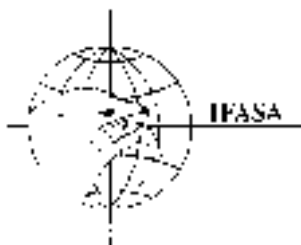
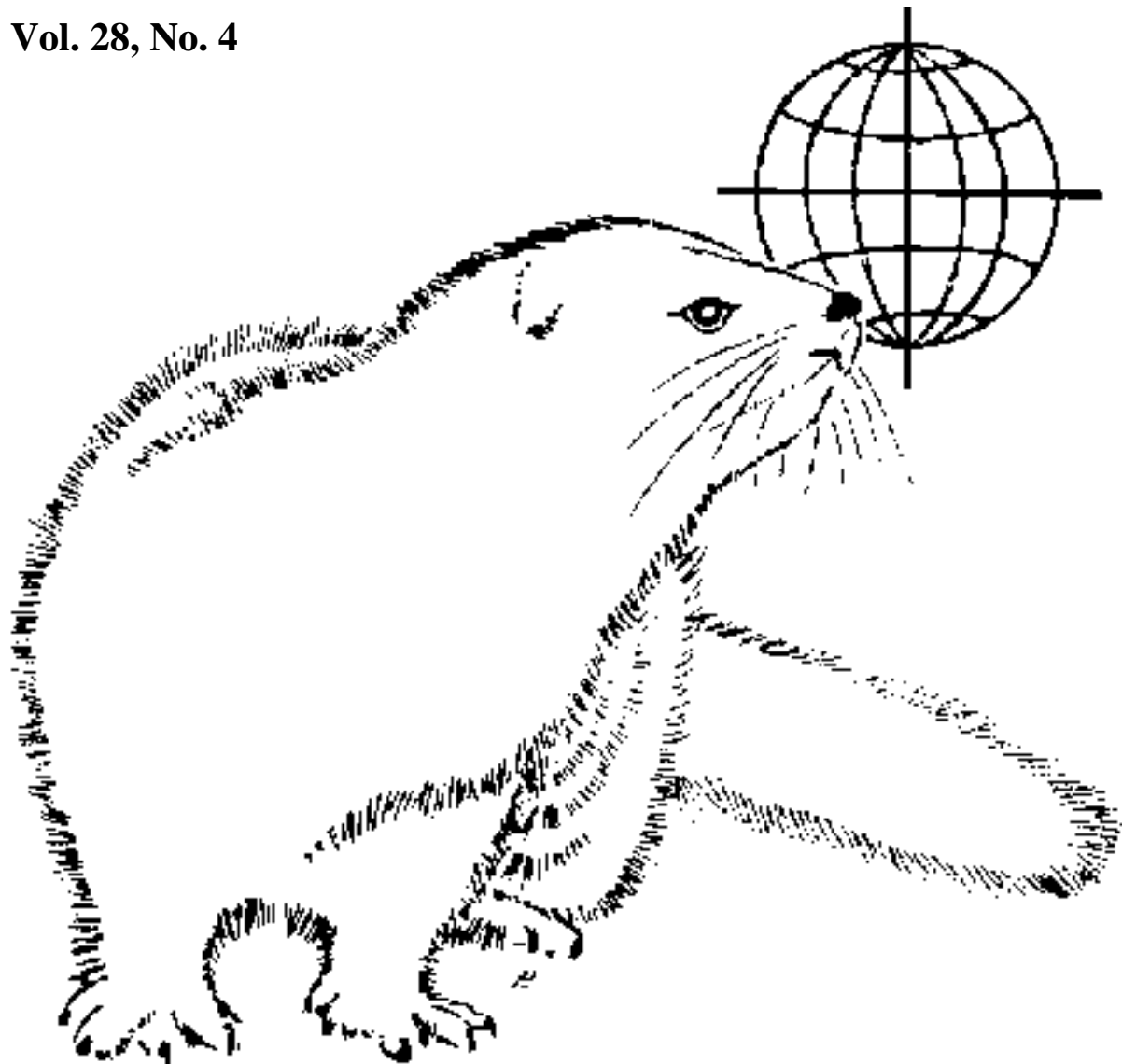


SCIENTIFUR

SCIENTIFIC INFORMATION IN FUR ANIMAL PRODUCTION

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INTERNATIONAL FUR ANIMAL SCIENTIFIC ASSOCIATION

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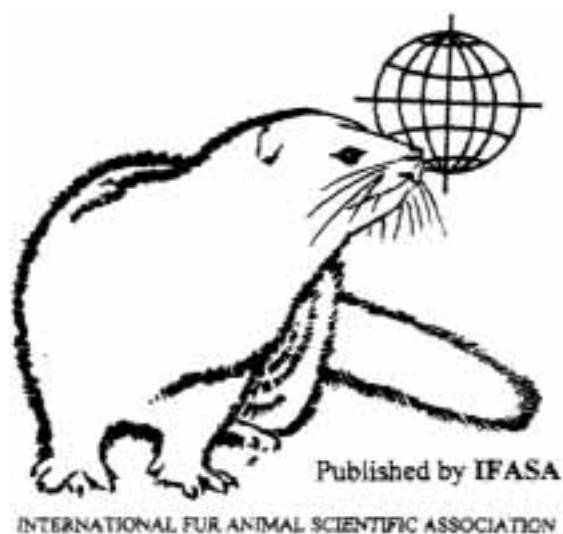
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Notes from the Group of Editors

This issue of *Scientifur*, which is the fourth issue of Volume 28, contains a number of interesting abstracts of papers published in *Journal of Nutrition* during the period 1997 – 2004.

The issue also contains various abstracts presented at a meeting held at the Danish Institute of Agricultural Sciences, Research Centre Foulum on

30 September 2004. The subject of this meeting was ‘Research in relation to practical mink production’.

For future issues of *Scientifur*, we invite our readers to submit proceedings, articles for reviewing, short communications, abstracts and letters on fur animal production.

On behalf of the
Group of Editors

Birthe Damgaard

Direct measurements of dairy milk intake in suckling mink (*Mustela vison*) kits

S. Wamberg, A.-H. Tauson

In studies of the lactational performance of small mammals, estimates of the daily milk yield have been based mainly on methods involving various forms of test-weighing of the animals. However, because these methods require separation of the mothers from their young for a considerable length of time, such methods are unphysiological and may therefore lead to grossly erroneous results (Coward et al. 1982).

In the mink, daily milk production during the 6-wk lactation period is uncertain, although a few estimates, made by factorial methods, are available (Wamberg and Tauson 1998). More recently, direct methods based on the water isotope dilution technique have been introduced and their usefulness for estimating milk production documented in a number of animal species (Coward et al. 1982, Wamberg and Tauson 1998). Direct measurements by the isotope dilution technique of the milk yield of female mink have been reported in only a single study with few animals at peak lactation (Oftedal 1981).

Because newborn mink kits lack mobilizable energy stores, they are totally dependent on mother's milk for nourishment during the first 24-26 d of life. The high energetic demands of lactation, on the other hand, often result in a negative energy balance of the dam (Tauson et al. 1998), which may lead to metabolic disorders such as the so-called nursing sickness (Clausen et al. 1992, Wamberg et al. 1992). Therefore, a detailed knowledge of the daily milk production during the first 4 wk of lactation constitutes an important basis for adequate feeding of the mink dams.

Conclusions

In this study, the tritiated water dilution technique was found to be a useful and reproducible method for measurement of daily water turnover and milk intake in mink kits with a minimum of interference in the mother-young relationship. During postnatal wk 1-4, the calculated energy output of the daily milk yield of each dam corresponded well with the estimated value for daily energy requirements for growth and maintenance of the kits.

Journal of Nutrition, 1998: 128, 2620S-2622S, 2 figs, 1 table, 10 refs.

Accuracy of quantitative collection of urine in carnivores

S. Wamberg, A.-H. Tauson

In studies of animal nutrition, complete 24-h collections of urine samples are often required for detailed analysis and interpretation of urinary excretion of dietary and metabolic constituents. Most reports include a detailed description of the experimental techniques and the equipment used. However, to our knowledge, there is no information available on the completeness of daily urine collection in animal species commonly used for scientific purposes (Wamberg et al. 1996a and 1996c).

In strictly carnivorous mammals, such as cats, ferrets (*Mustela putorius furo*) and mink (*Mustela vison*), accurate collection of urine is extremely difficult because of their habit of squirting and spreading the urine all over the cage and on top of the feces. Furthermore, due to the excretion of a highly concentrated urine with a high nitrogen content, incomplete collection of urine may lead to overestimation of nitrogen balances and, hence, of the true protein requirements of these animals (Elnif 1992, Tauson et al. 1997).

This study was designed to assess the accuracy of quantitative urine collection in conscious female mink by repeated measurements of the recovery, in 24-h urine collections, of two well-documented, radioactively labeled urinary markers, [3H]-p-aminohippuric acid (3H-PAH)4 and [14C]-inulin (14C-IN), continuously released, for a period of 8 d, by small osmotic pumps implanted intraperitoneally. Details of the experimental procedure and the results obtained on water, electrolyte and nitrogen turnover during six consecutive 24-h balance periods in mink are reported elsewhere (Tauson et al. 1997, Wamberg et al. 1996c).

Conclusions

The experimental method described in this paper, using implanted osmotic pumps for continuous release of specific urinary markers, to assess the accuracy of quantitative collection of urine in small,

strictly carnivorous mammals, was shown to be feasible and highly reproducible. The technique may also be used in experimental studies on renal clearances and water turnover rates in animal species in which permanent catheterization is not easily performed. Finally, 24-h urinary excretion of endogenous creatinine is a poor index of the accuracy of daily urine collection in mink.

Journal of Nutrition, 1998: 128, 2758S-2760S, 3 figs, 1 table, 9 refs.

Comparative nutrient digestibility in dogs, blue foxes, mink and rats

Ø. Ahlstrøm, A. Skrede

The importance of considering nutrient digestibility of commercial feeds for different species is well known. Thus, commercial dog feeds with similar chemical composition can vary widely in nutrient digestibility (Huber et al. 1986). This can be due to the nature of the raw materials or differences among processing methods. Compared with pelleting, extrusion of dog feed has been shown to reduce digestibility (Stroucken et al. 1996).

The results of digestibility studies with different monogastric animals provide information directly applicable to the species studied. In addition, the information may be used for prediction of digestibility in other species. Studies have shown that digestibility in dogs can be predicted from cat digestibility and vice versa, although most digestibilities in dogs were higher than corresponding figures in cats (Kendall et al. 1982). Investigations concerning the relationships between dog digestibility and that of other carnivorous species are limited. Like dogs, mink (*Mustela vison*) and blue foxes (*Alopex lagopus*) belong to the mammalian order Carnivora. The carnivores are adapted to relatively concentrated and highly digestible diets, and are characterized by a gastric stomach and a relatively short and uncomplicated intestine. The mink lacks a cecum and has a short digestive tract with very limited bacterial activity in the colon. Dogs and foxes have little cecal capacity and an unsacculated colon, but some bacterial fermentation takes place in the cecum and colon. The rat is an omnivorous species with a somewhat enlarged hindgut and higher microbial fermentation

compared with carnivorous species, especially in the cecum.

The objective of this study was to compare nutrient digestibility in dogs with that of blue foxes, mink and rats, emphasizing the possibility of using these three species as a model for dog digestibility.

Digestibility data obtained with foxes may be especially useful for prediction of dog digestibility because the digestive system of foxes is anatomically and functionally similar to that of dogs. This was confirmed in this study comparing blue foxes and dogs. On the basis of similar average digestibility of protein, fat and carbohydrate in dogs and blue foxes, and high correlations between digestibilities obtained for different diets, digestibilities obtained with blue foxes can be used as direct estimates of dog digestibility. Although mink digestibility was generally lower than dog digestibility, the high correlation coefficients between dog and mink digestibility indicate that dog digestibility may be estimated from mink data by regression equations. The variable relationships between digestibility values in dogs and rats could be related to the more extensive cecal fermentation in rats and suggest that rats are not suitable as a model for digestibility measurements in dogs.

Journal of Nutrition, 1998: 128, 2676S-2677S, 3 tables, 6 refs.

Energy metabolism, nutrient oxidation and water turnover in the lactating mink (*Mustela vison*)

A.-H. Tauson, H.J. Sørensen, S. Wamberg, A. Chwalibog

Mink kits are born very immature physiologically; they are blind, nearly hairless, devoid of their own thermoregulatory capacity and have very limited locomotor ability. Moreover, they have almost no mobilizable energy reserves because the fat content in the body at birth is only 1% (Tauson 1994). On the other hand, they have the capacity for rapid growth during the suckling period, with an average relative growth rate of 12%/24 h during the first 3 wk of life (Tauson 1994), a period in which the kits are totally dependent on mother's milk for nourishment. For these reasons, and because litters usually are large (commonly averaging >6 kits), the

lactation period is very demanding on the energy resources of the dam. Despite a substantial increase in food intake, dams with large litters are unable to sustain their energy needs by food consumption and have to mobilize body fat reserves; weight losses of 20% frequently occur during the lactation period (Hansen 1997). Furthermore, female mink have been shown to be in negative energy balance during late gestation (Tauson and Elnif 1994); therefore, a profound additional weight loss during lactation may lead to nursing sickness (Wamberg et al. 1992). It is of utmost importance, therefore, to stimulate energy and water intake to improve lactation performance and animal health. This study aimed to increase knowledge regarding the specific features of energy metabolism and water turnover in lactating mink and to estimate the milk yield by the use of a factorial approach.

Conclusions

This study has clearly demonstrated that lactating mink are not able to sustain their energy requirements by feed intake after wk 2 of lactation, but have to mobilize fat reserves from the body. The milk yield can be considered very high in relation to body size; our data indicate that a female of 1100 g with a litter size of 5 kits produces 3000 g milk during the first 4 wk of lactation. Water to sustain milk production is provided mainly by the feed, provided that conventional wet diets are fed, but metabolic water contributes 10% of the total water input. Water output in urine increases substantially in lactating animals, reflecting the need for excretion of excess nitrogen from deaminated protein via urine. To sustain the metabolic needs of high yielding female mink, palatable diets with a high energy concentration must be provided, as well as an ample water supply.

Journal of Nutrition, 1998: 128, 2615S-2617S, 1 fig., 1 table, 10 refs.

Effects of protein supply on plasma urea and creatinine concentrations in female mink (*Mustela vison*)

A.-H. Tauson, S. Wamberg

In clinical veterinary medicine, single or serial measurements of plasma concentrations of urea and creatinine are widely used to evaluate the functional

status of the kidneys. In carnivores such as dogs, cats and mink, however, the diagnostic value of these measures may be limited or uncertain, because they are markedly affected by nonrenal factors, and particularly by the amount and quality of dietary protein intake. Thus, Watson et al. (1981) showed that the plasma response in dogs was different when the animals were fed raw vs. heat-treated meat; the postprandial response in plasma urea was more affected by processing than that of creatinine. Changes in plasma concentrations of urea and creatinine, therefore, even in the postabsorptive state, must be interpreted with caution. The aim of this study was to evaluate the influence of dietary protein level on the postprandial changes in plasma concentrations of urea and creatinine in adult female mink given a single test meal.

Conclusions

This experiment underscores the importance of feed-induced changes in plasma concentrations of urea and creatinine in carnivores. Interpretation should be made with caution and the effects of sampling time in relation to feeding and quantity of dietary protein intake taken into consideration.

Journal of Nutrition, 1998: 128, 2584S-2586S, 3 figs., 1 table, 9 refs.

Plasma concentrations of leptin mirror changes in body weight but do not influence the pattern of the preovulatory luteinizing hormone surge in mink (*Mustela vison*)

A.-H. Tauson, M. Forsberg, A. Chwalibog

The discovery of leptin, the protein product of the obesity gene (1), has generated a vast amount of research into leptin's different roles in metabolism (2). One area of special interest is reproduction: from empirical research it is well known that nutritional status is important for the reproductive processes, although as yet there is no complete understanding of how nutrition regulates reproduction. Leptin has been suggested to play an important role in the nutrition-reproduction interaction, possibly by acting as a metabolic gate (3-5). Nutrient supply is reflected in luteinizing hormone (LH) secretion: when insufficient, LH pulse frequency is suppressed but rapidly restored in response to refeeding (6). The objective of this

study was to evaluate whether the plane of nutrient supply before breeding influenced plasma concentrations of leptin and other metabolic hormones and LH during the preovulatory surge in the mink. The mink is a reflex ovulator and the preovulatory LH surge is hence induced by mating.

In conclusion, the present data suggest that plasma leptin concentrations in mink are very responsive to changes in food supply and body weight within the range of body weight of the animals in this investigation. However, it could not be shown that plasma leptin concentrations were reflected in plasma LH concentrations during the LH surge.

Journal of Nutrition, 2002: 134, 1790S-1792S, 3 figs., 1 table, 13 refs.

Fatty acid composition in commercial dog foods

Ø. Ahlstrøm, Å. Krogdahl, S.G. Vhile, A. Skrede

Dietary fat supplies essential fatty acids (EFA) and is crucial for carrying fat-soluble vitamins. Fat is also the most energy-concentrated nutrient, and is important for palatability and texture in pet food. In dry extruded dog food, the fat source can be of either animal or vegetable origin or often a mixture of both. Which fat sources the food producer will include in dog food will depend on several factors such as content of EFA, melting point of the fat (saturation), effect on palatability, susceptibility for oxidation, and market price.

As of 1985, linoleic acid (18:2 n-6) (LA) was the only EFA listed for dogs by the National Research Council (1). From LA, dogs can synthesize arachidonic acid (20:4 n-6) (AA), which is an essential cell membrane constituent. In humans, both LA and the parent fatty acid from the (n-3) series, α -linolenic acid, 18:3 (n-3) (ALA), have been established as essential and beneficial to health. In dogs, a requirement for (n-3) fatty acids has not been documented, but may exist at certain stages in their life cycle. If the requirement for (n-3) EFA is low, mother's milk and food rations may provide sufficient amounts to prevent deficiency symptoms. However, there are indications that foods occasionally are deficient in essential fatty acids, as skin defects in adult dogs may be alleviated or cured by changing food or by supplementation with

vegetable or marine oils. Pruritic skin diseases in dogs have become significantly less severe after supplementing marine oils rich in eicosapentaenoic acid, 20:5 (n-3) (EPA), and docosahexaenoic acid, 22:6 (n-3) (DHA), than after dietary supplementation with (n-6) fatty acids (2). Numerous fatty acid supplements are sold by veterinarians to reduce problems with the coat and skin in dogs. Most of these supplements contain a mixture of (n-6) and (n-3) fatty acids, and often include EPA and DHA from marine sources. Recent discussions on EFA for dogs, have involved (n-3) fatty acids and the relationship between dietary EFA (n-6):(n-3) fatty acids. This study aimed at investigating fatty acid composition in commercial dry dog foods to monitor existing variation among different foods.

Conclusions

Fatty acid composition in commercial dry dog foods, including contents of EFA, varies substantially. Differences in the levels of (n-6) and (n-3) EFA may explain some of the differences in biological responses to dog food observed by dog owners.

Journal of Nutrition, 2004: 134, 2145S-2147S, 2 tables, 9 refs.

Nutrient digestibility of commercial dog foods using mink as a model

Å. Krogdahl, Ø. Ahlstrøm, A. Skrede

Nutrient composition and digestibility are of crucial importance for health and well being of animals. Although great attention is paid to nutritional quality in the marketing of dog foods there is usually limited or no independent information on digestibilities. The most highly recognized dog food brands claim to have optimum nutritional quality and high digestibility. In Norway, these brands are usually the most expensive and they offer a set of dog food products with a specific nutrient composition intended for dogs in different life stages. These brands are often sold in pet shops and through veterinaries and they are well recognized by dog owners. Low-priced dog food brands typically have one or two products and they are sold in grocery store chains or sold locally directly from the producer.

The objective of this study was to compare digestibility of six expensive dry dog food brands [high price (HP)] with six low price dog food brands [low price (LP)] sold in the Norwegian market.

Conclusions

Digestibility of main nutrients varies significantly among commercial dry dog foods. This study demonstrated that there is no difference in digestibility of nutrients between high-price and low-price dog foods offered in the Norwegian market.

Journal of Nutrition, 2004: 134, 2141S-2144S, 5 tables, 9 refs.

Growing kittens require less dietary calcium than current allowances

J.G. Morris, K.E. Earle

We previously demonstrated that a purified diet containing 3.125 µg of cholecalciferol/kg was adequate to maintain plasma concentrations of 25-hydroxyvitamin D in growing kittens. With the use of this concentration of cholecalciferol, the response of growing kittens to varying levels of calcium in purified diets was measured. Five groups (treatments 1–5), each comprised of seven weaned kittens, were given diets containing 3.8, 5.0, 6.0, 7.2 or 8.1 g calcium/kg diet (Ca:P ratio of 1:1.25) from 9 to 18 wk of age. Two further groups of kittens (treatments 6 and 7) received similar diets containing 6.0 g Ca/kg diet, with Ca:P ratios of 1:1.55 and 1:2.61, respectively. No clinical signs of calcium deficiency were observed, i.e., growth rate, energy intake and plasma total calcium were not affected by the treatments. However, ionized calcium was significantly lower in kittens in treatment 7. Plasma phosphorus was lower in kittens in treatment 7 than in kittens in treatments 1, 2, 3 and 4, and there was a negative relationship between dietary and plasma phosphorus concentrations. Kittens in treatment 7 had a significantly higher alkaline phosphatase concentration in plasma than kittens in treatments 1, 2, 3 and 5. Kittens in treatment 1 had a lower percentage of bone minerals measured by dual-energy X-ray absorptiometry than kittens in treatments 2–6. These results indicate that the calcium requirement of growing kittens is not

>6.0 g/kg diet, (calculated metabolizable energy ~20 kJ/g) and that kittens are not very sensitive to inverse Ca:P ratios up to 1:1.55.

Journal of Nutrition, 1999: 129, 1698-1704, 1 fig. 6 tables, 33 refs.

Bacterial protein produced on natural gas: A new potential feed ingredient for dogs evaluated using the blue fox as a model

A. Skrede, Ø. Ahlstrøm

Bacterial protein meal (BPM) produced by continuous bacterial fermentation using a defined mixture of four different bacteria [*Methylococcus capsulatus* (Bath), *Alcaligenes acidovorans*, *Bacillus brevis*, and *Bacillus firmus*] and natural gas as the carbon and energy source is a novel high-protein feed ingredient (1). The BPM is a reddish/brownish nondusty meal containing 70% crude protein on a dry matter basis and a nutritionally well-balanced amino acid composition. The amino acids of BPM are well digested by several animal species, including mink, Atlantic salmon, pigs and young chicks (1). Recent studies have shown that BPM is suitable as a major protein source in diets for weanling and slaughter pigs (2). Although digestibility studies with mink have shown promising results with regard to palatability and digestibility, the potential of BPM as an ingredient of diets for carnivores has hitherto not been extensively investigated. Previous studies of digestive capacity have shown a close similarity between dogs and blue foxes (3). The present study was conducted to extend the knowledge of BPM as an ingredient of diets for dogs, using the blue fox (*Alopex lagopus*) as a model animal.

Journal of Nutrition, 2002: 132, 1668S-1669S, 3 tables, 8 refs.

Milk intake of suckling kittens remains relatively constant from one to four weeks of age

W.H. Hendriks, S. Wamberg

The daily milk intake of 14 domestic short-haired kittens (*Felis catus*) from five litters was estimated

during wk 1–4 postpartum using the isotope dilution technique. Kittens received a single intraperitoneal injection of tritiated water, and blood samples were obtained from the jugular vein for radioactivity measurements at 2 and 96 h after injection. One kitten in each litter was used as a control to allow calculation of recycling of tritiated water. The mean (\pm SEM) biological half-life of tritiated water in the kittens increased from 2.4 ± 0.1 d in wk 1 to 4.9 ± 0.2 d in wk 4 postpartum. Recycling of tritiated water accounted for (mean \pm SEM) 5.9 ± 0.8 , 12.0 ± 0.5 , 7.7 ± 1.3 and $10.0 \pm 1.3\%$ of the kittens' daily water intake during postnatal wk 1–4, respectively. Daily milk intake of the kittens during wk 1–4 postpartum was 47.3 ± 0.8 , 47.4 ± 1.5 , 48.7 ± 1.6 and 43.7 ± 2.0 g, respectively. There was no effect of gender on milk intake. The daily metabolizable energy requirement of suckling kittens, estimated by multiple regression analysis, was 356 kJ/kg^{0.75}, whereas the metabolizable energy required per gram of gain was estimated to be 7.8 kJ/d. The milk intake of suckling kittens remained relatively constant throughout the first 4 wk of lactation, and during this period, they seemed to have a lower energy requirement for maintenance.

Journal of Nutrition, 2000: 130, 77-82, 3 figs., 2 tables, 41 refs.

Net protein oxidation is adapted to dietary protein intake in domestic cats (*Felis silvestris catus*)

K. Russell, P.R. Murgatroyd, R.M. Batt

Cats have a requirement for dietary protein two to three times that of omnivores and herbivores. This was reported to be due to the hepatic catabolic enzymes of this species being set to a permanently high level and, therefore, showing little adaptation to low dietary protein. A major mechanism for adapting to dietary protein in other species is amino acid oxidation (hereafter referred to as protein oxidation), and the objective of this study was to determine whether protein oxidation in cats was correlated with protein intake. Net protein and net fat oxidation in six adult cats were studied directly from gas exchanges using indirect calorimetry, after feeding moderate protein (MP; 35% energy) and high protein (HP; 52% energy) diets. Protein oxidation was significantly higher ($P < 0.05$) when

cats were fed the HP diet (28.4 ± 0.7 mg/min) rather than the MP diet (20.4 ± 0.8 mg/min). Fat oxidation was significantly higher ($P < 0.05$) when cats consumed the MP diet (9.0 ± 0.7 mg/min) rather than the HP diet (4.7 ± 0.5 mg/min). Protein oxidation was significantly correlated (linear regression, $R^2 = 46.0$, $P < 0.05$) with protein intake such that the mean ratio of 18-h oxidation: 18-h intake was 1.2 on both diets. Fat oxidation was significantly correlated (linear regression, $R^2 = 18.9$, $P < 0.05$) with fat intake such that the mean ratio of 18-h fat oxidation: 18-h fat intake was 1.1 (MP) and 0.9 (HP). This study demonstrated that cats adapt net protein oxidation at these levels of protein intake, and the reason for the high dietary protein requirement of this species is, therefore, unclear.

Journal of Nutrition, 2002: 132, 456-460, 4 tables, 31 refs.

Substrate oxidation in male blue foxes (*Alopex lagopus*) during feeding, fasting and realimentation

A.-H. Tauson, A. Chwalibog, Ø. Ahlstrøm

When living in the wild the blue fox may experience extended periods without access to food during the winter. As a survival strategy it accretes large amounts of fat during the autumn, a body reserve that has dual purposes: it can serve as insulation of the body during periods of extreme cold and as energy reserve during periods of food scarcity. The animals are strictly seasonal, and the process of fat accretion is regulated by photo-period. The objective of this study was to evaluate how the fox economizes with its body reserves during a period of fasting, and how reserves are restored during realimentation.

In conclusion, our results suggest that well-fed blue foxes are able to withstand a prolonged period of fasting without deleterious effects because they are able to mobilize substantial amounts of body fat, which is used as the main metabolic fuel, supported by amino acid gluconeogenesis as a glucose source. The level of UN excretion during fasting indicated that the foxes had not started to mobilize excessive amounts of body protein, and the continuous decrease in HE suggested that HE had not reached

its minimum level by the end of the fasting period. The realimentation period used here, however, was not sufficiently long to induce a complete recovery of metabolism.

Journal of Nutrition, 2002: 132, 1793S-1795S, 3 figs., 1 table, 7 refs.

Feline reference values for urine composition

Y.H. Cottam, P. Caley, S. Wamberg, W.H. Hendriks

Cats have evolved over many years, thriving on a natural diet consisting mainly of animal tissues, and as a result have developed a specialized metabolism like other true carnivores such as mink and ferrets. In the wild, cats are predominantly predators of small mammals. In one New Zealand study, small mammals (rats, rabbits, possums, mice, stoats) made up 93% (by weight) of the diet of feral cats over 3 y. However, the feral diet varies with seasonal availability of prey species and is therefore difficult to characterize.

Domestic cats can suffer from a number of urinary tract diseases in which the diet is implicated as a major causal factor. An example of this is urolithiasis, a common condition in which uroliths (crystals or stones) of various types form in the urinary tract. It has been shown that the potential for struvite ($\text{MgNH}_4\text{PO}_4 \cdot 6\text{H}_2\text{O}$) crystal formation is reduced if urine pH is <6.6 , whereas calcium oxalate crystal formation is less likely to occur at a higher urinary pH. Cook stated that a carnivorous diet, is known to produce acidic urine, which is assumed to be entirely safe for cats. When cats are fed commercial diets, it is possible to lower the urine pH by addition of acidifying agents (such as ammonium chloride, calcium chloride and methionine) to the diet to prevent struvite formation. Currently, it is recommended to maintain urine pH of adult cats between 6.0 and 6.4 to minimize the risk of struvite urolithiasis. However, urine acidification together with a low magnesium intake increases the risk of calcium oxalate formation in domestic cats.

Urine composition and characteristics are directly related to the diet of cats and because the natural diet is difficult to characterize, it is difficult to establish "normal" reference values. Vondruska

found a mean urine pH of 6.98 in cats fed a "seminatural diet" of rat carcasses. The latter study can be criticized, however, given that the rat carcasses were canned and heat sterilized. The approach used in this study to obtain "normal" biological reference values for cat urine was to determine the composition of feral cat urine because these animals are ingesting a "natural diet." Thus by measuring the various constituents and characteristics of feral cats' urine it is possible to provide a set of baseline data for the evaluation of urinary compositional characteristics of domestic cats fed commercial pet foods.

Journal of Nutrition, 2002: 132, 1754S-1756S, 1 fig., 1 table, 15 refs.

Urinary excretion of endogenous nitrogen metabolites in adult domestic cats using a protein-free diet and the regression technique

W.H. Hendriks, P.J. Moughan, M.F. Tarttelin

The study was designed to determine urinary excretions of endogenous total, urea, ammonia and creatinine nitrogen in adult domestic cats. Endogenous urinary nitrogen metabolite excretions were determined by feeding adult cats a protein-free diet for 10 d or by regression to zero protein intake of the urinary nitrogen metabolite excretions of adult cats fed four levels of dietary protein. The mean (\pm SEM) endogenous total, urea and ammonia nitrogen excretions for the cats fed the protein-free diet were 360 (± 11.3), 243 (± 8.8) and 27.6 (± 1.06) mg/kg body weight $^{-0.75} \cdot \text{d}^{-1}$, respectively. Estimates of 316 (± 53.9), 232 (± 43.4) and 33.7 (± 5.68) mg/kg body weight $^{-0.75} \cdot \text{d}^{-1}$, respectively, were obtained using the regression technique. The differences in results between the two techniques were not statistically significant. Daily excretions of creatinine nitrogen were not significantly ($P = 0.64$) different between the protein-free and regression technique (mean \pm SEM, 14.4 ± 0.49 and 15.9 ± 1.05 mg/kg body weight $^{0.75}$, respectively). The endogenous urinary total and urea nitrogen excretion of adult domestic cats is higher than values for other mammals such as humans, dogs, rats and pigs.

Journal of Nutrition, 1997: 127, 623-629, 5 figs., 2 table, 24 refs.

**Meeting at the Danish Institute of Agricultural Sciences, Research Centre Foulum,
on 30 September 2004 on the subject**

‘Research in relation to practical mink production’

Internal Report 2004, no. 208 (in Danish)

The meeting hosted 10 presentations concerning 1) advantages and disadvantages of using FarmPilot in connection with feeding and the possibilities of increasing feed efficiency in theory and practice, 2) starch as a functional ingredient in mink feed and its effect on behaviour and production results, and 3) new knowledge of parturition, kit growth and transfer of vitamin E from the dam to her kits. Approximately 100 farmers, advisers, researchers and others participated in the meeting, and the presentations hosted were as follows:

Towards a more sustainable production of mink by means of individual FarmPilot feeding

M. Sønderup

Meeting at DIAS, Research Centre Foulum, 30 September 2004 on the subject ‘Research in relation to practical mink production’. Internal Report 2004, no. 208 (in Danish). 4 pp, 2 tables.

Individual feeding of mink kits during the growth period – better feed efficiency

S.H. Møller, V.H. Nielsen, B.K. Hansen

Most farmed mink in Denmark are fed close to the average ad libitum intake during the growth period, based on feed leftovers at farm, shed or row level. Variation in voluntary feed intake between male + female pairs is ignored apart from the distribution of feed leftovers to cages without feed left over from the day before. Technological development has facilitated individual feeding and

thus the possibility for true ad libitum feeding of mink. The variation in voluntary feed intake was studied in 174 male + female pairs of Scanbrown mink kits during 16 weeks from 11 weeks of age in July to 26 weeks of age in November. The feed allowance was adjusted Tuesday and Friday based on feed leftovers registered Monday + Tuesday and Thursday + Friday. The average feed intake was 44.3 kg per pair of kits equivalent to 395 g per day. The average weight gain was 2490 g per male + female pair. The average feed efficiency (g gain/kg feed) was 56 g/kg and in general, the feed efficiency increased with weight gain. The average difference between the lower and upper quartile of feed efficiency was 29% equal to an estimated difference in feed consumption of 15 kg for both quartiles to reach the average weight gain of 2.5 kg during the 16 weeks of growth. Compared to the normal feeding practice, individual ad libitum feeding provides the opportunity to utilise the full potential of the mink kits for growth and feed efficiency, and thereby for effective selection for these traits.

Meeting at DIAS, Research Centre Foulum, 30 September 2004 on the subject ‘Research in relation to practical mink production’. Internal Report 2004, no. 208 (in Danish). 7 pp, 2 figs, 3 tables, 5 refs. Authors’ abstract.

Growth curves of individually fed mink

V.H. Nielsen, S.H. Møller, B.K. Hansen, P. Berg

The effect of ad libitum feeding (AL), restricted feeding (RF), and farm feeding (FF) on weight

and growth rate is studied in lines of mink in a selection experiment. The AL- and RF-line are selected for high November weight. The FF-line is a control line. The investigation is made before selection is performed. The results show that the growth curves can be described by a fourth degree polynomial specific to line and sex. Significant differences are found between the AL-line and the RF-line for both November weight and overall growth rate ($P < 0.0001$). Body weight and growth rate are reduced in the RF-line compared to the AL-line. When the feeding results in lines with different weights it can be assumed that high November weight genetically seen not is the same trait in the lines. Thus, selection for high November weight under ad libitum and restricted feeding is expected to result in animals with different correlated characters e.g. feed efficiency.

Meeting at DIAS, Research Centre Foulum, 30 September 2004 on the subject 'Research in relation to practical mink production'. Internal Report 2004, no. 208 (in Danish). 5 pp, 2 figs, 6 refs. Authors' abstract.

Breeding in theory and practice and with a focus on individual feeding

J. Vistofte, P. Berg

Meeting at DIAS, Research Centre Foulum, 30 September 2004 on the subject 'Research in relation to practical mink production'. Internal Report 2004, no. 208 (in Danish). 9 pp, 3 refs.

New knowledge of parturitions in mink

M. Gade, J. Malmkvist

Early kit mortality is of a considerable size in mink production, and a reduction in the mortality would be an advantage. Based solely on kit counts, the mortality rates between birth and weaning average 20-30%; however, direct observations of births based upon video recordings 2002-2004 indicate that the real numbers are higher – at least as regards the one-year-old females examined. Based on direct observations of pregnant female mink before,

during and after birth as well as collection and autopsy of all the dead kits, in 2004 the purpose of the project was to study a number of factors of importance in relation to early kit mortality. In the study 84% of all the dead kits died within the first 24 hours after birth, and the percentage of stillborn kits was 42%. The duration of the births differed between the females (mean \pm sd.: 9 h 3 min \pm 6 h 8 min), and the duration had an effect on the number of kits that died within seven days after birth. The behaviour of the females before, during and after birth was analysed systematically, and the litters of females with high kit mortality rates were often left lying around compared to the litters of females with low kit mortality rates. The study demonstrated that the duration of birth as well as some, but not all the behavioural patterns of the female mink had an effect on early kit mortality. This knowledge is of importance in relation to future studies aiming to reduce the relatively high early kit mortality in mink.

Meeting at DIAS, Research Centre Foulum, 30 September 2004 on the subject 'Research in relation to practical mink production'. Internal Report 2004, no. 208 (in Danish). 10 pp, 2 figs, 5 tables, 2 pictures, 14 refs. Authors' abstract.

Transfer of vitamin E from mink mothers to kits via the milk

S. Krogh Jensen

Vitamin E (α -tocopherol) is a very important antioxidant for minks and beyond its function as an antioxidant in cell membranes vitamin E is very important for the development and maintenance of the immune system. Vitamin E is added to the feed as synthetic *all-rac*- α -tocopheryl acetate. The synthetic form consist of an equal amount of 8 stereoisomers of α -tocopherol, while α -tocopherol synthesized by nature always posses the RRR configuration. Several investigations have shown a higher utilization of the natural form of vitamin E compared to the synthetic form, caused by a biodiscrimination within the animals. In an experiment with lactating mink the transfer of the different isomers of α -tocopherol from feed to

mink, mink milk and further to the mink kits was studied. Fifteen Scanbrown female mink was included in the experiment, they were fed with traditional farm feed containing 60 mg *all-rac- α -tocopheryl acetate* per kg feed. Thus the natural isomer constituted only 16% of the α -tocopherol in the feed. Blood samples were taken in April before birth and 28 and 42 days after birth. Milk samples were taken at day 2 and 28 after birth. From the kits plasma and tissue samples was taken 28 days after birth. Analysis of the vitamin E content and of the distribution of the α -tocopherol stereoisomers showed that the natural isomer were dominating in plasma and milk from the mothers as well as in plasma and tissues from the kits. In heart muscle the natural isomer made up 60% of the total α -tocopherol content. Based on the relative abundance of the different stereoisomers it can be calculated that mink utilize RRR- α -tocopherol a factor 2.5 – 3 times better than *all-rac- α -tocopherol*.

Meeting at DIAS, Research Centre Foulum, 30 September 2004 on the subject 'Research in relation to practical mink production'. Internal Report 2004, no. 208 (in Danish). 4 pp, 3 tables, 2 refs. Authors' abstract.

Growth rate in mink kits - Effect of protein, fat and carbohydrate supply

R. Fink, A.-H. Tauson

The effect of dietary protein, fat and carbohydrate supply on growth rate of mink kits from parturition until 9 weeks of age, were measured by means of weekly weight recording. The kits (n=475 per dietary treatment) were raised under conventional farm conditions by dams fed ad libitum from parturition with one of 3 diets containing different energy ratios (% of metabolisable energy (ME)) between protein:fat:carbohydrate (high protein (HP): 60:35:5, medium protein (MP): 45:40:15 or low protein (LP): 30:45:25). Live weights 4 weeks post partum, where the kits' only source of nutrients is milk from the dams, were highest (P<0.05) in kits nursed by dams fed the LP diet, whereas live weights 9 weeks post partum were highest (P<0.05) among kits fed the MP diet. In

conclusions, live weights of the kits 4 weeks post partum indicated that dams fed the LP diet had the highest milk yield. However, during transition from milk to solid feed and after weaning, kits fed the HP and MP diet had higher growth rates, which may be caused either by the kits' lower ability to utilise the high carbohydrate content of the LP diet or, that they have a higher protein requirement. However, further experiments are needed to elucidate the actual nutrient requirement of mink kits during transition from milk to solid feed and at weaning.

Meeting at DIAS, Research Centre Foulum, 30 September 2004 on the subject 'Research in relation to practical mink production'. Internal Report 2004, no. 208 (in Danish). 5 pp, 5 figs, 1 table, 2 refs. Authors' abstract.

Carbohydrates as functional ingredients in mink feeds

Helle Nygaard Lærke

With increased focus on environmental, health and welfare issues in mink production there has been renewed interest in the use of carbohydrate rich feedstuffs in mink feeds.

Traditionally the term crude carbohydrate – calculated as the difference between content of dry matter and the sum of crude protein, fat and ash- is used. However, crude carbohydrate covers a range of different structures with different functionality and energy value.

Carbohydrates consist of mono-, di- and oligosakkarides, and polysaccharides that are digestible or non-digestible depending on their chemical structure.

Apart from differences in digestibility due to chemical composition and enclosure in a complex botanical matrix, carbohydrates also have different physico-chemical properties, affecting extract. The physico-chemical properties are not only affected by chemical structure but also physical rupture (milling) and heat treatment.

The carbohydrates are important as functional ingredients in the feed, regulating consistency and

binding water. Due to the dilution with other non-carbohydrate ingredients variation in physico-chemical properties in mink feeds containing different sources of carbohydrates is much smaller than the variation between the ingredients themselves. However, increasing water binding capacity of the carbohydrate source, generally leads to a strong impact of the amount of water addition to the diet.

Studies of gastrointestinal contents of mink fed various carbohydrate sources indicates that viscosity and water binding capacity in the gastrointestinal tract is only marginally influenced at fibre levels corresponding to levels in a standard feed mix for the growing-furring period.

Meeting at DIAS, Research Centre Foulum, 30 September 2004 on the subject 'Research in relation to practical mink production'. Internal Report 2004, no. 208 (in Danish). 13 pp, 5 figs, 4 table, 15 refs. Author's abstract.

Feeding mink – effects on behaviour and welfare

S.W. Hansen, B.M. Damgaard, T.N. Clausen

The diurnal rhythm of juvenile mink fed ad libitum and restricted rations (10% below farm average), respectively, showed that the animals were active at sunrise, at feeding, and at sunset. The mink fed restricted rations were less active at sunrise and more active just before feeding than the mink fed ad libitum. The mink fed restricted rations seemed to have an expectation of the time of feeding in that they increased their activity before the expected time of feeding and this high level of activity was maintained until they were actually fed. Such an increase in the level of activity was not seen in the mink fed ad libitum. Stereotypies constituted a considerable part of the increased level of activity in mink fed restricted rations. By adding increased amounts of barley or fibre products to the feed and thus reducing the energy content, it is possible to slim mink without increasing the levels of activity and stereotypy. If the content of fibres in the feed is increased, the time without food is reduced and this is likely to contribute to a reduction in the levels of activity and stereotypy in mink.

Meeting at DIAS, Research Centre Foulum, 30 September 2004 on the subject 'Research in relation to practical mink production'. Internal Report 2004, no. 208 (in Danish). 7 pp, 6 figs, 1 table, 5 refs. Authors' abstract.

Feeding of mink in the winter period. Effect on reproduction

T. Clausen, S.W. Hansen

In the winter periods 2003 and 2004 we each year used 3 groups, consisting of 178 black mink females, to investigate the effect fibres in the feed on the time without feed, the stereotypic behaviour of the females and their reproductive results. The control group each year was fed a typical grower feed (energy distribution, protein:fat:carbohydrates; 30:52:18). In 2003 we used a control group and two groups with 7.4 % and 12.9 % husk meal from barely. In 2004 we used a control group, a group with 10 % citrus pectin offal and a group with addition of the amino acid tryptophan (up to a total of 0,30 g digestible Trp / 100 kcal). Each of the three groups received the same amount of energy per mink per day. Trial feed was fed from late Dec. to Feb. 24. After that, feed from the local feedkitchen was fed to all groups.

In 2003 it was concluded that high fibre feed reduced the time spent without eating and the occurrence of stereotypies in mink. However, feeding mink high fibre feed during the winter period had no negative effect on the number of kits per fertile female.

In 2004 it was concluded, that citrus pectin offal and tryptophan in January had no influence on the female's time without feed and her stereotypic behaviour, probably because the feed reduction was too high. In February we found that citrus pectin offal in the feed and to a lesser extent tryptofan reduced the time without feed. However the reduced time without feed did not reduce stereotypic behaviour, so the taste of these products is probably more important for the reduction in time without feed than satiety.

The products had no negative effect on the reproduction results, and they could not reduce stereotypic behaviour.

Females eating fast in January and February are those females that loose much weight in the same period. These females also are low in weight, eat fast and have stereotypic behaviour.

Meeting at DIAS, Research Centre Foulum, 30 September 2004 on the subject 'Research in relation to practical mink production'. Internal Report 2004, no. 208 (in Danish). 11 pp, 6 figs, 6 tables, 26 refs. Authors' abstract.

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