High Dietary Taurine Effects on Feline Tissue Taurine Concentrations and Reproductive Performance[1]

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ABSTRACT The reproductive performance and outcome of kittens was determined for female cats fed 0.05, 0.2 or 1% taurine. No adverse effects of high taurine diets were noted in the adults or offspring, and the reproductive performance was slightly better than that of females fed the normal (0.05% taurine) diet. Body weight at birth and brain weight at weaning were significantly greater in the very high taurine group than in the normal taurine group, although the greatest growth rate was achieved by the normal taurine group. The concentration of taurine in milk of lactating females was substantially higher in cats fed the higher taurine diets. Brain of adult cats was resistant to increases in brain taurine concentrations, as was brain of newborn cats. However, brain of juvenile cats responded to higher dietary taurine intake with increased taurine concentrations. These results indicate that the higher taurine content in cat foods recently introduced for prevention of feline dilated cardiomyopathy should have no adverse effects over a prolonged period on health and reproduction of cats. J. Nutr. 122: 82–88, 1992.

INDEXING KEY WORDS:

- *cats* • *high taurine diet*
- *reproduction* • *taurine*

The dietary importance of taurine for cats has received a great deal of attention in recent years, mostly with regard to the effects of insufficient dietary taurine (see 1–4 for reviews). Recent reports (5–7) implicated taurine deficiency in feline dilated cardiomyopathy and demonstrated its reversal by nutritional taurine therapy if treated in time. This successful treatment led to the fortification of commercial cat foods (which already contained taurine) with additional taurine. Although this fortification has resulted in the virtual disappearance of this condition, no systematic studies have been reported on the long-term effects of a high taurine diet. The results of such a study are reported here.

MATERIALS AND METHODS

Female domestic cats raised in the Institute for Basic Research (IBR) colony and vaccinated against feline viral rhinotracheitis, panleukopenia virus and calici virus (modified live virus) (Pitman-Moore, Mundelein, IL) were fed a completely defined purified diet (taurine-free) (BioServ, Frenchtown, NJ) containing 0.05, 0.2 or 1% taurine for at least 6 mo prior to mating (8). All were bred as follows: when in estrus they were caged with a male for 1 wk; conception was defined as the middle of this period. Male cats were fed a nonpurified diet, except for the interval of cohabitation with females fed the different diets. Pregnancies were confirmed by palpation and in some cases also by X-ray 4–6 wk after conception. Kittens were weaned onto the same diet consumed by their mother. Data from females fed the 0.05% taurine diet were collected over the past 10 y, and data from the females fed the 0.2 and 1% taurine diets were obtained over a 3-y period in each case.

The birth and twice-weekly weights of all kittens were determined. Maternal samples of blood (weekly) and milk (twice-weekly) were taken beginning within 48 h of birth, without food deprivation and under light sedation as previously described (8). The protein concentration in milk was measured by the method of Bradford (9).

Kittens were killed at the time of weaning (8 wk after birth), 12 wk after birth or 20 wk after birth by first overdosing with sodium pentobarbitol (Nembutal, Abbott Laboratories, North Chicago, IL) fol-

[1]Supported by National Institutes of Health grant HD-16634 and by the New York State Office of Mental Retardation and Developmental Disabilities.

0022-3166/92 $3.00 Received 26 April 1991. Accepted 9 July 1991.

TABLE 1

Outcome of pregnancies from females fed a purified diet supplemented with various amounts of taurine

Diet (% taurine)	Pregnancies	To term	Kittens stillborn[1]	Kittens live[1]	Survivors[2]	Percentage of pregnancies to term	No. kittens/ term pregnancy[3]	No. survivors/ term pregnancy
0.05	73	64	12	218	154	88	3.6	2.41
0.2	24	20	9	65	44	83	3.7	2.20
1.0	38	37	4	125	99	97	3.5	2.68

[1]From term pregnancies.
[2]Alive at weaning (8 wk after birth).
[3]Includes live and stillborn kittens.

lowed by exsanguination by cardiac puncture. Tissues were immediately dissected and processed immediately or frozen on dry ice until processed by homogenizing in 5% trifluoroacetic acid and centrifuging to obtain a clear supernatant fluid. This extract was stored at −80°C until derivatized with phenylisothiocyanate and separated by reverse-phase HPLC (10). The apparatus used consisted of a Spectra Physics (Piscataway, NJ) 8800 ternary HPLC pump and a 4.6 mm × 25 cm BakerBond C-18 column (Baker, Phillipsburg, NJ) maintained at 34°C. The taurine derivative was detected at 254 nm with an LDC SpectroMonitor D (Milton Roy, Riviera Beach, FL) and quantified using Nelson Analytical (Cupertino, CA) 2600 chromatography software with an IBM PC-AT (New York, NY). A Waters 712 WISP (Milford, MA), with refrigeration unit set at 5°C, allowed the automatic analysis of up to 96 samples.

Some live kittens were killed at birth as described for the 8-wk-old kittens. When this was done, these pregnancies and any subsequent growth data on remaining kittens were not used in calculating the reproductive data presented because of possible bias caused by artificially reducing the number of kittens in a litter.

Adult female cats were killed by overdosing with sodium pentobarbitol (Nembutal, Abbott Laboratories) followed by exsanguination by cardiac puncture after at least four pregnancies and at least 2 wk after the last kittens were weaned. Tissues were removed and processed as described for the kittens. These studies were approved by the IBR animal welfare committee.

Results from multiple groups of animals were analyzed using one-way ANOVA variance ("oneway" Stata, Computing Resource Center, Los Angeles, CA) and if significance was found ($P \leq 0.05\%$), individual groups were compared using Student's t test (protected t test). Results from two groups of animals were analyzed directly using Student's t test.

TABLE 2

Body and brain weights of newborn and 8-wk-old kittens from females fed a purified diet supplemented with various amounts of taurine[1]

Diet (% taurine)	Newborn		8-Wk-old	
	Body	Brain	Body	Brain
	g			
0.05	105.6 ± 30.3	4.86 ± 1.14 (23)	749 ± 142	21.7 ± 1.8 (28)
0.2	111.6 ± 23.8	4.44 ± 1.10 (11)	722 ± 141	22.1 ± 0.9 (13)
1.0	113.4 ± 20.8[2]	5.41 ± 0.90[3] (9)	699 ± 147[4]	23.0 ± 1.0[5] (10)

[1]Values are means ± SD of the body weights of all kittens used in this study and of the number of brain samples in parentheses. Significance was determined using Student's t test.
[2]Significantly greater than 0.05% taurine group ($P < 0.01$).
[3]Significantly greater than 0.2% taurine group ($P < 0.05$).
[4]Significantly smaller than 0.05% taurine group ($P < 0.05$).
[5]Significantly greater than 0.05 and 0.2% taurine groups ($P < 0.05$).

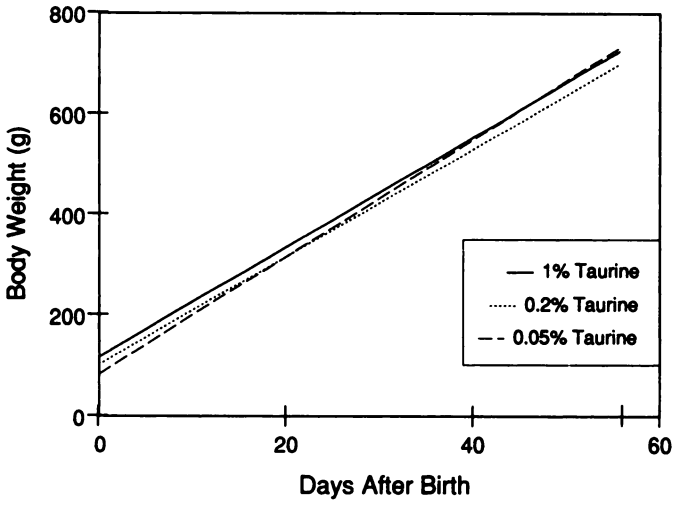

FIGURE 1 Growth curves of kittens from females fed 0.05, 0.2 or 1.0% taurine. The curves are derived from the twice-weekly weights of all kittens included in this study using a standard computer program for linear regression. Correlation coefficients are 0.87, 0.85 and 0.86, respectively.

RESULTS

The high taurine diet had no effect on appetite, food consumption, weight gain or estrus cycle of the adult females. The reproductive performance was slightly better in the females fed the highest taurine diet; the proportion of pregnancies reaching term and the number of kittens surviving to weaning per term pregnancy were slightly greater for cats fed 1% taurine than for those fed 0.05 or 0.2% taurine, although none of these trends was statistically significant (Table 1). The growth rates of kittens from females fed the different amounts of taurine were not significantly different, although the greatest rate was achieved by kittens from females fed the 0.05% taurine diet (Fig. 1). This observation is supported by examination of the birth weights and 8-week-old weights of all kittens in this study (Table 2). The kittens from females fed the greatest amount of taurine weighed more at birth than those from females fed 0.05% taurine, whereas the reverse was true at 8 wk of age. The brain weights of kittens from mothers fed 1% taurine were greater than those of the other diet groups, both at birth and at 8 wk of age. The concentration of taurine in the milk of the lactating females was greater in those fed the highest

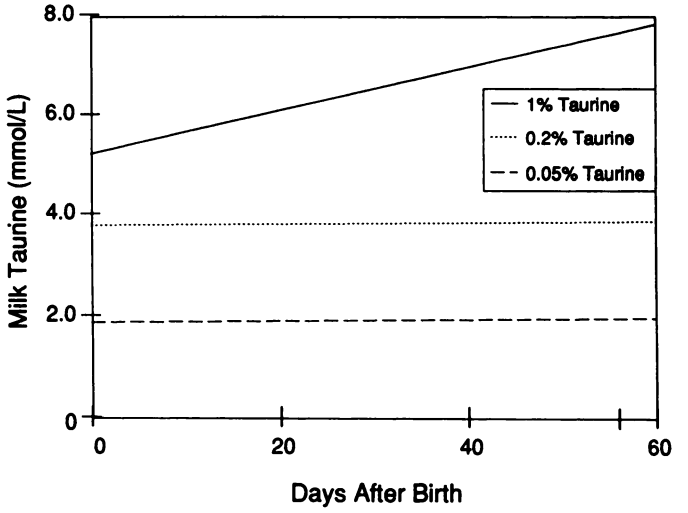

FIGURE 2 Concentration of taurine in milk of lactating females fed 0.05, 0.2 or 1% taurine. The curves are derived from the twice-weekly milk samples from all females included in this study using a standard computer program for linear regression. Correlation coefficients are 0.03, 0.03 and 0.05, respectively.

TABLE 3

Concentration of taurine in tissues and fluids of adult cats fed a purified diet supplemented with 0.05 or 1% taurine[1]

Tissue	Dietary taurine 0.05%	1%
	μmol/g wet wt	
Retina	42.4 ± 4.4	42.2 ± 9.1
Tapetum	11.1 ± 3.6	13.3 ± 5.3
Lens	6.64 ± 2.30	7.50 ± 1.50
Liver	8.50 ± 3.33	17.2 ± 6.3[2]
Kidney	5.15 ± 1.91	12.3 ± 2.9[2]
Lung	8.28 ± 2.60	11.8 ± 2.1[2]
Spleen	7.34 ± 2.44	11.0 ± 1.9[2]
Adrenal	12.5 ± 3.6	14.0 ± 3.7
Heart	12.0 ± 2.7	15.7 ± 3.2
Gastrocnemius	5.84 ± 1.02	9.92 ± 1.59[2]
Biceps	6.35 ± 1.62	11.4 ± 3.1[2]
Triceps	7.83 ± 2.96	13.4 ± 5.4[2]
Diaphragm	5.49 ± 2.33	6.56 ± 1.25
Plasma, *μmol/L*	127 ± 53	429 ± 172[2]
Occipital lobe	2.28 ± 0.88	2.36 ± 0.48
Frontal lobe	2.19 ± 0.49	3.01 ± 0.87
Temporal lobe	1.92 ± 0.88	2.55 ± 0.57
Parietal lobe	2.32 ± 0.76	2.68 ± 0.69
Cerebellum	3.14 ± 0.80	3.76 ± 0.78
Superior colliculus	1.65 ± 0.44	1.89 ± 0.46
Inferior colliculus	1.56 ± 0.47	1.79 ± 0.69
Hippocampus	2.19 ± 0.64	3.41 ± 0.51[2]
Corpus callosum	2.67 ± 0.57	3.34 ± 0.77
Thalamus	1.55 ± 0.29	1.94 ± 0.43
Pons	1.48 ± 0.38	1.65 ± 0.37
Medulla	1.47 ± 0.47	2.22 ± 1.14
Olfactory bulb	7.43 ± 1.89	7.88 ± 2.00
Lateral geniculate nucleus	1.95 ± 0.71	2.17 ± 0.50
Optic tract	2.25 ± 0.84	2.93 ± 0.92
Optic nerve	3.29 ± 1.08	4.20 ± 0.90
Spinal cord	1.03 ± 0.41	1.55 ± 0.37
Sciatic nerve	1.14 ± 0.40	1.43 ± 1.21

[1]Values are means ± SD for 10 to 14 cats.
[2]Significantly greater than 0.05% taurine group ($P < 0.05$), Student's t test.

TABLE 4

Concentration of taurine in tissues and fluids of newborn kittens from mothers fed a purified diet supplemented with 0.05, 0.2 or 1% taurine[1]

Tissue	Dietary taurine		
	0.05%	0.2%	1%
	μmol/g wet wt		
Retina	19.6 ± 5.9	23.0 ± 2.4	20.1 ± 5.1
Lens	15.2 ± 2.0	16.8 ± 3.2	14.2 ± 4.0
Liver	9.37 ± 3.95	11.3 ± 3.8	12.9 ± 3.0[2]
Kidney	6.58 ± 1.97	7.80 ± 3.27	7.95 ± 1.59
Lung	8.54 ± 2.31	9.99 ± 3.16	9.35 ± 2.19
Spleen	5.81 ± 1.61	6.49 ± 2.90	5.98 ± 1.04
Heart	12.9 ± 4.7	15.9 ± 5.4	13.3 ± 3.5
Gastrocnemius	9.36 ± 3.45	11.8 ± 3.6	11.2 ± 2.2
Biceps	9.58 ± 2.51	10.2 ± 5.6	9.41 ± 4.52
Triceps	9.35 ± 2.15	10.4 ± 3.2	11.7 ± 3.7
Diaphragm	6.54 ± 2.03	6.44 ± 2.40	8.41 ± 2.40[2,3]
Stomach contents	0.87 ± 0.73	0.84 ± 0.44	1.73 ± 0.56[2,3]
Plasma, *μmol/L*	155 ± 71	387 ± 126[2]	437 ± 185[2]
Occipital lobe	7.77 ± 2.15	8.53 ± 2.52	7.78 ± 1.58
Frontal lobe	8.84 ± 0.83	8.61 ± 1.75	7.98 ± 1.55
Cerebellum	7.17 ± 1.71	8.32 ± 3.74	7.95 ± 1.15
Superior colliculus	5.50 ± 1.15	5.98 ± 1.41	7.64 ± 4.21
Thalamus	6.22 ± 0.51	6.60 ± 1.31	6.89 ± 0.76
Olfactory bulb	11.7 ± 2.9	12.3 ± 4.2	11.5 ± 3.1
Spinal cord	3.88 ± 0.76	3.97 ± 1.05	3.93 ± 0.67

[1]Values are means ± SD for 12 to 18 kittens.
[2]Significantly greater than 0.05% taurine group ($P < 0.05$), Student's t test.
[3]Significantly greater than 0.2% taurine group ($P < 0.05$), Student's t test.

amounts of dietary taurine and generally increased during lactation (Fig. 2). The concentration of protein in milk did not vary substantially among groups or during lactation; mean values (± SD) were 56.8 ± 17.0, 61.8 ± 15.9 and 60.1 ± 16.1 g/L for mothers fed 0.05, 0.2 and 1% taurine, respectively.

The tissue taurine concentrations of adult cats fed the 1% taurine diet for a mean (± SD) of 29.7 ± 4.8 mo were generally greater than those of cats fed the 0.05% taurine diet for 32.3 ± 7.1 mo (Table 3). The greatest differences were observed in the soft tissues ($P < 0.05$): liver, kidney, lung and spleen. Significant differences were observed in gastrocnemius, biceps and triceps, in plasma, and only in hippocampus of the brain regions.

Very few significant differences in taurine concentrations were noted in newborn kittens from mothers fed 0.05, 0.2 or 1% taurine (Table 4). Only liver, diaphragm, stomach contents and plasma values were significantly different. No brain regions showed significantly different taurine concentrations.

In 8-wk-old kittens there were many statistically significant differences in tissue taurine concentrations among the diet groups (Table 5). These changes were quite different from those observed in adult cats. Of the soft tissues, only kidney had significantly greater taurine concentration in kittens from mothers fed high taurine diets than in those from mothers fed 0.05% taurine. The concentration of taurine in most brain regions of kittens from mothers fed 1% taurine were greater than those of the other diet groups.

At 12 wk after birth (Table 6) and at 20 wk after birth (Table 7) most of the tissues from the 1% taurine group had significantly greater taurine concentrations than those from the 0.05% taurine group.

DISCUSSION

Several studies have indicated that a normal level of taurine in purified diets for cats is ~0.05% by weight (1, 8, 11, 12). The major conclusion from the present studies is that feeding a very high taurine diet (approximately 20-fold normal) even for years had no apparent ill effects on adult female cats. If anything, such cats had a slightly better reproductive performance than cats fed the normal diet, which contained 0.05% taurine. Kittens born to mothers fed the high taurine diet generally flourished, having greater birth weights, and newborn and 8-wk-old brain weights, than comparable kittens from mothers fed 0.05% taurine. Body weight at 8 wk, however, was

TABLE 5

Concentration of taurine in tissues and fluids of 8-wk-old kittens from mothers fed a purified diet supplemented with 0.05, 0.2 or 1% taurine[1]

Tissue	Dietary taurine		
	0.05%	0.2%	1%
		μmol/g wet wt	
Retina	45.6 ± 10.8	40.0 ± 12.2	43.2 ± 14.9
Tapetum	8.22 ± 2.34	7.94 ± 2.87	9.75 ± 3.06
Lens	16.0 ± 4.2	14.5 ± 6.3	16.5 ± 1.8
Liver	13.1 ± 4.4	12.7 ± 5.0	13.1 ± 3.0
Kidney	5.45 ± 2.06	9.00 ± 2.96[2]	10.3 ± 1.8[2]
Lung	9.73 ± 3.58	9.65 ± 4.80	10.5 ± 1.6
Spleen	7.18 ± 3.17	8.26 ± 2.81	8.30 ± 2.43
Pancreas	3.64 ± 0.86	4.34 ± 1.18	3.12 ± 1.76
Adrenal	9.55 ± 1.38	6.32 ± 2.59	5.83 ± 1.59
Heart	15.1 ± 1.1	18.7 ± 8.8	16.5 ± 7.7
Gastrocnemius	8.63 ± 2.50	14.8 ± 7.6[2]	17.6 ± 5.0[2]
Biceps	10.6 ± 4.8	12.5 ± 6.0	13.7 ± 3.7
Triceps	9.47 ± 3.51	14.7 ± 7.5[2]	15.4 ± 4.0[2]
Diaphragm	8.02 ± 2.68	8.09 ± 2.96	8.06 ± 2.11
Stomach contents	0.88 ± 0.12	1.73 ± 0.51[2]	4.34 ± 1.24[2,3]
Plasma, μmol/L	72.4 ± 37.0	341 ± 119[2]	364 ± 151[2]
Urine, mmol/L	0.3 ± 0.1	11.6 ± 4.5[2]	23.8 ± 9.4[2,3]
Occipital lobe	5.60 ± 1.82	5.58 ± 1.69	7.31 ± 1.61[2,3]
Frontal lobe	4.79 ± 0.91	5.16 ± 2.09	5.58 ± 0.91[2]
Temporal lobe	5.23 ± 0.97	5.01 ± 1.34	6.17 ± 0.90[2,3]
Parietal lobe	4.67 ± 1.22	4.93 ± 1.60	6.13 ± 1.22[2]
Cerebellum	5.55 ± 1.49	5.95 ± 1.93	7.44 ± 0.70[2,3]
Superior colliculus	4.24 ± 1.34	4.15 ± 1.52	4.76 ± 0.93[2]
Inferior colliculus	3.14 ± 0.70	3.74 ± 2.32	3.71 ± 0.47[2]
Hippocampus	5.03 ± 1.31	4.51 ± 1.00	5.59 ± 0.83[3]
Corpus callosum	4.87 ± 1.11	5.44 ± 1.55	6.95 ± 1.23[2,3]
Thalamus	3.71 ± 1.10	4.01 ± 1.05	4.30 ± 0.49[2]
Pons	3.03 ± 0.95	2.77 ± 0.74	3.09 ± 0.26
Medulla	2.65 ± 0.37	2.91 ± 0.93	3.26 ± 0.58
Olfactory bulb	8.37 ± 1.06	7.20 ± 2.86	8.50 ± 1.44
Lateral geniculate nucleus	4.44 ± 1.26	5.04 ± 1.52	5.58 ± 0.96[2]
Optic tract	4.49 ± 1.48	6.16 ± 2.14	6.28 ± 1.27
Optic nerve	6.40 ± 1.18	6.62 ± 1.75	7.99 ± 1.22
Spinal cord	3.29 ± 0.91	2.82 ± 1.09	3.09 ± 0.77
Sciatic nerve	3.26 ± 0.81	5.70 ± 2.93[2]	4.10 ± 0.38[2]

[1]Values are means ± SD for 25–30 kittens (0.05% taurine group) and for 10–15 kittens (0.2 and 1% taurine groups).
[2]Significantly greater than 0.05% taurine group ($P < 0.05$), Student's t test.
[3]Significantly greater than 0.2% taurine group ($P < 0.05$), Student's t test.

smaller. A previous report (13) noted that rats drinking a 5% solution of taurine had a smaller weight gain than rats drinking water without taurine, and appeared lethargic but otherwise healthy.

Adult female cats fed the high taurine diet over this extended period had greater taurine concentrations in soft tissues and some muscles, but not in retina or brain, with the single exception of hippocampus. As expected, plasma taurine concentrations were much greater in cats fed the high taurine diets, as were milk taurine concentrations during lactation. The milk taurine concentration in lactating females fed the 1% taurine diet increased ~50% from birth to weaning at 8 wk. Somewhat surprisingly, despite spending the entire gestation period in a taurine-enriched environment, only liver, diaphragm, plasma and stomach contents of newborn kittens had greater concentrations of taurine. By weaning, at 8 wk after birth, kittens from mothers fed the high taurine diet had greater taurine concentrations in a number of tissues, including most brain regions, than kittens from mothers fed the diet containing 0.05% taurine. Notable exceptions were in the eye tissues, retina, tapetum, lens, optic nerve and optic tract, and olfactory bulb. Kittens from mothers fed the 1% taurine diet and themselves weaned onto the same diet had significantly greater taurine concentrations in most tissues at 12 and 20 wk after birth than did similar

TABLE 6

Concentration of taurine in tissues and fluids of 12-wk-old cats fed a purified diet supplemented with 0.05 or 1% taurine[1]

Tissue	Dietary taurine 0.05%	1%
	μmol/g wet wt	
Retina	44.3 ± 6.1	50.6 ± 2.6
Tapetum	8.23 ± 2.43	12.8 ± 2.1[2]
Lens	11.6 ± 5.7	17.4 ± 6.2
Liver	12.5 ± 4.1	20.1 ± 3.4[2]
Kidney	6.65 ± 3.49	14.2 ± 1.5[2]
Lung	11.1 ± 2.2	14.9 ± 2.3[2]
Spleen	7.60 ± 2.00	11.2 ± 2.1[2]
Adrenal	9.07 ± 2.87	10.7 ± 2.0
Heart	13.5 ± 4.2	18.7 ± 5.3
Gastrocnemius	11.1 ± 5.1	19.7 ± 2.9[2]
Biceps	10.1 ± 3.7	19.3 ± 3.2[2]
Triceps	12.6 ± 4.1	20.9 ± 4.0[2]
Diaphragm	6.42 ± 1.72	11.4 ± 1.3[2]
Plasma, *μmol/L*	96 ± 87	651 ± 277[2]
Occipital lobe	3.09 ± 0.83	5.36 ± 0.85[2]
Frontal lobe	3.68 ± 0.37	5.80 ± 0.91[2]
Temporal lobe	3.51 ± 0.31	5.23 ± 0.65[2]
Parietal lobe	3.70 ± 0.35	5.46 ± 0.87[2]
Cerebellum	4.01 ± 0.43	8.18 ± 1.04[2]
Superior colliculus	2.36 ± 0.27	4.16 ± 0.52[2]
Inferior colliculus	2.39 ± 0.16	3.38 ± 0.31[2]
Hippocampus	3.51 ± 0.21	4.55 ± 0.42[2]
Corpus callosum	3.68 ± 0.37	7.22 ± 1.36[2]
Thalamus	2.83 ± 0.44	3.69 ± 0.24[2]
Pons	1.89 ± 0.25	3.50 ± 1.73
Medulla	1.91 ± 0.23	3.10 ± 0.40[2]
Olfactory bulb	7.52 ± 0.89	8.62 ± 1.01
Lateral geniculate nucleus	2.77 ± 0.41	4.55 ± 0.45[2]
Optic tract	3.43 ± 0.23	5.65 ± 0.95[2]
Optic nerve	5.22 ± 0.20	6.01 ± 2.11
Spinal cord	2.55 ± 0.73	4.01 ± 0.71[2]
Sciatic nerve	3.54 ± 0.88	4.64 ± 1.86

[1]Values are means ± SD for 5 to 8 cats.
[2]Significantly greater than 0.05% taurine group ($P < 0.05$), Student's t test.

TABLE 7

Concentration of taurine in tissues and fluids of 20-wk-old cats fed a purified diet supplemented with 0.05 or 1% taurine[1]

Tissue	Dietary taurine 0.05%	1%
	μmol/g wet wt	
Retina	50.4 ± 2.3	42.6 ± 12.4
Tapetum	17.2 ± 7.3	14.5 ± 4.4
Lens	16.9 ± 1.8	16.5 ± 1.8
Liver	9.16 ± 2.92	18.2 ± 0.8[2]
Kidney	5.12 ± 1.05	13.9 ± 1.4[2]
Lung	14.9 ± 10.3	15.2 ± 2.0
Spleen	8.53 ± 0.50	11.4 ± 0.8[2]
Adrenal	12.0 ± 2.4	18.0 ± 9.9
Heart	10.7 ± 5.8	15.9 ± 2.1
Gastrocnemius	8.75 ± 1.55	15.9 ± 4.1[2]
Biceps	9.38 ± 1.35	14.4 ± 2.8[2]
Triceps	10.9 ± 1.7	15.7 ± 1.1[2]
Diaphragm	4.14 ± 0.78	8.55 ± 0.63[2]
Plasma, *μmol/L*	218 ± 186	477 ± 302
Occipital lobe	2.57 ± 0.33	3.95 ± 0.66[2]
Frontal lobe	2.92 ± 0.34	4.25 ± 0.81[2]
Temporal lobe	2.94 ± 0.42	4.05 ± 0.58[2]
Parietal lobe	2.46 ± 0.56	4.21 ± 0.52[2]
Cerebellum	3.35 ± 0.28	5.83 ± 0.69[2]
Superior colliculus	1.51 ± 0.73	2.74 ± 0.48[2]
Inferior colliculus	1.25 ± 0.39	2.22 ± 0.28[2]
Hippocampus	2.29 ± 0.11	4.18 ± 0.22[2]
Corpus callosum	3.04 ± 0.47	4.35 ± 0.40[2]
Thalamus	1.63 ± 0.31	2.32 ± 0.31[2]
Pons	1.28 ± 0.31	2.74 ± 1.48
Medulla	1.20 ± 0.20	2.27 ± 0.54[2]
Olfactory bulb	10.2 ± 3.2	9.42 ± 0.32
Lateral geniculate nucleus	1.59 ± 0.62	3.00 ± 0.22[2]
Optic tract	1.88 ± 0.73	3.50 ± 0.16[2]
Optic nerve	4.36 ± 2.71	4.76 ± 0.15
Spinal cord	1.18 ± 0.30	2.43 ± 0.04[2]
Sciatic nerve	3.81 ± 3.30	2.72 ± 0.92

[1]Values are means ± SD for 4 to 6 cats.
[2]Significantly greater than 0.05% taurine group ($P < 0.05$), Student's t test.

kittens from the 0.05% taurine group. Notable exceptions were in the retina, lens, optic nerve, olfactory bulb and sciatic nerve.

Taken together, these results indicate that the fully mature cat brain is largely resistant to significant increases in taurine concentration when cats are fed a high taurine diet over a long period of time, as might be expected. Less expected was the observation that the fetal cat brain was also resistant to increases in taurine concentration, despite the immaturity of the blood brain barrier during gestation. Even more surprising in light of this observation was the apparent decrease in resistance to increased brain taurine concentrations in young juveniles, at 8, 12 and 20 wk after birth, when brain development has been largely completed and the blood brain barrier is fully mature. The high dietary intake provided to the kittens during lactation had a greater impact than the in utero environment of the mothers fed the high taurine diet. It would be of interest to know when the adult property of resistance to increased brain taurine concentrations is reached, and whether other compounds besides taurine can increase in juvenile kitten brain.

A number of reports in the literature have associated dietary taurine metabolism with dietary protein content. Mature rhesus monkeys do not seem to be dependent on dietary taurine to maintain their body taurine pools although rhesus monkey infants do seem dependent [14]] unless their diet is deficient in protein [15, 16]. Supplementary dietary taurine

given to lactating mice fed a protein-deficient diet increased neonatal survival, but had no effect on lactating mice fed a protein-sufficient diet (17). Further data obtained from this same animal model showed that a limited period of undernutrition had a permanent effect on the levels of certain amino acids, including taurine, in the adult cerebellum, and that these changes were modified by taurine supplementation (18). Weanling rats fed a low protein diet had reduced taurine concentrations in plasma and retina and abnormal retinal function (depressed a and b waves in the electroretinogram) (19). Dietary taurine supplementation normalized the taurine concentrations but resulted in further impairment of visual function. Injection of taurine, but not of sodium chloride or valine, into fertilized chicken eggs resulted in increased taurine concentrations in heart and brain, and hatchlings with severe ataxia, reduced muscle strength and impaired motor coordination (20). Our studies have provided no evidence of ill effects produced by prolonged feeding of high taurine diets to adult female cats or on their offspring, although these diets contained normal amounts of protein for felines.

ACKNOWLEDGMENTS

We are grateful to Sharon Mathier for art work, to Ann Parese for secretarial assistance and to members of the IBR Animal Colony Facility for practical help throughout this study.

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