The taurine requirement of the adult cat

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ABSTRACT

The taurine requirement of adult cats was investigated using a purified amino-acid diet containing various levels of added taurine. From the results of two earlier investigations it appeared that the minimum daily taurine requirement was between 35 and 56 mg for an adult cat. The results of the present study show that a taurine intake of about 10 mg/kg bodyweight/day is sufficient to maintain adult cats in adequate taurine status. This value is in agreement with the previous estimate and approximates to a taurine concentration of 500 mg/kg of dry matter in a commercial cat food.

INTRODUCTION

Research over the last five or six years has established the amino-sulphonic acid taurine as an essential nutrient for the cat (Hayes, Carey & Schmidt, 1975; Schmidt, Berson & Hayes, 1976; Berson *et al.*, 1976). Taurine is essential because the cat is unable to synthesize sufficient quantities from cysteine to meet its requirements. Diets low in or devoid of taurine result in low levels in plasma, liver and retina (Sturman *et al.*, 1978). Abnormalities in the electroretinogram can occur after several months (Schmidt *et al.*, 1977).

We have investigated the taurine requirements of young adult cats using a purified amino-acid diet similar to that developed at the University of California (Hardy, Morris & Rogers, 1977). In the first experiment (Barnett and Burger, 1980) cats were fed either control (0·15 per cent taurine) or taurine-free diets for eleven months. Plasma taurine concentrations decreased rapidly in cats on taurine-free diets and about 50 per cent of these animals showed a feline central retinal degeneration (FCRD) distinctive in its ophthalmoscopic appearance and progressive; nevertheless visual acuity was apparently unaffected. Control cats showed no retinal changes. In the second investigation (Burger & Barnett, 1980) the same

cats were regrouped and fed taurine levels of 0·1, 0·05 and 0·02 per cent in the same amino-acid diet to obtain an estimate of the lowest satisfactory taurine intake. After 30 weeks feeding the results of the second study indicated that the minimum daily taurine requirement was between 35 and 56 mg per cat. The present investigation is a continuation of that study to confirm the preliminary results and to determine the minimum adequate taurine intake for the typical adult cat.

MATERIALS AND METHODS

The cats used in the investigation were of mixed breed, born and reared at the Animal Studies Centre. They were housed individually in metabolism cages in a controlled temperature environment (20°C ± 2°C) and fed one meal per day of 70 g of amino-acid diet. Food was available for 24 hours, except when blood samples were to be taken for taurine analysis the next day. Water was available *ad libitum*. At the start of this study the cats were approximately two years old. Plasma taurine concentrations were analysed in blood samples taken from the cephalic vein of cats fasted for 16 hours. The cats' retinas were examined by direct ophthalmoscopy. The methods used were as described previously (Barnett & Burger, 1980).

RESULTS AND DISCUSSION

The two groups (each of five cats) used for this investigation had been fed the control diet (adequate taurine) in the first experiment. In the second study they were fed either 0·02 or 0·05 per cent taurine for 30 weeks. No retinal changes had been observed up to this time.

Plasma taurine values for week 30 onwards are shown in Fig. 1. Cats receiving 0·02 per cent taurine showed a low plasma taurine concentration which was similar to the values obtained in the second investigation from weeks 12 to 16 onwards. After 43 weeks one of the cats in this group showed a typical early sign of FCRD (Fig. 2); at 45 weeks this group was removed from the test and fed standard commercial cat food.

Plasma taurine levels for cats receiving 0·05 per cent taurine showed some variation from one measurement to the next but were consistently higher than those obtained from the cats fed 0·02 per cent taurine. Nevertheless, they were substantially lower than values obtained previously for diets containing 0·1 or 0·15 per cent taurine, which averaged 100 nmole/g or more. As with the 0·02 per cent taurine group, the plasma taurine values recorded for these cats from week 30 onwards were similar to those obtained after 12 to 16 weeks. A plasma taurine 'plateau' appeared to be established after about three to four months on a particular dietary taurine level. We continued to feed 0·05 per cent taurine for about one year after the first appearance of this plateau value (67 weeks in all), and at the end of this period none of the cats showed FCRD. At 67 weeks these cats were fed 0·075 per cent taurine to observe the effect on plasma taurine values. There was a large

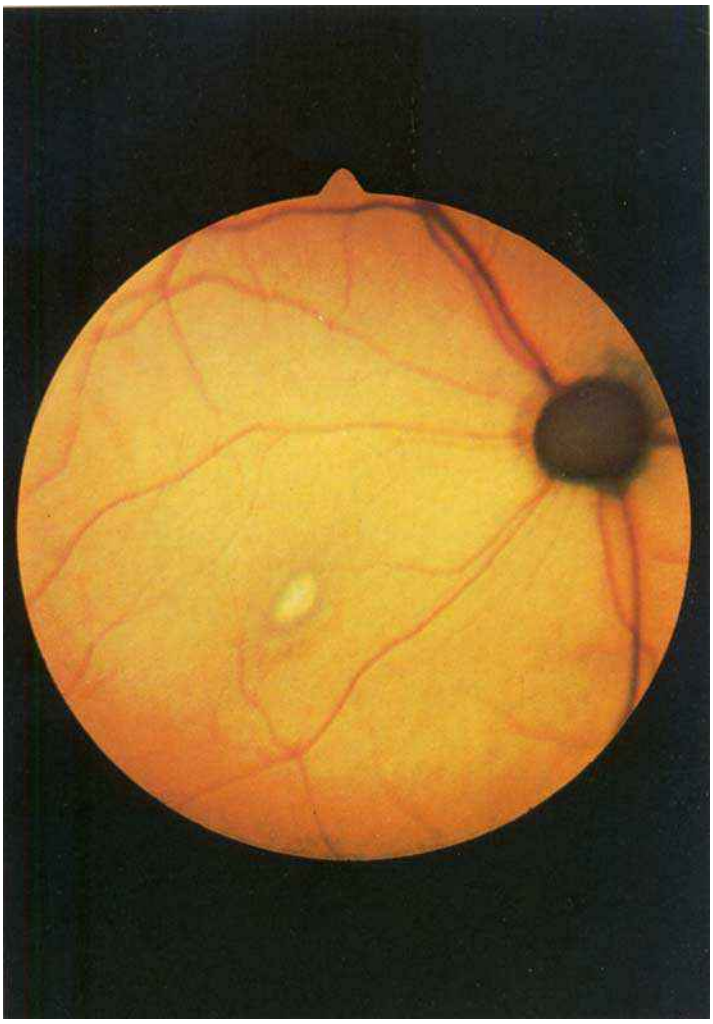

FIG. 2. Retinal photograph showing early stage of the typical taurine deficiency lesion in one cat which had received 0·02 per cent taurine for 43 weeks.

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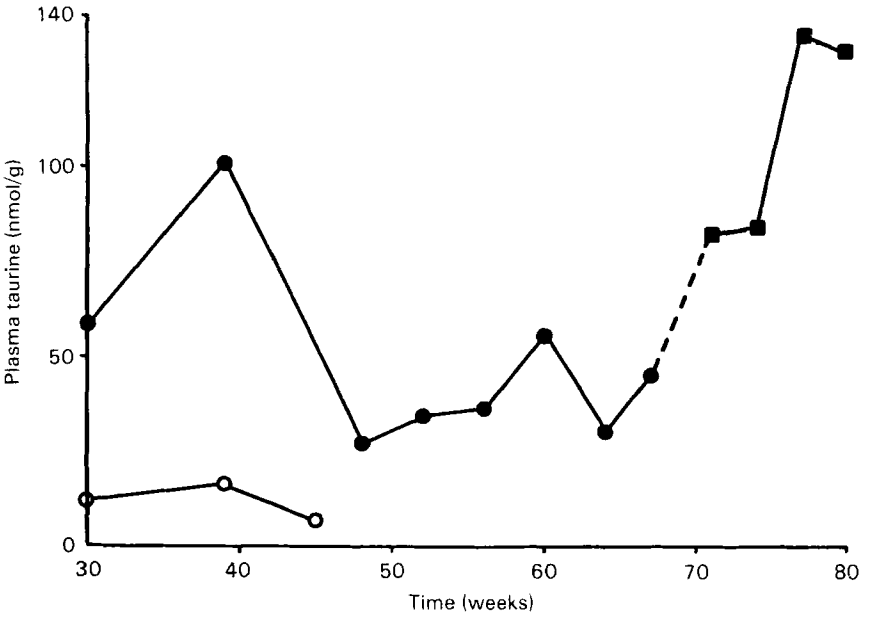

FIG. 1. Mean plasma taurine concentrations for groups of five cats fed 0·02 per cent taurine (○) or 0·05 per cent taurine (●). At 67 weeks the latter group was fed 0·075 per cent taurine (■).

increase after four weeks with a further increase after ten weeks (Fig. 1). The values obtained after ten and twelve weeks were similar to those obtained for control cats in the two previous investigations. As might be expected no retinal changes were observed in these cats at the completion of the study. Comparison of the overall mean plasma taurine values for each dietary treatment shows significant differences between 0·05 per cent taurine and the other two treatments (Table 1).

In previous studies we showed that cats fed taurine-free diets developed FCRD and had decreased concentrations of plasma taurine. Cats fed diets containing 0·1

TABLE 1. Plasma taurine concentrations for cats receiving various dietary taurine levels

Dietary taurine (%)	Feeding period (weeks)	Plasma taurine* (nmole/g)	P†
0·02	30–45	11·1 ± 7·7 ($n = 5$)	<0·01
0·05	30–67	48·4 ± 17·0 ($n = 5$)	—
0·075	67–79·5	108·0 ± 27·0 ($n = 5$)	<0·01

* Plasma taurines stated as mean ± s.d.; n = number of cats.

† Significant differences between 0·05 per cent taurine and other diets calculated using Student's t test.

per cent taurine or more had normal plasma taurine levels and showed no signs of FCRD. It is clear both from the low plasma values and more importantly, the FCRD observed in one of the cats on 0·02 per cent taurine that this represents too low a dietary level. A concentration of 0·05 per cent taurine did not result in FCRD even when fed for over a year. Nevertheless it did not increase plasma taurine concentrations to values similar to those obtained for the control diets. In one of the previous investigations (Burger & Barnett, 1980) we found that a diet containing 0·05 per cent taurine, even after 27 weeks feeding, did not increase plasma taurine levels in cats previously fed a taurine-free diet. Schmidt *et al.* (1977) reported that in taurine-deficient cats retinal taurine accumulation comparable to normal levels occurred at a plasma taurine concentration of 40 nmole/g. The mean plasma taurine concentration of cats on the 0·05 per cent taurine diet was slightly higher than this value (Table 1) which, together with the lack of retinal changes, suggests that this dietary level of taurine is just enough to maintain normal (i.e. non-depleted) cats in adequate taurine status. When 0·075 per cent taurine was fed plasma taurine showed a relatively rapid increase to a mean value (108 nmole/g) which was similar to control values obtained in previous studies. To incorporate a reasonable margin of safety it is the latter diet that should be considered to provide the minimum safe taurine intake for the cat, particularly in view of the small number of cats in the group. The taurine intake (mean ± s.d.) of the five cats on this diet over the 12·5 weeks it was fed was 10·2 ± 1·8 mg/kg bodyweight/day (about 41 mg for a typical 4 kg adult cat). This is in agreement with the earlier estimate of a minimum daily requirement of between 35 and 56 mg/cat. An intake of 10·2 mg/kg/day approximates to a concentration of 500 mg/kg of dry matter in a commercial cat food. This calculation assumes an active adult cat requires 85 kcal of metabolizable energy (ME) per kg bodyweight per day and the ME content of the food is 4 kcal/g of dry matter (NRC, 1978). Although this recommendation is based on results obtained with young adult cats and it is possible that the requirements of cats at other stages of the life cycle (e.g. growth) may be higher, the safety margin incorporated into the recommendation should ensure an adequate intake throughout the animal's life. It must also be remembered that taurine deficiency takes a relatively long time to produce FCRD. A transient fall in intake, for example over a few weeks, would be unlikely to cause adverse effects assuming the dietary taurine level did not fall to zero.

Our studies were carried out using a basal diet which contained 0·89 per cent and 0·64 per cent methionine and cystine respectively. These levels were originally selected using the knowledge of amino-acid requirements in the cat that was available at the time and were based on levels that we had found to give good growth in kittens. Since the time of the first experiment the sulphur amino-acid requirements of the cat have been more closely defined and this may affect the taurine requirement (Anderson *et al.*, 1979). It has recently been suggested that with dietary concentrations of methionine plus cystine below 1·55 per cent the taurine requirement of the cat may be a function of the sulphur amino-acid content

of the diet (O'Donnell III, Rogers & Morris, 1981). As this concentration is approximately the same as that in our basal diet it may explain why the addition of extra cystine to the taurine-free diet did not result in a large increase in plasma taurine nor a reduction in FCRD (Barnett & Burger, 1980). It might also be argued that the taurine requirement will be higher in a diet containing lower (but still nutritionally adequate) levels of methionine and cystine. Our suggested satisfactory taurine intake must be viewed in the light of this new evidence which is a further reason for the incorporation of a margin of safety in the recommendation.

ACKNOWLEDGEMENTS

The authors wish to thank the staff of the Animal Studies Centre for invaluable technical assistance. They are also grateful to the Analytical Studies Laboratory of Pedigree Petfoods for carrying out the plasma taurine analyses.

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