% Na-bisulfate (2.25% dry matter) has been used in trials and up to 1% (2.5% dry matter) has been tested with no palatability problems.

The use of 0.34% adipic acid in feed for mink kits in the growing period resulted in longer skin and a drop in urinary pH compared to the control group. Benzoic acid had no lasting effect. However, not only urinary pH determines whether struvite is precipitated, also organic components as protein and glycosaminoglycans may regulate struvite crystal formation as a matrix. Therefore it is not always certain that struvite calcali can be prevented with urine acidification.

In the present trial we tested the effect of ammonium chloride, Na-bisulfate, benzoic acid or adipic acid on urinary pH when added to the feed in the early growing period and a potential effect on the kits' acid-base balance. We also wanted to evaluate whether the BE value in the feed can be used to predict the urinary pH, if we use acids as additives.

Methods

We used 5 groups of standard mink that were fed control feed until the trial started. Each group consisted of 21 litters of mink kits with 5-6-7 kits in each litter at birth, born in the period from April 24th to May 1st. Trial feeding and urine investigations were carried out when the kits were between 4 and 8 weeks. Trial plan is shown in table 1. For the control group (CON) we produced a basic feed (45:40:15 + maximum salt according to the norm).

Table 1. Trial plan

Group	Treatment	Litter, n
CON	Control (45:40:15)	21
ADP	Con + 0.34% adipic acid	21
BEN	CON + 0.1% benzoic acid	21
AMM	CON + 0.2%	21
NABI	CON + 0.5% Na-bisulfate	21

From the basic feed the trial feeds were added 0.34% adipic acid (ADP), 0.1% benzoic acid (BEN), 0.2% ammonium chloride (AMM) or 0.5% Na-bisulfate (NABI). The trial feeding started May 29 and ended when the kits were 52 days old. The dams were removed from the kits before their spot samples of urine were collected on June 6. The feed composition is shown in table 2. Aside from the usual feed analysis, content of minerals and amino acids were analysed and feed pH was measured.

Table 2.

Dry matter, %	35
Energy distribution	49:38:13
Ash, %	3, 4

The BE value of the feed was calculated according to the following formulas: Base excess (mmol/Kg dry matter) = 49.9*Ca + 82.3*Mg + 43.5*Na + 25.6*K – 64.6*P – 13.4*met – 16.6*cys – 28.2*Cl and BE (mmol/Kg dry matter) = Na + K + 2*Ca + 2*Mg – Cl – 1.8*P – S.

The basic feed was prepared before the start of the trial and put into cold storage in daily portions. Additives were added a few hours before feeding.

The kits were weighed at the beginning and the end of the trial. Spot samples of urine were collected June 19 approximately 4 hours after feeding when the urinary pH is at its highest point. Urinary pH was measured, sediment was graded and the urine was investigated microscopically for crystals and others.

Results and Discussion

The results of the feed analysis are shown in table 2. There were more protein and less fat in the feed than calculated but as this applied for all the groups it had no effect on the results. Adipic acid and Na-bisulfate gave a limited drop of the feed pH. There was no significant difference between the groups regarding the kit quantity per litter size at the end of the trial (table 3).

Table 3. Nursing period, litter size

Group	Litter, n	Litter, n Day 28 at start	Kits, n Day 52
CON	21	6.05 (0.86)	5.85 (0.99)
ADP	21	6.00 (1.26)	5.43 (1.40)
BEN	21	5.67 (1.11)	5.15 (1.35)
AMM	21	5.71 (1.74)	5.30 (1.87)
NABI	21	6.05 (1.02)	5.71 (1.06)
p-value		NS	NS

NS indicates no significant difference between the groups.

Likewise, there was no difference in kit body weight gain between the groups (table 4). Previous investigations have shown reduced body weight gain when added 0.35% ammonium chloride every day in the feed in the early growing period. But when the ammonium chloride was added every second day there was no influence on kit body weight gain.

In this trial there was a tendency of a lower weight gain in the AMM male kits compared to the other groups, but there was no significant negative effect on the addition when adding 0.2% ammonium chloride (table 4).

While 0.1% benzoic acid did not lower the urinary pH compared with CON (table 5), 0.34% adipic acid lowered urinary pH significantly. This corresponds to the results from the growing period where adipic acid also lowered urinary pH where benzoic acid gave a limited and not lasting drop in pH. 0.2% ammonium chloride gave a significant

Table 4. Results from nursing period, kits body weight

Group	Litters, n	Kits body weight, day 28, g		Kits body weight day 52, g		Addition day 28 til 52, g	
		Male	Female	Male	Female	Male	Female
CON	21	215 (23)	197 (21)	600 (71)	513 (51)	383 (61)	314 (47)
ADP	21	210 (35)	193 (28)	589 (62)	494 (41)	380 (44)	300 (29)
BEN	21	228 (35)	206 (26)	634 (83)	515 (55)	395 (60)	304 (44)
AMM	21	203 (45)	190 (32)	573 (90)	500 (52)	361 (71)	310 (38)
NABI	21	209 (27)	187 (24)	599 (71)	492 (43)	390 (57)	304 (32)
p-value		NS	NS	NS	NS	NS	NS

NS indicates no significant difference between the groups. There were sticky kits from May 28 to May 30, respectively, 0, 3, 0, 1 og 1 i CON, ADP, BEN, AMM and NABI.

drop in urinary pH from 6.9 in the control group to 6.4, supporting earlier trials with added ammonium chloride where a larger drop in urinary pH was found with increased addition of ammonium chloride.

Table 5. Urinary pH, 15 kits per group.

Group	Urinary pH
CON	6.9 (0,3) A
ADP	6.6 (0,2) B
BEN	6.8 (0,3) A
AMM	6.4 (0,2) C
NABI	6.2 (0,3) C
p-value	< 0.0001

Different letters show statistical significance differences in the groups.

Na-bisulfate resulted in the largest drop in urinary pH in comparison to the control group. Likewise there was no negative effect on the influence on kit body weight gain (table 4). Na-bisulfate has been tested in the USA to lower the urinary pH and as much as 1% has been added in the trials without any apparent effect on feed intake.

Urinary pH varied very much. Almost half of the kits had a urinary pH above 6.6 In these trials we found sediment and crystals. The most common crystal in mink is urine struvite crystal (magnesium ammonium phosphate, hexahydrate) which precipitates in alkaline urine at a pH higher than 7.0% and dissolves in acid urine at pH lower than 6.6. The urinary pH is recommended to be between 6.0 and 6.6. In contrast for earlier trials there was a very inferior correlation between feed BE and urinary pH at both methods of calculation.

Ahlstrøm used the addition of methionine to the same basic feed as Clausen and Wamberg used Ammonium chloride and MgO, whereas we used several different acids in the present trial. Application of different acids might be the actual reason why it is impossible to see any correlation between BE in the feed and urinary pH. Comparison with BE and urinary pH in several trials is not possible, perhaps as a consequence of different digestibility in the raw materials in the different basic feedings.

Conclusion

Benzoic acid (0.1%) did not result in a lower urinary pH in comparison with the control group, whereas adipic acid (0.34%) resulted in a significant drop. Ammonium chloride (0.2% and Na-bisulfate (0.5%) were those of the tested products which gave the significantly largest drop in urinary pH in the early growth period, without any negative influence on weight gain. Ammonium chloride gave the lowest body weight gain (day 28 to 52) in male kits but there was no significant differences between the groups. The urinary pH could not be predicted from a calculation of BE in he feed in this investigation.

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