Waltham International Symposium: Pet Nutrition Coming of Age

Estimation of Iodine Status in Cats[1,2]

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EXPANDED ABSTRACT

KEY WORDS: • *iodine* • *cat* • *cat food* • *iodine status* • *iodine excretion* • *iodine requirement*

Feline hyperthyroidism is the most common endocrine disorder of middle-aged to old cats in the United States. In Germany, the latest investigations have shown increasing feline hyperthyroidism (1,2). The role of iodine in feline hyperthyroidism is still not clear. A deficient or excess level of dietary iodine has been suggested by several authors as an important factor in the development of feline hyperthyroidism (3). Analyses from other countries have shown that iodine levels in prepared cat foods vary widely (4,5). Recommended iodine levels have been reported by several authors; however, figures disagree by a factor of 10 to 30 (4–8). To get more information about the iodine supplied by commercial cat foods available in Germany, iodine was measured in 92 prepared cat foods. In addition, data were collected during a feeding study investigating iodine intake and excretion in the cat, to look for a suitable variable to estimate iodine status and to check hitherto existing iodine requirement figures.

MATERIALS AND METHODS

The study consisted of two parts. In part 1, 92 prepared complete cat foods were purchased at supermarkets and analyzed for iodine content. In part 2, a balance trial with increasing iodine content in the food was carried out.

Food analysis

The iodine content was analyzed in 92 feline commercial complete foods (74 canned and 18 dry foods from 27 different manufacturers). The prepared cat foods were bought at local supermarkets and thus represent the current cat food preparations available in Germany. Additionally, the dry matter (DM[4]) content of each preparation was determined and the metabolizable energy (ME) content was calculated (9). The determination of the iodine content was replicated four to eight times in each product, whereas the variability in iodine concentrations within a single brand or product was not measured.

Feeding study

The feeding study lasted 54 d with a preperiod of 7 d, six feeding periods of 7 d each and a postperiod of 5-d duration. For eight adult, healthy cats (European Shorthair, 5 males and 3 females) with increasing iodine supplementation (0, 12, 25, 50, 75 and 150 μg iodine/kg body weight (BW)/24 h) in addition to their normal ration (40.8 μg iodine/kg BW/24 h) the renal and fecal excretion of iodine was determined. The cats were 1.5 to 8 y of age and the average weight was 5.1 ± 0.9 kg. The cats were kept together in groups except for the collection periods and for feeding. The diet (prepared cat food, 0.34 MJ ME/100 g wet weight, 3500 μg iodine/kg DM) was allocated based on the energy requirement of the cats (0.22 MJ ME/kg BW), which resulted in constant body weight. For iodine supplementation (aqueous solution of potassium iodate) the meal feeding technique was used. Samples (urine and feces, 24 h each) were taken the last day of each period and were analyzed for iodine content (urine, feces), dry matter (feces) and creatinine (urine).

To determine the iodine content of the foods and feces, a modified analytical method was used. This method is based on an alkaline ashing procedure followed by iodine determination using the Sandell–Kolthoff reaction (10). These results were compared with the results obtained from neutron activation analysis (NAA): the percentage recovery rate of our method in relation to those from NAA were in the range of 82 to 128% and, therefore, our measuring technique was considered to be satisfactory.

For the determination of the urine samples, a WHO-recommended method for the iodine analysis of human urine was used (11). The method, also based on the Sandell–Kolthoff reaction, was slightly modified to accommodate a wider range of iodine concentrations and supplied reliable results for the iodine content of feline urine.

The study was approved by the Regierung von Oberbayern, which

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[4] Abbreviations used: BW, body weight; DM, dry matter; I, iodine; IDD, iodine deficiency disorder; WHO, World Health Organization.

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is the appropriate authority according to German law on animal welfare (Deutsches Tierschutzgesetz).

RESULTS AND DISCUSSION

Food analysis

The range of the iodine content in prepared cat foods varied by a factor of 30 (minimum: 218; maximum: 6356 μg iodine/kg DM) (**Fig. 1**). The iodine content of the dry foods varied from 473 to 3181 μg iodine/kg DM (28.1 to 163.2 μg iodine/MJ ME), whereas the iodine content in the canned foods was in the range of 218 to 6356 μg iodine/kg DM (11.4 to 290.4 μg iodine/MJ ME). The mean iodine content in the dry foods was 1917 ± 958 μg iodine/kg DM (104.0 ± 49.6 μg iodine/MJ ME) and in the canned foods, 1942 ± 1390 μg iodine/kg DM (95.9 ± 67.7 μg iodine/MJ ME).

According to the nutritional recommendations by Meyer and Heckötter (6) (50 μg/kg BW/24 h for maintenance), an average-weight cat of 4 kg BW and an energy requirement of 0.22 MJ ME/kg BW needs about 227 μg iodine/MJ ME. Only very few of the investigated cat foods met these iodine requirement figures, whereas according to the minimal requirement figures of the National Research Council (NRC) and the Association of American Feed Control Officials (AAFCO) (350 μg iodine/kg DM with 16.7 MJ ME/kg DM for maintenance and 20.9 MJ ME/kg DM for growing kittens, respectively), nearly all of the foods met the nutritional minimum requirement figure of the cat.

Whether the cat foods with highest or lowest iodine concentrations represent a risk to feline thyroid health is still not clear. Tarttelin et al. (12) showed in a short-term feeding study that cat food of widely differing iodine content results in a dramatic thyroid response, as measured by serum-free thyroxine. Comparison with these findings, the results of a long-term study of the same group support the concept that adaptive mechanisms tend to maintain the blood levels of thyroid hormone within the normal range in chronic states of high or low dietary iodine (13). As already known, chronic excess or lack of iodine may eventually lead to goiter formation in exposed individuals. It is interesting that recent investigations (14) in Germany have shown alterations (nodular hyperplasia and adenoma) in extracted thyroids of deceased cats in a surprisingly high number (nearly 50%) by ultrasonographic and histologic measurements. A hypothesis was made that the high occurrence in this cat population of that kind of alterations, which are one of the substantial causes of feline hyperthyroidism, is analogous to the etiology of nodular hyperplasia and adenoma in humans attributed to a chronically deficient iodine supply. Therefore, these findings may indicate that long-term feeding of cat foods with very low iodine concentration eventually represents a risk to feline thyroid health.

On the other hand, we do not know anything about the bioavailability of iodine in cat foods. Cat foods very high in iodine are possibly enriched with iodine-containing pigments for food (e.g., erythrosine). Normally, the digestibility of these pigments is very low and iodine is thus only insignificantly bioavailable.

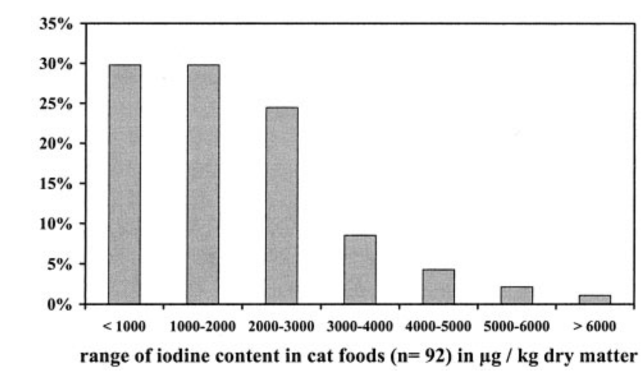

FIGURE 1 Distribution of iodine content of 92 commercial cat foods (complete dry and canned foods) in μg/kg dry matter expressed as percentage.

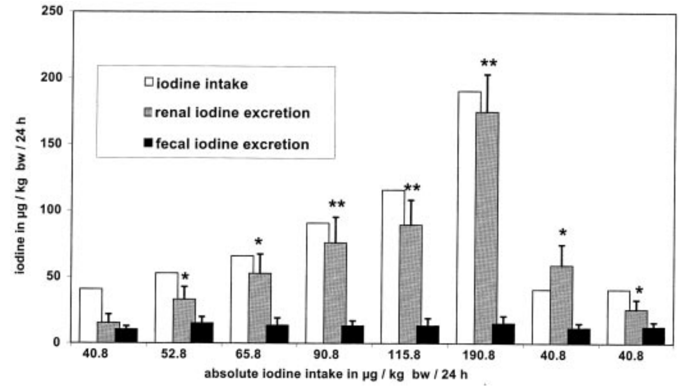

FIGURE 2 Iodine intake, renal and fecal iodine excretion (means ± SD) of eight cats during six 7-d periods of the feeding study with increasing amounts of iodine and the 5-d postperiod (d 2 and d 5) without additional iodine supplementation. *$P < 0.05$; **$P < 0.001$ in relation to period 1.

Feeding study

Figure 2 shows iodine balance in the feeding study. Fecal iodine excretion was independent of iodine intake, whereas renal iodine excretion increases with iodine intake. During the complete study, mean fecal iodine excretion was 13 ± 4 μg/kg BW/24 h. This figure may roughly represent fecal endogenous losses. A significant linear correlation was found between the iodine intake and the renal excretion of iodine ($r = 0.995$; $P < 0.0001$). Extrapolation of renal iodine excretion to zero iodine intake gave a figure of 6 μg iodine/kg BW/24 h. This can be considered to represent endogenous renal losses. Total endogenous losses amount to nearly 20 μg iodine/kg BW/24 h. Renal excretion indicates a bioavailability of iodine that is close to 100%. Therefore about 20 μg iodine/kg BW/24 h should be sufficient for an appropriate iodine balance. As **Table 1** shows, the ratio of iodine to creatinine in urine is

TABLE 1

Correlation of iodine intake and renal iodine excretion in eight adult, healthy cats

Renal iodine excretion (urine samples: $n = 64$)	Correlation of iodine intake and renal iodine excretion r	P
Iodine in μg/kg BW/24 h	0.964	<0.001
Iodine in μg/L	0.952	<0.001
Iodine in μg/mg creatinine	0.995	<0.0001

correlated to iodine intake. This ratio might be useful in assessing iodine status under clinical conditions.

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